

FARROWIA, A NEW GENUS IN THE CHAETOMIACEAE

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(With four Text-figures and one Table)

The new genus *Farrowia* D. Hawksw. is described to accommodate *Chaetomium longicolleum* Krzem. & Badura and *C. longirostre* (Farrow) L. Ames, species formerly incorrectly referred to *Chaetoceratostoma* Turc. & Maffei. These two species are united under the name *F. longicollea* (Krzem. & Badura) D. Hawksw. *comb. nov.*, the type species of *Farrowia*. The genus is also considered to include two further species, *F. malaysiensis* D. Hawksw. *sp. nov.* and *F. seminuda* (L. Ames) D. Hawksw. *comb. nov.* (syn. *Chaetomium seminudum* L. Ames). The separation of the genus from *Chaetomium* Kunze ex Fr. and *Scopinella* Lév. is discussed and conidial states reported in the family Chaetomiaceae Wint. reviewed. A key to the species of the Chaetomiaceae with *Botryotrichum*-like aleuriospores is included. The name *B. piluliferum* Sacc. & Marchal may refer to conidial states of several members of the Chaetomiaceae in addition to *C. piluliferum* J. Daniels.

In the course of studies in the family Chaetomiaceae Wint. (Ascomycotina—Pyrenomycetes — Sphaeriales) it has become increasingly clear that within the genus *Chaetomium* Kunze ex Fr. *C. longirostre* (Farrow) L. Ames and some allied taxa merit recognition as a distinct genus. The generic name *Chaetoceratostoma* Turc. & Maffei has been adopted for this group by several authors (Farrow, 1955; Badura, 1964; Dennis, 1970; Hawksworth, 1971, Hawksworth & Wells, 1973), but a closer examination of the type species of *Chaetoceratostoma*, *C. hispidum* Turc. & Maffei, has recently shown that this taxon is conspecific with *Scopinella barbata* (Pers. ex Gray) Lév. ex Sacc. (Hawksworth, 1975). *S. barbata*, the only species of the monotypic genus *Scopinella* Lév., differs from *Chaetomium longirostre* in so many characters that the taxa cannot be regarded as congeneric (Table I).

No detailed account of the segregate from *Chaetomium* including *C. longirostre* has previously been published. In this paper the new genus *Farrowia* D. Hawksw. is proposed to accommodate this group of *Chaetomium*-like fungi.

Apart from *C. hispidum* referred to above and taxa treated in detail elsewhere in this paper, only one other taxon has been referred to *Chaetoceratostoma*, viz. *C. graphioides* (Sacc.) C. Booth & Dennis, which proves to be a synonym of *Phaeostoma vitis* (Fuckel) Arx & E. Müll. (Hawksworth, 1975).

TAXONOMY

The characters distinguishing *Farrowia* from *Chaetomium* and *Scopinella* are indicated in Table I. Of these it was the formation of a distinctive long neck which led Farrow

TABLE I
SYNOPSIS OF CHARACTERS SEPARATING CHAETOMIUM, FARROWIA AND SCOPINELLA

	PERITHECIA	ASCI AND ASCOSPORES	CULTURES AND CONIDIAL STATE
CHAETOMIUM (180+ spp.)	Subglobose to vasiform, with lateral and terminal hairs which may be variously branched or contorted; terminal hairs not arising synchronously from adjacent elongated cells at the apex of the perithecia, not fused or adhering to form a neck; hairs with slight rugose (few spp.) to coarse (most spp.) ornamentation ($\times 10,000$); pedestal-like rhizoidal base usually absent.		Most species known in culture; cultures before the ascospores mature; ascospores varying in shape, not usually 1-guttulate, not ornamented.
FARROWIA (3 spp.)	Subglobose, with lateral and terminal hairs which are straight and unbranched; terminal hairs arising synchronously from adjacent elongated cells at the apex of the perithecia, fused below to form a distinct neck-like structure which may be rudimentary; hairs \pm smooth ($\times 10,000$); pedestal-like rhizoidal base usually present.	Asci clavate, deliquescing before the ascospores mature; ascospores lemoniform, biapiculate with a subapical germ pore, usually 1-guttulate; not ornamented.	Only known in culture; cultures often forming reddish pigments in the medium in the presence of contaminants; conidial state <i>Botryotrichum</i> (all species).
SCOPINELLA (1 sp.)	Subglobose, with lateral and terminal hairs which are both straight, unbranched, and fused in groups; terminal hairs arising synchronously from adjacent elongated cells at the apex of the perithecia, fused below to form a distinct neck-like structure, fused above the neck to varying extents; hairs smooth ($\times 10,000$); pedestal-like rhizoidal base absent.	Asci clavate, deliquescing after the ascospores mature; ascospores quadrangular, not guttulate; with a broad Z-shaped deeply pigmented band.	Not known in culture; conidial state (if any) unknown.

(1955) to describe his *Chaetoceratostoma longirostre* in a genus other than *Chaetomium*. A few species of *Chaetomium* have perithecia which become somewhat elongated, vase-like or cone-like above but where this does occur the apical region always appears to be composed of cells similar to those making up the rest of the peridium and not elongated cells which give rise to the neck-like structures in *Farrowia*. Within *Farrowia* the neck may be extremely tall or reduced to a few short elongated cells representing a rudimentary neck in *F. seminuda*. The lateral and terminal hairs in *F. longicollea* are completely smooth when examined by scanning electron microscopy (Hawksworth & Wells, 1973) and this is also true for *F. malaysiensis*. Hawksworth & Wells detected some slight rugose ornamentation in *F. seminuda* and this is sometimes visible towards the bases of the lateral hairs even by light microscopy. Of the other 91 species of *Chaetomium* studied by these authors, only five (*C. atrobrunneum* L. Ames, *C. erectum* Skolko & Groves, *C. fusisporale* Rai & Mukerji, *C. indicum* Corda and *C. reflexum* Skolko & Groves) had a similar type of ornamentation on their hairs to that seen in *F. seminuda*. Interestingly all these five species belong to a group of *Chaetomium* species with stiff, usually dichotomously branched, terminal hairs which lack all other features separating *Farrowia* from *Chaetomium*.

The method of attachment of perithecia to the substrate is a somewhat overlooked character in the Chaetomiaceae. In *Chaetomium* the perithecia are attached by hyaline to pale brown hyphae which ramify and spread prostrately along or penetrate the substrate to varying degrees. When grown in culture these hyphae, which I will refer to as 'rhizoidal', are sometimes concentrated below the perithecia but within the agar. In *Farrowia*, in contrast, the rhizoidal hyphae usually form a distinct, compact, pedestal-like tuft which supports the perithecium above the surface of the substrate. It is possible that some taxa in *Chaetomium* may have a pedestal-like tuft as in *Farrowia* to judge from published illustrations of various species but in all those I have so far been able to examine this proves not to be the case.

The ascospores of *Farrowia* are remarkably similar in shape, apical apparatus and in often having a single massive round guttule. I have not seen exactly comparable guttulate ascospores in any *Chaetomium* species; where guttules occur in *Chaetomium* ascospores there tend to be several small guttules rather than a single massive round one or an almost quadrangular one (*C. bostrychodes* Zopf). A study by transmission electron microscopy might conceivably reveal some differences in internal structure between ascospores of *Chaetomium* and *Farrowia*.

