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Opportunistic, human-pathogenic species in the *Herpotrichiellaceae* are phenotypically similar to saprobic or phytopathogenic species in the *Venturiaceae*

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Abstract: Although morphologically similar, species of *Cladophialophora* (*Herpotrichiellaceae*) were shown to be phylogenetically distinct from *Pseudocladosporium* (*Venturiaceae*), which was revealed to be synonymous with the older genus, *Fusicladium*. Other than being associated with human disorders, species of *Cladophialophora* were found to also be phytopathogenic, or to occur as saprobes on organic material, or in water, fruit juices, or sports drinks, along with species of *Exophiala*. *Caproventuria* and *Metacoleroa* were confirmed to be synonyms of *Venturia*, which has *Fusicladium* (= *Pseudocladosporium*) anamorphs. *Apiosporina*, based on *A. collinsii*, clustered basal to the *Venturia* clade, and appears to represent a further synonym. Several species with a pseudocladosporium-like morphology *in vitro* represent a sister clade to the *Venturia* clade, and are unrelated to *Polyscytalum*. These taxa are newly described in *Fusicladium*, which is morphologically close to *Anungitea*, a heterogeneous genus with unknown phylogenetic affinity. In contrast to the *Herpotrichiellaceae*, which were shown to produce numerous synanamorphs in culture, species of the *Venturiaceae* were morphologically and phylogenetically more uniform. Several new species and new combinations were introduced in *Cladophialophora, Cyphellophora* (*Herpotrichiellaceae*), *Exophiala*, *Fusicladium, Venturia* (*Venturiaceae*), and *Cylindrosympodium* (*incertae sedis*).

Taxonomic novelties: *Cladophialophora australiensis* Crous & A.D. Hocking, sp. nov., *Cladophialophora chaetospira* (Grove) Crous & Arzanlou, comb. nov., *Cladophialophora hostae* Crous, U. Braun & H.D. Shin, sp. nov., *Cladophialophora humicola* Crous & U. Braun, sp. nov., *Cladophialophora potulentorum* Crous & A.D. Hocking, sp. nov., *Cladophialophora scillae* (Deighton) Crous, U. Braun & K. Schub., comb. nov., *Cladophialophora sylvestris* Crous & de Hoog, sp. nov., *Cylindrosympodium lauri* Crous & R.F. Castañeda, sp. nov., *Cyphellophora hylomeconis* Crous, de Hoog & H.D. Shin, sp. nov., *Exophiala eucalyptorum* Crous, sp. nov., *Fusicladium africanum* Crous, sp. nov., *Fusicladium amoenum* (R.F. Castañeda & Dugan) Crous, K. Schub. & U. Braun, comb. nov., *Fusicladium brevicatenatum* (U. Braun & Feiler) Crous, U. Braun & K. Schub., comb. nov., *Fusicladium fagi* Crous & de Hoog, sp. nov., *Fusicladium intermedium* (Crous & W.B. Kendr.) Crous, comb. nov., *Fusicladium matsushimae* (U. Braun & C.F. Hill) Crous, U. Braun & K. Schub., comb. nov., *Fusicladium pini* Crous & de Hoog, sp. nov., *Fusicladium ramoconidii* Crous & de Hoog, sp. nov., *Fusicladium rhodense* Crous & M.J. Wingf., sp. nov., *Venturia hystrioides* (Dugan, R.G. Roberts & Hanlin) Crous & U. Braun, comb. nov.
Key words: *Anungitea*, *Anungitopsis*, *Cladophialophora*, *Exophiala*, *Fusicladium*, phylogeny, *Pseudocladosporium*, systematics, *Venturia*.

INTRODUCTION

Species of *Cladophialophora* Borelli are relatively simple hyphomycetes with brown hyphae that give rise to branched chains of pale brown conidia. Phylogenetically they are defined to belong to the *Chaetothyriales* (Haase *et al*. 1999, Untereiner 2000), an order containing numerous opportunists (de Hoog *et al*. 2000); teleomorph relationships are with *Capronia* Sacc. in the *Herpotrichiellaceae*. In several cases cladophialophora-like synanamorphs are found accompanying black yeasts of the genus *Exophiala* J.W. Carmich. (de Hoog *et al*. 1995). Braun & Feiler (1995) placed several saprobic hyphomycetes in *Cladophialophora*, and described *Capronia hanliniana* U. Braun & Feiler as teleomorph of *Cladophialophora brevicatenata* U. Braun & Feiler. This work was continued by Dugan *et al*. (1995), who described an additional teleomorph, *Capronia hystrioides* Dugan, R.G. Roberts & Hanlin for *Cladophialophora hachijoensis* (Matsush.) U. Braun & Feiler. Untereiner (1997) reduced *Capronia hystrioides* to synonymy with *C. hanliniana*, and placed them in *Venturia* Sacc. (*Venturiaceae, Pleosporales*). The concept of *Cladophialophora hachijoensis*, which is based on *Phaeoramularia hachijoensis* Matsush. (Matsushima 1975) is confused, however, and phylogenetic studies have revealed that isolates attributed to this name in recent studies, were in fact representatives of three different species in phylogenetically distinct genera (Braun *et al*. 2003). The separation of *Cladophialophora* with *Capronia* teleomorphs (*Herpotrichiellaceae, Chaetothyriales*; commonly isolated as human pathogens), from predominantly saprobic or phytopathogenic isolates in the *Dothideomycetes* was recognised by Braun (1998). Recently the cactus endophyte *Cladophialophora yegresii* de Hoog was reported to be the nearest neighbour of *C. carrionii* (Trejos) de Hoog *et al*., a major agent of human chromoblastomycosis (de Hoog *et al*. 2007), so that the main distinction between the two anamorph genera remains in their phylogenetic positions. *Capronia hanliniana* and *C. hystrioides* were again recognised as distinct species, and placed in a new genus, *Caproventuria* U. Braun (*Venturiaceae*), while their anamorphs were accommodated in *Pseudocladosporium* U. Braun. *Caproventuria* was primarily distinguished from *Venturia* based on its distinct *Pseudocladosporium* anamorphs. Recently, Crous *et al*. (2007b) introduced a third genus, namely *Sympoventuria* Crous & Seifert, which produces a sympodiella-like anamorph in culture. To complicate matters further, Beck *et al*. (2005) concluded, based on an ITS DNA phylogeny, that the morphology attributed to the form genera *Spilocaea* Fr., *Pollaccia* E. Bald. & Cif., and *Fusicladium* Bonord. has evolved several times within *Venturia*, and that a single anamorph genus should be used for *Venturia*, namely *Fusicladium* (see Schubert *et al*. 2003 for additional generic synonyms).

In their treatment of *Venturia* anamorphs, Schubert *et al*. (2003) excluded *Pseudocladosporium*, and stated that its status needs to be confirmed along with that of other genera such as *Anungitea* B. Sutton, *Fusicladium* and *Polyscytalum* Riess. In the study by Beck *et al*. (2005) an isolate of *Caproventuria hystrioides* (*Pseudocladosporium* sp.) was included to confirm the link to the *Venturiaceae*, though this was not well resolved, nor was the status of the older generic names mentioned above addressed.

The aim of the present study, therefore, was to use DNA sequence comparisons in conjunction with morphology in an attempt to clarify these generic issues, as well as to determine which morphological characters could be used to distinguish *Pseudocladosporium* from *Cladophialophora*.

MATERIALS AND METHODS

Isolates

Cultures were obtained from the Centraalbureau voor Schimmelcultures (CBS) in Utrecht, the Netherlands, or isolated from plant material incubated in moist chambers to promote sporulation. Isolates were cultured on 2 % malt extract plates (MEA; Gams *et al*. 2007), by obtaining single conidial colonies as explained in Crous (2002). Colonies were subcultured onto fresh MEA, oatmeal agar (OA), potato-dextrose agar (PDA) and synthetic nutrient-poor agar (SNA) (Gams *et al*. 2007), and incubated at 25 °C under continuous near-ultraviolet light to promote sporulation.

DNA extraction, amplification and phylogeny

Fungal colonies were established on agar plates, and genomic DNA was isolated following the CTAB-based protocol described in Gams *et al*. (2007). The primers V9G (de Hoog & Gerrits van den Ende 1998) and LR5 (Vilgalys & Hester 1990) were used to amplify part (ITS) of the nuclear rDNA operon spanning the 3' end of the 18S rRNA gene (SSU), the first internal transcribed spacer (ITS1), the 5.8S rRNA gene, the second ITS region and the 5' end of the 28S rRNA gene (LSU). Four internal primers, namely ITS4 (White *et al*. 1990), LR0R (Rehner & Samuels 1994), LR3R (www.biology.duke.edu/fungi/mycolab/primers.htm), and LR16 (Moncalvo *et al*. 1993), were used for sequencing to ensure good quality overlapping sequences were obtained. The PCR conditions, sequence alignment and subsequent phylogenetic analysis followed the methods of Crous *et al*. (2006a). The ITS1, ITS2 and 5.8S rRNA gene were only sequenced for isolates of which these data were not available. The ITS data were not included in the analyses but deposited in GenBank where applicable. Gaps longer than 10 bases were coded as single events for the phylogenetic analyses; the remaining gaps were treated as missing data. Sequence data were deposited in GenBank (Table 1) and alignments in TreeBASE (www.treebase.org).

Taxonomy

Structures were mounted in lactic acid, and 30 measurements (× 1 000 magnification) determined wherever possible, with the extremes of spore measurements given in parentheses. Colony colours (surface and reverse) were assessed after 2–4 wk on OA and PDA at 25 °C in the dark, using the colour charts of Rayner (1970). All cultures obtained in this study are maintained in the CBS collection (Table 1). Nomenclatural novelties and descriptions were deposited in MycoBank (www.MycoBank.org).

RESULTS

DNA phylogeny

Amplicons of approximately 1 700 bases were obtained for the isolates listed in Table 1. These sequences were used to obtain additional sequences from GenBank which were added to the alignment. The manually adjusted LSU alignment contained 116 sequences (including the two outgroup sequences) and 1 157 characters including alignment gaps (available in TreeBASE). Of the 830 characters used in the phylogenetic analysis, 326 were parsimony-informative, 79 were variable and parsimony-uninformative, and 425 were constant. Neighbour-joining analyses using three substitution models on the sequence data yielded trees with identical topologies to one another. The neighbour-joining trees support the same clades as obtained from the parsimony analysis, but with a different arrangement at the deep nodes, for example, the clade containing *Protoventuria alpina* (Sacc.) M.E. Barr (CBS 140.83) is placed as sister to the *Venturiaceae* using parsimony but basal to the *Herpotrichiellaceae* using neighbour-joining. Because of the large number of different strain associations in the *Venturia* clade (see the small number of strict consensus branches for this clade in Fig. 1), only the first 5 000 equally most parsimonious trees (TL = 1 752 steps; CI = 0.392; RI = 0.849; RC = 0.333) were saved, one of which is shown in Fig. 1.

Bayesian analysis was conducted on the same aligned LSU data set using a general time-reversible (GTR) substitution model with inverse gamma rates and dirichlet base frequencies. The Markov Chain Monte Carlo (MCMC) analysis of 4 chains started from a random tree topology and lasted 2 000 000 generations. Trees were saved each 1 000 generations, resulting in 2 000 saved trees. Burn-in was set at 500 000 generations after which the likelihood values were stationary, leaving 1 500 trees from which the consensus tree (Fig. 2) and posterior probabilities (PP's) were calculated. The average standard deviation of split frequencies was 0.06683 at the end of the run. The same overall topology as that observed using parsimony was obtained, with the exception of the position of *Anungitopsis speciosa* R.F. Castañeda & W.B. Kendr., which is placed between the *Leotiomycetes* and the *Sordariomycetes* based on the Bayesian analysis. Also, similar to the results obtained using neighbour-joining, the clade containing *Protoventuria alpina* (CBS 140.83) is placed as sister to the *Herpotrichiellaceae* and not to the *Venturiaceae*. The phylogenetic affinity of specific genera or species are discussed below.

Taxonomy

Several collections represented novel members of the *Herpotrichiellaceae* and *Venturiaceae*, and these are described below. Taxa that were cladophialophora- or pseudocladosporium-like, but that clustered elsewhere, are treated under excluded species.

Members of *Chaetothyriales, Herpotrichiellaceae*

Cladophialophora australiensis Crous & A.D. Hocking, **sp. nov.** MycoBank MB504525. Fig. 3.

Etymology: Named after its country of origin, Australia.

Cladophialophorae carrionii similis, sed conidiis secundis majoribus, (7–)8–12(–15) × 3–4 µm.

In vitro: *Mycelium* consisting of branched, septate, smooth, pale brown, guttulate, 2–3 µm wide hyphae; hyphal coils not seen. *Conidiophores* dimorphic; macroconidiophores mononematous, subcylindrical, multi-septate, straight to curved, up to 150 µm long (including conidiogenous cells), and 4 µm wide, pale to medium brown, smooth, guttulate; microconidiophores integrated with hyphae, which terminate in subcylindrical conidiogenous cells that give rise to branched chains of conidia; conidiophores (including

conidiogenous cells) up to 5-septate, 50 µm long, with terminal and lateral conidiogenous cells. *Conidiogenous cells* pale to medium brown, smooth, guttulate, terminal and lateral, subcylindrical, 20–35 × 2–3.5 µm, or reduced to indistinct subtruncate to truncate loci, scars up to 2 µm wide, mono- to polyblastic, proliferating sympodially, scars neither darkened, thickened, nor refractive. *Conidia* pale to medium brown, guttulate, smooth; ramoconidia subcylindrical, 0–1-septate, 20–35 × 2–3 µm, hila subtruncate, inconspicuous, up to 2 µm wide, giving rise to branched chains of conidia; conidia ellipsoid, pale brown, but becoming dark brown and thick-walled in older cultures, guttulate, tapering towards subtruncate terminal loci, 0–1-septate, occurring in chains of up to 20 conidia, (7–)8–12(–15) × 3–4 µm (older, dark brown conidia are ellipsoid, up to 5 µm wide).

Cultural characteristics: Colonies erumpent, somewhat spreading, margins crenate, feathery, aerial mycelium sparse; colonies on PDA olivaceous-grey to iron-grey (surface); reverse iron-grey; on OA and SNA olivaceous-grey. Colonies reaching 5 mm diam after 2 wk at 25 °C in the dark; colonies fertile. Not able to grow at 37 °C.

Specimen examined: **Australia**, isolated from apple juice, Dec. 1986, A.D. Hocking, **holotype** CBS H-19899, culture ex-type CBS 112793 = CPC 1377.

Notes: *Cladophialophora australiensis* is one of two novel species of *Cladophialophora* originally isolated from sports drinks in Australia. *Cladophialophora* spp. are commonly associated with human disorders (Honbo *et al*. 1984, de Hoog *et al*. 2000, Levin *et al*. 2004), and thus their occurrence in sports drinks is cause for concern. However, none of the new species described here had the ability to grow at 37 °C, and therefore it is not expected that they could pose a danger to humans. Comparing ITS diversity, the species shows more than 12 % difference to established pathogens such as *C. carrionii* and *C. bantiana* (Sacc.) de Hoog *et al.*

Cladophialophora chaetospira (Grove) Crous & Arzanlou, **comb. nov.** MycoBank MB504526. Fig. 4.

Basionym: *Septocylindrium chaetospira* Grove, J. Bot. Lond. 24: 199. 1886.

≡ *Septonema chaetospira* (Grove) S. Hughes, Naturalist, London 840: 9. 1952.

≡ *Heteroconium chaetospira* (Grove) M.B. Ellis, in Ellis, *More Dematiaceous Hyphomycetes*: 64. 1976.

In vitro: *Mycelium* consisting of branched, septate, smooth, medium brown hyphae, 2–3.5 µm wide. *Conidiophores* reduced to conidiogenous cells, or a single supporting cell, 20–40 × 3–4 µm. *Conidiogenous cells* subcylindrical, erect, straight to irregularly curved, medium brown, smooth, 15–30 × 3–4 µm. *Conidia* in branched, acropetal chains with up to 30 conidia; subcylindrical to fusiform, medium brown, smooth, tapering slightly at subtruncate ends, 1(–3)-septate, thin-walled, becoming slightly constricted at septa of older conidia, (20–)25–30(–45) × 3–4(–5) µm; conidia remaining attached in long chains; hila neither thickened, nor darkened-refractive.

Cultural characteristics: Colonies erumpent, convex, spreading, with sparse to dense aerial mycelium; margins smooth, undulate; on PDA iron-grey (surface), margins olivaceous-black; reverse olivaceous-black; on OA olivaceous-grey in the middle due to fluffy aerial mycelium, iron-grey in wide outer margin; on SNA olivaceous-grey. Colonies reaching 12 mm diam after 2 wk on PDA at 25 °C in the dark. Not able to grow at 37 °C.

Specimens examined: **China**, Yunnan, Yiliang, isolated from *Phyllostachys bambusoides* (*Gramineae*), decaying bamboo, freshwater, 6 Jul. 2003, L. Cai, CBS 114747; China, Yunnan, stream in Kunming, isolated from bamboo wood, 15 Jun. 2003, C. Lei, CBS 115468. **Denmark**, isolated from roots of *Picea abies* (*Pinaceae*), isol. by D.S. Malla, CBS 491.70. **Germany**, Schleswig-Holstein, Kiel-Kitzeberg, isolated from wheat field soil, isol. by W. Gams, CBS 514.63 = ATCC 16274 = MUCL 8310.

Notes: Two cultures of *Heteroconium chaetospira* were originally deposited as *Spadicoides minuta* L. Cai, McKenzie & K.D. Hyde (Cai *et al*. 2004), but later found to represent *Heteroconium chaetospira*, a species commonly found on rotting wood in Europe (Ellis 1976). The genus *Heteroconium* Petr. has in recent years been used to name leaf spotting fungi with chains of brown, disarticulating conidia (Crous *et al*. 2006b), which have phylogenetic affinities to several orders, obviously being polyphyletic. The type species of *Heteroconium*, *H. citharexyli* Petr., is a plant pathogen on *Cytharexylum* (Petrak 1949) with hitherto unknown phylogenetic position. The fact that *H. chaetospira* is linked to the *Chaetothyriales*, was rather unexpected. The species appears to be similar to others placed in *Cladophialophora* by having short, lateral conidiogenous cells, and long chains of branched subcylindrical conidia that largely remain attached. It is, however, quite distinct from other members of *Cladophialophora* in having medium brown conidia, and in lacking the ellipsoid conidia observed in several species.

Cladophialophora hostae Crous, U. Braun & H.D. Shin, **sp. nov.** MycoBank MB504527. Figs 5–6.

Etymology: Epithet derived from the host genus, *Hosta*.

Cladophialophorae scillae similis, sed conidiophoris in vitro brevioribus et leniter angustioribus, 10–15 × 1.5–2 µm, conidiis brevioribus, (7–)10–15(–20) µm.

In vivo: *Leaf spots* amphigenous, subcircular to somewhat angular-irregular, 1–5 mm wide, scattered to aggregated, sometimes confluent, pale to medium brown or with a reddish brown tinge, later greyish brown, margin indefinite or on the upper leaf surface with a narrow slightly raised marginal line or very narrow lighter halo, yellowish, ochraceous to brownish. *Caespituli* epiphyllous, punctiform to confluent, dingy greyish brown. *Mycelium* immersed, forming fusicladium-like hyphal strands or plates; hyphae septate, sometimes with constrictions at the septa, thin-walled, pale olivaceous, 1.5–7 µm wide. *Stromata* immersed, small, 10–40 µm diam, composed of swollen hyphal cells, subcircular to somewhat angular-irregular in outline, 2–8 µm diam, wall somewhat thickened, brown. *Conidiophores* in small to moderately large fascicles, loose, divergent to moderately dense, rarely solitary, arising from stromatic hyphal aggregations, erumpent, erect, usually unbranched, rarely branched, straight, subcylindrical to distinctly geniculate-sinuous, 5–40 × 2–5 µm, 0–6-septate, pale to medium olivaceous to olivaceous-brown, thin-walled, up to 0.5 µm, smooth. *Conidiogenous cells* integrated, terminal, 5–15(–20) µm long, sympodial, conidiogenous loci rather inconspicuous to subdenticulate, flat-tipped, 1–1.5 µm diam, unthickened or almost so, not to slightly darkened-refractive. *Conidia* in simple or branched chains, narrowly ellipsoid-subcylindrical, 10–15 × 1.5–3.5 µm, 0–1-septate, subhyaline to pale olivaceous, thin-walled, smooth, ends truncate or with two denticle-like hila in ramoconidia, (0.75–)1–1.5(–2) µm diam, unthickened or almost so, at most slightly darkened-refractive.

In vitro: *Mycelium* composed of branched, smooth, pale olivaceous to medium brown hyphae, frequently forming hyphal coils, guttulate, septa inconspicuous, not constricted, hyphae somewhat irregular in width, 1–2 µm wide. *Conidiophores* reduced to conidiogenous cells, integrated in hyphae, terminal, subcylindrical, pale olivaceous to pale brown, smooth, 0–1-septate, proliferating sympodially at

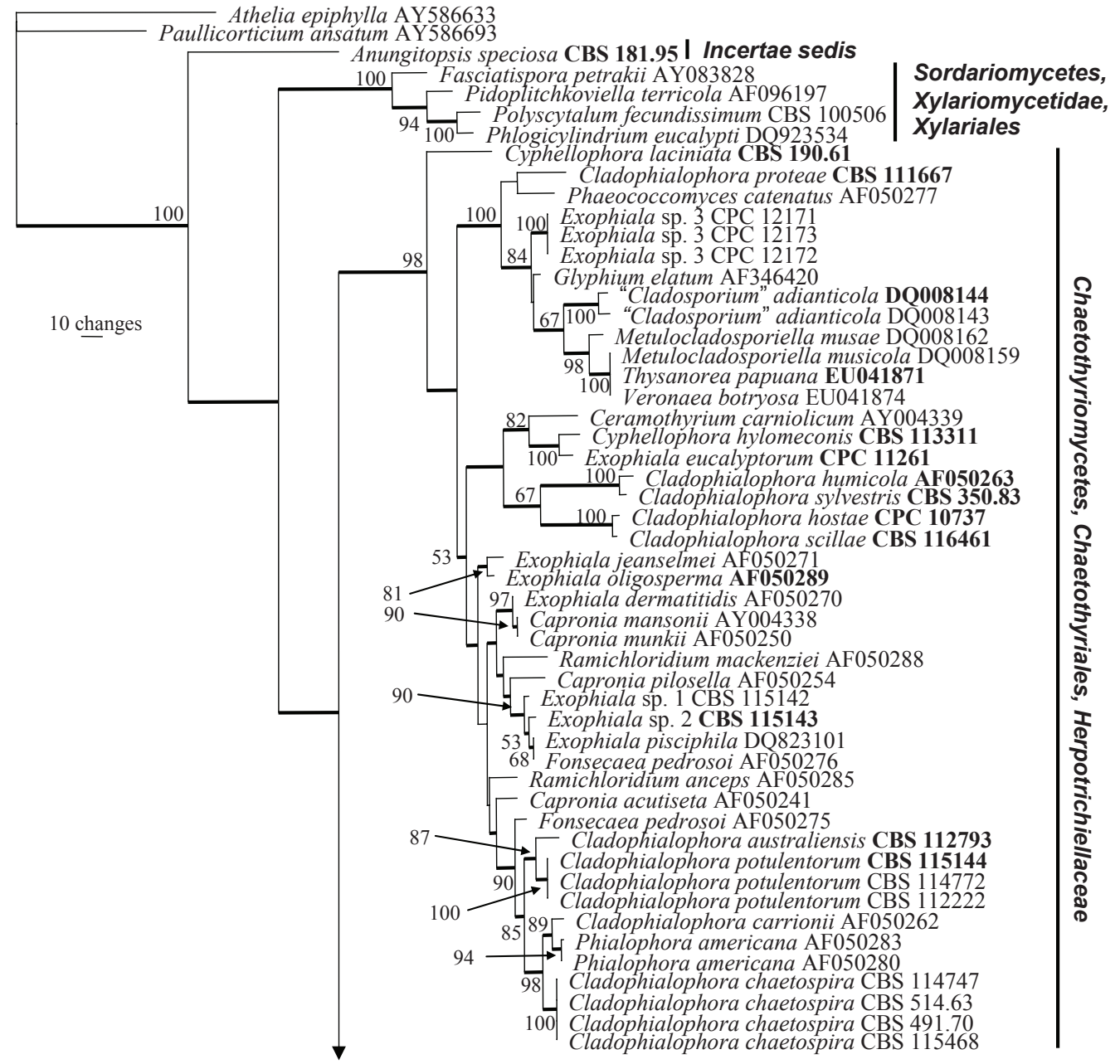

Fig. 1. (Page 188–189). One of 5 000 equally most parsimonious trees obtained from a heuristic search with 100 random taxon additions of the LSU sequence alignment using PAUP v. 4.0b10. The scale bar shows 10 changes, and bootstrap support values from 1 000 replicates are shown at the nodes. Thickened lines indicate the strict consensus branches and ex-type sequences are printed in bold face. The tree was rooted to two sequences obtained from GenBank (*Athelia epiphylla* AY586633 and *Paullicorticium ansatum* AY586693).

apex via 1–2(–3) flat-tipped, minute, denticle-like loci, 1–1.5 µm wide, 10–15 × 1.5–2 µm; scars minutely darkened and thickened, but not refractive. *Conidia* in extremely long chains (–60), simple or branched, subcylindrical, or narrowly ellipsoid, smooth, pale olivaceous, 0–1-septate, (7–)10–15(–20) × (1.5–)2(–2.5) µm, hila truncate, 1–1.5 µm wide, minutely thickened and darkened-refractive.

