

## THE GENUS MYCELIOPHTHORA

C. A. N. VAN OORSCHOT

*Centraalbureau voor Schimmelcultures, Baarn*

(With four Text-figures and Plate 49)

The hyphomycetous genus *Myceliophthora* Cost. is reintroduced with its type species, *M. lutea* Cost., and two new combinations are proposed: *Myceliophthora thermophila* and *M. fergusii*. The genus is characterised by blastoconidia with narrow basal attachments (sometimes borne on ampulliform swellings) and by lacking arthroconidia. All three species are more or less thermophilic, with temperature optima between 30 and 45 °C.

In 1894 Costantin & Matruchot described the 'vert de gris' mat disease or cultivated mushrooms and named the pathogen *Myceliophthora lutea* Cost. Carmichael (1962) included Costantin's species in *Chrysosporium* Corda as *Chrysosporium luteum* (Cost.) Carmichael. Von Arx (1973) suggested that *C. luteum* should be removed from this genus and returned to *Myceliophthora* Cost. *Myceliophthora lutea* produces blastoconidia with narrow basal attachments, borne directly on hyphae or pedicels or ampulliform swellings, and has no arthroconidia. *Chrysosporium* Corda becomes a more homogeneous group, with perfect states only in the Gymnoascaceae, when it is defined as having arthroconidia and aleurioconidia which are terminal, intercalary or lateral, occasionally formed in chains and have broad basal attachments (see Fig. 1).

### MYCELIOPHTHORA Cost.

*Myceliophthora* Cost. In C.r. hebd. Séanc. Acad. Sci., Paris: 2. 1892.  
Type species: *M. lutea* Cost.

Colonies on 2% malt agar initially white, later pale yellow, pale brown, cream or even occasionally dark green; reverse pale yellow, bright yellow, honey brown, brown, cream or occasionally green. Colonies powdery and felty with a defined margin, or cottony and floccose without a defined margin; growing rapidly, reaching 30-80 mm diam. in 7 days at 30 °C. More or less thermophilic, with optima between 36 and 45 °C. Some species are cellulolytic, some keratinolytic. Hyphae septate, hyaline, branched, the submerged occasionally broader than the aerial hyphae, thin-walled (rarely bearing blastoconidia). Aerial hyphae arising individually from submerged hyphae, erect, 1-2 mm high, sterile at the base, profusely branched and usually fertile at the apex. Blastoconidia borne directly on the sides of the hyphae, on long or short pedicels or in groups of 1-4 on ampulliform swellings; globose, pyriform, clavate or obovoid with narrow basal attachments, smooth- or rough-walled at maturity.