A consideration of any conidial states and resting spores has also been a very much neglected character in the Chaetomiaceae. Ames (1963) provided measurements and illustrations of aleuriospores he noted (frequently incorrectly applying the term 'chlamydospores' to them) but in the more recent publication of Seth (1972) even these were omitted from the descriptions of species. The majority of *Chaetomium* species do not appear to have any conidial state at all but in *Farrowia* all three species have a *Botryotrichum*-like aleuriospore state. Conidia referable to *Botryotrichum* Sacc. & Marchal are known to me in *Chaetomium* from *C. brevipilium* L. Ames, *C. homopilatum* Omvik and *C. piluliferum* J. Daniels. In addition, to judge from published descriptions,

Botryotrichum-like aleuriospores also occur in *C. distortum* L. Ames, *C. pinnatum* L. Ames, *C. pulchellum* L. Ames, *C. semispirale* Udagawa & Cain, some strains of *C. bostrychodes* Zopf (Calviello, 1971), and possibly also in *C. silvaticum* var. *variabile* Kiril. The only other conidial states (apart from true chlamydo-spores or other resting structures) reported in *Chaetomium* are of *Scopulariopsis* Bain. in *C. trigonosporum* (Marchal) Chiv. (Corlett, 1966) and of *Acremonium* Link ex Fr.-like states in *C. elatum* Kunze ex Fr. (Moreau & Moreau, 1954; Domsch & Gams, 1970), *C. globosum* Kunze ex Fr. (Zopf, 1881), *C. piluliferum* J. Daniels (Daniels, 1961) and possibly a few other species. In *Thielavia* Zopf (sensu Malloch & Cain, 1973), a cleistocarpic genus of the Chaetomiaceae, conidial states referable to *Botryotrichum* (*T. cephalothecoides* Malloch & Benny), *Chrysosporium* Corda (*T. novoguineensis* Udagawa & Horie and *T. sepedonium* Emmons; see Udagawa & Horie, 1972), *Sporotrichum* Link ex Fr. (*T. thermophila* Fergus & Sinden), possibly *Acremonium* (*T. terrestris* (Apinis) Malloch & Cain) and of uncertain position (*T. pallidospora* Pidopl. & al.) occur. As in *Chaetomium*, however, most *Thielavia* species do not appear to produce any conidial state.

Perfect states for *Botryotrichum*-like aleuriospores are unknown outside the genera *Chaetomium*, *Farrowia* and *Thielavia*. Apart from some variations in size and pigmentation, both features perhaps related to cultural conditions, the aleuriospores are remarkably similar, so much so that in the absence of perithecia it seems to be impossible at the present time to determine to which perfect state such imperfect isolates belong. The name *C. piluliferum* J. Daniels was introduced by Daniels (1961) as that for the perfect state of *B. piluliferum* Sacc. & Marchal, but in my view conidial states referable to *B. piluliferum* should not be assigned to this *Chaetomium* in the absence of the perfect state. The 'setae' characteristic of *B. piluliferum* are perhaps merely mycelial hairs which arise just prior to the initiation of perithecia in *Chaetomium* and *Farrowia*. A key to the taxa reported as having *Botryotrichum*-like aleuriospores is included below (p. 171); details of aleuriospores are omitted from this for the reasons indicated above.

The occurrence of an imperfect state in all species of *Farrowia* is of interest as this is the first genus of the Chaetomiaceae to be recognised in which all species have an imperfect state referable to a single imperfect state genus. All species of *Ascotricha* Berk. have conidial states belonging to *Dicyma* Boul., but that genus is more appropriately placed in either the Coniochaetaceae Malloch & Cain or the Xylariaceae Tul. (Hawksworth & Wells, 1973).

The affinity of *Farrowia* to the Chaetomiaceae is also supported by the production of *Thielavia*-like cleistothecia in mutants from one strain of *F. longicollea* (p. 177). This is the first time an ostiolate species in this family appears to have been reported as producing non-ostiolate ascocarps in culture. This phenomenon is well known in some other pyrenomycete families, however, and this subject has recently been reviewed by von Arx (1973). The genera *Thielavia* (incl. *Chaetomidium* (Zopf) Sacc.) and *Corynascus* Arx may be interpreted as cleistocarpic counterparts of *Chaetomium* (and ? *Farrowia*) and *Achaetomiella* Arx, respectively.

The characters of the *Farrowia* species treated here are of interest in other respects as well. The nature of the structures at the apices of the perithecia in *F. malaysiensis* and *F. seminuda* resemble growth stages through which *F. longicollea* passes (Doguet, 1955a; Cooke, 1973). These characters are maintained in culture, however, and it appears almost as if development becomes arrested at different stages in the three species—indicating genotypic differences. The ascospores in *F. longicollea* tend to be very slightly larger than those in *F. malaysiensis* and *F. seminuda*, these latter having ascospores almost identical in size. The geographical distribution of soil fungi is generally accorded little taxonomic weight but this may perhaps to a large extent arise from inadequate study of soil mycofloras throughout the world. Bartoli (1972) drew attention to the fact that *F. longicollea* had been obtained almost exclusively from tropical soils and this is largely borne out by my own studies (Fig. 1). *F. malaysiensis* is currently known only from three independently made isolations from Malaysia — it will be of interest to see if it is in fact so restricted geographically as studies of soil fungi in other parts of the world proceed. *F. longicollea* is unknown from Malaysia, in contrast, and it might be tempting to speculate that geographical isolation had played some role in its speciation. *F. seminuda* perhaps tends to prefer slightly cooler soils, predominates in North America, and is unknown from India and Central and South America. Doguet (1959) found that the ascospores of *F. longicollea* were tolerant of high temperatures and it would appear that an investigation of the temperature requirements of other species in the genus might yield interesting information.

Chemotaxonomy is almost unknown in pyrenomycetes. Both *F. longicollea* and *F. malaysiensis* produce a reddish-purple pigment in the presence of contaminant organisms which appears to be due to a lack of the enzyme saccharase (Doguet, 1955b; see p. 178). Reddish pigments are formed by several *Chaetomium* species in pure culture (in the absence of contaminants) but whether the compounds involved are the same as those in *Farrowia* is uncertain — in neither case is their structure known. The shades of colour produced, however, suggest that the compounds involved may well be different and so there may also be chemotaxonomic differences between these two genera.

KEY TO THE PERFECT STATES OF MEMBERS OF THE CHAETOMIACEAE
WITH BOTRYOTRICHUM-LIKE ALEURIOSPORES

- 1a. Ascocarps cleistothecia; peridium cephalothecoid; ascospores 12–15.5 × 8–10.5 μm; aleuriospores 8–25 μm diam. *Thielavia cephalothecoides* Malloch & Benny
- b. Ascocarps perithecia; peridium not cephalothecoid 2
- 2a. Perithecia with distinct necks over 80 μm tall formed from synchronously arising fused terminal hairs; hairs not ornamented; perithecia with a distinct pedestal-like tuft of rhizoidal hyphae; cultures producing reddish pigments in the presence of contaminant organisms 3
- b. Perithecia without distinct necks over 80 μm tall formed from synchronously arising fused terminal hairs 4