Cultural characteristics: Colonies on PDA erumpent, spreading, with smooth, undulate margins and dense aerial mycelium; surface hazel (middle), outer zone isabelline; reverse fuscous-black in middle, isabelline in outer zone. Colonies reaching 25 mm diam on SNA, and 40 mm diam on PDA after 1 mo at 25 °C in the dark; colonies fertile.

Specimen examined: **Korea**, Pyongchang, *Hosta plantaginea* (*Hostaceae*), 20 Sep. 2003, H.D. Shin, HAL 2030 F, **holotype**, culture ex-type SMK 19664, CPC 10737 = CBS 121637, CPC 10738–10739.

Notes: Although this species is morphologically similar to *Cladophialophora scillae* (Deighton) Crous, U. Braun & K. Schub. described below in this paper, *C. hostae* is treated as a separate taxon due to the differences in the length and width of its conidiophores and conidia *in vitro*, as well as 17 bp differences in the ITS DNA sequence data and a distinct ecology causing leaf-spots on a different, unrelated host. Based on disease symptoms caused on the living host leaves, *C. hostae* is a very unusual, unexpected member of the genus *Cladophialophora*. *In vivo*, the mycelium forms obvious hyphal strands and plates which are characteristic for *Fusicladium* species. The conidiophores and conidia are also fusicladium-like. Nevertheless, this species clusters within the *Herpotrichiellaceae*, i.e., it has to be placed in the genus *Cladophialophora*. Biotrophic species like *C. hostae* and *C. scillae* without phialidic synanamorphs render the differentiation between *Cladophialophora* and *Fusicladium* (incl. *Pseudocladosporium*) almost impossible without sequence data. Furthermore, the

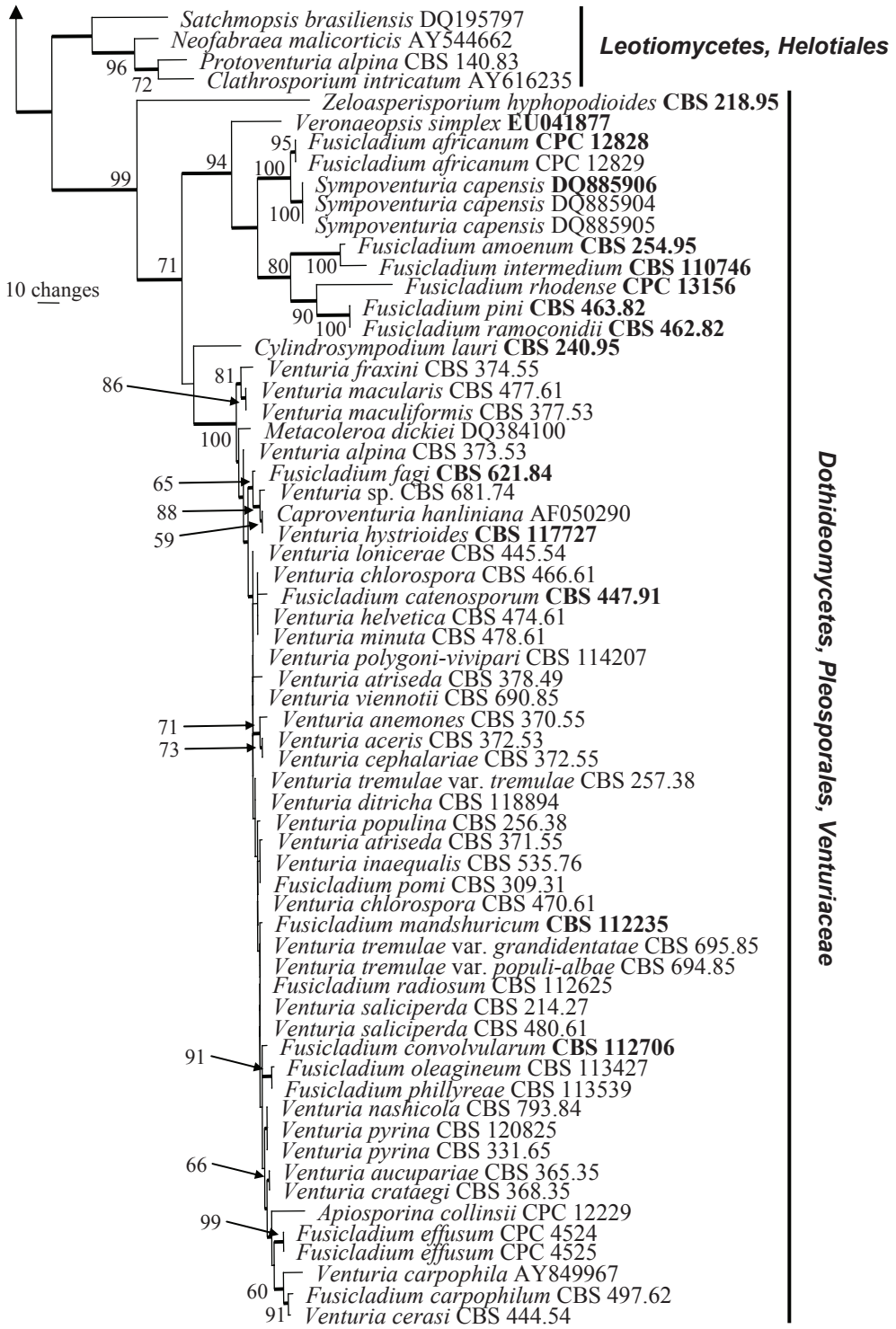

Fig 1. (Continued).

morphology of *C. hostae in vivo* and *in vitro* shows remarkable differences in conidiophore morphology, i.e., the growth *in vivo* is characteristically fusicladium-like (conidiophores macronematous, long, septate), whereas habit *in vitro* is rather pseudocladosporium-like (conidiophores less developed, usually reduced to conidiogenous cells, short). However, several *Fusicladium* species have also been observed to exibit a *Pseudocladosporium* growth habit in culture, suggesting this growth plasticity to be rather common, and strongly influenced by growth conditions.

Cladophialophora humicola Crous & U. Braun, **sp. nov.** MycoBank MB504528. Figs 7–8.

Etymology: Named after its ecology, namely occurring in soil.

Cladophialophorae bantianae similis, sed conidiis majoribus, (8–)11–14(–17) × (1.5–)2(–2.5) µm, locis conidiogenis et hilis angustioribus, 1–1.5 µm latis.

In vitro: *Mycelium* composed of branched, smooth, pale olivaceous to pale brown hyphae, frequently forming hyphal coils, prominently guttulate, not to slightly constricted at the septa, 1–2 µm wide, cells somewhat uneven in width. *Conidiophores* solitary, mostly inconspicuous and integrated in hyphae, varying from inconspicuously truncate lateral loci on hyphal cells, 1–1.5 µm wide, to occasionally terminal conidiophores, 0–3-septate, subcylindrical, proliferating sympodially, 10–30 × 1.5–3 µm, pale brown, smooth.

Table 1. Isolates used for sequence analysis.

Anamorph	Teleomorph	Accession number[1]	Host	Country	Collector	GenBank numbers[2] (ITS, LSU)
Anungitopsis speciosa		CBS 181.95*; INIFAT C94/135	Leaf litter of *Buchenavia capitata*	Cuba	R.F. Castañeda	EU035401, EU035401
Cladophialophora australiensis		CBS 112793*; CPC 1377	Sports drink	Australia	–	EU035402, EU035402
Cladophialophora chaetospira		CBS 114747	*Phyllostachys bambusoides*	China	L. Cai	EU035403, EU035403
		CBS 115468; HKUCC 10147	Bamboo	China	–	EU035404, EU035404
		CBS 491.70	Roots of *Picea abies*	Denmark	–	EU035405, EU035405
		CBS 514.63; ATCC 16274; MUCL 8310	Soil, wheat field	Germany	–	EU035406, EU035406
Cladophialophora hostae		CPC 10737*	*Hosta plantaginea*	Korea	H.D. Shin	EU035407, EU035407
Cladophialophora humicola		CBS 117536*; BBA 65570	Soil, arable	Germany	Z. Zaspel & H. Nirenberg	EU035408, AF050263
Cladophialophora potulentorum		CBS 112222; CPC 1376; FRR 4946	Sports drink	Australia	N.J. Charley	EU035409, EU035409
		CBS 114772; CPC 1375; FRR 4947	Sports drink	Australia	N.J. Charley	EU035410, EU035410
		CBS 115144*; CPC 11048; FRR 3318	Apple juice	–	–	DQ008141, DQ008141
Cladophialophora proteae		CBS 111667*; CPC 1514	*Protea cynaroides*	South Africa	L. Viljoen	EU035411, EU035411
Cladophialophora scillae		CBS 116461*	*Scilla peruviana*	New Zealand	C.F. Hill	EU035412, EU035412
Cladophialophora sylvestris		CBS 350.83	*Pinus sylvestris*	Netherlands	–	EU035413, EU035413
"Cladosporium" adianticola		CBS 735.87*; ATCC 200931; INIFAT C87/40	*Adiantum* sp.	Cuba	R.F. Castañeda & G. Arnold	DQ008125, DQ008144
Cylindrosympodium lauri		CBS 240.95*; INIFAT C95/3-2	*Laurus* sp.	Spain, Canary Islands	R.F. Castañeda	EU035414, EU035414
Cyphellophora hylomeconis		CBS 113311*	*Helomeco velane*	Korea	H.D. Shin	EU035415, EU035415
Cyphellophora laciniata		CBS 190.61*; ATCC 14166; MUCL 9569	Man, skin	Switzerland	K.M. Wissel	EU035416, EU035416
Exophiala eucalyptorum		CPC 11261*	*Eucalyptus* sp.	New Zealand	J. Stalpers	EU035417, EU035417
Exophiala sp. 1		CBS 115142; CPC 11044; FRR 5582	Fruit-based drink	–	–	DQ008139, EU035418
Exophiala sp. 2		CBS 115143*; CPC 11047; FRR 5599	Bottled spring water	–	–	DQ008140, EU035419
Exophiala sp. 3		CPC 12171	*Prunus* sp.	Canada	K.A. Seifert	EU035420, EU035420
		CPC 12172	*Prunus* sp.	Canada	K.A. Seifert	EU035421, EU035421
		CPC 12173	*Prunus* sp.	Canada	K.A. Seifert	EU035422, EU035422
Fusicladium africanum		CPC 12828*	*Eucalyptus* sp.	South Africa	P.W. Crous	EU035423, EU035423
		CPC 12829	*Eucalyptus* sp.	South Africa	P.W. Crous	EU035424, EU035424
Fusicladium amoenum		CBS 254.95*; ATCC 200947; CPC 3681; IMI 367525; INIFAT C94/155; MUCL 39143	Leaf litter of *Eucalyptus grandis*	Cuba	R.F. Castañeda	EU035425, EU035425
Fusicladium carpophilum	*Venturia carpophila*	CBS 497.62; ETH 4568	*Prunus* sp.	Switzerland	–	EU035426, EU035426

Fusicladium catenosporum		CBS 447.91*	*Salix triandra*	Germany	H. Butin	EU035427, EU035427
Fusicladium convolvularum		CBS 112706*; CPC 3884; IMI 383037	*Convolvulus arvensis*	New Zealand	C.F. Hill	AY251082, EU035428
Fusicladium effusum		CPC 4524	*Carya illinoinensis*	U.S.A.	K. Stevenson	AY251084, EU035429
		CPC 4525	*Carya illinoinensis*	U.S.A.	K. Stevenson	AY251085, EU035430
Fusicladium fagi		CBS 621.84*; ATCC 200937	*Fagus sylvatica*	Netherlands	G.S. de Hoog	EU035431, EU035431
Fusicladium intermedium		CBS 110746*; CPC 778; IMI 362702	*Eucalyptus* sp.	Madagascar	P.W. Crous	EU035432, EU035432
Fusicladium mandshuricum	*Venturia mandshurica*	CBS 112235*; CPC 3639	*Populus simonii*	China	–	EU035433, EU035433
Fusicladium oleagineum		CBS 113427	*Olea europaea*	New Zealand	C.F. Hill	EU035434, EU035434
Fusicladium phillyreae		CBS 113539; UPSC 1329	–	Portugal	B. d'Oliveira	EU035435, EU035435
Fusicladium pini		CBS 463.82*	*Pinus sylvestris*	Netherlands	G.S. de Hoog	EU035436, EU035436
Fusicladium pomi	*Venturia inaequalis*	CBS 309.31	–	–	–	EU035437, EU035437
		CBS 535.76	*Sorbus aria*	Switzerland	–	EU035460, EU035460
Fusicladium radiosum	*Venturia tremulae*	CBS 112625; CPC 3638	*Populus tremula*	France	–	EU035438, EU035438
Fusicladium ramoconidii		CBS 462.82*; CPC 3679	*Pinus* sp.	Netherlands	G.S. de Hoog	AY251086, EU035439
Fusicladium rhodense		CPC 13156*	*Ceratonia siliqua*	Greece	P.W. Crous	EU035440, EU035440
Polyscytalum fecundissimum		CBS 100506	*Fagus sylvatica*	Netherlands	W. Gams	EU035441, EU035441
Zeloasperisporium hyphopodioides		CBS 218.95*; IMI 367520; INIFAT C94/114; MUCL 39155	Air	Cuba	R. F. Castañeda	EU035442, EU035442
	Apiosporina collinsii	CPC 12229	*Amelanchier alnifolia*	Canada	L.J. Hutchinson	EU035443, EU035443
	Protoventuria alpina	CBS 140.83	*Arctostaphylos uva-ursi*	Switzerland	–	EU035444, EU035444
	Sympoventuria capensis	CBS 120136; CPC 12838	*Eucalyptus* sp.	South Africa	P.W. Crous	DQ885906, DQ885906
		CPC 12839	*Eucalyptus* sp.	South Africa	P.W. Crous	DQ885905, DQ885905
		CPC 12840	*Eucalyptus* sp.	South Africa	P.W. Crous	DQ885904, DQ885904
	Venturia aceris	CBS 372.53	*Acer pseudoplatanus*	Switzerland	–	EU035445, EU035445
	Venturia alpina	CBS 373.53	*Arctostaphylos alpina*	Switzerland	–	EU035446, EU035446
	Venturia anemones	CBS 370.55; IMI 163998	*Anemone alpina*	France	–	EU035447, EU035447
	Venturia atriseda	CBS 371.55	*Gentiana punctata*	Switzerland	–	EU035448, EU035448
		CBS 378.49	*Gentiana lutea*	Switzerland	J.A. von Arx	EU035449, EU035449
	Venturia aucupariae	CBS 365.35; IMI 163987	*Sorbus aucuparia*	Germany	–	EU035450, EU035450
	Venturia cephalariae	CBS 372.55	*Cephalaria alpina*	Switzerland	–	EU035451, EU035451
	Venturia cerasi	CBS 444.54; ATCC 12119; IMI 163988	*Prunus cerasus*	Germany	–	EU035452, EU035452
	Venturia chlorospora	CBS 466.61; ETH 543	*Salix caesia*	Switzerland	J. Nüesch	EU035453, EU035453
		CBS 470.61	*Salix daphnoides*	France	J. Nüesch	EU035454, EU035454
	Venturia crataegi	CBS 368.35	*Crataegus* sp.	Germany	–	EU035455, EU035455

Table 1. (Continued).

Anamorph	Teleomorph	Accession number[1]	Host	Country	Collector	GenBank numbers[2] (ITS, LSU)
	Venturia ditricha	CBS 118894	*Betula pubescens* var. *tortuosa*	Finland	–	EU035456, EU035456
	Venturia fraxini	CBS 374.55	*Fraxinus excelsior*	Switzerland	–	EU035457, EU035457
	Venturia helvetica	CBS 474.61; ETH 2571; IMI 163990	*Salix helvetica*	Switzerland	J. Nüesch	EU035458, EU035458
	Venturia hystrioides	CBS 117727*; ATCC 96019; CPC 5391	*Prunus avium* cv. Bing	U.S.A.	R.G. Roberts	EU035459, EU035459
	Venturia lonicerae	CBS 445.54; IMI 163997	*Lonicera coerulea*	Switzerland	–	EU035461, EU035461
	Venturia macularis	CBS 477.61; ETH 2831	*Populus tremula*	France	–	EU035462, EU035462
	Venturia maculiformis	CBS 377.53	*Epilobium montanum*	France	–	EU035463, EU035463
	Venturia minuta	CBS 478.61; ETH 523; IMI 163991	*Salix nigricans*	Switzerland	J. Nüesch	EU035464, EU035464
	Venturia nashicola	CBS 793.84	*Pyrus serotina*	Japan	–	EU035465, EU035465
	Venturia polygoni-vivipari	CBS 114207; UPSC 2754	*Polygonum viviparum*	Norway	K. & L. Holm	EU035466, EU035466
	Venturia populina	CBS 256.38; IMI 163996	*Populus canadensis*	Italy	–	EU035467, EU035467
	Venturia pyrina	CBS 120825	*Pyrus communis*	Brazil	–	EU035468, EU035468
		CBS 331.65	*Pyrus* sp.	–	–	EU035469, EU035469
	Venturia saliciperda	CBS 214.27; IMI 163993	–	–	–	EU035470, EU035470
		CBS 480.61; ETH 2836	*Salix cordata*	Switzerland	–	EU035471, EU035471
	Venturia sp.	CBS 681.74	*Cedrus atlantica*	France	W. Gams	EU035472, EU035472
	Venturia tremulae var. *grandidentatae*	CBS 695.85	*Populus tremuloides*	Canada	–	EU035473, EU035473
	Venturia tremulae var. *populi-albae*	CBS 694.85	*Populus alba*	France	–	EU035474, EU035474
	Venturia tremulae var. *tremulae*	CBS 257.38	*Populus tremula*	Italy	–	EU035475, EU035475
	Venturia viennotii	CBS 690.85	*Populus tremula*	France	–	EU035476, EU035476

[1]ATCC: American Type Culture Collection, Virginia, U.S.A.; BBA: Biologische Bundesanstalt für Land- und Forstwirtschaft, Berlin-Dahlem, Germany; CBS: Centraalbureau voor Schimmelcultures, Utrecht, The Netherlands; CPC: Culture collection of Pedro Crous, housed at CBS; ETH: Eidgenössische Technische Hochschule, Institute for Special Botany, Zürich, Switzerland; FRR: Division of Food Research, CSIRO, North Ryde, N.S.W., Australia; HKUCC: The University of Hong Kong Culture Collection, Dept. of Ecology and Biodiversity, University of Hong Kong, Pokfulam Road, China; IMI: International Mycological Institute, CABI-Bioscience, Egham, Bakeham Lane, U.K.; INIFAT: Alexander Humboldt Institute for Basic Research in Tropical Agriculture, Ciudad de La Habana, Cuba; MUCL: Mycotheque de l' Université Catholique de Louvain, Louvain-la-Neuve, Belgium; UPSC: Uppsala University Culture Collection of Fungi, Museum of Evolution, Botany Section, Evolutionary Biology Centre, Uppsala, Sweden.

[2]ITS: internal transcribed spacer regions, LSU: partial 28S rDNA sequence.

*Ex-type cultures.

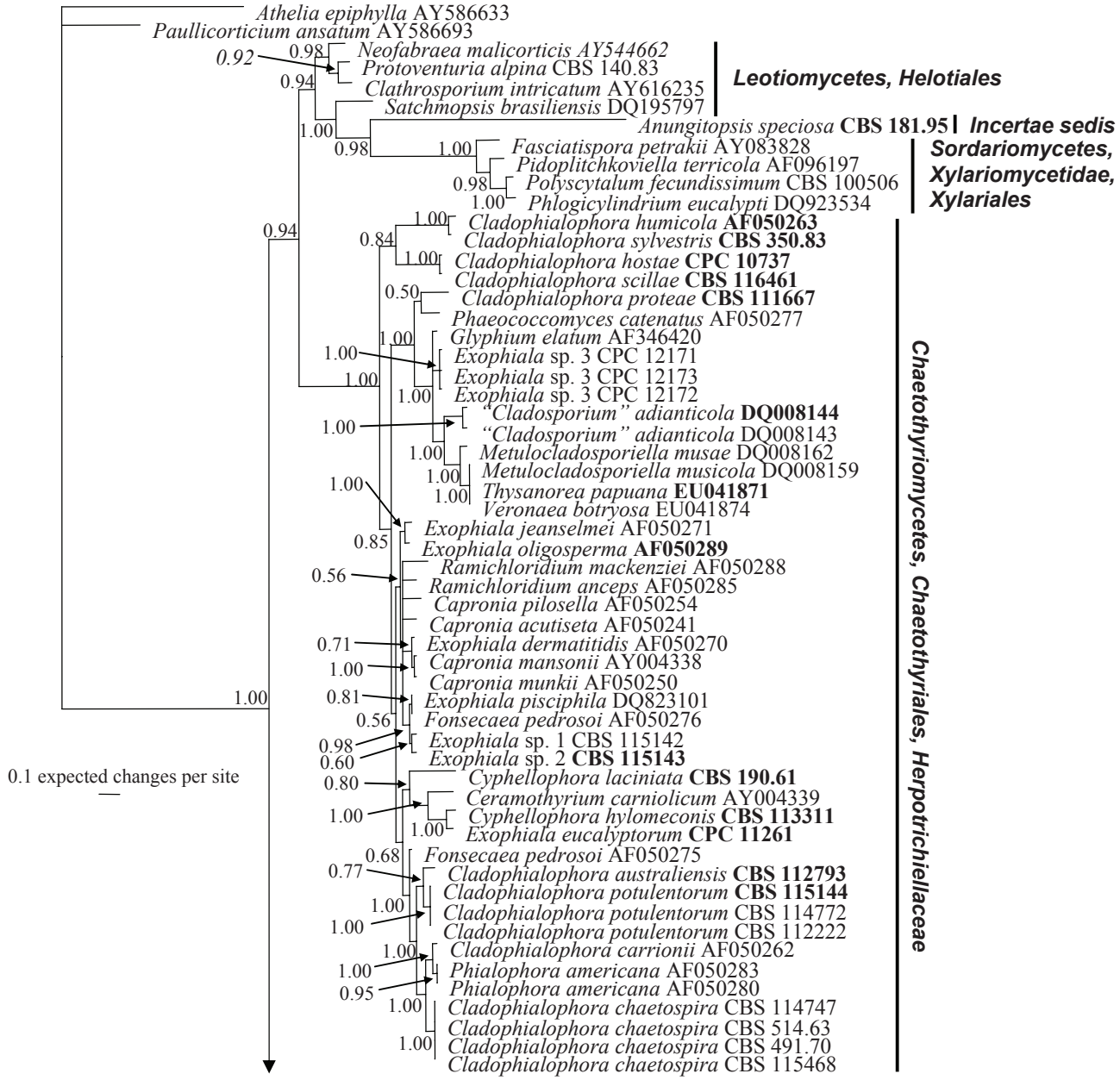

Fig. 2. (Page 193–194). Consensus phylogram (50 % majority rule) of 1 500 trees resulting from a Bayesian analysis of the LSU sequence alignment using MRBAYES v. 3.1.2. Bayesian posterior probabilities are indicated at the nodes. Ex-type sequences are printed in bold face. The tree was rooted to two sequences obtained from GenBank (*Athelia epiphylla* AY586633 and *Paullicorticium ansatum* AY586693).

Conidiogenous cells integrated, inconspicuous, truncate, lateral loci 1–1.5 µm wide, or conidiogenous cells subcylindrical with 1–3 sympodial loci (which appear as minute lateral denticles), 7–17 × 1.5–2 µm; scars inconspicuous, neither darkened, refractive nor thickened. *Conidia* in short chains of up to 10, simple or branched, subcylindrical to narrowly ellipsoid, 0–1-septate, (8–)11–14(–17) × (1.5–)2(–2.5) µm, pale olivaceous to olivaceous-brown or pale brown, smooth, hila truncate, 1–1.5 µm wide, unthickened, neither darkened, nor refractive.

Cultural characteristics: Colonies erumpent, spreading, with uneven, feathery margins and dense aerial mycelium on PDA; pale olivaceous-grey in the middle, becoming olivaceous-grey in the outer zone (surface); reverse olivaceous-black, with grey-olivaceous margins. Colonies reaching 7 mm diam after 2 wk at 25 °C in the dark; colonies fertile.

