

**Taxonomic revision of the genus *Cladosporium* s. lat.  
2. Morphotaxonomic examination of *Cladosporium*  
species occurring on hosts of the families Bignoniaceae  
and Orchidaceae**

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*Cladosporium* species described and reported on hosts belonging to the Bignoniaceae and Orchidaceae have been examined. They are redescribed, illustrated and their taxonomic positions are discussed. Three new *Cladosporium* species are described, and two new combinations into the genus *Fusicladium* are introduced. *Cladosporium cattleyae* is reduced to synonymy with *Dendryphiella vinosa*.

Keywords: hyphomycetes, *Cladosporium*, taxonomy, *C. jacarandicola*, *C. orchidophilum*, *C. rectangulare*, *Fusicladium jacarandae*, *F. orchidis*, new species, new combinations, key.

During the course of monographic studies of the genus *Cladosporium* (Pers.: Fr.) Link s. lat. several new, undescribed species of *Cladosporium* s. str. have been found. Other species, which have previously been placed into *Cladosporium* proved to be distinct from the latter genus and have to be excluded. A first paper dealing with some excluded species has recently been published by Schubert & Braun (2004). In the present paper, *Cladosporium* species described from or recorded on hosts belonging to the families Bignoniaceae and Orchidaceae are described, illustrated and discussed.

The monographic studies of the genus *Cladosporium* s. lat. are based on three approaches, viz., morphotaxonomic examinations of collections in vivo, in vitro and, as far as living cultures are available, molecular analyses to get sequence data. A recently published *Cladosporium* checklist contains 772 names (Dugan et al., 2004). Cultures as basis for molecular studies are only available for a very limited number of species. However, detailed morphotaxonomic examinations of the numerous described *Cladosporium* species, including revisions of type collections, are urgently necessary and indispensable as basis for molecular analyses. With regard to mor-

photaxonomic concepts of common saprobic *Cladosporium* species, e.g., *C. cladosporioides* (Fresen.) G. A. de Vries, *C. herbarum* (Pers.: Fr.) Link and *C. oxysporum* Berk. & M. A. Curtis, we follow Ellis (1971, 1976) and Ho et al. (1999). Taxonomic revisions should not exclusively rely on sequence data. The phenotype as expression of the genotype should also be taken into consideration. This paper is a contribution to the morphotaxonomic revision of *Cladosporium* species.

## Materials and Methods

All collections have been examined and measured, mounted in distilled water, by standard light microscopy (Olympus BX 50, Hamburg, Germany). The collections examined are deposited at the herbaria BPI, GENT, HAL, IACM, IMI, M, NY, PH and VPRI (abbreviations according to Holmgren et al. (1990).

## Taxonomy

### 1. *Cladosporium* species on Bignoniaceae

***Cladosporium bignoniae*** Schwein., Trans. Amer. Philos. Soc., N. S., 4 (2): 277 (1832).

Material examined. – USA: Carolina, Pennsylvania, Bethlehem, on capsules of *Bignonia radicans*, Schweinitz, No. 2600 (PH 1020422, 1020423, syntypes).

Schweinitz (1832) described this species as follows: “*C. acervulis sparsis, minutis, frequentibus, sphaeriaeformibus, nigro-olivaceis. Floccis breviusculis cum sporidiis concoloribus*”. The re-examination of type material, which is only sparingly fruiting, revealed the presence of two fungi, viz., one species with slightly nodulose conidiophores and verruculose to verrucose, often 1-septate conidia, resembling *Cladosporium herbarum*, and a second *Cladosporium* species with small, catenate, 0–1-septate, pale brown, smooth conidia. It is not clear on which fungus Schweinitz’s description had been based. González-Fragoso (1927) reported a collection from Spain (Barcelona, San Gervasio, Parque de la Bonanova) on fallen fruits of *Jacaranda mimosifolia* and published a more detailed description: conidiophores short, erect, dark olivaceous; conidia more or less oblong, 5–9 × 3–4 µm, aseptate and concolorous with the conidiophores. It is quite unclear if the fungus from Spain was allied to or even identical with *C. bignoniae*. The original description of *C. bignoniae* is too meagre to identify this species, and this name was based on two different elements. A typification of this name by con-

fining it on one of the two elements is necessary, but impossible at the moment since the type material is too meagre. New collections on fruits of *Bignonia radicans* from North America are urgently needed. *C. bignoniae* is tentatively considered a nomen dubium.

***Cladosporium heterophragmatis*** S. A. Khan & Kamal, Mycopathol. Mycol. Appl. 18 (4): 246 (1962). – Fig. 1.

Material examined. – West Pakistan: Tandoja, Campus A.R.I., on living leaves of *Heterophragma adenophyllum*, 15 Nov. 1961, Shakil Ahmad Khan (IMI 90787, holotype).

Illustration: Khan & Kamal (1962: 247, Fig.).

On living leaves, forming subcircular, oval-oblong to irregular discolorations on the upper leaf surface, confluent, yellowish brown or ochraceous. – Colonies hypophyllous, caespitose, effuse, dense, grey-brown to dark brown, blackish, not vein-limited, velvety, later confluent, covering large areas of the leaf surface. Mycelium external, superficial, hyphae branched, 2.5–6  $\mu\text{m}$  wide, septate, sometimes slightly constricted at the septa, pale olivaceous to olivaceous-brown, smooth, rarely rough-walled to verruculose, walls thickened, hyphae often aggregated forming horizontal threads, or cells swollen, swollen hyphal cells subcircular-ellipsoid, up to 13  $\mu\text{m}$  diam. – Conidiophores solitary, arising from swollen hyphal cells or creeping hyphae, lateral or terminal, erect or sometimes decumbent, creeping, straight to somewhat flexuous, geniculate-sinuous, unbranched or branched, 4–113(–190)  $\times$  2–5  $\mu\text{m}$ , often slightly attenuated towards the apex, continuous or with few septa, not constricted at the septa, pale olivaceous to olivaceous-brown, concolorous with the hyphae, often growing like, and hardly distinguishable from and confusable with superficial hyphae, smooth, occasionally verruculose. – Conidiogenous cells integrated, terminal, rarely intercalary, subcylindrical to oblong, 3–14  $\mu\text{m}$  long, proliferation sympodial, with a single to several conidiogenous loci, often crowded at the apex, scars protuberant, conspicuous, sometimes subdenticulate, slightly convex, 1–2  $\mu\text{m}$  wide, thickened, more or less darkened-refractive. – Conidia catenate, frequently in branched chains, straight to slightly curved, variable in shape, small conidia (apex without any hila or with a single apical hilum) subglobose, ellipsoid-ovoid, obovoid, fusiform, 3–14  $\times$  2–4.5  $\mu\text{m}$ , 0–1(–2)-septate, larger conidia with two to several apical hila (ramoconidia s. lat.) ellipsoid, fusiform, cylindrical to somewhat irregular, 5–23(–27)  $\times$  3–5(–6)  $\mu\text{m}$ , 0–3(–4)-septate, not or only slightly constricted at the septa, pale olivaceous, pale brown to olivaceous-brown, smooth, rarely verruculose, walls unthickened or only