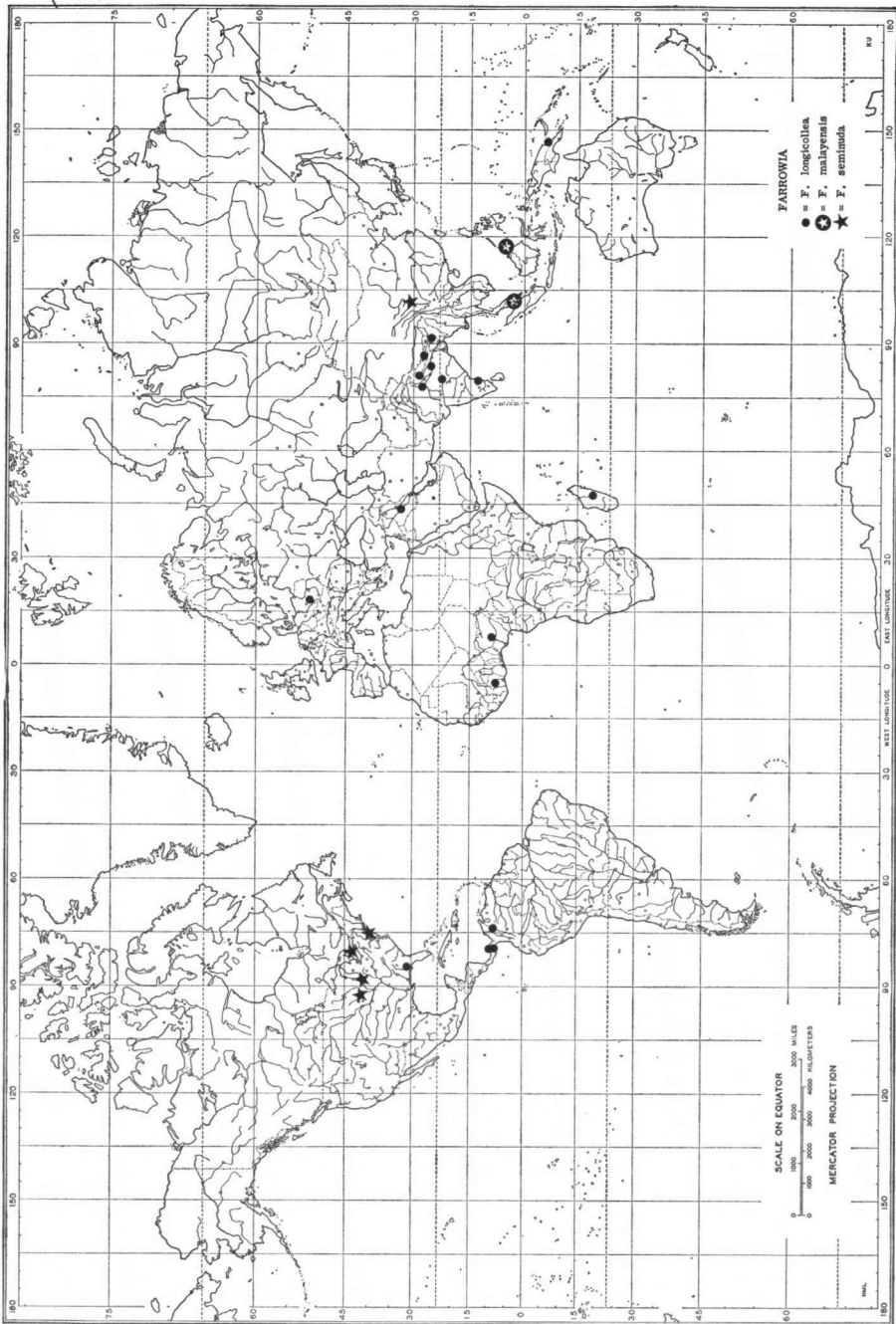


Fig. 1

- 3a. Terminal hairs (including fused portion) 850–2500 μm tall when mature; ascospores 8–12 \times 8–10 μm *Farrowia longicollea* (Krzem. & Badura) D. Hawksw., p. 174
- b. Terminal hairs (including fused portion) 275–350(–400) μm tall when mature; ascospores 7–9(–10) \times 7–8 μm *Farrowia malaysiensis* D. Hawksw., p. 178
- 4a. Apex of perithecium composed of elongated cells forming a distinct but rudimentary neck; perithecia with a distinct pedestal-like tuft of rhizoidal hyphae; hairs not or scarcely ornamented; ascospores 7.5–9(–10) \times 7–8.5 μm
Farrowia seminuda (L. Ames) D. Hawksw., p. 182
- b. Apex of perithecium not composed of elongated cells forming a rudimentary neck; perithecia lacking a distinct pedestal-like tuft of rhizoidal hyphae; hairs usually distinctly coarsely ornamented. 5
- 5a. Terminal hairs flexuose, irregularly to dichotomously branched, not coiled; ascospores 6–7 \times 4.5–6 μm [material not seen]. *Chaetomium pinnatum* L. Ames
- b. Terminal hairs not as above 6
- 6a. Terminal hairs spirally or circinately coiled at least at the apices 7
- b. Terminal hairs not distinctly spirally or circinately coiled 9
- 7a. Terminal hairs geniculate branched with circinately coiled apices; ascospores 6–8 \times 4–6 μm [material not seen] *Chaetomium distortum* L. Ames
- b. Terminal hairs spirally coiled above 8
- 8a. Terminal hairs often branched, heads readily becoming detached; ascospores with quadrangular guttules, 5.5–8 \times 5.5–6.5 μm *Chaetomium bostrychodes* Zopf
- b. Terminal hairs unbranched, heads not becoming detached; ascospores not guttulate, (4.5–)6–8 \times 3.5–5 μm [aleuriospores not seen in isotype although reported by Ames (1963)] *Chaetomium pulchellum* L. Ames
- 9a. Perithecia elongate to vasiform 10
- b. Perithecia subglobose to ovoid. 11
- 10a. Terminal hairs forming a dense apical tuft, straight to somewhat recurved; ascospores ellipsoid, 7–8 \times 6.5–8 μm *Chaetomium brevipilium* L. Ames
- b. Terminal hairs sparse, not forming a dense tuft; ascospores biumbonate, 7–9 \times 5–7 μm [conidial state possibly not *Botryotrichum*; material not seen]
Chaetomium silvaticum var. *variabile* Kiril.
- 11a. Ascospores 13–16 \times 8.5–10.5 μm *Chaetomium piluliferum* J. Daniels
- b. Ascospores less than 12 μm long 12
- 12a. Terminal hairs straight, rigid, sparse; ascospores 5.5–7 \times 4.5–6 μm
Chaetomium homopilatum Omvik
- b. Terminal hairs flexuose to undulate, abundant; ascospores 7–9.5 \times 6.5–7.5 μm [material not seen] *Chaetomium semispirale* Udagawa & Cain

Farrowia D. Hawksw., *gen. nov.*

Genus Pyrenomycetum (Sphaeriales, Chaetomiaceae). Perithecia dispersa, singularia, infra subglobosa ad obpyriformia, brunnea ad nigra; muris compositis e 2–3 stratis cellularum atrobrunnearum, polyedricarum sed elongatarum ad apicem; affixa ad substratum hyphis basi peritheciorum exorientibus, plerumque formantibus caespitem pedicello-similem; pila lateralibus singularia, brunnea, recta, non ramosa, muris levibus instructa; pila terminalia

Fig. 1. The known world distribution of *Farrowia* species; records of *F. longicollea* from Iraq, Ivory Coast and Nigeria have not been accurately localized and dots have been placed centrally in those countries; literature records of *F. seminuda* from Angola and Israel are omitted as in need of confirmation. (Base map copyright The University of Chicago Press; for *F. malaysiensis* read *F. malaysiensis*.)

simul cellulis contiguus apice peritheciolorum exorientia, infra fasceatim connata itaque collum formantia, supra secreta (sed in una specie rudimentalia), brunnea, recta, non ramosa, muris levibus praedita.

Asci exorientes in fasciculis basi cavositatis peritheciolorum, clavati, unitunicati, deliquescentes ante sporarum maturitatem, octospori. Paraphyses desunt. Ascospores irregulariter in asco dispositae, in cirrhum accumulatae demissae, late ellipsoideae, biapiculatae, cum uno poro subapicali germinativo, brunneae ad atrobunneae, simplices, plerumque 1-guttulatae.

Aleuriosporae ad *Botryotrichum* pertinentes, exorientes e hyphis hyalinis et prostratis, plerumque copiosae.

Culturae contaminatae centro plerumque pigmentum rubro-purpurascens producentes.

SPECIES HOLOTYPEICA: *Farrowia longicollea* (Krzem. & Badura) D. Hawksw. (syn. *Chaetomium longicolleum* Krzem. & Badura, *Chaetocerotostoma longirostre* Farrow).