Specimen examined: **Germany**, Brandenburg, Müncheberg, from soil, Zaspel, Zalf & H. Nirenberg, **holotype** CBS H-19902, culture ex-type BBA 65570 = CBS 117536.

Notes: Phylogenetically *Cladophialophora humicola* is closely related to *C. sylvestris* Crous & de Hoog (see below). Morphologically the two species can be distinguished in that *C. humicola* lacks ramoconidia, and has 1-septate conidia, while those of *C. sylvestris* are 0–3-septate.

Cladophialophora potulentorum Crous & A.D. Hocking, **sp. nov.** MycoBank MB504529. Figs 9–10.

Etymology: Refers to its presence in fruit juices and sports drinks.

Cladophialophorae carrionii similis, sed conidiis secundis majoribus, (6–)8–10(–13) × 2–3 µm.

In vitro: *Mycelium* consisting of branched, septate, smooth, pale brown, guttulate, 1.5–2.5 µm wide hyphae. *Conidiophores* solitary, macronematous, well distinguishable under the dissecting microscope from aerial mycelium, pale to medium brown, subcylindrical, straight to somewhat curved, erect, with apical apparatus appearing as a tuft due to extremely long conidial

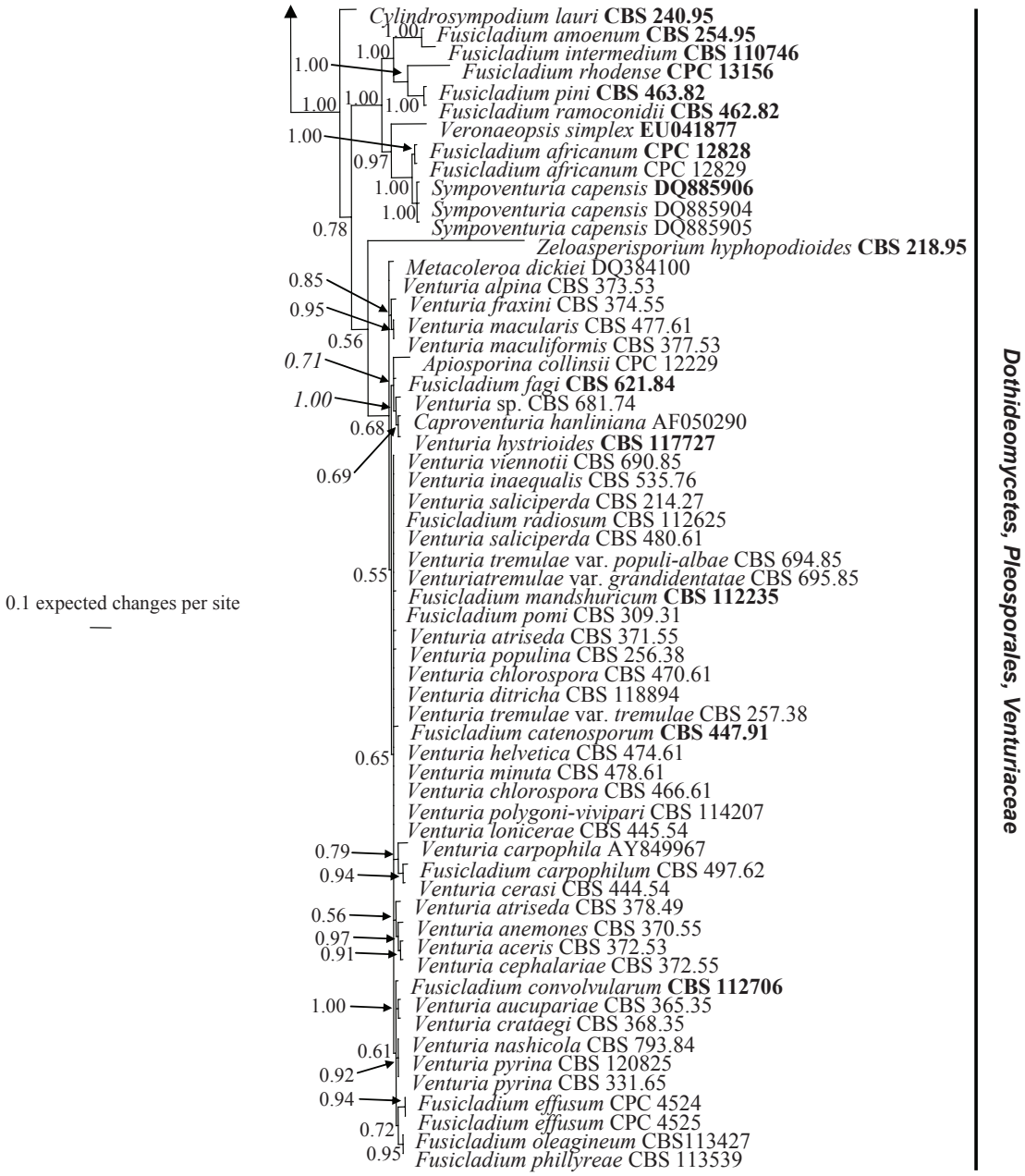

Fig. 2. (Continued).

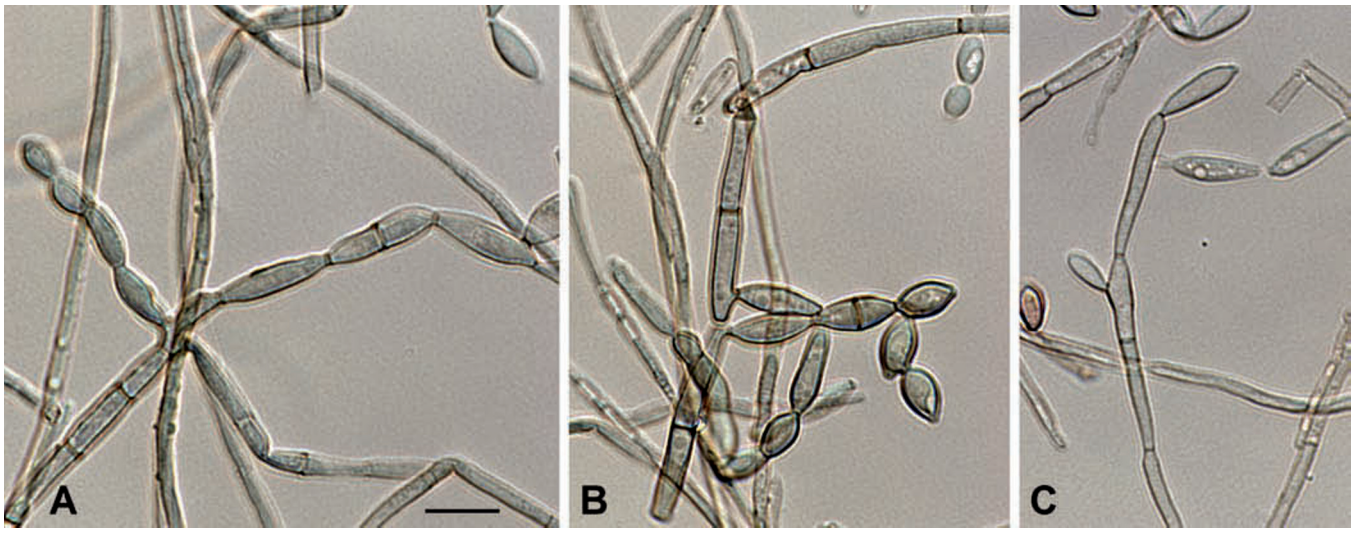

Fig. 3. *Cladophialophora australiensis* (CBS 112793). A. Conidiophore. B–C. Subcylindrical ramoconidia, and ellipsoid conidia. Scale bar = 10 µm.

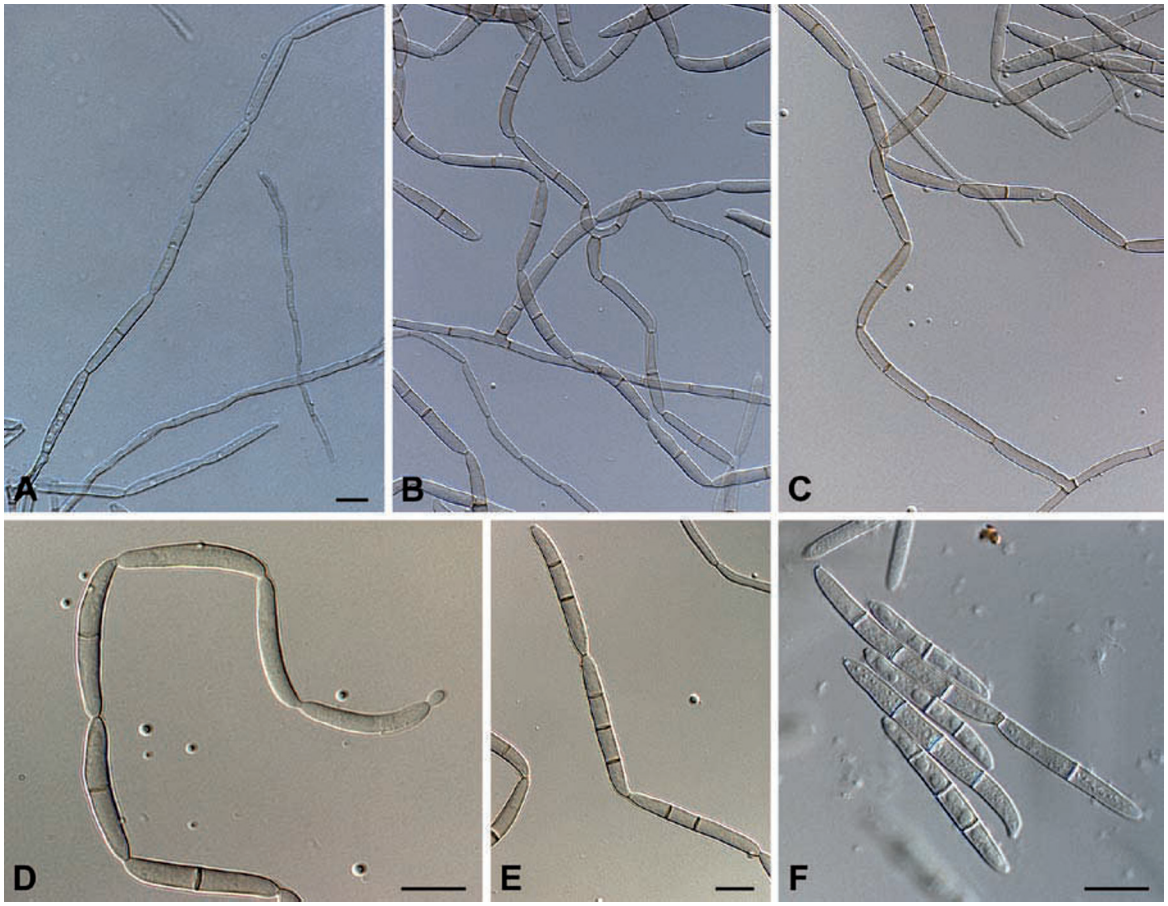

Fig. 4. *Cladophialophora chaetospira* (CBS 114747). A–C. Hyphae giving rise to conidiophores with catenulate conidia. D–F. Conidia become up to 3-septate, frequently remaining attached in chains. Scale bars = 10 µm.

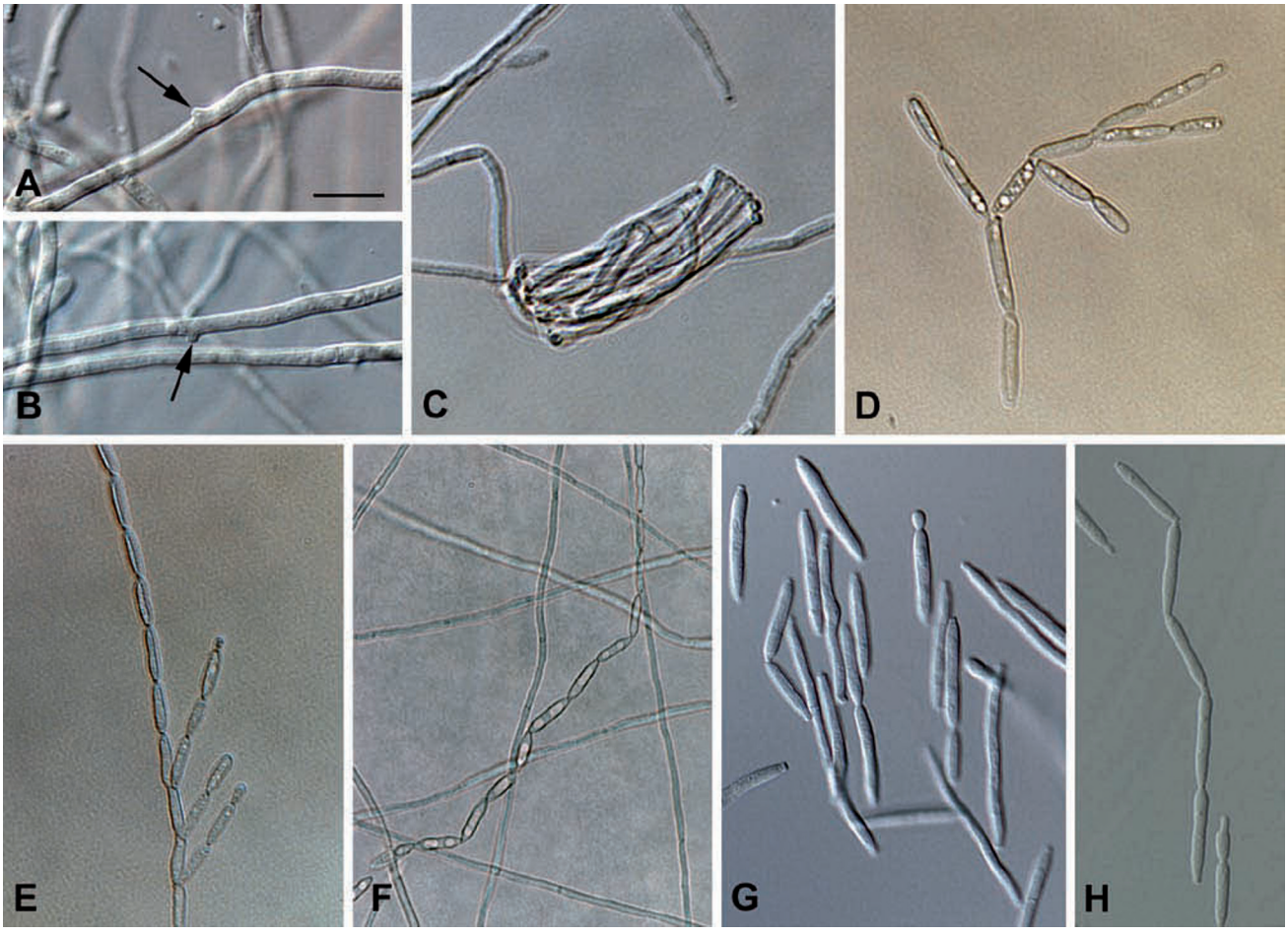

Fig. 5. *Cladophialophora hostae* (CPC 10737). A–B. Conidiogenous loci (arrows). C. Hyphal coil. D–F. Branched conidial chains. G–H. Conidia. Scale bar = 10 µm.

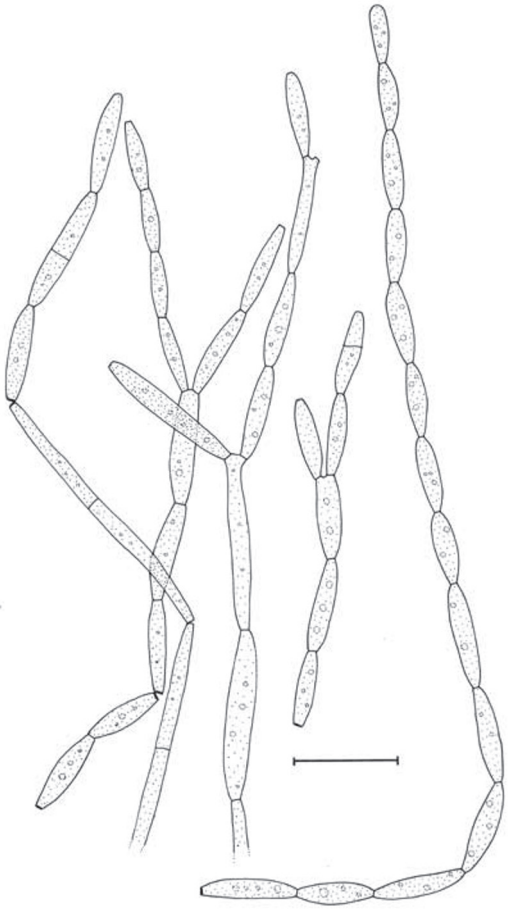

Fig. 6. *Cladophialophora hostae* (CPC 10737). Branched conidial chains with ramoconidia and conidia. Scale bar = 10 µm.

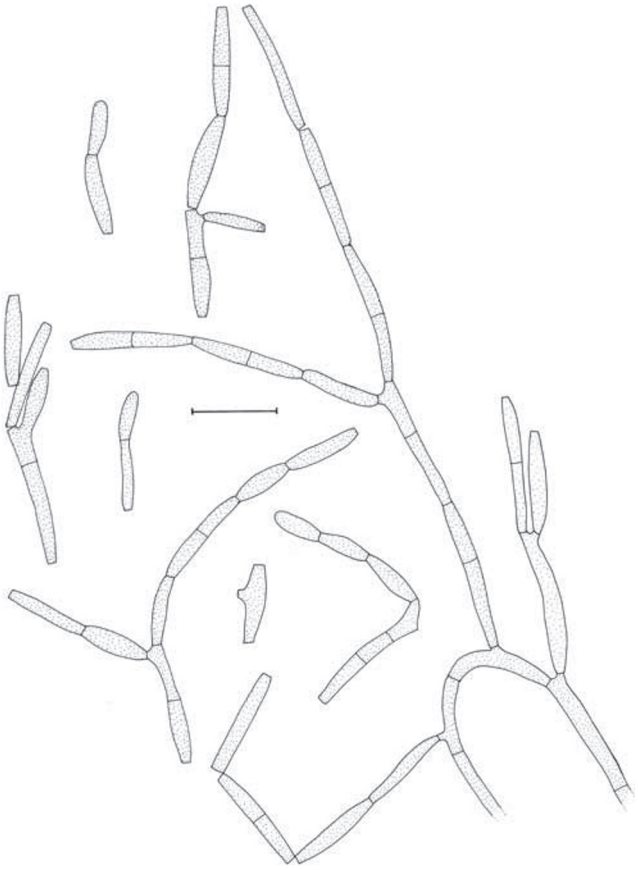

Fig. 7. *Cladophialophora humicola* (CBS 117536). Conidiophore with branched conidial chains. Scale bar = 10 µm.

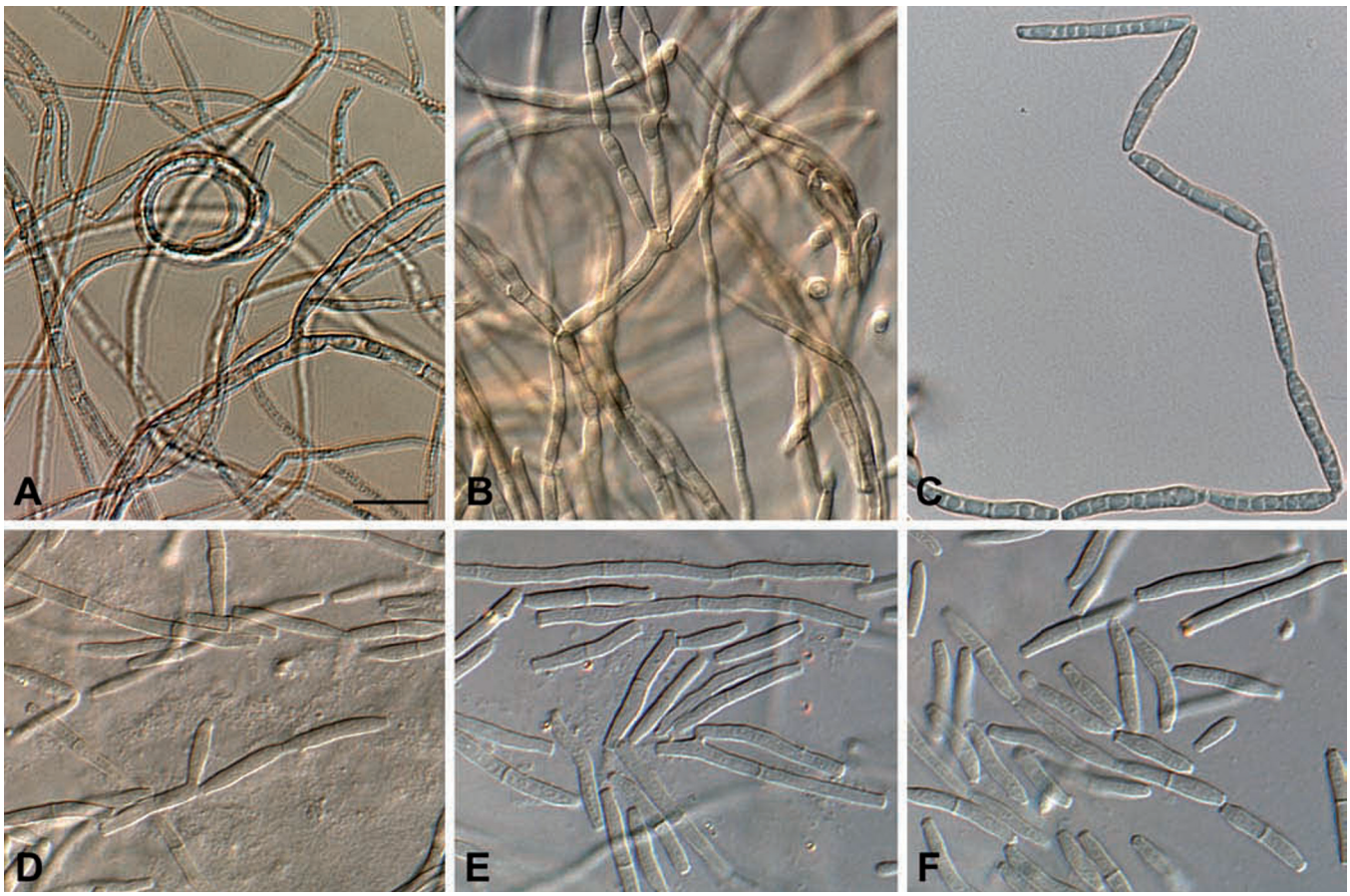

Fig. 8. *Cladophialophora humicola* (CBS 117536). A. Hyphal coil. B. Conidiophore. C–F. Conidial chains with ramoconidia and conidia. Scale bar = 10 µm.

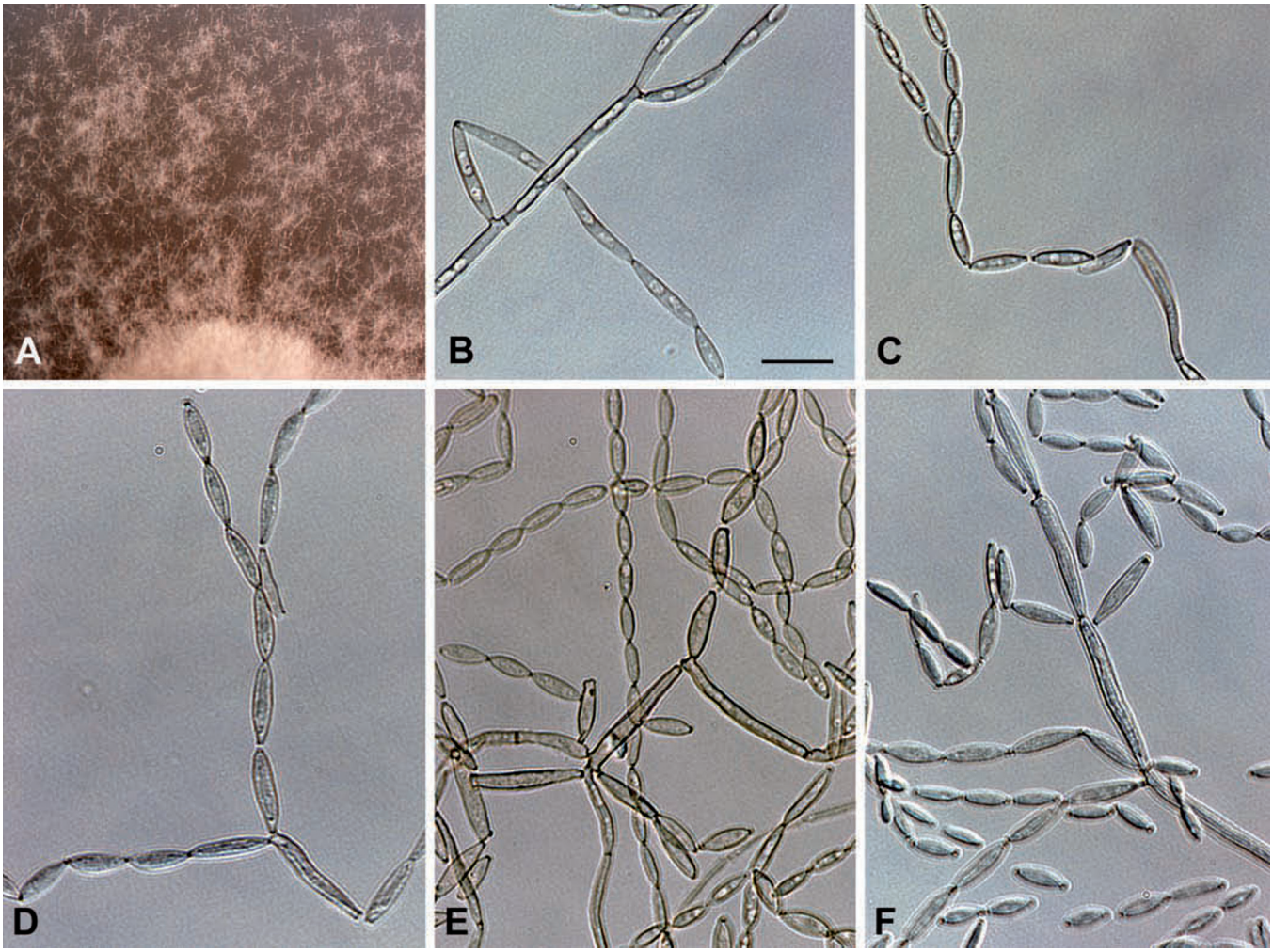

Fig. 9. *Cladophialophora potulentorum* (CBS 115144). A. Colony on PDA. B. Conidiophore. C–D. Conidial chains. E–F. Ramoconidia and conidia. Scale bar = 10 µm.

