

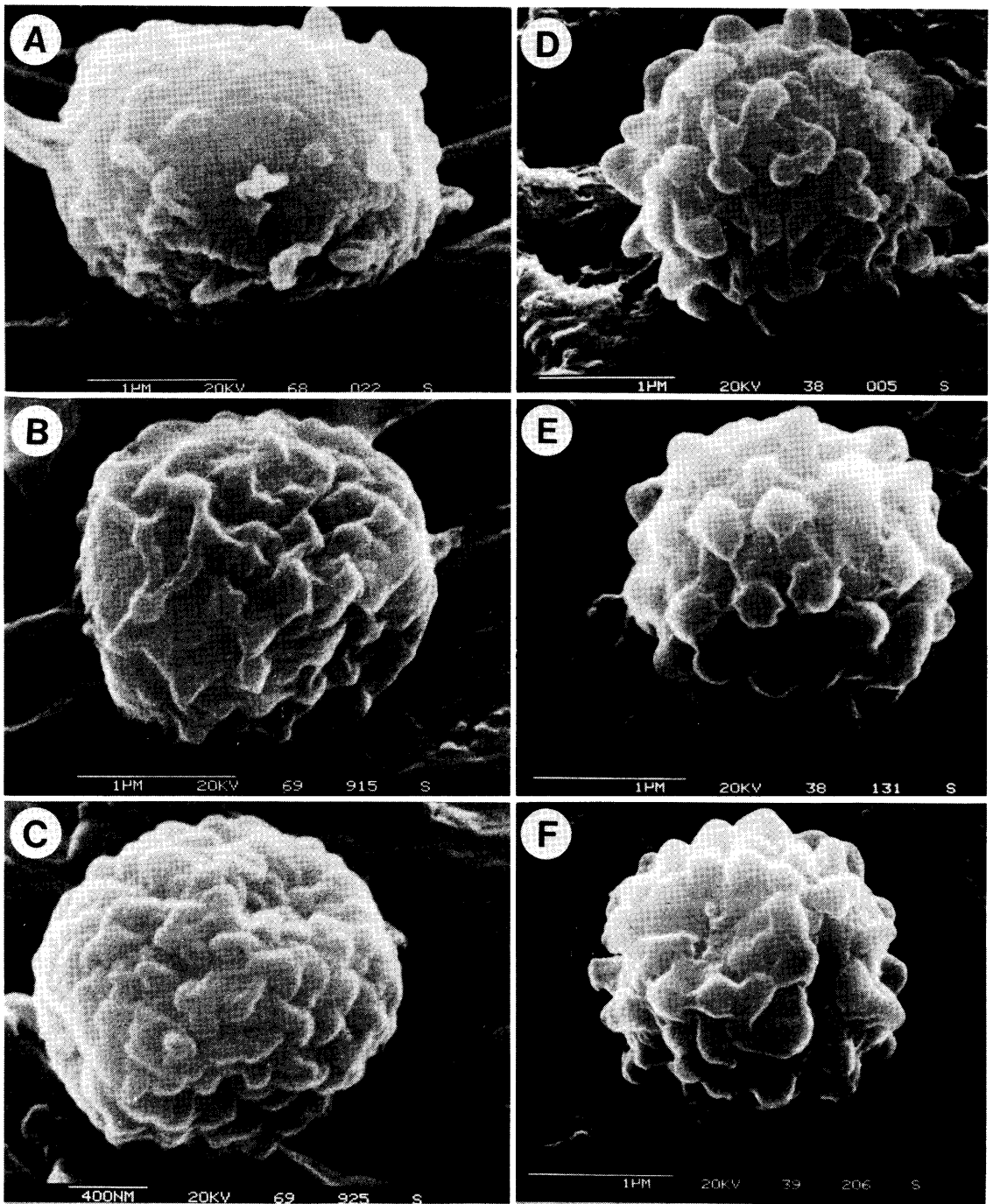


Fig. 19. *A. fumigatus* group: the lobate-reticulate category SEM micrographs of A, *A. fumigatus*, IMI 16152; B, *N. aurata*, IMI 75886; C, *N. aureola*, IMI 61451; D, *A. brevipes*, IMI 51494; E, *A. brevipes* var. *unilateralis*, IMI 62876; F, *A. duricaulis*, IMI 172282.

