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STUDIES ON TALAROMYCES AND RELATED GENERA I.

Hamigera gen. nov. and Byssochlamys

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(With five Text-figures)

The genus *Talaromyces* Benjamin, being a heterogeneous genus is divided into two genera: *Talaromyces*, based on *T. vermiculatus*, characterized by asci developing in chains and *Hamigera* gen. nov., based on *T. avellaneus*, characterized by asci formed singly from croziers. *Talaromyces striatus* is also included in *Hamigera*. Descriptions and drawings are presented of the two species of *Hamigera* and the three species of the closely related genus *Byssochlamys*. A new series of *Penicillium*, the *P. avellaneum* series, is erected to accomodate *P. avellaneum* and *P. ingelheimense*.

According to its description, the genus *Talaromyces* Benjamin (*1955*), based on the type species *T. vermiculatus*, is characterized by soft ascomata with loose-textured to more or less compressed walls composed of interwoven hyphae; ovate to globose asci borne predominantly in short chains or rarely formed singly from croziers; ascospores of very different types and a conidial state belonging in *Penicillium* Link ex Fr.

Talaromyces was equated by Benjamin (*1955*) to the *Penicillium luteum* series of Raper & Thom (*1949*). In the opinion of these latter authors (Raper & Thom, *1949*; Raper, *1957*) the genus *Penicillium* should include both imperfect and perfect species. This view, however, is not in accordance with the 'International Code of Botanical Nomenclature' (Art. 59).

Because of its soft ascomata *Talaromyces* is quite different from the other perfect penicillate genus: *Eupenicillium* Ludwig (Stolk & Scott, *1967*; Scott, *1968*). The latter genus is characterized by sclerotioid ascomata, that are very hard to gritty when young.

The closely related genus *Byssochlamys* Westling (*1909*), type species *B. nivea* Westling, is usually separated from *Talaromyces* on the basis of asci produced in naked clusters and its conidial state belonging to *Paecilomyces* Bainier. However, re-examination of the ascomata of a few, well-developed, fresh isolates of *B. nivea* and *B. fulva* showed that the clusters of asci are not always naked, but are usually surrounded by inconspicuous, very scanty, loose wefts of hyaline, thin, branched and sometimes radiating hyphae. In *Byssochlamys* asci are produced from croziers.

Recently two new species of *Talaromyces* have been described, *T. emersonii* Stolk (*1965*) and *T. leycettanus* Evans & Stolk (*1971*) representing intermediate forms between *Talaromyces* and *Byssochlamys*. In *T. emersonii* the ascomata consist of clusters of asci surrounded by inconspicuous, very scanty wefts of branched, yellow, thin hyphae, thus approximating to the structure of the ascomata of *Byssochlamys*. However, the asci are produced in chains and the conidial state belongs in *Penicillium*. The perfect state of *T. leycettanus* agrees with that of a *Talaromyces* since the ascomata are surrounded by a definite network of pale yellow hyphae while the asci are produced in chains. However, the imperfect state, though described as a *Penicillium*, shows much closer relationship with the imperfect genus *Paecilomyces* and thus must be transferred to that genus, as **Paecilomyces leycettanus** (Evans & Stolk) Stolk, Samson & Evans, *comb. nov.* (basionymum, *Penicillium leycettanum* Evans & Stolk *in* Trans. Br. mycol. Soc. **56**: 45. 1971). This means either bringing a *Paecilomyces* conidial state into *Talaromyces* or including a species with ascomata surrounded by conspicuous peridial hyphae in *Byssochlamys*.

Whereas *Byssochlamys* is a natural genus, *Talaromyces*, from its origin has been a heterogeneous genus. The structure of the ascomatal covering differs markedly in the different species of *Talaromyces*. In some species (e.g. *T. thermophilus*) the ascomata are bounded by rather closely knit hyphae, simulating a true peridium, whereas in others (e.g. *T. emersonii*) the covering is very scanty. Thus, as far as the structure of the 'wall' is concerned, the ascomata of *Talaromyces* merge via *T. emersonii* into those of *Byssochlamys*.

In most species of *Talaromyces* asci are borne in chains. However, in two species, *T. avellaneus* (Thom & Turesson) Benjamin and *T. striatus* (Raper & Fennell) Benjamin, they develop singly from croziers as in *Byssochlamys*. According to Emmons (*1935*) the asci of *T. luteus* also develop singly from croziers. However, our examination of two strains of this species, showed short chains of asci to be present.

The conidial states of different species of *Talaromyces* also vary considerably. In *T. leycettanus* the imperfect state belongs in *Paecilomyces* and though the conidial states of all other described species are to be classified in *Penicillium*, they belong to quite different series of that genus.

Thus we conclude that neither the complexity of the covering of the ascomata, in both genera consisting of the same type of hyphae, nor the nature of the conidial state can be considered to be satisfactory characters in distinguishing *Talaromyces* from *Byssochlamys*. Instead, we prefer to separate the two genera on the disposition of the asci. This entails the exclusion of the crozier-producing species *T. avellaneus* and *T. striatus* from *Talaromyces* and the introduction of the new genus *Hamigera* to include these two species.

Hamigera Stolk & Samson, *gen. nov.*

Ascomata mollia, globosa vel subglobosa, superficialia, discreta vel confluentia, pariete e hyphis intertextis constante, ex ascogoniis spiralibus oriuntur, anteridiis absentibus. Asci evanescentes, plerumque octospori, subglobosi vel ellipsoidei vel clavati, pedicellati, singuli

ex hamis oriuntur. Ascosporae continuae, plerumque ellipsoideae, varie ornamentatae, subflavae.

STATUS CONIDIALIS.—*Penicillium* Link ex Fr.

SPECIES TYPICA.—*Hamigera avellanea* (Thom & Turesson) Stolk & Samson.

Ascomata soft, globose to subglobose, superficial, discrete and confluent. Coverings composed of interwoven hyphae. Ascomatal initials consisting of coiled ascogonia without antheridia. Asci evanescent, mostly 8-spored, subglobose to ellipsoid to clavate, stalked, formed singly from croziers. Ascospores continuous, mostly ellipsoid showing different ornamentations, yellowish.

CONIDIAL STATE.—*Penicillium* Link ex Fr.

TYPE SPECIES.—*Hamigera avellanea* (Thom & Turesson) Stolk & Samson.

The two species now combined in the new genus *Hamigera* agree in the structure of their initials and ascomata and in the development of their asci. They differ markedly from one another in the ornamentation of their ascospores and in their conidial states. The brown imperfect state of *H. avellanea* does not fit in any of Raper & Thom's series of *Penicillium* (Raper & Thom, *1949*), while *P. striatum* can best be classified in the Divaricata.

For these reasons, the classification of these species in two different new genera may be justified. However, as no other species which may be related to either of the above species has been encountered as yet, we prefer to place them together in one new genus, *Hamigera*. This decision is supported by the fact that species which differ in respect of their conidial states and ornamentation of their ascospores are also included in the genus *Talaromyces*. Further emphasis of these differences might ultimately lead to the splitting of the genus *Talaromyces* into different genera but we do not regard this as desirable at present.