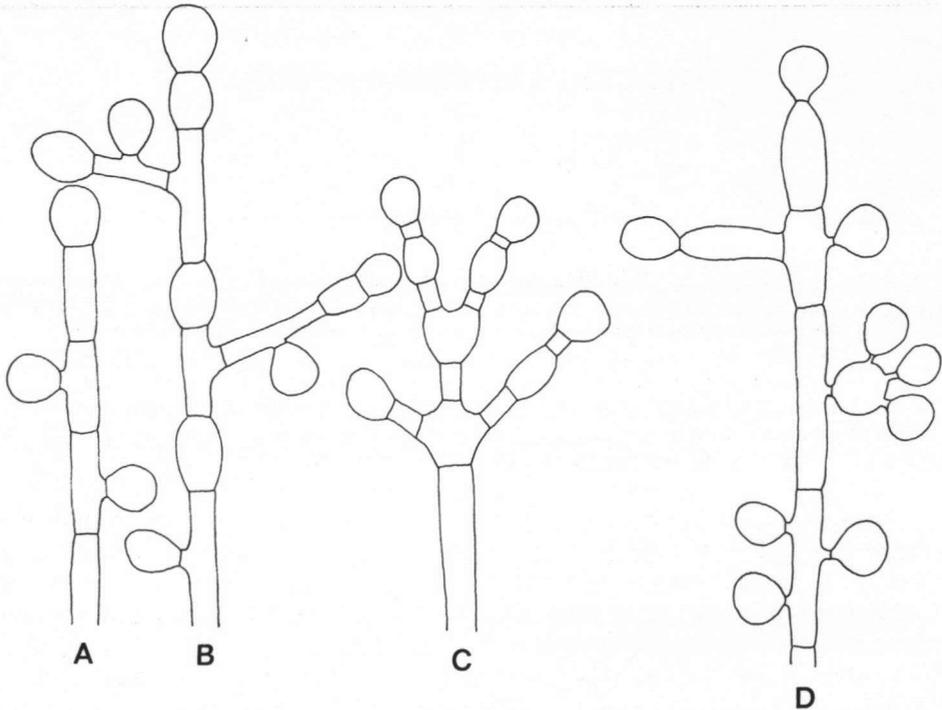


Fig. 1. Schematic diagram to illustrate varying conidiogenesis. — A–C. *Chrysosporium*-type with arthrospores and 'aleuriospores'. — D. *Myceliophthora*-type with blastoconidia.

*Myceliophthora* Cost. may be distinguished from the blastoconidial genera, *Emmonsia* Cif. & Montemartini (1958) and *Beniowskia* (1900) by the smaller (up to 10  $\mu\text{m}$  diam.), almost globose conidia of the former, and the larger (up to 10  $\mu\text{m}$  diam.), globose conidia (borne on denticles all over the hyphal surface) of the latter. In addition *Emmonsia* produces white, felty colonies. The genus *Trichosporiella* Kamyschko ex Gams & Domsch (1969) also has blastoconidia but differs by having moist colonies which usually lack an aerial mycelium.

The cellulolytic and keratinolytic properties of the species were tested by inoculation onto suitable media at optimal temperatures; a strip of cellophane or a number of human hairs being placed on the agar 2–3 cm from the point of inoculation.

#### KEY TO THE SPECIES

- 1a. Hyphal width not exceeding 3.0  $\mu\text{m}$ ; cultures felty, woolly, not floccose . . . . . 2
- b. Hyphal width 3.2–5.2  $\mu\text{m}$ ; cultures pinkish-cream, floccose; cellulolytic and keratinolytic; blastoconidia 4.8–12.0  $\times$  2.8–5.2  $\mu\text{m}$  . . . . . *M. fergusii* (3)

- 2a. Cultures yellow, felty; cellulolytic; blastoconidia  $3.8-9.0 \times 3.0-6.0 \mu\text{m}$  . . . *M. lutea* (1)  
 b. Cultures brown, occasionally green, woolly; keratinolytic but not cellulolytic; blastoconidia smooth or rough,  $4.5-11.0 \times 3.0-4.5 \mu\text{m}$  . . . . . *M. thermophila* (2)

(1) *MYCELIOPHTHORA LUTEA* Cost.—Fig. 2

*Myceliophthora lutea* Cost. in C.r. hebd. Séanc. Acad. Sci., Paris: 2. 1892. — *Chrysosporium luteum* (Cost.) Carmichael in Can. J. Bot. 40: 1158. 1962.

*Sporotrichum carthusio-viride* Rai & Mukerji in Mycopath. Mycol. appl. 18: 122. 1962.

Colonies on 2% malt agar initially white, later pale yellow, felty, with a defined, dented margin, reaching 23–31 mm diam. in 7 days on 2% malt agar at 30°C; reverse pale or bright yellow. Thermotolerant with optimal growth at 33°C, temperature minimum 20°C, maximum 40°C. Cellulolytic, not keratinolytic. Submerged hyphae occasionally wider than aerial hyphae (up to 6.0 μm diam.), thin-walled; aerial hyphae 0.75–3.0 μm wide. Blastoconidia borne terminally or laterally on aerial hyphae, sometimes with short or long pedicels and occasionally a secondary blastoconidium being produced from the distal end of the first; 1–4 blastoconidia may be borne on one hyphal cell or on an ampulliform swelling; conidia pyriform to globose, smooth and fairly thick-walled, hyaline,  $3.8-9.0 \times 3.0-6.0 \mu\text{m}$ .