Genus of Pyrenomycetes (Sphaeriales, Chaetomiaceae). Perithecia scattered, single, subglobose to obpyriform below, brown to black; peridium composed of 2-3 layers of cells, cells dark brown, polyhedral but becoming elongate towards the apex of the perithecium; attached to the substrate by hyphae originating from the base of the perithecium, often producing a pedestal-like tuft; lateral hairs arising singly, brown, straight, unbranched, smooth-walled ($\times 10,000$); terminal hairs arising simultaneously from adjacent cells at the apex of the perithecium, fused and producing a distinct neck below but separating and single above (but in one species rudimentary), brown, straight, unbranched, smooth-walled ($\times 10,000$).

Asci arising in a fascicle at the base of the perithecial cavity, clavate, unitunicate, deliquescing before the ascospores mature, eight-spored. Paraphyses absent. Ascospores irregularly arranged in the asci, discharged in a cirrhus through the neck formed by the terminal hairs, broadly ellipsoid, biapiculate, with a single subapical germ pore, brown to dark brown, simple, often 1-guttulate.

Aleuriosporae belonging to the genus *Botryotrichum*, arising from hyaline, prostrate hyphae, often abundant.

Contaminated cultures often producing a reddish-purple pigment in the medium.

ETYMOLOGY.—Named after W. M. Farrow, the first author to recognise that the type species of the genus should be placed in a genus other than *Chaetomium*.

HOLOTYPE SPECIES.—*Farrowia longicollea* (Krzem. & Badura) D. Hawksw. (syn. *Chaetomium longicolleum* Krzem. & Badura, *Chaetocerotostoma longirostre* Farrow).

The genus is known to comprise three species and has representatives in Africa, Asia, Europe and Central, North and South America (Fig. 1). A key to the species is included in that to the perfect states of members of the Chaetomiaceae with *Botryotrichum*-like aleuriospores presented above (pp. 171-173). The characters separating the genus from *Chaetomium* and *Scopinella* are summarised in Table I and discussed in more detail on pp. 169-171.

***Farrowia longicollea* (Krzem. & Badura) D. Hawksw., comb. nov.—Fig. 2**

Chaetomium longicolleum Krzem. & Badura in Acta Soc. Bot. Poloniae 23: 748. 1954 (basionym).
— *Chaetocerotostoma longicolleum* (Krzem. & Badura) Badura in Allionia 9: 181. 1964. —

Fig. 2. *Farrowia longicollea*. — a. Perithecia. — b. Portion of the lower part of the "neck" region. — c. Origin of a lateral hair. — d. Rhizoidal hyphae. — e. Aleuriospores. — f. Ascospores. (From the holotype of *Chaetocerotostoma longirostre*, IA.)

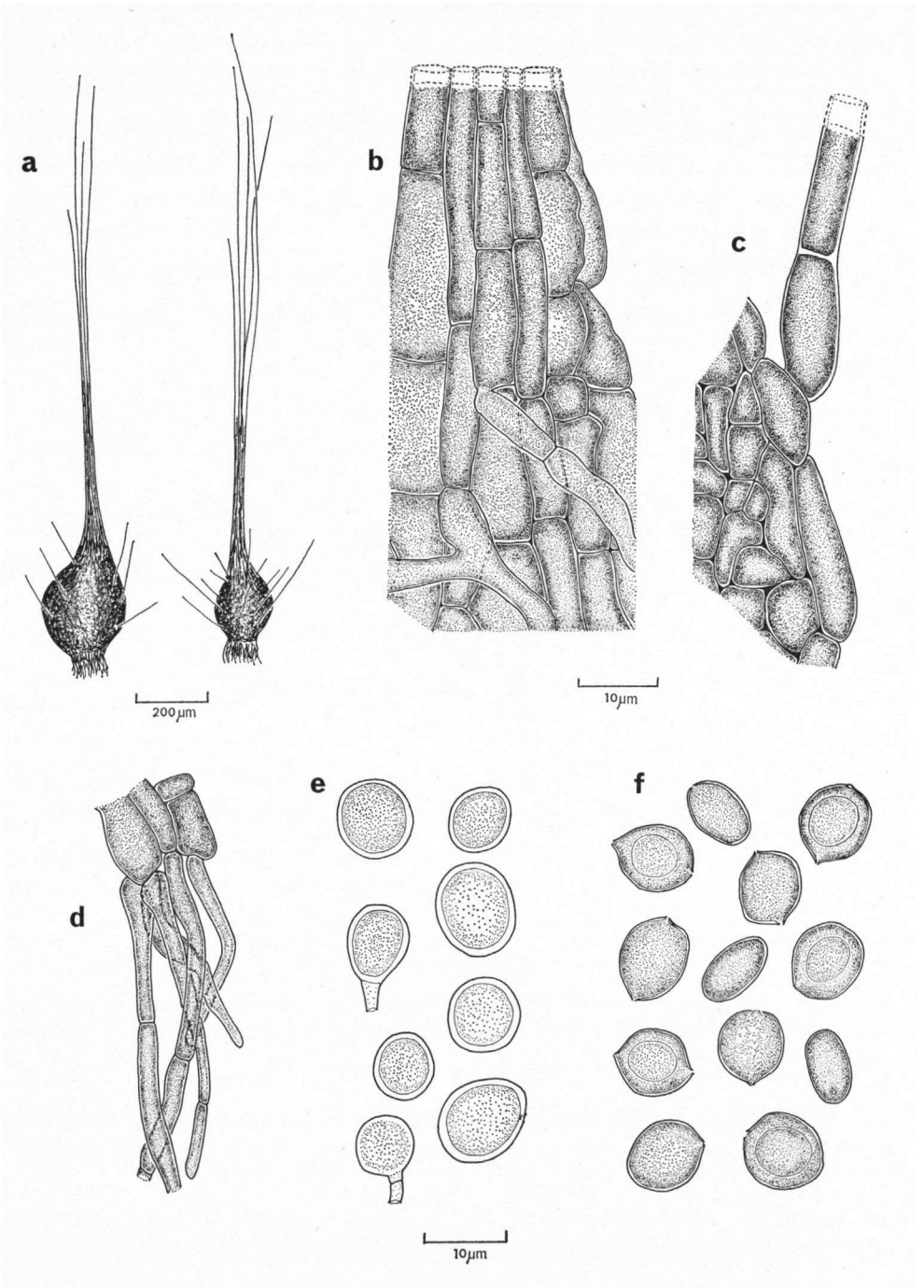


Fig. 2

Lectotype: Poland, Kieleckin Province [Kiekie], Miechów, isol. ex soil from coniferous forest, 1947, *H. Krzemieniewska* & *L. Badura* (BPI-A 121, slide).

Chaetocerotostoma longirostre Farrow in *Mycologia* 47: 418. 1955. — *Chaetomium longirostre* (Farrow) L. Ames, *Monogr. Chaetom.*: 29. 1963. — Holotype: Panamá Canal Zone, Barro Colorado Island, Rio Sardinilla, isol. ex soil, summer 1952, *G. W. Martin 8875* (IA). — Isotypes: ATCC 16959, BPI-A 122, CBS 155-55, DAOM 41854, IMI 184923, UCSW.

Perithecia superficial, scattered, arising singly, subglobose to obpyriform below, 135–200(–270) × 70–120 μm, dark brown to black, often somewhat shiny; peridium mainly 2–3 layers of cells thick, cells brown to dark brown, polyhedral, mainly 5–15 μm diam. except near the neck where they become elongated; pale brown ± vertically orientated rhizoidal hyphae arising from the base of the perithecium, forming a compact pedestal-like tuft usually 40–70 μm tall, hyphae rather thin-walled, undulate to contorted, mainly 2–4 μm diam.; lateral hairs arising singly from the peridium, brown, not fused in groups, straight, septate, unbranched, smooth-walled, mainly (150–)200–600(–650) μm tall, basal cell swollen and 5–8 μm diam., tapering above and 3–5 μm diam. for most of their length; terminal hairs arising synchronously from adjacent elongated ± rectangular cells at the apex of the perithecium, brown, straight, septate, unbranched, smooth-walled, 850–2500 μm tall, singly mainly 6–10 μm diam. at the base, tapering above and 3–5 μm diam. for most of their length, fused together for one third to one half of their length to form a tapering beak-like neck 35–55 μm diam. at the base and through the channel of which the ascospores are discharged; a few secondary ‘supporting hyphae’ may arise from peridial cells near the base of the neck.