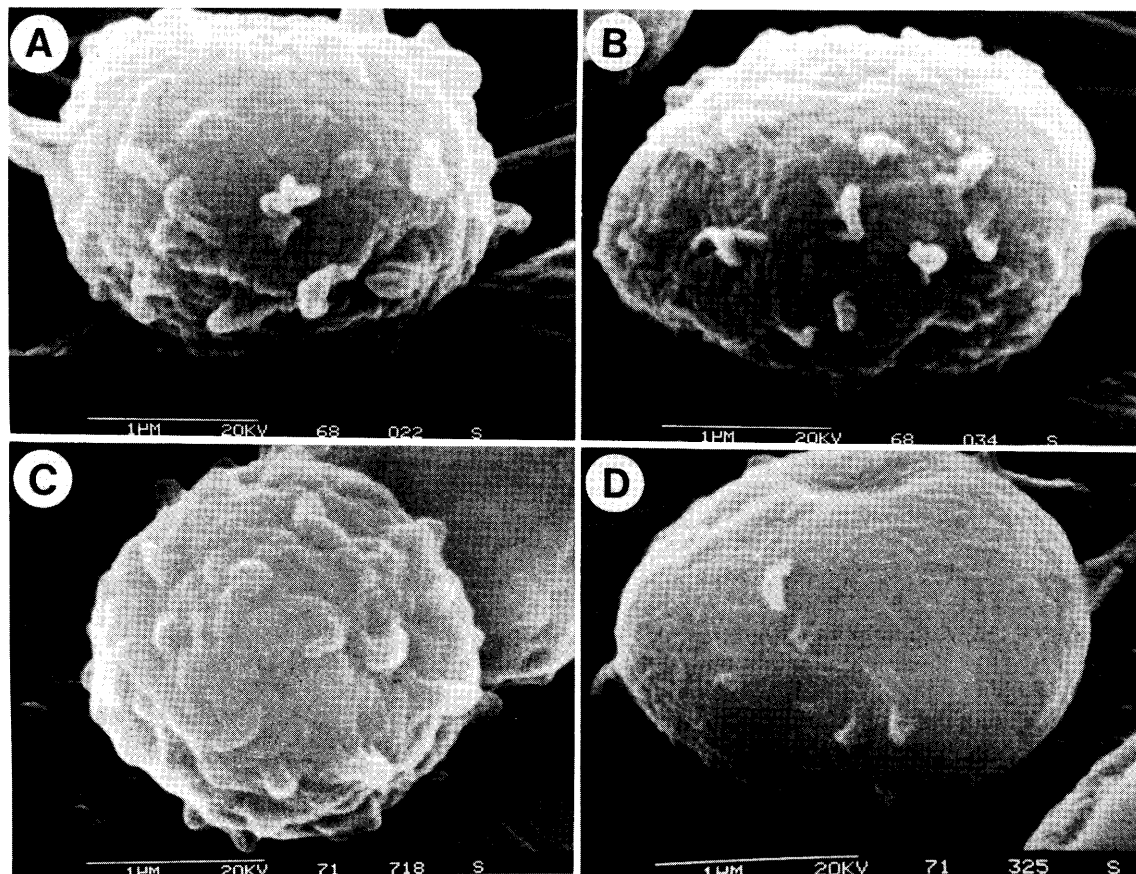


Fig. 20. *A. fumigatus* group: varieties of *A. fumigatus*. A, *A. fumigatus* var. *fumigatus*, IMI 16152; B, *A. fumigatus* var. *helvolus*, IMI 16153; C, *A. fumigatus* var. *acolumnaris*, IMI 174456; D, *A. fumigatus* var. *albus*, CBS 386.75.

taxa may be conspecific. However, according to Raper & Fennell (1965) their ascospores are different, those of *N. aureola* bearing much more prominent equatorial crests than do those of *N. aurata*.

The exceptionally long crests of *N. aureola* are shown in Fig. 21f. It has not been possible so far to produce ascomata in cultures of *N. aurata*, and until they can be compared it is preferred to maintain the two taxa as separate species, even though the anamorphs do not appear to differ.

Neosartorya aurata (Warcup) Malloch & Cain, *Can. J. Bot.* **50**: 2620 (1973).

Aspergillus auratus Warcup, in Raper & Fennell, *The genus Aspergillus*: 263 (1965).

Sartorya aurata (Warcup) Subram., *Curr. Sci.* **41**: 760 (1972).

Anamorph: ***Aspergillus igneus*** Kozakiewicz, **sp. nov.**

Diagnosis Latina anamorphosi *Aspergilli* restricta in Warcup apud Raper & Fennell, *The genus Aspergillus*: 263 (1965).

Holotypus cultura sicca IMI 75886 pro parte *Aspergilli* pertinans.

Illustration: Fig. 19b.

Description: *Conidia* lobate-reticulate. *Conidiogenous cells* uniseriate. *Conidiophores* smooth, 60–120 μm long. *Conidial heads* loosely columnar, scattered, in dull blue-grey colours. *Ascomata* orange (R. XV) surrounded by encrusted orange hyphae. *Ascospores* not obtained yet.