**MATERIAL EXAMINED.**—CBS 146.50, isolated from mushroom beds, Delaware, U.S.A., *E. T. Reese*, 1940; CBS 147.50, isolated from mushroom beds, Pennsylvania, U.S.A., *J. W. Sinden*, 1942; CBS 157.51, *P. J. Bels*, 1951; CBS 157.59, isolated from air in pig sty, Baarn, Netherlands, *G. A. de Vries*, 1959; CBS 227.67, isolated from soil, India, *J. P. Tewari* (type of *Sporotrichum carthusio-viride* Rai & Mukerji); CBS 145.77, (neotype) isolated from hay, Newmarket, U. K., *M. Archer*, 1974; CBS 146.77, isolated from *Hordeum vulgare*, Carlow, Ireland, *B. Dunne*, 1970; CBS 147.77, isolated from dust in stable, Newmarket, U. K., *M. Archer*, 1973.

No living or herbarium material is known of the original isolates of *M. lutea* described by Costantin & Matruchot in 1894 (Hawksworth, 1974) but the origin from yellow patches in mushroom compost and the careful description leaves no doubt about the identity of this species. There is one discrepancy, however, in that the conidia described in 1894 were  $3-4 \times 2 \mu\text{m}$ , while the strains listed above have larger conidia ( $3.8-9.0 \times 3.0-6.0 \mu\text{m}$ ). The richly sporulating strain CBS 145.77 (IMI 182034) is here designated as neotype.

(2) *Myceliophthora thermophila* (Apinis) Oorschot, *comb. nov.*—

Fig. 3, Plate 1A, B

*Sporotrichum thermophilum* Apinis in Nova Hedwegia 5: 74. 1963 (basionym). — *Chrysosporium thermophilum* (Apinis) Klopotek in Arch. Microbiol. 98: 366. 1974.

Ascigerous state: *Thielavia heterothallica* Klopotek in Arch. Microbiol. 107: 223–224. 1976.

Colonies on 2% malt agar initially white, cottony, later pale brown, occasionally greenish, woolly, without a well-defined margin; reaching 60–70 μm diam., in 7 days at 30°C. Moderately thermotolerant, with optimal growth at 30–36°C, minimum 24°C, maximum 54°C (von Klopotek, 1974). Keratinolytic but not markedly

