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CONTENTS

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NOTES ON MUCORALES—I
Observations on Absidia

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An account is given of species of *Absidia* maintained in the CBS collection. Cultures were studied on the basis of morphology, temperature relations and mating results. Synonymy is concluded for *A. atrospora*, *A. griseola*, and *A. hyalospora* with *A. blakesleeana*; *A. hesseltinei* with *A. corymbifera*. Mating activity was strong in the subgenus *Mycocladus*, weak or absent in the subgenus *Absidia*, under the test condition. A key to the species is included.

All strains of *Absidia* Tiegh. in the CBS collection, maintained in a lyophilized condition since 1962 or later, were checked for viability and identity. The opportunity was taken to commence a general survey of the genus.

A monograph of the genus *Absidia* was published by Hesseltine & Ellis (1964, 1966) and Ellis & Hesseltine (1965, 1966). More recent studies on *Absidia* isolates are by Váňová (1980, 1983, 1985). She presented well documented and profusely illustrated papers on representatives of the genus in Czechoslovakia. Unfortunately I am not familiar with the Czech language used in descriptions and discussions; a key to the treated species, in English, was added.

All available cultures were compared with the original descriptions of the species and with the descriptions of Hesseltine & Ellis (l.c.). The subdivision of the genus, as proposed by Hesseltine & Ellis, in the subgenera *Mycocladus* (Beauverie) Hesselt. & J.J. Ellis and *Absidia* Tiegh. is followed. A secondary grouping of species in the subgenera is used to show further relationships. The taxonomic positions of (new) species not included in the above monograph were studied. Mating experiments to trace eventual synonymy of morphologically similar species were part of the study.

The value of colony colour is discussed, as it may cause confusion in identification of *Absidia* species. Special attention is also given to the occurrence of giant-cells in the mycelium of, in particular, *Absidia blakesleeanus* Lendn. and *A. corymbifera* (Cohn in Lichtheim) Sacc. & Trott.

CLOSELY RELATED TAXA

The genera *Apophysomyces* Misra and *Gongronella* Ribaldi were studied along with *Absidia* to decide their status in relation to *Absidia*. *Apophysomyces* is close to *Absidia* in general

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morphology. Zygospores are unknown. The single species *Apophysomyces elegans* Misra & al., shows optimal sporulation at 33 °C, the growth maximum is at 40 °C. At 25 °C growth is slow, sporulation poor and sporangia often sterile. For sporulation yeast powder-soluble starch agar (Emerson's medium) is better than malt agar. This species is treated here as distinct from *Absidia*.

Gongronella with the species *G. butleri* (Lendn.) Peyronel & Dal Vesco and *G. lacrispora* Hesselt. & J.J. Ellis is regarded as a separate genus.

Mucor faisalabadensis.—The general morphology of the species *Mucor faisalabadensis* Mirza & al. place it between *Mucor* Mich.: Fr. and *Absidia*. Its apophysate piriform sporangia are characteristic of species of *Absidia*. As in the subgenus *Mycocladus* Hesselt. & J.J. Ellis, *M. faisalabadensis* has unadorned suspensors, gradually enlarging sporangiophores which show a darker colouring just below the sporangia, as well as giant-cells in the substrate. The temperature-growth relation (15–40 (and 45 °C)) differs from *Mucor*, in which only few species grow and sporulate well at 40 °C and only slowly at 15 °C, e.g. *Mucor indicus* Lendn., *M. prayagensis* Mehrotra & Nand ex Schipper and *M. variabilis* Sarbhoy.

It is not characteristic of *Absidia* having sporangiophores which arise from the substrate, stolons and rhizoids absent and distinctly stellate zygospores as seen, in species of *Mucor*.

Methods

As a routine, cultures were grown on two media (beerwort agar, potato-dextrose agar) and at various temperatures (between 15 °C and 45 °C).

In addition strains were contrasted with intraspecific and/or related interspecific partners.

The media used are: (i) beerwort agar containing 4% sugar, (ii) potato-dextrose agar (PDA) containing 20 g dextrose (1 l), (iii) beerwort agar with 20 or 40% saccharose added, (iv) czapek agar containing 30 g saccharose (1 l). For the preparation of media see 'CBS course of mycology' (Gams & al., 1987).

Colony colour in species of Absidia

Traditionally, *Absidia glauca* Hagem and *A. coerulea* Bainier are distinguished by the colour of their young colonies; bluish-green in the former, versus bluish-purple in the latter.

Unfortunately, in practice the choice is often problematic. The colour is more intense on PDA, rice and bread, than on beerwort agar, more distinct in slant cultures then in petri dish cultures. No influence of temperature (15 °C, 25 °C, 30 °C) was observed. Aging cultures of both species are grey. Of the strains studied, only a few showed distinctive tinges in the young colonies, the majority were greyish and indistinctive.

Tentative tests to extract and identify the colouring-matter by thin-layer-chromatography were unsuccessful. It seems that the compound is cellwall-bound (aerial hyphae; personal communication Dr G.W. van Eijk).

The closely related, slightly smaller, *A. californica* J.J. Ellis & Hesselt. does not have a greenish or bluish tinge in young colonies, but is greyish initially. Aerial hyphae beset with

dark droplets as occur in *A. glauca, A. coerulea,* and *A. macrospora* Váňová were not observed in *A. californica*. *Absidia macrospora* has a greenish tinge when young.

Another group of related species in which greenish and bluish violet tinges occur is *Absidia cylindrospora* Hagem, *A. spinosa* Lendner, and *A. anomala* Hesselt. & J.J. Ellis. The changeable nature of the colouring in these species is shown below.

Absidia cylindrospora (6 strains) on PDA at 15°C bluish-grey, on PDA at 30°C yellowish grey, on beerwort agar at 25°C brownish or greenish grey.

Absidia spinosa (4 strains) on PDA at 15°C, one strain brownish grey, one strain greenish grey, and two strains bluish grey; on beerwort agar (25°C) all were brownish-greenish grey.

Absidia anomala, the single strain available was violet under all conditions of this study.

A third group producing bluish-greyish pigments consists of *Absidia blakesleeana* Lendn., *A. atrospora* Naganishi & Hirahara, *A. hyalospora* (Saito) Lendn., *A. griseola* Naganishi & Hirahara, *A. hesseltinei* Mehrotra, and *A. corymbifera* (Cohn in Lichtheim) Sacc. & Trott. Young colonies on beerwort agar (25°C) are bluish grey in *A. blakesleeana* and *A. griseola,* deep bluish grey in *A. atrospora* and *A. hyalospora,* pale grey in *A. corymbifera* and *A. hesseltinei*.

When these osmo-tolerant species were grown on high sugar concentrations, it was observed that colonies on beerwort agar with 20% and 40% additional saccharose (25°C) showed a slightly different colouring: bluish grey in part of the *A. blakesleeana* strains and in *A. hyalospora,* slightly darker in *A. griseola,* deep bluish grey in other strains of *A. blakesleeana,* while deep violet-grey in *A. atrospora*.

So, colony colour is a useful characteristic in species of *Absidia,* but variable with conditions and not consistently present.

The genus Absidia

Absidia was characterized according to van Tieghem (1876) by stolons with rhizoids; by sporangiophores bearing apophysate piriform sporangia arising, mostly in small groups, from the elevated parts of the stolons (not opposite rhizoids); and by zygospores enveloped in appendages from the suspensors.

Since the characterization of the genus *Absidia* by van Tieghem (l.c.), material has been described fitting the above asexual features, but lacking appendages on suspensors. See Hesseltine & Ellis (1964) for a historical review of name changes and divisions of the genus.

The asexual condition is in most species the usual appearance; transferring species with an unadorned sexual state to a different genus might be very confusing for identifications, even though distinguishing secondary characters exist (see below).

In this paper the subdivision of the genus after Hesseltine & Ellis (1964) is followed: subgenus *Mycocladus* (Beauverie) Hesselt. & J.J. Ellis for species with free zygospores, and subgenus *Absidia* for species with zygospores enveloped in appendages from the suspensors, as described by van Tieghem (l.c.).

Furthermore, species belonging to the subgenus *Absidia* have been grouped according to similarity in shape of sporangiospores, arrangement of sporangiophores, maximum temperature for growth, and temperature range for sporulation. These groups are indicated here with A, B, C, etc.

KEY TO THE SPECIES OF ABSIDIA

1a. Colonies 40 mm or less in diam., in a month at 25 °C; sucker-like branches in the substrate mycelium (species of uncertain position) 2
b. Colonies usually filling petridish (90 mm diam.) in a few days; sucker-like substrate hyphae absent . 3
2a. Homothallic zygospores present at 25 °C ..... *A. parricida* (Fig. 6a–c)
b. Zygospores absent (unknown) ..... *A. zychae* (Fig. 6d–f)
3a. Determinate growth of the fertile aerial hyphae, generally ending in a large piriform sporangium; good growth at 36 °C 4
b. Indeterminate growth of the fertile aerial hyphae; typically no growth at 36 °C. 7
4a. Stolons and rhizoids absent; sporangiophores arising from the substrate ..... (excluded from *Absidia*)
b. Stolons and rhizoids present; sporangiophores arranged in random fashion on the stolons; whorls or verticils not obvious ..... (subgenus *Mycocladus*) 5
5a. Sporangiospores subglobose, partly with roughened walls; at 45 °C growth insignificant to absent . 6
b. Sporangiospores subglobose to ellipsoidal or ellipsoidal-cylindrical, smooth; at 45 °C rather good growth *A. corymbifera* (Fig. 2)
6a. Sporangiospores globose to broadly ellipsoidal, 5–10 µm diam. *A. blakesleeana* var. *atrospora* (Fig. 1q–t)
b. Sporangiospores subglobose, mostly 5–6 µm diam ..... *A. blakesleeana* (Fig. 1)
7a. Sporangiospores globose or short ellipsoidal 8
b. Sporangiospores cylindrical or lacrimoid-cuneate 12
8a. Sporangiospores globose-short ellipsoidal or slightly angular; sporangiophores both of the usual *Absidia*-type and single, short sporangiophores in series along stolons (subgenus *Absidia* group F) *A. repens* (Fig. 5n–h)
b. Sporangiospores globose; sporangiophores of one type only ..... (subgenus *Absidia* group A) 9
9a. Columellae with projections of intricate shape ..... *A. macrospora* (Fig. 3j, k)
b. Columellae with a single apical projection 10
10a. Sporangia up to 35 µm diam. ..... *A. californica* (Fig. 3d–f)
b. Sporangia up to 50 µm diam. 11
11a. Young colonies bluish ..... *A. coerulea* (Fig. 3a–c)
b. Young colonies greenish (see text) ..... *A. glauca* (Fig. 3g–i)
12a. Sporangiospores lacrimoid-cuneate ..... (subgenus *Absidia* group E) *A. cuneospora* (Fig. 5f, g)
b. Sporangiospores cylindrical with rounded ends 13
13a. Sporangiospores variable in size (3–6 × 2–3.5 µm) (subgenus *Absidia* group C) *A. heterospora* (Fig. 5a–c)
b. Sporangiospores up to 5 × 2.5 µm 14
14a. At 30 °C no growth; optimal at 15 °C ..... (subgenus *Absidia* group D) *A. psychrophila* (Fig. 5d, e)
b. At 30 °C growth; optimal at 20 °C–24 °C ..... (subgenus *Absidia* group B) 15
15a. Homothallic zygospores present 16
b. Zygospores absent 18
16a. Suspensors unequal, mono-appendiculate 17
b. Suspensors equal, bi-appendiculate ..... *A. spinosa* var. *biappendiculata*
17a. Zygospores up to 70 µm diam. ..... *A. spinosa* (Fig. 4j–m)
b. Zygospores up to 80(–120) µm diam. ..... *A. anomala* (Fig. 4n–p)
18a. Whorls of 5 or more sporangiophores quite common 19
b. Whorls of more than 3 sporangiophores rare 20
19a. Sporangiophores unequal in length ..... *A. fusca* (Fig. 4g–i)
b. Sporangiophores equal in length ..... *A. pseudocylindrospora* (Fig. 4d–f)
20a. Sporangiospores 4–5 × 2–2.5 µm ..... *A. cylindrospora* var. *rhizomorpha*
b. Sporangiospores 4 × 2 µm 21
21a. Colonies (malt extract agar, 25 °C) rather pale brownish-greenish grey ... *A. cylindrospora* (Fig. 4a–c)
b. Colonies (malt extract agar, 25 °C) dark brownish-greenish grey ..... *A. cylindrospora* var. *nigra*

ABSIDIA SUBGENUS **MYCOCLADUS** (BEAUVERIE) HESSELT. & J.J. ELLIS

Zygospores not with appendaged suspensors.

Other characters.—Growth determinate with aerial hyphae generally ending in a large piriform sporangium. Sporangiophores arranged in random fashion on the stolons; whorls or verticils not obvious. Tendency to grow at elevated temperatures and also to produce zygospores at higher temperatures (typically at 31°C). (After Hesseltine & Ellis, 1964).

Since zygospores are unknown in species of which only one strain is available, the additional characters, such as growth at 37°C., were used to indicate the taxonomic position.

Absidia parricida Renner & Muskat ex Hesselt. & J.J. Ellis, a homothallic species with unadorned zygospores was not considered here, in view of its psychrophilic nature and other features at variance with the above.

ACCEPTED SPECIES

Absidia atrospora Naganishi & Hirahara, *A. blakesleeana* Lendn., *A. griseola* Naganishi & Hirahara, and *A. hyalospora* (Saito) Lendn., with subglobose sporangiospores, some with roughened walls; at 45°C growth insignificant to absent, at 36°C growth and sporulation.

Absidia corymbifera (Cohn in Lichtheim) Sacc. & Trott. (syn: *A. ramosa* (Lindt) Lendn.) and *A. hesseltinei* Mehrotra, with subglobose to ellipsoidal or ellipsoidal-cylindrical, smooth sporangiospores; and at 45°C rather good growth.

MATERIAL STUDIED (all cultures from the CBS)

Absidia blakesleeana: CBS 100.28, 100.36, and 102.36. — Tentatively designated as *A. blakesleeana* ('A aff. *blakesleeana*'): CBS 647.78, 648.78, and 420.70.

Absidia atrospora: CBS 518.71.

Absidia griseola: CBS 519.71.

Absidia hyalospora: CBS 173.67.

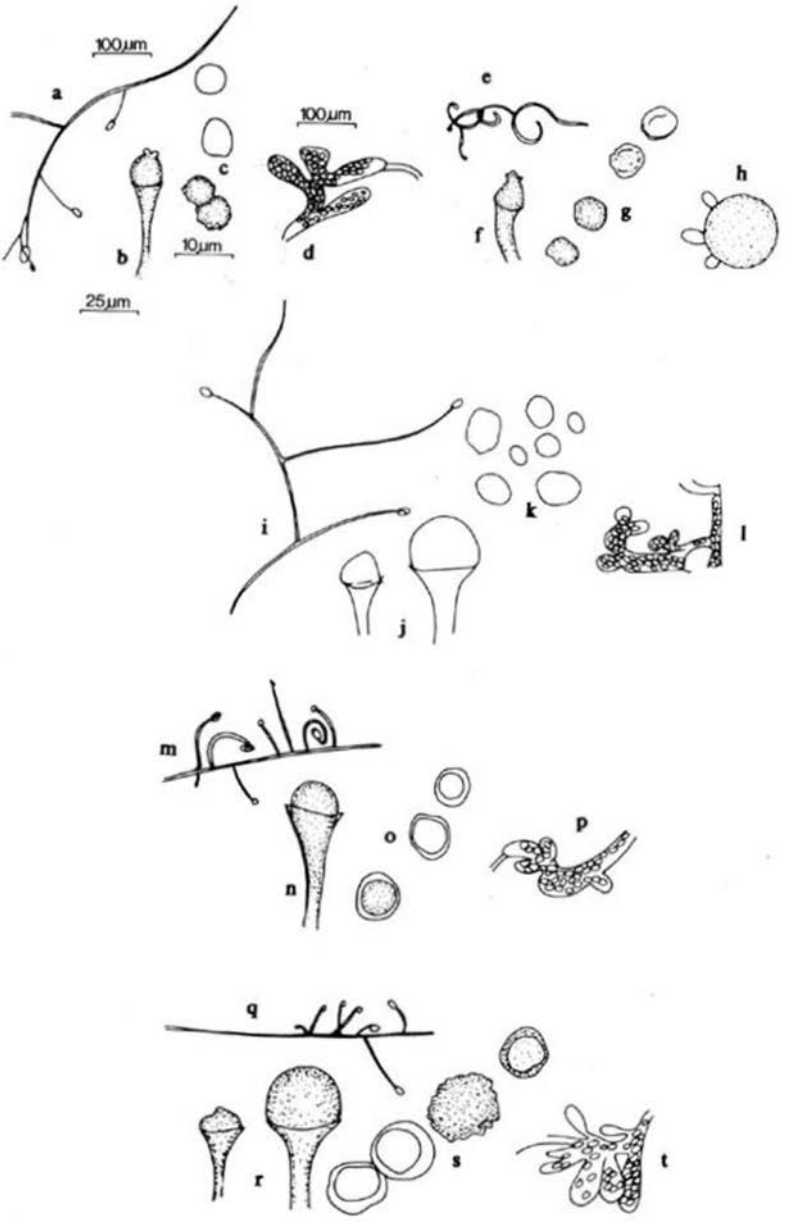
Absidia corymbifera: CBS 100.17, 100.24, 100.31, 103.35, 102.48, 100.49, 100.51, 101.51, 100.55, 101.55, 269.65, 270.65, 271.65, 582.65, 291.66, 713.74, 429.75, 223.78, and 649.78.

Absidia hesseltinei: CBS 958.68.

TEMPERATURE-GROWTH REACTIONS

Slant cultures (beerwort agar) were placed at 15°C, 36°C, and 45°C immediately after inoculation. Results were noted after three days for 36°C and 45°C, and after twelve days in the case of cultures at 15°C. The slants had been inoculated with a tiny piece of inoculum (substrate with airial mycelium and spores) and a streak of the needle upwards. It was found that both at 15°C and 45°C sporulation might occur at the very edge of the slant, though little or no growth could be observed near the inoculum. This indication of possible osmophily was checked by culturing the strains on beerwort agar with 20% and 40% saccharose respectively, at 25°C.

At 45°C there was rather good growth in all strains of *A. corymbifera* and *A. hesseltinei*, slightly restricted, low growth in *A. griseola*, no growth near the inoculation piece, but sporulation at the very edge of the slant, in *A. blakesleeana*, and no growth at all in *A.* aff. *blakesleeana*, *A. atrospora*, and *A. hyalospora*.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At 36°C all strains studied showed growth and sporulation. The strains of *A.* aff. *blakesleeana* grew rather slowly and sporulation was poor.

At 15°C growth was insignificant in *A. atrospora* and *A. hesseltinei*, also insignificant, but with slight sporulation at the agar edge in *A. blakesleeana*, *A. hyalospora*, and most strains of *A. corymbifera;* while growth was restricted in *A.* aff. *blakesleeana* and *A. griseola*, and also restricted but with sporulation in some strains of *A. corymbifera*.

INFLUENCE OF SUGAR CONCENTRATION OF THE MEDIUM (beerwort slants with 20% and 40% saccharose, at 25°C)

All strains of *Absidia atrospora, A. blakesleeana, A. griseola,* and *A. hyalospora* had in common that after three days the development of aerial mycelium was less on media with 40% than on media with 20% saccharose. Among these strains, three were noticeable due to the presence of abundant young sporangia, both on slants with 40% and 20% saccharose, namely *A. atrospora, A. griseola,* and *A.* aff. *blakesleeana* (CBS 647.78). After two weeks, all colonies were well developed and no difference was obvious between cultures of each strain on the two media.

The strains of *A. corymbifera* and *A. hesseltinei* had in common that after three days development was more profuse on beerwort agar with 20% than with 40% saccarose. But after 10 days the slants with 40% saccarose were either a darker grey (good sporulation!) than with 20% saccarose, or alike.

GIANT-CELLS

Irregularly swollen, droplet-filled, substrate hyphae, sometimes swollen up to the size of 'giant-cells' are quite common in a number of *Absidia* species, especially in *A. blakesleeana* and *A. corymbifera*. Shape and size of the swollen parts vary from modest to elaborate with projecting parts (Fig. 1).

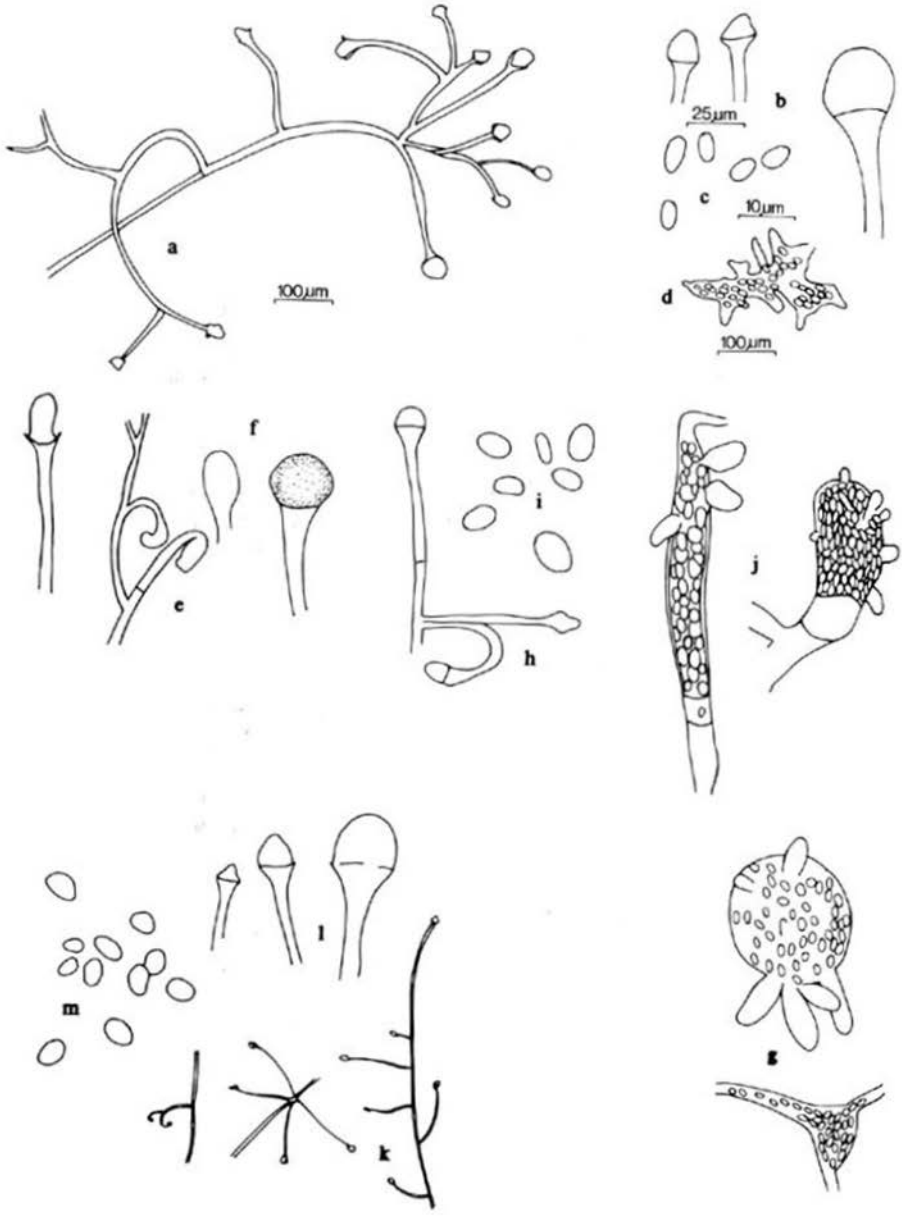
Generally, giant-cells only occur in substrate hyphae, but in strains CBS 420.70 and 648.78 (*A.* aff. *blakesleeana*), and CBS 223.78 (*A. corymbifera*) abundant, ornamented, giant-cells were also formed in the aerial mycelium.

MATINGS (on malt yeast agar at 33°C)

The three strains CBS 100.28 (+), 100.36 (-), and 102.36 (-) of *A. blakesleeana*, morphologically similar, are able to produce zygospores with the appropriate partner.

No mating reaction was observed in contrasts of the strains CBS 420.70, 647.78, and 648.78, of *A.* aff. *blakesleeana*, either with *A. blakesleeana* (+) or (-) or among each other.

Fig. 1. *Absidia blakesleeana* (sensu lato). — a–d. Strain CBS 100.36. — a. Sporangiophores on the stolon. — b. Columella. — c. Sporangiospores. — d. Giant-cell. — e–h. Strain CBS 420.70 (*A.* aff. *blakesleeana*). — e. Sporangiophores on the stolon. — f. Columella. — g. Sporangiospores. — h. Giant-cell. — i–l. Strain CBS 519.17 (*A. griseola*). — i. Sporangiophores on the stolon. — j. Columellae. — k. Sporangiospores. — l. Giant-cell. — m–p. Strain CBS 173.67 (*A. hyalospora*). — m. Sporangiophores on the stolon. — n. Columella. — o. Sporangiospores. — p. Giant-cell. — q–t. Strain CBS 518.71 (*A. blakesleeana* var. *atrospora*). — q. Sporangiophores on the stolon. — r. Columellae. — s. Sporangiospores. — t. Giant-cell.


a
100µm
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c
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Absidia griseola produced zygospores with CBS 100.36 (-). *Absidia atrospora* × *A. blakesleeana*, CBS 100.36 (-) resulted in imperfect conjugations only. Contrasts of *A. hyalospora* × *A. blakesleeana* (+) and (-) failed.

Absidia corymbifera (+) CBS 270.65, 100.49, 101.55, 223.78, 649.78, and the (-) strains CBS 271.65 and 100.55, were interfertile and so was *A. hesseltinei* × *A. corymbifera*, CBS 270.65 (+). Consequently, *A. hesseltinei* is a synonym of *A. corymbifera*.

Absidia griseola Naganishi & Hirahara (1970) was not validly published (nom. inval., I.C.B.N. art. 35). The strain CBS 519.71, *A. griseola*, received from H. Naganishi, differs from *A. blakesleeana* morphologically in the production of sporangia of a larger maximum size, which are powdery dry in appearance, with columellae which are mostly smooth and sporangiospores mostly subglobose but mixed with a few ellipsoidal ones, all light in colour; at 45 °C slight growth occurs. Mated with CBS 100.36 (-), *A. blakesleeana*, zygospores were formed. *Absidia griseola* was published without a Latin diagnosis, and is based on an atypical specimen of *A. blakesleeana*, in some characteristics tending towards *A. corymbifera*.

Absidia atrospora Naganishi & Hirahara (1970) was published without Latin diagnosis (nom. inval., I.C.B.N. art. 35). The strain CBS 518.71, received from H. Naganishi, differs from *A. blakesleeana* mainly in the production of sporangiospores of a larger size and, mixed with the subglobose majority, some ellipsoidal ones. Mating tests of CBS 518.71 and *A. blakesleeana*, CBS 100.36 (-) revealed incomplete conjugations only. Though not interfertile, this strain is treated as a variety of *A. blakesleeana* that is newly described here.

Absidia blakesleeana Lendn. var. **atrospora** Schipper, *var. nov.* distinct from the var. *blakesleeana* in the production of globose to broadly ellipsoidal sporangiospores, 5–10 (–13) µm diam.

Absidia blakesleeana Lendn. var. *atrospora* Schipper, *var. nov.* A varietate *blakesleeana* differt sporangiosporis globosis vel late ovoideis, 5–10(–13) µm diam. Typus: CBS 518.71.

Absidia hyalospora (Saito) Lendn. was provided with a neotype and newly redescribed by Hesseltine & Ellis (1966). The strain derived from the neotype indicated by Hesseltine & Ellis is maintained at the CBS sub 173.67, *A. hyalospora*. The strain differs from *A. blakesleeana* in producing slightly larger sporangiospores. In *A. blakesleeana* strains grown on beerwort agar at 25 °C sporangiospores are 4–(5–)6 µm diam. (rarely larger; in strain CBS 173.67); sporangiospores are up to 7 µm diam., occasionally up to 10 µm, under the same conditions. Hesseltine & Ellis reported interfertility between *A. hyalospora* and *A. blakesleeana*. (Matings at the CBS failed to yield zygospores). The slight difference between the neotype of *A. hyalospora* and *A. blakesleeana* is not sufficient to justify maintaining these species separately.

Fig. 2. *Absidia corymbifera* (sensu lato). — a–d. Strain CBS 100.17. — a. Branching pattern sporangiophores on the stolon. — b. Columellae. — c. Sporangiospores. — d. Giant-cell. — e–g. Strain CBS 103.35. — e. Branching pattern sporangiophore. — f. Columellae. — g. Giant-cells. — h–i. CBS 100.55. — h. Sporangiophores on the stolon with top-sporangium. — i. Sporangiospores. — j. Strain CBS 270.65., giant-cells. — k–m. Strain CBS 950.68 *(A. hesseltinei)*. — k. Sporangiophores on the stolons, branching pattern. — l. Columellae. — m. Sporangiospores.

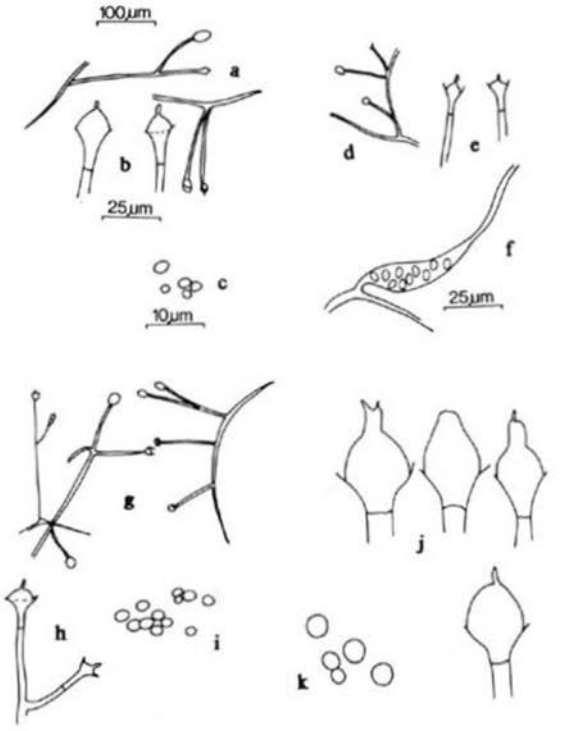


Fig. 3. *Absidia* subgenus *Absidia*, group A. — a–c. *A. coerulea* (CBS 104.08). — a. Sporangiophores on the stolons. — b. Columellae. — c. Sporangiospores. — d–f. *A. californica* (CBS 126.68). — d. Sporangiophores on the stolons. — e. Columellae. — f. Giant-cell. — g–i. *A. glauca* (CBS 101.08). — g. Sporangiophores on the stolons. — h. Columellae. — i. Sporangiospores. — j, k. *A. macrospora* (CBS 696.68). — j. Columellae. — k. Sporangiospores.

Absidia aff. *blakesleeana*.— Differences between the three strains (CBS 420.70, 647.78, and 648.78) tentatively identified with *A. blakesleeana* and the 'type' strain of the species (CBS 100.28), are in the more heavily branching sporangiophores with more circination, the brownish grey, powdery dry sporangia, the rather light colour of the sporangiospores, and the temperature reactions (no sporulation at the slant-edges at 45°C, slower growth and less sporulation at 36°C, and restricted growth at 15°C). Strain CBS 648.78 showed stronger sporulation under all conditions also at 15°C and on beerwort with 40% and with 20% saccharose. The strains CBS 420.70 and 648.78 produced abundant giant-cells with proliferations on aerial hyphae.

The deviations from the type characteristics are accepted as variability within the species. The unusual, very conspicuous aerial giant-cells, were also noted in a strain of *A. corymbifera*.

Absidia corymbifera (19 strains) and *A. hesseltinei* (one strain) are very similar, thus *A. hesseltinei* is regarded as synonymous with *A. corymbifera*.

ABSIDIA SUBGENUS ABSIDIA

Zygospores surrounded with appendaged suspensors.

Other characters.— Growth of the aerial hyphae indeterminate. Most of the sporangiophores usually occur in whorls or verticils from stolons. Typically no growth at 37°C; zygospores formed at room temperature. (After Hesseltine & Ellis, 1964).

In this subgenus six groups of related species may be recognized.

GROUP A

Sporangiospores globose. Sporangiophores often in pairs, extensive whorls unusual. No growth at 36°C, growth and sporulation at 15°C–30°C.

MATERIAL STUDIED (all cultures from the CBS)

Absidia californica J.J. Ellis & Hesselt.: CBS 126.68 and 314.78.

Absidia coerulea Bain.: CBS 104.08, 105.08, 101.28, 102.28, 103.28, 104.28, 100.32, 111.36, 100.38, 628.70A, and 628.70B.

Absidia glauca Hagem: CBS 100.06, 101.08, 102.08, 103.08, 100.48, 101.48, 100.59, 209.62, 422.70, and 423.70.

Absidia macrospora Váňová: CBS 696.68 and 697.68.

The colour of young colonies has been discussed before.

Matings on PDA at 25°C showed that all interspecific contrasts of *A. glauca, A. coerulea, A. californica,* and *A. macrospora* failed. The differences between *A. coerulea, A. glauca,* and *A. californica* seem mainly of a physiological nature. Zygospores of *A. macrospora* were not found.

Strain CBS 103.08, most probably a Lendner-strain, was originally designated as *A. septata* Tiegh. This species is homothallic, as can be judged from the original drawing. Lendner (1908) described *A. septata* 'after Fischer' with zygospores and azygospores. Zycha (1935) noted similarity with *A. glauca,* Ellis & Hesseltine (1965) with *A. coerulea* but for its homothallic nature. Strain CBS 103.08 did not show any sexual reactions and is morphologically identical with *A. glauca*. Whether the strain ever produced homothallic zygospores could not be traced.

GROUP B

Sporangiospores regularly cylindrical with slightly rounded ends. Sporangiophores in whorls. No (or neglectable) growth at 36°C; growth and sporulation at 15–30°C.