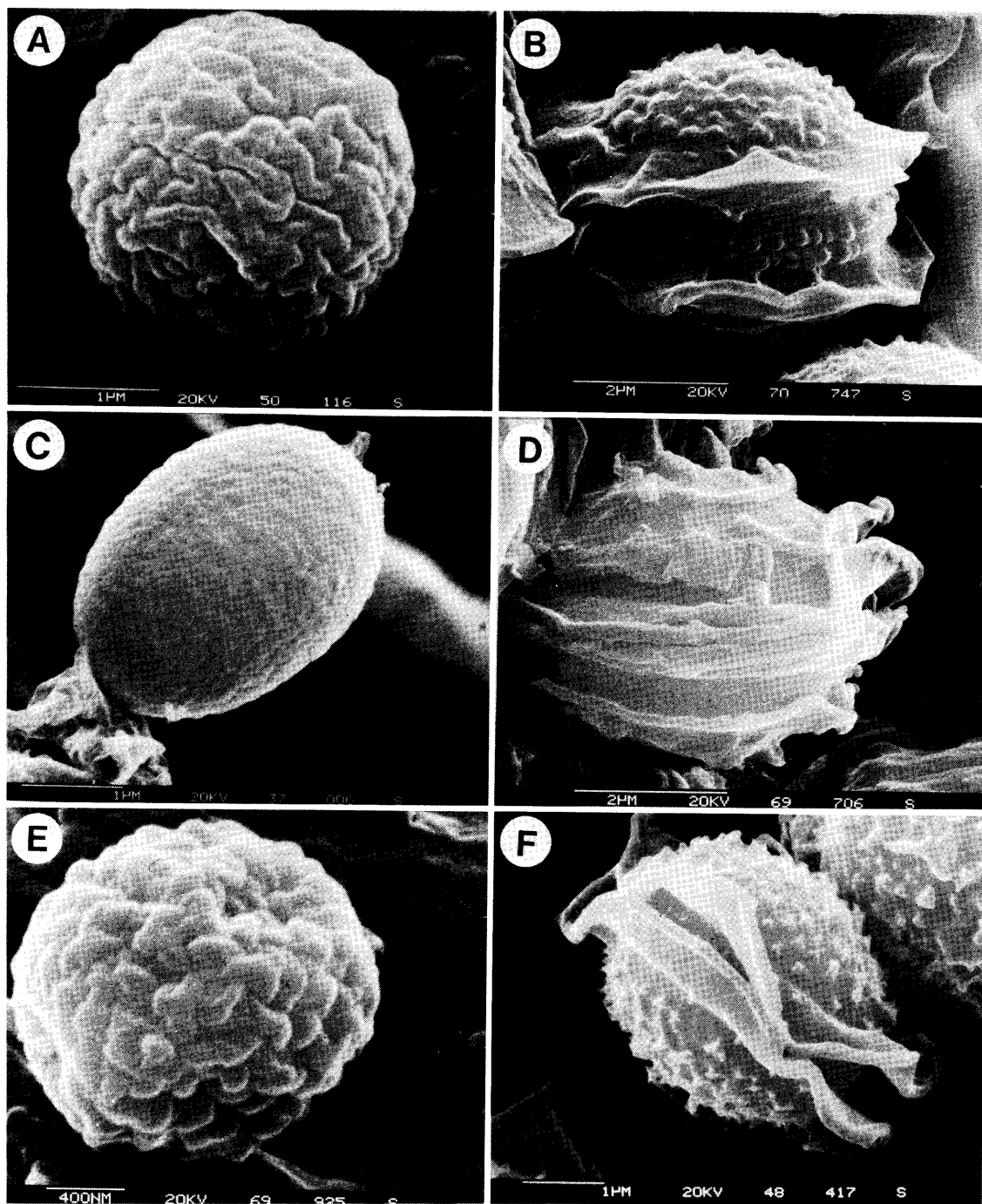


Fig. 21. *A. fumigatus* group: three species of *Neosartorya*. A,B, *N. stramenia*, IMI 172293; C,D, *N. quadricincta*, IMI 48583ii; E,F, *N. aureola*, IMI 61451.

Type: Brunei: Berakas-Muara, ex jungle soil, 1958, *J.H. Warcup* (IMI 75886, holotype).

Host: Soil.

Distribution: Brunei.

Notes: *N. aurata* has already been discussed under *N. aureola*.

Aspergillus brevipes G. Smith, *Trans. Br. mycol. Soc.* **35**: 241 (1952).

var. **brevipes**

Aspergillus duricaulis Raper & Fennell, *The genus Aspergillus*: 249 (1965).

Illustration: Fig.19d.

Description: *Conidia* lobate-reticulate. *Conidiogenous cells* uniseriate. *Conidiophores* short, sometimes entirely lacking, otherwise 15–50 µm long. *Conidial heads* radiate, at margins columnar, dark ivy to deep slate green (R. XLVII). *Vesicles* at angle to conidiophore to give nodding appearance. *Ascomata* absent. *Hyphal pigmentation* purple.

Type: Australia: Mt Kosciuszko, ex soil, 1950, *G. Smith* (IMI 51494).

Host: Soil.

Distribution: Argentina, Australia.

Specimens: Argentina: Buenos Aires, ex soil, 1953, *Winitzky* (IMI 172282) as *A. duricaulis*.

Notes: *A. brevipes* produces the mycotoxin viriditoxin (Lillehoj & Milburn, 1973) which by acting via the intraperitoneal route has been shown to be toxic to mice.

The specific identity of this species has been discussed under general remarks on the lobate-reticulate group as has the synonymy of *A. duricaulis*.

Aspergillus brevipes var. **unilateralis** (Thrower) Kozakiewicz, **comb. nov.**

Aspergillus unilateralis Thrower, *Aust. J. Bot.* **2**: 355 (1954).

Illustration: Fig.19e.

Description: *Conidia* lobate-reticulate. *Conidiogenous cells* uniseriate, set at angle to vesicle. *Conidiophores* smooth, 5–30 µm long. *Conidial heads* near slate-olive (R. XLVII), diminutive. *Vesicle* upright on conidiophore. *Ascomata* absent.