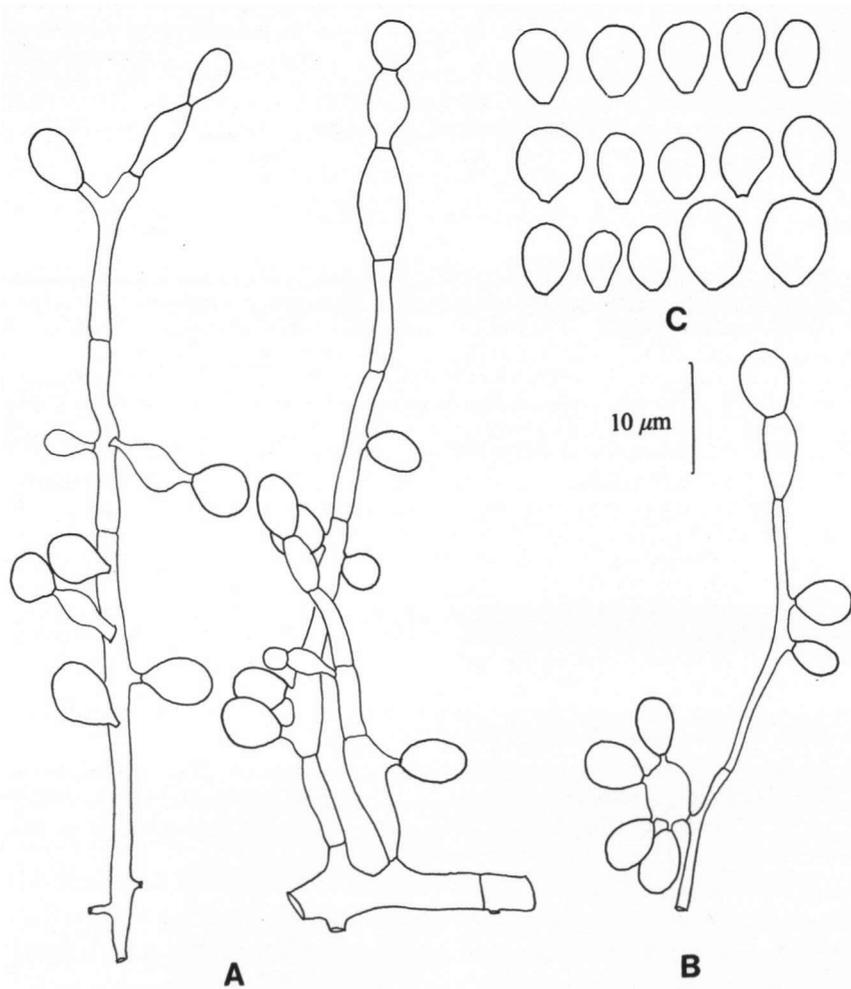


Fig. 2. *Myceliophthora lutea*. — A. Strain CBS 379.76. Aerial hypha bearing conidia. — B, C. Strain CBS 157.51. — B. Part of aerial hypha bearing an ampulliform swelling with 4 conidia. — C. Conidia.

cellulolytic. Submerged hyphae occasionally wider than aerial hyphae (up to  $6.0\ \mu\text{m}$  diam.); aerial hyphae  $0.8\text{--}3.0\ \mu\text{m}$  in diam. Blastoconidia borne terminally or laterally on hyphae, sometimes with short or long pedicels and occasionally a secondary blastoconidium being produced from the distal end of the first; 1-4 blastoconidia may be borne on one hyphal cell or on an ampulliform swelling; conidia obovoid to pyriform,  $4.5\text{--}11.0 \times 3.0\text{--}4.5\ \mu\text{m}$ , hyaline, smooth- and thick-walled.

**MATERIAL EXAMINED.**—CBS 117.65 (type strain) isolated from dry pasture soil, Attenborough, England, *A. E. Apinis*, 1951; CBS 131.65 isolated from birch chips, Stockholm, Sweden, *T. Nilsson*, 1965; CBS 375.69 isolated from woodpulp, New Brunswick, Canada, *J. W. Carmichael*, 1969; CBS 173.70 isolated from wheat straw compost, Cambridge, England, *H. J. Hudson*, 1970; CBS 663.74 isolated from soil beneath *Adansonia* sp., Senegal, *H. Lindner*, 1974; CBS 202.75 isolated from garden soil, Giessen, Germany, *A. van Klopotek*, 1974; CBS 203.75 isolated from soil, Indiana, U. S. A., *M. R. Tansey*, 1974.