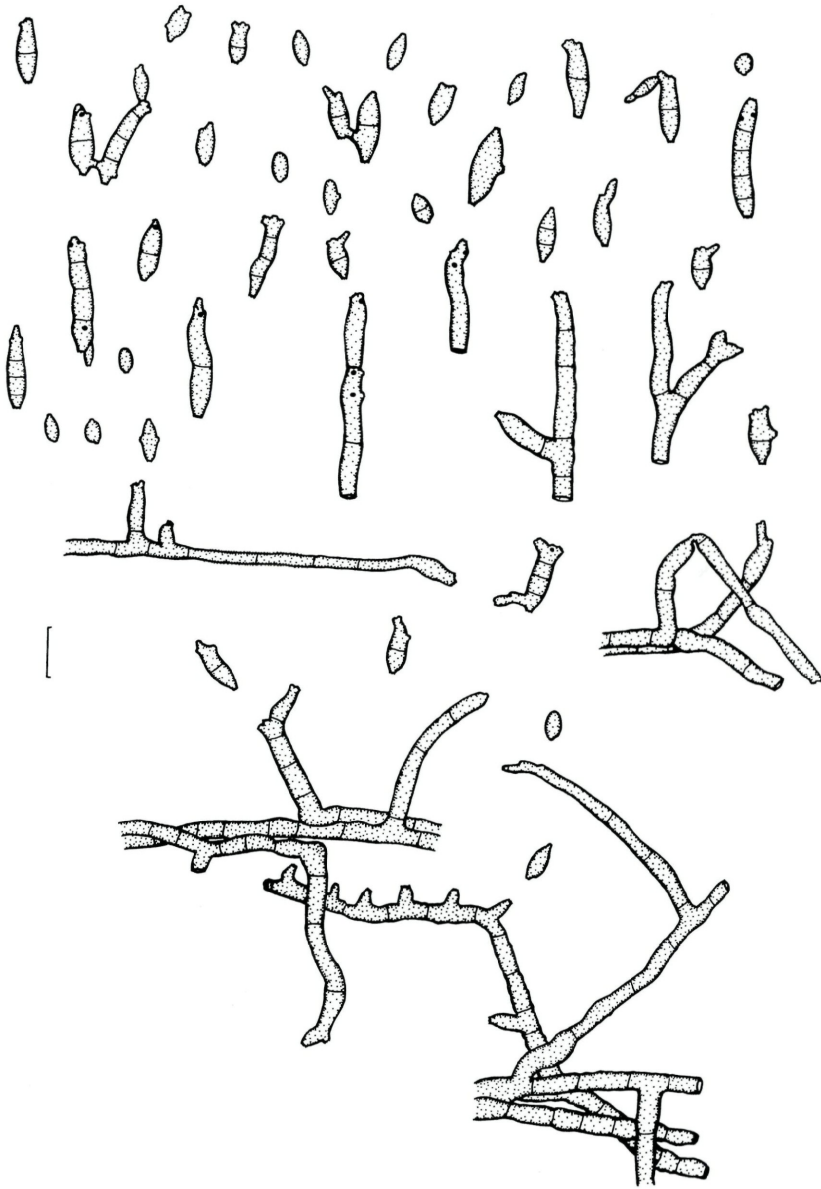


Fig. 1. - *Cladosporium heterophragmatis*. - Conidiophores and conidia from the type material. - Bar = 10  $\mu$ m.

slightly thickened, apex rounded or attenuated, hila conspicuous, subdenticulate, slightly convex, (0.5-)1-1.5  $\mu$ m wide, thickened, darkened-refractive.



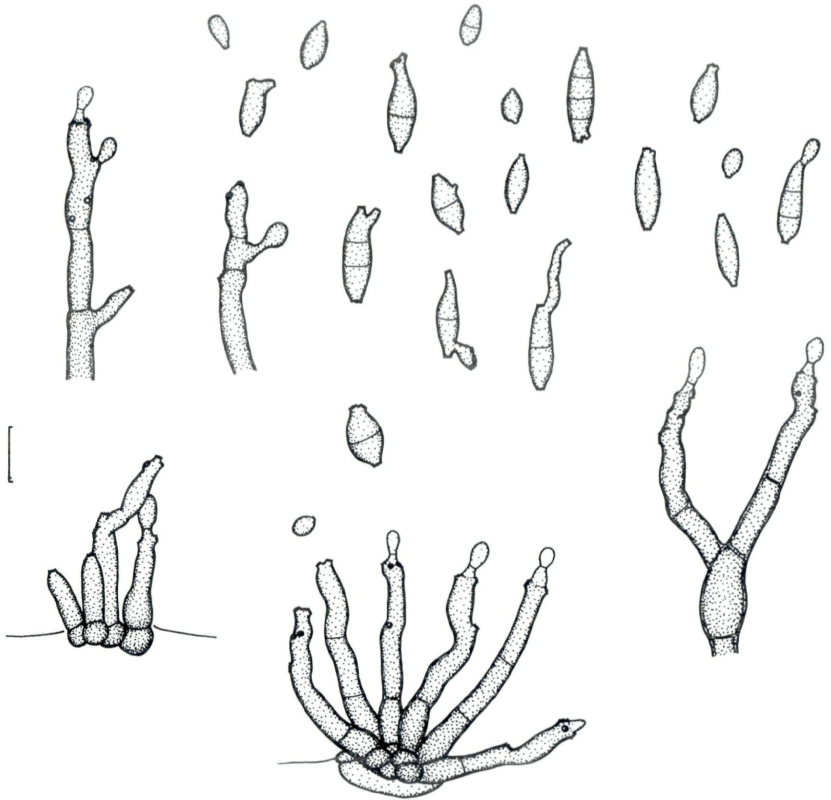


Fig. 2. – *Cladosporium jacarandicola* sp. nov. – Conidiophore fascicle, conidiophores and conidia from the type material. – Bar = 10  $\mu$ m.

This species is morphologically close to the hyperparasitic species *Cladosporium exoasci* Lindau, but the latter species is easily distinguishable by having longer and somewhat wider, usually multibranching, pluriseptate conidiophores (20–250  $\times$  3–7  $\mu$ m) and wider, 0–5(–6)-septate conidia [small conidia 4–13  $\times$  3–6  $\mu$ m, large conidia 10–30(–35)  $\times$  4–10  $\mu$ m] (Braun, 2001).

***Cladosporium jacarandicola*** K. Schub., U. Braun & C. F. Hill, **sp. nov.**  
– Fig. 2.

Material examined. – New Zealand: Mt. Albert, Ruarangi Road, on living leaves of *Jacaranda mimosifolia*, 6 Aug. 2002, C. F. Hill 693 [HAL 1812 (F), holotype].

Coloniae punctiformes, dispersae, brunneae. Mycelium immersum. Hyphae 3–4(–5)  $\mu$ m latae, septatae, pallide olivaceae. Stromata nulla vel bene evoluta, substomatalia, ex cellulis subglobosis, 5–7  $\mu$ m latis, olivaceis vel olivaceo brunneis, crassitunicatis composita. Conidiophora solitaria vel laxe ad dense fasciculata, per

stoma emergentia, erecta, recta vel leniter flexuosa, leniter geniculata-sinuosa, non-ramosa vel interdum ramosa,  $10-58 \times 3.5-5 \mu\text{m}$ , continua vel sparse septata, olivacea vel olivaceo-brunnea, apice saepe subhyalino, levia, leniter crassitunicata, basi leniter inflata. Cellulae conidiogenae integratae, terminales, raro intercalares, cylindricae-oblongae,  $10-30 \mu\text{m}$  longae, sympodiales, cicatrices conidiales terminales, aggregatae, prominentes,  $1-1.5(-2) \mu\text{m}$  latae, incrassatae, fuscatae-refractivae. Conidia catenata vel ramificata, subglobosa, obovoidea, fusiformes, ellipsoidea,  $4-18 \times 3-5(-6.5) \mu\text{m}$ ,  $0-3$ -septata, pallide olivacea, levia vel verruculosa, tenuitunicata vel leniter crassitunicata, apice rotundato, attenuato vel truncato, basi truncata vel subconvexa, hila  $(0.5-1)-1.5(-2) \mu\text{m}$  lata, incrassata, fuscata-refractiva.