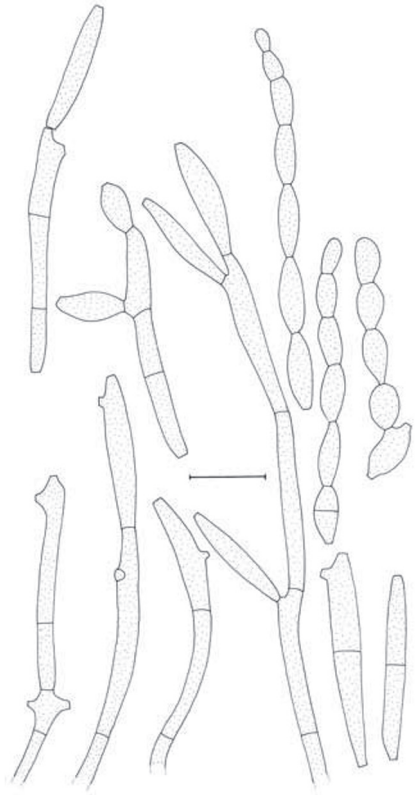

Fig. 10. *Cladophialophora potulentorum* (CBS 115144). Conidiophores with chains of ramoconidia and conidia. Scale bar = 10 µm.

chains; conidiophores up to 5-septate, and 100 µm tall (excluding conidiogenous cells). *Conidiogenous cells* pale brown, smooth, terminal and lateral, subcylindrical, tapering towards subtruncate to truncate loci, 1 µm wide, somewhat darkened, thickened, but not refractive, loci appearing subdenticulate on lateral conidiogenous cells, mono- to polyblastic, proliferating sympodially, 10–35 × 1.5–2 µm. *Conidia* pale brown, smooth, guttulate, occurring in branched chains of up to 60; hila somewhat darkened and thickened, but not refractive, 0.5 µm wide; ramoconidia subcylindrical, 0–1-septate, 15–17(–20) × 2.5–3 µm; conidia ellipsoid, (6–)8–10(–13) × 2–3 µm.

Cultural characteristics: Colonies erumpent, spreading, with smooth margins and dense aerial mycelium on PDA, olivaceous-grey (surface), with a thin, olivaceous-black margin; reverse olivaceous-black; on OA olivaceous-grey (surface) with a wide olivaceous-black margin. Colonies reaching 25–30 mm diam after 1 mo at 25 °C in the dark; colonies fertile, also sporulating in the agar. Not able to grow at 37 °C.

Specimens examined: **Australia**, isolated from apple juice drink, Dec. 1986, A.D. Hocking, **holotype** CBS H-19901, culture ex-type CBS 115144 = CPC 11048; **Australia**, isolated from sports drink, Feb. 1996, A.D. Hocking, CBS 114772 = CPC 1375 = FRR 4947; **Australia**, isolated from sports drink, Feb. 1996, A.D. Hocking, CBS 112222 = FRR 4946.

Notes: Originally this taxon, isolated from fruit and sports drinks, was thought to be an undescribed species of *Pseudocladosporium* (= *Fusicladium*, see below). However, upon closer examination, this

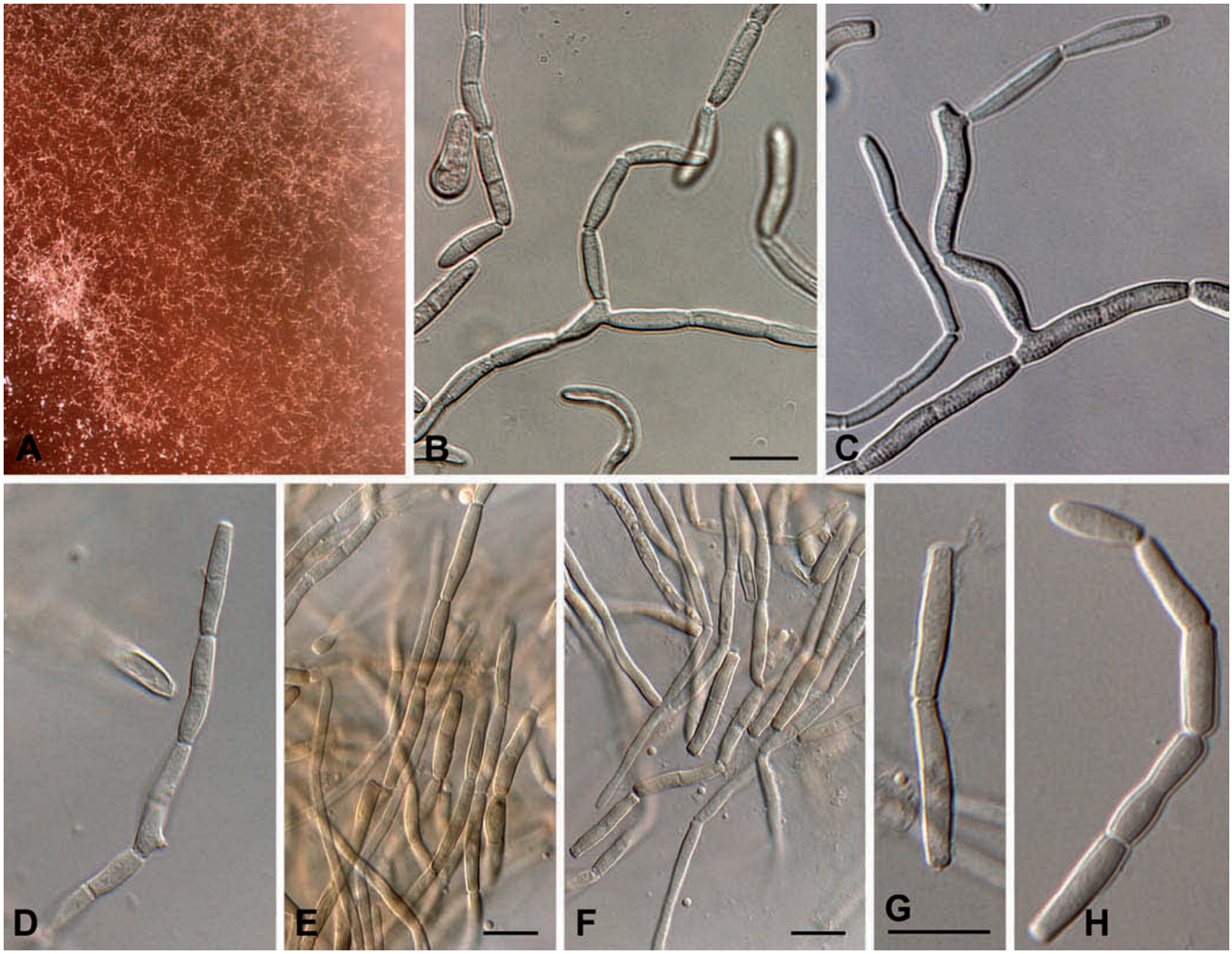

Fig. 11. *Cladophialophora proteae* (CBS 111667). A. Colony on OA. B–C. Conidiophores. D–H. Catenulate conidia. Scale bars = 10 µm.

proved not to be the case. Conidiophores appear as distinct tufts under the dissecting microscope, and are readily distinguishable from the superficial mycelium, as is normally observed in species of *Fusicladium*, but the conidial chains are extremely long, and the conidia tend to be more ellipsoid than the predominantly fusiform or subcylindrical conidia observed in species of *Fusicladium.* Hyphal coils were also not observed in cultures of *C. potulentorum*, but are rather common in species of *Fusicladium*. The phylogenetic position of this taxon within the *Herpotrichiellaceae* clade also supports inclusion in the genus *Cladophialophora*.

Cladophialophora proteae Viljoen & Crous, S. African J. Bot. 64: 137. 1998. Fig. 11.

≡ *Pseudocladosporium proteae* (Viljoen & Crous) Crous, in Crous *et al*., *Cultivation and Diseases of Proteaceae: Leucadendron, Leucospermum and Protea*: 101. 2004.

In vitro: *Mycelium* consisting of branched, septate hyphae, often forming strands, anastomosing, smooth to finely verruculose, frequently constricted at septa, olivaceous, 3–4 µm wide; hyphal cells in older cultures becoming swollen, up to 6 µm wide. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* holoblastic, integrated, forming short, truncate protuberances, 2–3 × 1.5–2 µm, concolorous with mycelium, subcylindrical. *Conidia in vitro* arranged in long acropetal chains (up to 20), simple or branched, subcylindrical to oblong-doliiform, (9–)13–17(–22) × 2.5–3(–4) µm *in vitro* on MEA, (9–)16–22(–25) × (2.5–)3–4(–6) µm on SNA; 0–1(–4)-septate, pale brown to pale olivaceous, smooth, hila subtruncate to truncate, not thickened, but somewhat refractive.

Cultural characteristics: Colonies erumpent, with sparse aerial mycelium on PDA; margins irregular, feathery; greyish rose, with patches of pale olivaceous-grey (surface); reverse olivaceous-grey. Colonies reaching 10 mm diam after 2 wk at 25 °C in the dark; colonies fertile.

Specimen examined: **South Africa**, Western Cape Province, Stellenbosch, J.S. Marais Nature Reserve, leaves of *Protea cynaroides* (*Proteaceae*), 26 Aug. 1996, L. Viljoen, **holotype** PREM 55345, culture ex-type CBS 111667.

Notes: *Cladophialophora proteae* differs from species of *Fusicladium* (= *Pseudocladosporium*) based on its colony colour, the slimy nature of colonies, as well as its conidia that have inconspicuous, unthickened hila (Fig. 11) (Crous *et al*. 2004), unlike those observed in species of *Fusicladium*. Sequence data show that this species is not allied to the *Venturiaceae*, but to the *Herpotrichiellaceae*.

Cladophialophora scillae (Deighton) Crous, U. Braun & K. Schub., **comb. nov.** MycoBank MB504530. Fig. 12.

Basionym: *Cladosporium scillae* Deighton, N. Zealand J. Bot. 8: 55. 1970.

≡ *Fusicladium scillae* (Deighton) U. Braun & K. Schub., *IMI Descriptions of Fungi and Bacteria* 152: 1518. 2002.

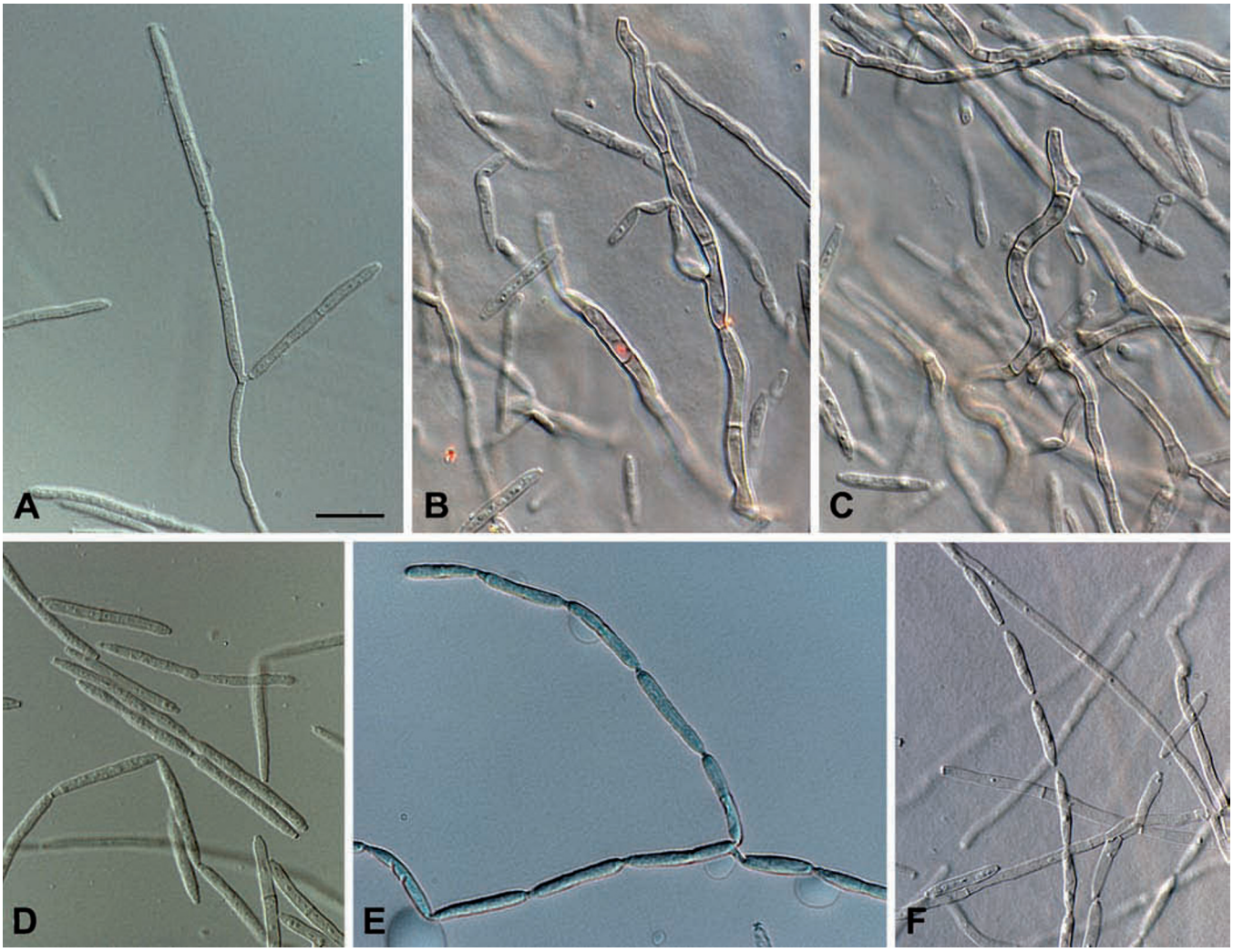

Fig. 12. *Cladophialophora scillae* (CBS 116461). A–C. Conidiophores. D–F. Catenulate conidia. Scale bar = 10 µm.

In vivo: see Schubert & Braun (2002a) and Schubert *et al*. (2003).

In vitro: *Mycelium* consisting of branched, septate, smooth, green-brown to medium brown, guttulate hyphae, variable in width, 1.5–3 µm diam. *Conidiophores* lateral or terminal on hyphae, erect, straight to slightly flexuous, solitary, in some cases aggregated, subcylindrical, curved to geniculate-sinuous, unbranched, up to 55 µm long, 2–3 µm wide, 0–7-septate, septa in short succession, pale to medium brown, somewhat paler towards apices, smooth. *Conidiogenous cells* integrated, terminal or lateral as individual loci on hyphal cells, straight to curved, subcylindrical, up to 14(–18) µm long and 2 µm wide, pale to medium brown, smooth, with a single or few subdenticulate to denticulate loci at the apex due to sympodial proliferation, or reduced to individual loci, 0.8–1.5(–2) µm wide; scars minutely thickened and darkened, but not refractive. *Conidia* occurring in long, unbranched or loosely branched chains (–30), straight to slightly curved, ellipsoid to mostly narrowly subcylindrical, obclavate in some larger, septate conidia, (5–)10–20(–35) × 1.5–3 µm, 0–1(–3)-septate, sometimes slightly constricted at the septa, subhyaline to pale brown, smooth, guttulate, tapering at ends to subtruncate hila, 0.8–1.5 µm wide, minutely thickened and darkened, but not refractive; microcyclic conidiogenesis occurring.

Cultural characteristics: Colonies erumpent, spreading, with smooth, even margins and dense, abundant aerial mycelium on PDA; grey-olivaceous (surface); reverse dark olivaceous. Colonies on OA olivaceous-grey, smoke-grey due to profuse sporulation, reverse olivaceous-grey to iron-grey, velvety, aerial mycelium sparse, diffuse. Colonies reaching 20 mm diam on SNA, and 40 mm on PDA after 1 mo at 25 °C in the dark; colonies fertile.

Specimens examined: **New Zealand**, Levin, on *Scilla peruviana* (*Hyacinthaceae*), 21 Dec. 1965, G.F. Laudon, IMI 116997 **holotype**; Auckland, Manurewa, Auckland Botanic Gardens, on leaf spots of *Scilla peruviana*, 25 Apr. 2004, C.F. Hill, 1044, CBS H-19903, **epitype designated here**, culture ex-type CBS 116461.

Notes: In culture *Cladophialophora scillae* forms a pseudocladosporium-like state, though the scars are somewhat darkened and thickened, but not refractive. Conidiophores are reduced to conidiogenous cells that are integrated in the mycelium, terminal or lateral, frequently also as an inconspicuous lateral denticle, with a flat-tipped scar. Conidia occur in long, branched chains, which are subcylindrical to narrowly ellipsoid, and are up to 35 µm long, 1.5–3 µm wide, thus longer and thinner than reported on the host, which were 0–3-septate, subcylindrical to ellipsoid-ovoid, 7–22 × 2.5–4 µm. Due to the fusicladioid habit of this species *in vivo*, Schubert & Braun (2002a) reallocated it to *Fusicladium*. Based on ITS sequence data, morphology and cultural characteristics, *Cladophialophora scillae* was almost identical to an isolate obtained from leaf spots of *Hosta plantaginea* in Korea. These isolates appeared to resemble species of *Fusicladium*, but phylogenetically they clustered in the *Herpotrichiellaceae*. Therefore, "*Fusicladium*" *scillae* was placed in the genus *Cladophialophora*. As far as we are aware, this species and *C. hostae* are first reports of phytopathogenic species within the genus *Cladophialophora*.

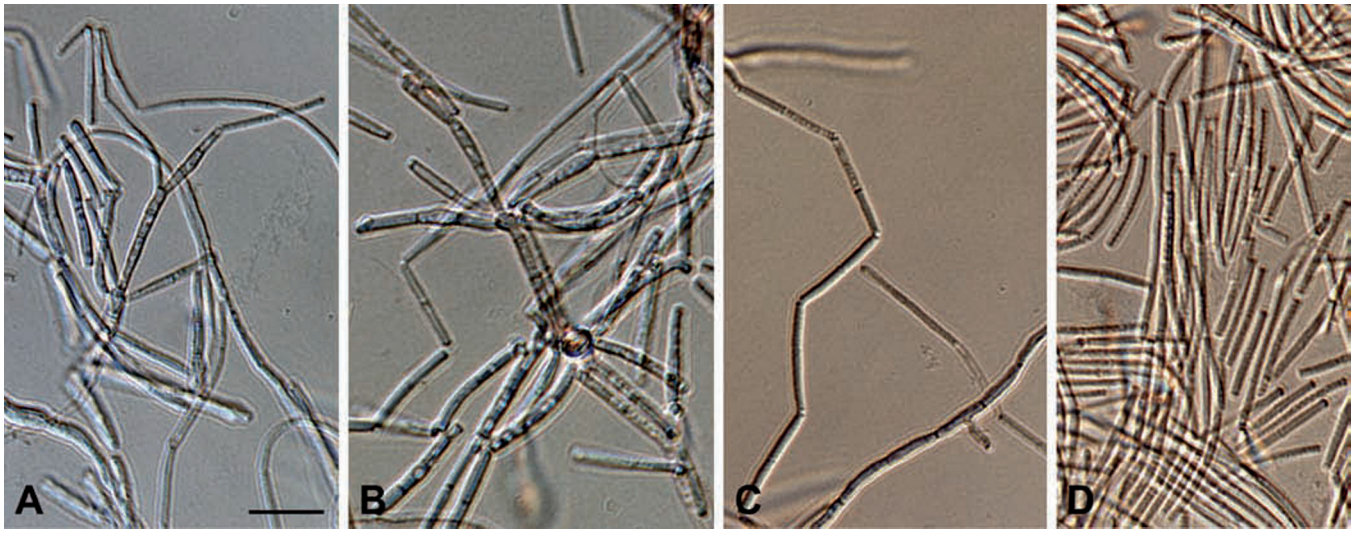

Fig. 13. *Cladophialophora sylvestris* (CBS 350.83). A–B. Conidiophores. C. Catenulate conidia. D. Conidial mass. Scale bar = 10 µm.

Fig. 14. *Cyphellophora hylomeconis* (CBS 113311). A. Colony on PDA. B–C. Hyphae with truncate conidiogenous loci. D–F. Conidia. Scale bars = 10 µm.

Cladophialophora sylvestris Crous & de Hoog, **sp. nov.** MycoBank MB504531. Fig. 13.

Etymology: Refers to its host, *Pinus sylvestris*.

Cladophialophorae humicolae similis, sed conidiis 0–3-septatis, (7–)10–16(–20) × 1.5–2 µm.

Mycelium composed of branched, smooth, pale olivaceous to pale brown hyphae, frequently forming hyphal coils, not to slightly constricted at the septa, 1–2 µm wide. *Conidiophores* medium brown, subcylindrical, flexuous, mononematous, multiseptate, up to 50 µm long, and 2–3 µm wide. *Conidiogenous cells* apical, sympodial, pale brown, 5–12 × 2–3 µm; scars somewhat darkened and thickened, not refractive. *Conidia* occurring in branched chains; ramoconidia up to 2 µm wide, giving rise apically to disarticulating chains of conidia; smooth, 0–3-septate, pale olivaceous, subcylindrical, (7–)10–16(–20) × 1.5–2 µm, with truncate ends; hila somewhat darkened and thickened, not refractive.

Cultural characteristics: Colonies erumpent on PDA, with smooth, catenulate margins; iron-grey (surface); reverse greenish black. Colonies reaching 15 mm diam after 1 mo at 25 °C in the dark; colonies fertile.

Specimen examined: **Netherlands**, Kootwijk, needle litter of *Pinus sylvestris* (*Pinaceae*), 8 Nov. 1982, G.S. de Hoog, **holotype** CBS H-19917, culture ex-type CBS 350.83.

Notes: Morphologically CBS 350.83 was originally identified as *Polyscytalum griseum* Sacc., but the latter is reported to have conidia that are 5–5.5 × 1 µm (Saccardo 1877), which is much smaller than that observed for the present isolate. Furthermore, the type species of *Polyscytalum*, *P. fecundissimum* Riess (CBS 100506), does not cluster within the *Herpotrichiellaceae*, thus suggesting that CBS 350.83 is best treated as a new species of *Cladophialophora.*

Cyphellophora hylomeconis Crous, de Hoog & H.D. Shin, **sp. nov.** MycoBank MB504532. Fig. 14.

Etymology: Named after its host genus, *Hylomecon*.

Cyphellophorae lacinatae similis, sed conidiis longioribus et leniter angustioribus, (15–)25–35(–55) × (2.5–)3(–4) µm.

Mycelium consisting of branched, greenish brown, septate, branched, smooth, 3–5 µm wide hyphae, constricted at septa. *Conidiogenous cells* phialidic, intercalary, appearing denticulate, 1 µm tall, 1.5–2 µm wide, with minute collarettes (at times

proliferating percurrently). *Conidia* sickle-shaped, smooth, medium brown, guttulate, (1–)3(–5)-septate, constricted at septa, widest in middle, or lower third of the conidium; apex subacutely rounded, base subtruncate, or having a slight constriction, giving rise to a foot cell, 1 µm long, 0.5–1 µm wide, subacutely rounded, (15–)25–35(–55) × (2.5–)3(–4) µm; a marginal frill is visible above the foot cell, suggesting this foot cell may be the onset of basal germination; conidia also anastomose and undergo microcyclic conidiation in culture.