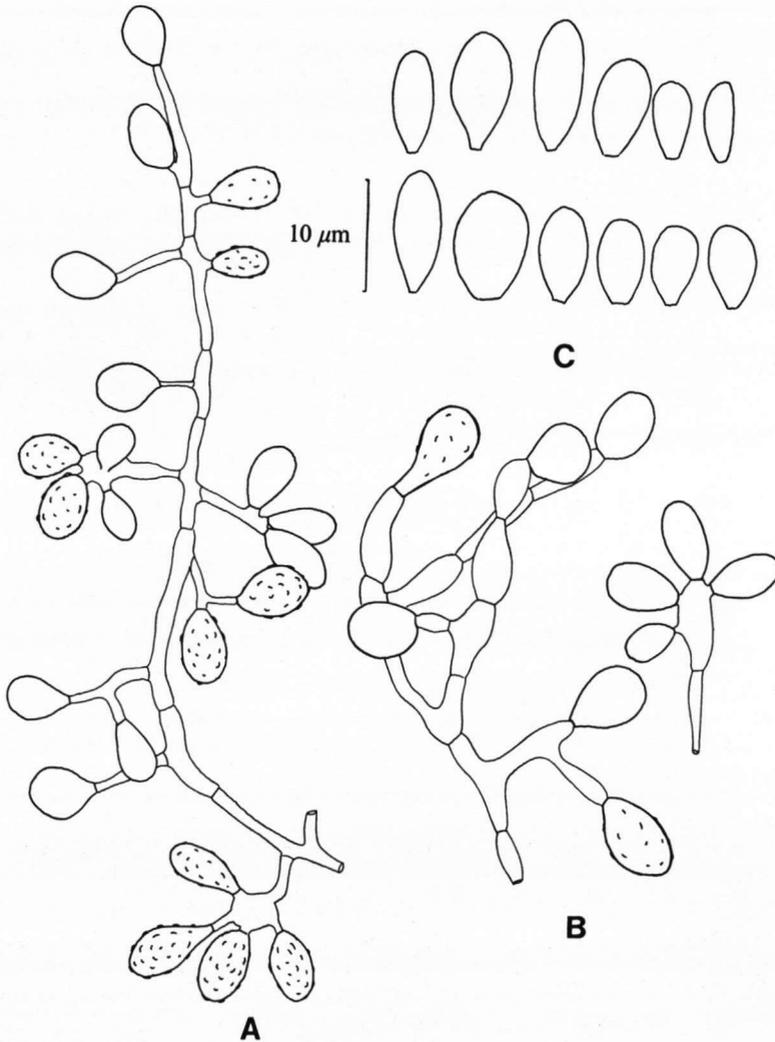


Fig. 3. *Myceliophthora thermophila*. — A. Strain CBS 202.75. Aerial hypha bearing conidia. — B, C. Strain CBS 131.65. — B. Parts of aerial hypha showing branching and ampulliform swelling with conidia. — C. Conidia.

*Sporotrichum thermophilum* was originally isolated amongst other thermophilic fungi from soil and plant debris in swamps in Britain (Apinis, 1963). Von Klopotek (1974) transferred it to *Chrysosporium* because the hyphae lacked basidiomycete-type clamp connections which are present in *Sporotrichum aereum* Link ex Fr., the lectotype species of the genus. Moreover, *Sporotrichum thermophilum* has an ascomycetous perfect state. As the hyphae bear blastoconidia with narrow basal attachments, hyphal cells which may each produce up to 4 blastoconidia and ampulliform swellings, *M. thermophilum* is very close to *M. lutea*. Fresh isolates of *M. thermophila* always have rough conidia but older cultures tend to produce smooth conidia. Even an old isolate of the type strain CBS 117.65 (maintained since 1951) which was originally described as having smooth conidia (Apinis, 1963), produced some rough conidia after 30 days on YpSs agar at 30°C.

**MATING EXPERIMENTS.**—Von Klopotek (1976) obtained a perfect state which she called *Thielavia heterothallica*. The isolates which she used, CBS 202.75 and CBS 203.75, plus another strain, CBS 663.74, were mated. Single conidial isolates of CBS 203.75 with either CBS 202.75 or CBS 663.74, mated and produced mature ascomata of *T. heterothallica* Klopotek on 2% malt agar at 30°C. In both cases the asci formed on the CBS 203.75 side of the dividing line between the two colonies. This would seem to indicate that either CBS 203.75 is homothallic and is induced by the other strains to produce ascomata, or that CBS 203.75 is heterothallic and acts as the 'female' partner.

(3) *Myceliophthora fergusii* (Klopotek) Oorschot, *comb. nov.*—Fig. 3

*Chrysosporium fergusii* Klopotek in Arch. Mikrobiol. 98: 366. 1974 (basionym).

Ascigerous state: *Thielavia thermophila* Fergus & Sinden in Can. J. Bot. 47: 1635. 1969. — *Corynascus thermophilus* (Fergus & Sinden) Klopotek in Arch. Mikrobiol. 98: 366. 1974.

