

## THE GENUS PHAEOSARIA

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(With three Text-figures)

The type species of *Phaeoisaria*, *P. clematidis* (Fuckel) Hughes is described from pure culture. The conidiogenous cells occur on both the synnemata and undifferentiated hyphae. The latter condition is compared with that of the fertile cells of some non-synnematous genera of the Hyphomycetes. *Chloridium glaucum* Ellis & Everh. is placed in *Phaeoisaria* and a new species, *P. curvata*, is described. A key to the species of *Phaeoisaria* is provided.

On the natural substrate the genus *Phaeoisaria* is easily recognized by its erect synnemata bearing numerous denticulate conidiogenous cells in the apical region, as described by von Höhnelt (1909). Further species have been added by Mason & Hughes (in Mason & Ellis, 1953), Sutton (1973) and Deighton (1974). A generic description conforming to von Höhnelt's concept has been provided by Morris (1963b) and by Ellis (1971).

In 1973 a pure culture of the type species, *P. clematidis* (Fuckel) Hughes, became available for study. In cultures on oatmeal agar two types of fertile hyphae can be observed. In young subcultures some of the subhyaline aerial hyphae form lateral conidiogenous cells, which usually are not sealed off from the supporting hyphal cells. In cases of abundant sporulation, practically the whole aerial mycelium is converted into conidiogenous cells. After about two weeks clusters of thick-walled cells are formed in the hyphae, each giving rise to an erect bundle of stiff, closely coherent hyphae. Directly below many of the hyphal septa new branches which adhere to the shaft of the synnema, are formed. Terminally the hyphal elements of the synnema bend outwards and give rise to a number of conidia by sympodial growth.

When a strain of *Phaeoisaria clematidis* is transferred frequently at an early stage, the synnematal type of fertile hyphae may not be formed, and the colony remains flat, showing a powdery appearance owing to the abundance of undifferentiated fertile hyphae. In the strain CBS 307.73 synnemata were present on the natural substrate, but have not been observed in pure culture.

Consequently the presence of synnemata can not be used as a diagnostic feature of *Phaeoisaria*, and the genus diagnosis has to be altered as follows:

## PHAEOSARIA Höhn.

*Phaeosaria* Höhn. in Sber. Akad. Wiss. Wien, Abt. I, 118: 329. 1909. — *Graphiopsis* Bain. in Bull. trimest. Soc. mycol. Fr. 23: 19. 1907. — *Hansfordiula* Morris in Am. Midl. Nat. 69: 103. 1963.

Colonies restricted or effused, powdery to velvety, pale brown to blackish brown. Synnemata, if present, composed of parallel hyphae, bearing conidiogenous cells over entire length or in upper part only; sometimes synnemata short, brush-like. Conidiogenous cells brown, acicular or cylindrical with tapering apical part, forming conidia by sympodial growth, with spine- or blotch-shaped, 0.5–1.5  $\mu\text{m}$  long denticles scattered in the apical region. Conidia subglobose to fusiform, hyaline or nearly so, smooth, thin-walled, without any remains of ruptured cell-walls at base, one- or rarely two-celled. Sometimes brown, thick-walled, ellipsoidal, continuous chlamydospores present.

*Spiculostilbella* Morris may be a further synonym of *Phaeosaria*. According to Morris (1963a) the type material of *S. dentritica* Morris was deposited in Herb. IA, but as no such fungus is maintained there (M. A. Rosinski, pers. commun.) it could not be examined. Consequently *Spiculostilbella* is of doubtful identity.

A number of species hitherto assigned to *Acrotheca* Fuckel, *Chloridium* Link and similar genera are related to *Phaeosaria*. They differ in the conidiogenous cells which are usually integrated in the stalks of short conidiophores sealed off from the supporting hypha, and in the conidium-bearing denticles, which mostly are short and flat, resulting in clearly discernable scars on the conidial bases. If denticles are cylindrical, the conidiogenous cells are not acicular. The colonies of such strains are spreading, lanose, and have olivaceous or reddish pigments. *Rhinocladiella* sensu Schol-Schwarz is also reminiscent of *Phaeosaria*, but differs in having crowded conidium-bearing denticles, and in the presence of conidiogenous cells with annellated zones and budding cells. Some species of *Sporothrix* also resemble the above genera, but differ in their cottony colonies and the absence of pigmentation from the fertile hyphae.