Type: Australia: ex rhizosphere of *Epacris impressa* and *Hibbertia fasciculata*, 1954, *G. McLennan* (IMI 62876).

Host: Soil.

Distribution: Australia.

Notes: Its varietal position has already been discussed under the lobate-reticulate group.

Micro-tuberculate category

Neosartorya quadricincta (Yuill) Malloch & Cain, *Can. J. Bot.* **50**: 2621 (1973).

Aspergillus quadricinctus Yuill, *Trans. Br. mycol. Soc.* **36**: 58 (1953).

Sartorya quadricincta (Yuill) Udagawa & Kawasaki, *Trans. mycol. Soc. Japan* **8**: 119 (1968).

Anamorph: **Aspergillus quadricingens** Kozakiewicz, **sp. nov.**

Capitula conidiorum mineral grey vel tea green (R. XLVII) vel olive-grey (R. LI). laxae columnariae. Conidia micro-tuberculata. Cellulae conidiogenae uniseriatae. Conidiophora laevia, 400–500 µm longa.

Holotypus cultura sicca IMI 48583ii pro parte *Aspergilli* pertinans.

Illustrations: Figs 21c,d,22a.

Description: *Conidia* micro-tuberculate. *Conidiogenous cells* uniseriate. *Conidiophores* smooth, 400–500 µm long. *Conidial heads* few, mineral grey to tea green (R. XLVII) or olive-grey (R. LI), loosely columnar. *Ascomata* abundant, white. *Ascospores* hyaline, with prominent wide equatorial crests, each duplicated by another band, echinulate hemispheres.

Type: United Kingdom: York, ex cardboard, 1947, *E. Yuill* (IMI 48583ii, holotype).

Hosts: Soil, cardboard, fabric, paper.

Distribution: Australia, U.S.A., United Kingdom, India.

Notes: Raper & Fennell (1965) thought that the species could not be identified purely on colony characters, but required reference to the ascospore characteristics. Scanning electron micrographs of conidia show the ornamentation to be a reliable diagnostic character.

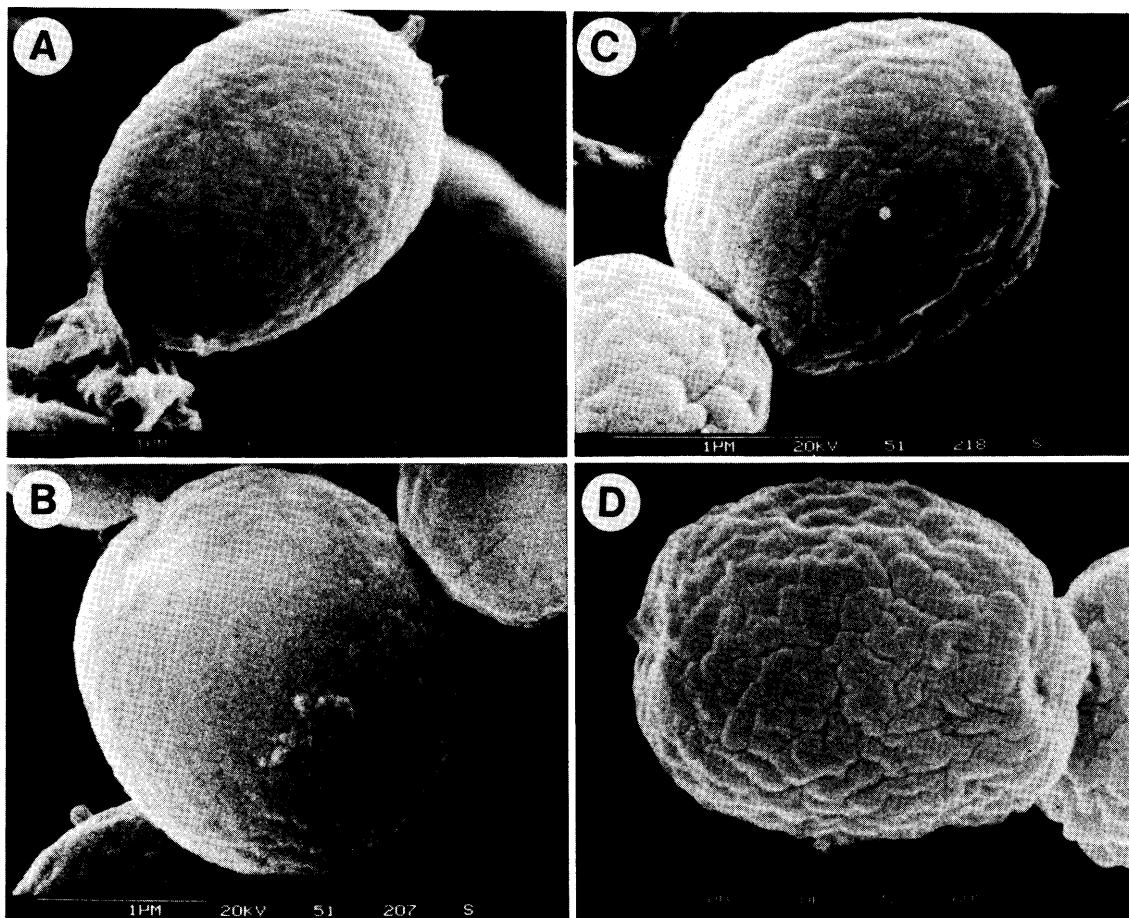


Fig. 22. *A. fumigatus* group: micro-tuberculate category. A, *N. quadricincta*, IMI 48583ii; B, *A. neoellipticus*, IMI 172286; C, *N. fischeri*, IMI 211391; D, *N. glabra*, IMI 61447.