Ascomatal initials consist of coiled ascogonia, each borne as a branch from a vegetative hypha. They are usually surrounded by thin, twisted branching hyphae which are developing into the 'wall' of the ascoma. After having produced about 2 to 3 (4) coils, the ascogonia may grow straight for a short distance and then develop new coils.

Most of the straight segments disintegrate while the coiled parts become septate and produce either croziers directly or develop crozier-producing ascogenous hyphae. These secondary coils occur in both species, but are more common in *H. avellanea* than in *H. striata*.

Asci are borne singly on short branches. They develop from the penultimate cell of a crozier; occasionally penultimate cells grow out to form a continuation of the ascogenous hypha, developing secondary croziers etc., resulting in the formation of large clusters of asci.

Hamigera belongs in the Eurotiaceae and, because of the development of the asci, is closely related to the genera *Byssochlamys* Westling and *Thermoascus* Miehe. It differs from *Byssochlamys* primarily in the structure of the ascomatal initials. Moreover, the 'wall' of the ascomata is much denser in *Hamigera* than in *Byssochlamys*, where the covering may be entirely lacking. In addition, *Hamigera* is characterized by a *Penicil-*

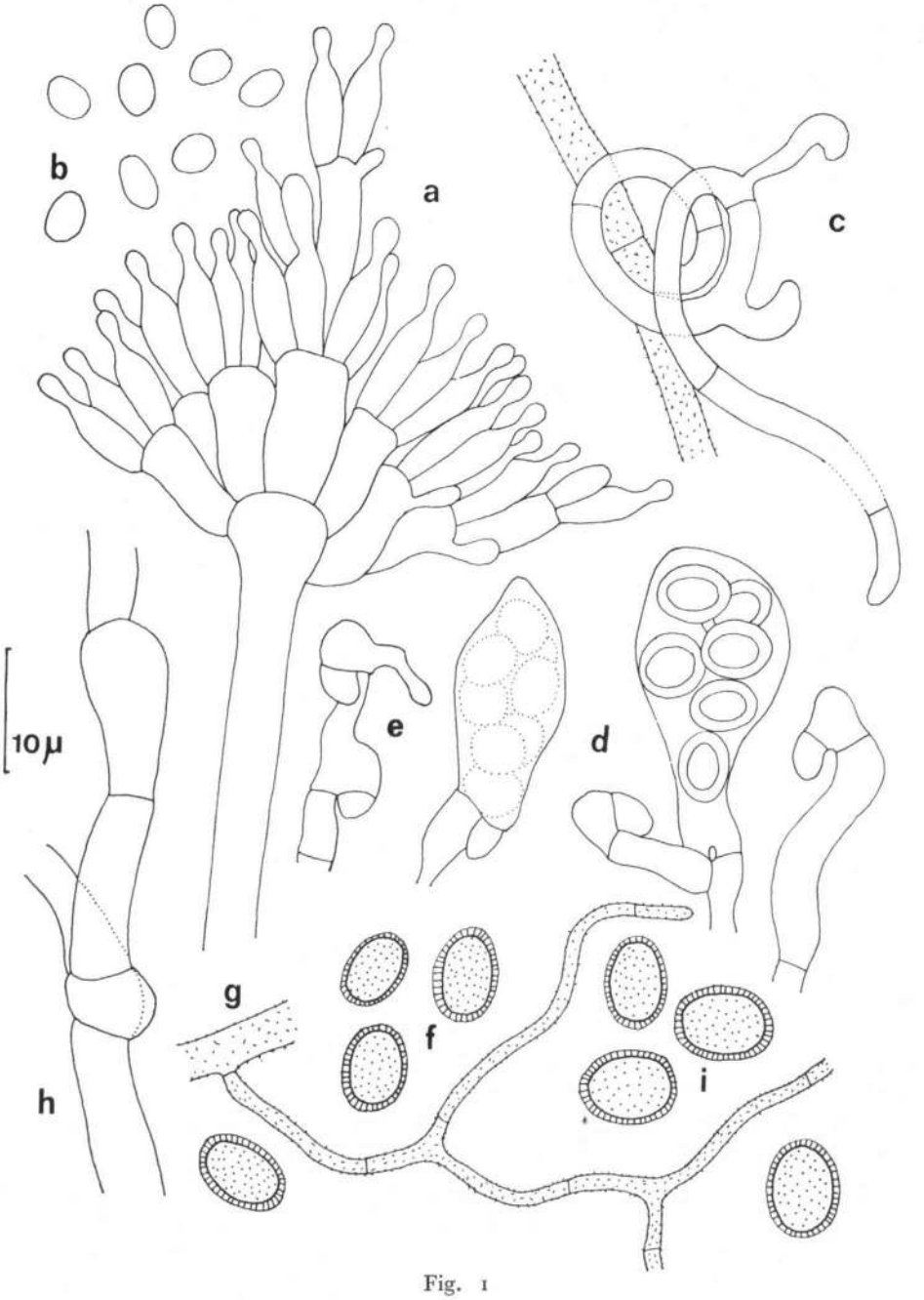

Fig. 1

lium conidial state while in *Byssochlamys* a *Paecilomyces* conidial state is present.

In both *Thermoascus* and *Hamigera*, asci are produced from croziers and ascomatal initials are identical. Moreover, in two species of *Thermoascus*, *T. crustaceus* (Apinis & Chesters) Stolk (*1965*) and *T. thermophilus* (Sopp) von Arx (*1970*), phialides occur. The two genera differ mainly from one another in the nature of their ascomatal-walls: those of *Hamigera* consisting of a loose weft of interwoven hyphae, while those of *Thermoascus* are brown, pseudoparenchymatous and composed of one or more layers of somewhat thick-walled polygonal cells. The ascomata of *Thermoascus* are often aggregated in large brown or red-brown crusts. The ascospores of *Hamigera* are yellow, those of *Thermoascus* are hyaline becoming brown in age. Moreover, the three species of *Thermoascus* are thermophilic.

Separation between *Hamigera* and *Talaromyces* is based on the development of the asci.

Hamigera differs from *Arachniotus*, as represented by its type species *A. ruber* (van Tieghem) Schroeter, primarily in producing a quite different conidial state, since in *Arachniotus* only arthrospore- of aleuriospore-bearing structures occur (Kuehn, *1957*, *1958*; Apinis, *1964*). Originally the two species of *Hamigera*, though described inclusive of their perfect states, were placed in the imperfect genus *Penicillium*. In accordance with Art. 59 of the International Code of Botanical Nomenclature of 1966 the perfect states of the two species are now described as new species of the genus *Hamigera*.

Hamigera avellanea Stolk & Samson, *sp. nov.*—Fig. 1

Penicillium avellaneum Thom & Turesson *in* Mycologia **7**: 284. 1915. — *Talaromyces avellaneus* (Thom & Turesson) Benjamin *in* Mycologia **47**: 682. 1955.

STATUS CONIDIALIS.—*Penicillium avellaneum* Thom & Turesson *in* Mycologia **7**: 284. 1915.

SPECIAL LITERATURE.—Raper & Thom (*1949*: 597).