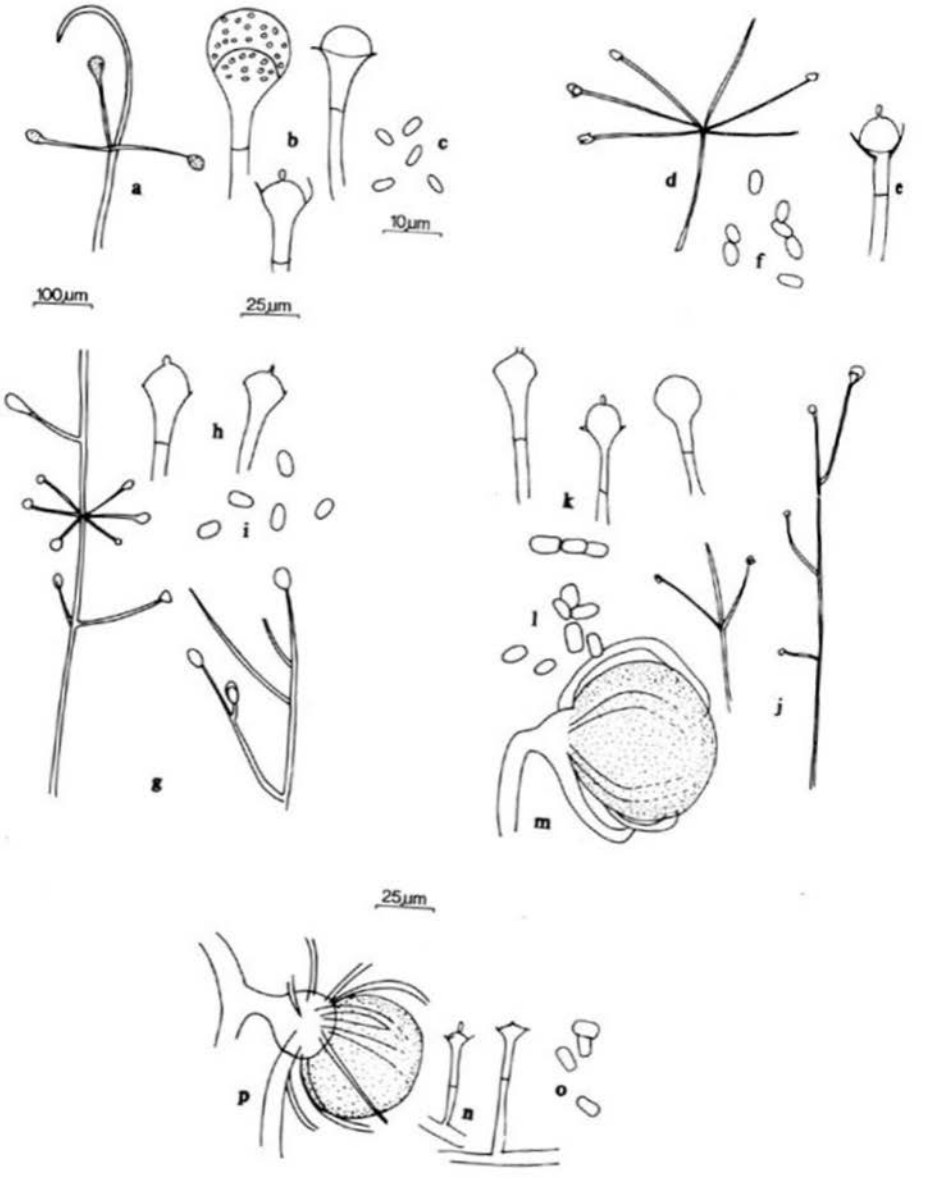
MATERIAL STUDIED (all cultures from the CBS)

Absidia cylindrospora Hagem: CBS 100.08, 100.35, 101.35, 100.37, 101.37, 324.71, and 410.85.

Absidia cylindrospora var. *nigra* Hesselt. & J.J. Ellis: CBS 127.68 and 315.78.

Absidia cylindrospora var. *rhizomorpha* Hesselt. & J.J. Ellis: CBS 153.63 and 154.63.

Absidia pseudocylindrospora Hesselt. & J.J. Ellis: CBS 100.62 and 480.66.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b
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100µm
25µm
d
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Absidia fusca Linnem.: CBS 102.35.
Absidia spinosa Lendn.: CBS 106.08, 332.74, 222.78, and 316.78.
Absidia spinosa var. *biappendiculata* Rall & Solheim: CBS 187.64.
Absidia anomala Hesselt. & J.J. Ellis: CBS 125.68.

Colony colours have been discussed before.

Morphologically, *Absidia cylindrospora* var. *nigra* differs from the variety *cylindrospora* in the forming of darker colonies. In *Absidia cylindrospora* var. *rhizomorpha* whorls were mostly composed of three or two sporangiophores, but at the tips of stolons whorls of up to five sporangiophores occurred in strains of this variety. Furthermore the strains of this variety produced slightly larger sporangia, smooth columellae and also the maximum size of the sporangiospores was slightly larger than in the varieties *cylindrospora* and *nigra*. Though parts of the substrate hyphae were rather wide, 'rhizomorph-like' growth, as described by Hesseltine & Ellis (1964) was not observed. Some growth occurred at 36°C. On PDA 25°C, after seven days a 'rosette' colony was produced. Like the diagnostic good growth on Czapek agar, this indicates a physiological difference between the variety *rhizomorpha* and the varieties *cylindrospora* and *nigra*.

Absidia fusca was named after its dark colour, which, however, is produced only in older colonies, at lower temperatures, in the strain derived from the holotype which is the only one available. The species is related to *A. cylindrospora*, but different in the whorls of up to six sporangiophores (in seven day old colonies on beerwort agar, at 25°C), the mostly short (but rarely tall), not uncommonly branching sporangiophores, and the presence of swollen substrate hyphae filled with droplets. Compared with strains of *A. cylindrospora* development of *A. fusca* was rather slow at the studied temperatures (15°C, 25°C, and 30°C).

After the diagnosis *Absidia pseudocylindrospora* should be able to grow restrictedly, but sporulate well at 37°C. However, no growth was observed at 36°C on PDA. Morphologically, *A. pseudocylindrospora* differs from *A. cylindrospora* in the production of much darker colonies, and usually, more extensive whorls of sporangiophores (five being a quite common number).

Stain CBS 324.71, tentatively identified as *A. cylindrospora*, might be intermediate between *A. cylindrospora* and *A. pseudocylindrospora:* the sporangiophores are in extensive whorls, and insignificant growth occurs on PDA at 36°C, but poor on Czapek agar.

The homothallic counterparts of *A. cylindrospora* are *A. spinosa* and *A. anomala*.

Absidia anomala is very close to *A. spinosa*. Sporulation was scarce in *A. anomala* and zygospore production abundant, which interferes with a clear comparison of the species. In aging colonies of *A. spinosa* sporangiospores might be less uniform and reach a larger size, up to 5 × 2.5–3 µm (cf. *A. cylindrospora* var. *rhizomorpha*).

Fig. 4. *Absidia* subgenus *Absidia*, group B. — a–c. *A. cylindrospora* (CBS 101.37). — a. Sporangiophores on the stolon. — b. Sporangium and columellae. — c. Sporangiospores. — d–f. *A. pseudocylindrospora* (CBS 480.66). — d. Sporangiophores on the stolon. — e. Columella. — f. Sporangiospores. — g–i. *A. fusca* (CBS 102.35). — g. Sporangiophores on the stolons. — h. Columellae. — i. Sporangiospores. — j–m. *A. spinosa* (CBS 106.08). — j. Sporangiophores on the stolons. — k. Columellae. — l. Sporangiospores. — m. Zygospore. — n–p. *A. anomala* (CBS 125.68). — n. Columellae. — o. Sporangiospores. — p. Zygospore.

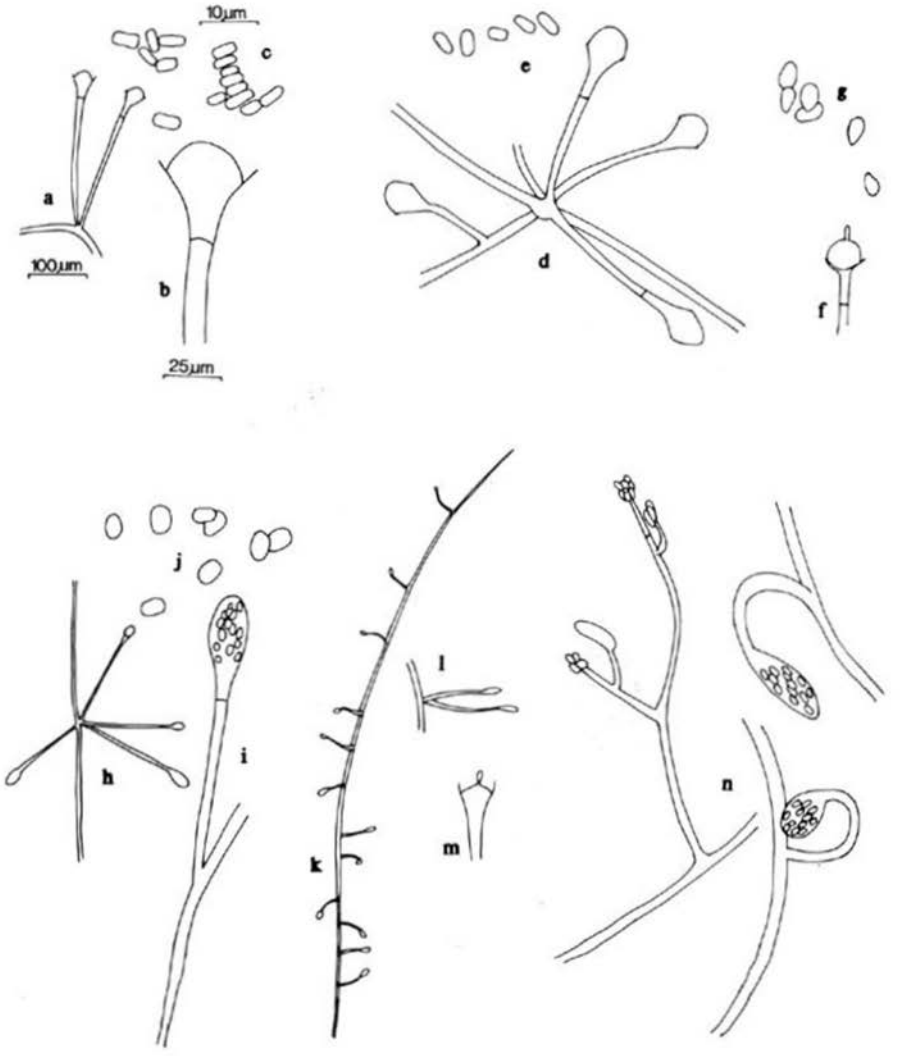

Fig. 5. *Absidia* subgenus *Absidia*, group C, D, E, F. — a–c. Group C, *A. heterospora* (CBS 588.74). — a. Sporangiophores on the stolon. — b. Columella. — c. Sporangiospores. — d, e. Group D, *A. psychrophyla* (CBS 128.68). — d. Sporangiophores, columellae. — e. Sporangiospores. — f, g. Group E, *A. cuneospora* (CBS 101.59). f. Columella. — g. Sporangiospores. — h–n. Group F, *A. repens* — h–j. Strain CBS 100.16 — h, i. Sporangiophores on stolons — j. Sporangiophores. — k–m. Strain CBS 101.32 — k, l. Sporangiophores on stolons. — m. Columella. — n. Strain CBS 102.32, Sporangiophores on stolons.

Matings on PDA at 25 °C demonstrated that strains of *Absidia cylindrospora* were intrafertile with one exception: CBS 324.71 (see above). This strain mated neither with *A. cylindrospora* (+) and (-) nor with *A. pseudocylindrospora* (+) and (-). In *A. cylindrospora* var. *nigra*, and *A. pseudocylindrospora* intrafertile partners were available.

The strains of *A. cylindrospora* var. *rhizomorpha* failed to yield zygospores, though they were received as mating partners (Hesseltine & Ellis, 1961). At the time of this study, no sexual reactions were observed.

Zygotes and mating reactions.— In *Absidia fusca* zygospores are unknown. Interspecific and intervarietal contrasts of *A. cylindrospora, A. cylindrospora* var. *nigra, A. cylindrospora* var. *rhizomorpha, A. pseudocylindrospora,* and *A. fusca* failed to show reactions. Homothallic zygospores are formed in *Absidia spinosa, A. spinosa* var. *biappendiculata,* and *A. anomala.*

Absidia spinosa and *A. spinosa* var. *biappendiculata.*— The zygospores of *A. spinosa* are borne between unequal suspensors, the larger one forming appendages; *A. spinosa* var. *biappendiculata* is distinct by producing equal suspensors, both forming appendages.

In *A. anomala* zygospores tended to be larger, and infrequently much larger than in *A. spinosa*.

Group C

A single species, *Absidia heterospora* Ling-Young, with irregular cylindrical sporangiospores, of varying sizes. The strains, CBS 101.29 and 588.74, showed a slight submersed growth at 30 °C; growth and sporulation occurred at 15 °C and 25 °C; at 25 °C globose and cylindrical-ellipsoidal sporangiospores were produced.

The species differs morphologically from *A. cylindrospora* in the production of columellae without distinct projections and in irregularly shaped sporangiospores. Zygospores are unknown. Interspecific contrasts were without result.

Group D

The single representative of this group, *Absidia psychrophila* Hesselt. & J.J. Ellis (one strain, CBS 128.68), is close to *Absidia cylindrospora* (group B) sporangiospores cylindrical with rounded ends; sporangiophores in whorls; different in temperature-growth range: at 30 °C no growth, at 20 °C and 25 °C growth in 'rosette' colony, with sporangia but sporangiospores rather unequal at 25 °C, cylindrical at 20 °C, growth and sporulation at 15 °C rather slow. Zygospores unknown; no mating reaction with *A. cylindrospora* (+) and (-) (which may be, at least partly, due to incompatibility of optimal temperature for mating).

Group E

A single species with lacrimoid-cuneate sporangiospores, *Absidia cuneospora* Orr & Plunkett, related to *A. cylindrospora* and *A. spinosa,* differing in the cuneate shape of the sporan-

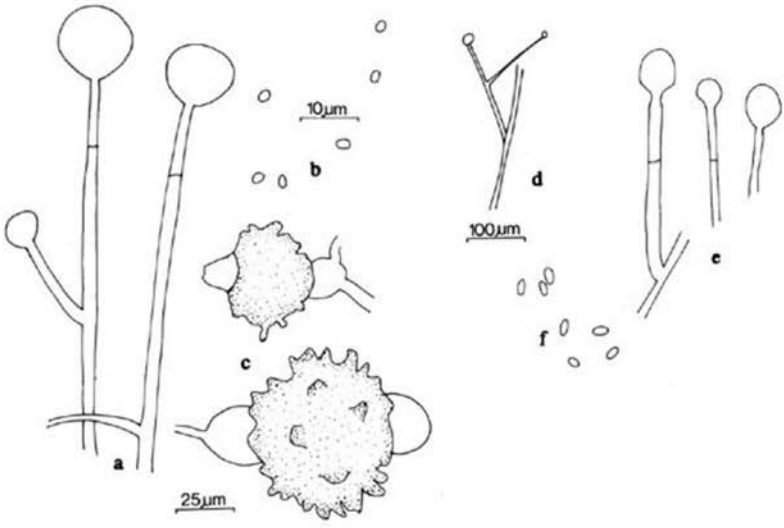

Fig. 6. Species of *Absidia* of uncertain position. — a–c. *A. parricida* (CBS 174.67). — a. Sporangiophores and columellae. — b. Sporangiospores. — c. Zygospores and suspensors. — d–f. *A. zychae* (CBS 104.35). — d. Sporangiophores. — e. Columellae. — f. Sporangiospores.

giospores. At 36°C the two strains (CBS 101.59 and 102.59) showed some growth but no sporulation; at 15°C–30°C growth and sporulation occurred.

The strains received as mating partners, did not react sexually on either PDA or hay infusion agar at 25°C, but produced a distinct yellow colony on the PDA medium, which is indicative of a sexual response. According to the first description of *A. cuneospora*, zygospores are up to 72 µm diam., finely tuberculate or reticulate, and surrounded by branched, circinate appendages from the larger suspensor. In this respect it differs from *A. cylindrospora* and *A. spinosa*. Contrasts with *A. cylindrospora* (+) and (-) were unsuccessful.

Group F

The single species of this group, *Absidia repens* Tiegh., produces globose to short-ellipsoidal or slightly angular sporangiospores; smooth or slightly roughened; in the small sporangia dark coloured. Available strains: CBS 100.16, 101.32, and 102.32. This species differs from all other species of the genus in the production of two types of sporangiophores: the usual *Absidia* type and series of single, short, sporangiophores, straight or recurved, bearing small and narrow sporangia. At 30°C growth was restricted, though sporulation occurred; 15°C–25°C growth and sporulation occurred. The strains mentioned were intrafertile on PDA at 25°C; suspensors were either unequal, with only the larger appendaged or equal, with both appendaged.

Species of uncertain position

Absidia parricida Renner & Muskat ex Hesselt. & J.J. Ellis (CBS 174.67) and *Absidia zychae* Hesselt. & J.J. Ellis (CBS 104.35) are both slow growing species with a very restricted temperature-growth range.

Absidia parricida is a mycoparasite. In pure culture development is slow, abundant sucker-like branches occur in the substrate-mycelium. *Absidia zychae* has the characteristics of a parasite (e.g. sucker-like branches) like *A. parricida*, but no potential host is known. Trials in this field failed: in mixed cultures with potential hosts, no parasitizing was observed. In *A. parricida* sporangiophores are borne on distinct stolons. In *A. zychae* sporangiophores arise either from distinct aerial hyphae (stolons) or from hyphae very near the substrate (surfacial substrate hyphae ?).

Zygosporic stage.— *Absidia parricida* shows homothallic zygospores, up to 65(–80) µm diam. with blunt projections, borne between equal, unadorned suspensors. In *A. zycha* zygospores are unknown, and interspecific contrasts were unsuccesful.

Temperature-growth response.— In *A. parricida* very restricted colonies occurred at 30°C; growth and sporulation were very slow at 20°C and 25°C; and no development was found at 15°C. In *A. zycha* no growth was found at 30°C, only very slow growth and sporulation at 25°C, while growth was extremely slow with restricted colonies and sporulation at 15°C.

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CHAMPIGNONS DE NOUVELLE-CALÉDONIE—I
QUELQUES DÉMATIÉES INTÉRESSANTES DE LITIÈRE FORESTIÈRE

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*Laboratoire de Cryptogamie, Paris**

En utilisant la méthode d'incubation en chambres humides, nous avons réalisé un suivi des champignons se développant à partir de fragments foliaires, issus de litières forestières en Nouvelle-Calédonie. Cette première note rapporte les particularités taxonomiques et biologiques de quelques micromycètes dématiés, peu communs à rares, inédits pour la mycoflore de cette île: *Beltraniella portoricensis* (F.L. Stevens) Pirozynski & Patil, *Nakataea fusispora* (Matsushima) Matsushima, *Paliphora aurea* Sivanesan & Sutton, *Pleurotheum recurvatum* (Morgan) Höhn. et *Speiropsis scopiformis* Kuthubutheen & Nawawi.

Patouillard paraît être le premier à s'intéresser dès 1887 aux champignons de la Nouvelle-Calédonie. Seul ou en collaboration avec Hariot, il publia jusqu'en 1926, une série d'articles comportant, entre autres, la description d'une centaine d'espèces inédites pour la Science, récoltées dans les territoires Français du Pacifique Sud.

La création, après 1945, de l'Institut Français d'Océanie, devenu Centre ORSTOM de Nouméa, donna une impulsion nouvelle à la connaissance de la mycoflore de cette région. Les recherches réalisées, d'abord par Bugnicourt et ses collaborateurs, aboutirent à l'établissement d'une liste de champignons, parasites des plantes cultivées (Bugnicourt & Marty, 1961). Huguenin poursuivit cet effort de collection et d'inventaire, en particulier des micromycètes de Nouvelle-Calédonie (Huguenin, 1966).

Les litières forestières tropicales de Nouvelle-Calédonie, n'avaient pas encore été explorées, pour déterminer les champignons actifs dans leur dégradation. Une analyse d'échantillons de quelques localités méridionales de l'île principale a donc été entreprise par la méthode d'incubation en chambres humides, employée pour l'étude de la colonisation fongique des organes foliaires de *Carpinus betulus* L., en France (Mouchacca & Geoffroy, 1984). Cette première note rapporte les particularités taxonomiques et biologiques, de quelques hyphomycètes dématiés, peu communs ou rares, de cet habitat; ceux-ci étaient également inédits pour la mycoflore de cette région.

Beltraniella portoricensis (F.L. Stevens) Pirozynski & Patil—Fig. 1A–C

Ellisiella portoricensis F.L. Stevens *in* Trans. Ill. Acad. Sci. 10: 203. 1917 (basionyme). — *Ellisiellina portoricensis* (F.L. Stevens) Batista *in* An. Soc. Biol. Pernambuco 14: 9. 1956. — *Ellisiopsis portoricensis* (F.L. Stevens) Pirozynski *in* Mycol. Pap. 90: 22. 1963. — *Beltraniella portoricensis* (F.L. Stevens) Pirozynski & Patil *in* Can. J. Bot. 48: 575. 1970.

Ellisiopsis gallesiae Batista & Nascimento *in* An. Soc. Biol. Pernambuco 14: 21. 1956.

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Colonie veloutée, noirâtre, s'étalant progressivement. Mycélium en partie superficiel, en partie immergé. Stromas généralement présents.

Setae présentes, simples, dressées, effilées, septées, à paroi épaisse et verruqueuse, brun rougeâtre sombre, atteignant 200 µm de longueur, larges de 8 µm à la base, émanant d'une assise basale de cellules à contour lobé de diamètre atteignant 22 µm.

Conidiophores différenciés, monofilamenteux, regroupés autour des setae et émanant de leurs cellules basales lobées, partie inférieure à paroi épaisse, brun olivacé; conidiophores atteignant 25 µm de longueur, larges de 5–7 µm, septés, peu ramifiés, branches se transformant quelquefois en setae.

Cellules conidiogènes polyblastiques, non différenciées ou terminales, sympodiales, arrondies ou pointues, denticulées avec jusqu'à 6 denticules conoïdes. Conidies acropleurogènes, solitaires, unicellulaires, lagéniformes à naviculaires, lisses, apex arrondi et base effilée, olivacé clair avec une bande médiane hyaline, 18–27 × 5–8,5 µm; conidies pourvues ou non de cellules séparatrices ovoïdes à fusiformes, effilées aux extrémités, hyalines, lisses, 7–14 × 3–4 µm.

Répartition.— Cette dématiée est un élément commun de la mycoflore de litière en régions tropicales, subtropicales et tempérées chaudes; observée au sud des Etats-Unis, Inde, Tanzanie (Pirozynski & Patil, 1970); Brésil, Japon, Pakistan, Afrique de l'Ouest, Puerto-Rico, Venezuela (Ellis, 1971); Taiwan (Matsushima, 1980); Mts Koghis, Nouvelle-Calédonie.

Beltraniella portoricensis se cultive aisément sur des milieux gélosés usuels, mais les cultures obtenues se détériorent rapidement. *In vitro*, il révèle une plasticitié marquée de ses particularités morphologiques et biométriques; ainsi certaines cellules basales des setae donnent naissance à des conidiophores fonctionnels.

Ce comportement est à l'origine de la synonymie du genre *Ellisiopsis* Batista avec *Beltraniella* Subramanian. D'autre part, les variations biométriques enregistrées en culture pour l'appareil conidiifère soulignent une absence de séparation entre *E. gallesiae* et *E. portoricensis* (Pirozynski & Patil, 1970). D'ailleurs, Onofri & Castagnola (1982), après une étude au MEB des types respectifs de ces deux genres, concluent également à une homologie de leur modes de conidiogenèse excluant une reconnaissance séparée.

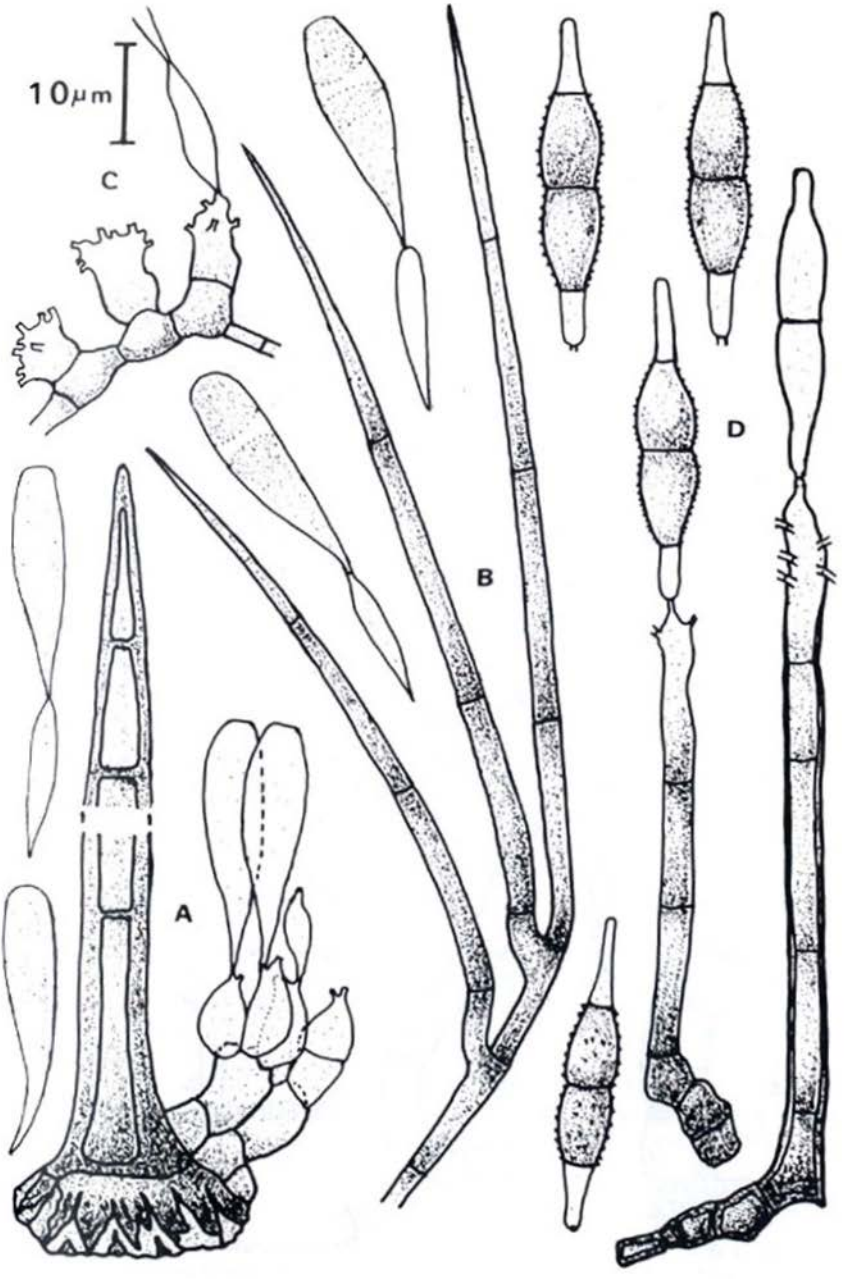
Nakataea fusispora (Matsushima) Matsushima — Figs. 1D; 3A, B

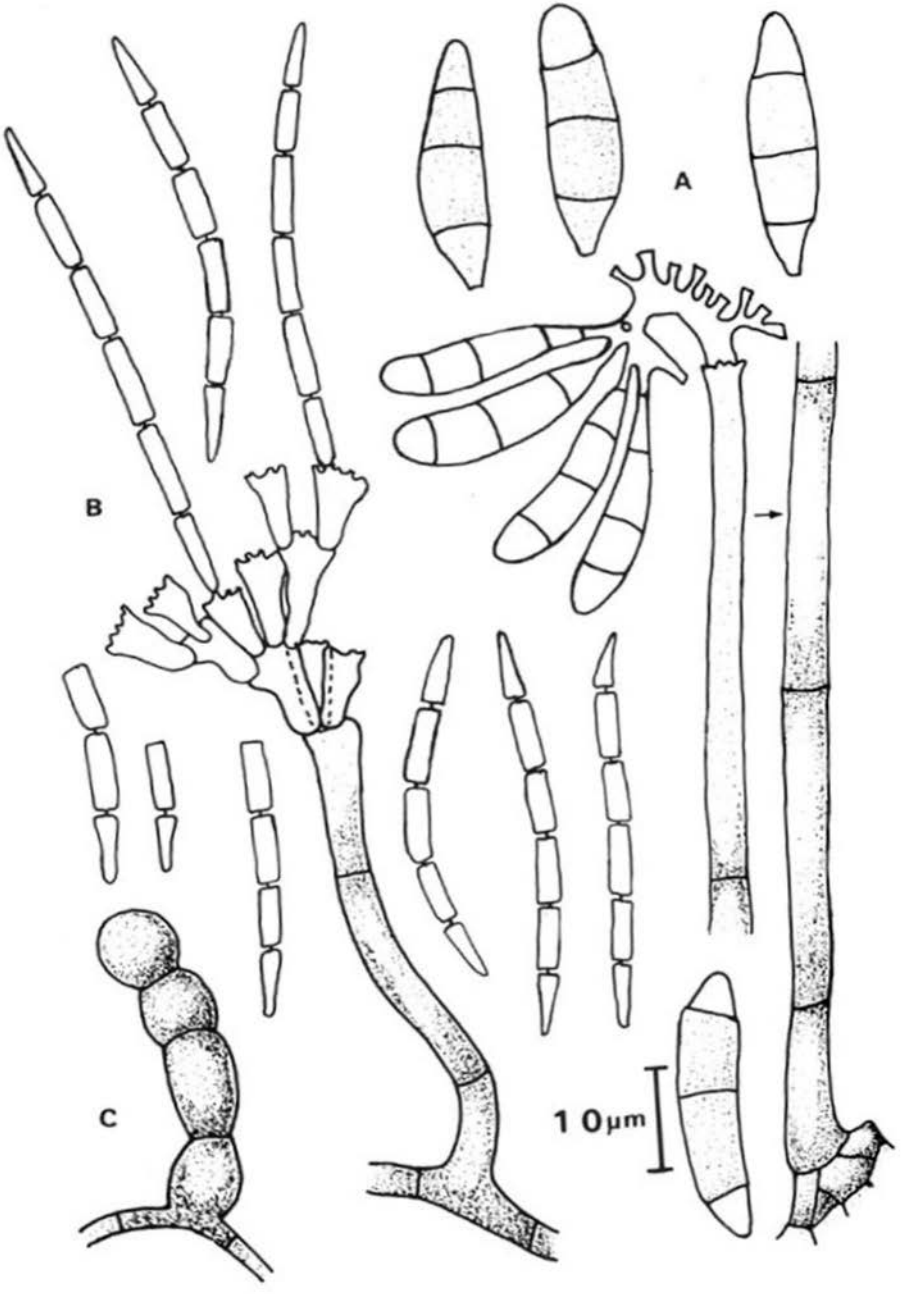
Vakrabeeja fusispora Matsushima, Microfungi of the Solomon Islands and Papua-New Guinea, Kobe: 66. 1971 (basionyme). — *Nakataea fusispora* (Matsushima) Matsushima, Icones microfungorum a Matsushima lectorum, Kobe: 100. 1975.

Colonie veloutée, brun sombre, s'étalant progressivement. Mycélium en partie superficiel, en partie immergé dans le substratum, composé d'hyphes ramifiées, septées, hyalines à brun sombre, larges jusqu'à 4 µm.

Conidiophores différenciés, monofilamenteux, solitaires ou en groupes de 2 à 4, simples, droits à sinueux, septés, lisses, issus d'hyphes rampantes, hauts jusqu'à 200 µm, larges de

Fig. 1. A–C. *Beltraniella portoricensis*. — A. Seta, appareil conidien et conidies observées sur fragment foliaire. — B, C. Détails des structures sétiformes (B) et des conidiophores (C), observées en culture. — D. *Nakataea fusispora*, conidiophores et conidies se développant sur fragment foliaire.


10µm
C
A
B
D


A
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C
10 µm

3–3,5 µm, brun sombre, partie apicale à paroi comparativement moins épaisse et brunâtre clair; conidiophore soutenu par une assise basale de plusieurs cellules à paroi brun sombre.

Cellules conidiogènes polyblastiques, non différenciées, terminales devenant intercalaires, sympodiales, cylindriques, denticulées; denticules à paroi fine, cylindriques, pourvus d'une cloison basale délimitant une cellule de séparation. Conidies solitaires, acropleurogènes, fusiformes, 3-septées, se détachant par rupture de la fine paroi de la cellule de séparation, 26–35 (–38) × 4,5–6 µm, peu resserrées aux cloisons, à cellules centrales brun sombre et verruqueuses; cellules terminales presque hyalines et lisses et cellules basales se continuant par un bouchon réfringent ou avec un fragment du denticule porteur.

Répartition. —Sol de jardin, Papouasie-Nouvelle Guinée, localité d'origine (Matsushima, 1971); feuilles mortes de *Rhi succedaneae*, Japon, et *Castanopsis cuspidatae* var. *sieboldii*, Japon et Okinawa (Matsushima, 1975); litière forestière, Mts Koghis, Nouvelle-Calédonie.

Nakataea Hara a été établit pour la forme conidienne de *Magnaporthe salvinii* (Cattanea) Krause & Webster (*Leptosphaeria salvinii* Cattanea), agent d'une pourriture des tiges de riz en régions tropicales et tempérées (Ellis, 1971). A ce jour, il comporte quatre espèces et une variété: *N. sigmoidea* (Cavara) Hara et sa variété *irregulare* Cralley & Tullis (1935)—selon Ou (1985: 253), le statut taxonomique de cette variété demeure imprécis —*N. fusispora*, *N. serpens* Shearer & Crane et *N. curvularioides* Arnold.

Le champignon défini par Arnold, observé sur des feuilles mortes de *Bromelia pinguinis* L. à Cuba, possède des conidies triseptées comparables à l'espèce-type, mais de dimensions franchement plus réduites: 18–26 × 8–9,5 µm contre 40–83 × 11–14 µm (Arnold & Castaneda Ruiz, 1987). *Nakataea serpens*, isolé de débris végétaux flottants aux États-Unis, révèle des conidies tétraseptées à cellules apicales se continuant par un fin et long appendice (Shearer & Crane, 1979). Curieusement, les auteurs de ces deux hyphomycètes ne comparent leurs champignons respectifs à *N. fusispora*.

Paliphora aurea Sivanesan & Sutton—Fig. 3C–E

Paliphora aurea Sivanesan & Sutton, *in* Trans. Br. mycol. Soc. 85: 251. 1985.

Colonies villeuses, brun doré, s'étalant progressivement. Mycélium en partie superficiel, en partie immergé dans le substratum, composé d'hyphes ramifiées, septées, brun pâle, lisses, ayant 2 µm de largeur.

Conidiophores différenciés, monofilamenteux, solitaires ou apparaissant en petits groupes, dressés, droits à peu courbés, simples, rigides, effilés, brun doré uniformément, hauts de 120–200 µm, à cellules basales lobées, larges de 13–15 µm; parties médianes des conidiophores mûrs recouvertes d'une couche muqueuse de conidies, l'ensemble évoquant alors un sapin élancé. Conidiophores pourvus de jusqu'à 20 cloisons transversales, séparées par des distances presque identiques, délimitant des cellules longues de 6–10 µm dans l'ensemble; cellules des parties apicales stériles a paroi légèrement verruqueuse et lumen comparativement plus étroit; parties médianes à cellules de nature phialidique, à paroi mince, lisse, cha-

Fig. 2. A. *Pleurothecium recurvatum*, conidiophore et conidies sur fragment foliaire. — B, C. *Speiropsis scopiformis*. — B. Conidiophore et conidies sur fragment foliaire. — C. Chaîne de chlamydospores observée en culture.

cune pourvue d'une minuscule perforation (diam. 1 µm) située juste en dessous des cloisons transversales, en position opposée et de manière alternée de part et d'autre du conidiophore; parties basales larges de 6–7 µm, rassemblent 2–5 cellules stériles apparaissant identiques à celles des parties médianes.