Colonies on cornmeal agar initially white, cottony, later pinkish-cream, floccose, covering an 8.5 cm petri dish within 72 h at 40°C; reverse cream. Thermophilic with optimum growth at 45°C, minimum 20°C, maximum 56°C. Cellulolytic and keratinolytic. Submerged hyphae of the same width as aerial hyphae (3.2–5.2 µm); aerial hyphae fertile at the apex or sterile, up to 5 mm high. Blastoconidia borne laterally or terminally on aerial hyphae, sometimes with short pedicels; up to 5 conidia being borne per hyphal cell. A secondary blastoconidium may be produced from the distal end of the first and ampulliform swellings are globose or slightly obovoid with one (occasionally two) blastoconidia per swelling. Conidia 4.8–12.0 × 2.8–5.2 µm, pyriform to clavate, occasionally somewhat globose, smooth- and thick-walled, hyaline, with narrow basal attachments.

**MATERIAL EXAMINED**—CBS 405.69 (type-strain) (+), isolated from mushroom compost, U. S. A., *C. L. Fergus*, 1969; CBS 406.69 (—) isolated from mushroom compost, U. S. A., *C. L. Fergus*, 1969; CBS 174.70 isolated from wheat straw compost, Cambridge, England, *H. J. Hudson*, 1969.

In 1969 Fergus & Sinden described the imperfect state of *Thielavia thermophila* Fergus & Sinden as resembling *Sporotrichum thermophilum* (i.e. *M. thermophila*) except in

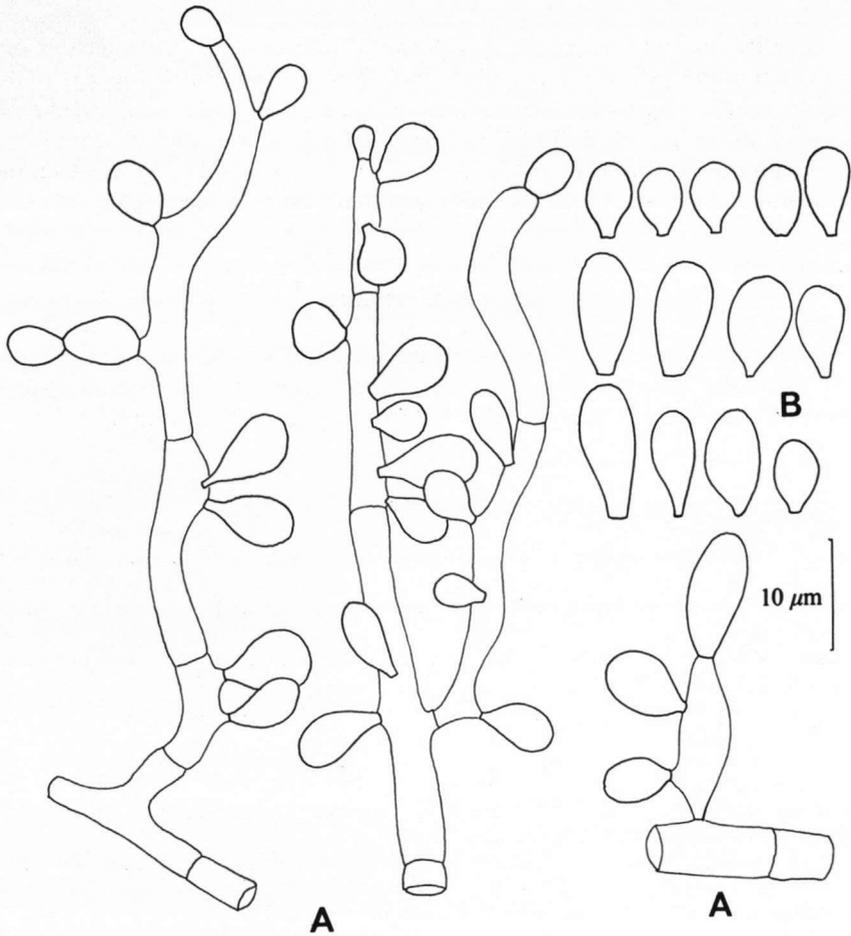


Fig. 4. *Myceliophthora fergusii*. — A, B. Strain CBS 406.69. — A. Parts of aerial hyphae bearing conidia. — B. Conidia.

cultural characteristics and temperature range. Hedger & Hudson (1970) pointed out most of the differences between *M. thermophila* and the conidial state of *Thielavia thermophila*. In addition it should be noted that the latter species has wider hyphae (3.2–5.2  $\mu\text{m}$ ) than *M. thermophila* (0.75–3.0  $\mu\text{m}$ ) and fewer, usually more elongate ampulliform swellings with less conidia per swelling. This species is transferred to *Myceliophthora* for the same reasons as *Myceliophthora thermophila*.