Ascomata flava, globosa vel subglobosa, 100–300 μ diametro, XX diebus maturantia, reticulo hypharum laxe intertextarum flavarum incrustatarum, circa 1,5 μ crassarum circumdata. Asci ellipsoidei vel clavati, 18–24 × 10–12 μ, sex- vel octospori. Ascosporae flavae, ellipsoideae, 6–8 × 4–6,5 μ, crassitunicatae; paries translucens flavus fere 0,5 μ crassus, in plano medio adspectum radiatim striatum praebet, in superficie punctatus. Status conidicus *Penicillium avellaneum* Thom & Turesson.

TYPUS status perfecti CBS 295.48 = NRRL 1938, isolatus e terra, San Antonio, Texas, 1943.

Colonies on malt agar spreading broadly, attaining a diameter of about 7 cm within 10 days at 25° C, composed of a basal felt with numerous yellow ascomata, more or less obscured in the central area by a dense, layer of penicilli, giving the surface of the colonies a brown appearance, ranging from Avellaneous to Wood Brown (Ridgway, *1912*, Pl. 40; Rayner, *1970*, 17'''b, 17'''), the margins of colonies

FIG. 1. *Hamigera avellanea*, CBS 295.48. — a. Penicillus. — b. Conidia. — c. Ascomatal initial developing as a branch from a yellow-encrusted aerial hypha. — d. Ascus production from croziers. — e. Penultimate cell of a crozier growing out to form a secondary crozier. — f. Ascospores. — g. Young hypha surrounding the initials and developing into the ascomatal covering. — h. Submerged hypha, CBS 343.68. — i. Ascospores.

showing bright yellow colours because of developing ascomata and yellow mycelium near Citron Yellow (Ridgway, Pl. 16; Rayner 23'b). Reverse purple red near Diamine Brown (Ridgway, Pl. 13; Rayner, 3'm).

Production of ascomata is more pronounced on oatmeal agar, on which medium the surface of the colonies may be predominantly yellow, the brown colour of the conidial state being less conspicuous than on malt agar, at least in fresh isolates. Reverse purple.

Vegetative hyphae hyaline to reddish coloured, about 2–4 μ in diameter, submerged hyphae, often very wide showing conspicuous inflations up to 8 μ in diameter.

Ascomata yellow, globose or nearly so, 100–300 μ in diameter, ripening within 3 weeks. Coverings consisting of a loosely interwoven network of yellow-encrusted hyphae, about 1.5 μ in diameter, invested in yellow-encrusted, somewhat twisted, branching, radiating hyphae.

Initials consist of large loosely coiled ascogonia, developing in about 10 days inside small, loose tufts of narrow branched, twisted, yellow-encrusted hyphae which later develop into the ascomatal 'walls'. Asci ellipsoid, sometimes slightly clavate, 18–24 × 10–12 μ, 6–8-spored. Ascospores yellow, ellipsoid, thick-walled, surrounded by a transparent yellow wall about 0.5 μ in diameter, which in transverse section shows radiate striations, the surface appearing punctate, with overall dimensions, 6–8 × 4–6.5 μ.

Conidiophores arising from both submerged and aerial hyphae, up to 400 μ in length by 3–5 μ in diameter, hyaline, septate, smooth-walled, inflated at their apices up to 8–8.5 μ in diameter. Penicilli very large, compact, each consisting of a crowded verticil of 5–12 metulae, sometimes with secondary metulae, each metula bearing a verticil of phialides; all elements of the penicillus are hyaline and smooth-walled. Rami lacking. Metulae developing successively on the inflated apex of the conidiophore, rarely occurring also on its subterminal portion, sometimes somewhat irregularly disposed, 9–15 × 3.5—4.5 μ, slightly inflated apically. Phialides 8–11 × 2–3 μ, occurring in verticils of about 5, cylindrical, sometimes slightly swollen, narrowing abruptly at the apex to form small conidium-bearing tips, about 1.5 μ long. Conidia hyaline to pale brownish, ovoid to slightly ellipsoid 3–4.5 × 2–3 μ, smooth, forming tangled chains.

The species is slightly thermotolerant, minimum temperature about 10°, optimum 30–35°, maximum about 45° C.

CULTURES EXAMINED.—

CBS 295.48 = NRRL 1938, type strain, isolated from soil from San Antonio, Texas, September, 1943.

CBS 189.67, isolated as an air contaminant by H. D. Ackermann, Berlin, in 1967. This culture is now predominantly conidial, only occasionally producing a few small ascomata.

CBS 343.68 = NHL 6081 and CBS 344.68 = NHL 6088, isolated by Udagawa & Takada from soil in Japan, 1966.

The ascospores of CBS 343.68 and CBS 344.68 are slightly larger than those of CBS 295.48 and CBS 189.67, but all are within the given range of sizes. The temperature relationships are somewhat variable too; maximum temperatures of CBS 295.48 and CBS 189.67 are slightly higher than those of CBS 343.68 and CBS 344.68. Strains of this species, e.g. CBS 189.67, when maintained in culture may soon loose their capacity to produce ascomata.

Classification of the imperfect state in the scheme of the genus *Penicillium* as suggested by Raper & Thom (*1949*) is difficult. On account of the structure of the

perfect state Raper & Thom place it in the Biverticillata-Symmetrica, but they add "Upon the basis of the conidial structures alone, one might be tempted to assign this species to the Brevi-Compacta series'. Smith (*1963*) places it in the Asymmetrica-Velutina, without, however, assigning it to any of its series. According to Udagawa *& al.* (*1967*) the conidial state should be related to many species of *Aspergillus*, especially to *A. carneus* (van Tieghem) Blochwitz. They consider *P. avellaneum* as an intermediate form between *Penicillium* and *Aspergillus*. The 'Hülle-cells' they described refer to the strongly inflated cells of the submerged mycelium. These lack the morphological characters of Hülle-cells.

In our opinion the imperfect state of *H. avellanea* belongs in *Penicillium* since the metulae develop successively on the apex of the conidiophore and not simultaneously as in *Aspergillus*. Also, its conidiophores lack footcells. However, it can not be classified satisfactorily in any of Raper & Thom's series of *Penicillium*. Therefore we propose to erect a new series of *Penicillium*, the *P. avellaneum* series to accomodate *P. avellaneum* and the closely related imperfect species *P. ingelheimense* van Beyma (*1942*). These two species differ from one another mainly in the shape of their conidia and the sizes of their conidiophores and penicilli. Moreover, *P. ingelheimense* does not produce the purple red pigment which characterizes *P. avellaneum*.

Hamigera striata Stolk & Samson, *sp. nov.*—Fig. 2

Penicillium striatum Raper & Fennell *in* Mycologia **40**: 521. 1948. — *Talaromyces striatus* (Raper & Fennell) Benjamin *in* Mycologia **47**: 682. 1955.

STATUS CONIDIALIS.—*Penicillium striatum* Raper & Fennell *in* Mycologia **40**: 521. 1948.

SPECIAL LITERATURE.—Raper & Thom (*1949*: 603).