On living leaves, causing small, subcircular, brownish spots. Colonies punctiform, scattered, brownish. Mycelium internal, hyphae  $3-4(-5) \mu\text{m}$  wide, septate, pale olivaceous. Stromata absent to well-developed, substomatal, composed of subglobose, more or less thick-walled cells,  $5-7 \mu\text{m}$  wide, olivaceous to olivaceous-brown. – Conidiophores solitary or in loose to dense fascicles, arising from stromata, emerging through stomata, erect, straight to somewhat flexuous, somewhat geniculate-sinuuous, unbranched, occasionally branched,  $10-58 \times 3.5-5 \mu\text{m}$ , continuous to sparsely septate, olivaceous, olivaceous-brown, apex often paler, subhyaline, smooth, walls slightly thickened, somewhat swollen at the base. – Conidiogenous cells integrated, terminal, rarely intercalary, cylindrical-oblong,  $10-30 \mu\text{m}$  long, proliferation sympodial, with several conidiogenous loci, often crowded at the apex, loci protuberant,  $1-1.5(-2) \mu\text{m}$  wide, thickened, darkened-refractive. – Conidia in unbranched or branched chains, subglobose, obovoid, fusiform, ellipsoid,  $4-18 \times 3-5(-6.5) \mu\text{m}$ ,  $0-3$ -septate, pale olivaceous, smooth to verruculose, walls not to slightly thickened, apex rounded, somewhat attenuated or truncate, base truncate to slightly convex, hila  $(0.5-1)-1.5(-2) \mu\text{m}$  wide, thickened, darkened-refractive.

There are some morphologically similar species with consistently short conidiophores, which are, however, quite distinct from *C. jacarandicola* in forming wider conidiophores ( $3-10 \mu\text{m}$  wide in *C. agoseridis* U. Braun & Rogerson;  $3-8 \mu\text{m}$  in *C. lupiniphilum* U. Braun), larger, above all wider conidia with different surface ornamentations [ $(6.5-12-26(-31) \times 4-8 \mu\text{m}$ , faintly to conspicuously verruculose-echinulate in *C. praecox* (Niessl) U. Braun;  $(10-12-30(-50) \times (5-6-13(-15) \mu\text{m}$ , densely verruculose in *C. agoseridis*;  $6-28 \times 4-8 \mu\text{m}$ , smooth or almost so in *C. lupiniphilum*] and wider loci, respectively ( $1.5-2.5 \mu\text{m}$  in *C. orchidearum* Cooke & Massee) (Braun & Rogerson, 1995; Braun, 1998, 2000; Ellis, 1976).

In addition to the new species of *Cladosporium*, this collection (no. 693) also contained rich fructification of *Cercospora apii* Fresen. s. lat.

***Fusicladium jacarandae*** (Viégas) K. Schub., U. Braun & F. Freire,  
**comb. nov.** – Fig. 3.

≡ *Cladosporium jacarandae* Viégas, *Bragantia* 7(2): 33 (1947).

Material examined. – Brazil: Minas Gerais, Agua Limpa, Est. Exp. de Agua Limpa, on living leaves of *Jacaranda* sp., 21 May 1945, E. P. Heringer (IACM, holotype).

Illustration: Viégas (1947: 46, Fig. 11).

Original description (Viégas, 1947): “Maculis numerosis, sparsis vel aggregatis, amphigenis, circularibus, centro albo, margine elevato donatis, 0.5–1 mm diam. Sporodochiis epiphyllis, sparsis, subcuticularibus, 20–50  $\mu\text{m}$  diam., fuscis. Conidiophoris fuscis, basim versus raro septatis, simplicibus vel ramificatis, 14–40  $\times$  3–4  $\mu\text{m}$ , geniculatis vel non, cum cicatricibus acrogenis vel pleurogenis. Sporis fusoides vel ovoideis vel subcylindratis, 0–1 septatis, fuscis, 5–15  $\times$  2.5–3  $\mu\text{m}$ ”.

Mycelium internal. – Conidiophores erect, straight, unbranched, 14–60  $\times$  3–4  $\mu\text{m}$ , septate, walls slightly thickened. – Conidiogenous cells integrated, terminal or intercalary, cylindrical, proliferation sympodial, with several conidiogenous loci, cicatrised, loci subdenticulate, truncate, 1–1.5  $\mu\text{m}$  wide, not thickened, slightly darkened-refractive. – Conidia solitary or in unbranched chains, straight, fusiform, ellipsoid, ovoid, 5–15  $\times$  2.5–5  $\mu\text{m}$ , 0–1-septate, more or less constricted at the septum, smooth, walls not to only slightly thickened, apex rounded or somewhat attenuated, loci truncate, 1–1.5  $\mu\text{m}$  wide, not thickened, but somewhat darkened-refractive.

The holotype of this species, which is in poor condition, has been examined by F. Freire (Fortaleza, Brazil). A preparation, only with a single conidiophore and few conidia, could be examined, but the structures seen agree well with the original description and illustration of *C. jacarandae*. The conidiogenous loci and conidial hila are not cladosporioid, but they are denticle-like, truncate, unthickened and agree well with the concept of the genus *Fusicladium* emend. (Schubert et al., 2003), to which this species has to be assigned. It pertains into a group of *Fusicladium* species forming catenate conidia, but differs from morphologically allied taxa in having smaller conidia [11–25(–28)  $\times$  4–7  $\mu\text{m}$  in *F. cerasi* (Rabenh.) Erikss.; 10–25  $\times$  4–6(–8.5) in *F. crataegi* Aderh.], 0–1-septate conidia [usually aseptate in *F. asperatum* K. Schub. & U. Braun and *F. effusum* G. Winter; 0–3-septate in *F. humile* (Davis) K. Schub. & U. Braun and *F. convolvularum* Ondřej] and smaller conidiogenous loci and hila,

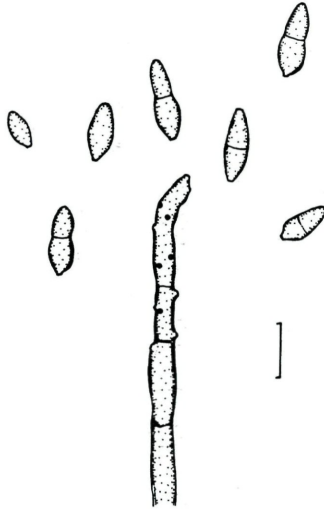


Fig. 3. – *Fusicladium jacarandae*. – Conidiophores and conidia from the type material. – Bar = 10 µm.

respectively [(1–)1.5–2(–2.5) µm wide in *F. carpophilum* (Thüm.) Oudem.; 1.5–3 µm wide in *F. levieri* Magnus; 1.5–3(–4) µm in *F. euphorbiae* Karak.] (Schubert et al., 2003).

2. *Cladosporium* species on Orchidaceae

**Key to *Cladosporium* species occurring on orchids:**

- 1. Conidiophores straight, distinctly nodulose, swellings with conidiogenous loci (scars); conidia usually smooth or almost so; saprobic, on numerous substrates, incl. orchids . . . . . *C. oxysporum*
- 1\*. Conidiophores either non-nodulose or, if nodulose, without any conidiogenous loci (scars) at the small intercalary swellings; conidia smooth to minutely verruculose . . . . . 2
- 2. Conidiophores characteristically branched, right-angled; on *Epidendrum prismatocarpum*, Great Britain . . . . . *C. rectangulare*
- 2\*. Conidiophores unbranched, rarely sparingly branched, but not right-angled . . . . . 3
- 3. Conidiophores loosely to densely fasciculate, rarely solitary, usually emerging through stomata . . . . . 4
- 3\*. Conidiophores solitary, rarely in small groups, not emerging through stomata . . . . . 5