Cultural characteristics: Colonies slow-growing, slimy, aerial mycelium absent, margins smooth, catenate; surface crumpled, olivaceous-black to iron-grey. Colonies reaching 20 mm diam after 1 mo at 25 °C in the dark on PDA, 12 mm on SNA; colonies fertile.

Specimen examined: **Korea**, Yangpyeong, on leaves of *Hylomecon verlance* (*Papaveraceae*), 4 Jun. 2003, H.D. Shin, **holotype** CBS H-19907, **isotype** SMK 19550, culture ex-type CBS 113311.

Notes: *Cyphellophora hylomeconis* is related to the type species of the genus, *Cyphellophora laciniata* G.A. de Vries, which also resides in the *Herpotrichiellaceae*. The genus *Cyphellophora* G.A. de Vries is phenetically distinguished from *Pseudomicrodochium* B.C. Sutton, typified by *P. aciculare* B.C. Sutton (1975) by melanized *versus* hyaline thalli. Phylogenetic confirmation is pending due to unavailability of sequence data. Decock *et al*. (2003) synonymised the hyaline genus *Kumbhamaya* M. Jacob & D.J. Bhat (Jacob & Bhat 2000) with *Cyphellophora*, but as no cultures of this fungus are available this decision seems premature. Nearly all *Cyphellophora* species accepted by Decock *et al.* (2003) have been found to be involved in cutaneous infections in humans. This also holds true for the species originally described as being environmental, *C. vermispora* Walz & de Hoog, which is closely related to *C. suttonii* (Ajello *et al*.) Decock and *C. fusarioides* (C.K. Campbell & B.C. Sutton) Decock known from proven human and animal infections. Decock *et al*. (2003) added the melanized species *C. guyanensis* Decock & Delgado, isolated as a saprobe from tropical leaf litter. *Cyphellophora hylomeconis* is the first species of the genus infecting a living plant host. ITS sequences are remote from those of the remaining *Cyphellophora* species, the nearest neighbour being *C. pluriseptata* G.A. de Vries, Elders & Luykx at 19.1 % distance (data not shown). *Cyphellophora hylomeconis* can be distinguished based on its conidial dimensions and septation. Conidia are larger than those of *C. fusarioides* (11–20 × 2–2.5 µm, 1–2-septate), and those of *C. laciniata* (11–25 × 2–5 µm, 1–3-septate) (for a key to the species see Decock *et al*. 2003).

***Exophiala* sp. 1.** Fig. 15.

Mycelium consisting of smooth, branched, septate, medium brown, 2–3 µm wide hyphae, regular in width, forming hyphal strands and hyphal coils, with free yeast-like cells present in culture; chlamydospores terminal on hyphae, frequently forming clusters or chains, medium brown, ellipsoid, 0–1-septate, up to 10 µm long and 5 µm wide. *Conidiophores* reduced to conidiogenous cells, or consisting of one supporting cell, giving rise to a single conidiogenous cell, subcylindrical to ellipsoid, medium brown, smooth, 5–12 × 3.5–4 µm, with 1(–3) phialidic loci, somewhat protruding, appearing subdenticulate at first glance under the light microscope. *Conidiogenous cells* integrated as lateral loci on hyphal cells, inconspicuous, 1–1.5 µm wide, with a slightly flaring collarette, (1–)1.5(–2) µm long. *Conidia* ellipsoid, smooth, guttulate, becoming brown, swollen and elongated, and at times 1-septate, 4–5(–7) × (2.5–)3(–4) µm (description based on CBS 115142).

Cultural characteristics: Colonies erumpent, spreading, with sparse to dense aerial mycelium on PDA, olivaceous-grey (surface), with a thin to wide, smooth, olivaceous-black margins; reverse olivaceous-black; on OA olivaceous-grey (surface) with wide, olivaceous-black margins. Colonies reaching 40–50 mm diam after 1 mo at 25 °C in the dark; colonies fertile, but sporulation sparse. Not able to grow at 37 °C.

Specimen examined: **Australia**, from a fruit drink, May 2002, N.J. Charley, CBS 115142 = CPC 11044 = FRR 5582.

Notes: Species of *Exophiala* are frequently observed as agents of human mycoses in immunocompromised patients (de Hoog *et al*. 2000). They are found in the environment as slow-growing, oligotrophic colonisers of moist substrates. For example the thermotolerant species *E. dermatitidis* (Kano) de Hoog and *E. phaeomuriformis* (Matsumoto *et al.*) Matos *et al.* are common in public steam baths (Matos *et al*. 2003), while *E. mesophila* Listemann & Freiesleben can be found in showers and swimming pools (unpubl. data). Both species are able to cause infections in humans (Zeng *et al*. 2007). Several other species have been associated primarily with infections in fish and cold-blooded animals (Richards *et al.* 1978) and are occasionally found on humans (Madan *et al.* 2006). The occurrence of the present species in fruit drinks, therefore, is cause of concern, although it was unable to grow at 37 °C. This species forms part of a larger study, and will be treated elsewhere.

***Exophiala* sp. 2.** Fig. 16.

Mycelium consisting of smooth, branched, septate, pale brown, 1.5–3 µm wide hyphae, forming hyphal strands and hyphal coils; hyphae at times terminating in chains of ellipsoid chlamydospores that are medium brown, smooth, up to 10 µm long and 5 µm wide. *Conidiophores* subcylindrical, medium brown, smooth, consisting of a supporting cell and a single conidiogenous cell, or reduced to a conidiogenous cell, straight to curved, up to 30 µm long and 2–3 µm wide. *Conidiogenous cells* pale to medium brown, subcylindrical to narrowly ellipsoid or subclavate, with 1–3 apical, phialidic loci, 1 µm wide, 1–2 µm tall, collarette somewhat flaring, but mostly cylindrical, 7–20 × 2–2.5 µm; at times proliferating percurrently. *Conidia* ellipsoid, smooth, guttulate, hyaline, becoming pale olivaceous, apex obtuse, base subtruncate, (4–)5–7(–10) × 2–2.5(–3) µm.

Cultural characteristics: Colonies spreading with smooth, submerged margins, moderate aerial mycelium on PDA, sparse on OA, on PDA and OA olivaceous-grey (surface), with a wide, iron-grey margin; reverse iron-grey. Colonies reaching 40–50 mm diam after 1 mo at 25 °C in the dark; colonies fertile. Not able to grow at 37 °C.

Specimen examined: **Australia**, from bottled spring water, May 2003, N.J. Charley, CBS 115143 = CPC 11047 = FRR 5599.

Notes: This strain represents another taxon occurring in bottled drinks destined for human consumption. As it is unable to grow at 37 °C, it does not appear to pose any serious threat to human health. This species forms part of a larger study, and will be treated elsewhere.

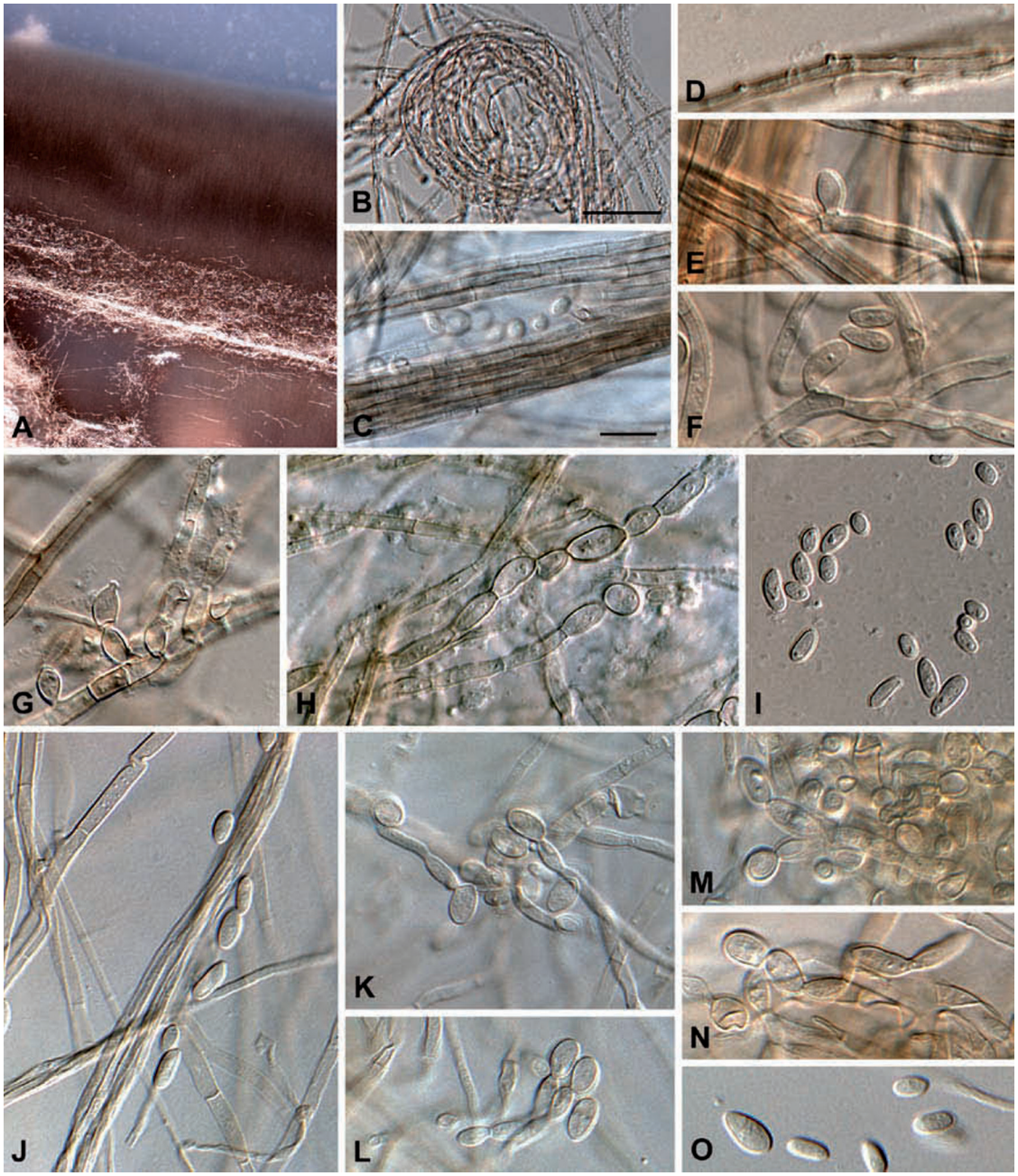

Fig. 15. *Exophiala* sp. 1 (CBS 115142). A. Colony on PDA. B. Hyphal coil. C. Hyphal strand. D–H. Conidiogenous cells and loci. I–O. Conidiogenous cells and conidia. Scale bars = 10 µm.

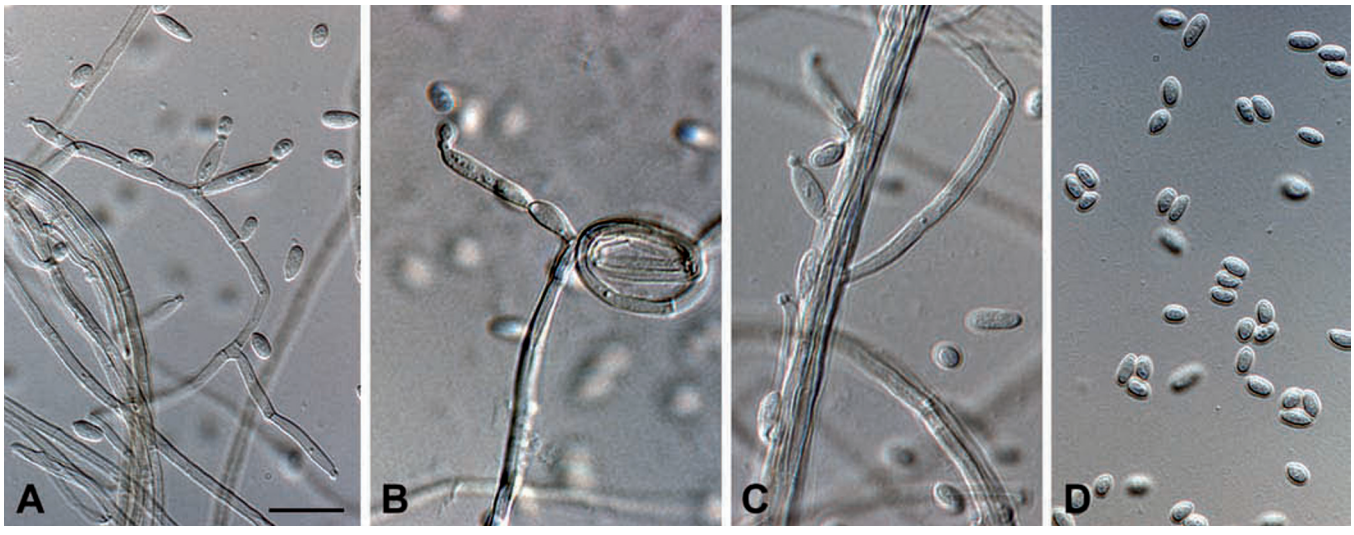

Fig. 16. *Exophiala* sp. 2 (CBS 115143). A. Conidiogenous cells. B. Conidiophore with hyphal coil. C. Conidiogenous cell with hyphal strand. D. Conidia. Scale bar = 10 µm.

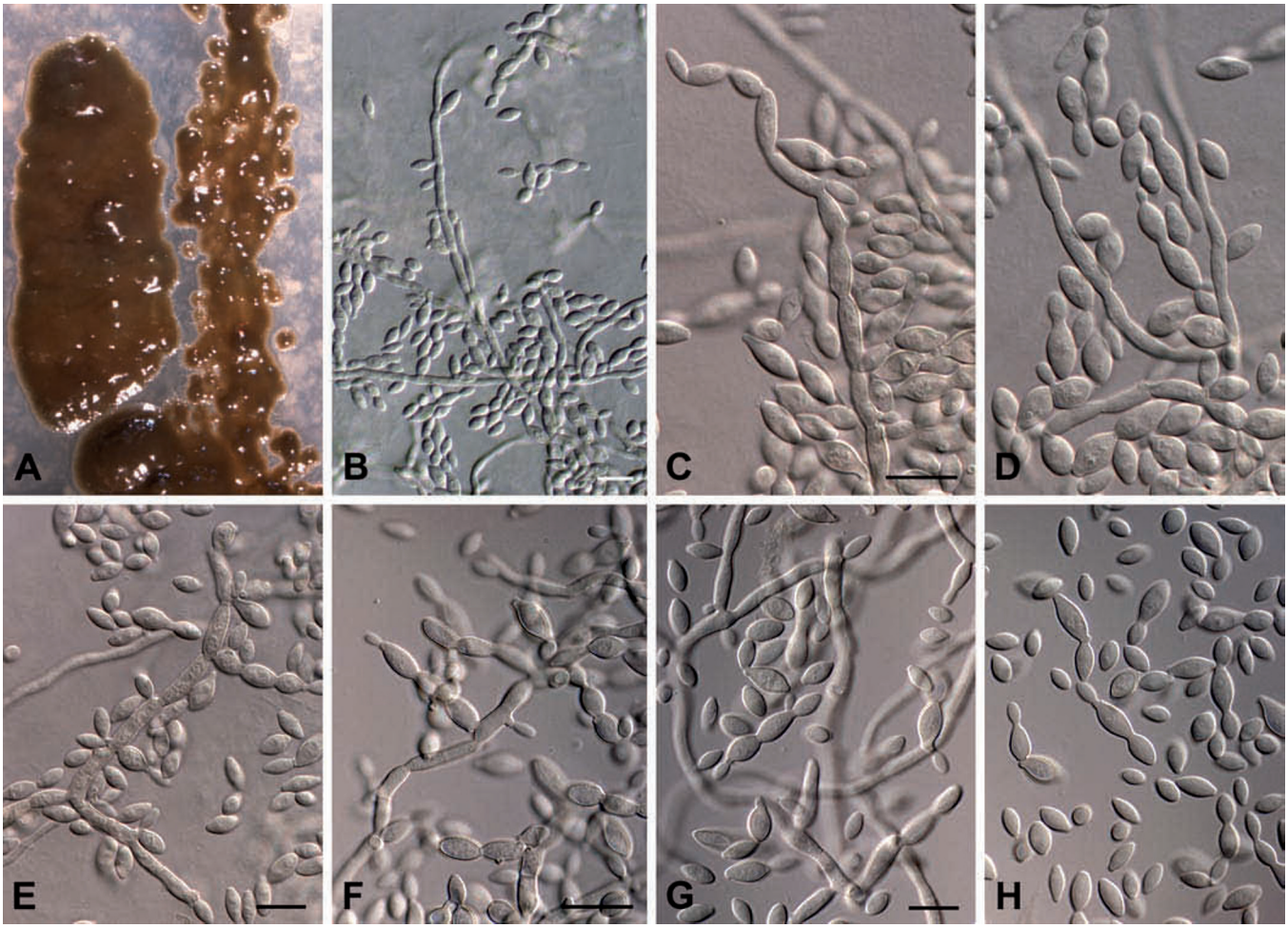

Fig. 17. *Exophiala eucalyptorum* (CPC 11261). A. Colony on PDA. B–H. Hyphae, conidiogenous cells and conidia. Scale bars = 10 µm.

Exophiala eucalyptorum Crous, **sp. nov.** MycoBank MB504533. Fig. 17.

Etymology: Named after its occurrence on *Eucalyptus* leaves.

Exophialae spiniferae similis, sed conidiis fusoidibus-ellipsoideis, (5–)6–8(–10) × (3–)4–5(–7) µm, et cellulis conidiogenis saepe catenatis, in catenis brevibus, dividentibus.

Mycelium consisting of smooth to finely verruculose, branched, septate, 2–4 µm wide hyphae, at times giving rise to chains of dark brown, fusoid-ellipsoid chlamydospores, which can still have phialides, suggesting they were conidiogenous cells; hyphae becoming constricted at septa when fertile. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* numerous, terminal and lateral, mono- to polyphialidic, 5–15 × 3–5 µm; loci 1–1.5 µm wide and tall, with inconspicuous collarettes, at time proliferating percurrently; conidiogenous cells fusoid-ellipsoid, and frequently breaking off, appearing as short chains of conidia, but distinct in having conidiogenous loci. *Conidia* fusoid-ellipsoid, apex acutely rounded, base subtruncate, (5–)6–8(–10) × (3–)4–5(–7) µm; frequently becoming fertile, septate and brown with age.

Cultural characteristics: Colonies erumpent, convex, smooth, slimy, margins feathery to crenate and smooth; aerial mycelium absent, growth yeast-like. Colonies on PDA, OA and SNA chestnut on surface and reverse. Colonies reaching 4 mm diam after 2 wk on PDA at 25 °C in the dark.

Specimen examined: **New Zealand**, Wellington Botanical Garden, on leaf litter of *Eucalyptus* sp. (*Myrtaceae*), Mar. 2004, J.A. Stalpers, **holotype** CBS H-19905, culture ex-type CBS 121638 = CPC 11261.

Notes: *Exophiala eucalyptorum* is rather characteristic in that, in culture, chains of conidiogenous cells frequently detach from hyphae, appearing as short, intact chains of fertile conidia. Its phylogenetic position is somewhat outside the core of the *Herpotrichiellaceae* containing most *Capronia* teleomorphs and the remaining opportunistic *Exophiala* species, but still within the *Chaetothyriales* (Figs 1–2).

Members of *Venturiaceae*

Anungitea B. Sutton and *Anungitopsis* R.F. Castañeda & W.B. Kendr.

Sutton (1973) erected the genus *Anungitea* to accommodate species with brown, mononematous conidiophores bearing apically aggregated, flat-tipped, subdenticulate conidiogenous loci that give rise to chains of pale brown subcylindrical conidia with thickened, darkened hila. He compared the type species, *A. fragilis* B. Sutton with anamorph genera of the *Mycosphaerellaceae*, but did not compare it to *Fusicladium*, to which it is remarkably similar. Castañeda & Kendrick (1990b) introduced the genus *Anungitopsis* based on *A. speciosa* R.F. Castañeda & W.B. Kendr. This genus was distinguished from *Anungitea* by its formation of subdenticulate conidiogenous loci distributed along the apical region of the conidiophore, and by the relatively poorly defined appearance of these loci. No cultures are available of the ex-type species of *Anungitea*, but we studied strains of *Anungitopsis*

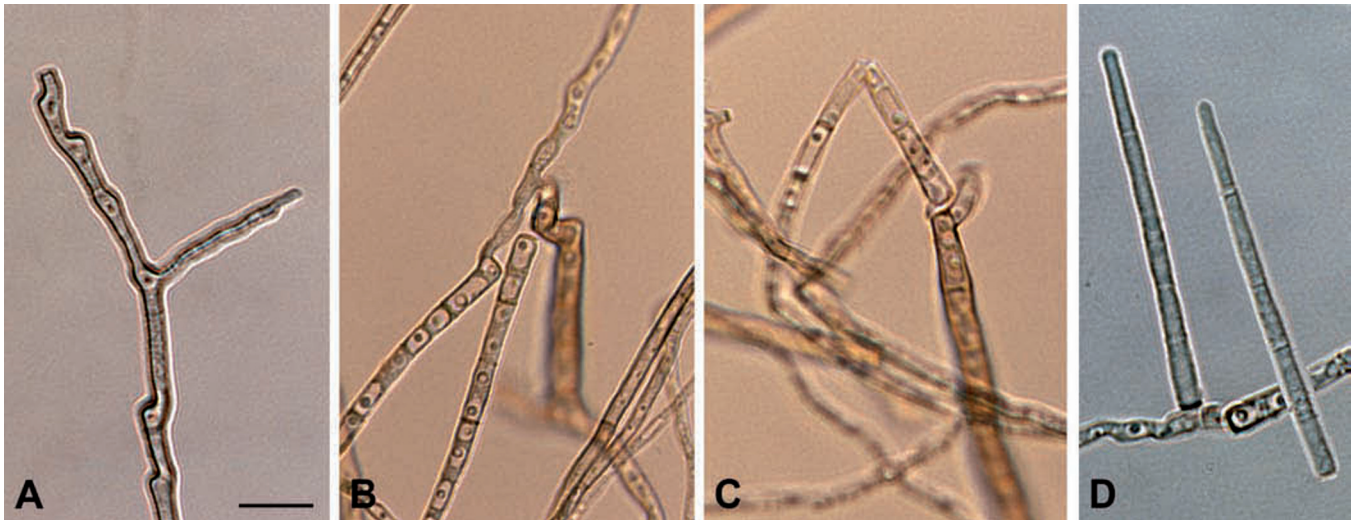

Fig. 18. *Cylindrosympodium lauri* (CBS 240.95). A–C. Conidiophores with conidiogenous loci. D. Conidia. Scale bar = 10 µm.

amoena R.F. Castañeda & Dugan (CBS 254.95, ex-type), and *Anungitopsis intermedia* Crous & W.B. Kendr. (CBS 110746, ex-epitype), and found them to cluster adjacent to *Fusicladium* (*Venturiaceae*). However, the ex-type strain of *Anungitopsis speciosa* (CBS 181.95), type species of *Anungitopsis*, clustered distantly from all other species, confirming that the genus name *Anungitopsis* is not available for any of the taxa treated here. In any case, *A. speciosa* has unusual subdenticulate conidiogenous loci with indistinct marginal frills, and these are obviously different from those of anungitea- and fusicladium-like anamorphs, including *A. amoena* and *A. intermedia*. The latter two species previously referred to as *Anungitopsis* belong to a sister clade of the *Venturia* (*Fusicladium*, incl. *Pseudocladosporium*) clade. *Sympoventuria* (Crous *et al.* 2007b), which produces a sympodiella-like anamorph in culture, is the only teleomorph of this clade hitherto known. The venturia-like habit of *Sympoventuria*, connected with fusicladium- / pseudocladosporium-like anamorphs distributed in both clades, indicates a close relation between these clades, suggesting a placement in the *Venturiaceae*. Schubert *et al*. (2003) referred to the difficulty to distinguish between *Anungitea* and *Fusicladium*. *Anungitea* is undoubtedly heterogeneous. *Anungitea rhabdospora* P.M. Kirk (Kirk 1983) is, for instance, intermediate between *Anungitea* (conidiophores with a terminal denticulate conidiogenous cell, but conidia disarticulating in an arthroconidium-like manner) and *Sympodiella* B. Kendr. (conidiophores distinctly sympodial, forming arthroconidia). Other species assigned to *Anungitea* possess a distinctly swollen, lobed conidiophore base, e.g. *A. heterospora* P.M. Kirk (Kirk 1983), which is comparable with other morphologically similar genera, e.g., *Parapleurotheciopsis* P.M. Kirk (Kirk 1982), *Rhizocladosporium* Crous & U. Braun (see Crous *et al*. 2007a – this volume), and *Subramaniomyces* Varghese & V.G. Rao (Varghese & Rao 1979, Kirk 1982). The application of *Anungitea* depends, however, on the affinity of *A. fragilis*, the type species, of which sequence data are not yet available. The best solution for this problem is the widened application of *Fusicladium* (incl. *Pseudocladosporium*) to both sister clades, i.e., to the whole *Venturiaceae*. Morphologically a distinction between fusicladioid anamorphs of both clades is impossible. The more "fusicladium-like" growth is mainly characteristic for the fruiting *in vivo*, above all in biotrophic taxa, whereas the more "pseudocladosporium-like" habit is typical for the growth *in vitro* and in saprobic taxa, a phenomenon which is also evident in species of the morphologically similar genus *Cladophialophora* (see *C. hostae* and *C. scillae*). A potential placement of *Anungitea fragilis* within the *Venturiaceae*, which has still to be proven, would render the genus *Anungitea* a synonym of *Fusicladium*, but in the case of a quite distinct phylogenetic position a new circumscription of this genus, excluding the *Venturiaceae* anamorphs, would be necessary. Thus, a final conclusion about *Anungitea* has to be postponed, awaiting cultures and sequence analyses of its type species.