Diagnosis latina in 'Mycologia' **40**: 521. 1948, continetur.

TYPUS novae speciei status perfectus culturae CBS 377.48.

Colonies on malt agar spreading broadly, attaining a diameter of 6 cm within 10 days at 25° C, thin, largely composed of a dense layer of ascomata occurring at the agar surface, showing creamish shades near Pale Pinkish Buff (Ridgway, Pl. 29; Rayner, 17''f), becoming brown in age ranging from Chamois to Tawny-Olive (Ridgway, Pl. 30, 29; Rayner, 19''b, 17''i); in the centre overgrown by a thin network of uncoloured mycelium, bearing very few penicilli, not affecting the colony appearance. Reverse of colonies brown, near Warm Sepia (Ridgway, Pl. 29; Rayner, 13''m).

Colonies on Czapek agar growing very restrictedly, about 1.5–2 cm in 10 days. Colonies on oatmeal- and cornmeal-agar growing more rapidly, producing ascomata abundantly, reverses ranging from brownish to conspicuous purple near Anthracene Purple (Ridgway, Pl. 44, Rayner, 69'''k).

Vegetative hyphae hyaline, 1.5–5 μ in diameter, submerged hyphae occasionally showing inflations up to 8 μ in diameter.

Ascomata brownish, globose to subglobose, 100–160 μ in diameter, ripening within 10 days. Coverings consisting of a somewhat closely knit network of hyaline to slightly brownish hyphae surrounded by long, slightly twisted, branching, radiating hyphae about 1–2 μ in diameter.

Initials consisting of coiled ascogonia, developing mostly simultaneously with the surrounding hyphae in 6 days old cultures. Asci, subglobose to ellipsoid, occa-

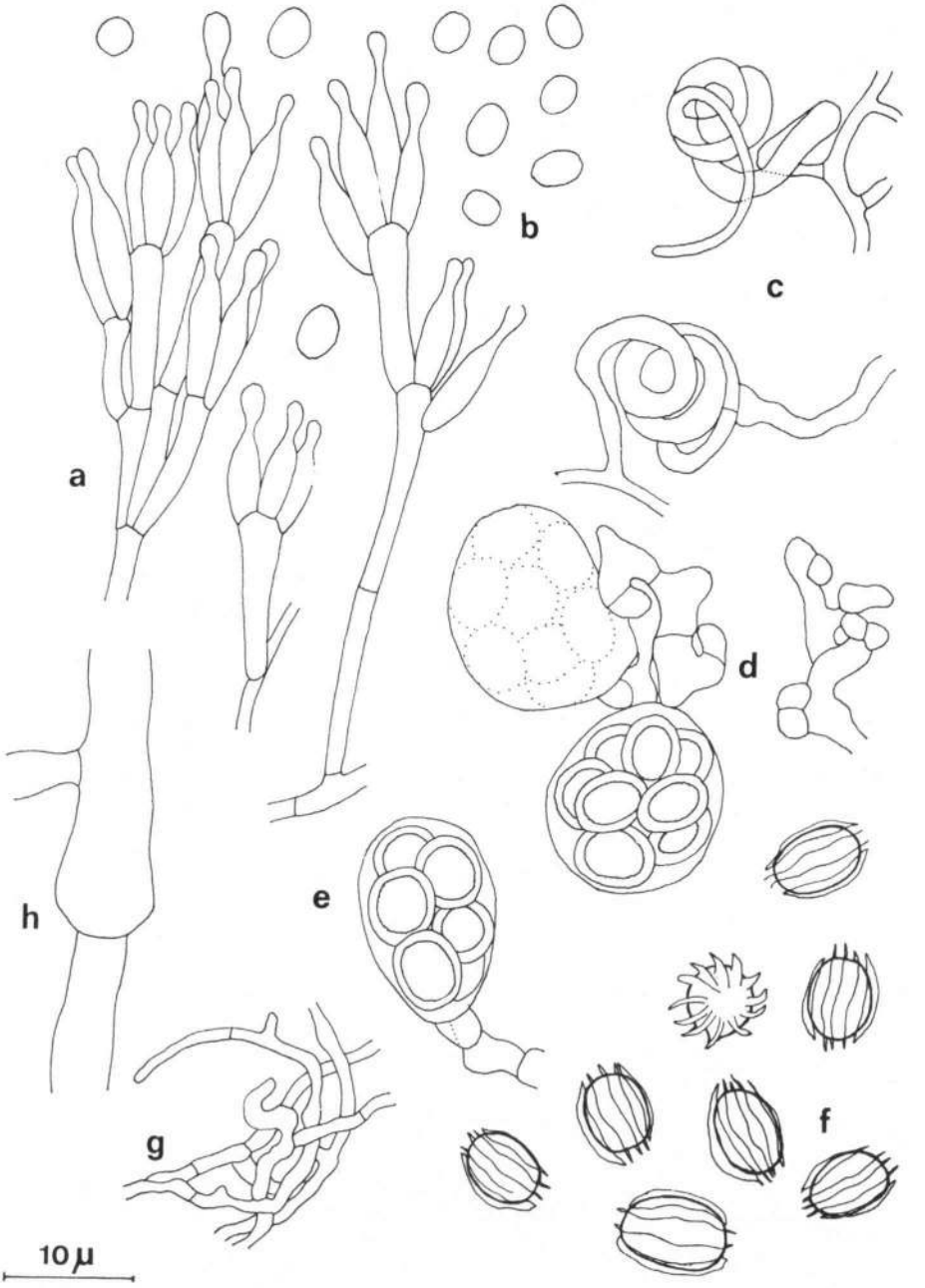

FIG. 2. *Hamigera striata*, CBS 377.48. — a. Different types of penicilli. — b. Conidia. — c. Ascomatal initials. — d. Ascus production. — e. Ascus. — f. Ascospores. — g. Part of ascomatal covering. — h. Submerged hypha.

sionally slightly clavate, mostly 8-spored, 17–23 × 12–14 μ. Ascospores pale yellow, ellipsoid, bearing 8 to 12 longitudinal, nearly hyaline, wavy frills about 1 μ wide, usually converging at the two ends; 7.5–9.5 × 5.5–7 μ, frills included.

Conidial state very scantily produced on all media tested, the best development on Czapek with 20 % sucrose, though still scarce. Conidiophores mostly arising from aerial hyphae, occasionally from submerged hyphae, usually short, 15–50 × 1.5–3 μ, smooth-walled. Penicilli irregular in pattern, ranging from monoverticillate to biverticillate and then consisting of rami bearing metulae with phialides; all elements of the penicillus smooth-walled. Rami occurring rarely, 1 to 2 in addition to the main axis, 9–12 × 2–2.5 μ. Metulae 8–14 × 2–3 μ in verticils of 2 to 3, Phialides 8–12 × 2–3 μ, occurring in clusters of 2 to 5, cylindrical, sometimes slightly swollen, tapering abruptly to conspicuous conidium-bearing tips, about 2 μ in length. Conidia hyaline, subglobose to ellipsoid, 3–4,5 × 2–3.5 μ, smooth, forming divergent chains.