Asci arising in a basal fascicle within the perithecial cavity, apparently not accompanied by lateral or hymenial paraphyses, unitunicate, clavate, short-stalked, thin-walled, deliquescing before the ascospores mature, (25–)40–60 × 10–20 μm, 8-spored. Ascospores irregularly arranged in the asci, accumulating in a cirrus and discharged, often in ± parallel rows, through the neck-like fused portion of the terminal hairs, hyaline at first but becoming brown to dark brown when mature, subglobose to ellipsoid, usually distinctly 1-guttulate, simple, smooth-walled, bi-apiculate with a distinct often subapical germ-pore at one end, 8–12 × 8–10 μm in surface view, 6–7 μm wide in lateral view.

Aleuriospores almost always present, often abundant, *Botryotrichum*-like; conidiophores arising from hyaline, sparsely septate hyphae mainly 1–2.5 μm diam. spreading prostrately around the perithecia; conidiogenous cells integrated, terminal, determinate, monoblastic, cylindrical; conidia (aleuriospores) arising singly at the apices of the conidiogenous cells, usually hyaline but occasionally with a slight brownish tinge, simple, very thick-walled, smooth-walled, globose, sometimes with a somewhat flattened base, mainly 7–12(–15) μm diam.

Cultures growing fairly rapidly on most media (MA, OMA, PCA, PDA, TWA, etc.), usually attaining 4–5 cm diam. in eight weeks at room temperature; aerial mycelium, when present, flocculose, white to pale orange, composed of hyaline hyphae mainly 1–3.5 μm diam.; sectoring occurring in some strains, sectors sometimes producing non, or aberrant, ascocarps (cleistothecia 70–150 μm diam. with hairs to 150 μm long and 2.5–4(–8) μm diam. at the base, ascospores thin-walled and failing to mature) and sometimes no aleuriospores; in the presence of contaminant organisms a characteristic reddish-purple pigment is produced which diffuses into the agar and is readily visible in reverse; reverse otherwise ± uncoloured.

STRATE.—Known only from material in culture isolated from soils of various types, plant debris and fruits of *Arachis hypogaea*. Also reported by Agnihothru (1958) from the rhizospheres of *Camellia sinensis*, *Monochoria vaginalis* var. *plantaginea* and *Polygonum glabrum*.

ETYMOLOGY.—From Latin *longus*, long, and *collum*, neck.

ILLUSTRATIONS.—Agnihotrudu in *Sci. Cult.* **23**: 748 figs. A–E. 1958; Ames, *Monogr. Chaet.* pl. 24 figs. 1–2. 1963; Bartoli in *Annali Bot.* **31**: 45–47 figs. 1–10. 1972; Benedeck in *Mycopath. Mycol. appl.* **14**, *Icon. mycol.* pl. C 40 fig. 2 a–c. 1961; Cooke in *Can. J. Bot.* **50**: 1272–1273 pl. I figs. 1–15, II figs. 16–26. 1973; Doguet in *Revue Mycol.* **20** (Suppl. colon. 2): 135–141 figs. 1 a–l, 2 a–j, 3 a–h. 1955; Farrow in *Mycologia* **47**: 417–418 figs. 1–5. 1955; Hawksworth & Wells in *Mycol. Pap.* **134**: pl. 7 figs. C–D. 1973; Krzemieniewska & Badura in *Acta Soc. Bot. Poloniae* **23**: 780 pl. 2 figs. 2–4. 1954; Mazzucchetti, *Gen. Chaetom.*: 323 pl. 24 figs. 1–12. 1965; Seth in *Beih. Nova Hedwigia* **37**: fig. 37 a–d. 1972; Udagawa, Furuya & Horie in *Bull. natn. Sci. Mus., Tokyo* **16**: 511 fig. 14 a–f. 1973.

DISTRIBUTION.—I have examined material from Colombia, India, Iraq, Nigeria, Panamá and Poland. In addition there are reliable reports from the Ivory Coast (Bartoli, 1972), Madagascar (Doguet, 1955a, 1955b, 1959), New Guinea (Udagawa & al., 1973) and the U.S.A. (Georgia; Cooke, 1973). *Farrowia longicollea* appears to be not uncommon in India, from which country it was first reported by Agnihotrudu (1958) on the basis of three collections, and Farrow (1955) indicated that it was 'isolated frequently' in Panamá. The paper of Harvey & al. (1969) utilised isotype material derived from Ames (via H. K. Seth) and the source of that employed by Sedlar & al. (1973) is uncertain.

OTHER SPECIMENS EXAMINED.—C O L O M B I A: near El Banco, c. 160 miles south of Barranquilla, 1965, leg. *Oxford Labs.* (*Chicago, Illinois*), isol. ex plant debris on surface of soil-water culture, 3 Sept. 1966, *E. E. Davis* (ATCC 16509, IMI 186019).

I N D I A: Varanasi, Banaras Hindu University, comm. 31 Jan. 1967, *Singh & Pande* 5 (IMI 137386); Aurangabad, Marathwade University, comm. 6 Febr. 1969, *L. V. Gangawane* 2 (IMI 137648); Jabalpur, isol. ex grassland soil, comm. 22 Sept. 1971, *P. D. Agrawal* 93 (IMI 160309); sine loc., isol. ex soil, comm. 12 April 1972, *V. Nair* 8k (IMI 165736k); Agra College, isol. ex soil, comm. 7 April 1974, *M. N. Gupta* 20 (IMI 185148), 33 (IMI 185159).

I R A Q: Bakoba Nursery, isol. ex soil, comm. 25 May 1968, *M. Majeed* 6 (IMI 133629).

N I G E R I A: Samaru, Institute of Agricultural Research, isol. ex *Arachis hypogaea* fruits, comm. 6 Jan. 1966, *D. McDonald* 807 (IMI 116862).

Doguet (1955a), Ames (1963) and Mazzucchetti (1965) endeavoured to separate *Chaetomium longicolleum* from *C. longirostre* on the basis of the latter having a longer neck and narrower spore-channel. This character varies considerably within single isolates, however, and material conforming to the lectotype of *C. longicolleum* occurs within isotype cultures of *C. longirostre*. Apart from in this feature, the perithecia of *F. longicollea* are very constant in their characters. The amount of aerial mycelium produced in culture varies according to the medium, more being formed on nutrient-rich than on nutrient-poor media. Of particular interest is the sectoring produced by one isolate (IMI 186019 = ATCC 16509) in which cleistothecia are produced. These cleistothecia, described above, arise in sectors lacking aleuriospores, have hairs distributed over their surface and fail to form ascospores. These were obtained from single-ascospore isolates from perithecia several times but perithecia were not produced by cleistothecial isolates or in subcultures prepared from them.

Although Farrow (1955) did not mention any aleuriospores in his original description of *Chaetocerotostoma longirostre*, these are in fact present in both the holotype collection and isotype cultures.