Like many *Neosartorya* species, ascumatal production is temperature-dependent. When grown at 37°C the colony is predominantly conidial, but if kept at 25°C, since the species is thermophilic, it will be under stress and is therefore predominantly ascumatal. Ascomata are typically white, producing characteristic ascospores with up to four equatorial crests.

***Aspergillus neoellipticus* Kozakiewicz, nom. nov.**

Aspergillus fumigatus var. *ellipticus* Raper & Fennell, *The genus Aspergillus*: 246 (1965), non *A. ellipticus* Raper & Fennell emend. Al-Musallam, *Revision of the black Aspergillus species*: 20 (1980).

Illustration: Fig. 22b.

Description: *Conidia* micro-tuberculate. *Conidiogenous cells* uniseriate. *Conidiophores* smooth, short, up to 300 μm long. *Conidial heads* abundant, short columnar, in shades near artemesia to lily green (R. XLVII). *Ascomata* absent.

Type: U.S.A.: Chicago, ex pus specimen from man, 1963 (IMI 172286).

Hosts: *Phaseolus aconitifolius*, man.

Distribution: India, U.S.A.

Notes: Except for its conidial ornamentation, this species closely resembles *A. fumigatus*. It was originally placed as a variety of *A. fumigatus* by Raper & Fennell (1965), although at the time they said 'the conidia differ markedly from those of the species and are elliptical, smooth or nearly so'. Such differences are confirmed by SEM micrographs (cf. Figs 19a and 22b).

Neosartorya fischeri (Wehmer) Malloch & Cain, *Can. J. Bot.* **50**: 2621 (1973).

Aspergillus fischeri Wehmer, *Centr. Bakteriolog. Parasitenk. Abt. II*, **18**: 390 (1907).

Sartorya fumigata Vuill., *Compt. rendu Acad. Sci. Paris* **184**: 136 (1927).

Anamorph: **Aspergillus fischerianus** Samson & W. Gams, *Advances in Penicillium and Aspergillus Systematics*: 39 (1986).

Illustrations: Figs 22c, 23a, b.

Description: *Conidia* micro-tuberculate. *Conidiogenous cells* uniseriate. *Conidiophores* smooth, 300–500 µm, but may reach 1 mm in length. *Conidial heads* columnar, abundant at 37°C, pale blue-grey. *Ascomata* white. *Ascospores* with prominent equatorial crests, delicate, flexuose. Hemispheres bearing distinct reticulations.

Type: ex canned apples *C. Wehmer* (IMI 211391, holotype).

Hosts: Soil, air (CMI, 1988), canned strawberries (Kavanagh *et al.*, 1963), fruit drinks (Pitt & Hocking, 1985).

Distribution: United Kingdom, Australia, Nigeria, The Netherlands.

Specimens: United Kingdom: ex soil, 1942, *E. Yuill* (IMI 16143).

Notes: There is some indication that *A. fischerianus* can sometimes act as a pathogen to man and animals (Raper & Fennell, 1965). The highly distinctive ascospores bear distinct reticulations.

Neosartorya glabra (Fennell & Raper) Kozakiewicz, **comb. nov.**

Aspergillus fischeri var. *glaber* Fennell & Raper, *Mycol.* **47**: 74 (1955).

Neosartorya fischeri var. *glabra* (Fennell & Raper) Malloch & Cain, *Can. J. Bot.* **50**: 2621 (1973).

Sartorya fumigata var. *glabra* (Fennell & Raper) Udagawa & Kawasaki, *Trans. mycol. Soc. Japan* **8**: 115 (1968).

Anamorph: **Aspergillus neoglaber** Kozakiewicz, **sp. nov.**

Capitula conidiorum columnaria, versus deep olive-grey (R. LI). *Conidia* micro-tuberculata. Cellulae conidiogenae uniseriatae. *Conidiophora* laevia, 300–500 µm, sed versus 1 mm longa.

Holotypus cultura sicca IMI 61447 pro parte *Aspergilli* pertinans.

Illustrations: Figs 22d, 23c, d.

Description: *Conidia* micro-tuberculate. *Conidiogenous cells* uniseriate. *Conidiophores* smooth, 300–500 µm, but can reach 1 mm in length. *Ascomata* white. *Conidial heads* columnar, near deep olive-grey (R. LI). *Ascospores* with equatorial crests well developed, sinuous, covered with small even-sized echines.

Type: U.S.A.: Iowa, ex rubber scrap, 1947, *G.W. Martin* (IMI 61447, holotype).

Hosts: Soil, man (ear swab), *Agropyron pungens* (CMI, 1988), canned *Fragaria vesca* (McEvoy & Stuart, 1970).