The taxonomic placement of a fungus from the Canary Islands, isolated from leaf litter of *Laurus* sp. (CBS 240.95), is somewhat problematic. It clusters within the *Venturiaceae*, but not within *Venturia s. str.* itself, and it does not fit into the current morphological concept of *Fusicladium* (incl. *Pseudocladosporium*). Based on its solitary, cylindrical, hyaline conidia and pale brown conidiogenous structures, it resembles species accommodated in *Cylindrosympodium* W.B. Kendr. & R.F. Castañeda (Castañeda & Kendrick 1990a, Marvanová & Laichmanová 2007).

Cylindrosympodium lauri Crous & R.F. Castañeda, **sp. nov.** MycoBank MB504534. Fig. 18.

Etymology: Named after the host genus it was collected from, *Laurus*.

Cylindrosympodii variabilis similis, sed conidiophoris longioribus, ad 70 µm, conidiis subhyalinis vel dilute olivaceis.

Mycelium consisting of brown, smooth, septate, branched hyphae, 1.5–2.5 µm wide. *Conidiophores* macronematous, mononematous, solitary, erect, subcylindrical, straight to geniculate-sinuous, medium brown, smooth, 35–70 × 2.5–4 µm, 1–5-septate. *Conidiogenous cells* terminal, integrated, pale to medium brown, smooth, 10–35 × 2–3 µm, proliferating sympodially, with one to several flat-tipped loci, 1.5–2 µm wide; scars somewhat darkened, minutely thickened, but not refractive. *Conidia* solitary, subacicular to narrowly subcylindrical, apex subobtuse, base truncate, or somewhat swollen, straight or curved, smooth, subhyaline to very pale olivaceous, guttulate, (45–)60–70(–80) × 2.5–3(–3.5) µm, (4–)6–8-septate; scars are somewhat darkened, minutely thickened, but not refractive, 2.5–3 µm wide.

Cultural characteristics: Colonies erumpent, convex, with smooth, lobed margins, and moderate, dense aerial mycelium on PDA; mouse-grey in the central part, and dark mouse-grey in the outer zone (surface); reverse dark mouse-grey. Colonies reaching 5 mm diam after 2 wk at 25 °C in the dark; colonies fertile.

Specimen examined: **Spain**, Canary Islands, leaf litter of *Laurus* sp. (*Lauraceae*), 4 Jan. 1995, R.F. Castañeda, **holotype** CBS H-19909, culture ex-type CBS 240.95.

Note: The present fungus differs from *Cylindrosympodium variabile* (de Hoog) W.B. Kendr. & R.F. Castañeda (de Hoog 1985) in that the conidiophores are much longer, the conidia are subhyaline to very pale olivaceous, and the scars and hila are thin, slightly darkened, but not refractive.

Venturia Sacc. and its anamorph *Fusicladium*

Venturia Sacc., Syll. fung. (Abellini) 1: 586. 1882.
= *Apiosporina* Höhn., Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturw. Cl., Abt. 1, 119: 439. 1910, **syn. nov.**
= *Metacoleroa* Petr., Ann. Mycol. 25: 332. 1927, **syn. nov.**
= *Caproventuria* U. Braun, *A Monograph of Cercosporella, Ramularia and Allied Genera (Phytopathogenic Hyphomycetes)* 2: 396. 1998, **syn. nov.**
For additional synonyms see Sivanesan, *The bitunicate Ascomycetes and their anamorphs*: 604. 1984.
Anamorph: ***Fusicladium*** Bonord., *Handb. Mykol.*: 80. 1851.
= *Pseudocladosporium* U. Braun, *A Monograph of Cercosporella, Ramularia and Allied Genera (Phytopathogenic Hyphomycetes)* 2: 392. 1998, **syn. nov.**
For additional synonyms, see Schubert *et al*. (2003).

Notes: The genus *Caproventuria*, based on *C. hanliniana* (U. Braun & Feiler) U. Braun, was erected to accommodate saprobic, soil-borne venturia-like ascomycetes with numerous ascomatal setae, and an anamorph quite distinct from *Fusicladium* (Braun 1998). The genus *Metacoleroa* is based on *M. dickiei* (Berk. & Broome) Petr., which clusters in the *Venturiaceae*, adjacent to *Caproventuria*, which has *Pseudocladosporium* anamorphs. *Metacoleroa* was retained by Barr (1987) as separate from *Venturia* based on its superficial ascomata with a thin, stromatic layer beneath the ascomata. Whether these criteria still justify the separation of *Caproventuria* and *Metacoleroa* from *Venturia* is debatable, and the names *Venturia dickiei* (Berk. & Broome) Ces. & de Not. and *Venturia hanliniana* (U. Braun & Feiler) Unter. are available for these organisms. The genus *Apiosporina*, which is based on *Apiosporina collinsii* (Schwein.) Höhn., clusters in the *Venturiaceae*, as was to be expected based on its *Fusicladium* anamorph (Schubert *et al*. 2003). It was distinguished from *Venturia* species by having ascospores strictly septate near the lower end (Sivanesan 1984).

The anamorph genus *Fusicladium* has been monographed by Schubert *et al*. (2003). Morphological as well as molecular studies (Beck *et al*. 2005) demonstrated that the genus *Venturia* with its *Fusicladium* anamorphs is monophyletic. A separation of *Venturia* into various uniform subclades based on the previous anamorph genera *Fusicladium, Pollaccia* and *Spilocaea* was not evident and could be rejected. As in cercosporoid anamorphs of *Mycosphaerella*, features such as the arrangement of the conidiophores (solitary, fasciculate, sporodochial), the proliferation of conidiogenous cells (sympodial, percurrent) and shape, size as well as formation of conidia (solitary, catenate) proved to be of little taxonomic value at generic level. Hence, Schubert *et al*. (2003) proposed to maintain *Fusicladium emend.* as sole anamorph genus for *Venturia*. The genus *Fusicladosporium* Partridge & Morgan-Jones (type species: *Cladosporium carpophilum* Thüm.) (Partridge & Morgan-Jones 2003), recently erected to accommodate fusicladium-like species with catenate conidia, represents a further synonym of *Fusicladium*.

Similar to their occurrence *in vivo* the conidiophores *in vitro* of species previously referred to the genera *Spilocaea* and *Pollaccia* are usually micronematous, conidia often appear to be directly formed on the mycelium, unilocal, determinate, mostly reduced to conidiogenous cells, sometimes forming a few percurrent proliferations, whereas the conidiophores of species of *Fusicladium s. str.* are mostly macronematous, but sometimes also micronematous. They are often initiated as short lateral, peg-like outgrowths of hyphae which proliferate sympodially, becoming slightly geniculate, forming a single, several or numerous subdenticulate to denticulate, truncate, unthickened or only slightly thickened, somewhat darkened-refractive conidiogenous loci.

The genus *Pseudocladosporium* was described to be quite distinct from *Fusicladium* by being saprobic and connected with a different teleomorph, viz. *Caproventuria* (Braun 1998). However, since the type species of *Caproventuria*, *C. hanliniana*, with its anamorph *Pseudocladosporium brevicatenatum* (U. Braun & Feiler) U. Braun clusters together with numerous *Venturia* species, the genus *Pseudocladosporium* should be reduced to synonymy with *Fusicladium*. Morphologically there is no clear delimitation between *Fusicladium* and *Pseudocladosporium*. The typically pseudocladosporium-like habit, characterised by forming solitary conidiophores, often reduced to conidiogenous cells or even micronematous, and conidia formed in long chains, is mainly found in culture, above all in saprobic taxa. The fusicladium-like growth with well-developed macronematous conidiophores is usually more evident *in vivo*, above all in biotrophic taxa. There are, however, all kinds of transitions between these two genera.

Fusicladium africanum Crous, **sp. nov.** MycoBank MB504535. Fig. 19.

Etymology: Named after the continent from which it was collected, Africa.

Fusicladio brevicatenato similis, sed conidiophoris brevioribus, 5–10 µm longis, conidiis minoribus, ad 20 × 3.5 µm, 0(–1)-septatis, locis conidiogenis et hilis angustioribus, 1–1.5 µm latis.

Mycelium composed of smooth, medium brown, branched, septate, 1.5–2 µm wide hyphae, frequently forming hyphal coils. *Conidiophores* reduced to conidiogenous cells, solitary, pale to medium brown, smooth, inconspicuous, integrated in hyphae, varying from small, truncate lateral loci on hyphal cells, 1–1.5 µm wide, to micronematous conidiogenous cells, 5–10 × 2–3 µm; mono- to polyblastic, sympodial, scars inconspicuous, 1 µm wide. *Conidia* in long, branched chains of up to 40, subcylindrical, 0(–1)-septate, pale brown, smooth; hila truncate, 1 µm wide, unthickened, neither darkened nor refractive; ramoconidia (11–)15–17(–20) × 2–3(–3.5) µm; conidia (8–)11–17 × 2–2.5 µm.

Cultural characteristics: Colonies somewhat erumpent, with moderate aerial mycelium and smooth, lobate margins on PDA, ochreous to umber (surface); reverse dark umber; on OA umber; on SNA ochreous. Colonies reaching 9 mm diam on PDA after 2 wk at 25 °C in the dark; colonies fertile.

Specimen examined: **South Africa**, Western Cape Province, Malmesbury, *Eucalyptus* leaf litter, Jan. 2006, P.W. Crous, **holotype** CBS H-19904, cultures ex-type CPC 12828 = CBS 121639, CPC 12829 = CBS 121640.

Notes: *Fusicladium africanum* is a somewhat atypical member of the genus, as its conidial hila are quite unthickened and inconspicuous. Among biotrophic, leaf-spotting *Fusicladium* species a wider morphological variation was found pertaining to the structure of the conidiogenous loci and conidial hila, ranging from being indistinct, unthickened and not darkened-refractive to unthickened or almost so, but somewhat darkened-refractive (Schubert *et al*. 2003). *Fusicladium africanum* was found occurring with *Sympoventuria capensis* Crous & Seifert on *Eucalyptus* leaf litter in South Africa (Crous *et al*. 2007b).

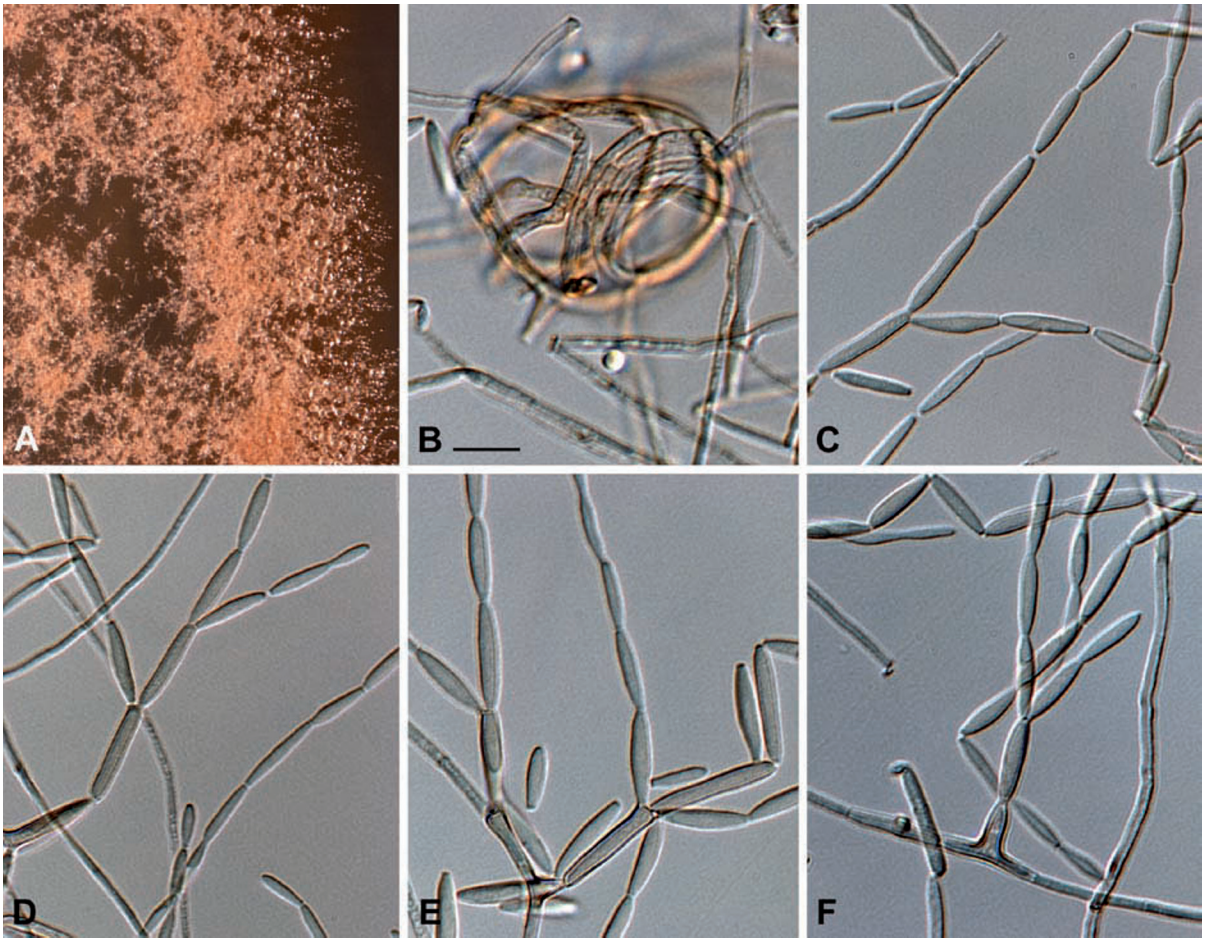

Fig. 19. *Fusicladium africanum* (CPC 12828). A. Colony on MEA. B. Hyphal coil. C. Branched conidial chain. D–F. Conidiophores with catenulate conidia. Scale bar = 10 µm.

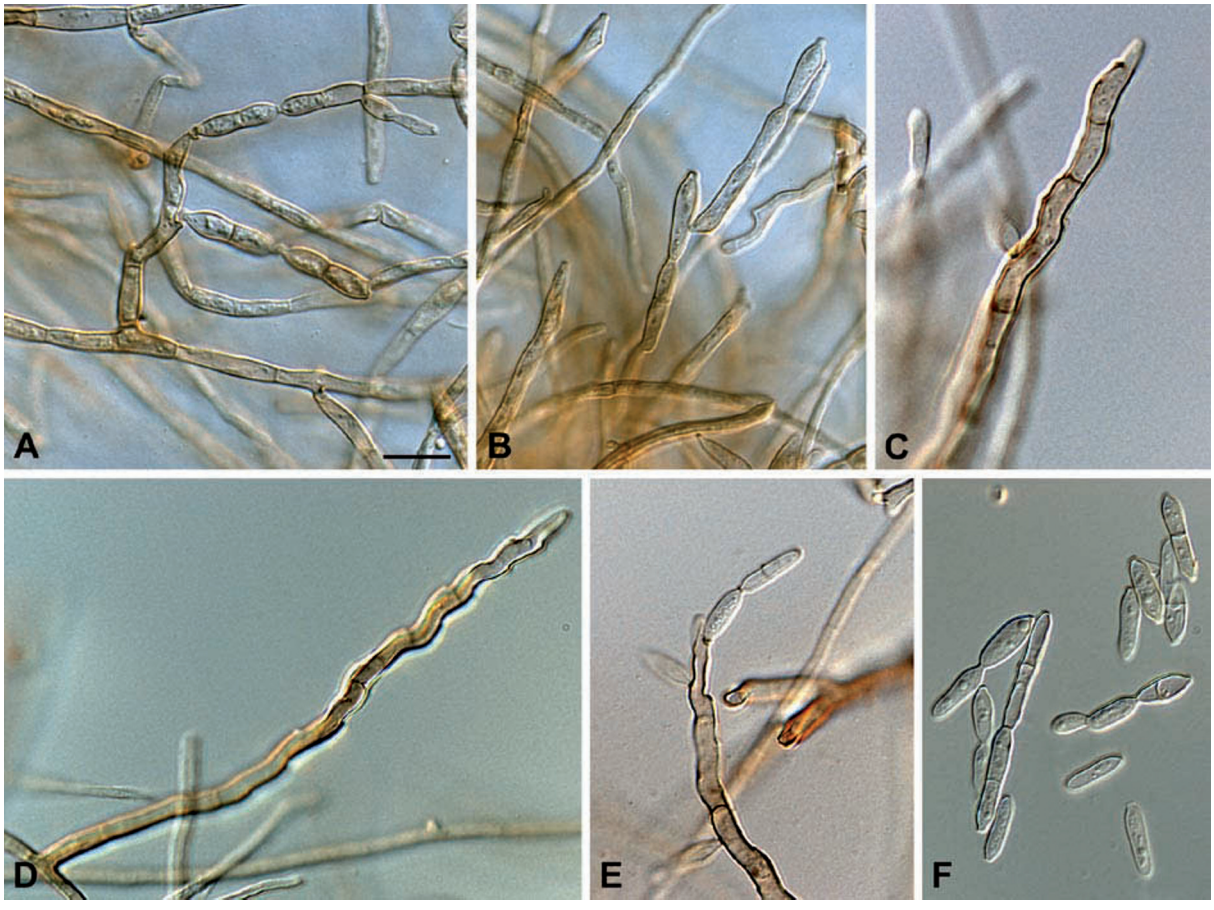

Fig. 20. *Fusicladium amoenum* (CBS 254.95). A–E. Conidiophores with conidiogenous loci. F. Conidia. Scale bar = 10 µm.

Fig. 21. *Fusicladium convolvularum* (CBS 112706). A–B, D–I. Conidiophores with conidiogenous loci. C, J–K. Ramoconidia and conidia. Scale bars = 10 µm.

Fusicladium amoenum (R.F. Castañeda & Dugan) Crous, K. Schub. & U. Braun, **comb. nov.** MycoBank MB504536. Fig. 20.

Basionym: *Anungitopsis amoena* R.F. Castañeda & Dugan, Mycotaxon 72: 118. 1999.

≡ *Cladosporium amoenum* R.F. Castañeda, in Untereiner *et al.*, 1998, *nom. nud.*

Specimen examined: **Cuba**, Santiago de Cuba, La Gran Piedra, fallen leaves of *Eucalyptus* sp. (*Myrtaceae*), 2 Nov. 1994, R.F. Castañeda, (Ho *et al.* 1999: 117, figs 2–3) **iconotype**, culture ex-type CBS 254.95 = ATCC 200947 = IMI 367525 = INIFAT C94/155 = MUCL 39143.

Note: In culture *F. amoenum* has a typical pseudocladosporium-like morphology, though the scars are neither prominently thickened, nor refractive.

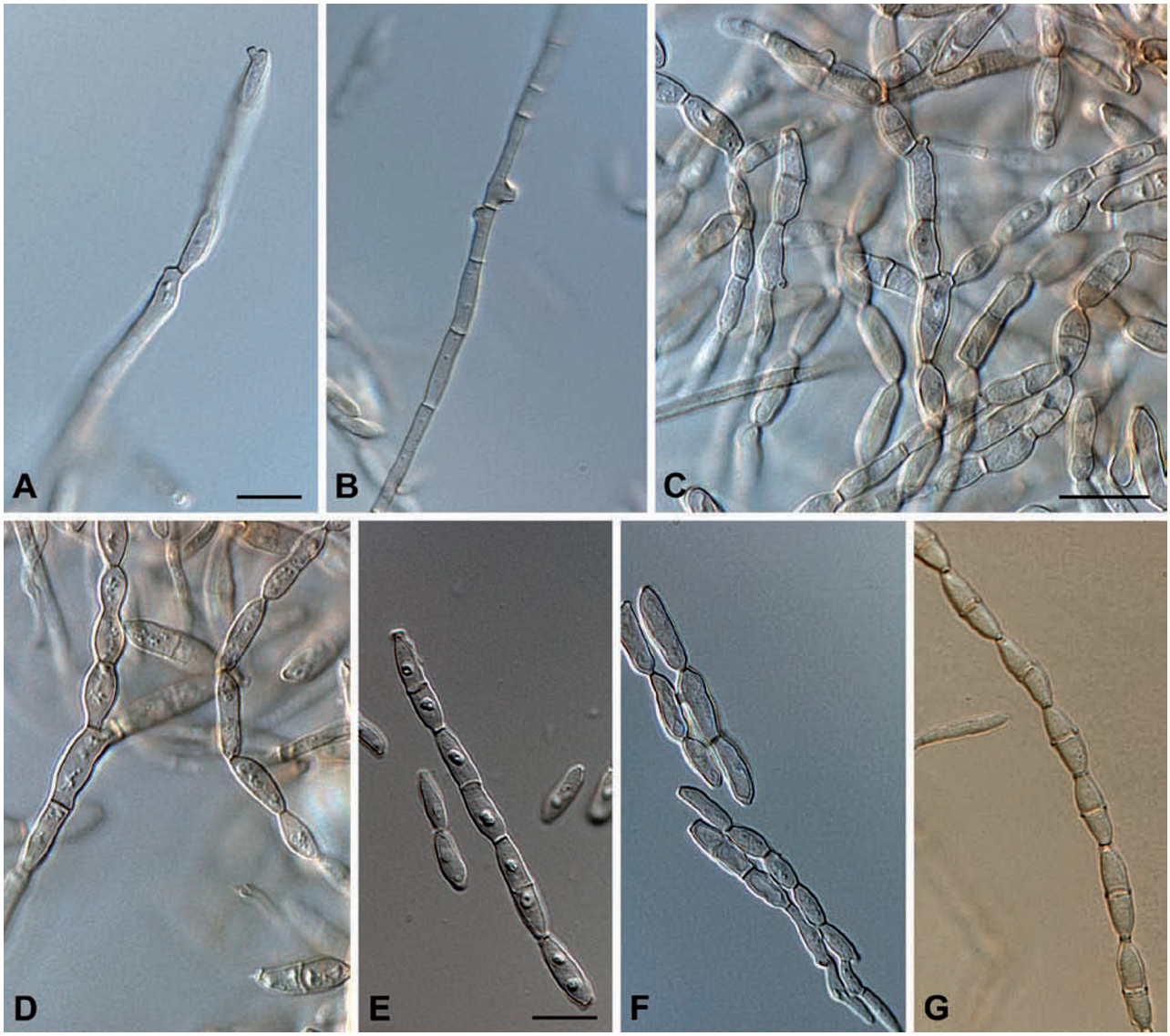

Fig. 22. *Fusicladium fagi* (CBS 621.84). A. Conidiophore with truncate conidiogenous loci. B. Hypha with conidiogenous loci. C–G. Conidial chains. Scale bars = 10 µm.

Fusicladium caruanianum Sacc., Ann. Mycol. 11: 20. 1913.
≡ *Pseudocladosporium caruanianum* (Sacc.) U. Braun, Schlechtendalia 9: 114. 2003.

Fusicladium convolvularum Ondřej, Česká Mycol. 25: 171. 1971. Fig. 21.

In vivo: Schubert *et al.* (2003: 37).

In vitro on SNA: *Mycelium* unbranched or only sparingly branched, 2–3 µm wide, septate, not constricted at septa, subhyaline to pale brown, smooth, walls unthickened or almost so. *Conidiophores* laterally arising from hyphae, erect, straight to somewhat flexuous, sometimes geniculate, unbranched, (6–)12–75 × (2.5–)3–4.5 µm, aseptate or septate, pale brown or pale medium brown, smooth, walls somewhat thickened, sometimes only as short lateral conical prolongations of hyphae, occasionally irregular in shape. *Conidiogenous cells* integrated, terminal or conidiophores reduced to conidiogenous cells, sometimes geniculate, 6–29 µm long, proliferation sympodial, with several denticle-like loci, broadly truncate, 1.5–2(–2.5) µm wide, unthickened, somewhat refractive or darkened. *Ramoconidia* occurring, 20–28 × 5 µm, 0–1-septate, somewhat darker, pale medium brown, with a broadly truncate base, 3–4 µm wide, usually with several denticle-like apical loci. *Conidia* catenate, formed in unbranched or loosely branched chains, straight to sometimes curved, cells sometimes irregularly swollen, fusiform, subcylindrical, sometimes obpyriform, 13–35 × 3.5–5.5(–6) µm, 0–3-septate, occasionally slightly constricted at the median septum, few very large conidia with up to five septa, up to 75 µm long, 4.5–6 µm wide, subhyaline to pale brown, smooth, walls slightly thickened, slightly attenuated towards apex and base, hila broadly truncate, 1–2 µm wide, unthickened or only slightly thickened, somewhat darkened-refractive; microcyclic conidiogenesis occurring, conidia often germinating.