Farrowia longicollea has been the subject of detailed ontogenetic investigations by Doguet (1955a) and Cooke (1973). Doguet's studies showed a *Chaetomium*-like rather than a *Melanospora*-like pattern of development with perithecia originating from stalked ascogonial coils which become enveloped in hyphae growing up from the base of the stalk with the perithecial cavity forming by the deliquescence of pseudo-parenchymatous cells. Periphyses occur in the upper portion of the perithecial cavity at first but appear to be lost as maturation proceeds. Cooke's investigations confirm Doguet's interpretation in all important respects but Cooke did not find any mycelial hairs although these are not uncommonly encountered in young cultures and have been figured by Doguet (1955a) and Bartoli (1972); Bartoli terms these 'setulae'. Cooke's opinion that the presence of mycelial hairs might afford a useful specific criterion in the *Chaetomiae* does not therefore appear to be well founded in at least this case.

Doguet (1955b) carried out some detailed studies on the production of the reddish-purple pigment in this species. Although the chemical nature of the compound concerned remains unknown, it is only produced in the presence of contaminant bacteria or fungi with saccharase enzymes which, on saccharose-rich media, permit *F. longicollea* to produce this pigment. Doguet suggested that this species might serve as a valuable indicator for saccharase within other organisms.

The reaction of the spores of this species to high temperatures has also been investigated by Doguet (1959) who found a few spores could survive a treatment of 61°C. Harvey & al. (1969), investigating spore liberation, found that most spores were liberated only under moist conditions, and Sedlar & al. (1973) confirmed that the species was homothallic, as reported by Doguet (1955a), on the basis of single-ascospore cultures.

Farrowia malaysiensis D. Hawksw., *sp. nov.*—Fig. 3

Perithecia superficialia, dispersa, infra subglobosa ad obpyriformia, 125–180 × 70–120 μm, atrobrunnea ad nigra, plerumque nitida; muris compositis e 2–3 stratis cellularum atrobrunnearum, polyedricarum, praecipue 6–14 μm diam. sed elongatarum ad apicem; affixa ad substratum hyphis brunneis, 2–5 μm diam., formantibus caespitem pedicellio usque 25–50 μm alto similem; pila lateralia singularia, brunnea, recta, non ramosa, muris levibus instructa, praecipue 50–150 μm longa; pila terminalia simul cellulis contiguis apice perithecorum exorientia, 275–350(–400) μm longa, infra fasceatim connata itaque collum 25–40 μm latum formantia, supra secreta, brunnea, recta, non ramosa, muris levibus praedita.

Asci exorientes in fasciculis basi cavositatis perithecorum, clavati, unitunicati, deliquescentes ante sporarum maturitatem, 20–35 × 8–16 μm, octospori. Paraphyses desunt. Ascosporae irregulariter in asco dispositae, in cirrhum accumulatae per collem demissae, late ellipsoideae, biapiculatae, cum uno poro subapicali germinativo, brunneae ad atrobrunneae, simplices, plerumque 1-guttulatae, 7–9(–10) × 7–8 μm, 4–6 μm latae aspectu laterali.

Fig. 3. *Farrowia malaysiensis*. — a. Perithecium. — b. Upper portion of the "neck" region. — c. Origin of a lateral hair. — d. Rhizoidal hyphae. — e. Asci in various stages of maturation. — f. Aleuriospores. — g. Ascospores. (From the holotype, IMI 183184.)

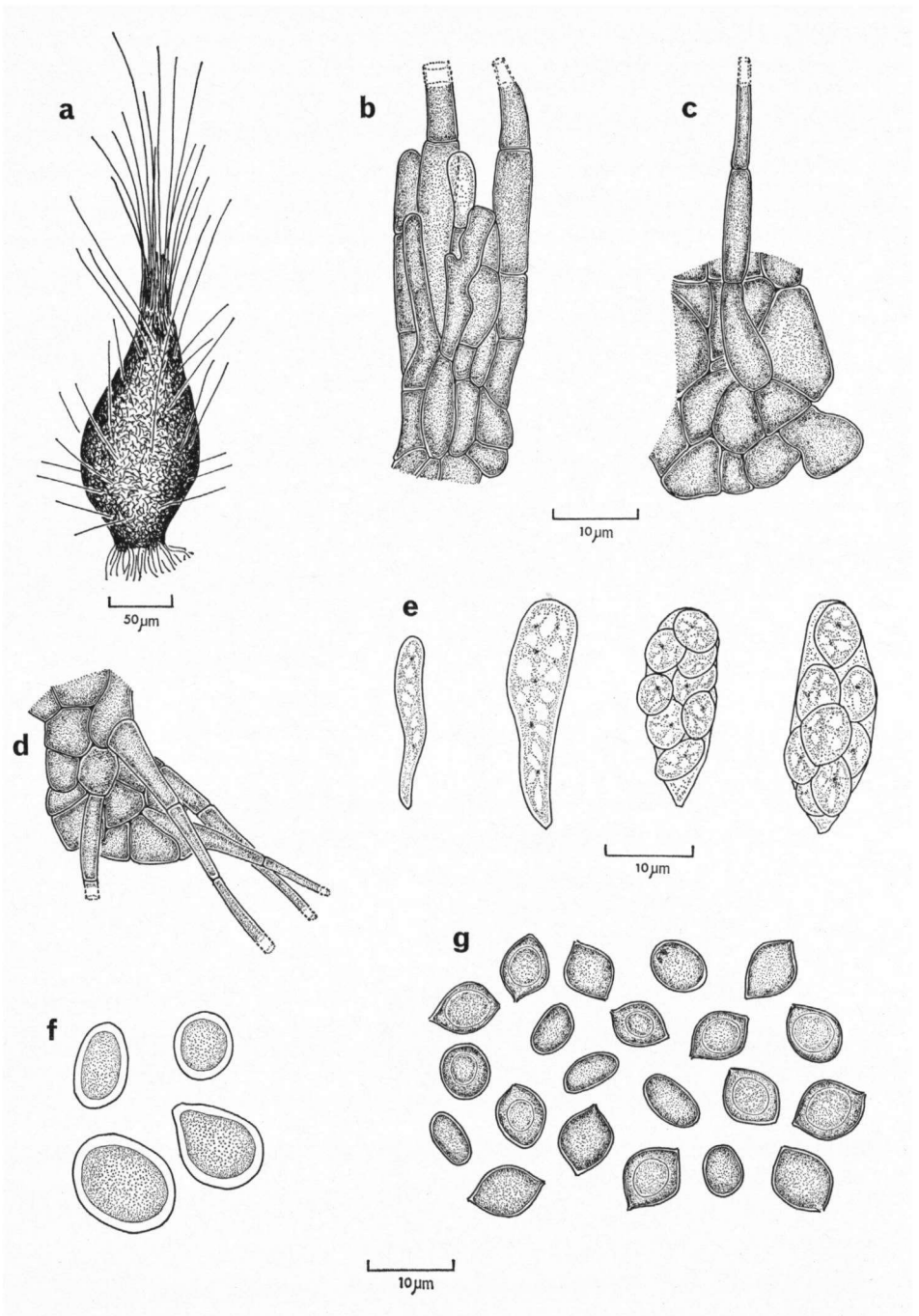


Fig. 3.

Aleuriosporae ad *Botryotrichum* pertinentes, hyphis hyalinis et prostratis exorientes, globosae vel subglobosae, muris crassis munitae, hyalinae, praecipue 5–15 μm diam., plerumque sparsae.

Culturae ad 4.5–5.5 cm diam. post 8 hebdomades, mycelium aerium floccosum, albidum ad pallide aurantiacum vel plusminusve absens; culturae contaminatae centro pigmentum rubro-purpurascens plerumque producentes.

HOLOTYPE: Malaysia occidentalis, Malaya, Selangor, Malaysian Agricultural Research and Development Institute, isol. ex *Elaeis guineensis*, comm. 19. iii. 1974, *Tai Luang Huan K* (IMI 183184).