Distribution: Australia, Ireland, U.S.A., United Kingdom.

Notes: Fennell & Raper (1955) proposed *N. fischeri* var. *glabra* to accommodate a taxon which differed in that the convex surfaces of the ascospores were smooth, or nearly so, compared with those of *N. fischeri* which they considered to bear anastomosing ridges. Scanning electron micrographs show the conidial ornamentation of these two fungi (Fig. 23a, c) to possess subtle differences. The ascospores show even greater differences (Fig. 23b, d), and *N. fischeri* var. *glabra* is raised to species rank accordingly.

Neosartorya fennelliae Kwon-Chung & Kim, *Mycol.* **66**: 629 (1974).

Anamorph: **Aspergillus fennelliae** Kwon-Chung & Kim, *Mycol.* **66**: 629 (1974).

Illustration: Fig. 24a.

Description: *Conidia* micro-tuberculate. *Conidiogenous cells* uniseriate. *Conidiophores* smooth, 150–250 µm long. *Conidial heads* columnar, gnaphalium green to court grey to tea green (R. XLVII). *Ascomata* white. *Ascospores* with equatorial crests well developed, reticulate, convex walls (not seen). *Mycelium* heterothallic.

Type: U.S.A.: Maryland, ex eyeballs of rabbit, 1972, *K.J. Kwon-Chung* (IMI 278382).

Distribution: U.S.A.

Notes: This is one of three *Aspergillus* species which is heterothallic (Kwon-Chung & Kim, 1974). *Aspergillus heterothallicus* is presently placed in the *A. nidulans* group, whilst the other, *N. spathulata*, is in the *A. fumigatus* group.

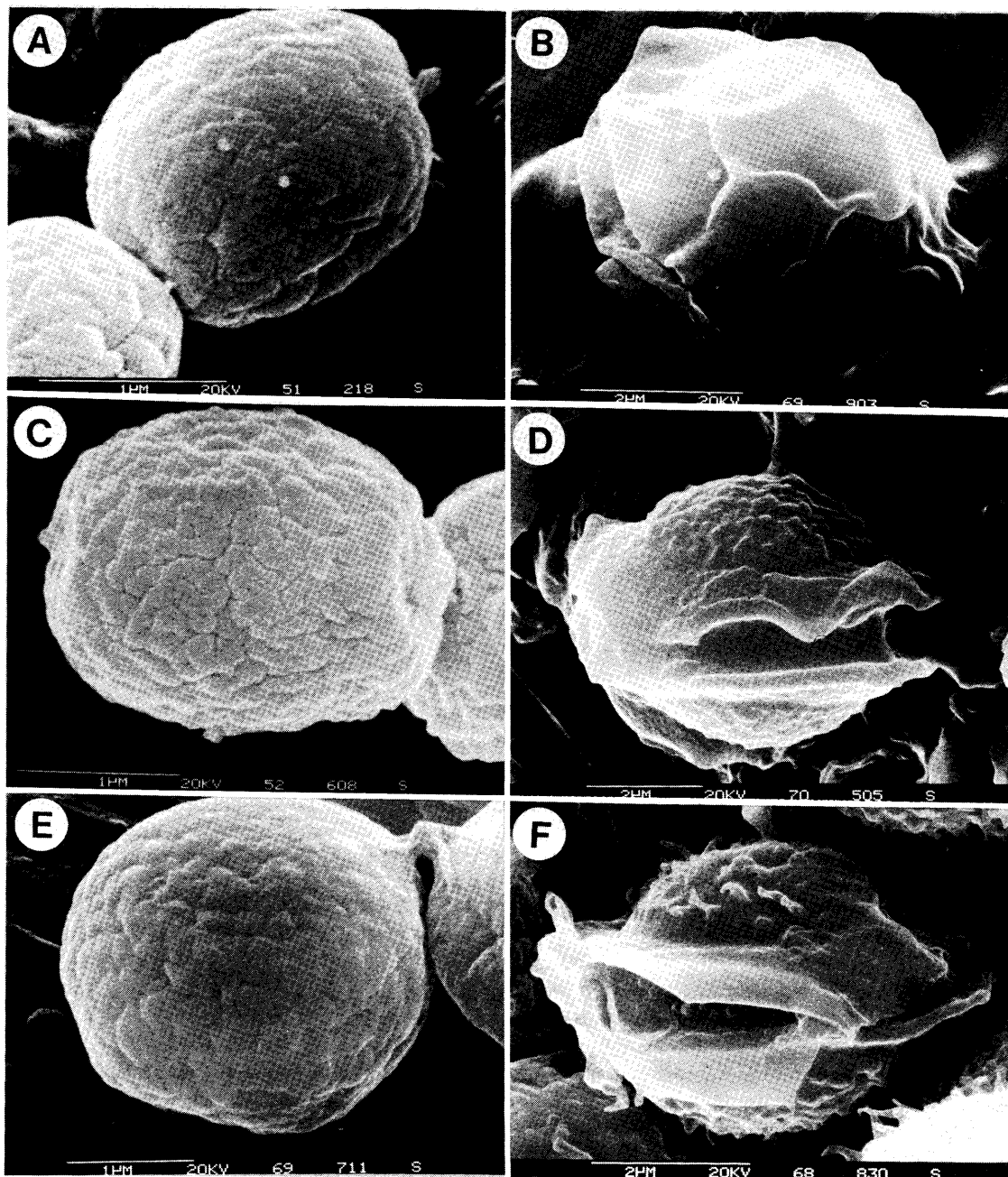


Fig. 23. *A. fumigatus* group: *N. fischeri* and its varieties, a comparison of their anamorphic (left) and teleomorphic (right) spores. A,B, *N. fischeri* var. *fischeri*, IMI 211391; C,D, *N. fischeri* var. *glabra*, IMI 61447; E,F, *N. fischeri* var. *spinosa*, IMI 211390.