4. Conidiophores 50–175  $\mu\text{m}$  long, pluriseptate, often percurrently proliferating, often nodulose with small intercalary swellings; conidiogenous cells terminal and intercalary, with numerous, crowded conidiogenous loci; conidia subglobose, broadly ovoid, ellipsoid to somewhat irregular, smooth to minutely verruculose, loci and hila 0.5–1.5  $\mu\text{m}$  wide; on *Cypripedium* sp., Australia . . .  
..... *C. orchidiphilum*
- 4\*. Conidiophores shorter, 20–75  $\mu\text{m}$  long, 0–3-septate, not percurrently proliferating, without swellings; conidiogenous cells terminal, only few conidiogenous loci, not crowded; conidia obovoid, ellipsoid to subcylindrical, usually verruculose, loci and hila (1–)1.5–2.5  $\mu\text{m}$  wide; on *Oncidium crispum*, Great Britain . .  
..... *C. orchidearum*
5. Conidiogenous cells terminal, rarely intercalary, conidiogenous loci scattered; conidia 0–1-septate; on different substrates, incl. orchids . . . . . *C. cladosporioides*
- 5\*. Conidiogenous cells terminal and often intercalary, several conidiogenous loci more or less arranged at the same level; conidia 0–4(–5)-septate; on *Stanhopea* sp., Germany . . . . *C. stanhopeae*

***Cladosporium cladosporioides*** (Fresen.) G.A. de Vries, Contr. Knowl. Genus *Cladosporium*: 57 (1952).

Material examined. – Brunei, on a blossom of *Phalaenopsis* sp., 25 Feb. 1975, W. T. H. Peregrine, SIB 1974 (IMI 192091, as '*C. oxysporum* Berk. & M. A. Curtis').

This collection is characterised as follows: Colonies punctiform to effuse, loose to dense, caespitose. – Conidiophores solitary or in small groups, arising from hyphae or swollen hyphal cells, unbranched or rarely branched, 18–177  $\times$  (2.5–)3–5  $\mu\text{m}$ , septate, pale olivaceous, often irregularly rough-walled, attenuated towards apex. – Conidia catenate, in unbranched or branched chains, small conidia (apex without or only with a single hilum) subglobose, ovoid, ellipsoid, subcylindrical, 3–16(–22)  $\times$  2–5(–6)  $\mu\text{m}$ , 0(–1)-septate, large conidia (ramo-conidia s. lat.) ellipsoid, subcylindrical to cylindrical, 8–33  $\times$  3–4  $\mu\text{m}$ , 0–1-septate, pale olivaceous, smooth or almost so to irregularly rough-walled, hila 1–2.5  $\mu\text{m}$  wide, occasionally microcyclic conidiogenesis occurring.

This collection was misidentified as '*Cladosporium oxysporum*' although the conidiophores are cylindrical, without any swellings. It agrees well with typical *C. cladosporioides* (sensu Ellis, 1971). Strains with somewhat rough-walled, verruculose conidiophores and conidia have been observed and described by various authors, e.g., Yamamoto (1959), Ellis (1971), Ho et al. (1999) and de Hoog et al. (2000).

***Cladosporium orchidearum*** Cooke & Masee, in Cooke, *Grevillea* 16(79): 80 (1888). – Fig. 4.

Material examined. – Great Britain: Surrey, Kew, Kew Gardens, H. Low's nursery, Borough of Richmond, on leaves of an orchid (*Oncidium crispum*) (NY 72454, holotype).

Illustration: Ellis (1976: 339, Fig. 257 B).

On living leaves, distinct leaf spots lacking. – Colonies hypophyllous, punctiform, in small tufts, scattered to dense, dark olivaceous-brown. Mycelium immersed, subcuticular, hyphae sparingly branched, 2–4.5  $\mu\text{m}$  wide, septate, not to slightly constricted at the septa, sometimes with small swellings, up to 7  $\mu\text{m}$  wide, subhyaline, pale olivaceous to pale brown, smooth, walls not or only slightly thickened. Stromata 25–65  $\mu\text{m}$  diam., composed of subcircular to somewhat angular or oblong cells, 5–11  $\mu\text{m}$  wide, pale to medium brown, walls slightly thickened. – Conidiophores solitary or in small fascicles, arising from stromata, mostly emerging through stromata, or erupting through the cuticle, erect, straight to slightly flexuous, sometimes somewhat geniculate-sinuuous, unbranched, occasionally branched, 20–75  $\times$  (3–)4–6  $\mu\text{m}$ , 0–3-septate, pale to medium olivaceous-brown, smooth, walls not or only very slightly thickened, not or somewhat swollen at the base, up to 7  $\mu\text{m}$  wide. – Conidiophores reduced to conidiogenous cells or conidiogenous cells integrated, terminal, 20–45  $\mu\text{m}$  long, proliferation sympodial, with one to several conidiogenous loci, often crowded at the apex, loci subdenticulate to denticulate, protuberant, truncate to slightly convex, 1.5–2.5  $\mu\text{m}$  wide, slightly thickened, darkened-refractive. – Conidia catenate, usually in branched chains, ellipsoid, ovoid, subcylindrical, 5–20  $\times$  4–7  $\mu\text{m}$ , 0–3-septate, not to slightly constricted at the septa, pale olivaceous, almost smooth to usually verruculose, walls only slightly thickened, somewhat attenuated towards apex and base, with up to three scars at the apex, hila truncate to slightly convex, 1–2(–2.5)  $\mu\text{m}$  wide, thickened, darkened-refractive.

*Cladosporium orchidearum* is only known from the type material; several collections from BPI identified as '*C. orchidearum*' proved to be misidentified and have to be referred to other taxa or they have to be described as new species. *C. orchidearum* belongs into a complex of foliicolous *Cladosporium* species with consistently short conidiophores, but differs in having narrower conidiophores (3–10  $\mu\text{m}$  wide in *C. agoseridis*; 3–8  $\mu\text{m}$  in *C. lupiniphilum*) and smaller, above all narrower conidia, respectively [(6.5–)12–26(–31)  $\times$  4–8  $\mu\text{m}$  in *C. praecox*; (10–)12–30(–50)  $\times$  (5–)6–13(–15)  $\mu\text{m}$  in *C. ago-*

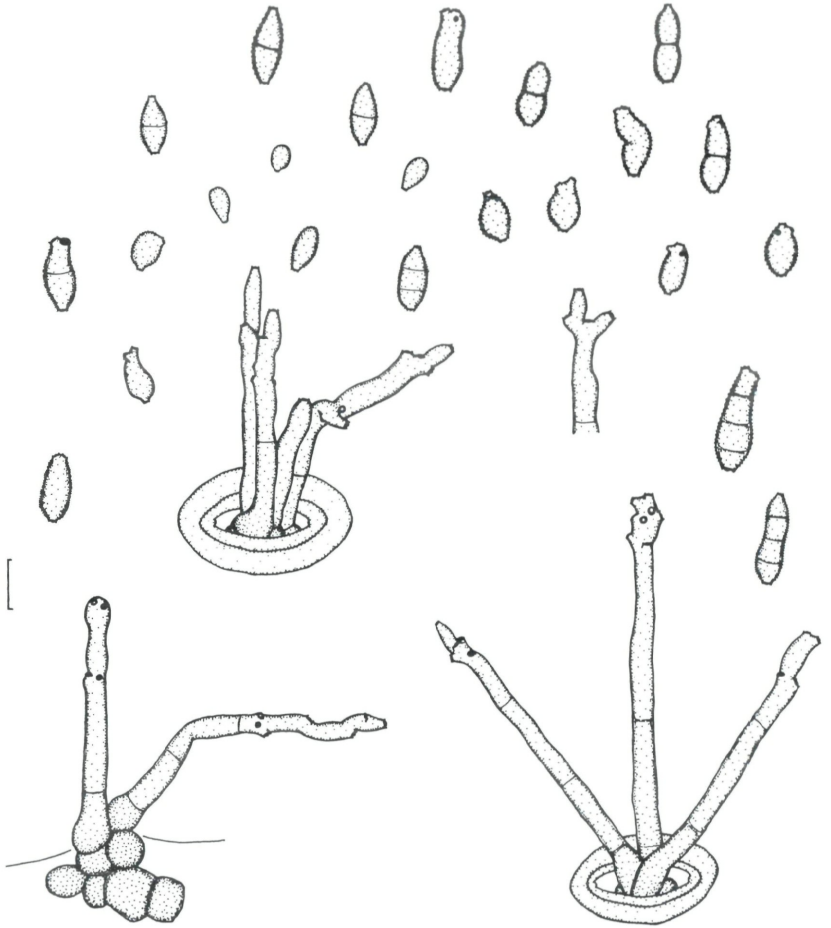


Fig. 4. – *Cladosporium orchidearum*. – Conidiophores and conidia from the type material. – Bar = 10  $\mu$ m.