*Acrodontium* de Hoog is distinguished by the regularly acicular conidiogenous cells of definite shape and size; either with crowded, or with minute denticles. *Tharoopama* Subram. and *Nodulisporium* Preuss differ in the short and flat denticles, and the presence of remains of ruptured cell-walls at the bases of detached conidia. Other genera with cylindrical denticles, such as *Scolecobasidium* Abbott, *Ochroconis* de Hoog & v. Arx and *Dactylaria* Sacc., can easily be distinguished by their septate, often warty and pigmented conidia.

KEY TO THE SPECIES OF *Phaeosaria*

- |   |                      |
|---|----------------------|
| 1a. Conidia usually over 4 $\mu\text{m}$ long. . . . .  | 2                    |
| b. Conidia usually less than 4 $\mu\text{m}$ long. . . . .  | 4                    |
| 2a. Conidia 4–10 $\mu\text{m}$ long, continuous . . . . .   | 3                    |
| b. Conidia over 10 $\mu\text{m}$ long, continuous or rarely two-celled . . . . .  | <i>P. sparsa</i>     |
| 3a. Conidia fusiform, 1.5–3(–4) $\mu\text{m}$ wide; cultures evenly velvety; synnemata, if present, without flaring hyphae at the tip . . . . . | <i>P. clematidis</i> |