Conidies produites à travers les pores des locus conidiogènes, cylindriques à fusiformes étroits, hyalines, 1-septées, 12–17 × 1,5–2 µm, restant accolées en paquets, après leur libération, sur toute leur longueur, au conidiophore.

Répartition.— Sur feuilles mortes de *Xanthorrhoeae* sp., Australie, localité d'origine (Sivanesan & Sutton, 1985); feuilles en décomposition, Inde et Malaisie (Rao & de Hoog, 1986); litière forestière, Mts Koghis, Nouvelle-Calédonie.

Paliphora aurea est une dématiée de litière récemment décrite. En 1986, Rao & de Hoog rapportent à cette espèce une deuxième collection provenant de l'Inde, mais dont les caractéristiques diffèrent quelque peu de la diagnose originale: production de conidies toutes uniseptées et de dimensions plus grandes (14–17 × 1,7–2 µm contre 6,5–9 × 1–1,5 µm), mode de répartition particulier des locus conidiogènes sur les conidiophores et nature plutôt phialidique de ces derniers. Kuthubutheen (1987) propose *P. porosa* ayant des conidiophores identiques à l'espèce-type, mais dont les conidies généralement uniseptées à quelquefois pourvues de 2–3 cloisons transversales, ont des dimensions plus elevées, 12–25 × 1–2,5 µm, en comparaison au biomètre du *P. aurea* rapporté dans le protologue original.

Les particularités du matériel néo-calédonien, confirment les observations de Rao & de Hoog (1986) pour *P. aurea*, dont la conidiogenèse et celle de *P. porosa* méritent d'etre mieux connue, par l'examen de cultures vivantes. La détection de *P. aurea* en Nouvelle-Calédonie élargit sensiblement son aire de répartition.

Pleurothecium recurvatum (Morgan) Höhn.—Fig. 2A

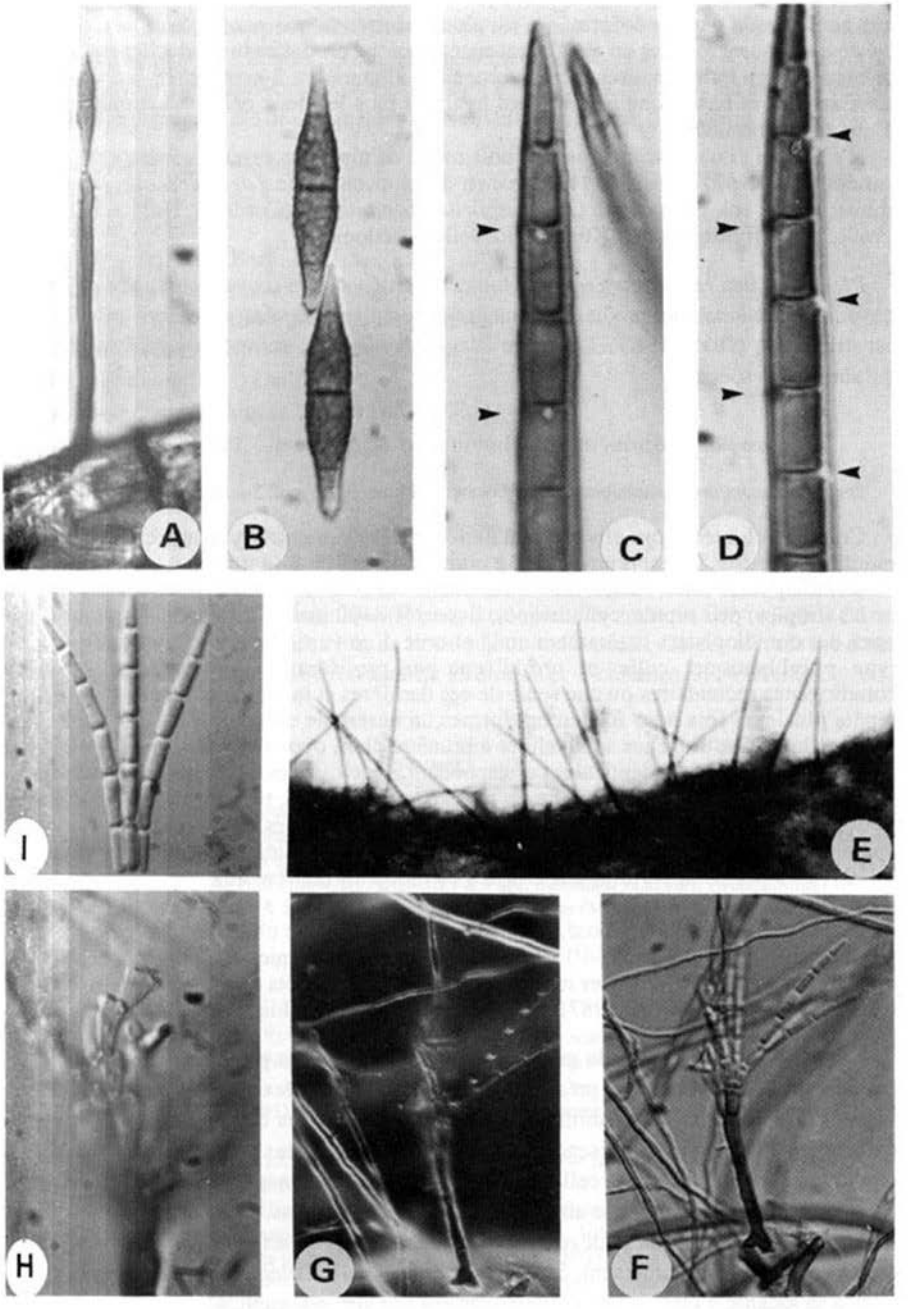
Acrothecium recurvatum Morgan *in* J. Cincinnati Soc. Nat. Hist. 18: 44. 1895 (basionyme). — *Pleurothecium recurvatum* (Morgan) Höhn. *in* Ber. dt. Bot. Ges. 37: 154. 1919.

Colonie veloutée, brunâtre à brun-rougeâtre, s'étalant progressivement.

Conidiophores différenciés, monofilamenteux, dressés, droits ou geniculés en zigzag, non ramifiés, septés, lisses, brun à brun sombre, à parties apicales franchement moins colorée, se terminant par une cyme helicoïdale hyaline; conidiophores atteignant 320 µm de longueur, larges de 4–7 µm.

Cellules conidiogènes non différenciées, intégrées, terminales, polyblastiques, à mode de croissance sympodial, cylindriques, denticulées avec des denticules cylindriques bien individualisés. Lors de la formation de la première conidie, la paroi externe brunâtre des cellules conidiogènes se déchire; ces dernières poursuivent ensuite leur croissance pour former d'au-

Fig. 3. A, B. Photomicrographies de *Nakataea fusispora*. — A. Conidiophore et conidie sur fragment foliaire (× 1100). — B. Conidies triseptées (× 1000). — C–E. *Paliphora aurea*. — C. Conidiophores sétiformes sur fragment foliaire (× 140). — D. Locus conidiogènes, en position alternée, des cellules fertiles du conidiophore (× 750). — E. Succession alternée et opposée de ces locus sur les deux faces du même conidiophore (× 750). — F–I. *Speiropsis scopiformis*. — F, G. Appareil conidien et conidies observés en culture (× 550). — H. Cellules conidiogènes étagées (× 1000). — I. Chaînes droites de conidies unicellulaires simplement accolées à leur base (× 900).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tres conidies; la partie néoformée n'est alors recouverte que par la paroi interne. Conidies blastosporées, regroupées en têtes muqueuses quoique produites individuellement, au bout de denticules bien individualisés, acropleurogènes, allantoïdes, 3-septées, 18–26 × 5–7,5 µm, à apex arrondi et base tronquée, d'abord hyalines puis les deux cellules centrales se teintent d'une couleur brunâtre.

Répartition.—Sur écorce et bois morts de plusieurs essences forestières, Europe et Amérique du Nord (Ellis, 1971); écorce en décomposition de *Fagus crenata*, Japon (Matsushima, 1975); sol, Congo: sub *Cacumisporium capitulatum* (Corda) S. Hughes (Kiffer & al., 1969); litière forestière, Mts Koghis, Nouvelle-Calédonie.

Pleurothecium recurvatum est resté longtemps méconnu et souvent confondu avec *Cacumisporium capitulatum* qui produit également des conidies triseptées, mais dont la conidiogenèse est différente (Goos, 1969). Le genre *Pleurothecium* ne comporte apparemment encore qu'une seule espèce.

Speiropsis scopiformis Kuthubutheen & Nawawi—Figs. 2B, C; 3F–I

Speiropsis scopiformis Kuthubutheen & Nawawi *in* Trans. Br. mycol. Soc. 89: 584. 1987.

Colonie veloutée, brun olivacé, s'étalant progressivement. Mycélium composé d'hyphes ramifiées, septées, lisses, brun olivacé à brunâre, larges de 2–4 µm.

Conidiophores différenciés, monofilamenteux, solitaires, dressés, droits à légèrement flexueux, simples, peu septés, cylindriques, lisses, 50–100 µm de longueur, larges de 4–5 µm; apex des conidiophores légèrement enflé et orné d'un verticille de cellules conidiogènes de type polyblastique; celles-ci produisent par prolifération sympodiale 1–3 cellules conidiogènes secondaires ou une seule de ces dernières et quelques conidies; ce processus se répète plusieurs fois pour finalement former un ensemble conidiogène étagé, évasé vers le haut; cellules conidiogènes subhyalines à brunâtre clair, obovoïdes, 4–10 × 3–5 µm, à partie apicale crénelée de 2–4 denticules correspondant aux cicatrices des locus conidiogènes.

Conidies hyalines, brun jaunâtre en masse, unicellulaires, réunies par des isthmes étroits pour former des chaînes non ramifiées de 5–7 cellules; chaînes longues de 43–65 µm, unités apicales et basales de forme conique, 6–8 × 2–2,5 µm, unités intermédiaires cylindriques 7–10 × 2–3 µm. L'apparition des chaînes conidiennes confère aux conidiophores la forme d'un balai.

En culture, sur milieu gélosé, on observe la présence de chlamydospores globuleuses à paroi épaisse brun sombre, 7–10 × 6–8 µm, solitaires ou réunies en courtes chaînes.

Répartition.—Feuilles mortes d'Angiospermes, forêts de Malaisie, localité d'origine (Kuthubutheen & Nawawi, 1987); litière forestière, Mts Koghis, Nouvelle-Calédonie.

Des six espèces connues du genre *Speiropsis* Tubaki, trois produisent des chaînes ramifiées de conidies unicellulaires présentant des structures complexes. *Speiropsis simplex* Matsushima, *S. belauensis* Matsushima et *S. scopiformis* ont des chaînes conidiennes simples. Concernant ce dernier, la présence de conidiophores solitaires non ramifiés, la prolifération répétée jusqu'à neuf fois des cellules conidiogènes et la formation de conidies comparativement plus étroites, le distingue aisément des *Speiropsis* voisins.

Speiropsis scopiformis se développe sur les millieux gélosés usuels, mais les cultures produites se détériorent rapidement. Sa détection en Nouvelle-Calédonie, dans un biotope comparable à sa localité d'origine, élargit sensiblement son aire géographique.

Les dématiées suivantes, ont été également observées dans les chambres humides, inoculées avec des fragments de litières forestières, collectées aux Mts Koghis. Ce sont, pour la plupart, des saprophytes plurivores cosmopolites ou à affinités torpicales; les espèces désignées par un astérisque, ont été déjà signalées en Nouvelle-Calédonie (Huguenin, 1966).

Alternaria alternata (Fr.) Keissler*
Beltrania rhombica O. Penzig*
Botrytis cinerea Pers.: Fr.*
Cladosporium oxysporum Berk. & Curt.
Cladosporium sphaerospermum O. Penzig
Doratomyces microsporus (Sacc.) Morton & Smith
Epicoccum purpurascens Ehrenb. ex Schlechtend.
Memnoniella echinata (Riv.) Galloway*
Myrothecium verrucaria (Alb. & Schw.) Ditmar: Fr.*
Stachybotrys atra Corda*
Ulocladium atrum Preuss

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Summary

A study of fungi developing from forest leaf litter collected in New Caledonia was conducted using the damp chamber method. This first contribution reports on taxonomic and biologic characteristics of the following less common or rare dematiaceous hyphomycetes representing new additions to the mycoflora of this island: *Beltraniella portoricensis* (F.L. Stevens) Pirozynski & Patil, *Nakataea fusispora* (Matsushima) Matsushima, *Paliphora aurea* Sivanesan & Sutton, *Pleurothecium recurvatum* (Morgan) Höhn., and *Speiropsis scopiformis* Kuthubutheen & Nawawi.

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ARSENIC ACCUMULATION IN SOME HIGHER FUNGI

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The high arsenic concentrations reported in literature for *Laccaria amethystina* were amply confirmed. In addition, it was demonstrated that *Laccaria fraterna* also accumulates the element, whereas in other species of *Laccaria* the phenomenon was far less outspoken. Few other basidiomycetes proved to have an affinity for the toxic element. The arsenic concentrations in the principal edible mushrooms of commerce were found to be very low, i.e. on the average 0.5 mg/kg on dry matter. Among the ascomycetes *Sarcosphaera coronaria* was recognized as an accumulating species. The arsenic content of four collections ranged from 360–2130 mg/kg with an average of 872 mg/kg on dry matter.

Many species of higher fungi from various genera are capable of accumulating trace elements including several potentially toxic metals (for reviews, see Stijve, 1980 and Seeger, 1982). So far, very few fungi have been reported to concentrate arsenic from their substrate. Byrne, Ravnik & Kosta (1976) analysed a number of fungi from different genera for this toxic element and found an average concentration of 1.3 mg/kg on dry matter, which is rather low. However, they observed significantly higher levels in *Amanita muscaria* (L.: Fr.) Hook., *Lycoperdon perlatum* Pers.: Pers. and especially in *Laccaria amethystina* Cooke.

This edible common species, sold on the markets in Switzerland, but of minor culinary importance, was found to contain up to 200 mg/kg on dry weight, a really staggering figure (Byrne & Tusek-Znidaric, 1983) if one considers that most vegetable foods contain a 1000 times less. Meanwhile, several other fungi have also been analysed (Allen & Steinnes, 1978) but no additional arsenic accumulators have been reported. It should, however, be noted that, on the whole, the arsenic content of fungi has not been subject of a systematic search. To the authors' knowledge a mere 35 species have been analysed, i.e. far less than the 236 screened for mercury and the 402 for cadmium (Seeger, 1976 and 1978).

Moreover, virtually nothing is known about the trace element content of all those fungi of which the botanical determination is difficult. For example, there are almost no data for the genera *Cortinarius* Fr. and *Entoloma* (Fr.) Kumm., to say nothing about those fungi that are generally known as LBMs (Little brown mushrooms).

Although *Laccaria amethystina* was recognized as an accumulating species more than 13 years ago, the high levels reported have never been checked elsewhere, nor has the search been extended to other members of the genus *Laccaria* B. & Br. in spite of the fact that several of these fungi have a world-wide distribution. Consequently, the present authors undertook a study of the arsenic content of common and rare *Laccaria* species gathered mostly in

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European countries. In order to check whether arsenic accumulation is specific for *Laccaria*, a selection of other higher fungi among which several ascomycetes were included in the investigation.

Experimental

The fungi studied were mostly gathered between 1985 and 1988 at various sites in the Netherlands, the German Federal Republic, Switzerland and France, although for the most rare *Laccaria* species, material was also obtained from Australia. Since *L. amethystina* is an edible mushroom for sale at markets in Switzerland, we included a number of samples purchased at two weekly intervals.

Arsenic was determined by hydride generation atomic absorption spectrometry (AAS) as described in the Manual of the Association of Official Analytical Chemists (1984).

Reliability of the results was ascertained by subjecting selected samples to neutron activation analysis, which was carried out by the direct (non-destructive) method: 0.6–1 samples were sealed in vials and irradiated for 30 minutes in a 'swimming pool' type reactor (capacity 2 KW/h) producing a flux of 10^9 thermal neutrons/cm^2.s. Gamma spectrometric analyses were performed after 20 hours and again after 2 days by measuring the decay of ^{76}. As at 559 KeV using a high resolution Ge-detector.

Results and Discussion

Fungi in general and edible mushrooms

A limited survey encompassing 16 genera of basidiomycetes (Table I) largely confirmed the observations made earlier that arsenic levels in fungi are generally low (Byrne, Ravnik & Kosta, 1976; Allen & Steinness, 1978). Only one collection of *Sarcodon imbricatus* (L.: Fr.) P. Karst., an edible species, was found to contain 22.4 mg/kg, but its origin could not be ascertained, since it was bought on a market. This finding prompted us to examine the principal edible mushrooms of commerce for their arsenic content, but, here again, the results were quite unremarkable (Table II), although the average concentration is somewhat higher than that of most foods of vegetable origin which rarely exceeds 0.25 mg/kg (Ishinishi & al., 1986).

The genus Laccaria

A total of 37 samples representing seven species of *Laccaria* were analysed (Table III). The arsenic-accumulating ability of *L. amethystina* was amply confirmed, although the wide fluctuations in the concentrations are striking. There is little doubt that *L. fraterna* (Sacc.) Pegl. also concentrates important quantities of the toxic element, but the accumulating power of the other species is difficult to appreciate. It is not unthinkable that *L. laccata* var. *pallidifolia* (Peck) Peck and *L. purpureobadia* D. Reid possess the faculty to concentrate arsenic, but that they will only do so under certain as yet unknown conditions. Collections of both species that contained the highest levels were gathered at sites where the soil concentration was definitely lower, i.e. 1.5–2 mg/kg.

Ascomycetes

Upon analysing a number of ascomycetes, the arsenic content of *Morchella* Dill.: Pers., *Gyromitra* Fr., *Helvellaceae,* and a number of cup fungi was found again rather low with the notable exception of that of *Sarcosphaera coronaria* (Jacq.) Boud., which even exceeded the high concentrations reported in *L. amethystina* (Table IV).

Sarcosphaera coronaria is popularly known as the Crown fungus. Its initially hypogeous fruit-bodies split open at maturity to form crown-like cups. In Europe the fungus is encountered in calcareous areas mainly under conifers, although it has also been recorded to grow in beech forests (Brandrud & al., 1986).

Several popular handbooks list it as edible, but some report that it has occasionally been responsible for intoxications. So far, we have never seen it on German or Swiss markets.

Confirmatory analysis

The almost absurdly high arsenic levels encountered in some species prompted us to subject a number of samples to confirmatory analysis by the neutron activation technique. For this purpose, we selected a series covering a concentration range of 0.5–400 mg/kg on dry weight.

The data listed in Table V indicate excellent agreement between the results found by both methods, and confirm the extremely high levels in both *Laccaria amethystina* and *Sarcosphaera coronaria* beyond reasonable doubt.

Conclusions

The high arsenic concentrations in *L. amethystina* reported earlier by Byrne, Ravnik & Kosta (1976) were readily confirmed. In addition, it was demonstrated that a member of the same genus, *L. fraterna,* also accumulates the element. However, few basidiomycetes seem to share this ability. The arsenic content of the principal edible mushrooms of commerce proved to be remarkably low.

Another isolated accumulating species, *Sarcosphaera coronaria,* was found among the ascomycetes. Its arsenic content (determined in four collections of various origin) proved to be about 300 times higher than that of fungi in general. It remains yet to be investigated in how far other cup fungi, such as *Discina* (Fr.) Fr., *Disciotis* Boud., and *Geopora* Harkn., are able to concentrate the toxic element. It is interesting to note that 47 mg/kg arsenic was found in a single *Geopyxis* species, but this observation should be confirmed.

Nothing is yet known about the form(s) in which arsenic occurs in the said mushrooms. *Laccaria amethystina,* although of minor culinary importance, is often sold on the Swiss markets, and it could well be that the arsenic ingested with this mushroom is probably not very toxic. Byrne & Tusek-Znidaric (1983) found that the element was present in a readily extractable, possibly ionic form, associated with low molecular weight substances. It is not unthinkable that this and other arsenic-accumulating fungi contain arsenobetaine and/or arsenocholine, two compounds occurring in several marine organisms (Ishinishi & al., 1986). The authors hope to verify this hypothesis at the earliest opportunity.

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Table I. Arsenic in various higher fungi

Species	Number of samples	Range in mg/kg on dry matter
Clitocybe div. spec.	12	0.14–0.53
Clathrus cancellatus Tourn.: Fr.	1	0.45
Strobilomyces floccopus (Vahl: Fr.) P. Karst.	1	0.37
Clitopilus div. spec.	3	0.99–2.3
Hygrophorus div. spec.	8	< 0.03–2.74
Squamanita odorata (Cool) Imbach	1	0.60
Macrolepiota div. spec.	3	1.2–4.0
Amanita div. spec.	6	0.2–1.85
Lactarius div. spec.	8	0.1–1.52
Russula cyanoxantha (Schaeff.) Fr.	2	0.06–0.09
Cortinarius div. spec.	4	0.81–1.2
Coprinus div. spec.	3	0.15–0.75
Agaricus div. spec.	3	0.15–0.45
Leccinum scabrum (Bull.: Fr.) S.F. Gray	2	< 0.2
Hydnum (Sarcodon) div. spec.	4	0.35–22.4
Polyporus div. spec.	3	< 0.05–0.2

Table II. Arsenic in edible mushrooms of commerce (1982–1987)

Species	Number of samples	Range in mg/kg on dry matter (average in brackets)
Agaricus bispora (J. Lange) Pilát (cultivated white mushrooms)	24	0.05–1.50 (0.50)
Boletus edulis Bull.: Fr. (dehydrated)	11	0.25–1.16 (0.50)
Suillus luteus (L.: Fr.) S.F. Gray (dehydrated)	4	< 0.04–0.26
Cantharellus cibarius Fr.: Fr.	6	0.13–1.30 (0.51)
Morchella esculenta (L.) Pers.	5	0.07–0.89 (0.58)
Auricularia spec.	6	0.08–0.50 (0.22)

Table III. Arsenic levels in members of the genus *Laccaria*

Species	Number of samples	Range in mg/kg on dry matter (average in brackets)
L. laccata var. *pallidifolia*	10	0.43–81 (10.9)
L. bicolor (Maire) P. D. Orton	4	0.28–1.17 (0.71)
L. proxima (Boud.) Pat.	3	0.22–0.66 (0.39)
L. tortilis (Bolt.) Cooke	1	0.39
L. amethystina	11	16–250! (92)
L. fraterna	4	23–266! (129)
L. purpureobadia	4	1.2–6.8 (4.3)

Table IV. Arsenic in some ascomycetes

Species	Number of samples	Range in mg/kg on dry matter (average in brackets)
Morchella esculenta	7	0.07–0.92 (0.61)
Gyromitra esculenta (Pers.) Fr.	2	2.0–2.5
Peziza vesiculosa Bull.: Fr.	2	< 1–2.8
Peziza badia Pers.: Fr.	pooled sample	< 1
Aleuria aurantia (Pers.: Fr.) Fuck.	2	< 1–8.0
Geopyxis carbonaria (Pers.: Fr.) Sacc.	1	47!
Sarcosphaera coronaria	4	360–2130! (872)
Helvella lacunosa Afz.: Fr.	1	0.31
Helvella crispa (Scop.) Fr.	1	0.60
Helvella elastica Bull.: Fr.	1	0.28

Table V. Confirmatory analysis by means of the neutron activation technique

Species	Values found by AAS (in mg/kg on dry matter)	NAA
Helvella crispa	0.67	0.60
Laccaria laccata var. *pallidifolia*	4.3	4.2
Sarcodon imbricatus	23.4	22.6
Laccaria amethystina	186	213
Sarcosphaera coronaria (collected in Fribourg)	405	402
Sarcosphaera coronaria (collected in Puidoux)	372	360

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THE EXPANSION OF SCHIZOPORA CARNEOLUTEA (BASIDIOMYCETES) IN EUROPE, IN PARTICULAR IN THE NETHERLANDS

P.J. KEIZER*

It is reported that the number of records of *Schizopora carneolutea* in Europe has strongly increased recently. This increase cannot be explained by better knowledge among mycologists. In the Netherlands the species has rapidly spread from the SE. in NW. direction. A few remarks on the ecology of the species are made.

The genus *Schizopora* Velen. comprises in Europe two species, viz. *S. paradoxa* (Schrad.: Fr.) Donk and *S. carneolutea* (Rodw. & Clel.) Kotl. & Pouzar. The former is in Europe a very common, well-known fungus; the latter is less common and less well-known. The two species are resupinate polypores and grow on dead wood. They are relatively easy to distinguish and extensive descriptions are available (e.g. Jahn, 1971, 1980; Kotlaba & Pouzar, 1979). In short, the main differences are: the pores are irregular, often slit and relatively large (1–3 per mm) in *S. paradoxa*, regularly roundish or polygonal and relatively small (c. 4–7 per mm) in *S. carneolutea*. The colour of the fruit-body is cream-coloured in *S. paradoxa* and light orange-brown in *S. carneolutea*. On vertical substrates *S. carneolutea* usually forms small pilei whereas *S. paradoxa* grows close to the substrate or only forms narrow ridges of pores. Microscopically, the spores of *S. carneolutea* are smaller and more globose than the spores of *S. paradoxa*, 3.5–4.2 × 3.0–3.4 µm with Q = 1.2–1.3 and 4.5–5–6 × 3–3.5–4.2 µm with Q = 1.4–1.8, respectively (Jahn, 1980).

DISTRIBUTION

Poria carneolutea was originally described by Rodway & Cleland in 1929 from New Zealand. It was known in Eurasia since 1935 as *Poria phellinoides*, described by Pilát (1936) from Siberia. Kotlaba & Pouzar (1979) discovered the synonymy of *Schizopora carneolutea* and *S. phellinoides*. *Poria flavipora* Cooke (1886) is probably an older name for this fungus and the correct name then would be *Schizopora flavipora* (Cooke) Ryv. (Ryvarden, 1985). The species was generally considered as rare. Jahn (1971) mentioned four known localities for the German Federal Republic until then and Domansky (1972) reported two localities in Poland. Less than 10 years later Jahn (1980) listed 42 records of this species in the central part of the German Federal Republic and Kotlaba & Pouzar (1979) published 108 localities in

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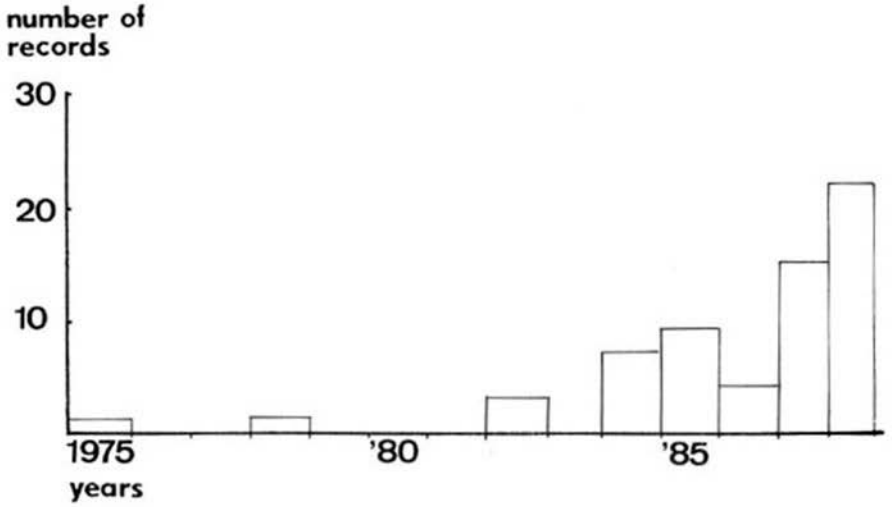

Fig. 1. Numbers of records of *Schizopora carneolutea* from 1975 to 1988.

eastern Czechoslovakia. The species is now also known from the German Federal Republic (Kreisel, 1987), although only from four localities, and occurs frequently in the eastern part of Australia (11 collections in the herbarium of Graz; pers. comm. Prof. Dr. J. Poelt). From the United Kingdom *S. carneolutea* has not yet been reported (pers. comm. herbaria K and E).

Although the species was not generally known before the seventies, it is most improbable that mycologists in that period would not have recognized this species. It must therefore be concluded that *S. carneolutea* was very rare and has drastically increased since. This can be exemplified with Dutch data on the distribution of *S. carneolutea*. In the publication by Donk (1933), who made a thorough study on the Aphyllophorales in the Netherlands, no species were described that fit *S. carneolutea*. The first observation was made by F. Tjallingii in 1975 in S.-Limburg and published by van der Laan (1976). This locality can be regarded as connected with the cluster of records in the central part of the German Federal Republic. After 1975 a strong increase of the number of records appeared, to the total of 62 in 1988 (see Fig. 1). Again, it seems unlikely that the species has completely been overlooked and the conclusion is that the species has strongly increased.

PATTERN OF DISTRIBUTION IN THE NETHERLANDS. — The map of distribution of *S. carneolutea* (Fig. 2) in the Netherlands shows that newer records are located more northwards and slightly more westwards compared with older ones. This indicates that the species has spread rapidly from the centre of the German Federal Republic in NW. direction. Even during mycocoenological research in moist *Alnus* and *Salix* forests in Drente in 1981 and 1982 the

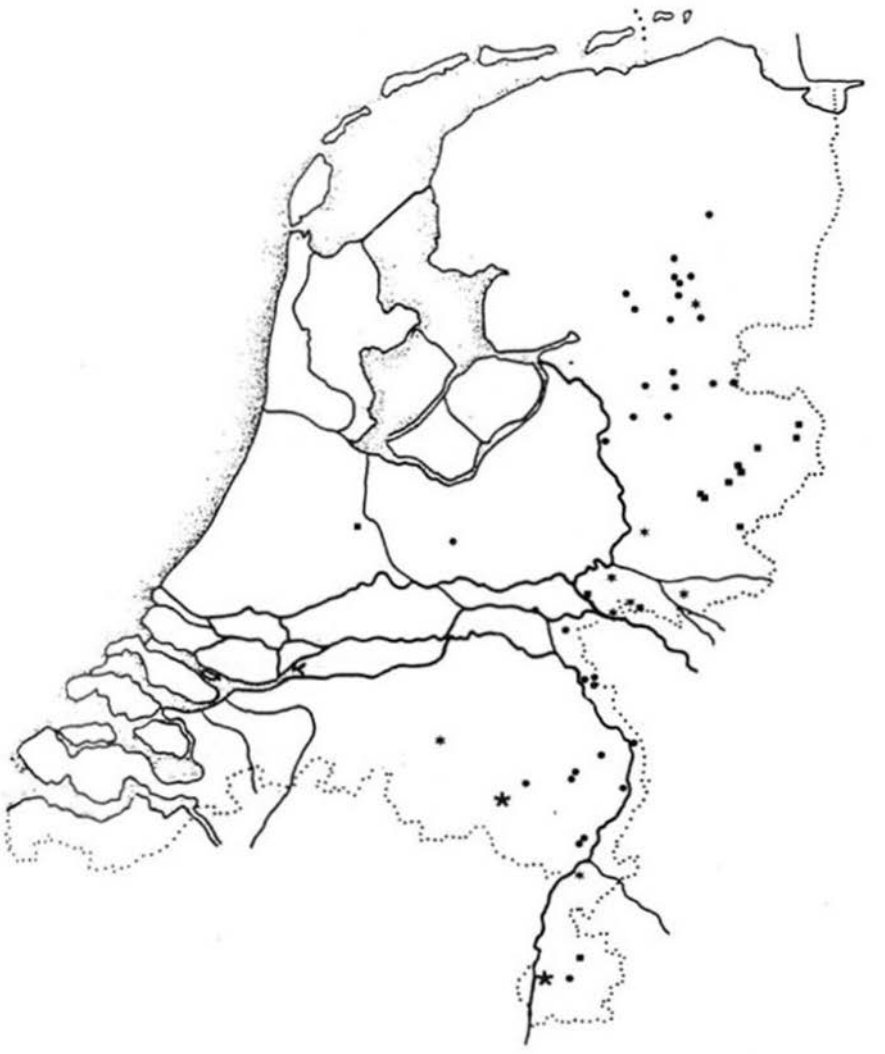

Fig. 2. Distribution of the at present (Jan. 1989) known records of *Schizopora carneolutea* in the Netherlands. Data by the courtesy of the Biogeographical Information Centre (B.I.C.) where many ecological and geographical data of various groups of organisms are stored.
✱ = records 1975–1979; ✶ = records 1980–1984; ■ = records 1985–1986; ● = records 1987–1988.

species was not encountered (Keizer, 1985), and only once in 1982 in *Betula* forests (Jalink & Nauta, 1984). Nowadays it is common in these habitats.

The clusters of records of a certain year in some regions reflect the inventory activities of the Dutch Mycological Society and show that not all regions have been studied with equal intensity. In 1986 there was a foray of a week in the province of Zeeland (in the south-western part of the country), and it is striking that *S. carneolutea* was not found in that region, whereas the species was observed in several places during forays in Twente (1985) and northern Limburg (1987).

It is to be expected that within a few years the species will have reached the forests in the coastal dunes and will cover by then the entire country.

Ecology

Schizopora carneolutea is a saprophyte occurring mostly on the wood of broad-leaved trees. It grows on a wide range of hosts in various types of forests, in the Netherlands mainly in deciduous forests on sandy and clay soils: Quercion roboripetreae 17, Alno-Padion 14 and other or unspecified forest types 10 records. According to Jahn (1980) in West Germany beech wood is the most common substrate, viz. 69% of the records. He reported seven other deciduous wood hosts with low frequency and one record on *Larix*. The annotated Dutch records are as follows: twelve (or 39%) on *Quercus*, six on *Betula*, four on unspecified broad-leaved wood, two on *Salix alba*, and one on *Alnus, Corylus, Fagus, Frangula, Picea, Populus canadensis* (or *P. nigra*), and *Sorbus*. Apparently the species is not very specific with regard to the host plant and the list of hosts merely reflects the availability and frequency of substrates. A great majority (77%) of the observations was made on branches of 1–15 cm thick; on thicker logs and trunks the species is rarer.

The habitat of *S. carneolutea* is very similar to that of *S. paradoxa*, illustrated by the fact that both species can often be found growing on the same piece of wood. The impression exists that the latter species is being locally competed away by the former. More detailed observations and in vitro experiments are needed to get more certainty about this supposition.

It is difficult to give a satisfactory explanation for the above described trends. One possibility is that the species has accidentally been imported from the southern hemisphere to Europe or Asia and has spread from there since. Another explanation, though also highly speculative, could be that certain changes have occurred in the environment, possibly caused by human activities, such as increased nitrogen availability or increased acidity of the habitat. These changes might have been in favour of *S. carneolutea*.