Because of the shape of the phialides the conidial state can best be placed in the Asymmetrica-Divaricata.

Minimum temperature about 5°, optimum 25–30°, maximum temperature about 38° C.

CULTURE EXAMINED.—

CBS 377.48 = NRRL 717, type strain, isolated in 1938 by Williams, Cameron & Williams (*1941*) from canned blue-berries.

Though the ascospores of *H. striata* differ markedly from those of *H. avellanea* in their ornamentation, they have one character in common. In both species the young developing ascospore is surrounded by a, probably gelatinous, layer. When ripening, the ascospores become larger and consequently the 'gelatinous' wall splits. In the ascospores of *H. avellanea* this surrounding layer develops radiate fissures appearing as the described radiate striations, while in *H. striata* this layer splits into longitudinal frills as in *Emericellopsis*.

BYSSOCHLAMYS Westling

Byssochlamys Westling *in* Svensk bot. Tidskr. **3**: 134. 1909.

Ascomata discrete and confluent. Covering lacking or very scanty, composed of loose wefts of hyaline, thin, twisted, hyphae. Ascomatal initials consisting of ascogonia coiled around swollen antheridia. Asci 8-spored, globose to subglobose, stalked, formed singly from croziers. Ascospores continuous, ellipsoid, smooth, pale-yellowish.

CONIDIAL STATE—*Paecilomyces* Bainier.

TYPE SPECIES—*Byssochlamys nivea* Westling.

Benjamin (*1957*) discussed the systematic position of *Byssochlamys*. Although he recognized the close relationship of *Byssochlamys* with other genera of the Eurotiaceae he followed the suggestion of Kuehn (*1955*), including *Byssochlamys* in the Gymnoascaceae on account of the production of the asci from croziers. The species of *Byssochlamys* are, however, characterized by the penicillate conidial apparatus of the *Paecilomyces*-type, and the genus appears to be better placed near the new genus *Hamigera* in the Eurotiaceae. It differs from this genus in the structure of the ascomatal initials, the conidial state and the nature of the covering of the ascomata.

The ascomatal initials of *Byssochlamys* consist of ascogonia, which are coiled around swollen, mostly club-shaped antheridia. The initials become septate and

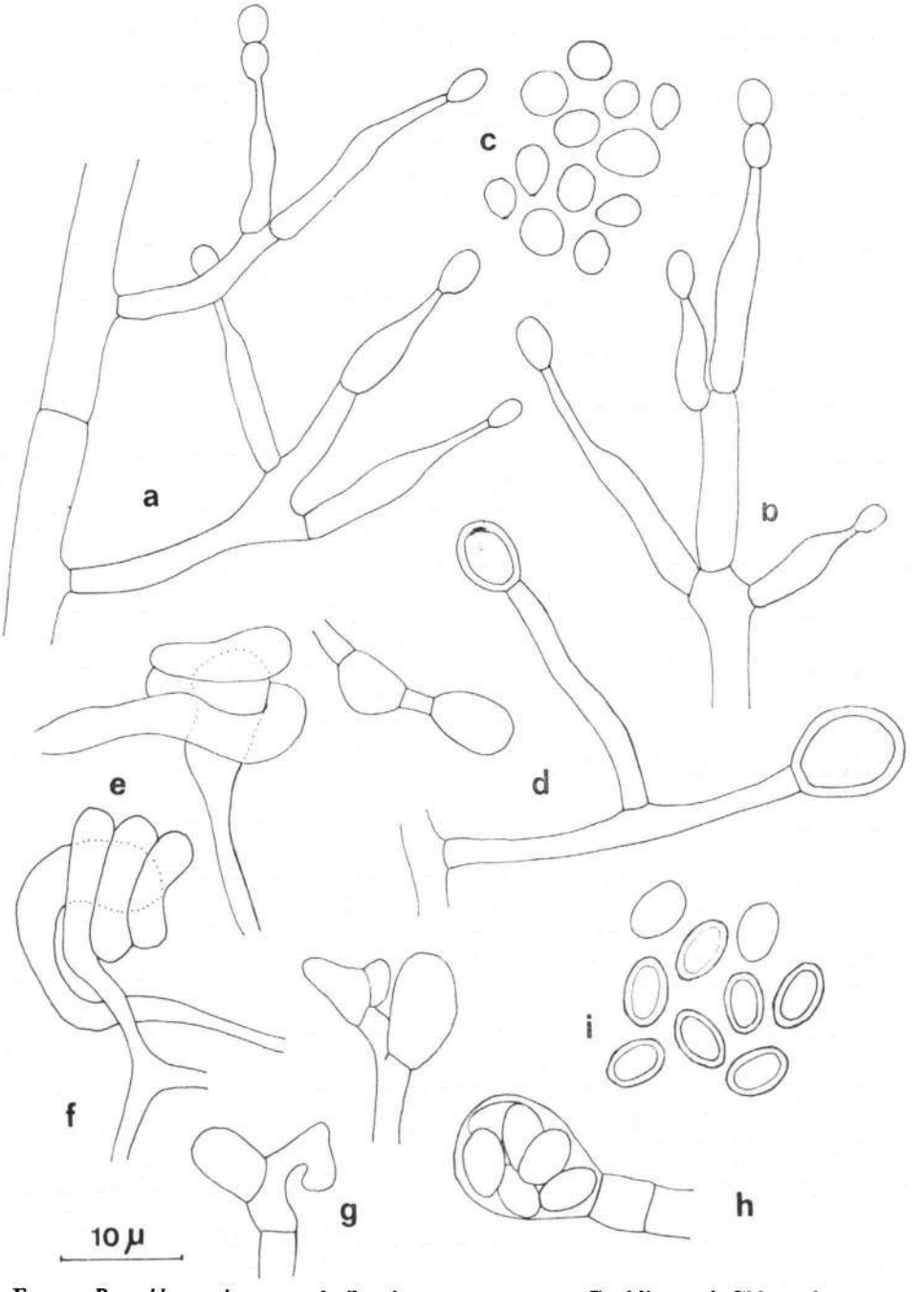

FIG. 3. *Byssochlamys nivea*. — a, b. Sporing structures. — c. Conidia. — d. Chlamydospores. — e, f. Ascomatal initials. — g. Ascus production. — h. Ascus. — i. Ascospores.

develop the crozier-producing ascogenous hyphae. As in *Hamigera* the penultimate cell may be converted directly into an ascus or may grow out to form secondary croziers.

The genera *Thermoascus* and *Byssochlamys* differ primarily in the structure of the ascomatal covering. The development of the asci in *Byssochlamys* is distinct from that seen in *Talaromyces*, where asci are produced in chains. The separation between *Byssochlamys* and *Arachniotus* is based on the differences in conidial state.

The three species of *Byssochlamys* can be distinguished easily from one another by differences in the size of the ascospores and the conidia, and the presence or absence of chlamydospores.