Cultural characteristics: Colonies on PDA spreading, somewhat erumpent, with moderate aerial mycelium and regular, but feathery margins; surface fuscous black, and reverse dark fuscous black. Colonies reaching 15 mm diam after 1 mo on PDA at 25 °C in the dark.

Specimens examined: **Czech Republic**, Libina, okraj pole pod nadrazim (okr. Sumperk), on *Convolvulus arvensis* (*Convolvulaceae*), 7 Sep. 1970, Ondřej, **holotype** BRA. **New Zealand**, on leaves of *Convolvulus arvensis*, 7 Nov. 2000, C.F. Hill, **epitype designated here** CBS H-19911, culture ex-epitype CBS 112706 = CPC 3884 = IMI 383037.

Note: Conidiophores are somewhat longer and narrower *in vitro* than *in vivo*, and ramoconidia occur (Schubert & Braun 2002b, Schubert *et al.* 2003).

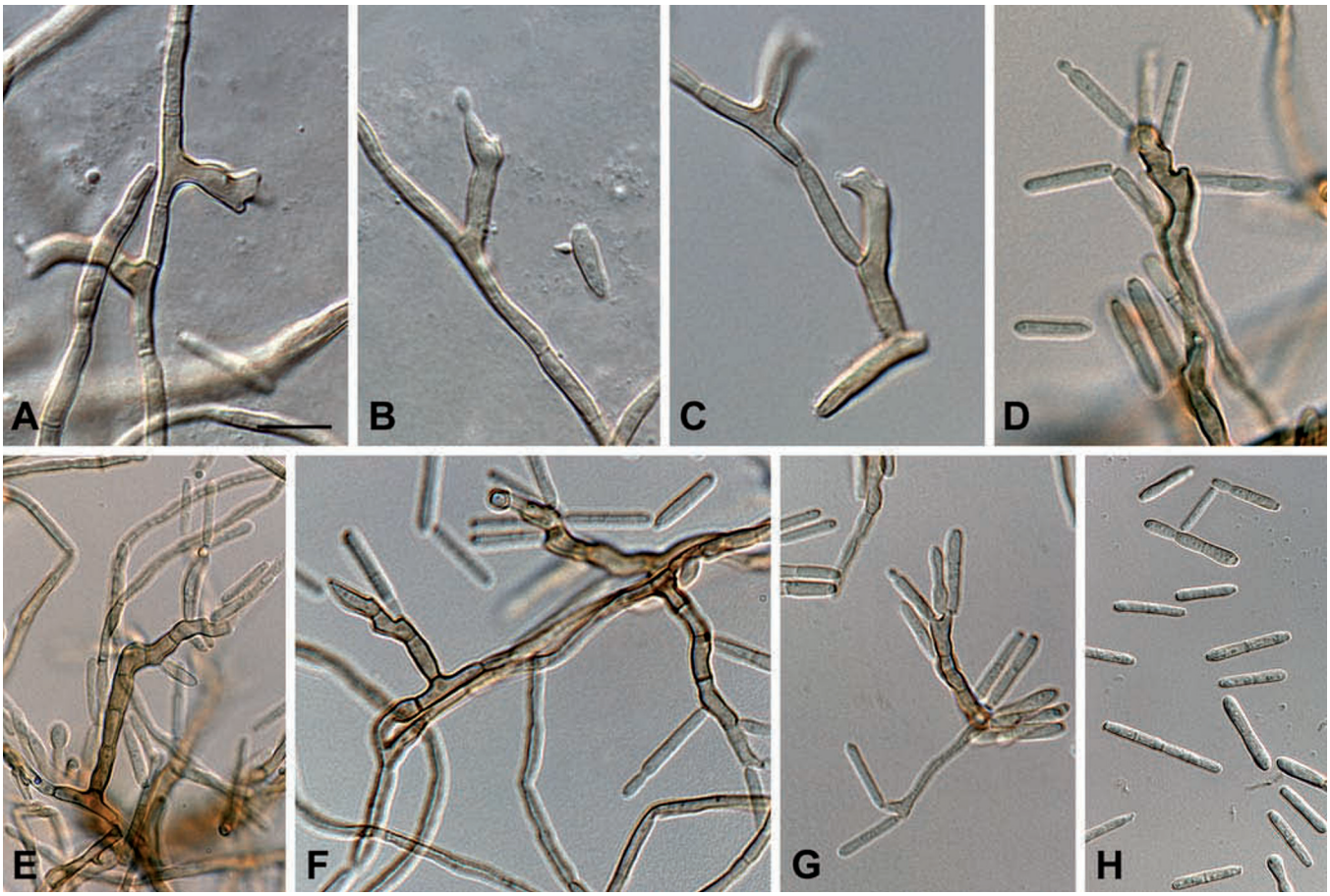

Fig. 23. *Fusicladium intermedium* (CBS 110746). A–G. Conidiophores with sympodial conidiogenous loci. H. Conidia. Scale bar = 10 µm.

Fusicladium fagi Crous & de Hoog, **sp. nov.** MycoBank MB504537. Fig. 22.

Etymology: Named after its host, *Fagus sylvatica*.

Fusicladio brevicatenato similis, sed conidiis secundis minoribus, (8–)11–17(–20) × 3–3.5 µm, locis conidiogenis et hilis angustioribus, 1–1.5 µm latis.

Mycelium consisting of pale to medium brown, smooth to finely verruculose, branched, 2–3 µm wide hyphae. *Conidiophores* integrated, terminal on hyphae, 0–1-septate, mostly reduced to conidiogenous cells, also lateral, visible as small, protruding, denticle-like loci, 10–15 × 2–3.5 µm. *Conidiogenous cells* subcylindrical, 5–15 × 2–3.5 µm, pale to medium brown, smooth to finely verruculose, tapering to 1–3 apical loci, 1–1.5 µm wide; scars inconspicuous. *Conidia* pale brown, smooth, guttulate, subcylindrical to narrowly ellipsoid, occurring in simple or branched chains, 0–1(–2)-septate, tapering towards subtruncate ends, 1.5–2.5 µm wide, aseptate conidia (8–)11–17(–20) × 3–3.5 µm, septate conidia up to 40 µm long and 4 µm wide; hila inconspicuous, i.e. neither thickened nor darkened-refractive; microcyclic conidiation common in older cultures.

Cultural characteristics: Colonies erumpent, spreading, with abundant aerial mycelium on PDA, and feathery to smooth margins; isabelline to patches of fuscous-black due to the absence of aerial mycelium, which collapses with age (surface); reverse fuscous-black. Colonies reaching 50 mm diam after 1 mo at 25 °C in the dark; colonies fertile.

Specimen examined: **Netherlands**, Baarn, Maarschalksbosch, decaying leaves of *Fagus sylvatica* (*Fagaceae*), 1 Oct. 1984, G.S. de Hoog, **holotype** CBS H-10366, culture ex-type CBS 621.84 = ATCC 200937.

Notes: Isolate CBS 621.84 was until recently preserved at the CBS as representative of *Cladosporium nigrellum* Ellis & Everh., a species known from bark of *Robinia* sp. in the U.S.A. Morphologically it is, however, quite distinct in having somewhat larger, and more subcylindrical to ellipsoid conidia. Conidia of *C. nigrellum* are fusiform to limoniform, 0–3-septate, 5–15 × 4–7 µm (Ellis 1976), possessing the typical cladosporioid scars with a central convex dome and a periclinal rim which characterise it as a true member of the genus *Cladosporium* Link, which has been confirmed by a re-examination of type material of *C. nigrellum* (on inner bark of railroad ties, U.S.A., West Virginia, Fayette Co., Nuttallburg, 20 Oct. 1893, L.A. Nuttall, Flora of Fayette County No. 172, NY; also Ellis & Everh., N. Amer. Fungi 3086 and Fungi Columb. 382, BPI, NY, PH).

Fusicladium intermedium (Crous & W.B. Kendr.) Crous, **comb. nov.** Mycobank MB504538. Fig. 23.
Basionym: *Anungitopsis intermedia* Crous & W.B. Kendr. S. Afr. J. Bot. 63: 286. 1997.

Specimens examined: **South Africa**, Mpumalanga, from leaf litter of *Eucalyptus* sp. (*Myrtaceae*), Oct. 1992, M.J. Wingfield, PREM 51438 **holotype**. **Madagascar**, Tamatave, *Eucalyptus* leaf litter, Apr. 1994, P.W. Crous, CBS H-19918, **epitype designated here**, culture ex-epitype CPC 778 = IMI 362702 = CBS 110746.

Note: Conidiophores are dimorphic in culture, being macronematous, anungitopsis-like, and micronematous, more pseudocladosporium-like.

Fusicladium matsushimae (U. Braun & C.F. Hill) Crous, U. Braun & K. Schub., **comb. nov.** Mycobank MB504539.
Basionym: *Pseudocladosporium matsushimae* U. Braun & C.F. Hill, Australas. Pl. Pathol. 33: 492. 2004.

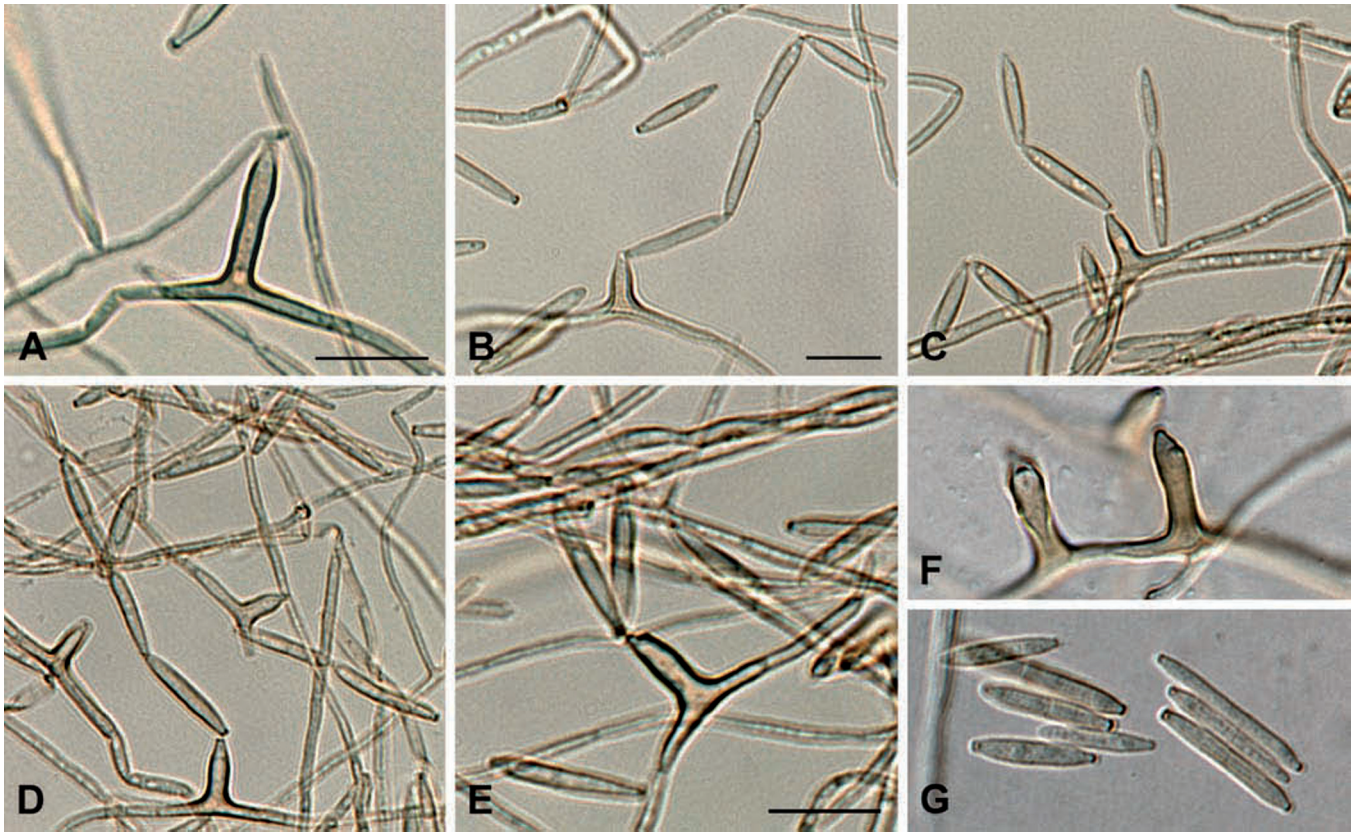

Fig. 24. *Fusicladium pini* (CBS 463.82). A–F. Conidiogenous cells with conidiogenous loci. G. Conidia. Scale bars = 10 µm.

Fusicladium mandshuricum (M. Morelet) Ritschel & U. Braun, Schlechtendalia 9: 62. 2003.
Basionym: *Pollaccia mandshurica* M. Morelet, Ann. Soc. Sci. Nat. Archéol. Toulon Var 45(3): 218. 1993.
= *Pollaccia sinensis* W.P. Wu & B. Sutton, in herb. (IMI).
Teleomorph: ***Venturia mandshurica*** M. Morelet, Ann. Soc. Sci. Nat. Archéol. Toulon Var 45(3): 219. 1993.

In vivo: Schubert *et al.* (2003: 62).

In vitro on OA: *Mycelium* loosely branched, filiform to narrowly cylindrical-oblong, 1–4 µm wide, later somewhat wider, up to 7 µm, septate, sometimes slightly constricted at the septa, sometimes irregular in outline due to small swellings, subhyaline to pale brown, smooth, walls unthickened, sometimes aggregating, forming compact conglomerations of slightly swollen hyphal cells. *Conidiophores* usually reduced to conidiogenous cells, arising terminally or laterally from hyphae, subcylindrical to cylindrical, unbranched, 9–20 × (2.5–)4–5(–6) µm, aseptate, very rarely 1-septate, very pale brown, smooth, walls unthickened, monoblastic, unilocal, determinate, later occasionally becoming percurrent, enteroblastically proliferating, forming a few (up to five) annellations, loci broadly truncate, (2–)3–5 µm wide, unthickened, not darkened. *Conidia* solitary, straight to curved, fusiform to obclavate, distinctly apiculate, 24–45(–57) × (6–)7–9(–10.5) µm, (1–)2–4(–5)-septate, more or less constricted at septa, sometimes up to 85 µm long with up to 7 septa, septa often somewhat darkened, second cell often bulging, pale medium to medium olivaceous-brown or brown, smooth, walls somewhat thickened, somewhat attenuated towards the base, hilum broadly truncate, (2–)3–5 µm wide, unthickened, not darkened; microcyclic conidiogenesis not observed.

Cultural characteristics: Colonies on OA iron-grey to olivaceous-grey due to aerial mycelium and sporulation (surface); reverse iron-grey to black, somewhat velvety; margin glabrous, olivaceous; aerial mycelium sparsely formed, loose, diffuse; sporulating.

Specimens examined: **China**, Liaoning, on *Populus simonii* × *P. nigra*, 17 Jun. 1992, M. Morelet, **holotype** PC (PFN 1466); *P. simonii*, 20 Apr. 1993, **epitype designated here** CBS H-19912, culture ex-epitype CBS 112235 = CPC 3639 = MPFN 307.

Note: Conidiophores are densely fasciculate *in vivo*, forming sporodochial conidiomata, cylindrical to ampulliform, 5–7 × 6–7.5 µm (Schubert *et al.* 2003).

Fusicladium pini Crous & de Hoog, **sp. nov.** MycoBank MB504540. Fig. 24.

Etymology: Named after its host, *Pinus*.

Fusicladio africano similis, sed conidiis minoribus, (6–)10–12(–17) × 1.5–2(–2.5) µm, locis conidiogenis et hilis angustioribus, 0.5–1 µm latis.

Mycelium consisting of smooth, medium brown, branched, 1.5–2 µm wide hyphae, giving rise to solitary, micronematous conidiophores. *Conidiophores* reduced to conidiogenous cells, medium to dark brown, erect, thick-walled, smooth, subcylindrical, widest at the base, tapering to a subtruncate apex, 5–15 × 2–3 µm; scars flat-tipped, somewhat darkened and thickened, one to several in the apical region, somewhat protruding, 0.5–1 µm wide. *Conidia* in branched or unbranched chains of up to 15, medium brown, smooth, subcylindrical, 0–1-septate, widest in the middle, tapering to subtruncate ends, straight to slightly curved, (6–)10–12(–17) × 1.5–2(–2.5) µm; hila somewhat darkened and thickened, not refractive, 0.5–1 µm wide.

Cultural characteristics: Colonies erumpent, with sparse aerial mycelium and smooth margins on PDA, greyish sepia (surface); reverse fuscous-black; on OA patches of greyish sepia and fuscous-black (surface); on SNA umber (surface). Colonies reaching 15 mm diam on PDA after 1 mo at 25 °C in the dark; colonies fertile.

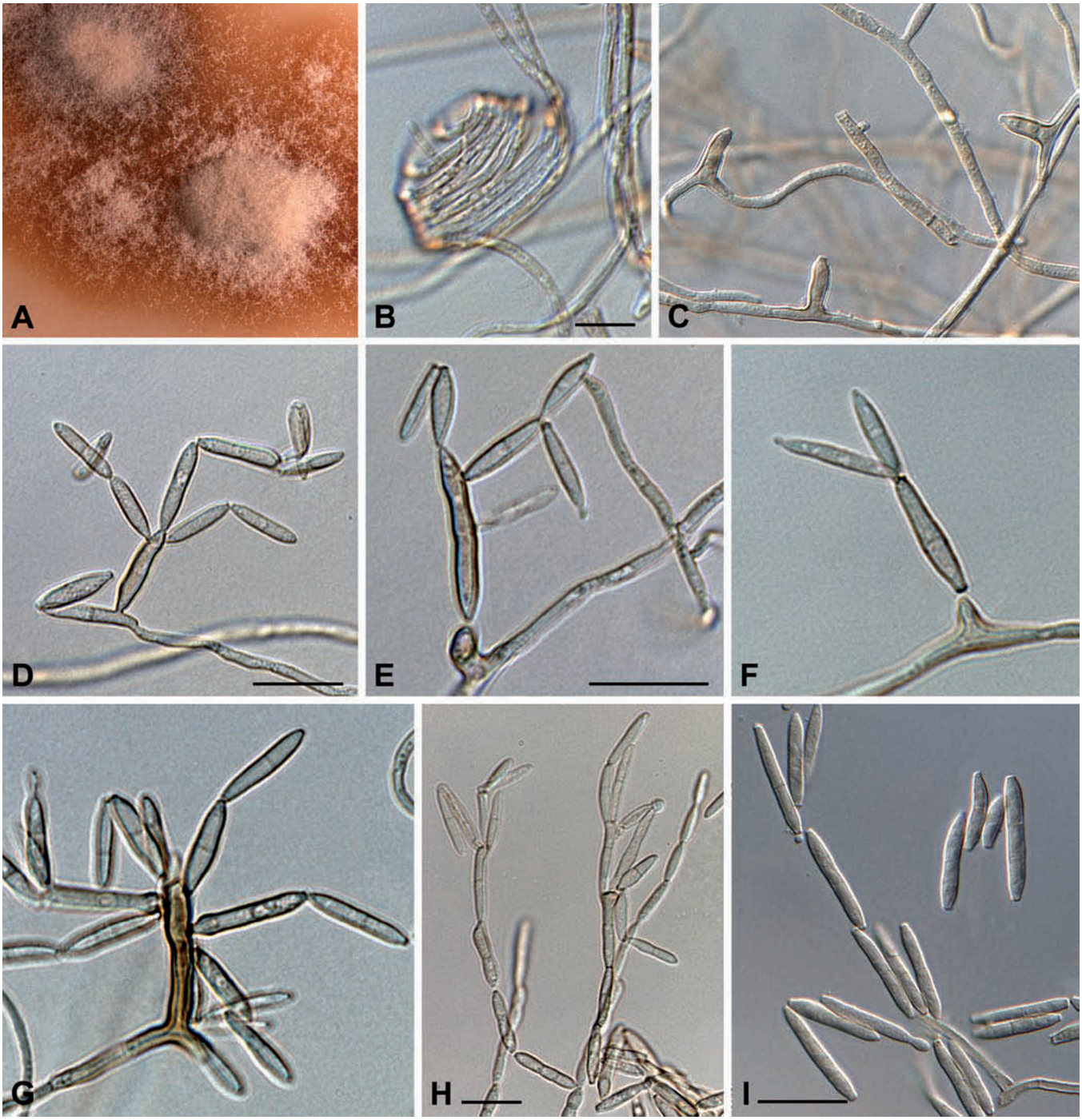

Fig. 25. *Fusicladium ramoconidii* (CBS 462.82). A. Colony on OA. B. Hyphal coil. C–F. Conidiophores reduced to conidiogenous cells. G–H. Conidiophores. I. Conidia. Scale bars = 10 µm.

Specimen examined: **Netherlands**, Baarn, De Vuursche, needle of *Pinus sylvestris* (*Pinaceae*), 12 Apr. 1982, G.S. de Hoog, **holotype** CBS H-1610, culture ex-type CBS 463.82.

Notes: This fungus was originally maintained in the CBS collection as *Anungitea uniseptata* Matsush. In culture, however, only a pseudocladosporium-like state was observed. Conidiophores are reduced to conidiogenous cells, and have several apical loci as in *Fusicladium*, but are not subdenticulate; scars are somewhat darkened and thickened, not refractive. Conidia of *F. africanum* are (8–)11–17(–20) × 2–3(–3.5) µm, thus similar, but somewhat larger than the mean conidial size range (10–12 × 1.5–2 µm) observed in *F. pini*. The conidiogenous loci and conidial hila of *F. africanum* are also somewhat larger. Although the LSU sequence of *F. pini* is identical to that of *F. ramoconidii*, the ITS sequence similarity is 97 % (572/585 nucleotides).

Fusicladium ramoconidii Crous & de Hoog, **sp. nov.** MycoBank MB504541. Figs 25–26.

Etymology: Named after the presence of its characteristic ramoconidia.

Fusicladio brevicatenato similis, sed ramoconidiis minoribus, (12–)15–17(–20) × 2(–3) µm, locis conidiogenis et hilis minoribus, 0.5–1 µm diam.

Mycelium consisting of branched, septate, 1.5–2 µm wide hyphae, pale brown, smooth, frequently with hyphal coils. *Conidiophores* integrated into hyphae, and reduced to small, lateral protruding conidiogenous cells, concolorous with hyphae, or macronematous, dark brown, erect, thick-walled, 10–40 × 3–4 µm, 0–3-septate. *Conidiogenous cells* terminal, integrated, subcylindrical, tapering to a rounded apex, concolorous with hyphae (as hyphal pegs), or dark

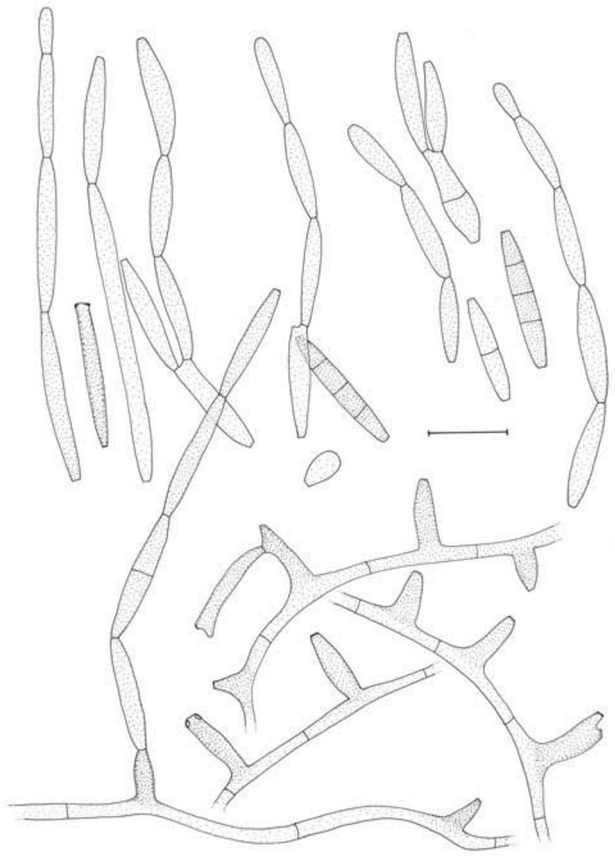

Fig. 26. *Fusicladium ramoconidii* (CBS 462.82). Conidiogenous cells with ramoconidia and conidia. Scale bar = 10 µm.

brown on mononematous conidiophores, smooth, 3–15 × 2–3(–4) µm; proliferating sympodially, loci slightly thickened, darkened and refractive, 0.5–1 µm wide. *Conidia* occurring in branched chains, narrowly ellipsoid to subcylindrical, pale olivaceous, guttulate; ramoconidia (0–)1(–3)-septate, (12–)15–17(–20) × 2(–3) µm; conidia occurring in short chains (–15), 0–1-septate, (8–)10–12(–16) × 2(–3) µm; hila slightly thickened and darkened, not refractive, 0.5–1 µm wide.