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I thank Dr. E. Arnolds for his critical remarks on the text and Prof. Dr. J. Poelt for some valuable information.

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THIELAVIA AEGYPTIACA, A NEW THERMOTOLERANT ASCOMYCETE FROM EGYPTIAN SOILS

A.F. MOUSTAFA and O.A. ABDUL-WAHID*

Thielavia aegyptiaca spec. nov., isolated from cultivated soil in Egypt, is described and illustrated. It is characterized by dark, fusiform, bi-apiculate ascospores, with single, subapical, conspicuous germ-pores. Its optimum growth is between 30°C and 40°C.

During a survey of the fungal flora of cultivated soils in Ismailia-Governorate, Egypt, an interesting species of *Thielavia*, with brown colonies and dark-pigmented ascomata, was isolated. It proved sufficiently different from other known species (Mouchacca, 1973; von Arx, 1975; Davidson, 1976; Moustafa, 1976) to warrant its description as a new taxon. A short comparison with morphologically similar species is included.

Thielavia aegyptiaca Moustafa & A. Wahid, *spec. nov.*—Figs. 1, 2

Coloniae fere lente crescunt, optime 30°C. Mycelium aeriume hyphis fuscis, 4–6 µm latis, constat. Ascomata dispersa, superficialia, levia, globosa, nonostiolata, 250–350 µm diam., pariete diaphano, 4–6 µm crasso e 2–3 stratis cellularum applanataru, dilute brunnearum, 3–7 µm latarum composito circumdata. Asci globosi vel ellipsoidei, octospori, 22–28 × 16–22 µm, evanescentes. Ascosporae fusiformes, fuscae, 13–14 × 8–10 µm, poro subapicali conspicuo praeditae. Chlamydosporae globosae vel ovoideae vel clavatae, 5–9 × 3–5 µm, singulae, laterales vel terminales in mycelio aerio.

Typus vivus et exsiccatus IMI 327073, isolatus e culta terra Ismailia in Aegypt.

Colonies on oatmeal agar grow moderately, attaining a diameter of 5 cm in seven days at 30°C, with 'Greyish-Sepia' to 'Fuscous-Black' colour (Rayner, 1970). Aerial mycelium composed of branched, septate, smooth, brown hyphae, 4–6 µm wide. Ascomata dispersed, superficial, smooth, spherical to obovate, non-ostiolate, (120–)250–350(–450) µm in diameter, with a translucent wall, 4–7 µm thick, composed of 2–3 layers, of flattened, light brown, 3–7 µm wide cells (textura epidermoidea). Asci globose, subglobose to ellipsoidal, 8-spored, 24–28 × 16–22 µm, evanescent when mature. Ascospores fusiform, dark brown, bi-apiculate, 13–14 × 8–10 µm, with single, very conspicuous, subapical germ pore of 1.0–1.5 µm wide. Chlamydospores abundant in the aerial mycelium, globose, ovate to clavate, single, lateral to terminal, subhyaline, 5–9 × 3–5 µm.

Thielavia aegyptiaca is a thermotolerant fungus, growing well in a wide range of temperatures up to 45°C; its optimum, however, lies between 30°C and 37°C. Growth and sporulation was best on oatmeal and on potato-carrot agar. Colonies on potato-dextrose and malt extract agars remained sterile.

Two species of the genus *Thielavia*, namely *T. arenaria* and *T. subthermophila*, are most

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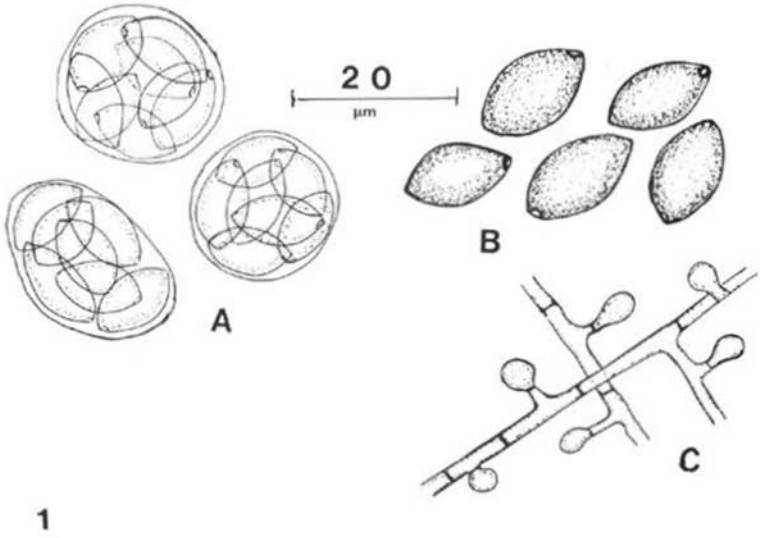

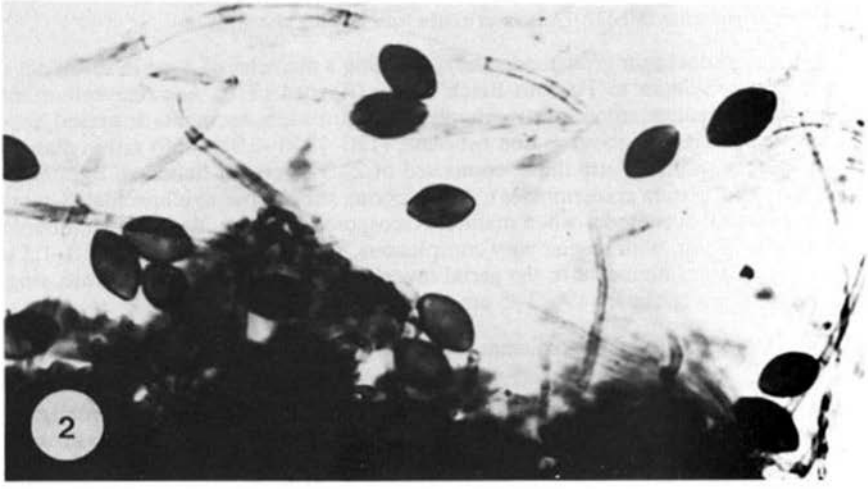

Fig. 1. *Thielavia aegyptiaca*. — A. Asci. — B. Ascospores. — C. Chlamydospores.
Fig. 2. *Thielavia aegyptiaca*, magnified ascospores (light microscopy, × 1300).

probably the nearest to *T. aegyptiaca* as both are thermotolerant, producing dark-coloured mycelium, pigmented chlamydospores, and brown ascospores, with quite distinct, subapical germpores. The ascospore dimension, however, differs markedly in these three species. *Thielavia aegyptiaca*, with ascospores of 13–14 × 8–10 µm, occupies an intermediate position between *T. arenaria* (8–12 × 5–6.5 µm) and *T. subthermophila* (14–19 × 8–10 µm).

It has to be mentioned here that within the genus *Thielavia*, there is a group of recognizable species characterized by dark-pigmented colonies with black reverse, elongated, obovate to ellipsoid, 8-spored asci; fusiform to ellipsoid, dark brown ascospores, with single, subapical germ-pores. The anamorph is always present and represented by clavate to spherical chlamydospores, borne directly on the hyphae or on short branches. This group comprises, in addition to the new taxon, the following species: *T. arenaria* Mouchacca, *T. subthermophila* Mouchacca, and *T. microspora* Mouchacca. These species differ only in ascospore size and position of germ-pores which are typically subapical in all, except *T. microspora*. It is worth mentioning that these four species are isolated from subtropical, arid to semi-arid soils in Egypt and all possess thermophilic potentiality. These common features seem to suggest, at least, an infrageneric taxon within the genus.

Acknowledgements

Sincere thanks are due to Dr. P. Cannon, CAB International Mycological Institute, Kew, UK, for confirming the identification. We extend our thanks also to Drs. R. A. Samson and W. Gams, Centraalbureau voor Schimmelcultures, Baarn, the Netherlands, for reviewing the manuscript and correcting the Latin diagnosis.

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A NEW SPECIES OF PENICILLIUM, P. SCABROSUM

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ROBERT A. SAMSON** and AMELIA C. STOLK**

A new species of *Penicillium*, *P. scabrosum*, was found repeatedly in soil samples from temperate regions of the world, especially northern Europe and Canada. It occurs in high frequencies in wheat and barley field soils together with *P. janczewskii* Zaleski. The species has also been found on fleshy fungi and in foods, particularly as a spoilage organism in food containing lipid and cereal-containing feedstuff. It produces many unknown strongly coloured secondary metabolites. Known mycotoxins from the species include fumagillin, viridicatin, and viridicatol.

An yet undescribed species was repeatedly isolated from soil and food samples and is characterized by strongly coloured colonies, one- to two-staged branched penicilli, very rough conidiophore stipes and rough-walled, globose conidia. Such isolates were encountered in earlier investigations and taxonomists had called them *P. canescens* Sopp, *P.* cf. *atrovenetum* G. Smith (Gams & Domsch, 1970), *P.* cf. *paxilli* Bain., or *P. aurantiogriseum* Dierckx. The isolates representing this taxon are different from all these species and are, therefore, described below as *P. scabrosum*. The specific epithet refers to the conspicuously roughened stipes of the penicilli.

MATERIALS AND METHODS

Isolates of *P. scabrosum* were obtained from food, feedstuff, and soil samples using direct and dilution plating on DG18, DRBC, PRYES or Czapek Dox agar media [see King & al. (1986) and Samson & van Reenen-Hoekstra (1988) for formulations]. They were strongly yellow on PRYES agar in both obverse and reverse, and typically yellow-, orange- or red-brown (usually in concentric differently coloured zones) on Czapek-based media.

The isolates were screened for secondary metabolites using thin-layer chromatography (TLC) (Filtenborg & al., 1983) and high-performance liquid chromatography (HPLC), using the method of Frisvad & Thrane (1987).

Penicillium scabrosum Frisvad, Samson & Stolk, *spec. nov.*—Figs. 1, 2

Stipites conidiophororum asperati, conidiophora bis vel ter verticillata, conidia asperulata, globosa, 2.4–3.2 µm diam.; phialides angustae, collulo conspicuo, fere elongato terminatae. Coloniae reversum luteum vel aurantiobrunneum. Substantiae metabolicae: fumagillinum et nonnulla viridicatina. — Typus: Herb. IMI 285533 (vivus CBS 420.89), isolatus e grano *Zeae maydis*, in Dania, dec. 1983.

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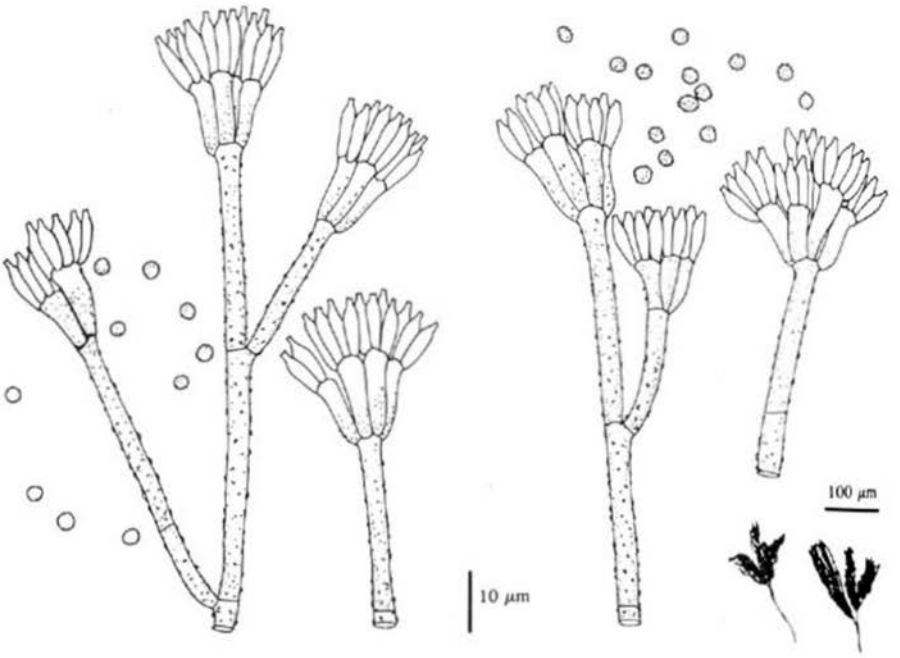


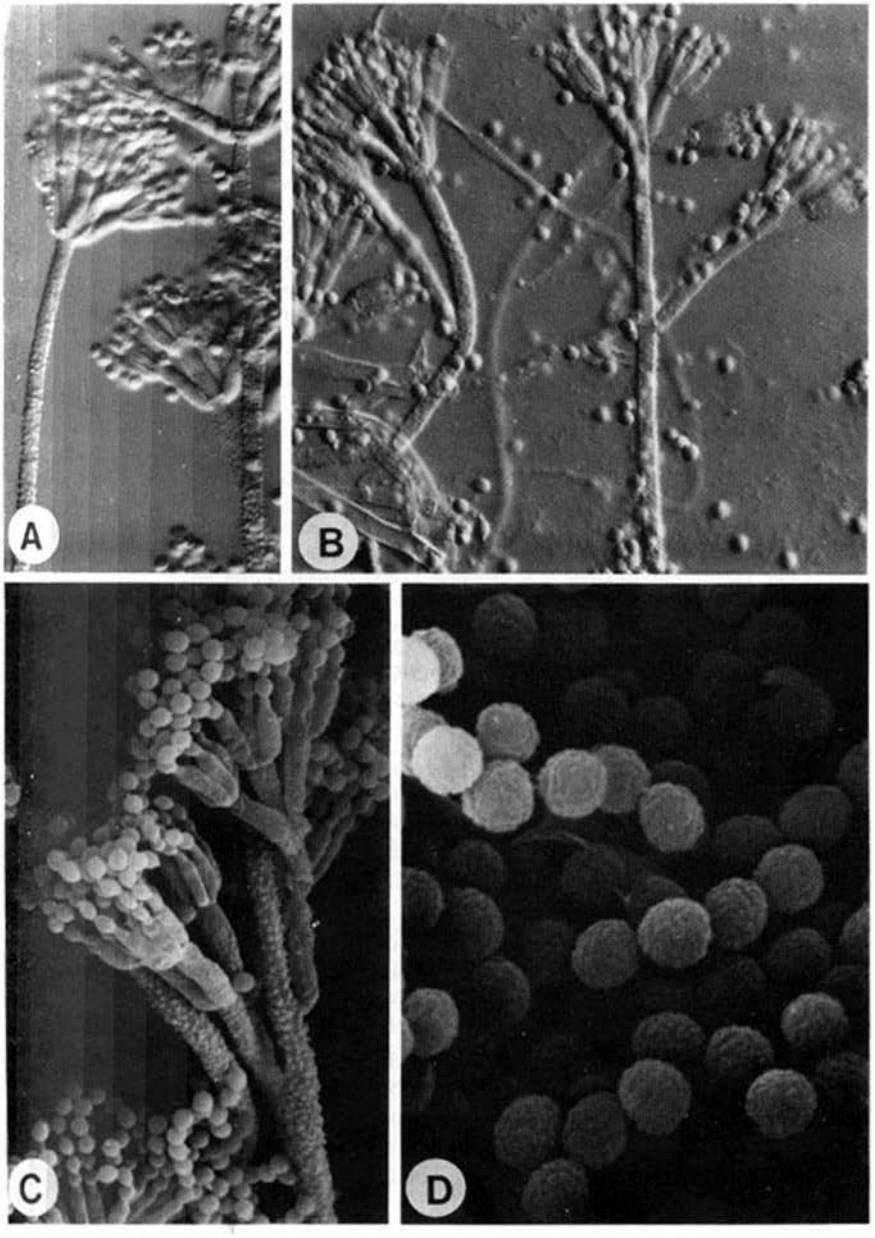
Fig. 1. Camera lucida drawing of the conidiophores and conidia of *P. scabrosum*.

Diagnosis.—Stipes conspicuously roughened, conidiophores bi- and terverticillate, conidia rough, globose (2.4–3.2 µm diam.), phialides slender, with a well-defined, abruptly narrowed collulum; colony reverse yellow to orange-brown on Czapek-based media. Metabolites: fumagillin and viridicatins.

Description.—Conidiophore stipes 200–400 × 3–4 µm, arising from subsurface and surface hyphae, consistently conspicuously roughened and often encrusted. Penicilli predominantly biverticillate, with a comparatively short and compact terminal verticil of 3–6 somewhat appressed to slightly divergent roughened metulae, 10–20 × 2.5–4.0 µm, and often with a relatively low, conspicuously roughened ramus, which occurs at an angle of about 45°, measuring 15–25 × 2.5–4.0 µm. Phialides 5–12 on each metula, slender, with a well-defined, abruptly narrowed collulum, phialides measuring 7–11 × 2.0–2.5 µm. Conidia globose to subglobose, rough-walled, often more or less echinulate, measuring 2.4–3.2 µm, adhering at first in parallel chains, forming loose columns on each metula, later becoming tangled.

Colonies on Czapek-yeast autolysate agar (CYA) 26–32 mm diam. after one week at 25°C, of strictly velutinous texture, plane and only seldom radiately wrinkled, with good

Fig. 2. *Penicillium scabrosum*, conidiophores and conidia. — A, B. Nomarski interference contrast light microscopy (× 800). — C, D. Scanning electron micrographs (× 1300 and × 4200 respectively).


A
B
C
D

sporulation, mycelium white and/or yellow, conidia bluish green en masse (Methuen 24–26 D–F 3), reverse characteristically strongly coloured, bright yellow, orange or yellow-, orange- or red-brown, often in conspicuous concentric zones, exudate often present, yellow or coloured like the reverse, the yellow to yellow-brown colour often diffusing into the agar (this is often more pronounced on malt extract agar, MEA, and Czapek agar), odour insignificant. Colonies on MEA 21–31 mm diam. after one week at 25°C, velutinous to floccose, with good sporulation, conidia dark bluish green en masse, reverse yellow to orange, the colour often diffusing into the agar.

Colonies on 2% Difco Yeast extract-15% sucrose agar (YES) agar conspicuously yellow in both reverse and obverse, radially wrinkled, 32–38 mm diam. after one week at 25°C, good sporulation. On CYA at 5°C colonies 2–4 mm diam. and on CYA at 37°C no growth. Growth on creatine-sucrose agar (Frisvad, 1985) very weak, with no or poor acid production.

ISOLATES EXAMINED.—ON VARIOUS SUBSTRATES: IMI 285533 (ex type) = FRR 2950 = CBS 420.89 = IBT[1] 3736, ex corn, Denmark, Dec. 1983, J.C.F.[2]; IMI 304296, ex mouldy *Flammulina velutipes*, Harderbos, Flevoland, the Netherlands, Nov. 1985, J.C.F.; IBT JHAT, ex mouldy *Armillarea mellea*, Sandbjeg, Denmark, Oct. 1986, J.C.F.; IBT NEE, Air spora, fruit juice production plant, Hørsholm, Denmark, J.C.F.; IBT 3733, 3734, 3737, 3738, 3892, 3897, ex Hollandaise sauce, March 1984, Odense, Denmark, J.C.F.; IBT 3735, ex potato, Lyngby, Denmark, 1985, J.C.F.; IBT B 699, ex swine feed, Oslo, Norway, H. Stenwig; IBT BB2/P4, ex onion, Lyngby, Denmark, 1984, J.C.F.; IBT MLP 6984.3, ex mouldy liver paste, Holbæk, Denmark, 1982, Per Godtfredsen; IBT FRO 15, ex bean sprouts, Lyngby, Denmark, 1986, J.C.F.; IBT BEDF 4 & 8, ex stone, Bedford, Great Britain, 1986, J.C.F.; IBT ALK 35-4, indoor airspora, Denmark, 1988, J.C.F. — ON CEREALS: IBT 3528, wheat (21% moisture content), UK, K.A. Scudamore; IBT KB 7, barley containing 2.83 ppm ochratoxin A, Denmark, 1980, J.C.F.; IBT SA 55, barley (21% water), Ans, Denmark, Feb. 1979; IBT Gamma 3, barley containing 0.432 ppm ochratoxin A, Gudhjem, Den-mark, Jan. 1979, J.C.F. — ON SOIL: CBS 355.68 (= IBT 3739) (as *P.* cf. *atrovenetum*), ex wheat-field soil, Kitzeberg, Kiel, FRG, 1968, W. Gams; CBS 632.70, the Netherlands, J.H. van Emden; CBS 922.70 (= IBT 3740) (as *P.* cf. *paxilli*), the Netherlands, J.H. van Emden; CBS 520.73 (= IBT 3341), Saskatoon, Saskatchewan, Canada, R.A.A. Morrall (SSF 73); CBS 420.89, ex wheat-field soil, Flakkebjerg, Denmark, 1985, S. Elmholt; IMI 304293, ex barley field soil, Flakkebjerg, Aug. 1985, S. Elmholt; IMI 304294, Hven, Sweden, Aug. 1985, J.C.F.; IMI 304295, Teresienstadt, Czechoslovakia, Oct. 1984, J.C.F.; IMI 309316, J.C.F.; IBT HOJ 1, Jagersveld near Lelystad, the Netherlands, May 1985, J.C.F; IBT KLIM 2, Klitmøller, Denmark, Nov. 1986; IBT ISTA 2, lake side 200 km from Istanbul, Turkey, 1986, J.C.F.; IBT KNAJ 2 & 5, Knardijk, the Netherlands, Oct. 1986, J.C.F.; IBT HOUT 4 & 5, Houtribdijk, the Netherlands, Oct. 1986, J.C.F.

Penicillium scabrosum is characterized by conspicuously roughened conidiophore stipes and finely roughened globose to subglobose conidia. The penicilli are predominantly one-stage-branched, but a lower branch often occurs. The new taxon resembles *P. atrovenetum* G. Smith (1956), but this species has only finely roughened stipes and definitely echinulate conidia. Moreover *P. atrovenetum* grows more slowly on MEA (18–22 mm diam. after one week at 25°C). The two taxa have no secondary metabolites in common. Among the ca. 100 different secondary metabolites produced by *P. scabrosum*, cyclopenin, cyclopenol, and viridicatin are antibiotically active and fumagillin is antiprotozoan (Cole & Cox, 1981). In contrast, *P. atrovenetum* produces 3-nitropropionic acid and atroventin (Frisvad & Filtenborg, 1990).

[1] IBT = collection of the Institute of Biotechnology, Lyngby.

[2] J.C.F. = Jens C. Frisvad.

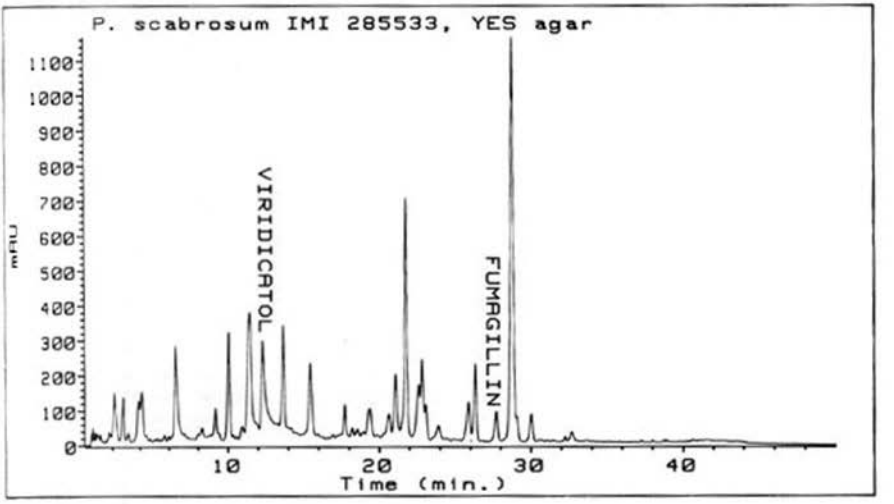


Fig 3. HPLC trace of a chloroform/methanol extract of the culture ex type of *P. scabrosum*.

A total number of 154 isolates of *P. scabrosum* were recovered from soil and food and feed samples and the most important isolates are listed under the isolates examined. We have isolated *P. scabrosum* repeatedly from cultivated soil in the Netherlands and Denmark. Isolates from wheat-field soil in Germany (e.g. CBS 355.68) which were originally assigned to *P. atrovenetum* by Gams & Domsch (1970) proved to be *P. scabrosum*. All the isolates examined have the same profile of secondary metabolites as evaluated by TLC, including several yellow- and blue-fluorescent compounds, both before and especially after treatment of the TLC plates with cold 50% sulphuric acid. Viridicatin, viridicatol, and fumagillin were among the blue-fluorescent metabolites and their identity was confirmed by HPLC with diode array detection.

Penicillium scabrosum should be placed in *Penicillium* subgenus *Penicillium* section *Divaricatum* Raper & Thom ex Pitt series *Atroveneta* Stolk & Samson (see Stolk & Samson, 1985).

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MYCENA OLIGOPHYLLA, ANOTHER NEW SPECIES FROM SOUTHERN NORWAY

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Mycena oligophylla is proposed as a new species and indicated as the type of the new section *Rarifoliatae*. The species is compared with similar-looking *Mycena paucilamellata*, as well as with *Delicatula cuspidata* which had been suggested as possibly identical.

Mycena oligophylla is another new species (cf. Aronsen & Maas Geesteranus, 1989), recently discovered in southern Norway by the first author. On account of the striking scarcity or even absence of lamellae in the specimens found, at first the name *Mycena paucilamellata* from the United States came to mind. The latter is a species described by Smith (1947: 97) who stated that 'the fruiting bodies make very poor herbarium specimens when dried.' This remark seemed likely to spell difficulties for the reexamination of the type material. Fortunately, however, investigation of the stipe, the least vulnerable part of any dried *Mycena*, yielded ample proof that *M. paucilamellata* differs from *M. oligophylla*.

Grateful acknowledgement is made to the authorities of the herbarium at Ann Arbor (MICH) for the loan of the type of *Mycena paucilamellata*.

Mycena **oligophylla** Aronsen & Maas G., *spec. nov.*[1]—Figs. 1–17

Basidiomata solitaria vel sparsa. Pileus 0.7–2.3 mm latus, apice obtusus vel papillatus, aetate interdum depressus, haud translucente striatus, minute pruinosus, glabrescens, udus haud lubricus, materia gelatinosa haud obtectus, albus. Caro tenuis, alba, odore nullo. Lamellae 0–5(–6) stipitem attingentes, late adnatae vel subdecurrentes, albae. Stipes 1–3(–4) × 0.1–0.3 mm, fragilis, totus pruinosus, albus, orbiculo basali instructus.

Basidia 23–27 × 7 µm, clavata, 4-spora, fibulata, sterigmata c. 3.5 µm longa. Sporae 9.4–10.8 × 3.6–4.5 µm, amyloideae. Cheilocystidia 20–27 × 4.5–7 µm, sparsa, subcylindraceae vel subfusiformia, fibulata. Pleurocystidia nulla. Trama lamellarum iodi ope vinescens. Hyphae pileipellis 3.5–6 µm latae, fibulatae, diverticulatae. Hyphae stipitis corticales 2–2.7 µm latae, fibulatae, laeves vel sparse diverticulatae, cellulae terminales (caulocystidia) varieformes ramosaeque, sursum tamen cystidiis similes, 22.5–35 × 6.5–9 × 3.5–4.5 µm. Hyphae orbiculi basalis 2–3.5 µm latae.

Ad Junci conglomerati vaginas vulgo invenitur, etiam ad Caricis sp. caules.

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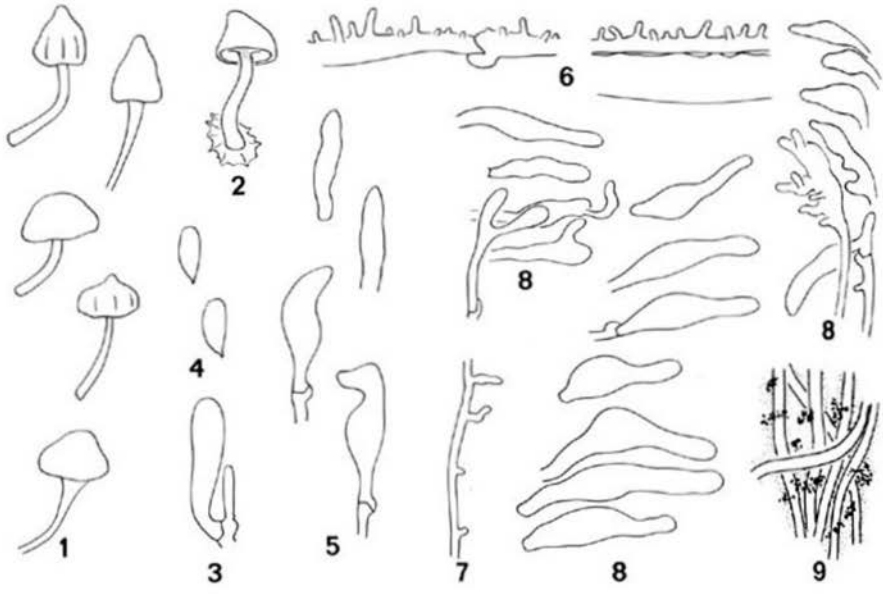
[1] Etymology: oligophylla, having few lamellae.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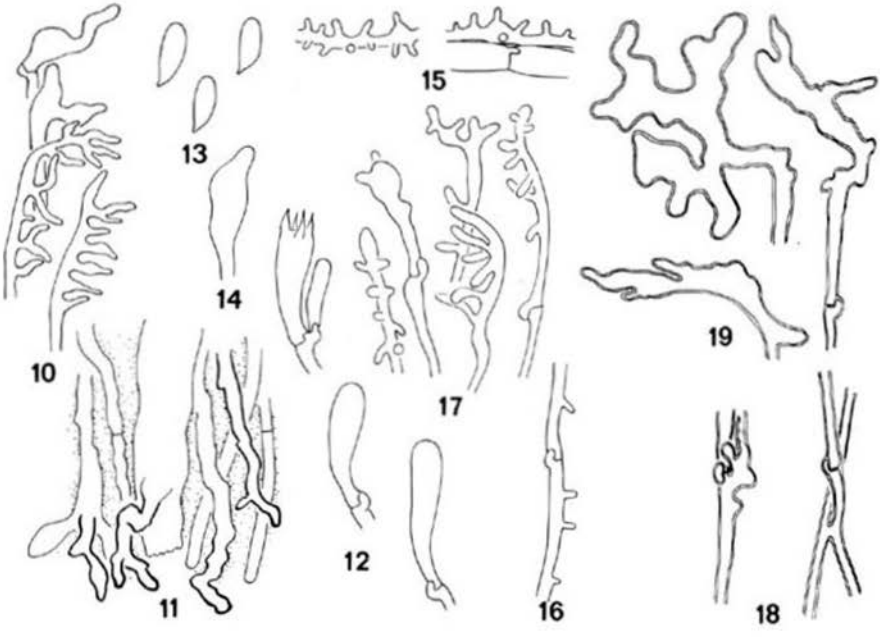
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Holotypus: 'Fungi norvegici / *Mycena oligophylla* Aronsen & Maas G. / leg. *A. Aronsen, no. A. 34/89* / 4 Oct. 1989 / Vestfold: Tjøme, Moutmarka / on the leaf sheaths of *Juncus conglomeratus*' (L, no. 986.126-085).

Basidiomata solitary to scattered. Pileus 0.7–2.3 mm across, conical to parabolical or convex, with or without a small papilla, more rarely hemispherical with the centre somewhat depressed, finally sometimes almost plane and the centre shallowly depressed, shallowly sulcate in some specimens, not in others, not translucent-striate, minutely pruinose, glabrescent, not lubricous when wet, white, the margin involute at first, straightening with age. Flesh very thin, white. Odour none, taste not recorded. Lamellae 0–5(–6) reaching the stipe, rarely fully developed (and then fairly broad), often only showing as low ridges and evanescent before reaching the margin of the pileus, tender, not ascending, broadly adnate to somewhat decurrent, smooth, white, the edge almost straight to concave, white. Stipe 1–3(–4) × 0.1–0.3 mm, fistulose (?), fragile, equal or widened just below the lamellae, sometimes also broadened near the base, terete, curved, smooth, delicately pruinose all over at first, glabrescent except at the apex, white, sometimes seemingly institious but actually attached to the substratum by radiating, fine, whitish fibrils which are united by a very thin film of gelatinous matter to form an irregularly shaped plaque (neither the plaque nor the fibrils being visible in dried material if the substratum has a rough surface).

Basidia 23–27 × 7 µm, clavate, 4-spored, clamped, with sterigmata c. 3.5 µm long. Spores 9.4–10.8 × 3.6–4.5 µm, somewhat narrowly pip-shaped, smooth, amyloid. Cheilocystidia 20–27 × 4.5–7 µm, rather scarce, occurring mixed with basidia, subcylindrical, subfusiform, clamped, smooth, apically gradually narrowed. Pleurocystidia absent. Lamellar trama weakly brownish vinescent in Melzer's reagent. Hyphae of the pileipellis 3.5–6 µm wide, clamped, covered with cylindrical, simple excrescences 2.5–5.5 × 1–2 µm which do not become gelatinized. Hyphae of the cortical layer of the stipe 2–2.7 µm wide, clamped, not gelatinizing, smooth or sparsely covered with cylindrical, simple excrescences 1.5–7 × 1–2 µm, terminal cells (caulocystidia) variously shaped, 20–40 × 2.5–9 µm, much branched, becoming less branched or even simple and subcylindrical farther upwards, then (just below the lamellae) gradually passing into cystidia-like, lageniform elements 22.5–35 × 6.5–9 × 3.5–4.5 µm. Hyphae of the basal plaque 2–3.5 µm wide, apparently not clamped, firm-walled, straight near the base of the stipe, embedded in a very thin film of gelatinous matter and with adhering clumps of dirt, more flexuous to kinked and thick-walled terminally, moreover mixed with some much inflated hyphae up to 13.5 µm wide.

Figs. 1–9. *Mycena oligophylla* (holotype, *Aronsen A 34/89*). — 1. Habit sketches (drawn by A. Aronsen after fresh material). — 2. Basidiome with basal plaque (drawn by M.G. after dried specimen). — 3. Immature basidia. — 4. Spores. — 5. Cheilocystidia. — 6. Hyphae of the pileipellis; one of the hyphae overlying a hypodermal hypha. — 7. Hypha of the cortical layer of the stipe. — 8. Caulocystidia. — 9. Hyphae of the basal plaque embedded in a film of gelatinous matter and encrusted with dirt.

Fig. 10. *Mycena oligophylla* (*Aronsen A 34c/89;* L). Caulocystidia.

Fig. 11. *Mycena oligophylla* (*Aronsen A 34d/89;* L). Hyphae of the basal plaque embedded in a film of gelatinous matter; one hypha much inflated.

Figs. 12–17. *Mycena oligophylla* (*P. Marstad 133-88;* L). — 12. Basidia. — 13. Spores. — 14. Cheilocystidium. — 15. Hyphae of the pileipellis. — 16. Hypha of the cortical layer of the stipe. — 17. Caulocystidia.