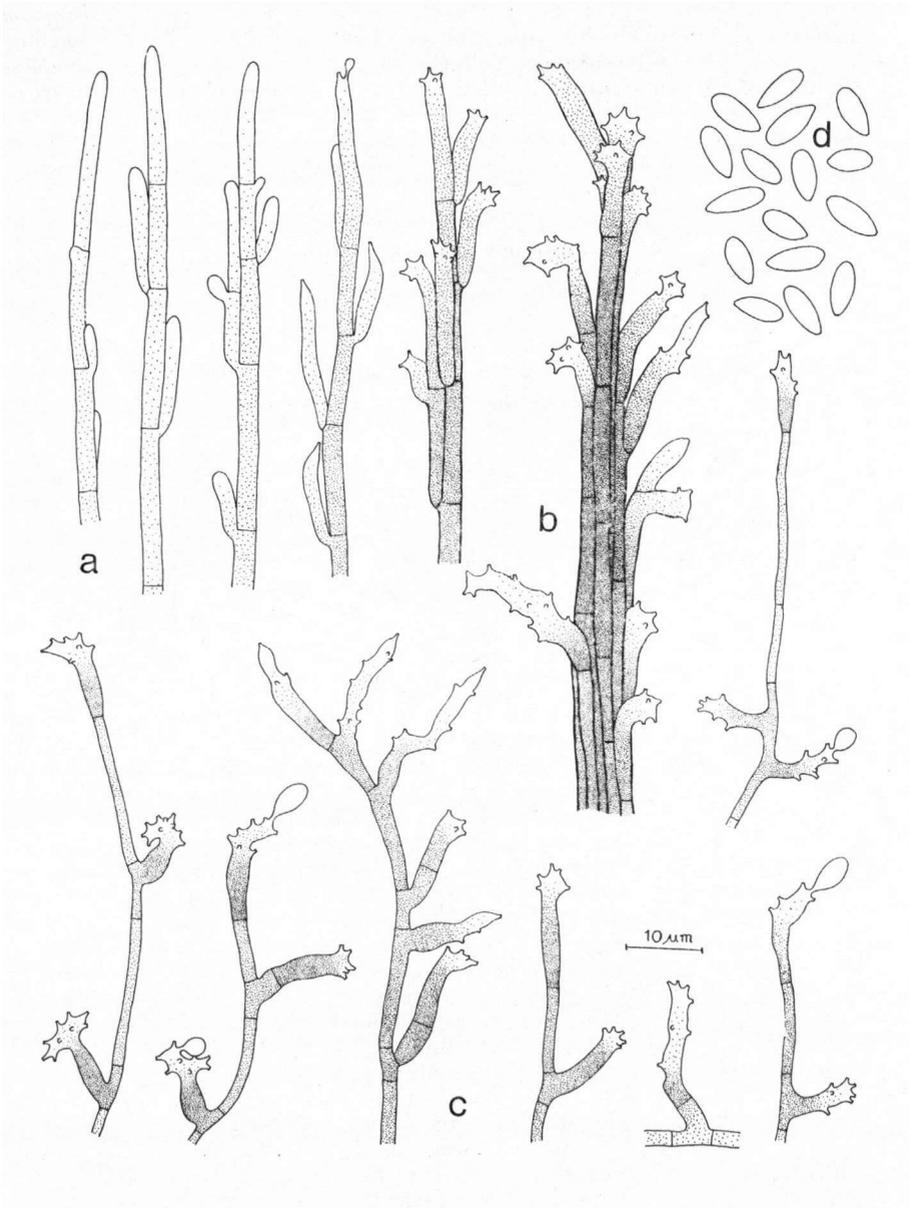


Fig. 1. *Phaeoisaria clematidis* on oatmeal agar. — a. CBS 504.73, developing synnemata. — b. CBS 429.73, mature synnema. — c. Diverse cultures, conidiogenous cells on undifferentiated hyphae. — d. Conidia.

- b. Conidia wider, 3–4.5  $\mu\text{m}$ ; cultures radially feathered; synnemata with flaring hyphae at the tip . . . . . *P. magnifica*
- 4a. Conidium-bearing denticles occurring on a thin rachis which is markedly differentiated from the basal part of the conidiogenous cell . . . . . *P. clavulata*
- b. Conidium-bearing denticles occurring scattered in the apical region of the conidiogenous cell. . . . . 5
- 5a. Conidia curved, clavate to sickle-shaped . . . . . *P. curvata*
- b. Conidia straight, guttuliform to clavate; occasionally sickle-shaped conidia present also *P. glauca*

### 1. PHAEOSIARIA SPARSA Sutton

*Phaeoisaria sparsa* Sutton in Mycol. Pap. 132: 87. 1973.

The type specimen (IMI 144, 569) is well distinct from all other *Phaeoisaria* species owing to the penicillate conidiogenous cells and to the comparatively large, occasionally septate conidia.

### 2. PHAEOSIARIA CLEMATIDIS (Fuckel) HUGHES—Fig. 1

*Stysanus clematidis* Fuckel in Jb. nassau. Ver. Naturk. 23–24 (Symb. mycol.): 365. 1870. — *Phaeoisaria clematidis* (Fuckel) Hughes in Can. J. Bot. 36: 795. 1958.

Colonies on oatmeal agar at 20°C attaining a diameter of 7–10 mm in 14 days, at first smooth, soon becoming powdery, usually remaining smooth near edge, occasionally slightly zonate, buff to brown, later on often with numerous synnemata; reverse greyish brown at centre, olivaceous near margin, finally almost entirely dark olivaceous; exudate and odour absent. Hyphae smooth, thin-walled, hyaline, pale brownish in mass, 1.5–2.5  $\mu\text{m}$  wide. Synnemata, when present, arising from dark brown, thick-walled cells, erect, cylindrical to narrowly clavate, pointed at tip, up to 3000  $\mu\text{m}$  high and 125  $\mu\text{m}$  wide, consisting of very regular, parallel, moderately thick-walled, brown hyphae. Conidiogenous cells arising from synnemata, inserted terminally, or laterally just below septa of peripheral hypha and appressed to column of synnemata, with apical fertile portion bent outwards, or on lateral fertile branches, and also arising from undifferentiated hyphae, often without septum at base; conidiogenous cells smooth, slightly thick-walled, pale brown near base, subhyaline towards apex, more or less cylindrical, usually about 10–15  $\mu\text{m}$  long, but in age often considerably longer, 2–3  $\mu\text{m}$  wide, forming conidia by sympodial growth on conspicuous denticles about 1–1.5  $\mu\text{m}$  long occurring scattered or clustered in apical region of cell. Conidia smooth, thin-walled, hyaline or nearly so, fusiform to obovoidal, (4.5–)6–8(–10)  $\times$  1.5–4  $\mu\text{m}$ , with a pointed base.