Perithecia superficial, scattered, arising singly, subglobose to obpyriform below, 125–180 \times 70–120 μm , dark brown to black, often somewhat shiny; peridium mainly 2–3 layers of cells thick, cells brown to dark brown, polyhedral, mainly 6–14 μm diam. except near the neck where they become elongated; pale brown to brown \pm vertically orientated entwined rhizoidal hyphae arising from the base of the perithecium, forming a compact pedestal-like tuft usually 25–50 μm tall, hyphae rather thin walled, mainly 2–5 μm diam.; lateral hairs arising singly from the peridium, brown, not fused in groups, straight, septate, unbranched, smooth-walled, 50–150 μm tall, basal cell swollen and 5–6 μm diam., tapering above and 2–3.5 μm diam. for most of their length; terminal hairs arising synchronously from adjacent elongated \pm rectangular cells at the apex of the perithecium, brown, straight, septate, unbranched, smooth-walled, 275–350(–400) μm tall, singly mainly 5–7 μm diam. at the base, tapering above and 2–4 μm diam. for most of their length, fused together for one third to one half of their length to form a tapering beak-like neck 25–40 μm diam. at the base and through the channel of which the ascospores are discharged; secondary 'supporting hyphae' arising from peridial cells near the base of the neck absent or poorly developed.

Asci arising in a basal fascicle within the perithecial cavity, apparently not accompanied by lateral or hymenial paraphyses, unitunicate, clavate, short-stalked, thin-walled, deliquescing before the ascospores mature, 20–35 \times 8–16 μm , 8-spored. Ascospores irregularly arranged in the asci, accumulating in a cirrus and discharged through the neck-like fused portion of the terminal hairs, hyaline at first but becoming brown to dark brown when mature, subglobose to ellipsoid, usually distinctly 1-guttulate, simple, smooth-walled, bi-apiculate with a distinct often subapical germ pore at one end, 7–9(–10) \times 7–8 μm in surface view, 4–6 μm wide in lateral view.

Aleuriospores usually present but often rather sparse, *Botryotrichum*-like; conidiophores arising from hyaline, sparsely septate hyphae mainly 1–3 μm diam. spreading prostrately around the perithecia; conidiogenous cells integrated, terminal, determinate, monoblastic, cylindrical; conidia (aleuriospores) arising singly at the apices of the conidiogenous cells, usually hyaline, simple, very thick-walled, globose, sometimes with a slightly flattened base, mainly 5–15 μm diam.

Cultures growing fairly rapidly on most media (MA, PCA, PDA, TWA, etc.), usually attaining 4.5–5.5 cm diam. in eight weeks at room temperature; aerial mycelium when present, flocculose, white to pale orange, composed of hyaline hyphae mainly 1–4 μm diam; sectoring not seen; in the presence of contaminant organisms a characteristic reddish-purple pigment is produced which diffuses into the agar and is readily visible in reverse; reverse otherwise \pm uncoloured.

HOLOTYPE.—West Malaysia, Malaya, Selangor, Malaysian Agricultural Research and Development Institute, isol. ex *Elaeis guineensis*, comm. 19 March 1974, *Tai Luang Huan K* (IMI 183184).

SUBSTRATE.—Known only from material in culture isolated from *Elaeis guineensis*, *Theobroma cacao* and *Uncaria gambir*.

ETYMOLOGY.—*Malaysiensis*, from Malaysia.

DISTRIBUTION.—Known only from East Malaysia (Sabah) and West Malaysia (Malaya).

OTHER SPECIMENS EXAMINED.—EAST MALAYSIA: Sabah (North Borneo), isol. ex *Theobroma cacao*, comm. 30 Oct. 1973, *P. S. W. Liu PP1425/60* (IMI 180057).

WEST MALAYSIA: Malaya, Kuala Lumpur, isol. ex *Uncaria gambir*, comm. 26 Dec. 1969, *Chee Keng Hoy 1162* (IMI 145691).

Farrowia malaysiensis is a distinctive species very similar to *F. longicollea* in most respects but differing in having a much shorter neck and terminal hairs and also in the ascospores being slightly smaller. It may also differ in being restricted to Malaysia (from which *F. longicollea* is unknown, although that species does occur in New Guinea) and has so far not been isolated from soil.

***Farrowia seminuda* (L. Ames) D. Hawksw., *comb. nov.*—Fig. 4.**

Chaetomium seminudum L. Ames in *Mycologia* 41: 642. 1949 (basionym). — Holotype: U.S.A., Iowa, Ames, Iowa State College, isol. ex vegetable detritus, *J. C. Gilman* (BPI-A 153, slide). — Isotype: DAOM 24579.

Perithecia superficial, scattered, arising singly, obpyriform, (125–)150–180(–200) × 75–100(–110) μm , yellowish brown and somewhat translucent at first, becoming darker brown when mature; peridium mainly 2–3 layers of cells thick, cells brown, polyhedral, mainly 7–15 μm diam. except near the neck where they become elongated; pale brown \pm vertically orientated rhizoidal hyphae arising from the base of the perithecium, forming a short spreading to pedestal-like tuft, hyphae rather thin-walled, undulate, mainly 2–5 μm diam.; lateral hairs arising singly from the peridium, pale brown to brown, not fused in groups, straight, septate, unbranched, smooth-walled or with a slight rugose ornamentation near the base, mainly 70–100 μm tall, basal cell somewhat swollen and 5–6 μm diam., tapering above and 2–3.5 μm diam., for most of their length; terminal hairs rudimentary, arising \pm synchronously from adjacent elongated \pm rectangular cells at the apex of the perithecium, pale brown to brown, straight, septate, unbranched, \pm smooth-walled, (some exceptionally to 75 μm tall, singly mainly 5–6 μm diam. at the base, tapering above and (1.5–) 2–3.5 μm diam. for most of their length), \pm fused together below to form a short neck-like structure mainly 10–25 μm tall and 20–30 μm wide and through which the ascospores are discharged in long tendrils; secondary “supporting hyphae” absent.

Asci arising in a basal fascicle within the perithecial cavity, apparently not accompanied by lateral or hymenial paraphyses, unitunicate, clavate, short-stalked, thin-walled, deliquescing before the ascospores mature, 25–32 × 10–15 μm , 8-spored. Ascospores irregularly arranged in the asci, accumulating in a cirrus and discharged through the short neck, hyaline at first but becoming brown to dark brown when mature, subglobose to ellipsoid, usually 1-guttulate, simple, smooth-walled, biplicate with a distinct often subapical germ pore at one end, 7.5–9(–10) × 7–8.5 μm in surface view, 4–6 μm wide in lateral view.

Aleuriospores almost always present and abundant, *Botryotrichum*-like; conidiospores arising from hyaline, sparsely septate hyphae mainly 1.5–3 μm diam. spreading prostrately around the perithecia; conidiogenous cells integrated, terminal, determinate, monoblastic, cylindrical; conidia (aleuriospores) arising singly at the apices of the conidiogenous cells, hyaline or with a slight fuscous-brown tinge, simple,

very thick-walled, smooth-walled, sometimes slightly flattened at the base, mainly 7–10 μm diam.

Cultures growing fairly rapidly on most media (MA, PCA, PDA, TWA, etc.) usually attaining about 5.5–7 cm diam. in eight weeks at room temperature; aerial mycelium, when present, flocculose, white, composed of hyaline hyphae mainly 1–3.5 μm diam.; sectoring not seen; no reddish pigment diffusing into the agar seen; reverse \pm uncoloured or with a slight orange tinge.

SUBSTRATE.—Known only from material in culture isolated from dung, soil, vegetable detritus and seeds of *Lycopersicum esculentum*.

ETYMOLOGY.—From Latin *semi-*, half, and *nudus*, naked.

ILLUSTRATIONS.—Ames in *Mycologia* 41: 643 figs. 23–29. 1949; Ames, *Monogr. Chaet.* pl. 24 Figs. 13–19. 1963; Mazzucchetti, *Gen. Chaetom.*: 323 pl. 24 Fig. 13–19. 1965; Seth in *Beih. Nova Hedwigia* 37: fig. 51. 1972; Skolko & Groves in *Can. J. Bot.* 31: pl. 2 figs. 1–4, pl. 13 fig 10. 1953.