Figs. 18–19. *Mycena paucilamellata* (holotype; MICH). — 18. Thick-walled hyphae of the cortical layer of the stipe. — 19. Thick-walled caulocystidia. (Fig. 1, × c. 20; fig. 2, × 20; all others, × 700.)

Growing on the leaf sheaths deep down in clumps of *Juncus conglomeratus*, often found together with *Mycena bulbosa* (Cejp) Kühner, more occasionally also together with *Hemimycena delectabilis* (Peck) Sing. on culms of *Carex* sp.

COLLECTIONS EXAMINED.—NORWAY, Vestfold, Tjøme, Moutmarka: 16 Oct. 1988, *P. Marstad 133-88* (L, no. 986.126-094); 16 Oct. 1988, *A. Aronsen M 45/88* (L, no. 988.051-005); 4 Oct. 1989, *A. Aronsen A 34/89* (holotype; L, no. 986.126-085); 4 Oct. 1989, *A. Aronsen A 34b/89* (L, no. 988.051-074); 4 Oct. 1989, *A. Aronsen A 34c–e/89* (L, no. 988.051-194).

The macroscopic description of the species has been made by the first author, complemented by the second author's observations on the dried material, while the microscopic details are based on reexamination of the collections cited above.

The way the stipe is attached to the substratum may be difficult to discern, especially in fresh material, probably because both the hyphae and the substance of the basal plaque do not stand out clearly against the background when wet. Moistening of this basal part of the dried stipe, however, causes the gelatinous matter of the basal plaque to swell, whereupon the whole is easily lifted from the substratum by means of a tiny scalpel.

The possession of two very differently shaped kinds of caulocystidia is a most unusual character, but it is apparently rare to find them both well-developed on the same stipe.

From the beginning, the name *Mycena paucilamellata* suggested itself since, going by Smith's description, several of its features were found to correspond with those of the Norwegian material, such as small size, white colour, little-developed, somewhat decurrent lamellae and narrow, amyloid spores. Disturbing elements, however, proved to be the description of the stipe as having its base 'inserted' on the substratum and the occurrence of the basidiomes on fallen twigs of *Sequoia sempervirens*. Subsequent reexamination of the type material of *M. paucilamellata* demonstrated that this species is fundamentally different from *M. oligophylla* on account of the thick-walled, smooth hyphae of the cortical layer of its stipe (Fig. 18) and their strangely shaped, much entwined terminal cells (Fig. 19). Extreme scantiness of the type prohibited further investigation.

Another species, kindly pointed out by Dr. Th. W. Kuyper (Wijster) as being possibly the same as the Norwegain find is *Delicatula cuspidata* (Quél.) Cejp. The description by Quélet (1881: 662, pl. 8, fig. 3, as *'Omphalia'*) records such features like 'Chapeau ... festonnée, ... finement floconneux. Lamelles ... très décurrentes, ramifiées. Stipe ... avec la base bulbilleuse et hérissée de soies.' These characters clearly do not apply to *M. oligophylla*. In passing, it may be remarked that Moser (1955: 93 till 1983: 67) accepted *Delicatula cuspidata* as a species with amyloid spores. This amyloidity, however, is an unproved assumption, while it is not clear whether the species actually belongs to *Delicatula*. Kühner (1980: 771) emphatically stated that the genus *Delicatula* in his opinion consists of only a single species — *D. integrella* (Pers.: Fr.) Pat.

Mycena oligophylla could easily be mistaken for some small species of *Hemimycena* on account of its white colour, shape of the pileus, poorly developed lamellae, rather narrow spores, and unobtrusiveness of the scanty cheilocystidia. This may add to the conviction of those who argue that (non-)amyloidity of the spores alone is insufficient as a character to separate *Mycena* and *Hemimycena*, but the issue cannot be pursued in the present paper.

Attempts at determining the pertinent section of *Mycena oligophylla* lead to the first half of couplet 20 of the key published in 1980 (Maas Geesteranus, 1980: 95), indicating section

Pudicae. Although the characters mentioned for this section are precisely those of *M. oligophylla*, this species is not a member of the *Pudicae*, a section which was subsequently abolished (Maas Geesteranus, 1986b: 285) as it was no longer considered to be a subdivision of *Mycena*. However, the abandonment of section *Pudicae* does not nullify the position it originally occupied in the key. In fact, by slightly emending the text of the couplet under discussion (e.g. by adding 'Stipe arising from a basal plaque'), some of the more important features are given that characterize the following new section.

Mycena section **Rarifoliatae** Aronsen & Maas G., *sect. nov.*

Basidiomata minuta. Pileus pruinosus, udus haud lubricus, materia gelatinosa haud obtectus, albus. Caro tenuis, alba, odore nullo. Lamellae perpaucae, molles, late adnatae vel subdecurrentes, albae. Stipes fragilis, totus pruinosus, albus, orbiculo basali instructus.

Basidia clavata, 4-spora, fibulata. Sporae inaequilateraliter ellipsoideae, laeves, amyloideae. Cheilocystidia sparsa, subcylindracea vel subfusiformia, fibulata. Pleurocystidia nulla. Trama lamellarum iodi ope vinescens. Hyphae pileipellis fibulatae, diverticulatae. Hyphae stipitis corticales fibulatae, laeves vel sparse diverticulatae, cellulae terminales (caulocystidia) varieformes ramosaeque, sursum cystidiis similes.

Herbicola.

Species typica: *Mycena oligophylla*.

Basidiomata minute. Pileus pruinose, glabrescent, not lubricous when wet, not covered with a separable, gelatinous pellicle, white. Flesh very thin, white. Odour none. Lamellae very few reaching the stipe, sometimes poorly developed, tender, broadly adnate or somewhat decurrent, white. Stipe fragile, pruinose all over, white, arising from a basal plaque.

Basidia clavate, 4-spored, clamped. Spores pip-shaped, smooth, amyloid. Cheilocystidia rather scarce, subcylindrical to subfusiform, clamped. Pleurocystidia absent. Lamellar trama brownish vinescent in Melzer's reagent. Hyphae of the pileipellis clamped, diverticulate. Hyphae of the cortical layer of the stipe smooth or sparsely diverticulate, terminal cells (caulocystidia) variously formed, branched, farther upwards more cystidia-like. Hyphae of the basidial plaque firm-walled.

Found on herbaceous culms.

Type species: *Mycena oligophylla*.

The specific epithet oligophylla is the plural form of a substantive, of which there exists no adjectival form suitable for the construction of a sectional name. Hence, an equivalent substitute had to be chosen. For euphonious reasons, however, the specific epithet is maintained.

The present section could be thought to be close to section *Basipedes* (Fr.) Quél. (Maas Geesteranus, 1983: 410) on account of its basal plaque. It differs, however, in the absence of a gelatinous pellicle covering the pileus and in the poorly developed, not ascending lamellae with concave edge.

Attachment of the stipe to the substratum by means of radiating fibrils is also known to occur in some species of section *Polyadelphia* Sing. ex Maas G. (Maas Geesteranus, 1986a: 159), more particularly in *M. culmigena* Maas G. and *M. juncicola* (Fr.) Gillet, two species which grow in a habitat similar to that of *M. oligophylla*. But members of this section are characterized by clavate cheilocystidia which are covered by numerous, usually evenly spaced cylindrical excrescences.

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THE TYPIFICATION OF AGARICUS FASTIBILIS PERS.: FR. THE TYPE SPECIES OF THE GENUS HEBELOMA (FR.) KUMM.[1]

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The typification of *Agaricus fastibilis* Pers.: Fr. is discussed. The neotype, which has been designated by Singer, is rejected. As lectotype the illustration of *Agaricus laterinus* by Batsch is designated. Problems associated with a special typification status for sanctioned names are discussed.

When Fries (1821: 249) described *Agaricus* tribus *Hebeloma,* he included only one species in it, viz. *Agaricus fastibilis* Pers.: Fr. The type of this species name is therefore considered as the holotype of both the tribus name (ICBN Art. 33.5, which declares subdivisions of genera termed tribus in Fries's Systema mycologicum as valid; Greuter & al., 1988) and the genus name *Hebeloma* (Fr.) Kumm. We call attention to Fries's diagnosis of tribus *Hebeloma,* which deviates importantly from the characters of *Agaricus fastibilis* as described by Persoon (1801: 326).

Persoon's concept of *Agaricus fastibilis* (Persoon 1801: 326–327) was very broad and included a number of infraspecific taxa, which had the absence of a veil (the species was classified under *Gymnopus*!), the unpleasant, nauseous smell, and the fibrillose-floccose stipe as common features.

Some of these infraspecific taxa belong to the *Hebeloma crustuliniforme*-complex, whereas the status of other infraspecific taxa is more difficult to interpret. Persoon also listed *A. laterinus* Batsch under *A. fastibilis*, and the name *A. fastibilis* would have been nomenclaturally superfluous for *A. laterinus,* if the name *A. fastibilis* had not been adopted and sanctioned by Fries.

The sanctioning description of *A. fastibilis* (Fries, 1821: 249) includes a number of different elements, amongst which both taxa with and without a cortina are present. The diagnosis of tribus *Hebeloma* suggests that in the opinion of Fries the elements with a cortina form the more important part.

Sanction implies not only nomenclatural protection, but also taxonomic protection, because sanctioned names have a special typification status (Korf, 1982). Typification of sanctioned

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names may be effected in the light of anything associated with the name in the sanctioning work (Art. 7.20). This special typification status, introduced at Sydney and reaffirmed at Berlin, is intended to promote nomenclatural and taxonomic stability.

The following three options might be applied in the typification process.—

(1) Typification with an element that is in accordance with Fries's sanctioning description of *A. fastibilis*.

(2) Typification with an element that is in accordance with Persoon's description of *A. fastibilis*.

(3) Typification with the type of *A. laterinus* Batsch, as this name was also cited as a synonym by Fries.

It is clear that all three options are in accordance with the present wording of Art. 7.20. Only the third possibility would have been acceptable if sanctioned names had not been accorded special typification status.

In this case, however, we are not completely free to typify the name *A. fastibilis*, as that name has already been typified by Singer (1961). His (lecto-)typification (actually neotypification, see below) has been accepted by Horak (1968) and Quadraccia (1987).

There are two collections in Persoon's herbarium at L marked *A. fastibilis*. One collection (L 910.258-593), with the remark in Persoon's handwriting '*A. fastibilis* cum cortina', was designated lectotype by Singer. The other collection (L 910.258-591) was rejected as lectotype, on the grounds that it represented a different species.

We consider it unlikely that the designated lectotype is part of the original material, as Persoon described *A. fastibilis* as lacking a cortina (the species was classified in *Gymnopus* and not in *Cortinaria*, where all species with a cortina were placed). As the collection designated lectotype by Singer is almost certainly not part of the original material, it should be regarded a neotype instead. The choice of this neotype must be followed (Art. 8.1), unless (i) any of the original material is rediscovered or (ii) if it can be shown that it is in serious conflict with the sanctioning description (not necessarily with the protologue!). Although the present wording of Art. 8.1 refers to 'serious conflict with the protologue', we note that such an interpretation is clearly contradicted by the explicit wording of Art. 7.20.

Typification according to the first option implies that we are bound to accept Singer's neotypification, as this collection is certainly not in conflict with the sanctioning description (although it is in serious conflict with the protologue). A reinvestigation of this collection by Vesterholt (1989) showed the following characters: spores nearly smooth, ellipsoid, 8.5–10 × 5 µm; cystidia not observed, apparently collapsed. As this collection consists of two slender specimens (pileus 16–22 mm diam.; stipe 32–36 × 2–3 mm), it is clear that this collection is not conspecific with the taxon that is now widely known as *H. fastibile* (sensu Lange, Bruchet, Moser), but represents a closely related taxon, viz. *H. mesophaeum* (Pers.) Quél.! Accepting Singer's neotypification would therefore result in nomenclatural instability and *H. mesophaeum* should be called *H. fastibile*, whereas *H. fastibile* sensu auct. should get another name. This is rather unfortunate, because *H. mesophaeum* is a well-known species in forestry and mycorrhizal research. Vesterholt (1989) proposed that both *H. mesophaeum* and *H. fastibile* sensu auct. should not be separated at specific, but only at varietal level. This taxonomic treatment does not, however, lessen the disadvantage of nomenclatural changes.

The other collection at L was also studied by Vesterholt and found to represent a taxon with longer, amygdaloid, somewhat dextrinoid spores (9.5–12 × 6.5–7 µm); cystidia were not found. Most likely it represents a non-veiled *Hebeloma*, although in the absence of several critical characters any conclusion on its status must remain debatable. Typification based on this collection would therefore hardly be commendable.

Typification according to the second option is excluded, since rejection of Singer's designated neotype is not possible, as this neotype is not in serious conflict with the sanctioning description.

Typification according to the third option seems a better possibility. Agaricus laterinus Batsch (1789: 29) was published with an illustration and, under the revised wording of Art. 9.3 this illustration may be considered the type of *A. laterinus* Batsch, as this latter name is without a type specimen. We designate this 'iconotype' illustration as lectotype of *A. fastibilis* Pers.: Fr. and this lectotype automatically supersedes Singer's neotype. We realise that types, which are based on illustrations, although permissible under the Code, have disadvantages in comparison with specimens, because illustrations cannot be sectioned, analysed, have reagents applied, etc.

This illustration indicates that *A. laterinus* Batsch lacks a veil, just like *A. fastibilis* as described by Persoon. The illustration most likely represents a species belonging to the species complex around *Hebeloma crustuliniforme* (Bull.) Kumm., although its exact identity cannot be determined.

Fries (1821: 249) thought that *A. fastibilis* could be divided in several species, and later (Fries 1838: 178) he set out to refine his earlier views. He reconsidered the importance of velar characters, and arrived at a new classification where *A. laterinus* Batsch was explicitly excluded from *A. fastibilis*, because *A. laterinus* Batsch was included under *A. crustuliniformis*. Interestingly, '*A. fastibilis* Pers. et S.M.' was maintained as a cortinate species, whereas '*A. fastibilis* vulgo' was cited under *A. crustuliniformis*. A study of the 1838 description makes it clear that Fries's revised concept is in close agreement with the taxon that is nowadays called *H. fastibile*.

This situation, that Fries (1838) revised earlier taxonomic decisions made in the sanctioning works, occurs not infrequently when a discrepancy between the protologue and the sanctioning description can be seen. Further examples are *Agaricus adiposus* and *A. scabellus*.

Such cases are normally handled under Art. 48.1 (adoption of an existing name but with explicit exclusion of its original type), but we are not sure whether the sanctioning of the name *A. fastibilis* makes application of that article as straightforward as it would have been without sanctioning. If this article can be applied in this case, we must conclude that *A. fastibilis* Fr. 1838 is a new name. If, however, this article cannot be applied, because Fries (1838) did not exclude all elements that are eligible for typification, we must still cite this taxon as *A. fastibilis* Pers.: Fr. A clarification of the ICBN in this respect seems in order.

In conclusion we note that our lectotypification of *A. fastibilis* has the positive effect of stabilising the nomenclature on species level. Unfortunately, this lectotypification will probably necessitate a change in sectional nomenclature, as *Hebeloma* sect. *Indusiata* will have to replace the name *Hebeloma* sect. *Hebeloma*.

As the sanctioning system is still beset with difficulties, e.g., the criteria for rejection of a neotype and the application of Art. 48.1, renewed study towards its consequences and a reconsideration of its usefulness are certainly necessary.

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NOTES ON THE TYPIFICATION OF SOME SPECIES OF PENICILLIUM

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A number of so far not correctly typified species of the genus *Penicillium* were re-examined. The profiles of secondary metabolites in old type strains and fresh isolates were compared. The type culture of *P. implicatum* Biourge was found to be identical with *P. citrinum* Thom. The first available name for *P. implicatum* sensu Raper & Thom is *P. hispanicum* Ramírez & al. *Penicillium fellutanum* Biourge and *P. phaeojanthinellum* Biourge are both considered to be synonyms of *P. citrinum*. *Penicillium janthinellum* Biourge sensu Raper & Thom agrees with the iconotype of *Spicaria simplicissima* Oud., while *P. simplicissimum* (Oud.) Raper & Thom sensu Pitt is conspecific with *P. brasilianum* Batista & al. *Penicillium minioluteum* Dierckx is redefined, based on an authentic type strain (Biourge 60 = CBS 642.68). *Penicillium griseoroseum* Dierckx is the first available name for *P. chrysogenum* Westling, but the latter name is to be protected by conservation. *Penicillium olsonii* Bain. & Sartory is considered to be a distinct species because it has a specific profile of secondary metabolites, clearly different from *P. brevicompactum* Dierckx. *Penicillium solitum* Westling is regarded as the correct name for dark (bluish) green strains previously called *P. verrucosum* Dierckx var. *melanochlorum* Samson & al. and *P. mali* Gorlenko & Novobranova.

For many decades taxonomic studies on the genus *Penicillium* had been hampered by the lack of proper typification of the described taxa. One of the greatest merits of Pitt (1980) in his monograph is that he typified most anamorphic and teleomorphic species related to *Penicillium*. If no holotype was available, he designated neotypes in many cases. The morphological study of type cultures of many *Penicillium* species can be difficult, when the strains have degenerated after many years of preservation. The atypical strains no longer fit the orginal description and it is sometimes impossible to identify a species using the original strains. However, by analysing the profiles of secondary metabolites, the identity of a type strain with recent, well-developed isolates is often possible (Frisvad, 1986).

In this paper we report the results of the morphological and biochemical examination of some problematic taxa.

MATERIALS AND METHODS

The following species were examined: *P. minioluteum* Dierckx, *P. implicatum* Biourge, *P. pazilli* Bainier, *P. fellutanum* Biourge, *P. janthinellum* Biourge, *P. simplicissimum* (Oud.) Thom, *P. olsonii* Bainier & Sartory, *P. griseoroseum* Dierckx, *P. majusculum* Westling, and *P. solitum* Westling.

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All cultures 'ex-neotypes' and 'ex-holotypes' were inoculated on Czapek agar (CzA), Czapek yeast autolysate agar (CYA), Malt extract agar (MEA, as used by Raper & Thom, 1949) and 2% malt-extract agar, yeast extract-sucrose agar (YES), oatmeal agar (OA) and creatine-sucrose agar (for formulations see Samson & Pitt, 1985; Frisvad & Filtenborg, 1983; and Frisvad, 1985). The fungi were incubated on CYA at 37 °C and on all the other media listed at 25 °C for 14 days and examined after 5, 7, and 14 days morphologically, physiologically, and chemically. The fungi were examined for secondary metabolites using the methods of Frisvad & Filtenborg (1983) based on thin-layer chromatography (TLC), and some were also examined using high-performance liquid chromatography (HPLC) (Frisvad, 1987; Frisvad & Thrane, 1987).

Results and discussion

Penicillium citrinum Thom

Penicillium citrinum Thom *in* Bull. Bur. anim. Ind. US Dep. Agric. 118: 61. 1910. — Lectotype: IMI 92196ii (Pitt, 1980).
Penicillium fellutanum Biourge *in* Cellule 33: 262. 1923.
Penicillium implicatum Biourge *in* Cellule 33: 278. 1923.
Penicillium phaeojanthinellum Biourge *in* Cellule 33: 289. 1923.
For further synonyms see Pitt (1980), except *P. steckii* Zaleski.

Raper & Thom (1949) described *P. implicatum* as an often strongly coloured species producing strictly simple (monoverticillate) penicilli and ellipsoidal to globose conidia with finely roughened walls. They regarded NRRL 2061 as a characteristic isolate. Pitt (1980) suggested to neotypify *P. implicatum* with NRRL 2061, indicating that the original type, Biourge 76, was lost. The original type culture is, however, kept in the collection of the Centraalbureau voor Schimmelcultures (CBS) as CBS 232.38. This latter isolate is, in accordance with the protologue, quite typical of *P. citrinum*. Therefore, *P. implicatum* is a synonym of *P. citrinum*, and this is further confirmed by the fact that CBS 232.38 is still a good producer of citrinin. The first available name for *P. implicatum* sensu Raper & Thom (1949) and Pitt (1980) is *P. hispanicum* Ramírez & al. (1978) (IJFM 3223 = CBS 691.77). Other representative cultures for *P. hispanicum* are NRRL 2061 (= CBS 180.81) and NRRL 2054 (= CBS 337.48). All these cultures do not produce citrinin, but a series of specific secondary metabolites with distinct UV spectra.

Penicillium fellutanum Biourge

The species was described as producing simple to one-stage-branched penicilli with a terminal verticil of 2–5 metulae, thus resembling *P. citrinum*. Biourge listed his no. 177 as type and this is maintained at CMI as IMI 92229ii. This culture is in rather poor condition, but resembles *P. citrinum* and it is in agreement with the protologue. Weak production of citrinin by IMI 92229ii is a further confirmation of the synonymy of *P. fellutanum* with *P. citrinum*. The first available name for *P. fellutanum* sensu Pitt (1980) or Raper & Thom (1949) is *P. charlesii* G. Smith. The ex-type culture of this species does not produce citrinin, but a series of tetronic acids (carolic acid, carlosic acid, etc.).

Penicillium phaeojanthinellum Biourge

Another species described by Biourge (1923), *P. phaeojanthinellum*, also develops simple to one-stage-branched penicilli. The type culture IMI 92267 also produced citrinin on YES agar and therefore this taxon should also be regarded as a further synonym of *P. citrinum*.

Penicillium simplicissimum (Oud.) Thom

Spicaria simplicissima Oud. *in* Ned. kruidk. Archf, Ser. 2, 3: 763. 1903. — *Penicillium simplicissimum* (Oud.) Thom, The Penicillia: 335. 1930. — Neotype: IMI 40238 (Culture ex CBS 340.48 = NRRL 2016).
Penicillium glaucoroseum Demelius *in* Verh. zool.-bot. Ges. Wien 72: 72. 1922 ('1923').
Penicillium janthinellum Biourge *in* Cellule 33: 258. 1923.
Teleomorph: *Eupenicillium javanicum* (van Beyma) Stolk & Scott.

As pointed out by Stolk & Samson (1983), *P. janthinellum* sensu Raper & Thom (1949) and sensu Pitt (1980) cannot be delimited satisfactorily against *P. simplicissimum*, which they considered to be the anamorph of *Eupenicillium javanicum* (van Beyma) Stolk & Scott. Typification of *P. simplicissimum* is based on an iconotype of *Spicaria simplicissima* Oud. in herb. L, and a representative isolate is IMI 40238 (= CBS 340.48).

Penicillium simplicissimum produces variable, irregularly one- to two-stage-branched conidiophores with 2–4 metulae per verticil, slender phialides with a conspicuously narrowed neck and subglobose, very finely roughened conidia. This interpretation of *P. simplicissimum* is different from that by Pitt (1979), who based the species on a dried specimen (Herb. CUP 5921). Pitt also included *P. brasilianum* Batista & al. and its synonyms *P. paraherquei* Abe ex G. Smith and *Penicillium skrjabinii* Schmotina & Golovleva in his concept of *P. simplicissimum*. *Penicillium brasilianum* differs, however, from *P. janthinellum* by larger, more regular, biverticillate penicilli (3–6 metulae per verticil) and ellipsoidal to slightly fusiform, transversely striate conidia. Stolk & Samson (1983) regarded *P. brasilianum*, *P. paraherquei*, and *P. skjabinii* as synonyms of *P. ochrochloron* Biourge. However, these four species differ significantly from *P. simplicissimum* in their capacity to grow at 37 °C, their tolerance to high concentrations of copper sulphate and profiles of secondary metabolites. *Penicillium pulvillorum* Turfitt and *P. piscarium* Westling also included by Pitt (1979) in his concept of *P. simplicissimum* represent separate taxa.

Penicillium ochrochloron, as originally described by Biourge (1923), may indeed be identical with *P. brasilianum*, because it was described as having rough-walled conidia. *Penicillium ochrochloron* was neotypified by Pitt (1979) based on a copper-resistant isolate with smooth-walled conidia, and this concept fits that of the species in the taxonomical and biochemical literature for at least 50 years. We, therefore, suggest that this neotypification be accepted and that *P. brasilianum* be used for the species producing spirally roughened conidia, represented by CBS 253.55.

Penicillium chrysogenum Westling

Penicillium chrysogenum Thom *in* Bull. Bur. anim. Ind. US Dep. Agric. 118: 58. 1910. — Lectotype IMI 24314 (Pitt, 1980).
Penicillium griseoroseum Dierckx *in* Annls Soc. scient. Brux. 25: 89. 1901.
For further synonyms see Samson & al. (1977), Pitt (1980) and Cruickshank & Pitt (1987).

Based on morphology and profiles of secondary metabolites, it is obvious that *P. griseoroseum* Dierckx and *P. chrysogenum* are synonyms. Cruickshank & Pitt (1987) reached the same conclusion using profiles of isoenzymes as a taxonomic criterion. Hennebert (1985) pointed out that the ex-type culture of *P. griseoroseum* (IMI 92220i) survived as the only culture of those described by Dierckx (1901). Because of the long tradition for *P. chrysogenum* and its tremendous importance as the best penicillin producer, we support the proposal to conserve the name *P. chrysogenum* (compare also Frisvad & al., 1990). All isolates examined of *P. chrysogenum* and *P. griseoroseum* produce penicillin, roquefortine C, and meleagrin.

Penicillium brevicompactum Dierckx

Penicillium brevicompactum Dierckx, *in* Annls Soc. scient. Brux. 25: 88. 1901. — Neotype: IMI 40225.

For further synonyms, see Pitt (1980) except *P. volgaense*, which is a synonym of *P. olsonii*.

Penicillium olsonii Bain. & Sartory *in* Annls mycol. 10: 398. 1912. — Neotype: IMI 192502.

Penicillium brevicompactum Dierckx, *P. stoloniferum* Thom, and *P. paxilli* Bain. were included in the *P. brevicompactum* series by Raper & Thom (1949). We concur with Pitt (1980) that *P. stoloniferum* cannot be separated from *P. brevicompactum* and agree with their synonymy. *Penicillium paxilli* was placed by Pitt (1980) in *Penicillium* subgenus *Furcatum* and considered as closely related to *P. herquei*. However, the nomenclature of *P. paxilli* Bain., as adapted by Raper & Thom (1949) and Pitt (1980), is not in accordance with its protologue (Bainier, 1907) and its correct status will be discussed elsewhere (Frisvad & al., in prep.).

Penicillium olsonii is closely related to *P. brevicompactum*. Stolk & Samson (1985) found both species identical based on their morphological examination of the ex-neotype culture, while Bridge & al. (1989a and b) synonymized them on the basis of an integrated multidisciplinary investigation using biochemical, physiological, and morphological features. A type of *P. olsonii* was apparently not distributed, but the species had been neotypified with IMI 195502, originating from *Picea rhizosphere* in the Austrian Alps (Pitt, 1980). The isolate, which has been maintained for twenty years on agar is now deteriorated and has become morphologically close to *P. brevicompactum* (Figs. 1, 2a). However, it is chemically different from this taxon, and in all other characters duplicates the protologue and fresh cultures of *P. olsonii*. *Penicillium brevicompactum* consistently produces mycophenolic acid and other phenols (Fig. 3). In contrast, *P. olsonii* does not produce any known mycotoxins, but a series of unknown specific secondary metabolites.

Penicillium olsonii is characterized by very large conidiophores consisting of a long stipe and a compact, broad, multi-branched penicillus producing pear-shaped or broadly ellipsoidal, finely roughened conidia (Fig. 2). We have obtained numerous typical isolates of *P. olsonii* from glass house soil and plants (including isolates from bananas, the original substrate of the species). In addition, the species was repeatedly found as an airborne indoor contaminant (Verhoeff & al., 1988).

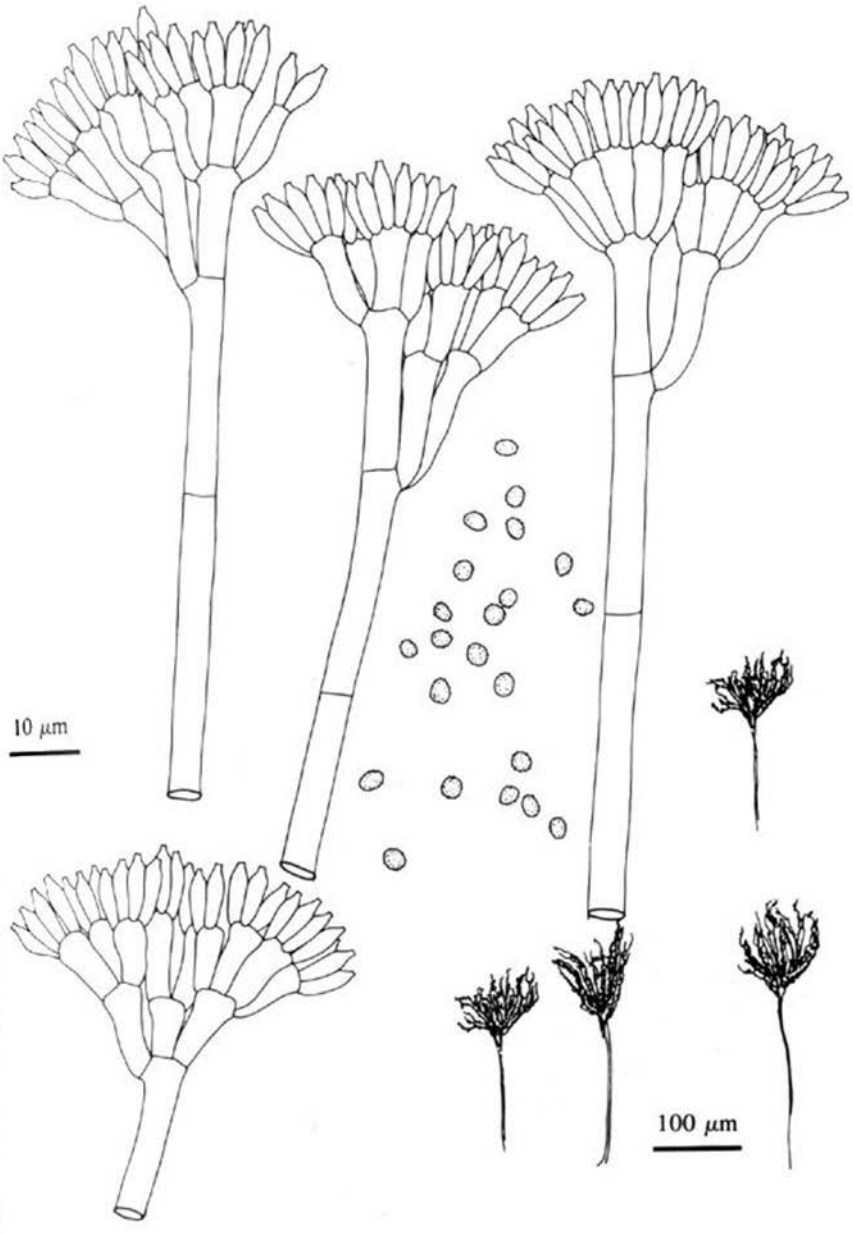

Fig. 1. Camera lucida drawings of *Penicillium brevicompactum*, conidiophores and conidia of CBS 210.28.

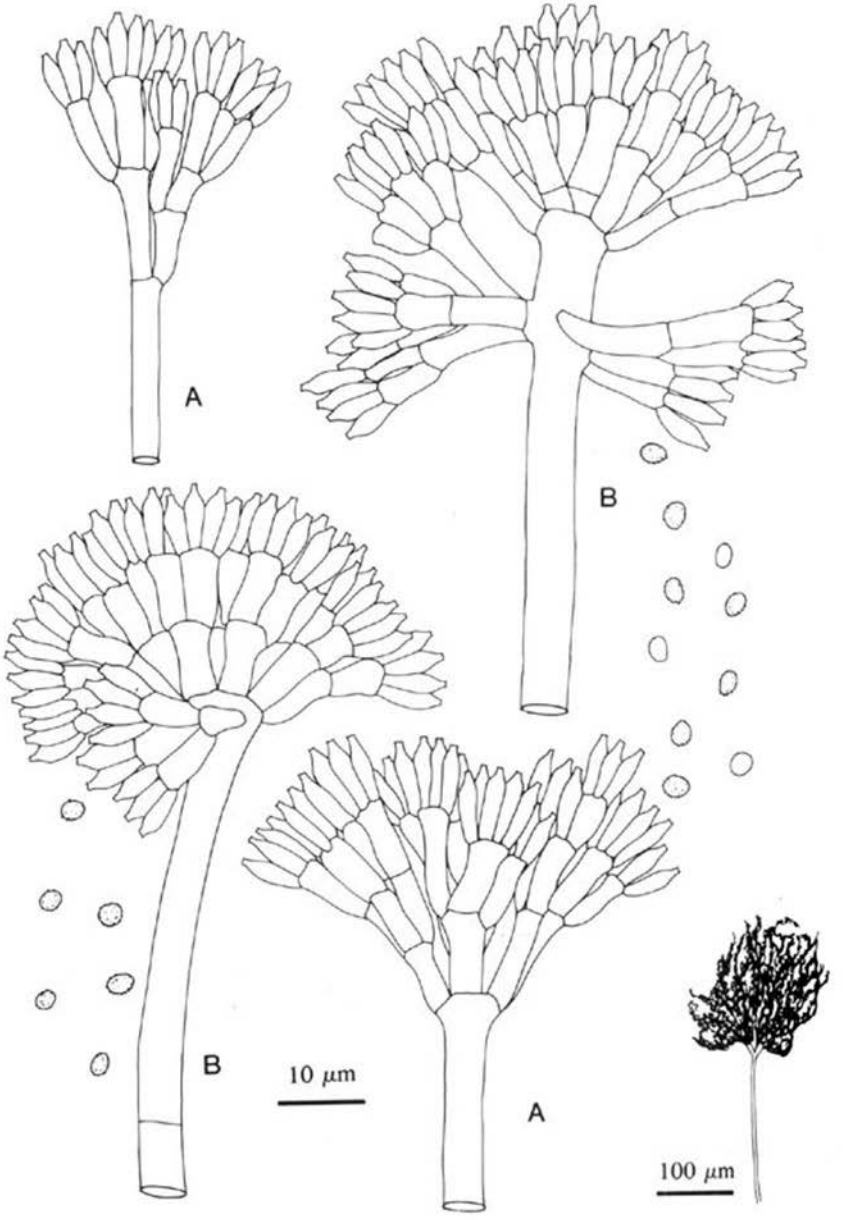

Fig. 2. Camera lucida drawings of *Penicillium olsonii*, conidiophores and conidia. — A. CBS 232.60 (neotype). — B. CBS 883.88.