MATERIAL EXAMINED.—H E R B A R I U M S P E C I M E N S: *Stysanus clematidis*, type in herb. L. Fuckel (G) under no. 2611, on *Clematis vitalba* L., Gottesthal, Nassau, Germany (two envelopes). — *Stysanus clematidis* in herb. G. Winter (B) under no. 1922, on branch of *Clematis vitalba*. — *Stysanus clematidis* in herb. A. Ludwig (B), on *Clematis vitalba*, Erdbach, Germany, April 1943. — *Graphium ceratostomoides* Speg., type, LPS 33.133, on *Salix* sp., Boca, Buenos Aires, Argentina, January 1880, leg. C. Spegazzini. — *Graphium fissum* Preuss in herb. P. A. Saccardo (PAD), on wood, May 1870. — *Graphium sacchari* Speg., type, LPS 33.137, on *Saccharum officinarum* L., Tucumán, Argentina, April 1894, leg. C. Spegazzini. — *Phaeoisaria bambusae*

Höhn., type, in herb. F. von Höhnel (FH) under no. 3001, on *Bambusa* sp., Buitenzorg, Java, Indonesia, 1907-8. — *Phaeoisaria clavulata*, on rotten wood of *Machilus thunbergii* Sieb. & Zucc., Kagashima Pref., Japan, 1971, leg. K. Tubaki (=IFO 9591 =CBS 307.73).

Living strains: CBS 307.73=IFO 9591, sent by K. Tubaki as *Phaeoisaria clavulata*. — CBS 429.73=IMI 171,447. — CBS 504.73, isolated by W. Gams from wood of *Dendrocalamus giganteus*, Hortus Peradenyia, Ceylon, January 1973.

In old cultures short chains or groups of brown, thick-walled chlamydo-spores are present. In CBS 307.73 they occur singly at the tips of undifferentiated hyphae and are dark brown, fitting the diagnosis of *Humicola* Traaen.

Descriptions of *Phaeoisaria clematidis* on the natural substrate have been provided by Udagawa & Takada (1971, as *P. bambusae*) and Deighton (1974). The latter author also compiled a list of synonyms. Additional data on synonymy are discussed below.

The type material of *Graphium fissum* Preuss has recently been rediscovered in Herb. B. It comprises some synnemata with percurrent conidiogenous cells, producing mucous heads of small conidia. The possible synonyms of *P. clematidis* as mentioned by von Höhnel (1909), viz. *Isaria sphecephila* Ditm., *I. gracilis* Vossler and *I. surinamensis* Vossler are all of doubtful identity (R. A. Samson, Baarn; pers. commun.). The type material of *Graphium verticillatum* Speg. (LPS), a species accommodated in *Graphiopsis* by Goidànich (1935), is too scanty for examination. The types of two other species described by Spegazzini, viz. *Graphium ceratostomoides* and *G. sacchari*, are in good condition; they can be identified with *Phaeoisaria clematidis*.

A number of CBS strains deviate slightly from CBS 504.73 in several respects. The colonies are rather pale, without any synnemata. The conidiogenous cells are cylindrical, provided with denticles which arise sympodially or at random, and the conidia are subcylindrical, with a more or less rounded base. Possibly they are identical to the *Phaeoisaria* state of *Peroneutypella echidna* (Cooke) Deighton, as tentatively described by Deighton (1974) from a poor collection. Further collections are needed for confirmation.

### 3. PHAEOISARIA MAGNIFICA Deighton

*Phaeoisaria magnifica* Deighton in Trans. Br. mycol. Soc. 62: 247. 1974.

The species is closely related to *P. clematidis*, from which it merely differs by the weakly discriminating key-features mentioned before.

### 4. PHAEOISARIA CLAVULATA (Grove) Mason & Hughes *apud* Mason & Ellis

*Pachnocybe clavulata* Grove in J. Bot., London 30: 168. 1885. — *Graphium grovei* Sacc. in Syll. Fung. 4: 613. 1886 (name change). — *Phaeoisaria clavulata* (Grove) Mason & Hughes *apud* Mason & Ellis in Mycol. Pap. 56: 42. 1953.

This species can be recognized by stiff synnemata, composed of parallel hyphae, packed with slender, curved conidiogenous cells with very thin, fragile conidiogenous rachides. Descriptions and illustrations have been provided by Ellis (1971) and Sutton (1973). A strain described as *P. clavulata* by Tubaki (1973) could be identified as *P. clematidis*.