DISTRIBUTION.—I have examined material from Canada (Ontario), China (prov. Szechwan) and the U.S.A. (Iowa and Pennsylvania). There are also published reports from Illinois (Parker, 1973), Angola (Sedlar & al., 1973) and Israel (Sedlar & al., 1973); these latter two records are in need of confirmation.

OTHER SPECIMENS EXAMINED.—C A N A D A: Ontario, Guelph, isol. ex soil in mixed wood, Aug. 1964, *G. L. Barron* (IMI 109880, OAC 10275).

C H I N A: prov. Szechwan, Lushan, isol. ex leaf fragments in soil, 1958, *G. Sörgel* 8517 (IMI 75854).

U.S.A.: Pennsylvania, Philadelphia, isol. ex seeds of *Lycopersicum esculentum*, 5 July 1943, *A. J. Skolko* (DAOM 15042, IMI 44209).

This species is being included in *Farrowia* with some reservations as placing it here broadens the circumscription of the genus and accounts for most of the 'usually' phrases in the generic description. While *F. seminuda* has almost all the characters seen in the other two species they tend to be of a rather rudimentary nature. At first sight this species is very similar to some other taxa in *Chaetomium*: *C. deceptivum* Malloch & Benny (ascospores 18–23 \times 7.5–10 μm), *C. homopilatum* Omvik (aleuriospores; ascospores 5.5–7 \times 4.5–6 μm), *C. minutum* Krzem. & Badura (ascospores 9.5–11 \times 7–9 μm ; treated by Badura, 1964, as a synonym of *C. seminudum*), *C. parvotrichum* Mazz. (material not seen; ascospores 9.3–11.5 \times 6–6.5 μm), *C. subterraneum* Swift & Povah (material not seen; ascospores 7–10 \times 5–7 μm) and *C. thielavioideum* Chen (material not seen; ascospores 13–15 \times 6–7.5 μm). All these six species appear to have distinctly ornamented hairs (in those studied), \pm no terminal hairs, and pale, almost translucent peridia (as do young perithecia of *F. seminuda*). They recall the genus *Achaetomiella* Arx (i.e. *A. macrospora* (Rai & al.) Arx, *A. megaspora* (Sörgel) D. Hawksw., *A. virescens* Arx and some undescribed taxa) in many respects and are currently being investigated further to ascertain their most appropriate generic position. None of these taxa, however, have a neck like that seen in *F. seminuda* and only one (*C. homopilatum*) produces aleuriospores. That perithecial development in

Fig. 4. *Farrowia seminuda*. — a. Perithecia. — b. The "neck" region of a perithecium. — c. Rhizoidal hyphae. — d. Asci in different stages of maturation. — e. Aleuriospores. — f. Ascospores. (From IMI 44209.)

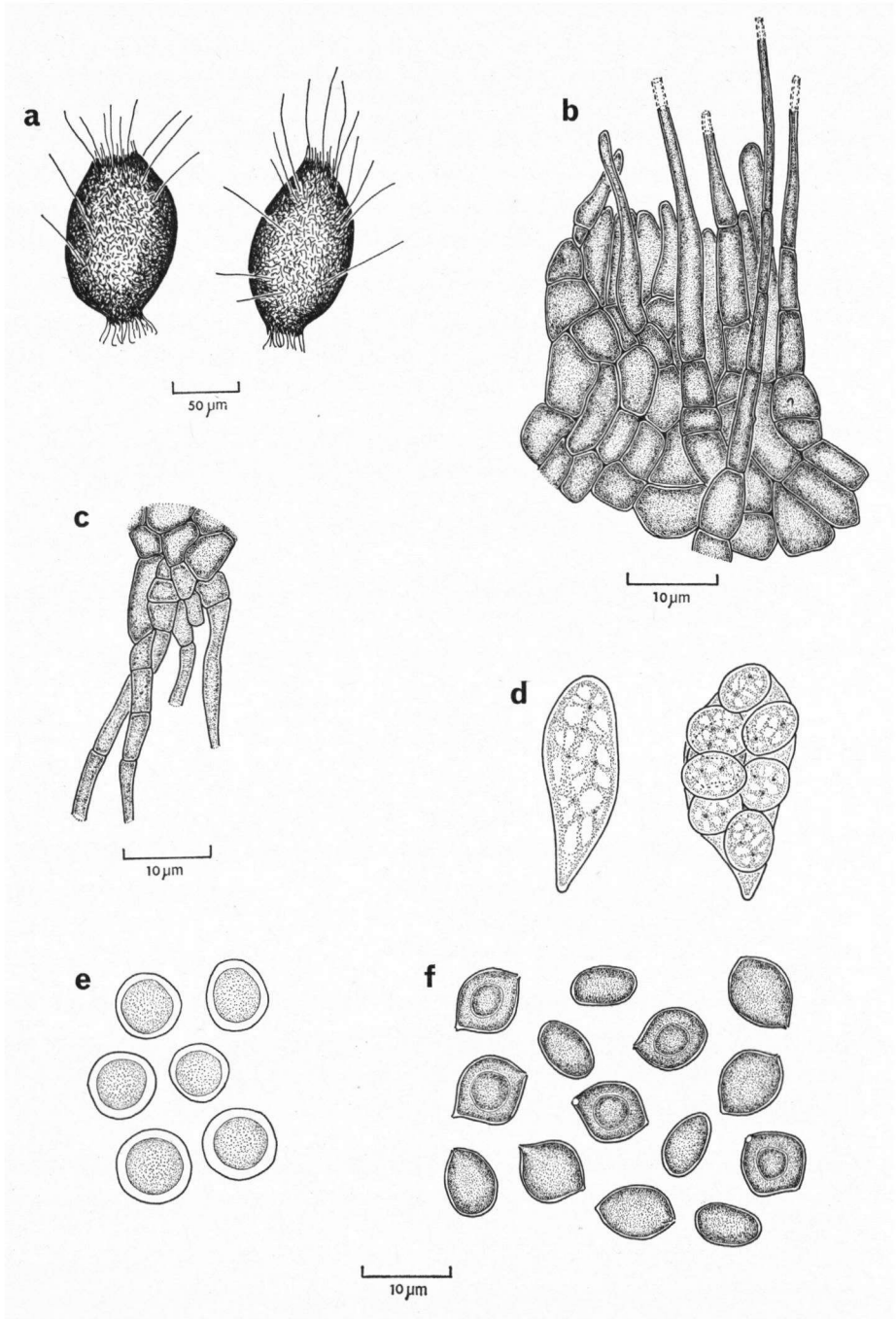


Fig. 4.

F. longicollea passes through a stage which is very like the mature perithecia of *F. seminuda* appears to add weight to its treatment in *Farrowia*, but the possibility of parallel evolution cannot be entirely ruled out.

Skolko & Groves (1953) compared the species to *C. torulosum* Bain. (a taxon with some similarities to the reportedly aleuriospore forming *C. brevopilium* L. Ames), but that species appears quite distinct from *F. seminuda* in many characters. These authors also pointed out that the measurements of the ascospores given by Ames (1949) of $9-14 \times 7-8 \mu\text{m}$ were incorrect — something apparently overlooked by Seth (1972). My examination of the holotype slide shows that Skolko & Groves' conclusion was indeed correct. The holotype slide is unfortunately not in a very good condition and the description presented above is consequently based primarily on other specimens examined (including IMI 44209 compared with cultures from the type by Skolko & Groves, 1953).

This species was reported to be homothallic by Tveit (1955), who studied IMI 44209, and the same conclusion was reached by Sedlar & al. (1973) on the basis of material from Angola and Israel they considered to belong to this species.

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