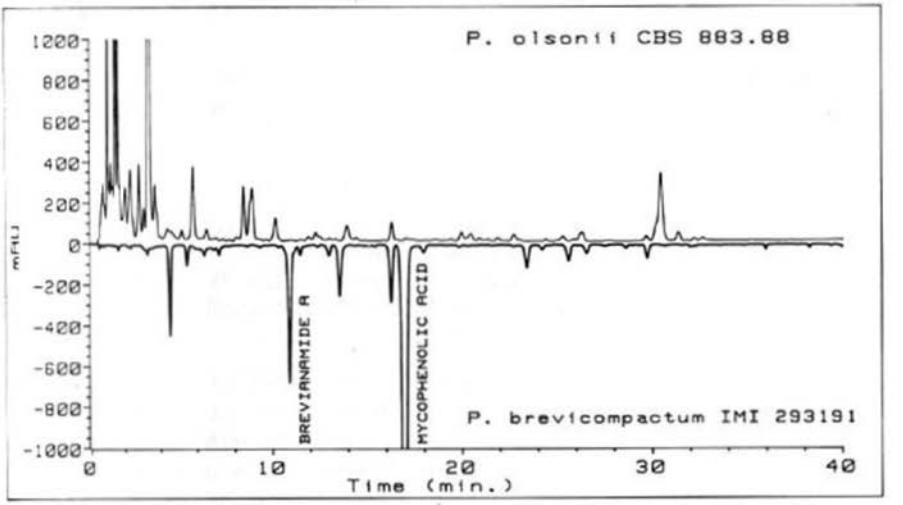

Fig. 3. Comparison of HPLC traces to show the difference between *P. brevicompactum* IMI 293191 and *P. olsonii* CBS 883.88. Note the absence of brevianamide A and mycophenolic acid in *P. olsonii*.

Penicillium minioluteum Dierckx

Penicillium minioluteum Dierckx *in* Annls Soc. scient. Brux. 25: 87. 1901. — Neotype IMI 89377 = CBS 642.68.

Penicillium gaditanum Ramírez & Martínez *in* Mycopathologia 74: 165. 1981.

Penicillium samsonii Quintanilla *in* Mycopathologia 91: 69. 1985.

The isolate Biourge 60 = IMI 89377 = CBS 642.68 considered by Biourge (1923) to represent *P. minioluteum*, is the most reliable material that can serve as neotype. This isolate is not the same as FRR 1714, the isolate on which Pitt (1980) based his concept of *P. minioluteum*. Biourge's isolate does not grow at 37 °C and it grows consistently more slowly than Pitt's FRR 1714 at 25 °C in one week: 6–13 mm diam. versus 20–40 mm on CYA, 10–22 mm versus 31–47 mm on MEA, 11–18 mm versus 22–40 mm on YES and 12–21 mm versus 31–41 mm on OA. The conidia of Biourge 60 are somewhat smaller than those of FRR 1714: 3–4 × 2–2.5 µm versus 4–5 × 2.5–3 µm. Furthermore the profiles of secondary metabolites are very different in the two isolates.

The specific epithet of *P. minioluteum* is particularly descriptive of the slow-growing strongly yellow strains such as CBS 642.68. A similar isolate, NRRL 1034 (from Pretoria, South Africa), was described by Raper & Thom (1949: 619) as 'producing restricted colonies on all substrata' and 'upon malt agar colonies are conspicuously tufted, funiculose, with sterile yellow mycelium' agreeing completely with e.g. CBS 642.68, but in sharp contrast to FRR 1714, which is 'fast growing', 'often low and velutinous' with 'conidiogenesis heavy' (Pitt, 1980: 420–421) on malt agar. The isolate FRR 1714, which Pitt (1980) designated as

the neotype of *P. minioluteum* can be best regarded in *P. rubrum* Stoll, although the exact taxonomic position is still under investigation.

Penicillium gaditanum Ramírez & Martínez and *P. samsonii* Quintanilla are synonyms of *P. minioluteum* (for a more detailed discussion see van Reenen-Hoekstra & al., 1990).

Penicillium solitum Westling

Penicillium solitum Westling *in* Ark. Bot. 11: 65. 1911. — Type: CBS 424.89 = NRRL 937.
Penicillium majusculum Westling *in* Ark. Bot. 11: 60, 1911.
Penicillium verrucosum Dierckx var. *melanochlorum* Samson, Stolk & Hadlok *in* Stud. Mycol. 11: 41. 1976 = *P. melanochlorum* (Samson & al.) Frisvad in Adv. *Penicillium Aspergillus* Syst.: 330. 1985.
For further synonyms see Pitt & Cruickshank (1990).

Westling's type culture of *P. solitum* was accessioned at CBS as CBS 288.36 (from Thom 275.2546) and in Peoria as NRRL 937. The CBS culture has smaller conidia than NRRL 937 and the former grows much faster than the latter on Czapek- and malt-based media and represent a taxon of *Penicillium* subgenus *Furcatum*. This seems to be caused by contamination and cannot be ascribed to degeneration. NRRL 937 is in perfect agreement with the protologue. NRRL 955 and NRRL 954 are Westling's original isolates of *P. majusculum* and they perfectly fit the protologue. Westling (1911) described *P. majusculum* with unusually large conidia, and indeed such conidia were found in both NRRL 954 and 955. However, such conidia were also observed in *P. solitum*, NRRL 937 and in *P. melanochlorum* (Samson & al.) Frisvad, CBS 487.75, even though they occurred in small proportions in all these isolates. Furthermore the four isolates mentioned above produced cyclopenin and some identical unidentified secondary metabolites and thus appear to represent the same species. *Penicillium solitum* was used by Raper & Thom (1949) and has recently been revived by Pitt (1988) and Pitt & Cruickshank (1990) and we follow this nomenclature.

The striking dark green conidial colour in fresh isolates of *P. melanochlorum* tends to get lost after prolonged cultivation on agar and the mycelial overgrowth often becomes more dominant. *Penicillium melanochlorum*, CBS 487.75 now has more greyish blue-green conidia.

Penicillium solitum is morphologically close to *P. commune* Thom, and both species also have a similar ecology (cheese and meat). By using pyrolysis gas chromatography, Soderstrom & Frisvad (1984) showed that an isolate of *P. commune* was different from three isolates of *P. solitum*, but Polonelli & al. (1987) found some relatedness between these taxa using serological techniques. The two taxa mainly differ by their profiles of secondary metabolites. *Penicillium solitum* produces viridicatin, cyclopenin, and compactin, while *P. commune* has cyclopiazonic acid, cyclopolic acid, rugulovasines, palitantin, and isofumigaclavine A. Isolates of *P. solitum* produce dark green conidia on Czapek-based media and orange-yellow mycelium and blue-green conidia on YES agar, while *P. commune* has greyish (blue) green conidia on Czapek-based media and cream-coloured mycelium on YES agar (the sporulation can be either poor or quite strong with green conidia on the latter medium).

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NOTES ON CUP-FUNGI—4
On two rare species of Ascobolus

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Ascobolus carletonii is recorded and studied from Brazil and *A. hawaiiensis* from Pakistan. Both are described and compared with authentic collections.

Ascobolus carletonii Boud.—Fig. 1

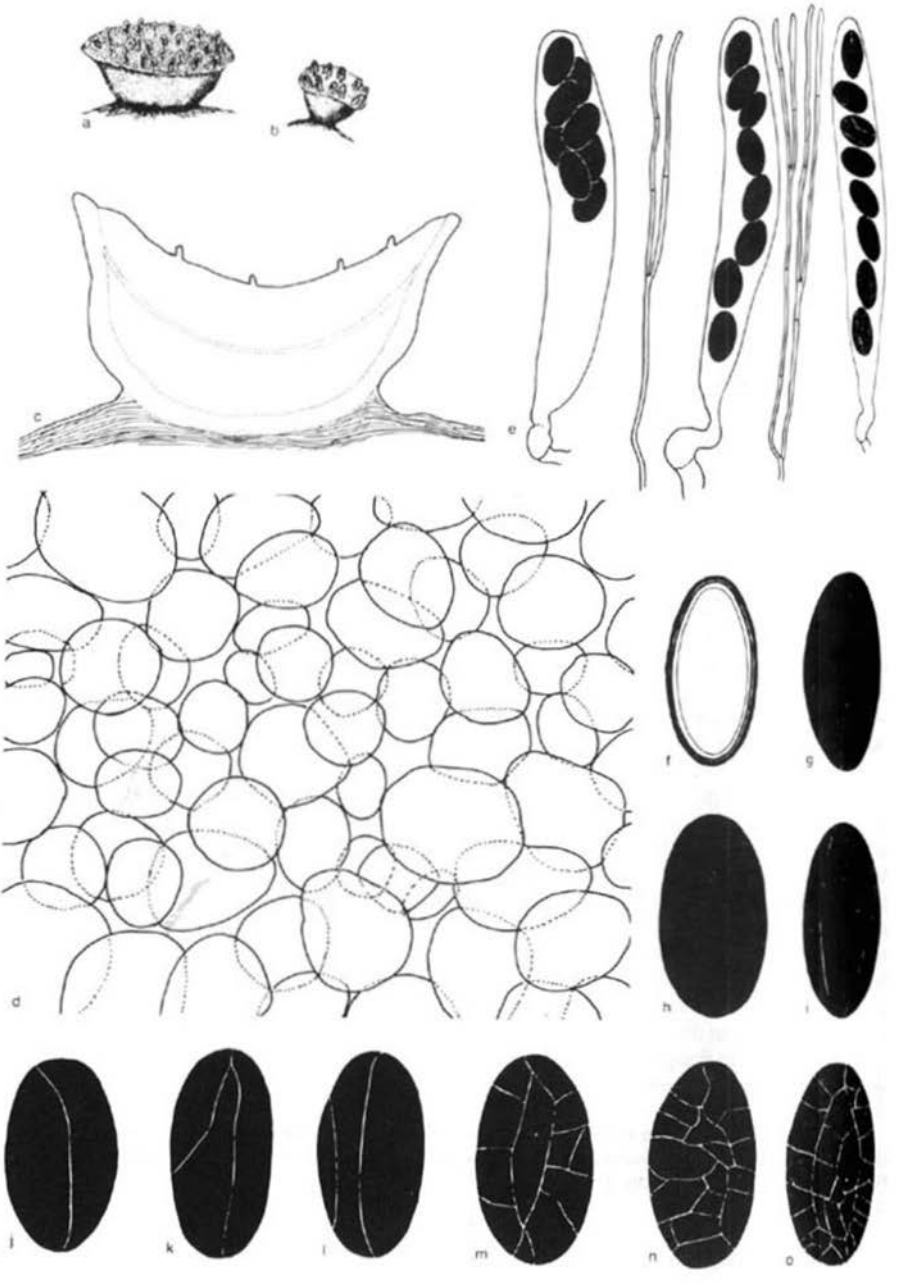
Ascobolus carletonii Boud. *in* Trans. Br. mycol. Soc. 4: 62, pl. 2 fig. 1. 1913.

Apothecia solitary or in small groups, superficial, sessile, 0.5–2 mm wide, 0.5–1 mm high. Receptacle at first subglobular and closed, then opening and cup-shaped, finally expanded, white to pale brownish; surface rather smooth; margin narrow, rather inconspicuous. Disc concave, then flat, roughened by the protruding tips of ripe asci. Hymenium 160–200 µm thick. Hypothecium about 10 µm thick, of closely compacted thin-walled, hyaline cells and hyphae 4–8 µm wide. Medulla clearly differentiated, 130–200 µm thick of isodiametric thin-walled hyaline cells (textura globulosa) 7–20 × 6–16 µm. Cortical excipulum clearly differentiated, 30–110 µm thick, near the base 55–110 µm thick, at the margin 30–50 µm wide, almost colourless to pale yellowish, consisting of subglobular and isodiametric, rather thick-walled (1–2.3 µm) cells 15–55(–70) µm (textura globulosa), in the lower part occasionally covered with somewhat protruding, small groups of subglobular cells; at the extreme base, in contact with the substratum, a layer up to 30 µm thick of closely intertwined thin hyphae 2.5–4.5 µm wide (textura intricata). Asci cylindric-clavate with a short stalk, rounded above, with a large operculum, 150–185(–205) × 16–20(–22) µm, 8-spored; the wall clearly blue with iodine. Ascospores obliquely uniseriate, at maturity often biseriate, ellipsoid (length/width ratio 1.7–2.0, average 1.86), at first hyaline, then violet, becoming purplish brown at maturity, 15–17.5 × 7.5–8.5 µm (pigment layer not included), when hypertrophied up to 19 × 9.5 µm, without oil globules, with a uniform thin smooth layer (0.5–1.0 µm thick) of pigment often with one or very few, more or less longitudinal, fine, rarely anastomosing fissures, but finally in hypertrophied spores usually with an irregular net-work of fine lines. Paraphyses frequent, septate, slender, filiform, sparsely branched, hyaline, 1.6–2.3 µm thick, not or scarcely enlarged upwards, towards the apothecial margin sometimes swollen up to 7 µm at the tip, embedded in yellowish green mucus.

Habitat.—On dung of *Capybara hydrochaeris*. Also known from dung of capercaillie and grouse in Scotland.

Specimens examined.—GREAT BRITAIN, Scotland, 'Inverness' (probably Perthshire according to Richardson (1972)), Dunkeld, on dung of capercaillie (*Tetrao urogalli*), 18.X.1912, *C. Rea* (type, PC). – BRAZIL, Pirai near Rio de Janeiro, on dung of *Capybara hydrochaeris* in moist chamber, 17.XI.1989, *E. Jahn* s.n. (L).

The above description is based on the collection from Brazil, kindly sent by Mr E. Jahn. *Ascobolus carletonii* is a little known species and has not previously been recorded from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outside the British Isles (Ramsbottom & Balfour-Browne, 1951; van Brummelen, 1967; Cannon & al., 1985). Richardson (1972) made it clear that the Scottish localities of this species, among which that of the type specimen (Boudier, 1913), are all in a small region in the county Perthshire. Records from Yorkshire by Masson & Grainger (1937) could not be verified, because of the absence of preserved material.

The Brazilian collection agrees well with the concept of this species as described by van Brummelen (1967). This species is readily recognized by the small fruit-bodies and ascospores which are smooth or with one or two longitudinal striae in the beginning and often with an irregular net-work of cracks in the end.

The presence of warts on the lower part of the outer surface is rarely as prominent as described and illustrated by Boudier (1913). Even in the type specimen most fruit-bodies are rather smooth. The presence of a layer of closely intertwined thin hyphae at the extreme base of the receptacle seems to be a more constant character (cf. Fig. 1c and van Brummelen, 1967: fig. 34a).

The exposed surface of all fruit-bodies and the substratum was found rather densely overgrown with smoke-brown hyphae of varying thickness with phialids of an anamorph belonging to *Phialophora* Medlar. Although the contact of this anamorph with the fruit-bodies of *A. carletonii* was very close, the concrescence of both fungi is considered to be quite coincidental.

Ascobolus hawaiiensis Brumm.—Fig. 2

Ascobolus hawaiiensis Brumm. *in* Persoonia (Suppl.) 1: 87, fig. 17, pl. 3G, H. 1967.

Apothecia solitary or gregarious, superficial, sessile, 170–450 µm wide, 300–600 µm high. Receptacle at first subglobular to ovoid, then barrel-shaped to cylindrical, finally sometimes obconical, pale brownish to pale pinkish grey, smooth, without margin. Disc flat, then convex, white, dotted by far-protruding violet tips of ripe asci. Hymenium 200–260 µm thick, at maturity often far protruding beyond the receptacle. Hypothecium and medulla not clearly differentiated as layers. Cortical excipulum very thin, 10–15 µm thick, pale brownish to pinkish grey, consisting of one or very few layers of subglobular and angular cells 6–20 × 6–12 µm (textura globulosa or angularis). Asci clavate, with a rather long narrow base, rounded above, with a large operculum, 210–250 × 20–30 µm, 8-spored; the wall clearly blue with iodine. Ascospores at first more or less bi-seriate, at maturity irregularly arranged in the upper part of the ascus, ellipsoid (length/width ratio 1.8–2.3, average 2.0), at first hyaline, then purplish violet, purplish brown at maturity, 16.5–21.5 × 9.2–10.5 µm, without oil-globules or granules, thick-walled (1–1.5 µm), ornamented with a uniform layer of isolated, fine, rounded warts 0.5–1.3 µm wide. Paraphyses abundant, sparsely septate, slender, filiform, simple, hyaline, 1.7–2.3 µm thick, not enlarged at the tip, without mucus. Mycelium especially near the base of the receptacles with numerous rather stout, straight hyphoid elements, arising from the outermost layer of the excipulum and connected with the substratum.

Habitat.—On dung of donkey. Also known from sheep dung in Hawaii.

Fig. 1. *Ascobolus carletonii*. — a, b. Habit of fruit-bodies, × 25. — c. Diagrammatic section of fruit-body, × 63. — d. Texture of excipulum seen from outside, × 400. — e. Asci and paraphyses, × 400. — f. Ascospore in optical section, × 1600. — g–o. Ascospores, × 1600. (All from *E. Jahn*, 17.XI.1989.)

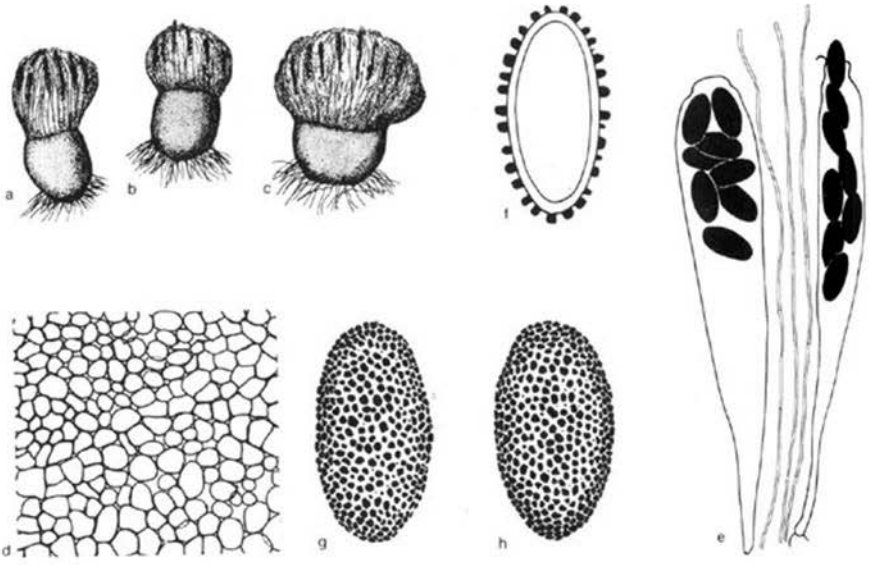

Fig. 2. *Ascobolus hawaiiensis*. — a–c. Habit of fruit-bodies in lateral view, × 40. — d. Texture of excipulum seen from outside, × 400. — e. Asci and paraphysis, × 400. — f. Ascospore in optical section, × 1600. — g, h. Ascospores, × 1600. (All from *E. Jahn*, 12.IV.1990.)

Specimen examined: — PAKISTAN, Upper Kagahn-Valley, on dung of donkey (comm. Dr Hechler) in moist chamber, 12.IV.1990, *E. Jahn* s.n. (L).

The collection cited is the second record of *Ascobolus hawaiiensis*. The above description is based on a specimen sent by Mr E. Jahn and agrees well with that of the type specimen (van Brummelen, 1967).

The smaller measurements of the asci in the specimen from Pakistan are certainly due to the absence of high turgor in the ripe asci. On the other hand the hymenium as a whole has swollen considerably and is protruding far beyond the margin of the receptacle. This is a rather common feature among members of *Ascobolus* sect. *Dasyobolus*, where the excipulum shows only a very restricted growth.

The species is readily recognized by the very small fruit-bodies and the finely round-warted ascospores.

Ascobolus hawaiiensis must have been overlooked because of its minute fruit-bodies and will probably be found again from tropical regions on a closer examination of dung samples.

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DISPOSITION OF RECENTLY DESCRIBED SPECIES OF PENICILLIUM

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ROBERT A. SAMSON** and AMELIA C. STOLK**

Hundred and twenty-two species, varieties, and new combinations of *Penicillium*, *Eupenicillium*, and *Talaromyces* described since 1977 have been studied taxonomically and screened for mycotoxin production. Only 48 taxa could be accepted: *Eupenicillium angustiporcatum*, *E. cryptum*, *E. lineolatum*, *E. limoneum*, *E. nepalense*, *E. sinaicum*, *Penicillium aethiopicum*, *P. coalescens*, *P. confertum*, *P. coprobium*, *P. coprophilum*, *P. dendriticum*, *P. eberhardtii*, *P. erythromellis*, *P. flavidostipitatum*, *P. heteromorphum*, *P. hispanicum*, *P. jugoslavicum*, *P. lapatayae*, *P. loliense*, *P. maclennaniae*, *P. macrosporum*, *P. mariaecrucis*, *P. mononematosum*, *P. nodulum*, *P. oblatum*, *P. onobense*, *P. palmae*, *P. palmense*, *P. panamense*, *P. patens*, *P. pittii*, *P. primulinum*, *P. rubefaciens*, P. sabulosum, P. shennongjianum, P. siamense, P. smithii, P. vasconiae, *P. vonarxii*, *P. vulpinum*, *Talaromyces assiutensis*, *T. derxii*, *T. macrosporus*, and *T. mimosinus*. Eleven varieties are recognized in *P. aurantiogriseum*, *P. chrysogenum*, *P. glandicola*, *P. griseofulvum* and *P. hirsutum*. *Paecilomyces pascuus* Pitt & Hocking and *Geosmithia viridis* Pitt & Hocking are transferred to *Penicillium*.

Since 1977 122 new names have been described in *Penicillium*, *Talaromyces* and *Eupenicillium*, which were not included in the monograph of Pitt (1980). Morphological and chemical studies of the type strains in our laboratories showed that some of the recently described species are not new to science. In this paper we report the results of our studies based on morphology and production of known mycotoxins and other secondary metabolites.

MATERIALS AND METHODS

Type and additional cultures of the recently described species of *Penicillium* and associated teleomorphs were obtained from the CAB International Mycological Institute, Kew, England and from J.A. Quintanilla, Compania de Industrias Agricolas, Valladolid, Spain, C. Ramírez, Instituto Jaime Ferrán de Microbiologia, Madrid, Spain, J.I. Pitt, CSIRO Division of Food Research, Sydney, Australia, and Qi Zu-tong, Institute of Microbiology, Academia Sinica, Beijing, China.

The cultures were grown on CYA (Czapek-yeast autolysate agar), MEA (malt extract agar), YES (yeast extract-sucrose agar) (Frisvad & Filtenborg, 1983), oatmeal agar (Samson & Pitt, 1985), creatine-sucrose agar (Frisvad, 1985b) at 25°C and on CYA at 37°C (Samson & Pitt, 1985). The cultures were screened for mycotoxin production by a simple thin layer chromatography method (Frisvad & Filtenborg, 1983) and in some cases by HPLC (Frisvad, 1987).

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Results and discussion

The isolates examined are listed in Table I. The status of the validly published taxa is summarized in alphabetic order in Table II. Several new names which were proposed by Pitt (1980) for known anamorphs of *Eupenicillium* and *Talaromyces*, to comply with Art. 59 of the International Botanical Code of Nomenclature are not included in this list. A list of nomina nuda in *Penicillium* and the correct identity of isolates deposited in major culture collections is given in Table III. The results of a TLC screening for mycotoxins and secondary metabolites are also listed in Tables II and III. Accepted taxa are indicated in the following text with an asterisk (*).

GENUS EUPENICILLIUM

Eupenicillium angustiporcatum Takada & Udagawa *in* Trans. mycol. Soc. Japan 24: 143. 1983.

The ex-type culture produces only a few reduced conidiophores and, in spite of many attempts, no teleomorph could be observed in culture. According to Takada & Udagawa's description, the ascospores are ornamented with two prominent well-separated equatorial ridges and the valves show several low ribs. The species is probably related to *E. lineolatum*.

Eupenicillium cryptum Gochenaur *in* Mycotaxon 26: 349. 1986.

According to the description, *E. cryptum* is probably close to *E. javanicum*. It differs morphologically in producing ascospores with prominent equitorial ridges. The type strain shows an unstable colonial morphology and a restricted carbon nutrition. It does not produce the teleomorph any more.

Eupenicillium limoneum Gochenaur & Zlattner apud Stolk & Samson *in* Stud. Mycol. 23: 100. 1983.

The description of this species was included by Stolk & Samson (1983).

Eupenicillium lineolatum Udagawa & Horie *in* Mycotaxon 5: 493. 1977.

Eupenicillium lineolatum was reduced to a variety of *E. javanicum* by Stolk & Samson (1983), but we now regard the taxon as a distinct species (Frisvad & al., 1990a).

Eupenicillium nepalense Takada & Udagawa *in* Trans. mycol. Soc. Japan 24: 146. 1983.

Eupenicillium nepalense is very close to *E. inusitanum* Scott but the penicilli of the latter species are biverticillate rather than monoverticillate and the ascospores of *E. nepalense* are smaller than those of *E. inusitanum* and *E. fractum*. The three taxa may be conspecific, and a detailed chemical study has still to be done.

Eupenicillium sinaicum Udagawa & Ueda *in* Mycotaxon 14: 266. 1982.

This species was discussed and accepted by Stolk & Samson (1983).

GENUS PENICILLIUM

Penicillium subgenus Aspergilloides

Penicillium alicantinum Ramírez & Martínez *in* Mycopathologia 72: 185. 1980.

Penicillium alicantinum is a synonym of *P. citreonigrum*, and this is further confirmed by the production of citreoviridin by all isolates of both taxa. Sclerotia were observed in the ex-type culture of *P. alicantinum* but also observed by Wicklow (1984) in an atypically vesiculate strain of *P. citreonigrum* producing citreoviridin.

Penicillium brevissimum Rai & Wadhwani *in* Curr. Sci. 45: 192. 1976.

The ex-type culture of *P. brevissimum* only produces few cylindrical conidia, but fits *P. capsulatum* Raper & Fennell and is therefore considered a synonym of this taxon.

Penicillium gallaicum Ramírez & al. *in* Mycopathologia 72: 30. 1980.

Like *P. alicantinum*, *P. gallaicum* is considered to be a synonym of *P. citreonigrum*. The type culture of *P. gallaicum* produces citreoviridin and forms sclerotia.

Penicillium gerundense Ramírez & Martínez *in* Mycopathologia 72: 182. 1980.

Because of its broadly ellipsoidal smooth-walled conidia, we consider *P. gerundense* a synonym of *P. dierckxii* Biourge.

Penicillium grancanariae Ramírez & al. *in* Mycopathologia 66: 79. 1978.

Penicillium grancanariae is conspecific with *P. thomii* Maire, differing slightly by the formation of rough-walled conidia with transverse striations.

****Penicillium heteromorphum*** Kong & Qi *in* Mycosystema 1: 107. 1988.

Penicillium heteromorphum strongly resembles species such as *P. cinereoatrum* Chalabuda, *P. arabicum* Baghdadi, *P. griseolum* G. Smith, and *P. dimorphosporum* Swart, characterized by the initial production of grey, smooth, subglobose to ellipsoidal conidia that later become globose and rough. According to the original description, *P. heteromorphum* differs from these species by its inability to utilize nitrate and no growth at 37°C. However, the cultures ex type kept at CBS and CMI all grew at 25°C and 37°C and reached a diameter of 10-12 mm on CYA after one week. *Penicillium heteromorphum* shares the inability to utilize nitrate with *P. griseolum*. A more detailed study is needed to elucidate its taxonomic position.

****Penicillium hispanicum*** Ramírez & al. *in* Mycopathologia 66: 77. 1978.

Frisvad & al. (1990c) have pointed out that *P. hispanicum* is the first available name for Raper & Thom's (1949) concept of *P. implicatum*, because the type of the latter species belongs in *P. citrinum* Thom. *Penicillium hispanicum* produces many specific secondary metabolites distinguishing it from other monoverticillate species.

****Penicillium juguslavicum*** Ramírez & Muntanola-Cvetkovic *in* Mycopathologia 88: 65. 1984.

The species is reminiscent of *P. bilaiae* and *P. charlesii*, but differs by its faster growth at Czapek agar.

Table I. Taxa of *Penicillium*, *Eupenicillium*, and *Talaromyces*, described since 1977, and isolates examined.

Name	Culture
P. aethiopicum	IMI 285624 (T)
P. alicantinum	IMI 253789 = CBS 164.81 (T)[1]
P. allii	CBS 131.89 (T), CBS 188.88
E. angustiporcatum	CBS 202.84 (T)
P. aragonense	IMI 253790 = CBS 171.81 (T)
T. assiutensis	CBS 147.78 (T)
P. asturianum	IMI 253788 = CBS 173.81 (T)
P. aurantioflammiferum	CBS 165.81 (T)
P. aurantiogriseum var. *melanoconidium*	IMI 321503 (T)
P. aurantiogriseum var. *neoechinulatum*	IMI 296937 = NRRL 13486 (T)
P. aurantiogriseum var. *polonicum*	CBS 222.28 (T)
P. brevicompactum var. *magnum*	IJFM 5954 (T)
P. brevissimum	CBS 763.68 (T)
P. brunneostoloniferum	CBS 317.50 (T)
P. burgense	CBS 325.89 (T)
P. caerulescens	Q 1147 (T), Q 1152, Q 1155, Q 1161, Q 1300[2]
P. castellae	CBS 272.83 = Q 1012 (T), Q 1024, Q 1036, Q 1349
P. castellonense	IMI 253791 = CBS 170.81 (T)
P. chalybeum	FRR 2660 = CBS 254.87 (T), FRR 2659, FRR 2658
P. chrysogenum var. *dipodomyis*	IMI 296926 = NRRL 13485 (T)
P. ciegleri	IJFM 7673 = CBS 275.73 (T)
P. cluniae	CBS 326.89 (T)
E. cryptum	ATCC 60138 = CBS 271.89 (T)
P. coalescens	CBS 104.83 = Q 1138 (T)
P. confertum	CBS 171.87 = IMI 296930 (T)
P. coprobium	IMI 293209 (T)
P. coprophilum	CBS 477.75
P. cordubense	CBS 162.81 (T)
P. corynephorum	FRR 2663 = CBS 256.87 (T), FRR 2676
P. dendriticum	CBS 660.80 = FRR 1885 (T), CBS 191.89
T. derxii	NHL 2982 = CBS 413.89 (T) + NHL 2981 = CBS 412.89 (T)
P. eberhardtii	- -
P. erythromellis	CBS 644.80 (T)
P. fagi	CBS 689.77 (T)
P. flavidostipitatum	CBS 202.87 = IJFM 7824 (T)
P. gaditanum	IMI 253792 = CBS 169.81 (T)
P. gallaicum	IMI 253794 = CBS 333.79 (T)
P. gerundense	IMI 253804 = CBS 334.79 (T)
P. glandicola var. *confertum*	IMI 296930 = NRRL 13488 (T)

[1] T: culture ex type.

[2] Q: from the collection of J.A. Quintanilla.

Name	Culture
P. glandicola var. *glandicola*	CBS 333.48
P. glandicola var. *glaucovenetum*	IMI 293197 (T)
P. glandicola var. *mononematosum*	IMI 296925 = NRRL 13482 (T)
T. gossypii	CBS 645.80 (T)
P. granatense	IMI 253795 = CBS 166.81 (T)
P. grancanariae	IMI 253783 = CBS 687.77 (T)
P. granulatum var. *globosum*	IMI 299049 (T), IMI 297543
P. griseofulvum var. *dipodomyicola*	IMI 296935 = NRRL 13487 (T)
P. heteromorphum	AS 3.4525 = CBS 226.89 (T)
P. hirsutum var. *albocoremium*	IMI 285511
P. hirsutum var. *allii*	CBS 131.89 (T)
P. hirsutum var. *hordei*	CBS 701.68 (T)
P. hirsutum var. *venetum*	IMI 321520
P. hispalense	- -
P. hispanicum	CBS 691.77 (T)
P. ilerdanum	IMI 253793 = CBS 335.79 (T)
P. juguslavicum	IJFM 7785 = CBS 192.87 (T)
P. lacus-sarmientei	IJFM 19078 = CBS 685.85 (T)
P. lapatayae	IJFM 19012 = CBS 203.87 (T)
E. limoneum	CBS 650.82 (T)
E. lineolatum	CBS 188.77 (T)
P. loliense	CBS 643.80 (T)
P. maclennaniae	IJFM 7852 = CBS 196.81 (T), CBS 197.81, CBS 198.81
T. macrosporus	CBS 317.63
P. malacaense	IMI 253801 = CBS 160.81 (T)
P. mali	CBS 500.73
P. mariaecrucis	CBS 270.83 (T), Q 1022, Q 1049, Q 1118
P. mediolanense	ATCC 44200 = IJFM 7812 (T)
P. melanochlorum	CBS 487.75 (T), CBS 140.86, CBS 141.86 – 146.86
P. michaelis	CBS 144.83, Q 1150
T. mimosinus	CBS 659.80 (T)
P. mononematosum	CBS 172.87 = IMI 296925 (T)
P. murcianum	CBS 161.81 = IMI 253800
E. nepalense	CBS 203.84
P. nodulum	AS 3.4524 = CBS 227.89
P. nordicum	IJFM 7813 (T)
P. oblatum	FRR 2234 = CBS 258.87 (T), FRR 2233
P. olivicolor	CBS 246.32 (T)
P. onobense	IMI 253787 = CBS 174.81 (T)
P. ovetense	CBS 163.81 (T)
P. palmae	CBS 442.88 (T), CBS 829.88
P. palmense	CBS 336.79 (T)
P. panamense	CBS 128.89 = IMI 297546 (T), IMI 297558 = CBS 129.89
P. patens	FRR 2661 = CBS 260.87 (T)

Name	Culture
P. pittii	CBS 139.84 = Q 1240 (T)
P. primulinum	CBS 321.48 = NRRL 1074 (T)
P. pulvillorum var. *echinulatum*	- -
P. rademiricii	CBS 140.84 = Q 1248 (T)
P. radiatolobatum	CBS 340.79 = IJFM 7845 (T)
P. resinae	CBS 324.83 (T)
P. roqueforti var. *carneum*	IMI 293204 (T)
P. rubefaciens	CBS 145.83 = Q 1133 (T)
P. sabulosum	FRR 2743 = CBS 261.87 (T)
P. sajarovii	CBS 277.83 = IJFM 7674 = Q 1099 (T)
P. samsonii	CBS 137.84 = Q 1032 (T), Q 1100
P. severskii	IJFM 19000 = CBS 438.88 (T)
P. shennongjianum	AS 3.4526 = CBS 228.89 (T)
P. siamense	CBS 475.88 (T)
E. sinaicum	CBS 279.82 (T)
P. solitum var. *crustosum*	IMI 91917 (T)
P. terraconense	IMI 283803 = CBS 177.81 (T)
P. turolense	CBS 176.81 (T)
P. turrispainense	CBS 204.87 (T), CBS 686.85
P. vaccaeorum	IJFM 7756 = Q 1134 = CBS 148.83 (T)
P. valentinum	IMI 253789 = CBS 338.79 (T)
P. vasconiae	IMI 253786 = CBS 339.79 (T)
P. vonarxii	CBS 348.51 (T)
P. vulpinum	CBS 126.63
P. zacinthae	CBS 178.81 (T)
Geosmithia viridis	FRR 1963 = CBS 252.87 (T)
Paecilomyces pascuus	FRR 1925 = CBS 253.87 (T)

Penicillium lacus-sarmientei Ramírez *in* Mycopathologia 96: 29. 1986.