5. *Phaeoisaria curvata* de Hoog & Papendorf, *spec. nov.*—Fig. 2

Coloniae in agar farina avenacea addita post 14 dies 10–14 mm diametro, cito pulverulentae in medio, margine levi indistincta circumdatae, zonatae, pallide vinoso-bubalinae in medio, cremeae in marginae; exsudatum et odor absunt. Hyphae leves, tenuitunicatae, hyalinae, 1–2  $\mu\text{m}$  latae. Cellulae conidiogenae ex hyphis indistinctis oriuntur, leves, pariete paulum inspissato ad basim dilute bubalinae, sursum hyalinae, forma et magnitudine variabiles, plerumque 10–15  $\mu\text{m}$  longae et ad basim 1.5–3  $\mu\text{m}$  crassae, sursum modice attenuatae; conidia polyblastice elongatione sympodiali in denticulis conspicuis circa 1  $\mu\text{m}$  longis, dense aggregatis formant. Conidia levia tenuitunicata, hyalina, clavata vel obovoidea, curvata, nonnumquam falciformia, basi acutata, (4–)6–8(–11)  $\times$  (1–)2–3  $\mu\text{m}$ .

Typus CBS 153.72, isolatus a M. C. Papendorf e foliis putrescentibus *Parinaris capensis* in Africa austro-occidentali.

Colonies on oatmeal agar at 20°C attaining a diameter of 10–14 mm in 14 days, at first smooth, soon becoming powdery but usually remaining smooth near indistinct margin, zonate, pale vinaceous buff; reverse pale vinaceous buff at centre, cream coloured near margin; exudate and odour absent. Hyphae smooth, thin-walled, hyaline, 1–2  $\mu\text{m}$  wide. Conidiogenous cells arising from undifferentiated hyphae, often without septum at base, smooth, slightly thick-walled, pale buff near base, hyaline towards apex, variable in shape and size, cylindrical, slightly tapering towards tip, 10–15  $\mu\text{m}$  long, about 1.5–3  $\mu\text{m}$  wide at base, forming conidia by

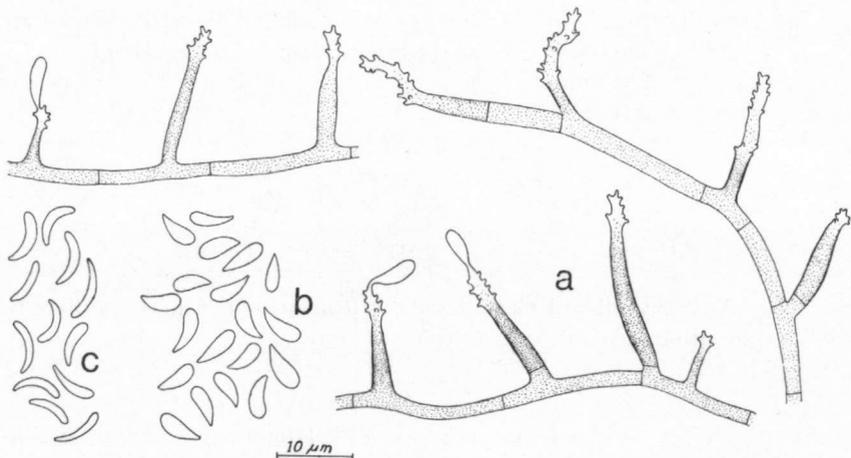


Fig. 2. *Phaeoisaria curvata*, CBS 153.72 on oatmeal agar. — a. Conidiogenous structures. — b. Conidia. — c. Sickleshaped conidia.

sympodial growth on conspicuous denticles of about  $1\ \mu\text{m}$  long occurring in dense groups at apex of cell. Conidia smooth, thin-walled, hyaline, clavate to bovoid and pointed at base, curved, occasionally sickle-shaped,  $(4-6-8(-11) \times (1-)2-3\ \mu\text{m})$ .

MATERIAL EXAMINED.—CBS 153.72, type culture, and CBS 532.72, isolated by M. C. Papendorf from leaves of *Parinari capense* Harv., South West Africa, under no. 1169 and 1176 respectively.

Young cultures of *Phaeoisaria curvata* are only faintly pigmented and may resemble some species of *Sporothrix*. In older colonies the pigmentation becomes more pronounced, especially in the conidiogenous cells, whereas in all species of *Sporothrix* the fertile cells remain hyaline and thin-walled. *Sporothrix curviconia* de Hoog differs in its slender conidiogenous cells with basal septa, dense apical clusters of short denticles, smaller conidia and in the presence of guttuliform lateral blastoconidia. In *S. inflata* de Hoog the conidia are occasionally allantoid (de Hoog, 1974) but this species is readily distinguished by the morphology of the conidiogenous cells and the sympodial conidia. Some species of *Idriella* Nelson & Wilhelm, e.g. *I. desertorum* Mouchacca, are reminiscent of *Phaeoisaria curvata*, but differ in cultural characteristics, in the shape of the conidiogenous cells, and in the presence of dark brown, thick-walled chlamydospores. *Microdochium* Syd. is distinct because of its inflated conidiogenous cells.