*seridis*; 6–28  $\times$  4–8  $\mu$ m in *C. lupiniphilum*] (Braun & Rogerson, 1995; Braun, 1998, 2000).

***Cladosporium orchidiphilum* K. Schub. & U. Braun, sp. nov.** – Fig. 5.

Material examined. – Australia: Canterbury, on a leaf of *Cypripedium* sp., 19 Aug. 1914 (VPRI 2488, holotype, as '*C. orchidearum*').

*Differt a C. orchidearum conidiophoris 50–175  $\mu$ m longis, pluriseptatis, subnodulosis, saepe annellatis (percurrentibus), locis et hilis 0.5–1.5  $\mu$ m diam.*

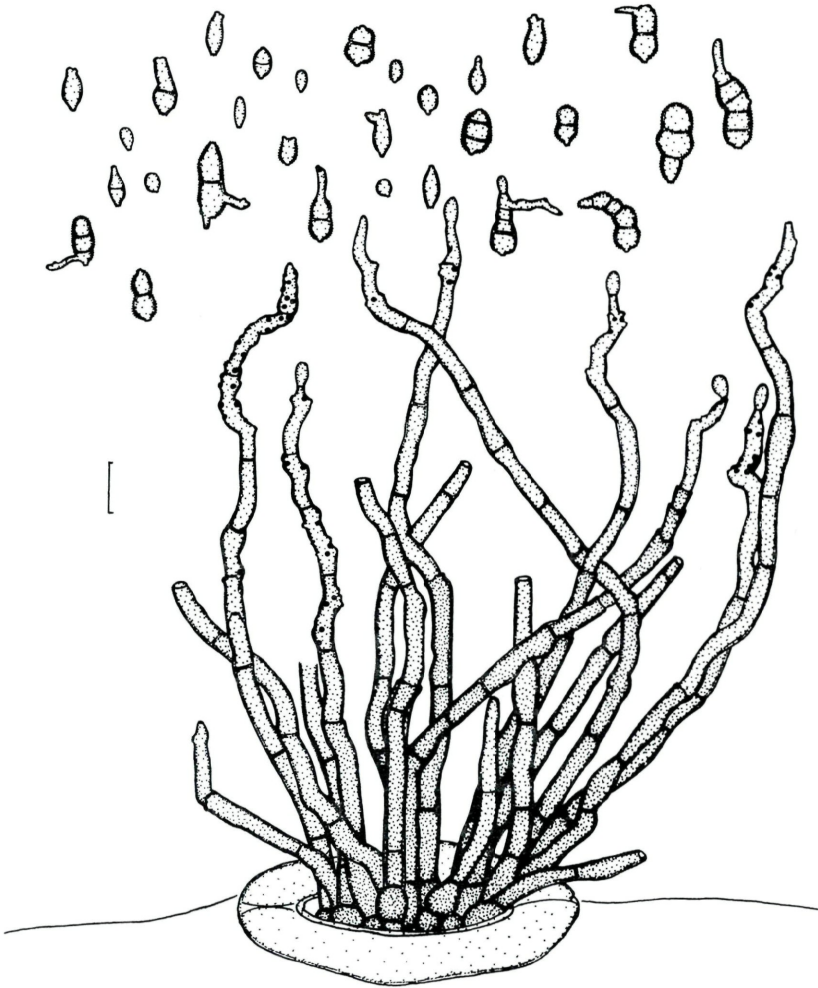


Fig. 5. – *Cladosporium orchidiphilum* sp. nov. – Conidiophore fascicle emerging through a stoma and conidia from the type material. – Bar = 10  $\mu$ m.

On living leaves, causing leaf spots, irregular in shape, on the upper leaf surface with a greyish centre, surrounded by a dark reddish brown margin, on the lower leaf surface more or less zonate, with a pale greyish brown centre, surrounded by dark red-brown and pale reddish brown segments, partly surrounded by a narrow dark red-brown margin and a pale to dark reddish brown halo. – Colonies hypophyllous, punctiform, in small tufts, scattered, blackish brown. Mycelium internal, hyphae sparingly branched, 2–4  $\mu$ m wide, septate, often slightly constricted at the septa, cells sometimes slightly swollen, pale olivaceous to pale olivaceous-



brown, smooth, walls slightly thickened. – Stromata dense, small to large, substomatal, subcuticular to intraepidermal, 35–75(–100)  $\mu\text{m}$  diam., composed of subglobose to somewhat angular or irregular, thick-walled cells, up to 13  $\mu\text{m}$  wide, medium to dark brown, smooth. – Conidiophores mostly densely fasciculate, arising from stromata, emerging through stomata or erumpent through the cuticle, more or less erect, straight to flexuous, often somewhat geniculate-sinuuous, nodulose, but swellings not connected with any conidiogenous loci (scars), mostly unbranched, rarely branched, 50–175  $\times$  (2.5–)3–6  $\mu\text{m}$ , pluriseptate, medium brown, paler towards the apex, smooth, thick-walled, somewhat attenuated towards the apex, often with percurrent proliferations (annellate), which are not connected with conidiogenesis. – Conidiogenous cells integrated, terminal or intercalary, 12–35  $\mu\text{m}$  long, with numerous, often crowded conidiogenous loci, somewhat nodulose, loci sub-denticulate, more or less protuberant, 0.5–1.5  $\mu\text{m}$  wide, slightly thickened, darkened-refractive. – Conidia catenate, in unbranched or branched chains, straight to curved, subglobose, ovoid, ellipsoid to somewhat irregular in shape, 3–15(–19)  $\times$  2–5(–7)  $\mu\text{m}$ , 0–3(–4)-septate, not to constricted at the septa, usually very pale to pale brown, rarely somewhat darker, pale medium brown, smooth to minutely verruculose, thick-walled, apex rounded or attenuated, often with one or several apical hila, hila protuberant, truncate to slightly convex, 0.5–1.5  $\mu\text{m}$  wide, slightly thickened, somewhat darkened-refractive, microcyclic conidiogenesis occurring.

*Cladosporium orchidearum* is a similar species, but easily distinguishable by having shorter, 0–3-septate, non-percurrent conidiophores, without swellings and wider loci and hila, (1–)1.5–2.5  $\mu\text{m}$ ; microcyclic conidiogenesis does not occur (Ellis, 1971). The identity of the host plant is not quite clear. *Cypripedium* spp. are not native in Australia, and they are not commercially grown. The cultivation of these orchids is very difficult, and they are generally only found in specialist hobby orchid collections. Confusion with commercially grown *Paphiopedilum* or *Phragmipedium* spp. is possible (C. F. Hill, in litt.).

***Cladosporium oxysporum*** Berk. & M. A. Curtis, in Berkeley, J. Linn. Soc., Bot. 10: 362 (1869).

Material examined. – From Mexico, intercepted at Laredo, Texas, USA, by Cary, on *Oncidium* sp., 13 Apr. 1954, det. A. H. Lewis (BPI 427293, as '*C. orchidearum*').