Penicillium lacus-sarmientei is regarded as a faster growing variant of *P. roseopurpureum* Dierckx. The ex-type culture produced beta-hydroxycurvularin and roseopurpurin. The production of this compound has been reported by Turner & Aldridge (1983) for *P. roseopurpureum*, and roseopurpurin for *P. roseopurpureum* (Posternak, 1940) and from *P. carminoviolaceum* (Hind, 1940 a and b).

****Penicillium lapatayae*** Ramírez *in* Mycopathologia 91: 97. 1985.

Penicillium lapatayae is a distinctive sclerotial species and it is accepted as new. It has a certain resemblance to the anamorph of *E. pinetorum*.

Penicillium malacaense Ramírez & Martínez *in* Mycopathologia 72: 186. 1980.

Examination of the ex-type culture showed that *P. malacaense* is a synonym of the variable *P. restrictum* Gilman & Abbott.

**Penicillium nodulum* Kong & Qi *in* Mycosystema 1: 108. 1988.

Penicillium nodulum is characterized by its ellipsoidal smooth conidia, its dark green reverse on all substrates, its good growth on creatine-sucrose agar and restricted growth on all media (7–17 mm diam. after one week at 25°C). It is therefore accepted as a good species.

Penicillium ovetense Ramírez & Martínez *in* Mycopathologia 74: 39. 1981.

Penicillium ovetense is regarded as a synonym of *P. phoeniceum*. The illustration of this species is similar to that of a strain (CBS 583.68) of *E. cinnamopurpureum* Scott & Stolk (compare Ramírez, 1982: 318 and Stolk & Samson, 1983: 63, fig. 30 e).

**Penicillium palmense* Ramírez & al. *in* Mycopathologia 66: 80. 1978 (as *'P. palmensis'*).

This species resembles *P. thomii* by its ellipsoidal conidia, but it also shares characters with isolates of the variable *P. glabrum*. For the time being, we accept this taxon, but a more detailed study is necessary to determine its identity.

**Penicillium patens* Pitt & Hocking *in* Mycotaxon 22: 205. 1985.

Penicillium patens resembles *P. homii*. The conidia of *P. patens* are smooth (like in *P. quercetorum* Baghdadi, another synonym of *P. thomii*), but colony colours are quite different from those of typical *P. thomii*. A more detailed biochemical study of these species should be performed before a final conclusion is drawn.

Penicillium terraconense Ramírez & Martínez *in* Mycopathologia 72: 187. 1980.

The drawings and description of *P. terraconense* indicate that it is a monoverticillate species with small conidia and rough stipes. However, the type culture of this species was contaminated, and is a typical *P. digitatum*. Since no holotype material was designated, this taxon is considered to be of doubtful identity and the name can be discarded as being invalidly described.

Penicillium vaccaeorum Quintanilla *in* Mycopathologia 80: 77. 1982.

Like *P. lacus-sarmientei*, *P. vaccaeorum* is considered to be a fast-growing isolate of *P. roseopurpureum*.

Penicillium valentinum Ramírez & Martínez *in* Mycopathologia 72: 183. 1980.

Penicillium valentinum strongly resembles non-sclerotial isolates (e.g. CBS 338.61) of *P. thomii* and it is therefore regarded as a synonym of this species.

Penicillium subgenus **Furcatum**

Penicillium aragonense Ramírez & Martínez *in* Mycopathologia 74: 41. 1981.

The drawing of this taxon suggests a typical *P. oxalicum*. However, cultures derived from the type and received from CMI were *P. glabrum* and may have been confused. Since no holotype material was designated, this taxon is considered to be of doubtful identity and the name can be discarded as being invalidly described.

Penicillium asturianum Ramírez & Martínez *in* Mycopathologia 74: 42. 1981.

This species is regarded as a synonym of *P. oxalicum*. The ex-type culture produces the typical profile of secondary metabolites from *P. oxalicum* including secalonic acid D, oxaline and bluish fluorescent compounds.

Penicillium burgense Quintanilla in Mycopathologia (in press).

The profile of secondary metabolites and morphology of the ex- type culture is identical with *Eupenicillium lapidosum*.

Penicillium caerulescens Quintanilla *in* Mycopathologia 82: 101. 1983.

Penicillium caerulescens is a synonym of *P. raciborskii* sensu stricto. Isolates of *P. raciborskii*, including the ex-type culture of *P. caerulescens*, are very good producers of mycophenolic acid.

Penicillium castellae Quintanilla *in* Avan. Nutr. Mej. anim. Alim. 23: 336. 1982.

This is a typical *P. raistrickii*. Quintanilla (l.c.) stated that the isolates produce griseofulvin and penicillic acid and this was confirmed in this study. These two mycotoxins are also produced by the ex-type and all other isolates investigated of *P. raistrickii*.

Penicillium castellonense Ramírez & Martínez *in* Mycopathologia 74: 46. 1981.

Penicillium castellonense is morphologically and biochemically identical with *P. matriti*. The ex-type culture is a good producer of penicillin and penicillic acid (Frisvad & Emborg, unpubl.).

Penicillium chalybeum Pitt & Hocking *in* Mycotaxon 22: 204. 1985.

The ex-type culture of *P. chalybeum* produces sclerotia on MEA, a feature not recorded by Pitt & Hocking (l.c.). It is regarded here as a synonym of *Eupenicillium terrenum*.

Penicillium ciegleri Quintanilla *in* Avan. Nutr. Mej. anim. Alim. 23: 338. 1982 (as '*P. cieglerii*').

Penicillium ciegleri is a typical *P. pulvillorum*. Some isolates of *P. pulvillorum*, such as the ex-type culture of *P. ciegleri* and isolates assigned to *P. novae-caledoniae*, have a bright red reverse colour and often a slow growth rate on MEA.

Penicillium cluniae Quintanilla *in* Mycopathologia (in press).

Penicillium cluniae is a synonym of *P. cremeogriseum* Chalabuda: among other features, it shares a fast growth rate at 37 °C and the production of brefeldin A.

Penicillium corynephorum Pitt & Hocking *in* Mycotaxon 22: 202. 1985.

Penicillium corynephorum is considered conspecific with *P. smithii* Quintanilla though it differs from it by less roughened conidiophore stipes. The type cultures of both species produce the same profile of secondary metabolites (including citreoviridin) and they have identical growth rates and conidial colours.

Penicillium fagi Martínez & Ramírez *in* Mycopathologia 63: 57. 1978.

Penicillium fagi, a good producer of mycophenolic acid, is the same as *P. raciborskii* sensu stricto. Like *P. caerulescens*, *P. fagi* produces a glaucous-black pigment in the reverse on MEA after 1–3 weeks storage at 0°C.

**Penicillium flavidostipitatum* Ramírez & González *in* Mycopathologia 88: 3. 1984.

Penicillium flavidostipitum morphologically resembles *P. brasilianum* Batista apud Batista & Maia. However, the two species markedly differ in their profiles of secondary metabolites, growth rates and conidial colour.

Penicillium granatense Ramírez & al. *in* Mycopathologia 72: 31. 1980.

The morphology, profile of secondary metabolites and colony characteristics of *P. granatense* are similar to *P. janczewskii*, and therefore the species is considered a further synonym of that species (also compare Fassatiová & Kubatová, 1990).

**Penicillium maclennaniae* Yip *in* Trans. Br. mycol. Soc. 77: 202. 1981.

In agreement with Ramírez (1985), we consider this species to be a distinct taxon characterized by the fast growth and conspicuously ornamented conidia.

**Penicillium mariaecrucis* Quintanilla *in* Avan. Nutr. Mej. anim. Alim. 23: 334. 1982.

Quintanilla (l.c.) described this sclerotial species as having strongly inflated metulae and phialides, but in our cultures of *P. mariaecrucis* the conidiophores, phialides, and conidia duplicate those of *P. pulvillorum*, though some atypical inflated structures were also observed. *Penicillium mariaecrucis* was found to be a good producer of xanthomegnin and viomellein. These nephrotoxins are also produced by *P. simplicissimum*, a species closely related to *P. pulvillorum*. *Penicillium pulvillorum* itself produces penicillic acid and pulvilloric acid, while *P. mariaecrucis* produces the naphthoquinones mentioned above, so there is a marked chemical difference between the two taxa. Also the dark reddish brown colonies of *P. mariaecrucis* are different from the quite weakly coloured strains of *P. pulvillorum*. The status of this species is therefore difficult.

Penicillium michaelis Quintanilla *in* Mycopathologia 80: 79. 1982.

Penicillium michaelis is in all aspects a typical *P. soppii*.

Penicillium murcianum Ramírez & Martínez *in* Mycopathologia 74: 37. 1981.

Penicillium murcianum is identical with *P. canescens* Sopp. Isolates like *P. murcianum* resemble those intermediate between *P. canescens* and *P. janczewskii* Zaleski described by Pitt (1980).

Penicillium jensenii (finely roughened conidia, smooth-walled stipes) through *P. canescens* (smooth to finely roughened conidia, rough stipes) to *P. janczewskii* (very rough conidia, smooth to finely roughened stipes) form a continuum of species, nearly all producing the same total profile of metabolites.

Table II. The status of taxa of *Penicillium* and their teleomorphs, described since 1977, and their production of known mycotoxins.

New taxa	Synonym of	Mycotoxins produced
P. aethiopicum	- -	Viridicatumtoxin
P. alicantinum	*P. citreonigrum*	Citreoviridin
P. allii	*P. hirsutum* var. *allii*	Roquefortine C, meleagrin
E. angustiporcatum	- -	-
P. aragonense	*P. oxalicum*	NT[3]
T. assiutensis		Glauconic acid
P. asturianum	*P. oxalicum*	Secalonic acid D, oxaline
P. aurantioflammiferum	*P. islandicum*	Emodin, skyrin, luteoskyrin, rugulosin
P. aurantiogriseum var. *melanoconidium*	- -	Penicillic acid, oxaline, penitrem A, verrucosidin
P. aurantiogriseum var. *neoechinulatum*	- -	Cyclopenin, viridicatin, penicillic acid
P. aurantiogriseum var. *polonicum*	- -	Penicillic acid, verrucosidin
P. brevicompactum var. *magnum*	*P. olsonii*	-[4]
P. brevissimum	*P. capsulatum*	-
P. brunneostoloniferum	*P. brevicompactum*	Raistrick phenols, mycophenolic acid, brevianamide A and B
P. burgense	*E. lapidosum*	-
P. caerulescens	*P. raciborskii*	Mycophenolic acid
P. castellae	*P. raistrickii*	Penicillic acid, griseofulvin
P. castellonense	*P. matriti*	Penicillin, penicillic acid
P. chalybeum	*E. terreneum*	-
P. chrysogenum var. *dipodomyis*	- -	Penicillin
P. ciegleri	*P. pulvillorum*	Penicillic acid
P. cluniae	*P. cremeogriseum*	Brefeldin A
E. cryptum	- -	-
P. coalescens	- -	-
P. confertum	- -	Meleagrin
P. coprobium	- -	Patulin
P. coprophilum	- -	Griseofulvin, roquefortine C, meleagrin
P. cordubense	*P. aurantiogriseum*	Penicillic acid, xanthomegnin, viomellein, viridicatin
P. corynephorum	*P. smithii*	Citreoviridin
P. damascenum	*P. westlingii*	Citrinin
P. dendriticum	- -	Mitorubrinic acid, secalonic acid D
T. derxii	- -	-
P. eberhardtii	- -	NT
P. erythromellis	- -	-

[3] NT: not tested.

[4] -: no known mycotoxins produced.

New taxa	Synonym of	Mycotoxins produced
P. fagi	*P. raciborskii*	Mycophenolic acid
P. flavidostipitatum	- -	
P. gaditanum	*P. minioluteum*	Mitorubrinic acid, mitorubrin, mitorubrinol
P. gallaicum	*P. citreonigrum*	Citreoviridin
P. gerundense	*P. restrictum*	-
P. glandicola var. *confertum*	*P. confertum*	Meleagrin
P. glandicola var. *glandicola*	- -	Penitrem A, patulin, roquefortine C
P. glandicola var. *glaucovenetum*		
P. glandicola var. *mononematosum*	*P. mononematosum*	Viriditoxin, cyclopaldic acid, isochromantoxin, verrucologen
T. gossyppii	*T. assiutensis*	Glauconic acid
P. granatense	*P. janczewskii*	Griseofulvin, penicillic acid, penitrem A
P. grancanariae	*P. thomii*	-
P. granulatum var. *globosum*	*P. glandicola*	NT
P. griseofulvum var. *dipodomyicola*	- -	Griseofulvin, patulin, cyclopiazonic acid
P. heteromorphum	- -	NT
P. hirsutum var. *albocoremium*	- -	Citrinin, roquefortine C, terrestric acid, meleagrin
P. hirsutum var. *allii*	- -	Roquefortine C, meleagrin
P. hirsutum var. *hordei*	- -	Roquefortine C, terrestric acid
P. hirsutum var. *venetum*	- -	Roquefortine C, terrestric acid
P. hispalense	*P. hirsutum*?	NT
P. hispanicum	- -	-
P. ilerdanum	*P. piceum*	Rugulosin
P. jugoslavicum	- -	-
P. lacus-sarmientei	*P. roseopurpureum*	Beta-hydroxycurvularin, roseo purpurin
P. lapatayae	- -	-
E. limoneum	- -	-
E. lineolatum	- -	-
P. loliense	- -	-
P. maclennaniae	- -	-
T. macrosporus	- -	Duclauxin
P. malacaense	*P. restrictum*	-
P. mali	*P. solitum*	Cyclopenin
P. mariaecrucis	- -	Xanthomegnin, viomellein
P. mediolanense	*P. verrucosum*	Ochratoxin A
P. melanochlorum	*P. solitum*	Cyclopenin
P. michaelis	*P. soppii*	Terrein, asperentin
T. mimosinus	- -	-

New taxa	Synonym of	Mycotoxins produced
P. mononematosum	- -	-
P. murcianum	*P. canescens*	Griseofulvin, penicillic acid
E. nepalense	- -	-
P. nodulum	- -	-
P. nordicum	*P. verrucosum*	Ochratoxin A and B
P. oblatum	- -	-
P. olivicolor	*P. aurantiogriseum* var. *viridicatum*	Brevianamide A, viridicatin
P. onobense	- -	Brefeldin A
P. ovetense	*P. phoeniceum*	-
P. palmae	- -	Mitorubrin, mitorubrinol, mitorubrinol acetat
P. palmense	?	-
P. panamense	- -	Mitorubrin, mitorubrinic acid, vermicellin
P. patens	- -	-
P. pittii	- -	-
P. primulinum	- -	-
P. pulvillorum var. *echinulatum*	*E. zonatum*	NT
P. rademiricii	*P. diversum*	-
P. radiatolobatum	*P. canescens*	-
P. resinae	*P. asperosporum*	-
P. roqueforti var. *carneum*	- -	Patulin, roquefortine C, mycophenolic acid
P. rubefaciens	- -	-
P. sabulosum	- -	-
P. sajarovii	? *P. cremeogriseum*	Brefeldin A
P. samsonii	*P. minioluteum*	Mitorubrins
P. severskii	*P. soppii*	Terrein
P. shennongjianum	- -	-
P. siamense	- -	Mitorubrins
E. sinaicum	- -	-
P. smithii	- -	Citreoviridin
P. solitum var. *crustosum*	*P. crustosum*	NT
P. terraconense	*P. digitatum*	-
P. turolense	*P. westlingii*	Citrinin
P. turrispainense	*P. namyslowskii*	-
P. vaccaeorum	*P. roseopurpureum*	Roseopurpurin, beta-hydroxy-curvularin
P. valentinum	*P. thomii*	-
P. vasconiae	- -	-
P. vonarxii	- -	-
P. vulpinum	- -	Patulin, roquefortine C
P. zacinthae	*P. allahabadense*	Rugulosin
Geosmithia viridis	*P. viride*	-
Paecilomyces pascuus	*P. pascuum*	-

Penicillium novae-caledoniae G. Smith var. ***album*** Ramírez & Martínez *in* Mycopathologia 74: 47. 1981.

Penicillium novae-caledoniae G. Smith (the type culture was lost but another representative isolate is IMI 140441) and its variety *album* (IJFM 7181) are both considered as synonyms of *P. pulvillorum*.

****Penicillium onobense*** Ramírez & Martínez *in* Mycopathologia 74: 44. 1981.

The ex-type culture of *P. onobense* morphologically resembles *P. brasilianum*, but the taxon has different secondary metabolites. Being a good producer of brefeldin A, *P. onobense* resembles *E. ehrlichii* (= *E. brefeldianum*), but the anamorph of the latter has subglobose conidia without striations and less roughened conidiophore stipes.

Penicillium pulvillorum Turfitt var. ***echinulatum*** Basu & Mehrotra *in* Nova Hedwigia 27: 786. 1976.

The ex-type culture (CBS 654.82) of this variety was lost and a dried specimen was never prepared. Stolk & Samson (1983) considered this variety as a synonym of the anamorph of *E. javanicum* (van Beyma) Stolk & Scott var. *javanicum*, under which they also synonymized *E. zonatum* Hodges & Perry. Recently Frisvad & al. (1990a) considered *E. zonatum* a separate species, characterized by its distinct profile of secondary metabolites and very rough conidia. *Penicillium pulvillorum* var. *echinulatum* may very well represent the anamorph of this species.

Penicillium radiatolobatum Lorinczi *in* Publ. Soc. Nat. Rom. Pent. Stiinta Sol. 10B: 435. 1972.

Penicillium radiatolobatum is considered to be a synonym of *P. canescens*. Like *P. murcianum* it is a transition form towards *P. janczewskii*.

****Penicillium rubefaciens*** Quintanilla *in* Mycopathologia 80: 73. 1982.

Penicillium rubefaciens resembles *P. raciborskii*, but it has a distinct profile of secondary metabolites.

****Penicillium sajarovii*** Quintanilla *in* Avan. Nutr. Mej. anim. Alim. 22: 539. 1981.

This species is related to *P. simplicissimum* and *P. canescens*. The growth rate of the ex-type culture is similar to that of *P. simplicissimum*, but the identity has not been confirmed chemically.

Penicillium severskii Schechovtsov *in* Microbiologia 43: 122. 1981.

Penicillium severskii is a synonym of *P. soppii*, based on the morphology and identical secondary metabolite profiles. It is not a synonym of *P. raciborskii* as stated by Ramírez (1985).

****Penicillium shennongjianum*** Kong & Qi *in* Mycosystema 1: 110. 1988.

The taxon is here accepted, being close to *P. citrinum* and *P. miczynskii*. It differs from these taxa by slow growth on all media (12–16 mm diam. after one week at 25 °C), its inabil-

ity to grow on nitrate as sole nitrogen source and to grow at 37 °C. The profile of secondary metabolites does not include citrinin and citreoviridin characteristic for *P. citrinum* and *P. miczynskii*, respectively, but other compounds.

Penicillium smithii Quintanilla *in* Avan. Nutr. Mej. anim. Alim. 23: 340. 1982.

Penicillium smithii is here accepted as a distinct species and not a synonym of *P. raciborskii*, as supposed by Ramírez (1985). These two species differ in their growth rates, their ability to produce sclerotia, the roughness of the stipes and profiles of secondary metabolites. The two species have a wide distribution and have been found repeatedly in soil, peat, wood, and on dried fish. All isolates produced great amounts of citreoviridin.

Penicillium turolense Ramírez & Martínez *in* Mycopathologia 74: 36. 1981.

Penicillium turolense is a synonym of *P. westlingii* Zaleski (Frisvad & Filtenborg, 1990). Both species produce large amounts of citrinin.

Penicillium vasconiae Ramírez & Martínez *in* Mycopathologia 72: 189. 1980.

Penicillium vasconiae is a good species, related to *P. daleae* Zaleski, but with conidia lacking transverse ridges.

Penicillium subgenus **Penicillium**

Penicillium aethiopicum Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 847. 1989.

Isolates of this species has been identified by other taxonomists as *P. cyclopium*, *P. verrucosum* var. *corymbiferum*, *P. crustosum* or *P. expansum*. Bridge & al. (1989a and b) regarded it as a tropical variant of *P. expansum*, while Pitt & Cruickshank (1990) accepted *P. aethiopicum*. It differs from all the species mentioned above in its growth at 37 °C, yellow reverse colours on CYA, MEA and YES, long coherent chains of ellipsoidal conidia, poor growth on creatine-sucrose agar, rough-walled stipes on MEA and the production of griseofulvin and viridicatum-toxin.

Penicillium allii Vincent & Pitt *in* Mycologia 81: 300. 1989.

When describing *P. allii*, Vincent & Pitt (l.c.) regarded it as being closely related to *P. crustosum* and *P. roqueforti*, but they stated that amylase isoenzyme patterns resemble those of *P. hirsutum* and *P. hordei*. This relationship has been further confirmed in that several secondary metabolites in *P. hirsutum* and its varieties are also found in *P. allii* (Frisvad & Filtenborg, 1989). Because of other similarities also (fast growth on most media, rough stipes, smooth globose conidia and association with bulbs and onions) we regard *P. allii* only as a variety of *P. hirsutum* (see also below).

Penicillium aurantiogriseum Dierckx var. ***melanoconidium*** Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 848. 1989.

This variety was distinguished from *P. aurantiogriseum* var. *aurantiogriseum* by dark green conidia, a yellow reverse on CYA, rich sporulation on YES and consistent production of

oxaline and penitrem A. Isolates of this variety formed a distinct cluster in the numerical taxonomy of subgenus *Penicillium* by Bridge & al. (1989a).

Penicillium aurantiogriseum* Dierckx var. ***neoechinulatum* Frisvad & al. *in* Can. J. Bot. 65: 767. 1987.

The variety *neoechinulatum* is reminiscent of *P. echinulatum* Raper & Thom ex Fassatiová, but differs from it by smaller blue-green conidia, poor growth on creatine-sucrose agar and production of aurantiamin, penicillic acid and questiomycin. This variety was also considered distinct by Bridge & al. (1989a).

Penicillium aurantiogriseum Dierkx var. ***polonicum*** (Zaleski) Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 849. 1989.

Penicillium polonicum Zaleski was considered to be close to *P. aurantiogriseum* var. *aurantiogriseum:* it only differs from it by the faster growth rates on all media, good sporulation on YES agar, consistent production of penicillic acid and verrucosidin combined with inability to produce xanthomegnin, and terrestric acid. Perhaps only studies on DNA-RNA relationships between the different varieties of *P. aurantiogriseum* can elucidate whether some or all of them should be regarded as species, varieties or chemotypes.

Penicillium brevicompactum Dierckx var. ***magnum*** Ramírez *in* Man. Atlas Penicillia: 398. 1982.

In its morphology, growth rates, and profile of secondary metabolites this taxon is indistinguishable from *P. olsonii* Bain. & Sartory.

Penicillium brunneostoloniferum Abe ex Ramírez *in* Man. Atlas Penicillia: 412. 1982.

Except for its brown conidia, probably caused by a mutation in the biochemical pathway to melanin, this taxon duplicates typical isolates of *P. brevicompactum* in all aspects. *Penicillium brunneostoloniferum,* like *P. brevicompactum* produced brevianamide A, mycophenolic acid and other bluish fluorescent compounds (short-wave UV light).

Penicillium chrysogenum* Thom var. ***dipodomyis* Frisvad & al. *in* Can. J. Bot. 65: 766. 1987.

This variety was distinguished from *P. chrysogenum* Westling var. *chrysogenum* by its very dark green conidia, rough conidiophore stipes, production of some unique secondary metabolites and faster growth rate on CYA at 37 °C.

**Penicillium confertum* (Frisvad & al.) Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 851. 1989.

This name was introduced to raise the variety *P. glandicola* var. *confertum* Frisvad & al. to specific level (see below).

**Penicillium coprobium* Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 851. 1989.

Penicillium coprobium can be distinguished from *P. coprophilum* by the formation of sclerotia, dark green conidia, green phialides, an entire colony margin on MEA, a pale reverse on CYA and MEA, a black-currant-like aroma and the production of several specific secondary metabolites including patulin. In contrast *P. coprophilum* does not form sclerotia, produces dull green conidia and hyaline phialides, has a lobate colony margin on MEA, a dark brown reverse on CYA and MEA, a herb-like aroma on all substrates and produces other secondary metabolites, including griseofulvin, meleagin and oxaline (Frisvad & Filtenborg, 1989).

Penicillium coprophilum (Berk. & Curtis) Seifert & Samson *in* Adv. *Penicillium* and *Aspergillus* Syst.: 145. 1986.

In herbarium studies this name was found to be the oldest available for the distinct species so far known as *P. concentricum* Samson, Stolk & Hadlok (1976).

Penicillium cordubense Ramírez & Martínez *in* Mycopathologia 74: 164. 1981.

Penicillium cordubense is a typical *P. aurantiogriseum* Dierckx var. *aurantiogriseum*, producing viomellein, xanthomegnin and viridicatin.

Penicillium glandicola (Oud.) Seifert & Samson *in* Adv. *Penicillium* and *Aspergillus* Syst.: 147. 1986.

In herbarium studies this name was found to be the oldest available for the distinct species so far known as *P. granulatum* Bain. (see Seifert & Samson, 1986).

Penicillium glandicola (Oud.) Seifert & Samson var. ***confertum*** Frisvad & al. *in* Can. J. Bot. 65: 769. 1987.

This fungus has only been found once. It appears to be more distant from *P. glandicola* than indicated by Frisvad & al. (l.c.). Good growth at 37 °C, production of meleagrin and a compound related or similar to asteltoxin, thin sigmoid stipes, and widely divergent phialides indicate that this taxon deserves specific status as *P. confertum* (see above).

Penicillium glandicola (Oud.) Seifert & Samson var. ***glaucovenetum*** Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 854. 1989.

The variety *glaucovenetum* differs from var. *glandicola* by its more discrete synnemata, bluish green conidia, and smooth stipe walls.

Penicillium glandicola (Oud.) Seifert & Samson var. ***mononematosum*** Frisvad & al. *in* Can. J. Bot. 65: 767. 1987. (as var. *'mononematosa'*).

Since the description of this variety, several new isolates have been obtained of this taxon, including two isolates from salt marsh soil in Egypt. *Penicillium glandicola* var. *mononematosum* is related to *P. lanosum* and *P. chrysogenum*. It differs from these species by its broad rough stipes, its consistently good growth at 37 °C, and its production of viriditoxin, isochromantoxin, cyclopaldic acid, verrucologen, fumitremorgin A and C, and occasionally some of the Raistrick phenols (Frisvad, unpubl.). The variety has been raised to specific rank by Frisvad & al. (1989; see also below).

Penicillium granulatum Bain. var. ***globosum*** Bridge & al. *in* J. Gen. Microbiol. 135: 2958. 1989.

Distinction of this variety seems to have little justification. In the study by Bridge & al. (1989a) one of the strains of *P. granulatum* (= *P. glandicola*, IMI 297543) appears in both clusters (of *P. granulatum* var. *granulatum* and var. *globosum*). Varieties are supposed to be based on clear-cut, non-overlapping characters (Hawksworth & al., 1983).

****Penicillium griseofulvum*** Dierckx var. ***dipodomyicola*** Frisvad & al. *in* Can. J. Bot. 65: 767. 1987.

This variety differs consistently from var. *griseofulvum* by rather dark green conidia, a dark brown reverse on CYA, a higher proportion of simpler penicilli, and its inability to produce roquefortine C. The production of roquefortine C in var. *griseofulvum* is consistent.

****Penicillium hirsutum*** Dierckx var. ***albocoremium*** Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 855. 1989.

The variety *albocoremium* differs from var. *hirsutum* by the formation of white synnemata and the production of citrinin and meleagrin.

****Penicillium hirsutum*** Diercks var. ***allii*** (Vincent & Pitt) Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 855. 1989.

This taxon was described as *P. allii* by Vincent & Pitt (1989). It, however, shares a number of similarities with other varieties of *P. hirsutum* (see above). Results from a numerical study of members of subgenus *Penicillium* also showed *P. hirsutum* var. *allii* to be a distinct taxon (Bridge & al., 1989a), but a possible link to other species was not discussed by these authors.

Penicillium hirsutum Diercks var. ***hordei*** (Stolk) Frisvad apud Frisvad & Filtenborg in Mycologia 81: 855. 1989.

Penicillium hordei Stolk has many characters in common with *P. hirsutum* var. *hirsutum* (Pitt, 1980; Frisvad & Filtenborg, 1983, 1989; Bridge & al., 1989a), but, like *P. allii* it has some distinctive diagnostic characters too. The most consistent solution is either to accept all the varieties of *P. aurantiogriseum* and *P. hirsutum* as such or to treat them all as species. Until more molecular data on DNA similarities are available we prefer to use the variety level in such cases, so we provisionally accept *P. hirsutum* var. *hordei*.

****Penicillium hirsutum*** Diercks var. ***venetum*** Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 855. 1989.

This variety differs from var. *hirsutum* by its dark blue-green conidia, slower growth rate, and production of viridicatins.

Penicillium hispalense Ramírez & Martínez *in* Mycopathologia 74: 169. 1981.

A dried type of *P. hispalense* was not prepared and the ex-type culture (IJFM 5940) is lost (Ramírez, pers. comm.). The 'polyverticillate' structure of the fungus was probably caused

by degeneration. The illustrations and description of *P. hispalense* suggests that this taxon is *P. hirsutum* Dierckx, but the exact status of the species remain in doubt.

Penicillium mali Gorlenko & Novobranova *in* Mikol. Fitopatol. 17: 464. 1983.

Penicillium mali is now regarded as a synonym of *P. solitum* (Pitt & Cruickshank, 1990; Stolk & al., 1990).

Penicillium mediolanense Dragoni & Cantoni *in* Ind. Aliment. 155: 281. 1979 (nom. inval., ICBN Art. 36; as '*P. mediolanensis*').

Penicillium mediolanense was described without a Latin diagnosis and designation of holotype material by Dragoni & Cantoni (1979) and Dragoni & Marino (1979). The morphology of this species is identical with *P. verrucosum*. Its synonymy was further supported by the production of ochratoxin A and the restricted growth.

Penicillium melanochlorum (Samson & al.) Frisvad *in* Adv. Pen. Asp. Syst.: 330. 1985.

This taxon is now regarded a synonym of *P. solitum* (Pitt & Cruickshank, 1990; Stolk & al., 1990).

****Penicillium mononematosum*** (Frisvad & al.) Frisvad *in* Mycologia 81: 856. 1989.

This taxon is discussed above, under *P. glandicola* var. *monematosum*.

Penicillium nordicum Dragoni & Cantoni *in* Ind. Aliment. 155: 283. 1979 (nom. inval., ICBN Art. 36); ex Ramírez in Adv. *Penicillium* and *Aspergillus* Syst.: 139. 1986.

The type culture produces hyaline and atypically large conidia (comparable to those of *P. commune*) and seems to be a mutant. Because of its growth rates, reverse colours, reaction on creatine-sucrose agar and copious production of ochratoxin A and B, it is allocated to *P. verrucosum*.

Penicillium olivicolor Pitt *in* Gen. *Penicillium:* 368. 1980.

Penicillium olivicolor was introduced by Pitt (l.c.) as a name change for *P. ochraceum* Bain. apud Thom, because the latter name had already been used for *P. ochraceum* (Corda) Biourge, *P. ochraceum* (Boudier) Biourge, and *P. ochraceum* Raillo. Apart from its inability to produce green melanin complexes, the type isolate is an atypical *P. viridicatum* Westling (Pitt & Cruickshank, 1990).

****Penicillium roqueforti*** Thom var. ***carneum*** Frisvad apud Frisvad & Filtenborg *in* Mycologia 81: 857. 1989.

The variety *carneum* differs from var. *roqueforti* by its dark blue-green conidia, pale reverse on all substrates, and production of patulin. It never produces PR-toxin as var. *roqueforti* does.

Penicillium solitum Westling var. ***crustosum*** (Thom) Bridge & al. *in* J. gen. Microbiol. 135: 2957. 1989.

Even though *P. solitum* Westling and *P. crustosum* Thom have some characters in common such as the ability to produce a restricted rot in apples, cyclopenin production and rough conidiophore stipes, the differences are very significant. *Penicillium solitum* produces compactin and related compounds, while *P. crustosum* produces penitrem A, roquefortine C, and terrestric acid. Furthermore *P. solitum* grows more slowly, has hydrophilic dark green conidia and does not form conidial crusts. *Penicillium crustosum* grows fast, produces grey-green highly hydrophobic conidia, and typical conidial crusts. With Pitt & Cruickshank (1990) and Stolk & al. (1990) we consider the two species as distinct species (also compare Frisvad & al., 1990c).

**Penicillium vulpinum* (Cooke & Massee) Seifert & Samson *in* Adv. *Penicillium* and *Aspergillus* Syst.: 144. 1986.

In herbarium studies this name was found to be the oldest available for a distinct species so far known as *P. claviforme* Bain. (Seifert & Samson, 1986).

Penicillium subgenus **Biverticillium**

Penicillium aurantioflammiferum Ramírez & al. *in* Mycopathologia 72: 28. 1980.

This species is in all respects a typical *P. islandicum* Sopp.

**Penicillium coalescens* Quintanilla *in* Mycopathologia 84: 115. 1983.

This species resembles *P. dendriticum* Pitt and *P. pseudostromaticum* Hodges & al., but, based on differences in conidial shape, growth rates and colony colours, the species is distinct (see also Samson & al., 1989).

**Penicillium dendriticum* Pitt *in* Gen. *Penicillium:* 413. 1980.

This species is distinct both morphologically and chemically (Samson & al., 1989).

**Penicillium eberhardtii* Yokoyama apud Kobayashi & Yokoyama *in* Bull. natn. Sci. Mus., Tokyo, Ser. B, 7: 20. 1981 (nom. inval., ICBN Art 36).

This name was introduced without Latin description and based on cultural studies of isolates obtained from immature tissues of *Dendrosphaera eberhardtii* Pat. The conidiophores are described and illustrated as biverticillate penicilli and therefore this anamorph should be placed in subgenus *Biverticillium*. We have not examined the isolates and a more detailed examination is required to identify its correct taxonomic status.

**Penicillium erythromellis* Hocking apud Pitt *in* Gen. *Penicillium:* 459. 1980.

This is a distinct species producing great amounts of carbohydrate and red exudate droplets.

Penicillium gaditanum Ramírez & Martínez *in* Mycopathologia 74: 165. 1981.

Penicillium gaditanum is a synonym of *P. minioluteum* (van Reenen-Hoekstra & al., 1990).

Penicillium ilerdanum Ramírez & al. *in* Mycopathologia 72: 32. 1980.

Because of its good growth at 37 °C (better than at 25 °C), characteristic conical conidial heads, profile of secondary metabolites, vesiculate stipes and metulae and conidial form, this species is inseparable from *P. piceum* Raper & Fennell.

****Penicillium loliense*** Pitt *in* Gen. *Penicillium:* 450. (1980).

Penicillium loliense resembles *P. proteolyticum* Kamyschko, but differs from it by more roughened conidia and slower growth rate at 37 °C.