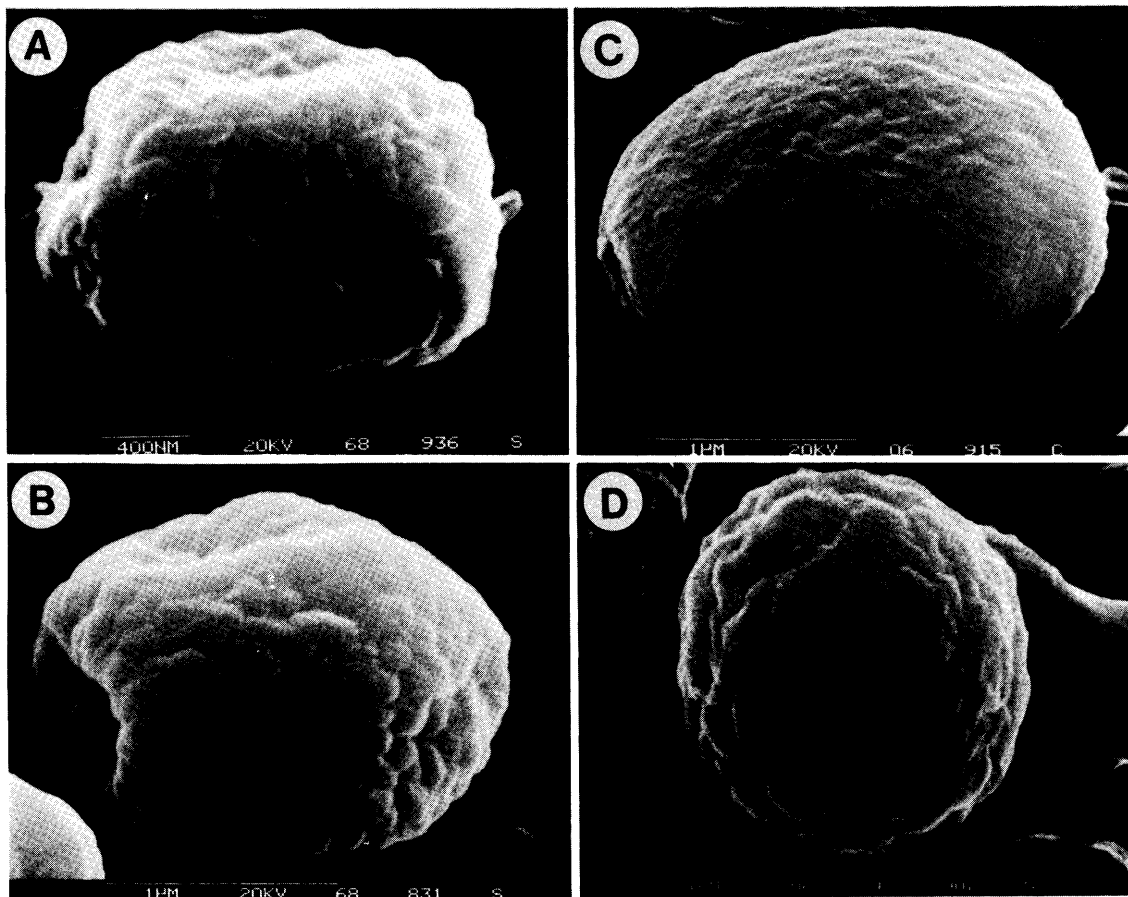


Fig. 24. *A. fumigatus* group: the micro-tuberculate category. A, *N. fennelliae*, IMI 278382; B, *N. spinosa*, IMI 211390; C, *N. spathulata*, IMI 308593; D, *A. viridinutans*, IMI 62875.

Neosartorya spinosa* (Raper & Fennell) Kozakiewicz, *comb. nov.

Aspergillus fischeri var. *spinosus* Raper & Fennell, *The genus Aspergillus*: 256 (1965).

Neosartorya fischeri var. *spinosa* (Raper & Fennell) Malloch & Cain, *Can. J. Bot.* **50**: 2621 (1973).

Sartorya fumigata var. *spinosa* (Raper & Fennell) Udagawa & Kawasaki, *Trans. mycol. Soc. Japan* **8**: 117 (1968).

Anamorph: ***Aspergillus spinosus* Kozakiewicz, *sp. nov.***

Anamorphosis *Neosartoryae spinosae*. Stipites conidiophorum 300–500 µm alti, vesiculae 12–18 µm diam., phialides 5.5–7.0 × 2.0–2.5 µm. Conidia subglobosa vel ellipsoidea 2.0–3.0 µm longa.