This collection is characterised as follows: Colonies hypophyllous, punctiform, scattered, greyish brown. – Conidiophores

arising from stromatic hyphal aggregations, unbranched or rarely branched,  $33\text{--}200 \times 3\text{--}5\text{--}(7) \mu\text{m}$ , septate, pale to medium olivaceous-brown, paler towards the apex, smooth, distinctly nodulose, with terminal and intercalary swellings, up to  $7 \mu\text{m}$  wide, which are connected with conidiogenesis, i.e., with a single or only few conidiogenous loci,  $1\text{--}1.5\text{--}(2) \mu\text{m}$  wide, occasionally percurrent. – Conidia catenate, subglobose, ovoid, limoniform, ellipsoid, subcylindrical,  $4\text{--}18 \times 3\text{--}6 \mu\text{m}$ ,  $0\text{--}1\text{--}(2)$ -septate, very pale to pale olivaceous, smooth or almost so, hila conspicuous, slightly convex,  $1\text{--}1.5 \mu\text{m}$  wide.

This collection agrees well with the species concept of *C. oxysporum* (Ellis, 1971; McKemy & Morgan-Jones, 1991; David, 1997; Ho et al., 1999).

***Cladosporium rectangulare*** K. Schub. & U. Braun, **sp. nov.** – Fig. 6.

Material examined. – From England, intercepted at Hoboken, New Jersey, USA, on still living and fading leaves of *Epidendrum prismatocarpum*, 29 Sept. 1941, D. P. Limber (BPI 427292, holotype, as '*C. orchidearum*').

*Differt a C. cladosporioides conidiophoris saepe ramosis, rectangularibus, erectis vel decumbentibus, leniter geniculatis-sinuosis.*

On leaves, forming crustaceous, stromatic layers, effuse, dark brown to black. Mycelium internal. – Conidiophores solitary, erect to decumbent, straight to flexuous, at first unbranched, later repeatedly characteristically branched, right-angled, somewhat geniculate-sinuuous,  $25\text{--}125 \times 2.5\text{--}4(5) \mu\text{m}$ , sometimes longer, attenuated towards the apex, septate, septa not very conspicuous, olivaceous-brown to somewhat reddish brown, paler towards the apex, smooth, walls only slightly thickened. – Conidiogenous cells integrated, terminal and intercalary, cylindrical,  $8\text{--}28 \mu\text{m}$  long, proliferation sympodial, with few subdenticulate, protuberant conidiogenous loci,  $0.5\text{--}1.5 \mu\text{m}$  wide, slightly thickened and darkened-refractive. – Conidia catenate, often in branched chains, straight, small conidia (without or only with a single apical hilum) subglobose, ovoid, obovoid, limoniform, ellipsoid,  $2.5\text{--}9 \times 2\text{--}4\text{--}(5) \mu\text{m}$ , aseptate, large conidia (ramo-conidia s. lat.) ovoid, ellipsoid, subcylindrical to cylindrical,  $5\text{--}33 \times 2.5\text{--}5\text{--}(6) \mu\text{m}$ ,  $0\text{--}(1)$ -septate, pale to medium olivaceous-brown or somewhat reddish brown, almost smooth to verruculose, walls only slightly thickened, apex rounded or slightly attenuated towards apex and base, hila protuberant,  $0.5\text{--}1.5 \mu\text{m}$  wide, somewhat thickened and darkened-refractive, microcyclic conidiogenesis often occurring (with conidia forming secondary conidiophores and secondary conidia).

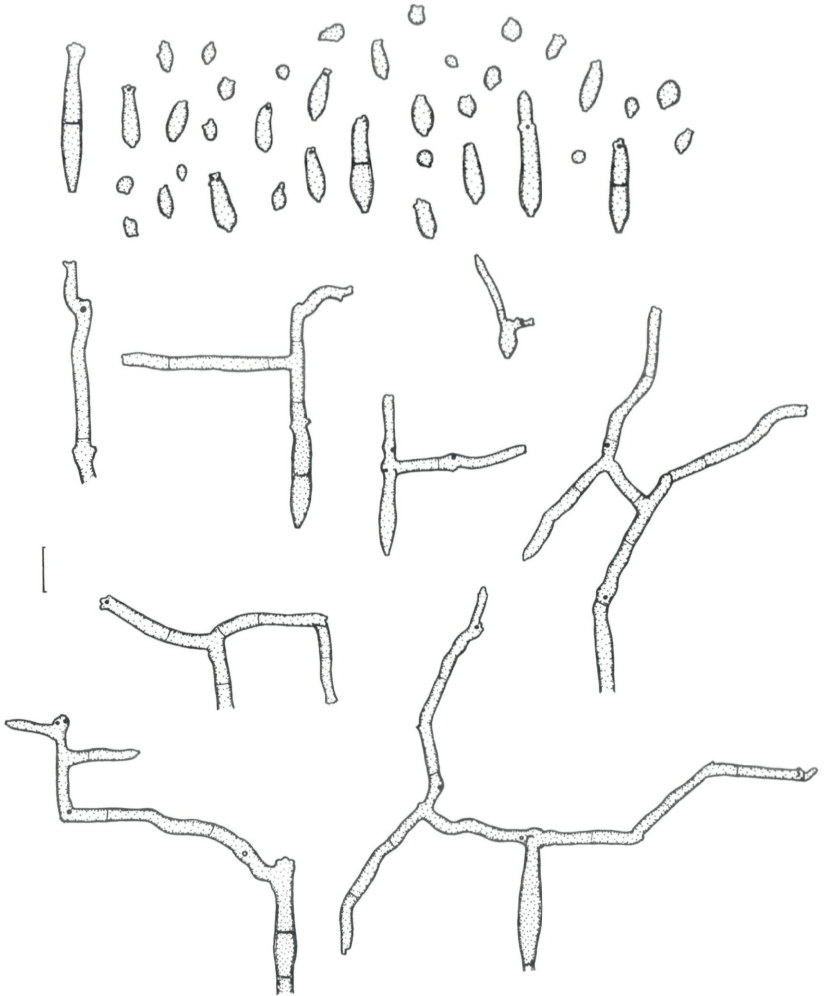


Fig. 6. – *Cladosporium rectangulare* sp. nov. – Conidiophores and conidia from the type material. – Bar = 10  $\mu$ m.

These characteristic features could also be observed in a small dried culture added to this collection. There are no differences between the collections in vitro and in vivo with regard to colour, septation, ramification and length, although these features are often variable in cultures of *Cladosporium* species. The distinctive right-angled branched and erect to decumbent, geniculate-sinuous conidiophores segregate this new species from the superficially similar *Cladosporium cladosporioides* and allied taxa.



***Cladosporium stanhopeae*** Allesch., Hedwigia 34: 221 (1895). – Fig. 7.

Material examined. – Germany: Bavaria, Munich, botanical garden, on faded leaves of *Stanhopea* sp., Sept. 1894, Allescher (M-57717, holotype).

On faded leaves, leaf spots amphigenous, varying in shape and size, mostly irregular, medium to dark brown, sometimes almost blackish, sometimes somewhat shiny. – Colonies hypophyllous, small, punctiform, scattered, greyish brown. Mycelium internal, hyphae sparingly branched, 1.5–3  $\mu\text{m}$  wide, septate, subhyaline to pale yellowish brown, walls unthickened to slightly thickened. – Stromata dense, often large, up to 130  $\mu\text{m}$  diam., composed of subcircular to somewhat angular cells, 4–12  $\mu\text{m}$  wide, medium to dark brown, smooth, walls only slightly thickened. – Conidiophores solitary or in loose small fascicles, arising from stromata, erumpent through the cuticle, erect, usually more or less flexuous, unbranched, up to 250  $\mu\text{m}$  long, 3–5.5  $\mu\text{m}$  wide, septate, pale to medium brown, slightly paler towards the apex, smooth, walls thickened, somewhat attenuated towards the apex, without swellings. – Conidiogenous cells integrated, terminal or intercalary, 5–25  $\mu\text{m}$  long, with a single or only few conidiogenous loci, arranged on about the same level (like a garland), rarely at small swellings, loci 1–2  $\mu\text{m}$  wide, thickened, only slightly darkened-refractive. – Conidia catenate, in branched chains, subglobose, ovoid, obovoid, ellipsoid, subcylindrical to cylindrical, 2–25  $\times$  2–6  $\mu\text{m}$ , 0–4(–5)-septate, not to slightly constricted at the septa, pale olivaceous to pale olivaceous-brown, smooth or almost so to verruculose, walls unthickened to somewhat thickened, apex rounded or with up to six apical hila, truncate to slightly convex at the base, hila 0.5–2  $\mu\text{m}$  wide, thickened, somewhat darkened-refractive, occasionally with microcyclic conidiogenesis.