BYSSOCHLAMYS NIVEA Westling—Fig. 3

Byssochlamys nivea Westling *in* Svensk bot. Tidskr. **3**: 134. 1909.
? *Byssochlamys musticola* Naumoff & Kiryalova *in* Trudy bot. Inst. Akad. SSSR **3**: 362. 1935.
Arachniotus trisporus Hotson *in* Mycologia **28**: 500–501. 1936.
Byssochlamys trisporus (Hotson) Cain *in* Can. J. Bot. **34**: 140. 1956.
Gymnoascus sudans Vailionis in Vyauto Didz. Univ. mat. gamos Fak. Darb. **11**: 115. 1936.
Byssochlamys nivea Westling var. *langucullariae* Ram *in* Nova Hedwigia **16**: 311. 1968.
STATUS CONIDIALIS.—*Paecilomyces niveus* Stolk & Samson, *stat. nov.*
? *Spicaria musticola* Naumoff & Kiryalova *in* Trudy bot. Inst. Akad. SSSR **3**: 363. 1935.

Paecilomyces niveus Stolk & Samson, *stat. nov.*

Conidiophora levia, ad 300 μ longa, 2–3 μ crassa, phialides binas vel ternas vel singulas ferunt. Phialides 12,5–20 μ longae, basi cylindrica 2–3,5 μ crassa, subito in collum exiguum, 2,5–7,5 μ longum, 0,7–1,5 μ crassum attenuatae. Conidia hyalina vel dilute flava, globosa vel late ellipsoidea, basi plerumque truncata, 3–5,7 × 2,2–4 μ, levia, catenis siccis divergentibus connexa. Chlamydosporae crassitunicatae, flavo-brunneae vel brunneae, globosae, ovoideae vel pyriformes, ad 10 μ diametro, leves vel asperulae.

TYPUS CBS 100.11.

Colonies on malt agar, spreading broadly, attaining a diameter of 9 cm in 7 to 14 days at 30° C, composed of a basal felt with white ascomata, occasionally in localized sectors, obscured by a floccose to funiculose overgrowth, which gives a creamish colour to the surface of the colonies, near Cartridge Buff (Ridgway, Pl. 30; Rayner, 19″f). Other, predominantly conidial strains, show buff shades between Olive-Buff (Ridgway, Pl. 40; Rayner, 21‴d) and Deep Olive-Buff (Ridgway, Pl. 40; Rayner, 21‴b). Reverse in pale brown to yellow shades. Odour slight or unpronounced. No exudate. Vegetative hyphae, hyaline, 0.5–4.5 μ in diameter, submerged hyphae mostly thick-walled, up to 8 μ in diameter.

Ascomata, white, up to 350 μ in diameter, ripening in 7 to 10 days at 30° C. Covering lacking or very scanty, composed of loose wefts of hyaline, thin hyphae with a diameter of 0.5–1 μ. Asci, globose to subglobose, 8.5–11 μ in diameter. Ascospores, pale-yellowish, ellipsoid, thick-walled, 4–5.5 × 2.5–3.5 μ smooth.

Conidiophores rare, septate, smooth, up to 300 μ in length and 2–3 μ in diameter; when present, bearing phialides in groups of two or three. Usually single phialides are borne directly on the trailing hyphae. Phialides 12.5–20 × 2–3.5 μ, with a cylindrical basal portion, tapering abruptly to a long thin neck, 2.5–7.5 in length and 0.7–1.5 in diameter, smooth. Conidia, hyaline to pale yellowish, globose to broadly ellipsoid, usually with a flattened base, 3–5.7 × 2.2–4 μ, smooth, in dry divergent chains.

Chlamydospores usually abundantly produced, singly or in short chains, thick-

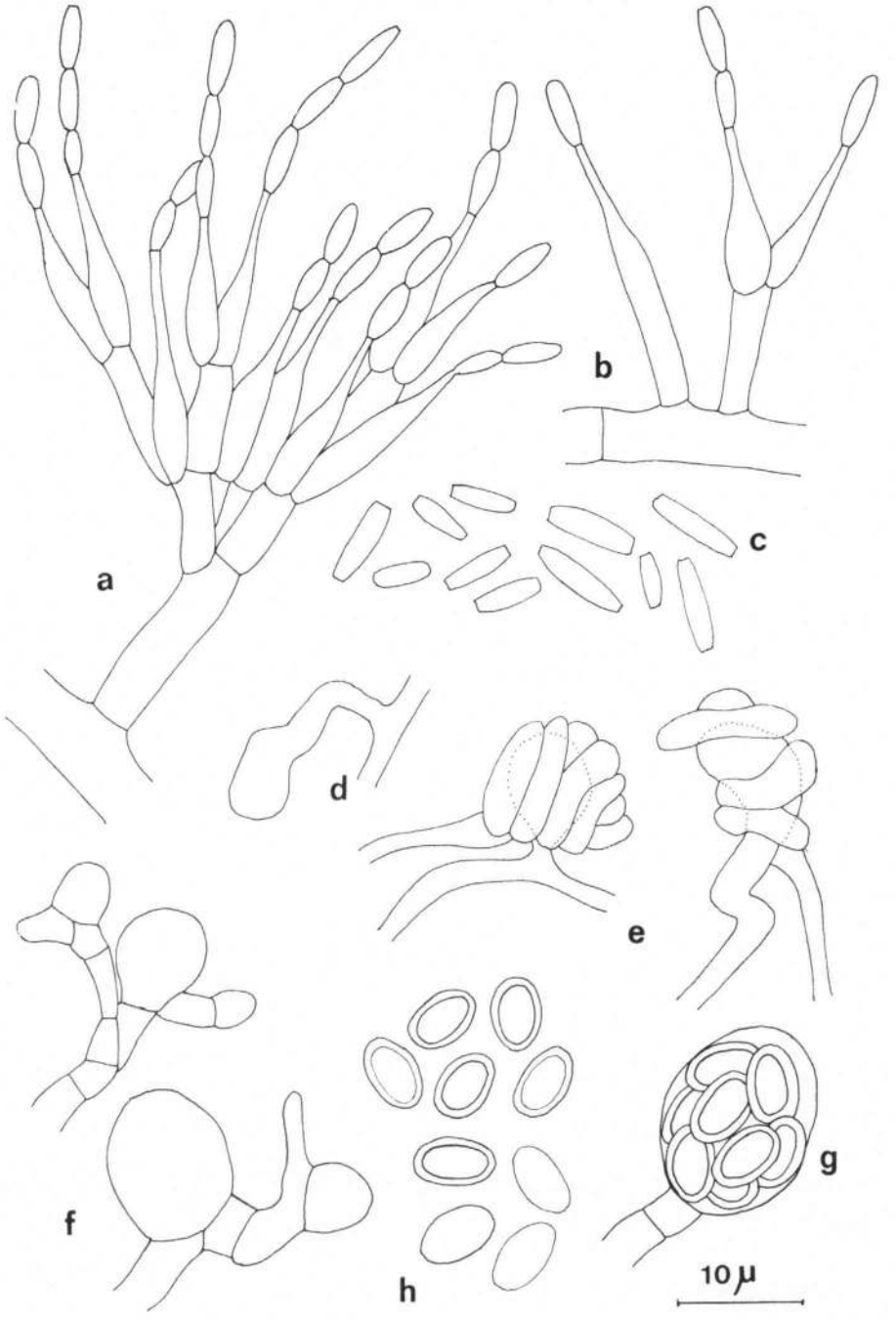

Fig. 4

walled, yellow-brown to brown, globose, ovoid to pyriform, up to 10 μ in diameter, smooth to slightly roughened.