****Penicillium oblatum*** Pitt & Hocking *in* Mycologia 77: 819 (1985).

Penicillium oblatum is a good species, characterized by simple to two- stage-branched penicilli of the *Biverticillium* type and acerose phialides and therefore, in contrast with Pitt & Hocking (1985), we accommodate it in subgenus *Biverticillium*.

****Penicillium palmae*** Samson & al. *in* Stud. Mycol. 31: 135 (1989).

This species is very distinctive. It is somewhat related to *P. isariiforme* Stolk & Meyer, but the latter grows much faster and has longer synnemata. Furthermore, *P. palmae* produces mitorubrins, while *P. isariiforme* produces secalonic acid D and citreoviridin (Samson & al., 1989).

****Penicillium panamense*** Samson & al. *in* Stud. Mycol. 31: 136 (1989).

Penicillium panamense is characterized by conspicuous synnemata in yellow and orange colours, apiculate conidia, and a strongly coloured basal mycelium (red and yellow). These characters set it apart from *P. vulpinum* (Cooke & Massee) Seifert & Samson, to which isolates of *P. panamense* were first allocated. Both species are strictly synnematous and do not produce mononematous conidiophores in culture.

****Penicillium pittii*** Quintanilla *in* Mycopathologia 91: 75 (1985).

This taxon resembles *P. rubrum* Stoll and *P. minioluteum* sensu Pitt, and a more detailed study is needed to elucidate its taxonomic position.

****Penicillium primulinum*** Pitt *in* Gen. *Penicillium:* 455 (1980).

Penicillium primulinum was introduced for *P. diversum* Raper & Fennell var. *aureum* Raper & Fennell, especially because its very characteristic arrangement of the metulae. A second isolate, included in this taxon by Pitt (1980), ATCC 24100, is however a typical *P. marneffei* Segretain (Samson & Frisvad, in prep.).

****Penicillium rademiricii*** Quintanilla *in* Mycopathologia 91: 72 (1985).

By its poor growth on Czapek agar and its morphology and growth rates this taxon is reminiscent of *P. diversum*, but this identity could not be confirmed by the profiles of secondary metabolites in the two species (van Reenen-Hoekstra & al., 1990).

Penicillium resinae Qi & Kong *in* Acta mycol. Sin. 1: 103. 1982.

This is a synonym of *P. asperosporum* G. Smith and duplicates the latter species in all respects.

**Penicillium sabulosum* Pitt & Hocking *in* Mycologia 77: 818 (1985).
This is a good species and resembles *P. diversum* Raper & Fennell and *P. tardum* Thom. Because of the unique combination of characters, this species should also be keyed out in subgenus *Furcatum*.

Penicillium samsonii Quintanilla *in* Mycopathologia 91: 69 (1985).
Penicillium samsonii is a synonym of *P. minioluteum* Dierxck (van Reenen- Hoekstra & al., 1990).

**Penicillium siamense* Manoch & Ramírez *in* Mycopathologia 101: 32 (1988).
Penicillium siamense appears to be a good species, but it has metabolites in common with *P. diversum*. It differs from this species by its better growth on all media.

Penicillium zacinthae Ramírez & Martínez *in* Mycopathologia 74: 167 (1981).
This species is considered to be a synonym of *P. allahabadense* Mehrotra & Kumar (van Reenen-Hoekstra & al., 1990).

Paecilomyces pascuus Pitt & Hocking *in* Mycologia 77: 822. 1985; as *'P. pascua'*).
Paecilomyces pascuus belongs to *Penicillium* subgenus *Biverticillium* because of its penicillus structure and the phialide shape. Consequently, we propose the combination: ***Penicillium pascuum*** (Pitt & Hocking) Frisvad, Stolk & Samson, *c o m b. n o v.* for it.
Penicillium pascuum resembles *P. dendriticum* Pitt, but we have not observed synnema production even after exposure to light, and isolates of *P. pascuum* produce only a few, if any, red or yellow pigments, in contrast to *P. dendriticum*.

Penicillium subgenus **Geosmithia**

Penicillium turris-painense Ramírez *in* Mycopathologia 91: 93 (1985) (as *'P. turris-painensis'*).
This taxon is indistinguishable from *P. namyslowskii* Zaleski in all respects.

Geosmithia viridis Pitt & Hocking in Mycologia 77: 822 (1985) (as *'G. virida'*).
Stolk & Samson (1985) did not recognize *Geosmithia* Pitt as a genus, but considered it as a subgenus of *Penicillium*, because it is difficult to use the morphological characters of species belonging to this group to separate it from the other subgenera with the variable structures e. g. monoverticillate versus biverticillate penicilli, flask-shaped versus acerose phialides, *Eupenicillium* versus *Talaromyces* teleomorphs. If *Geosmithia* was accepted, then separate genera for the subgenera *Biverticillium* and *Aspergilloides* should also be proposed.
Since we reject *Geosmithia* as genus, we propose ***Penicillium viride*** (Pitt & Hocking) Frisvad, Samson & Stolk, *c o m b. n o v. Penicillium viride* produces a diffusible red pigment in MEA after prolonged incubation at low temperatures, a character not observed in other species in subgenus *Geosmithia*.

Table III. List of *Penicillium* nomina nuda which appeared in collection catalogues and patents since 1977.

Nomina nuda	Culture number	Identity (mycotoxins)
P. allorensis Swanson	ATCC 20399	*P. rugulosum* Thom (rugulosin)
P. barcinonense Ramírez & Martínez	CBS 330.79	*P. corylophilum* Dierckx
P. betaolens Ramírez & Martínez	CBS 331.79	*P. simplicissimum* (= *P. janthinellum*)
P. citrinum var. *pseudopaxilli* Martínez & Ramírez	CBS 688.77	*P. citrinum* Thom, chemotype II (citrinin and terrein)
P. fungistaticum P.C. Misra	ATCC 18089	*P. capsulatum* Raper & Fennell
P. glaucocoeruleum Ferrer-Ortega & Ramírez	CBS 692.77	*P. aurantiogriseum* (penicillic acid, verrucosidin, cyclopenin)
P. janthinellum var. *kuensanii* Kinoshita & al.	ATCC 13154	*P. simplicissimum*
P. mariaecrucis var. *fulvescens* Quintanilla	ATCC 48476	*P. mariaecrucis* (xanthomegnin, viomellein)
P. ochraceoviride Ferrer-Ortega & Ramírez	CBS 690.77	*P. aurantiogriseum* (penicillic acid)
P. pimprinum A. Subramanian & Thirumalachar	CBS 373.75	*T. emersonii* Stolk
P. pinsaporum Ramírez & Martínez	IMI 265388A	*P. rugulosum* (rugulosin)
P. piperis Ramírez & Gonzales	CBS 406.73	*P. argillaceum* Stolk & al.
P. poonense A. Subramanian & Thirumalachar	CBS 204.75	*T. emersonii*
P. rinesinum Swanson	ATCC 20398	*P. variabile* Sopp (rugulosin)
P. restrictum var. *kuensanii* Kinoshita & al.	ATCC 13155	*P. restrictum*
P. verrucosum var. *cyclopium* strain *ananas-olens*	IJFM 3865	*P. chrysogenum* Thom

GENUS TALAROMYCES

Talaromyces assiutensis Samson & Abdel-Fattah *in* Persoonia 9: 501. 1978
Anamorph: *Penicillium assiutense* Samson & Abdel-Fattah.
This is a distinct species, described and illustrated by Samson & Abdel-Fattah (1978).

Talaromyces derxii Takada & Udagawa *in* Mycotaxon 31: 418. 1988.
Anamorph: *Penicillium derxii* Takada & Udagawa.
This distinct heterothallic species resembles *T. bacillisporus* Swift, by its dark green reverse, but differs from it by echinulate ascospores and the anamorph. Until now it is the only heterothallic teleomorph with a *Penicillium* anamorph.

Talaromyces gossypii Pitt *in* Gen. *Penicillium:* 500. 1980.
Anamorph: *Penicillium gossypii* Pitt.
This species is inseparable from *T. assiutensis* (Frisvad & al., 1990b).

Talaromyces macrosporus (Stolk & Samson) Frisvad & al. *in* Antonie van Leeuwenhoek 57: 186. 1990.
Anamorph: *Penicillium macrosporum* Frisvad & al.
The species was introduced to raise *T. flavus* (Kloecker) Stolk & Samson var. *macrosporus* Stolk & Samson to specific rank, because of the distinct profile of secondary meta-

bolites and larger ascospores which possess a higher heat-resistance (see Frisvad & al., 1990b).

**Talaromyces mimosinus* Hocking apud Pitt *in* Gen. *Penicillium:* 507. 1980.

Talaromyces mimosinus is a distinct species because of its ascospores which are ornamented with distinct sinuous flanges.

**Penicillium vonarxii* Frisvad & Samson in Antonie van Leeuwenhoek 57: 186. 1990.

This name was proposed because no name was available for the anamorph of *T. luteus* (Zukal) C.R. Benjamin as *P. luteum* Zukal was described inclusive of the teleomorph.

Further nomina nuda in Penicillium

A number of epithets appear in culture collection catalogues and patents and to our knowledge they have never been validly published. We have reidentified most of these isolates and they are listed in Table III. They produce many yet unidentified secondary metabolites and some of these secondary metabolites may have interesting biotechnological applications.

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NOTULAE AD FLORAM AGARICINAM NEERLANDICAM—XVII
On tribus names in the family Tricholomataceae sensu lato

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Five tribus names to be used in the Tricholomataceae sensu lato are introduced or validated, viz. Biannularieae, Laccarieae, Lyophylleae, Macrocystidieae, and Xeruleae. It is demonstrated that Fayod's tribus names are to be considered validly published and that tribus Hygrophoreae Kühner is a later homonym and synonym of tribus Hygrophoreae P. Henn.

In volume 2 of the Flora agaricina neerlandica (Bas & al., 1990: 67) a synopsis is given of the tribus and genera of the Tricholomataceae as to be treated in the second and following volumes of that flora.

Although the subdivision of the Tricholomataceae by Bas & al. is basically that of Singer (1986: 154), it deviates at some points, mainly on account of considerations published by Kühner (1978–1980), Redhead (1987), and Bas (in Bas & al., 1988: 40, 1990: 65).

Not in all cases where changes have been introduced in Bas & al. (1990: 67) valid tribus names were available and therefore these are provided here, while comments on some tribus names in use seem required.

New names.

Tribus **Biannularieae** Sing. ex Bas

Based on tribus Biannularieae Sing. *in* Annls mycol. 34: 330, 347. 1936 (not val. publ.; no Latin diagn.).

Fungi agaricoidei, bivelangiocarpi[1]; trama lamellarum divergens; sporae incoloratae, amyloideae, angustae; lamellae adnatae vel decurrentes.

Tribus **Laccarieae** (Jülich) Bas, *stat. nov.*

Basionym: Laccariaceae Jülich, Higher Taxa Basidiomyc.: 356. ('1981') 1982. — Synonym: Subtribus Laccariinae (Jülich) Sing., Agaricales mod. Taxon., Ed. 4: 233. 1986.

Arguments for maintaining *Laccaria* in the Tricholomataceae are given in Bas & al. (1988: 43). Because of the special type of sporal ornamentation it seems, however, desirable to place it in a separate tribus.

Tribus **Lyophylleae** Kühner ex Bas

Based on tribus Lyophylleae Kühner *in* Bull. mens. Soc. linn. Lyon 7: 209. 1938 (not val. publ.; no Latin diagn.).

Fungi agaricoidei leucospori basidiis granulis forte siderophilis munitis.

[1] For want of a better solution I follow Stearn (1967: 438) who treats 'gymnocarpus' as an adjective of the first declination, although I have been informed that that probably is incorrect.

Tribus **Macrocystidieae** (Kühner) Bas, *stat. nov.*

Basionym: Macrocystidiaceae Kühner *in* Bull. mens. Soc. linn. Lyon 48: 172. 1979.

The genus *Macrocystidia* is placed in tribus Tricholomataceae by Singer (1986: 154), but accommodated in a monotypic family by Kühner (1979: 172). Arguments for keeping this genus in the Tricholomataceae, placing it there in a tribus of its own, are supplied in Bas & al. (1988: 43).

Tribus **Xeruleae** (Jülich) Bas, *stat. nov.*

Basionym: Xerulaceae Jülich, Higher Taxa Basidiomyc.: 394. ('1981') 1982.

The family Xerulaceae has been published by Jülich to accommodate the genera *Xerula*, *Oudemansiella*, and *Lampteromyces*. Afterwards it has been strongly emended by Redhead (1987: 1551). Reasons for reducing this taxon to the status of tribus in a concept slightly differing from that of Redhead, have been given in Bas & al. (1990: 65, 67).

The tribus names published by Fayod.

Fayod (1889) introduced 27 tribus names for agaricoid fungi. Some of these have been accepted by Singer (1986: 351, 389) but are treated by that author as introduced but not validly published by Fayod and validated by other authors, viz. tribus Marasmieae Fayod ex Schröter and tribus Myceneae Fayod ex Ulbricht.

However, Fayod first gave a description under a French name (p. 310: tribu II Mycéné; p. 340, tribu X Marasmiés) but in the synopsis on p. 394–398 replaced the French names by Latin names, thus fulfilling all requirements for valid publication before 1935. Therefore the following are the correct citations of the three names of Fayod in Bas & al. (1990).

Tribus Clitocybeae Fay. (Prodr. Hist. nat. Agaricinés) *in* Annls Sci. nat. (Bot.) VII, 9: 334, 395. 1889.

Tribus Marasmieae Fay. (Prodr. Hist. nat. Agaricinés) *in* Annls Sci. nat. (Bot.) VII, 9: 340, 395. 1889.

Tribus Myceneae Fay. (Prodr. Hist. nat. Agaricinés) *in* Annls Sci. nat. (Bot.) VII, 9: 310, 394. 1889.

Corrections of two tribus names cited in Flora agaricina neerlandica 2 (1990).

In the publication mentioned, two tribus names, viz. tribus Hygrocybeae Kühner (on p. 70) and tribus Hygrophoreae Kühner (on p. 115) are 'recombined' with the family name Tricholomataceae. This is incorrect. Combinations exist only below the rank of genus (Art. 6.7 of I.C.B.N., Greuter & al., 1988). Consequently author citations do not change when tribus are transferred from one family to another. Moreover, the tribus name Hygrophoreae was published already much earlier, viz. by P. Hennings in 1898. In Hennings' concept this tribus comprised the genera *Gomphidius*, *Nyctalis*, *Hygrophorus*, and *Limacium*. Imai (1938: 97) restricted it to the genus *Hygrophorus* sensu lato; Kühner to the genus *Hygrophorus* sensu stricto. The following are the correct citations for these two tribus names.

Tribus Hygrophoreae P. Henn. *in* Engler & Prantl, Natürl. Pflanzenfam. 1 (1**): 209. 1898; emend. Kühner *in* Bull. mens. Soc. linn. Lyon 48: 617. 1979.

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BOOKS RECEIVED BY THE RIJKSHERBARIUM

R. Agerer (Editor). *Colour atlas of ectomycorrhizae [Fasc. 3].* (Einhorn-Verlag Eduard Dietenberger GmbH, Schwäbisch Gmünd. 1989.) Pp. 73, including 12 pp. with colour and 24 pp. with black-and-white photographs, on loose leafs to be assembled in binder. Price: DM 35.80.

The third delivery of this colour atlas contains an extended key for the identification of 64 ectomycorrhizae, new synoptic tables, and an updated list of literature. Twelve double sheets each with four excellent colour photographs and two pages of anatomical details in half-tone photomicrographs illustrate twelve new mycorrhizae: *Amphinema byssoides, Cortinarius variecolor, Hygrophorus pustulatus, Paxillus involutus, Piceirhiza chordata, P. conspicua, P. gelatinosa, P. glutinosa,* and *P. guttata* all on *Picea abies; Dermocybe semisanguinea* and *Tylopilus felleus* both on *Pinus silvestris; Xerocomus chrysenteron* on *Fagus sylvatica.*

C.A. Clark & J.W. Moyer. *Compendium of sweet potato diseases.* (APS Press, The American Phytopatological Society, St. Paul, Minnesota. 1988.) Pp. 74, 53 Text-figs., 74 Col. Photogr. Price: $ 25.- ($ 20.- in the U.S.A.) including postage.

This publication on diseases of the sweet potato (*Ipomoea batata*), a major food crop in tropical regions, includes 28 diseases of that plant caused by fungi, besides those caused by bacteria, viruses, nematodes, and several noninfectious disorders. For each disease the symptoms, causal organisms, disease cycle, epidemiology and control are described and discussed. The symptoms are clearly illustrated by means of coloured photographs.

C.D. Delp (Editor). *Fungicide resistance in North America.* (APS Press, The American Phytopathological Society, St. Paul, Minnesota.) Pp. V, 133, 26 Text-figs., 46 Tables. Price: $ 28.- in the U.S.A., $ 35.- elsewhere (both prices include postage).

This book is based on the papers presented and discussed at a workshop designed to focus on solutions to fungicide resistance problems in North America. Twenty-six scientists from Europe, Japan, and the U.S.A. present the state of the art and science. The intensive use of fungicides in Europe and Japan has resulted in valuable experiences and different approaches to the solutions of resistance problems. It is the aim of the organizers of the workshop to develop the necessary cooperation at all levels in North America to carry out the tough tasks of resistance management in the future.

H. Dörfelt (Editor). *Lexikon der Mykologie.* (Gustav Fischer Verlag, Stuttgart, New York. 1989.) Pp. 432, 217 Text-figs., 40 Col. Pls., 8 black-and-white Pls. Price: DM 39.80.

A mycological encyclopedia in the German language which is written by nine authors (U. Braun, H. Dörfelt, H. Heklau, G. Hirsch, J. Miersch, M.-B. Schröder, R. Strodeur,

G. Straube, and Th. Voigt). This is the West German edition of the East German 'Bi-Lexikon Mykologie Pilzkunde' (Leipzig, 1988).

Terms in use in taxonomy, morphology, cytology, genetics, physiology, and chemistry of fungi and in phytopathology, medical mycology, and economical mycology are explained and, when necessary, illustrated. Inserted are also biographical notes on outstanding mycologists and selected genera with their characteristics. The 198 coloured photographs present mostly fruiting bodies of macromycetes; the 8 black-and-white plates present 16 TEM and SEM photographs of ultramicroscopical structures. This relatively low-priced mycological dictionary will be particularly useful for those mycologists for whom German is their mother-tongue or first foreign language.

A. Düvell. *Struktur und Funktion linearer Plasmide bei dem phytopathogenen Ascomyceten Claviceps purpurea.* (Bibliotheca mycologica 126, J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Berlin, Stuttgart. 1989.) Pp. 118, 24 Text-figs., 4 Tables. Price: DM 70.-.

Claviceps purpurea, although being an obligatory parasite, is easily grown in culture. It is true that no fruit-bodies are formed in culture, but there is a rich production of conidia. In biotechnology the species plays an increasingly important role. Therefore *C. purpurea* is a perfect subject for molecular-genetic research.

Three linear plasmids have been found to be present and have been thoroughly studied and analysed. The creation of plasmid-free transformants and again-plasmid-carrying transformants opens the way for comparative infection tests in order to shed some light on the role of plasmids in the pathogenicy of fungi.

D.A. Farr, G.F. Bills, G.P. Chamuris & A.Y. Rossman. *Fungi on plants and plant products in the United States.* (APS Press, The American Phytopathological Society, St. Paul, Minnesota. 1989.) Pp. VIII, 1252. Price: $ 59.- in the U.S.A., $ 74.- elsewhere (both prices include postage).

This large-format, densely printed book of 1252 pages is a precious and extensive reference of the fungi that grow on plants and plant products in the United States. It can be considered as a strongly revised and updated version of the 'Index of Plant Diseases in the United States' (1950–1953) by the U.S. Department of Agriculture. The contents of 4030 cited articles, books, and monographs are accurately compiled in a very concise way. The host-fungus list contains 78,000 unique combinations of phanerogamic plants as host or substratum for fungi. The fungus list of 474 pages gives detailed information on the taxonomy and nomenclature of the 13,000 fungi included in this work. A host index, a host common name index, and a fungus index make the information easily accessible.

The work is appended by a new list of authors of fungal names, in which the 2,485 authors refered to in the book are listed in full and with the proposed abbreviations. For authors listed in F.A. Stafleu & R.S. Cowan (1976–1980), 'Taxonomic literature' or in R.D. Meilke (1980), 'Draft list of author abbreviations compiled at the Herbarium Royal Botanic Gardens,

Kew', the proposed abbreviations are used. Of authors not cited in either of these two references the last name is generally written out in full and handled in accordance with U.S. usage. This has led to some inconsistencies, especially in handling particles in names of European authors. On the one hand we see suppressed particles, in accordance with the International Code of Botanical Nomenclature, Recommendation 46A, e.g. Arx (J.A. von Arx), Overeem (C. van Overeem), Tiegh. (P.E.L. van Tieghem); but on the other hand, in similar cases, particles are maintained and even capitalized, e.g. De Hoog (G.S. de Hoog), Van Kesteren (H.A. van Kesteren), Van Oorschot (C.A.M. van Oorschot), etc.

In conclusion, the book is very much worth buying for any mycological, phytopathological, agricultural, or horticultural library.

T.C. Harrington & F.W. Cobb, Jr. (Editors). *Leptographium root diseases on conifers* (APS Press, The American Phytopathological Society, St. Paul, Minnesota. 1988.) Pp. 155, 19 Text-figs., 8 Tables. Price: $ 30.- ($ 24.- in the U.S.A.), postage included.

The anamorph genus *Leptographium* (teleomorph: *Ophiostoma*) comprises about 35 mostly bark beetle-associated fungi parasitizing conifers and broad-leaved trees. The beetle introduces the fungus in the tree. In chapter 1 of the present publication a survey of the genus is given. In chapters 2 and 3 *Leptographium wagneri*, a root parasite on *Pseudotsuga* and a serious forest pathogen in western North America, is extensively reviewed (history, distribution, biology, management). In the following two chapters *Leptographium* root disease in British Columbia and *L. procerum* as pathogen on *Pinus* are amply discussed. In the final chapter a more world-wide view of *Leptographium* as root pathogen of conifers is given. The bibliography consists of 240 entries.

J.R. Hartman (Editor). *Biological and cultural tests. Volume 3.* (APS Press, The American Phytopathological Society, St. Paul, Minnesota. 1988.) Pp. 100. Price: $ 22.50 ($ 18.- in the U.S.A.), postage included.

A collection of instant, mostly one-page research reports, many of which concern plant diseases caused by fungi. The publication aims at keeping scientific workers on plant diseases abreast of current research of which the results have not yet reached the pertinent journals. Genera like *Cercospora, Colletotrichum, Erysiphe, Fusarium, Puccinia, Sclerotinia, Uromyces,* and *Verticillum* score highly in the reports presented.

[G.L.] Hennebert, [Ph.] Boulenger & Balon. *La Mérule. Science, technique & droit.* (Éditions Ciaco, Artel, Chaussée de Gand 14, Brussels. 1990.) Pp. 198, 6 Text-figs., 55 Col. figs. Price not known.

An introduction and survey of problems concerning the 'true dry rot fungus', *Serpula lacrimans*, and a few related fungi. In the first part are chapters on growth, development, nutrition, and prevention. The second part is devoted to juridical implications and jurisdiction

concerning claims of insurances against the destructions caused by this fungus according to Belgian law.

M. Kloidt. *Untersuchungen zum Abbau der Buchenblattstreu durch Pilze – unter besonderer Berücksichtigung der Ascomyceten* – (Dissertationes botanicae 130, J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Berlin, Stuttgart. 1989.) Pp. 82, 71 Text-figs., 20 Tables. Price: DM 110.-.

The author reports on her studies concerning leaf-decomposition of *Fagus* leaves after leaf-fall over a period of three years. Mainly ascomycetes and imperfect fungi were found to be active among which *Apiognomia errabunda, Mycosphaerella punctiformis,* and *Naeviopsis carneopallida;* their anamorphs are the most common ones.

Sequence of settling, distribution over the leaves, visible decomposition-pattern, and the chemistry of leaf-decomposition have been analysed. After two years cellulose-contents of the leaves had considerably declined but lignin-contents had hardly changed. Nitrogen could slightly increase the decomposition-ability of some species, but in general optimal decomposition found place under N-deficient conditions.

W. D. J. Kuijs. *De Paddestoelen van Zuid-Beveland.* (Private edition, W. D. J. Kuijs, Plataanstraat 7, 4462 TW Goes. 1988.) Pp. 201, with many Text-figs., Maps and Tables. Price: Dfl. 12.50.

This is a report in the Dutch language on the macro-fungi found on the island Zuid-Beveland (prov. Zeeland, Netherlands) in the periods 1844–1847, 1950–1963 and 1982–1987. Habitat descriptions and separate lists are given for about 30 areas. In the general list 646 taxa are recorded.

G. Laaser. *Vergleichende systematische Studien an Basidiomycetenhefen unter besonderer Berücksichtigung der Hefestadien.* (Bibliotheca mycologica 130, J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Berlin, Stuttgart. 1989.) Pp. 335, 6 black-and-white figs. Price: DM 130.-.

This thesis is an important contribution to the taxonomy of basidiomycetous yeasts. Both hetero- and homobasidiomycetes are included. Many yeast strains of homobasidiomycetes were isolated and characterized by a series of eleven physiological standard tests for yeasts. Where possible yeast strains were analyzed and compared among each other and, where possible, with mycelial strains, from which they were isolated. New methods of molecular biology make possible the assessment of relatedness at the molecular level. Among methods of DNA analysis, DNA-DNA hybridization studies prove to be most valuable to indicate levels of homology or conspecificity. A first basis for the identification of basidiomycetous yeasts is given.

J.-M. Mangen (Editor). *Champignons du Luxembourg. Planches inédites de Pierre-Joseph Redouté (1759–1840). Manuscrit de Louis Marchand (1807–1843).* (Imprimerie Saint-Paul S.A., Luxembourg. 1989.) Pp. 115, 38 Col. Pls., 1 black-and-white portraiture (of P.J. Redouté).

At the occasion of the 150th anniversary of the declaration of independence of the Grand Duchy Luxembourg, the government commission for the commemoration of this fact had the bright idea to publish a series of 38 unpublished water-colour paintings of fungi from Luxemburg by Pierre-Joseph Redouté with the authentic text by Louis Marchand. The plates and the manuscript, originating from the Rijksherbarium, Leiden, are accurately reproduced on high-quality paper. In the introductory part are biographic notices on Redouté by A. Lawalrée and on Marchand by Prof. J.-M. Mangen.

The identity of the depicted fungi, among which several with new names by Marchand, has been established by a commission under P. Diederick, C. Besch, and B. Schultheis. Even four unfinished plates (Pls. 35–38) are published, mainly showing stages in their accomplishment.

The work was printed with a limited number of copies.

D.C. McGee. *Maize diseases. A reference source for seed technologists.* (APS Press, The American Phytopathological Society, St. Paul, Minnesota. 1988.) Pp. 150, 52 Text-figs. Price: $ 32.- ($ 26.- in the U.S.A.), postage included.

The author describes 150 diseases of maize subdivided into four groups: diseases that are seedborne and seed transmitted; diseases that are seedborne but not seed transmitted; diseases that are not seedborne and not seed transmitted; pathogens that are able to infect maize when inoculated. For each disease the following aspects are covered: disease distribution, susceptible plants other than maize, variability, control, seedborne aspect, effect on seed quality, pathogen transmission, seed health tests, key references. About 90 of the diseases reviewed are caused by fungi.

W.E. McKeen (Editor). *Blue mold to tobacco.* (APS Press, The American Phytopathological Society, St. Paul, Minnesota. 1989.) Pp. VII, 288, 10 Col. Pls. and 96 Text-figs. Price: $ 58.- in the U.S.A., $ 72.- elsewhere (both prices include postage).

This book provides a detailed picture of the pathogen *Peronospora hyoscyami,* its relationship with tobacco, its sensitivity to the environment, and the effect of human manipulation. In ten chapters aspects of taxonomy, structure, genetics, biochemistry, environment, systemic resistance, epidemiology, and meteorology are extensively discussed.

G. Mohr. *Grundlagen, Anwendungen und Möglichkeiten der Stammverbesserung biotechnologisch relevanter Hyphenpilze durch den Gentechnik: Integrative Transformation von Aspergillus niger.* (Dissertationes botanicae 131. J. Cramer in der Gebrüder Born-

traeger Verlagsbuchhandlung, Berlin, Stuttgart. 1989.) Pp. 114, 16 Text-figs., 15 Tables. Price: DM 70.-.

The object of this thesis is the study of the foundation of genetical transformation in *Aspergillus niger* and the indication of practical applications. The results show that the transformation with integrative vectors is a very efficient possibility in *A. niger*. Molecular analysis of the total DNA of transformants indicate, that many vector copies are present in a tandem-like arrangement. Free vectors could not be found. New possibilities for genetical analysis of hyphomycetes without a sexual process are mentioned.

M. Moser & W. Jülich. *Farbatlas der Basidiomyceten. Colour Atlas of Basidiomycetes. Lief. 7.* (Gustav Fischer Verlag, Stuttgart, New York. 1989.) Pp. 31, 84 Pls. with 144 coloured figs. (a binder for fasc. 5–7 is included). Price: DM 110.-.

This is the seventh issue in a series of a loose-leaved atlas with colour plates of European basidiomycetes. Most of the new plates are of reasonable to good quality. Descriptions are given of the genera *Phylloporus, Flammulina, Gymnopilus, Bulbillomyces, Meruliopsis,* and *Mycoacia*. A new index of all genera and species treated thus far is included.

R.C. Pearson & A.C. Goheen (Editors). *Compendium of grape diseases*. (APS Press, The American Phytopathological Society, St. Paul, Minnesota. 1988.) Pp. 93, 30 Text-figs., 28 Col. Pls. Price: $ 25.- ($ 20.- in the U.S.A.), postage included.

Authors from all over the world have contributed to this well-edited volume on grape diseases. About 60 disorders of the grape, caused by biotic or abiotic factors, are described, discussed, and illustrated in colour in 188 photographs. Among these are about 30 diseases caused by fungal agents. In each case symptoms, causal organism, disease cycle, epidemiology and control pass in review. In an appendix the equivalent names of grape diseases are given in French, German, Italian, and Spanish. A glossary is also added.

E.W. Ricek. *Die Pilzflora des Attergaues, Hausruck- und Kobernaußerwaldes*. (Abh. zool.-bot. Ges. Öst. 23. Zoologisch-botanische Gesellschaft, P.O. Box 287, Vienna. 1989.) Pp. 439, including 20 Col. Pls. Price not known.

This is an ecological fungus flora of the area around St. Georgen in the Attergau-region in Austria. After a biographic sketch of the author by E. Hübl and J. Krisai, surveys are presented of the types of landscape in the area and of the different biotopes distinguished. Since the observations cover a period of more than 30 years, special attention is paid to changes in the mycoflora. A list of threatened species of fungi for the area is given.

The special part of this volume consists of an extensive list of ascomycetes and basidiomycetes of the area with annotations on ecology and occurrence. For nomenclature and taxonomy of the fungi discussed, reference is made to other floras. In 20 coloured plates 4 species of *Peziza* and 33 species of agarics and boleti are rather coarsely depicted.

U. Schmidt. *Struktur, Spleißprozesse und Funktionen mitochondrialer Introne. Das 'mobile Intron' des Ascomyceten Podospora anserina.* (Bibliotheca mycologica 127. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Berlin, Stuttgart. 1989.) Pp. 124, 16 Text-figs., 6 Tables. Price: DM 70.-.

Subject of this thesis are cell-wall analyses of yeasts and yeast-like fungi belonging to ascomycetes and basidiomycetes. Cell-wall properties were especially tested for use as characters in chemotaxonomy. Of many representatives of yeasts the cell-wall sugars were determined quantitatively and qualitatively with gaschromatography. In some groups the chitin content and the composition of cell-wall proteins were also established. Among the many conclusions of this study, the author could e.g. recognize four different types of cell-walls within the heterobasidiomycetes, based on the composing sugars. Within the Ustilaginales two systematic groups can be distinguished, corresponding with growth on either Monocotyledonae or Dicotyledonae.

J.B. Sinclair & P.A. Backman (Editors). *Compendium of soybean diseases. Third edition.* (APS Press, The American Phytopathological Society, St. Paul, Minnesota. 1989.) Pp. VIII, 106, 102 Text-figs., 66 Col. Figs. Price: $ 20.- in the U.S.A., $ 25.- elsewhere (both prices include postage).

This is the third, fully revised edition of this compendium. Each section of it has been revised and updated with the aid of 57 agricultural scientists from all over the world. Many new illustrations and some new sections are added. The descriptions of diseases and other damages of the soybean (*Glycine max*) are arranged in sections according to the causal agents like bacteria, mycoplasma like organisms, fungi, viruses, and nematodes. Each disease or condition is described by symptoms, causal organism, disease cycle and epidemiology. Suggestions for control strategies and selected references are given.

J. Stangl. *Die Gattung Inocybe in Bayern.* (Hoppea 46, Verlag der Regensburgischen Botanischen Gesellschaft, Regensburg. 1989.) Pp. 410, 138 Text-figs., 38 Col. Pls. Price: DM 50.-.

A monograph by the well-known, unfortunately too early deceased specialist on *Inocybe*, Johann Stangl. In total 138 species, subspecies and varieties are extensively described and a key is given. The microscopical details are illustrated on full-page assemblages of line-drawings for each taxon, whereas excellent water-colours of all taxa, usually represented by 3 or more basidiocarps, are added.

This book is a must for every European agaricologist and a monument to its author.

J.O. Whiteside, S.M. Garnsey & L.W. Timmer (Editors). *Compendium of citrus diseases.* (APS Press, The American Phytopathological Society, St. Paul, Minnesota. 1988.)

Pp.VI, 80, 33 Text-figs., 171 Col. Figs. Price: $ 20.- in the U.S.A., $ 25.- elsewhere (both prices include postage).

This is a new addition to the APS-series of compendia on diseases of agricultural and horticultural crops. In this compendium 32 authors from around the world contribute many sections on the major diseases and disorders recorded on citrus. The citrus fruits treated fall in several groups, like e.g. sweet oranges, sour oranges, mandarins, pummelos, grapefruit, lemons, limes, and tangalos. About fifty fungal diseases are treated. A guide to the identification of diseases and a glossary of phytopathological and general botanical terms are included. It is an authoritative and practical reference for plant pathologists and other researchers working with citrus diseases.

T.D. Wyllie & D.H. Scott (Editors). *Soybean diseases*. (APS Press, The American Phytopathological Society, St. Paul, Minnesota. 1988.) Pp. 75, 13 Text-figs., 16 Tables. Price: $ 24.- ($ 19.- in the U.S.A.), postage included.

The purpose of this volume is to provide the latest information on the major diseases of the soy-bean (*Glycine max*) in the north central soy-bean area in the U.S.A. It gathers papers given at a Soybean Disease Workshop held in Indianapolis in 1987 of which many concern fungal affections of this important crop. The references consist of 572 entries.