*Cladosporium herbarum*, *C. oxysporum* and *C. sphaerospermum* Penz., widespread saprobic species occurring on a wide range of substrates, are easily distinguishable from *C. stanhopeae*. The conidia of *C. oxysporum* are smooth and only 0–1(–2)-septate, the conidiophores are consistently nodulose. *C. herbarum* differs in having conidiophores with intercalary and terminal swellings, which are connected with conidiogenesis, and verruculose to verrucose conidia (small subglobose conidia absent). *C. sphaerospermum* forms small conidia which are globose to subglobose and distinctly verrucose, as well as 0–3-septate, smooth or verruculose ramo-conidia (s. lat.), and the conidiophores do not have any swellings.



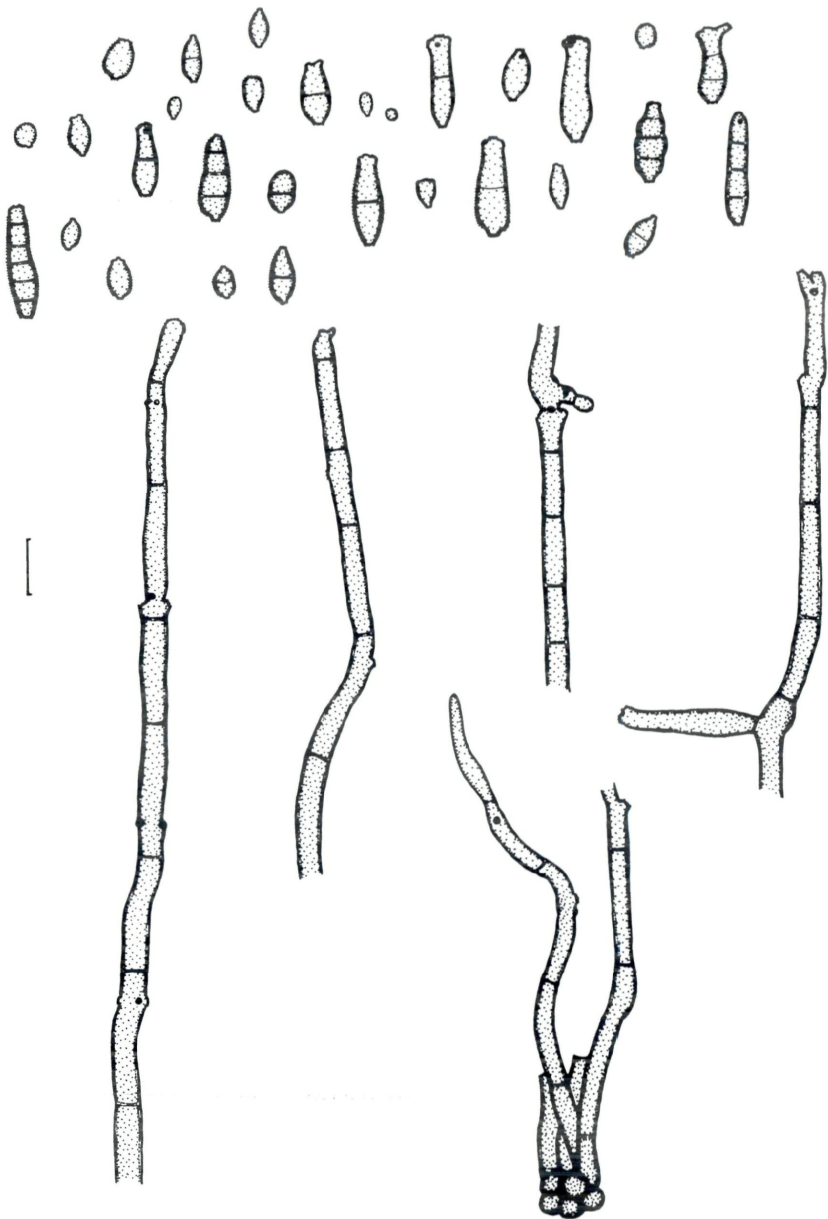


Fig. 7. - *Cladosporium stanhopeae*. - Conidiophores and conidia from the type material. - Bar = 10  $\mu$ m.

***Dendryphiella vinosa*** (Berk. & M.A. Curtis) Reisinger, Bull. Soc. Mycol. France 84(1): 27 (1968).

- ≡ *Helminthosporium vinosum* Berk. & M.A. Curtis, in Berkeley, J. Linn. Soc. Bot. 10(46): 361 (1869), as '*Helmisporium*'.
- ≡ *Dendryphion vinosum* (Berk. & M.A. Curtis) S. Hughes, Canad. J. Bot. 36: 761 (1958).
- = *Helminthosporium granulatum* Berk. & M.A. Curtis, in Berkeley, J. Linn. Soc. Bot. 10(46): 361 (1869).
- ≡ *Heterosporium granulatum* (Berk. & M.A. Curtis) Cooke, Grevillea 5: 123 (1877).
- = *Helminthosporium molle* Berk. & M.A. Curtis, in Berkeley, J. Linn. Soc. Bot. 10(46): 361 (1869).
- = *Helminthosporium fuscum* Fuckel, Jahrb. Nassauischen Vereins Naturk. 27–28: 78 (1873–1874).
- = *Helminthosporium interseminatum* Berk. & Ravenel, in Berkeley, Grevillea 3: 103 (1875), as '*Helmisporium*'.
- ≡ *Heterosporium interseminatum* (Berk. & Ravenel) G. F. Atk., Cornell Univ. Sci. Bull. 3(1): 48 (1897).
- ≡ *Dendryphiella interseminata* (Berk. & Ravenel) Bubák & Ranoj., Ann. Mycol. 12: 417 (1914).
- ≡ *Curvularia interseminata* (Berk. & Ravenel) J.C. Gilman, Manual Soil Fungi: 303 (1945).
- ≡ *Dendryphion interseminatum* (Berk. & Ravenel) S. Hughes, Canad. J. Bot. 31: 638 (1953).
- = *Helminthosporium urticae* Peck, Annual Rep. New York State Mus. 28: 62 (1876).
- = *Dendryphion nodulosum* Sacc., Michelia 1: 81 (1877).
- ≡ *Brachycladium nodulosum* (Sacc.) A.L. Smith, J. Bot. Lond. 41: 259 (1903).
- = *Heterosporium sambuci* Earle, Bull. Torrey Bot. Club 24(1): 30 (1897).
- = *Heterosporium repandum* Ferd. & Winge, Bot. Tidsskr. 29: 23 (1908).
- = *Heterosporium dalmaticum* Jaap, Ann. Mycol. 14: 43 (1916).
- = *Cladosporium cattleyae* Verpl., Meded. Landbouwhoogeschool Opzoekingsstat. Staat Gent 3: 103 (1935), **syn. nov.**

Material examined. – Belgium: Antwerp, botanical garden, on dead leaves of *Cattleya mossia*, 12 Mar. 1935 (GENT, holotype of *C. cattleyae*).

Illustration: Ellis (1971: 499, Fig. 358).