Minimum temperature about 10°, optimum 30–35°, maximum 40° C.

CULTURES EXAMINED:—

CBS 100.11 = ATCC 22260 = type of *B. nivea*, received from R. Westling.

CBS 133.37, received as type of *Arachniotus trisporus* Hotson by J. W. Hotson.

CBS 134.37, sent by L. Vailionis as *Gymnoascus sudans* n. sp., isolated from nutrient solution in which *Betula verrucosa* twigs were cultivated.

CBS 140.65, isolated from applejuice in Wädenswill and sent by E. Müller, Zurich.

CBS 136.67, soil-isolation in glasshouse by G. J. Bollen, Wageningen.

CBS 607.71 A = NRRL 5253, sent as *Byssochlamys* spec. by D. I. Fennell, isolation from soil.

CBS 607.71 B = NRRL 5254, sent as *Byssochlamys* spec. by D. I. Fennell, (received from G. F. Orr).

CBS 899.70 = C 769, isolated from moist barley grain as strain D 5/3 in 1965, received from J. Lacey, Rothamsted Experimental Station, Harpenden, Great Britain.

CBS 900.70 = C 901, isolated from moist barley grain as strain H 214D in 1965, received from J. Lacey, Rothamsted Experimental Station, Harpenden, Great Britain.

CBS 901.70 = C 1454, isolated from silage by M. R. M. Clark in 1969, received from J. Lacey, Rothamsted Experimental Station, Harpenden, Great Britain.

CBS 608.71 = F 5, isolated from mummified plums from orchard floor, received from D. F. Splittstoesser, Cornell University, New York, State Agricultural Experimental Station, Geneva, New York 14456, U.S.A.

CBS 606.71 = BKMF 1486, received as *Byssochlamys musticola*, isolated from oat grain by Tatarenko, Kharkov (1953), no type culture.

CBS 373.70 = IMUFPe 2195 = type culture of *Byssochlamys nivea* var. *languculariae* Ram, isolated from wood sample of *Langucularia racemosa* Gaertn. in Brazil.

Byssochlamys musticola was placed as a synonym of *B. nivea* by Brown & G. Smith (1957). Strain CBS 606.71, which does not represent the type culture, but was received as *B. musticola* from the Institute of Microbiology of Moscow, fits the description of this species. The ascospores and the globose to broadly ellipsoid conidia are slightly larger, but they fall within the given measurements of *B. nivea*. For these reasons *B. musticola* may be considered to be a possible synonym of *B. nivea*.

The type culture of *B. nivea* Westling var. *languculariae* Ram is predominantly conidial with a few white ascomata, which gives an avellaneous colour to the surface of the colony near Vinacous Buff (Ridgway, Pl. 40; Rayner, 17'''d) or Avellanous (Ridgway, Pl. 40; Rayner, 17'''b). It differs only slightly from the other examined strains of *B. nivea* in producing smaller conidia and ascospores and is therefore regarded as a synonym of *B. nivea*.

BYSSOCHLAMYS FULVA Olliver & G. Smith—Fig. 4

Byssochlamys fulva Olliver & G. Smith *in* J. Bot., London **72**: 197. 1933.

STATUS CONIDIALIS.—*Paecilomyces fulvus* Stolk & Samson, *stat. nov.*

FIG. 4. *Byssochlamys fulva*. — a, b. Sporing structures. — c. Conidia. — d. Antheridum. — e. Ascomatal initials — f. Ascus production. — g. Ascus. — h. Ascospores.

Paecilomyces fulvus Stolk & Samson, *stat. nov.*

Conidiophora levia, ad 150 μ longa, 3–5 μ crassa, phialides binas vel ternas metulis brevibus innatas vel singulas ferunt. Phialides 12,5–17 μ longae, basi cylindrica 2,5–3,5 μ crassa, subito in collum exiguum, 3–8,5 μ longum, 1–1,2 μ crassum attenuatae, pariete sursum inspissato. Conidia dilute flava, plerumque cylindrica, utrinque truncata, 4–8,7 × 1,5–5 μ, levia, catenis siccis divergentibus vel intricatis connexa.

TYPUS CBS 132.33.

Colonies on malt agar, spreading broadly, attaining a diameter of 9 cm in 7 to 14 days at 30° C, composed of a basal felt with white ascomata, occasionally in localized sectors, obscured by the velvety, occasionally floccose overgrowth of the conidial state, which gives a fulvous colour to the surface of the colonies near Olive-Buff (Ridgway, Pl. 40; Rayner, 21''' d) or Deep Olive-Buff (Ridgway, Pl. 40; Rayner, 21'''b). Reverse in pale brown to yellow shades. Odour slight, sweet aromatic. No exudate. Vegetative hyphae, 0.5–5 μ in diameter; submerged hyphae, usually thick-walled up to 10 μ in diameter.

Ascomata white, up to 150 μ in diameter, ripening in 7 to 10 days at 30° C. Covering lacking or very scanty, composed of loose wefts of hyaline, thin hyphae of about 1 μ in diameter. Asci, globose to subglobose, 9–12.5 μ in diameter. Ascospores pale-yellowish, ellipsoid, thick-walled, 5.2–6.5 × 3.2–4 μ in diameter, smooth.

Conidiophores septate, smooth, up to 150 μ in length with the phialides borne in groups of two or three on short metulae. Single phialides also borne directly on the aerial hyphae. Phialides 12.5–17 × 2.5–3.5 μ, with cylindrical basal portion, tapering abruptly to a long thin neck 3–8.5 μ in length and 1–1.2 μ in diameter, with the apex thickened, smooth.

Conidia yellowish, usually cylindrical with both ends flattened, 4–8.7 × 1.5–5 μ, in dry divergent or tangled chains.

Chlamydospores absent.

Temperature minimum about 10°, optimum 30–35°, maximum 45° C.

CULTURES EXAMINED.—

CBS 132.33 = IMI 58.421 = Type from G. Smith, isolated from bottled fruits. This strain is only conidial, producing occasionally some ascomatal initials.

CBS 146.48 = IMI 40.021 = ATCC 10099 = NRRL 1125 = probably identical with the type strain; isolated from bottled fruit and used for the production of byssochlamic acid and mannitol; only conidial.

CBS 135.62, isolated from fruitjuice and sent by H. Lüthi, Wädenswill, Switserland.

CBS 604.71 = NRRL 2975, received as the type culture of *Paecilomyces todicus*, sent by D. I. Fennell; Patent strain on the production of an antiviral antibiotic (U.S. Patent nos. 3, 303, 094).

CBS 605.71 = strain H-80, isolated from mechanically harvested grapes and sent by D. F. Splittstoesser, Geneva, New York, U.S.A.