#### 6. *Phaeoisaria glauca* (Ellis & Everh.) de Hoog & Papendorf, *comb. nov.*

Fig. 3

*Chloridium glaucum* Ellis & Everh. in J. Mycol. 4: 113. 1888 (basionym).

Colonies on oatmeal agar at  $20^\circ\text{C}$  attaining a diameter of 2–3 mm in 14 days, at first smooth, soon becoming powdery, pale buff to brown; reverse pale brown; exudate and odour absent. Vegetative hyphae smooth, thin-walled, hyaline or nearly so,  $1.5-2.5\ \mu\text{m}$  wide. Fertile hyphae usually slightly wider, often ascending, profusely branched in apical region, thus occasionally becoming synnema-like. Conidiogenous cells arising from undifferentiated or slightly thick-walled hyphae, pale brown near base, hyaline towards apex, variable in shape and size, usually about  $2-2.5\ \mu\text{m}$  wide at base and  $10-20\ \mu\text{m}$  long, cylindrical, tapering towards tip, forming conidia by sympodial growth on conspicuous denticles about  $1\ \mu\text{m}$  long, occurring scattered in apical region of cell. Conidia smooth, thin-walled, hyaline, guttuliform to ellipsoidal,  $2.5-3.5 \times 1.6-2.2\ \mu\text{m}$ , with pointed base, occasionally becoming inflated and giving rise to some globose to ellipsoidal secondary conidia or a short secondary conidiophore.

MATERIAL EXAMINED.—Herbarium specimen: *Chloridium glaucum*, type, in herb. NY, on rotten wood of *Quercus* sp., Gloucester County, Newfield, U.S.A., July 1888.

Living strains: CBS 319.74 and 320.74, isolated by W. Gams from *Acer* twigs, 'eendenkooi Buren', Isle of Ameland, Netherlands, October 1973. — CBS 479.75 A and B, isolated by G. S. de Hoog from rotten wood, Leningrad, USSR, July 1975. — CBS 481.75, isolated by W. Gams from *Buxus sempervirens*, Petit Lubéron, France, October 1974.

*Phaeoisaria glauca* is distinct from *P. clavulata* because of the absence of a well differentiated rachis on the conidiogenous cell. Usually the conidiophores occur

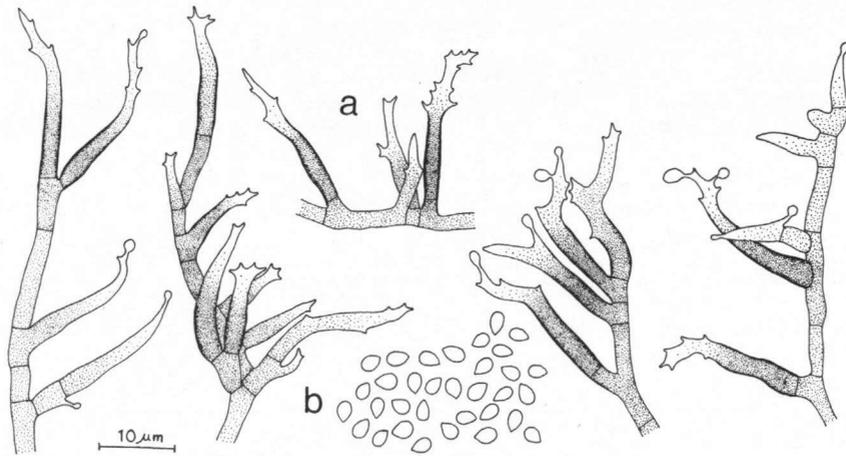


Fig. 3. *Phaeoisaria glauca*, CBS 319.74 and CBS 320.74 on oatmeal agar. — a. Conidiogenous structures. — b. Conidia.

singly or in loose brushes, in culture as well as on the natural substrate, whereas *P. clavulata* has well defined synnemata. In some of the strains, especially in CBS 319.74 and 320.74, secondary conidia are formed; occasionally some conidia become inflated, each producing a short fertile rachis. The species is closely related to *Rhinocladiella* Nannf.; in the latter genus, however, the conidium-bearing denticles are crowded on distinct fertile rachides.

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