Holotypus IMI 211390.

Illustrations: Figs 23e,f,24b.

Description: *Conidia* micro-tuberculate. *Conidiogenous cells* uniseriate. *Conidiophores* short. *Conidial heads* abundant, loosely columnar, pale blue-grey. *Ascomata* cartridge buff (R. XXX) to light buff (R. XV). *Ascospores* with two widely separated equatorial crests, hemispheres bearing spine-like projections.

Type: Nicaragua, ex soil, 1945 (IMI 211390, holotype).

Hosts: Mostly from soil.

Distribution: Sierra Leone, India, Nicaragua, Nepal.

Specimens: Sierra Leone Freetown, ex soil, 1968, A. Sivanesan (IMI 132731).

Notes: Raper & Fennell (1965) introduced the varietal name *N. fischeri* var. *spinosa* because the ascospore hemispheres bore discrete spines rather than anastomosing ridges. Scanning electron microscopy has confirmed this observation (cf. Fig. 23b with Fig. 23f). Since conidia of the variety also differ subtly from those of the type variety (cf. Fig. 23a with Fig. 23e), the varietal name is raised to species rank.

Neosartorya spathulata Takada & Udagawa, *Mycotaxon* **24**: 396 (1985).

Anamorph: **Aspergillus spathulatus** Takada & Udagawa, *Mycotaxon* **24**: 396 (1985).

Illustration: Fig. 24c.

Description: *Conidia* micro-tuberculate. *Conidiogenous cells* uniseriate. *Conidiophores* of two types: (1) large, roughened with numerous warts, 500–1500 μm long, and (2) small, smooth, 60–250 μm long. *Vesicles* spathulate in large heads. *Conidial heads* loosely columnar, greyish blue-green. *Ascomata* yellow. *Ascospores* with equatorial crest well-developed, smooth convex walls (not seen). *Mycelium* heterothallic.

Type: Taiwan: Ilan Prefecture, Tai-Ping, ex soil of *Alocasia macrorrhiza* fields, 1982, M. Takada (IMI 308593, holotype).

Host: Soil.

Distribution: Taiwan.

Notes: *N. spathulata* is the second heterothallic species in the *A. fumigatus* group and is distinguished from *N. fennelliae* by its yellow ascomata and ascospores possessing smooth convex walls as opposed to reticulate walls in *N. fennelliae* (not seen). In addition *N. spathulata* possesses two types of conidiophore and its conidia are much larger than those of *N. fennelliae*.

Aspergillus viridinutans Ducker & Thrower, *Austr. J. Bot.* **2**: 355 (1954).

Illustration: Fig. 24d.

Description: *Conidia* micro-tuberculate. *Conidiogenous cells* uniseriate. *Conidiophores* smooth, 50 μm or more long. *Conidial heads* abundant, columnar, niagara green (R. XXXIII). *Vesicles* set at an angle to conidiophore, giving a nodding appearance. *Ascomata* absent.

Type: Australia: Frankston, Victoria, ex rabbit dung, 1954, E.I. McLennan (IMI 62875).

Hosts: Mainly soil, but also isolated from *Pinus caribaea*.

Distribution: Sri Lanka, U.S.S.R., Australia, Zambia (CMI, 1988).

Specimens: Australia: ex soil, 1986, P. Mekwatanakarn (IMI 306135).

Notes: The species produces the mycotoxin viriditoxin, which is toxic to mice via the intraperitoneal route (Lillehoj & Ciegler, 1972; Lillehoj & Milburn, 1973).

Whilst the conidia of this species are considered indistinguishable from those of *N. fennelliae* and *N. spinosa* (cf. Figs 24a,b) the taxon is maintained as a separate species because, unlike the others, it possesses nodding heads. It is also not known to possess a teleomorph. *Neosartorya fennelliae* is considered to be heterothallic (Kwon-Chung & Kim, 1974), and so far has only been isolated on a few occasions.

Micro-verrucose category

Neosartorya stramenia (Novak & Raper) Malloch & Cain, *Can. J. Bot.* **50**: 2622 (1973).

Aspergillus stramenius Novak & Raper, *The genus Aspergillus*: 260 (1965).

Sartorya stramenia (Novak & Raper) Subram., *Curr. Sci.* **41**: 761 (1972).

Anamorph: **Aspergillus paleaceus** Samson & W. Gams, *Advances in Penicillium and Aspergillus Systematics*: 50 (1986).

Illustration: Fig. 21a,b.

Description: *Conidia* micro-verrucose. *Conidiogenous cells* uniseriate. *Conidiophores* smooth 80–140 μm long. *Conidial heads* few, loosely columnar, pale blue-grey. *Ascomata* mustard yellow (R. XVI). *Ascospores* with equatorial crests prominent but not flexuose, hemispheres bearing regularly spaced blister-like echines. These are also present as two or three rows around the circumference of the equatorial groove.

Type: U.S.A.: Arena, Wisconsin, ex soil in a maple-ash-elm forest, 1960, R. Novak (IMI 172293, holotype).

Host: Soil.

Distribution: U.S.A.

Notes: The conidial ornamentation is unique within the *A. fumigatus* group.