Description based on type material of *Cladosporium cattleyae*: Leaf spots punctiform, brown to blackish, somewhat raised. – Colonies epiphyllous on small, punctiform, brown to blackish, raised spots, caespitose, effuse, dense, villose, dark brown. Mycelium immersed. – Conidiophores macronematous, mononematous, arising from stromata, erumpent through the cuticle, erect, straight to flexuous, unbranched or branched, 4.5–6.5 µm wide, septate, medium reddish brown, paler towards the apex, very pale at the apex, sometimes subhyaline, smooth to verruculose, thick-walled, terminal and intercalary with conidiogenous nodulose swellings, up to 10 µm wide, sometimes with percurrent proliferations which are not connected with conidiogenesis. – Conidiogenous cells integrated, terminal as well as intercalary, conidiogenesis enteroblastic,

polytretic, proliferation sympodial, cicatrised, conidiogenous loci convex, 2.5–4  $\mu\text{m}$  wide, thickened and darkened-refractive with a central, small pale pore. – Conidia solitary or in unbranched chains, broadly ellipsoid to cylindrical, oblong, 12–30(–35)  $\times$  6–10.5  $\mu\text{m}$ , (1–)3(–4)-septate, not to slightly constricted at the septa, pale to mostly red-brown (burnt sienna), smooth to verrucose, thick-walled, rounded at the ends, hila convex, 2.5–4  $\mu\text{m}$  wide, thickened and darkened, with a central pale pore.

On the dead leaves of *Cattleya* this species occurs together with a second, non-identified hyphomycete which forms dark to blackish brown setae arising from more or less extended stromatic layers. The type collection of *Cladosporium cattleyae* agrees well with *Dendryphiella vinosa* (Ellis, 1971) and has to be reduced to synonymy with the latter species. In the original description (Verplancke, 1935) two additional hosts are mentioned, viz., *Cattleya sladdenii* and *C. labiata*.

***Fusicladium orchidis*** (E.A. Ellis & M. B. Ellis) K. Schub. & U. Braun, **comb. nov.** – Fig. 8.

= *Cladosporium orchidis* E.A. Ellis & M.B. Ellis, in M.B. Ellis, Mycol. Pap. 131: 17 (1972).

Material examined. – Great Britain: Norfolk, Horsey Warren, on living leaves of *Orchis praetermissa* (= *Dactylorhiza majalis* subsp. *praetermissa*), 17 Jul. 1955, E. A. Ellis (IMI 60545, holotype).

Illustration: Ellis (1972: 18, Fig. 17; 1976: 339, Fig. 257 A).

Leaf spots amphigenous, subcircular, oval to irregular, 6–20 mm wide, on the upper leaf surface dark blackish brown, on the lower leaf surface paler, greyish brown, often somewhat dendritic at the margin, without a specific margin, later confluent and covering large areas of the leaf surface. – Colonies epiphyllous, sparsely villose, olivaceous-brown to dark brown. Mycelium partly immersed, subcuticular and partly superficial, hyphae branched, (1–)3–10  $\mu\text{m}$  wide, septate, not to slightly constricted at the septa, subhyaline, olivaceous-brown to brown, smooth, walls thickened, often forming swollen hyphal cells, up to 12  $\mu\text{m}$  wide. Stromata absent. – Conidiophores solitary or in small groups, arising as lateral or terminal branches from hyphae or from swollen hyphal cells, erect, straight to somewhat flexuous, unbranched or rarely branched, 30–100  $\times$  (3–)3.5–7(–8)  $\mu\text{m}$ , septate, olivaceous-brown to brown, paler towards the apex, smooth, walls thickened, often somewhat swollen at the base, up to 11  $\mu\text{m}$  wide, often with percurrent proliferations, which are not connected with conidiogenesis. – Conidiogenous

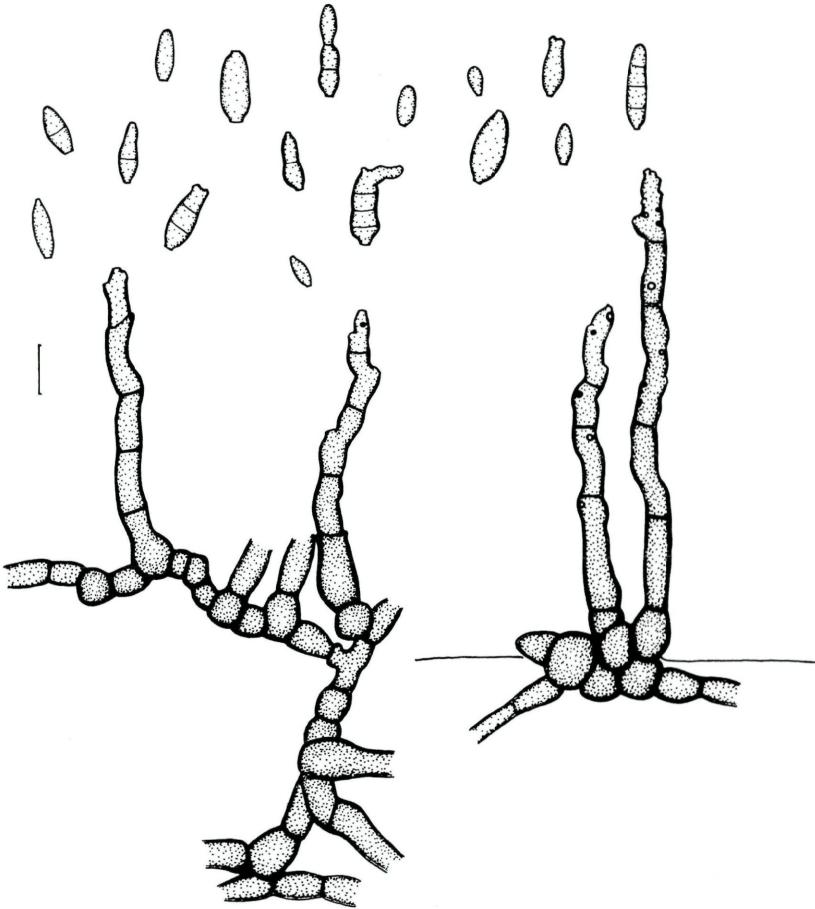


Fig. 8. – *Fusicladium orchidis*. – Conidiophores and conidia from the type material.  
– Bar = 10  $\mu\text{m}$ .

cells integrated, terminal or intercalary, 8–30  $\mu\text{m}$  long, proliferation sympodial, with a single to several conidiogenous loci, loci often crowded at the apex, subdenticulate, flat, truncate, planate, 1.5–2(–3)  $\mu\text{m}$  wide, not or only very slightly thickened and darkened-refractive. – Conidia catenate, in unbranched or branched chains, subcylindrical, ellipsoid to somewhat fusiform and doliiform, 6–17  $\times$  3–7  $\mu\text{m}$ , 0–3-septate, not to slightly constricted at the septa, subhyaline, pale brown to olivaceous-brown, smooth, walls slightly thickened, apex rounded or truncate with one to three hila, truncate at the base, hila 1–2(–3)  $\mu\text{m}$  wide, not or only very slightly thickened, somewhat darkened-refractive.



On account of the denticle-like, truncate, unthickened conidiogenous loci, this species has to be assigned to *Fusicladium* emend. (Schubert et al., 2003). This is the first member of *Fusicladium* on a host belonging to the Orchidaceae. It is well distinguished from allied taxa with catenate conidia by having 0–3-septate conidia [usually aseptate in *F. asperatum* and *F. carpineum* (Ellis & Everh.) U. Braun & K. Schub.; 0–1-septate in *F. byrsonimatis* (U. Braun & Mouch.) U. Braun and *F. carpophilum*], pluriseptate, longer and partly wider conidiophores [0–1(–2)-septate, (10–)20–40(–60) × (3–)4–6(–7) µm in *F. cerasi*; 0–2-septate, 20–54(–80) × (3.5–)4–5(–6) µm in *F. crataegi*] and smaller conidia, respectively [(8.5–)10–24 × 5–10 µm in *F. effusum*; 10–22(–40) × 3–6 µm in *F. euphorbiae*; 10–29 × 4–7 µm in *F. humile*] (Schubert et al., 2003).

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