#### EXCLUDED SPECIES

*MYCELIOPHTHORA SULPHUREA* Goddard in Bot. Gaz. 56: 263. 1963.

Type material of this species probably does not exist. The drawings and descriptions

of the colonies strongly suggest *Chrysosporium merdarium* (fide Carmichael, 1962).

MYCELIOPHTHORA INFLATA Burnside in Pap. Mich. Acad. Sci. **8**: 82-84. 1928. — *Paecilomyces inflatus* (Burnside) Carmichael in Can. J. Bot. **40**: 1148. 1962 (syn. *Paecilomyces flavescens* Brown & Smith in Trans. Br. mycol. Soc. **40**: 56. 1957).

MYCELIOPHTHORA FUSCA Doyer in Meded. phytopath. Lab. Willie Commelin Scholten **10**: 32. 1927. — *Ptychogaster rubescens* Boud. (fide von Arx, 1973).

#### ACKNOWLEDGEMENTS

The author wishes to thank Drs W. Gams and R. A. Samson for their advice, Mrs. M. Leyen for technical assistance, Mr. J. A. Stalpers for the scanning electron micrographs, and Miss H. Pannebakker for printing these micrographs.

#### REFERENCES

- APINIS, A. E. (1963). Occurrence of thermophilous microfungi in certain alluvial soils near Nottingham. In *Nova Hedwigia* **5**: 57-78.
- ARX, J. A. VON (1973). Further observations on *Sporotrichum* and some similar fungi. In *Persoonia* **7**: 127-130.
- CARMICHAEL, J. W. (1962). *Chrysosporium* and some other aleuriosporic hyphomycetes. In *Can. J. Bot.* **40**: 1137-1173.
- CIFERRI, H. & MONTEMARTINI, A. (1958). Taxonomy of *Haplosporangium parvum*. In *Mycopath. Mycol. appl.* **10**: 303-316.
- COSTANTIN, J. (1892). Sur quelques maladies du blanc de champignons. In *C.r. hebd. Séanc. Acad. Sci., Paris*: 1-3.
- FERGUS, C. L. & SINDEN, J. W. (1969). A new thermophilic fungus from mushroom compost: *Thielavia thermophila* spec. nov. In *Can. J. Bot.* **47**: 1635-1637.
- GAMS, W. & DOMSCH, K. H. (1969). Bemerkungen zu einigen schwer bestimmbareren Bodenpilzen. In *Nova Hedwigia* **18**: 1-29.
- HAWKSWORTH, D. L. (1974). *Mycologist's Handbook*. C. M. I., Kew.
- HEDGER, J. N. & HUDSON, H. J. (1970). *Thielavia thermophila* and *Sporotrichum thermophile*. In *Trans. Br. mycol. Soc.* **54**: 497-500.
- KLOPOTEK, A. VON (1974). Revision der thermophilen *Sporotrichum*-Arten: *Chrysosporium thermophilum* (Apinis) comb. nov. und *Chrysosporium fergusii* spec. nov. = Status conidialis von *Corynascus thermophilus* (Fergus & Sinden) comb. nov. In *Arch. Mikrobiol.* **98**: 365-369.
- (1976). *Thielavia thermophila* spec. nov., die perfekte Form von *Chrysosporium thermophilum*. In *Arch. Mikrobiol.* **107**: 223-224.
- RACIBORSKI, M. (1900). Parasitische Algen und Pilze Java's II. Batavia.

#### EXPLANATION OF PLATE 49

Scanning electron micrographs of *Myceliophthora thermophila* strain CBS 202.75. — A. Young aerial hypha showing development of blastoconida. — B. Aerial hypha bearing smooth and slightly rough blastoconida on pedicels and on an ampulliform swelling (top left).

The scale-markers represent 10  $\mu$ m.