Byssochlamys fulva can easily loose its capacity to produce ripe ascospores in pure culture e.g. the type strain CBS 132.33 is only represented by its conidial state. Olliver & G. Smith (*1933*) and Brown & G. Smith (*1957*) suggest that this conidial state represents the same fungus as *Paecilomyces variotii* Bainier. Our studies show however that the typical cylindrical conidia and the absence of chlamydospores distinguishes *Paecilomyces fulvus* from *P. variotii*.

BYSSOCHLAMYS ZOLLERNIAE Ram

Byssochlamys zollerniae Ram *in* Nova Hedwigia **16**: 312. 1968.

The description of this species is only based on the single type strain CBS 374.70.

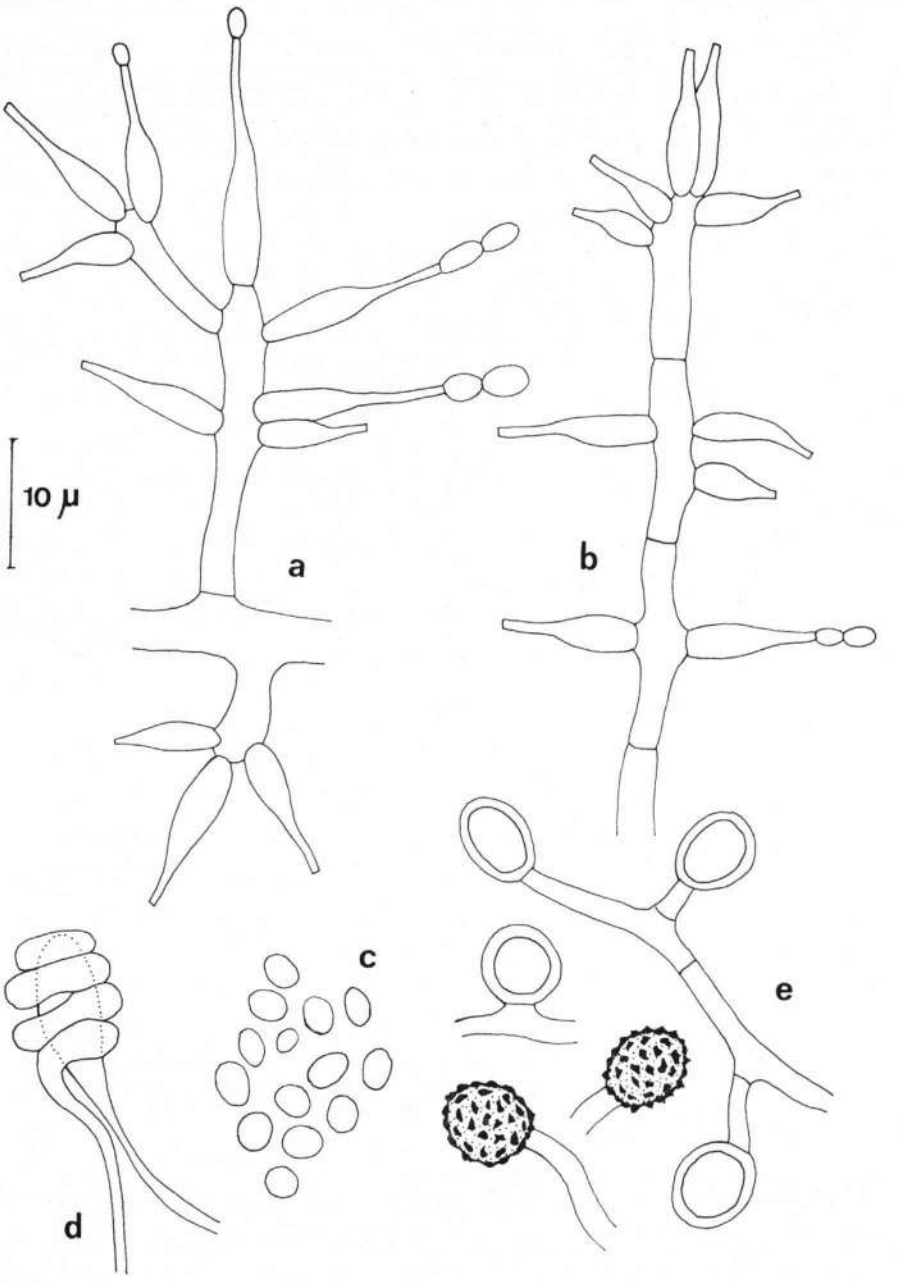

FIG. 5. *Paecilomyces zollerniae*, CBS 374.70. — a, b. Sporing structures. — c. Conidia. — d. Ascomatal initial. — e. Chlamydospores.

Ram (*1968*) described *B. zollerniae* with hyaline, oval to ellipsoid ascospores, measuring 3–4.5 × 2.5–3 μ. However, examination of the type culture showed, that it produces only the ascomatal initials but no ripe ascospores. The initials are of the *Byssochlamys* type, consisting of ascogonia coiled around swollen antheridia.

Until new isolations of this fungus are found, only the conidial state can be described.

Paecilomyces zollerniae Stolk & Samson, *stat. nov.*—Fig. 5.

Conidiophora levia, ad 150 μ longa, 2–3 μ crassa, e hyphis aeriis oriuntur, phialides binas vel ternas metulis brevibus innatas vel singulas ferunt. Phialides 8–20 μ longae, basi cylindrica 2–2,5 μ crassa, subito in collum exiguum, 2,5–7,5 μ longum, 0,7–1,0 μ crassum attenuatae. Conidia hyalina, globosa vel ellipsoidea, 2,5–4 × 1,5–3 μ, levia, catenis siccis divergentibus connexa. Chlamydosporae crassitunicatae, brunneae vel obscure brunneae, 5–10,5 μ diametro, plerumque globosa, primum leves, demum verrucosae.

TYPUS CBS 374.70.

Colonies on malt agar, spreading broadly, attaining a diameter of 8 cm in 14 days at 30° C, composed of a dense matted felt with floccose overgrowth, cottony, pure white at first, changing to Cream Buff (Ridgway, Pl. 30; Rayner, 19″d). Reverse in yellow to reddish shades. Odour slight. No exudate.

Vegetative hyphae, hyaline, thin 0.5–3 μ in diameter, submerged hyphae up to 5 μ in diameter.

Conidiophores, septate, smooth, up to 150 μ in length arising from the aerial hyphae bearing short metulae with the phialides in groups of two or three. Usually single phialides are borne directly on the trailing hyphae. Phialides 8–20 × 2–2.5 μ with a cylindrical basal portion tapering abruptly to a thin long neck, 2.5–7.5 μ in length and 0.7–1 μ in diameter, smooth.

Conidia, hyaline, globose to ellipsoid, 2.5–4 × 1.5–3 μ, smooth in dry divergent chains.

Chlamydospores abundantly produced, borne singly or in short chains, thick-walled, brown to dark-brown, 5–10.5 μ in diameter, usually globose, smooth when young, later becoming warty.

CULTURE EXAMINED.—

CBS 374.70 = IMUFPe 2190 = type culture of *B. zollerniae*, isolated from wood samples of *Zollernia illicifolia* Vog. and *Protium heptaphyllum* (Aubl.) March.

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