Cultural characteristics: Colonies erumpent, with sparse aerial mycelium and smooth margins on PDA, hazel to fawn (surface), with a thin, submerged margin; reverse brown-vinaceous; on OA hazel to fawn (surface) with a wide, fawn, submerged margin. Colonies reaching 25 mm diam on PDA after 1 mo at 25 °C in the dark; colonies fertile.

Specimen examined: **Netherlands**, Baarn, De Vuursche, needle of *Pinus* sp. (*Pinaceae*), 12 Apr. 1982, G.S. de Hoog, **holotype** CBS H-19908, culture ex-type CBS 462.82.

Notes: This strain has been deposited in the CBS collection as *Pseudocladosporium hachijoense* (Matsush.) U. Braun. However, its ramoconidia and conidia are smaller than those cited by Matsushima (1975) (ramoconidia up to 30 µm long, conidia 10–21 × 2–4 µm). Although it clusters with *F. pini* in the LSU phylogeny, there are 13 bp differences in their ITS sequence data. Furthermore, *F. ramoconidii* has ramoconidia which are absent in *F. pini*, and has a faster growth rate, and hazel to fawn colonies, compared to the greyish sepia colonies of *F. pini*. The well-developed, septate conidiophores and ramoconidia are reminiscent of *F. brevicatenatum*, which differs, however, by its longer and wider ramoconidia, up to 30 × 6(–7) µm, as well as larger conidiogenous loci and conidial hila, 1.5–3 µm diam.

Fusicladium rhodense Crous & M.J. Wingf., **sp. nov.** MycoBank MB504542. Fig. 27.

Etymology: Named after the Greek Island, Rhodos, where it was collected.

Fusicladio africano similis, sed locis conidiogenis angustioribus, 1.5–2 µm latis, et differt a F. pini ramoconidiis formantibus.

Mycelium consisting of smooth to finely roughened, medium brown, branched, septate, 1.5–3 µm wide hyphae, frequently forming hyphal coils, giving rise to solitary, micronematous conidiophores. *Conidiophores* reduced to conidiogenous cells that are terminal or lateral on hyphae, medium brown, smooth, subcylindrical, subdenticulate, erect, or more distinct, up to 15 µm tall, 1.5–2 µm wide, mono- to polyblastic; scars flat-tipped, somewhat darkened and thickened, but not refractive. *Conidia* in branched or unbranched chains of up to 15, pale brown in younger conidia, becoming medium brown, smooth, subcylindrical, 0–3-septate, tapering slightly towards the subtruncate ends, straight, but at times slightly curved, (8–)12–16(–20) × (2–)2.5–3(–4) µm; ramoconidia (0–)1(–3)-septate, 12–20 × 3–4 µm; conidia (0–)1-septate, 8–17 × 2–3 µm; hila somewhat darkened and thickened, not refractive, 1–1.5 µm wide.

Cultural characteristics: Colonies spreading, somewhat erumpent, with moderate aerial mycelium and crenate margins on PDA, uneven, greyish sepia (surface), margins fuscous-black; reverse fuscous-black; on OA smooth, spreading, with sparse aerial mycelium and even, regular margins, greyish sepia; on SNA spreading, smooth, even margins, sparse aerial mycelium, greyish sepia (surface). Colonies reaching 9 mm diam on PDA after 2 wk at 25 °C in the dark; colonies fertile.

Specimen examined: **Greece**, Rhodos, on branches of *Ceratonia siliqua* (*Fabaceae*), 1 Jun. 2006, P.W. Crous & M.J. Wingfield, **holotype** CBS H-19910, culture ex-type CBS 121641 = CPC 13156.

Note: *Fusicladium rhodense* has a typical pseudocladosporium-like morphology in culture, with conidial scars that are somewhat darkened and thickened.

Venturia hanliniana (U. Braun & Feiler) Unter., Mycologia 89: 129. 1997.

Basionym: *Capronia hanliniana* U. Braun & Feiler, Microbiol. Res. 150: 90. 1995.

≡ *Caproventuria hanliniana* (U. Braun & Feiler) U. Braun, in Braun, *A Monograph of Cercosporella, Ramularia and Allied Genera (Phytopathogenic Hyphomycetes)* 2: 396. 1998.

Anamorph: ***Fusicladium brevicatenatum*** (U. Braun & Feiler) Crous, U. Braun & K. Schub., **comb. nov.** MycoBank MB504543.

Basionym: *Cladophialophora brevicatenata* U. Braun & Feiler, Microbiol. Res. 150: 84. 1995.

≡ *Pseudocladosporium brevicatenatum* (U. Braun & Feiler) U. Braun, in Braun, *A Monograph of Cercosporella, Ramularia and Allied Genera (Phytopathogenic Hyphomycetes)* 2: 393. 1998.

Venturia hystrioides (Dugan, R.G. Roberts & Hanlin) Crous & U. Braun, **comb. nov.** MycoBank MB504544. Fig. 28.

Basionym: *Capronia hystrioides* Dugan, R.G. Roberts & Hanlin, Mycologia 87: 713. 1995.

≡ *Caproventuria hystrioides* (Dugan, R.G. Roberts & Hanlin) U. Braun, in Braun, *A monograph of Cercosporella, Ramularia and allied genera (Phytopathogenic Hyphomycetes)*. Vol. 2: 396. 1998.

Anamorph: ***Fusicladium*** sp.

Only the anamorph was observed on OA, PDA and SNA in culture.

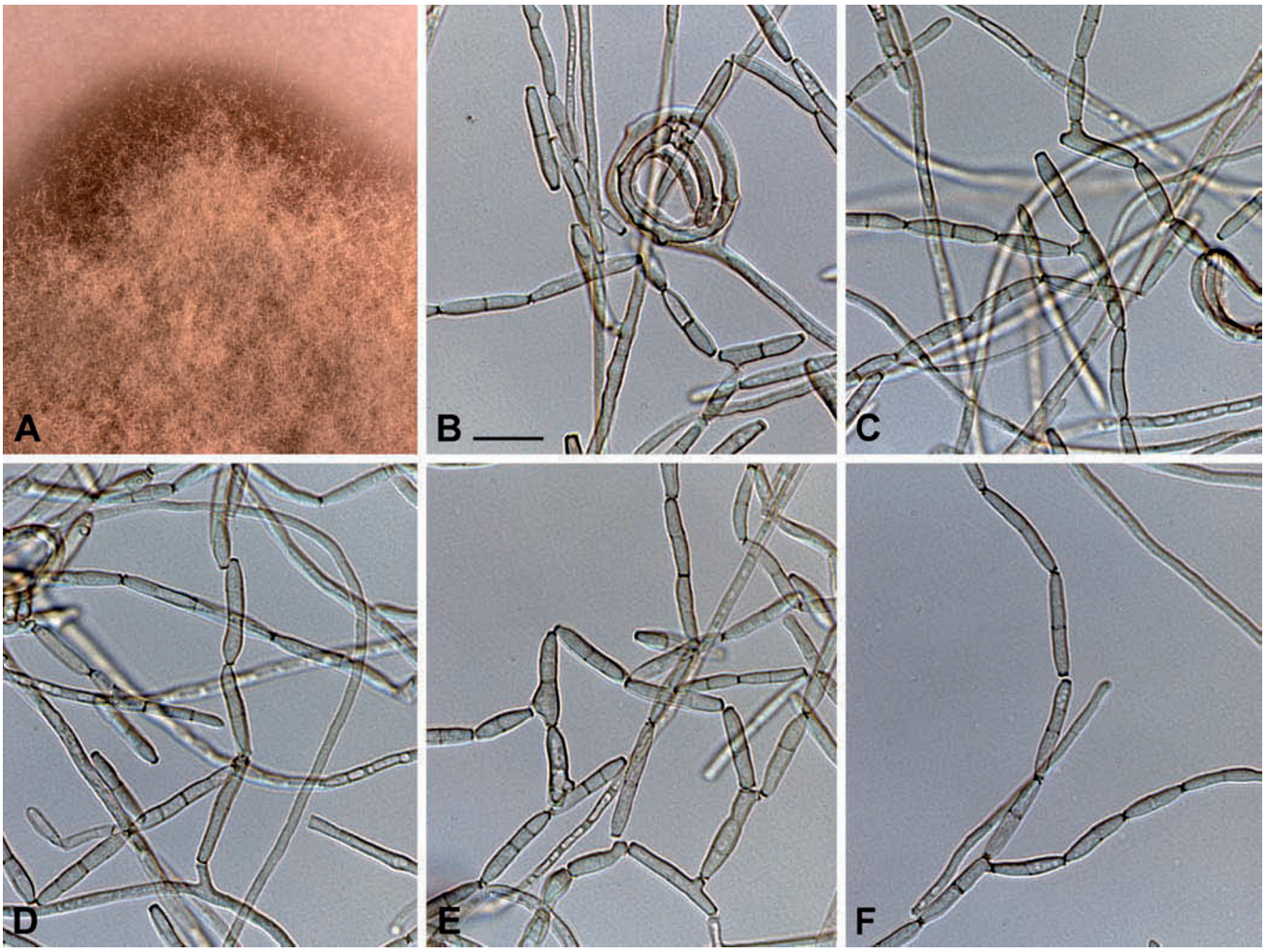

Fig. 27. *Fusicladium rhodense* (CPC 13156). A. Colony on OA. B. Conidial chains and hyphal coil. C–F. Chains of ramoconidia and conidia. Scale bar = 10 µm.

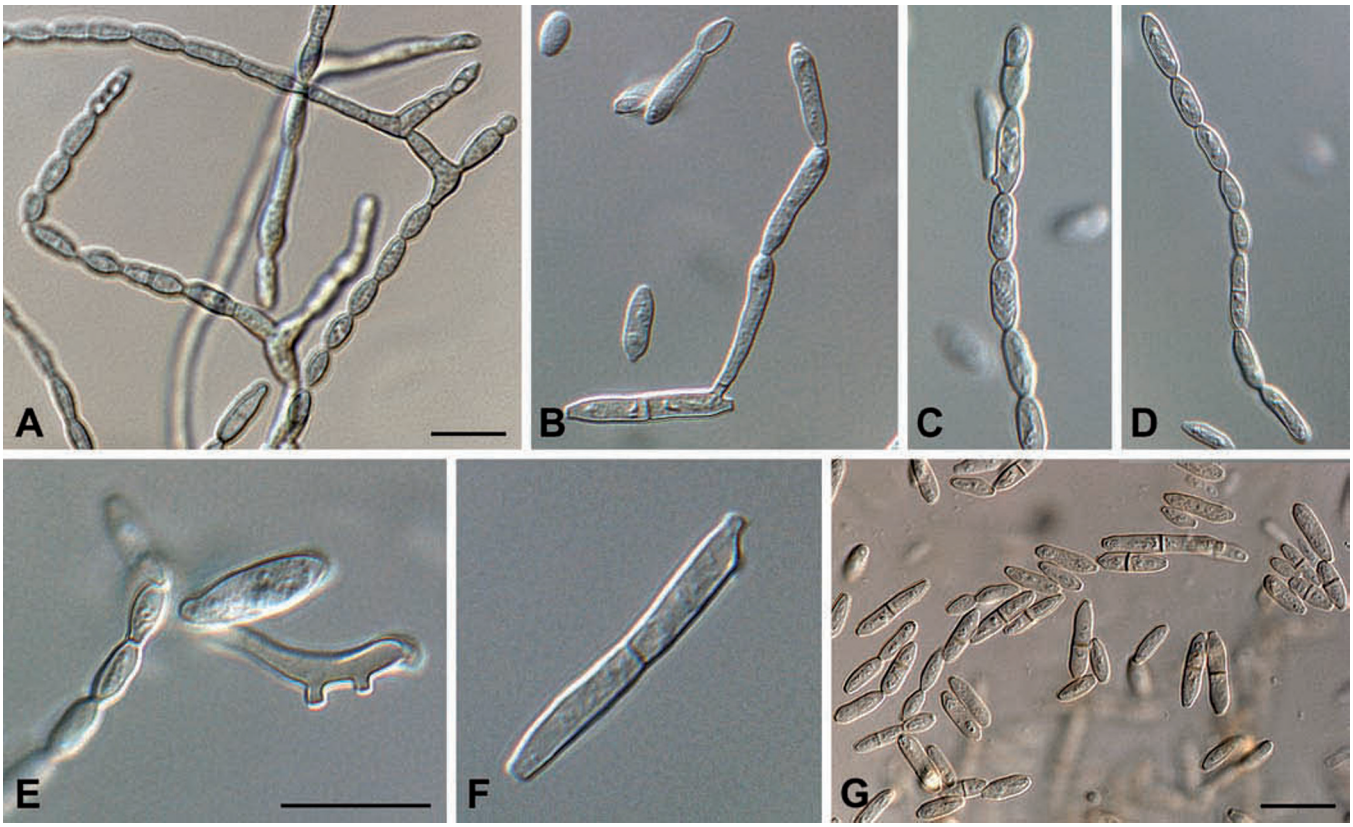

Fig. 28. *Venturia hystrioides* (CBS 117727). A. Conidiophores giving rise to catenulate conidia. B. Ramoconidium giving rise to conidia. C–D. Conidial chains. E. Conidia and conidiogenous cell with conidiogenous loci. F. Ramoconidium. G. Conidia. Scale bars = 10 µm.

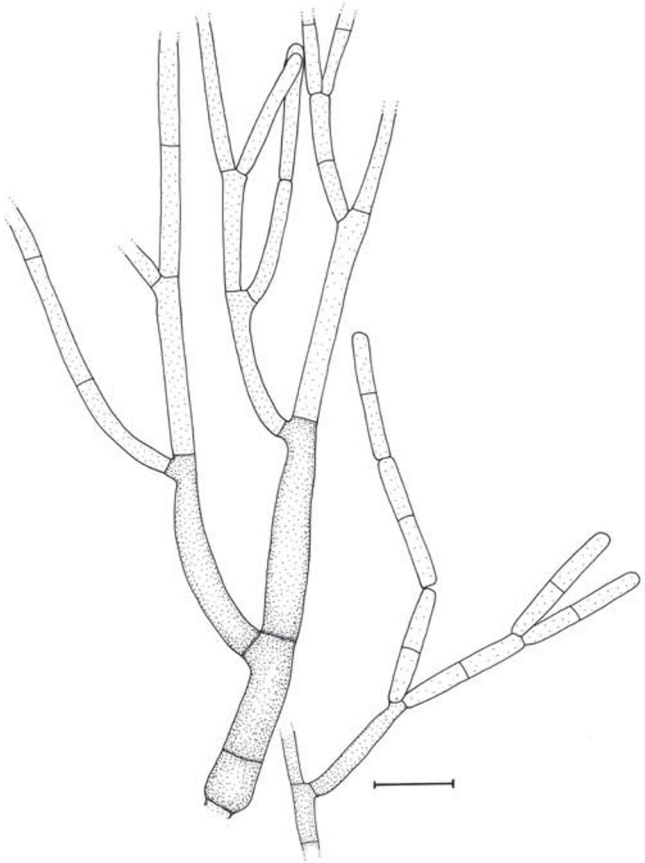

Fig. 29. *Polyscytalum fecundissimum* (CBS 100506). Conidiophores giving rise to catenulate conidia. Scale bar = 10 µm.

Mycelium consisting of branched, septate, smooth, guttulate, 1.5–2.5 µm wide hyphae, pale brown, forming hyphal strands. *Conidiophores* mostly reduced to conidiogenous cells, or if present, micronematous, consisting of a supporting cell, and single conidiogenous cell. *Conidiogenous cells* integrated in hyphae as lateral loci, or terminal, frequently disarticulating, subcylindrical, pale to medium brown, smooth, mono- to polyblastic, loci 1–1.5 µm wide, 2.5 µm tall; conidiogenous cells subcylindrical, up to 40 µm tall, and 2–2.5 µm wide. *Conidia* in long chains of up to 60, branched or not, subcylindrical to narrowly ellipsoid, pale olivaceous to pale brown, smooth; ramoconidia 0–1(–3)-septate, 15–20(–30) × 2–3(–3.5) µm; conidia 0(–1)-septate, 6–8(–12) × 2–3(–3.5) µm; hila 1–1.5 µm wide, inconspicuous to somewhat darkened, subtruncate.

Cultural characteristics: Colonies erumpent, with sparse aerial mycelium on PDA, and smooth, even margins; olivaceous-grey to iron-grey (surface); reverse greenish black; on OA dark mouse-grey (surface), with even, smooth margins. Colonies reaching 40 mm diam after 2 wk at 25 °C in the dark; colonies fertile.

Specimen examined: **U.S.A.**, Washington, Wenatchee, on bing cherry fruit, *Prunus avium* cv. *Bing* (*Rosaceae*), R.G. Roberts, culture ex-type, ATCC 96019 = CBS 117727.

Note: Dugan *et al.* (1995) commented that although similar to *"Phaeoramularia" hachijoensis*, the conidia of this species were predominantly aseptate and somewhat shorter than those described by Matsushima (1975).

Excluded taxa

Polyscytalum fecundissimum Riess, Bot. Zeitung (Berlin) 11: 138. 1853. Fig. 29.

Cultural characteristics: Colonies erumpent, spreading, aerial mycelium sparse, margins smooth; colonies sienna to umber on PDA, with patches of greyish sepia; reverse chestnut-brown; on OA whitish due to moderate aerial mycelium, with diffuse umber pigment in the agar; whitish on SNA. Colonies reaching 15 mm diam on PDA after 3 wk at 25 °C in the dark.

Specimen examined: **Netherlands**, Schovenhorst, leaf litter of *Fagus sylvatica* (*Fagaceae*), 8 Nov. 1997, W. Gams, CBS H-6049, culture CBS 100506.

Notes: *Polyscytalum fecundissimum* is the type species of the genus *Polyscytalum*. Several isolates of this species were investigated here to determine if *Polyscytalum* would be available for taxa that have a pseudocladosporium-like morphology. The clustering of CBS 681.74 within the *Venturiaceae* was surprising. However, this culture proved to be sterile, and therefore its identity could not be confirmed.

Isolate CBS 109882 sporulated profusely. Colonies were grey-olivaceous with olivaceous margins on PDA; conidiophores pale, and not dark brown as depicted for *Polyscytalum* in Ellis (1971); conidial chains were greenish yellow in mass, and pale olivaceous-green under the dissecting microscope, somewhat roughened, polyblastic; on ITS sequence this isolate is identical to U57492, *Cistella acuum* (Alb. & Schwein.) Svrček (*Helotiales*), but the latter species should have a phialidic anamorph, so it is possible that this GenBank sequence is incorrect. The identity of CBS 109882 therefore remains unresolved.

Although isolate CBS 100506 is poorly sporulating, illustrations made *in vitro* when it was collected show this isolate to be authentic for the species and the genus *Polyscytalum*. Based on its LSU sequence, it is allied to *Phlogicylindrium eucalypti* Crous, Summerb. & Summerell (CBS 120080; Summerell *et al*. 2006), and is therefore unrelated to the *Venturiaceae*.

Zeloasperisporium R.F. Castañeda, Mycotaxon 60: 285. 1996, **emend.**

Hyphomycetes. *Mycelium* mostly superficial, hyphae septate, brown to olivaceous. *Hyphopodia* absent. *Conidiophores* differentiated, mononematous, erect, aseptate or septate, brown to olivaceous. *Conidiogenous cells* integrated, terminal, proliferation sympodial, polyblastic, with subdenticulate, somewhat thickened and darkened scars. *Conidia* solitary, fusiform to obclavate or cylindrical, septate, asperulate to verrucose, olivaceous to brown, tips always hyaline, thinner-walled and smooth, forming mucoid appandages, often only visible as a thickened frill. *Synanamorph* present, micronematous. *Conidiogenous cells* short cylindrical, antenna or hyphopodium-like, phialidic, colarette sometimes present, aseptate, subhyaline. *Conidia* solitary, obovoid, ellipsoid, aseptate, brown to olivaceous, verruculose.

Zeloasperisporium hyphopodioides R.F. Castañeda, Mycotaxon 60: 285. 1996. Fig. 30.

In vitro on OA: *Mycelium* internal to superficial, unbranched to sparingly branched, 1.5–3 µm wide, loosely septate, septa almost invisible, pale brown, smooth to asperulate, minutely verruculose, walls unthickened, sometimes inflated at the base of conidiophores.

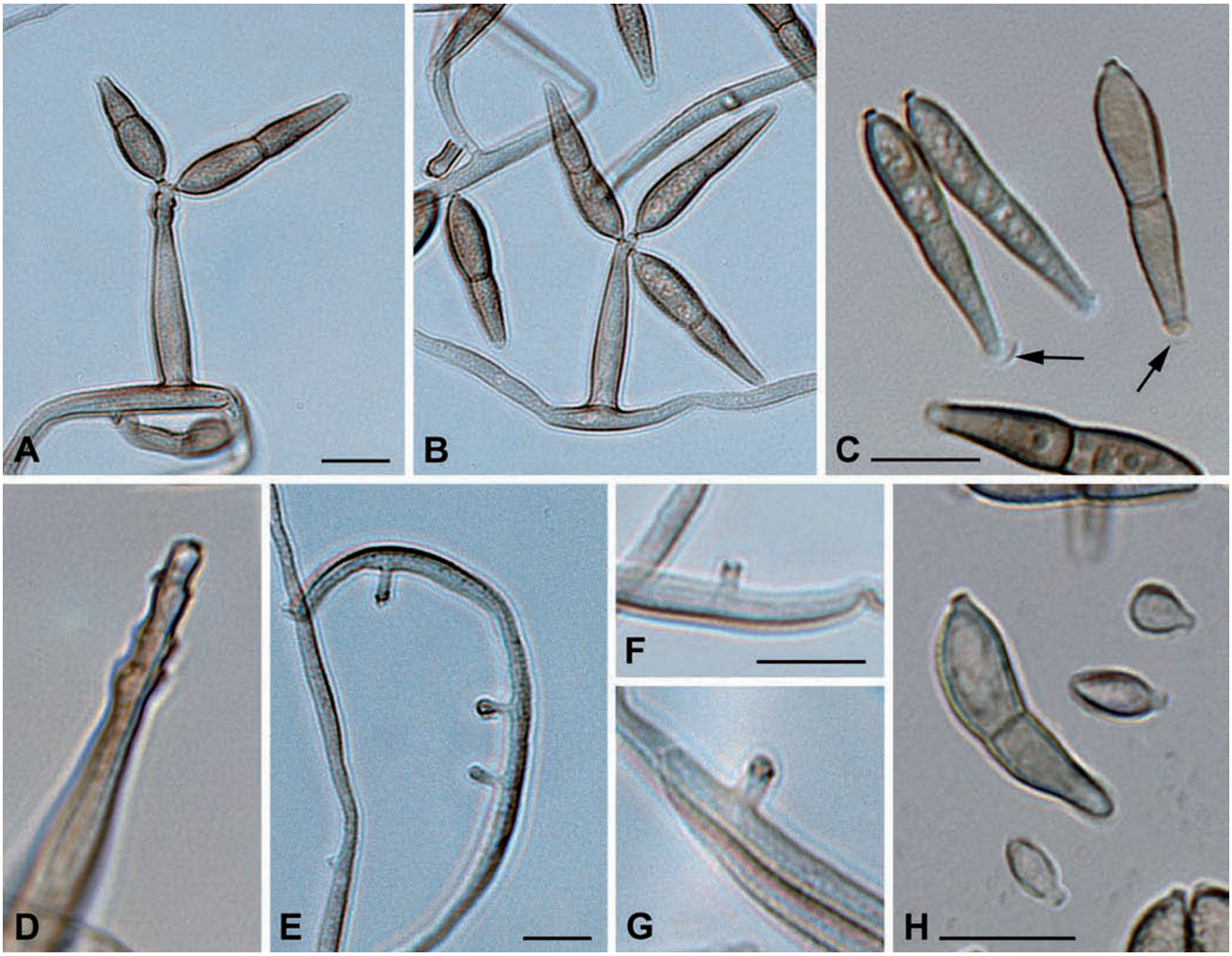

Fig. 30. *Zeloasperisporium hyphopodioides* (CBS 218.95). A–B. Conidiogenous cells. C. Conidia with apical mucoid caps. D. Conidiogenous cell with sympodial proliferation. E–G. Conidiogenous cells of micronematous synanamorph. H. Conidia, and microconidia of synanamorph. Scale bars = 10 µm.

Conidiophores macronematous, arising usually laterally from plagiotropous hyphae, erect, straight, subcylindrical or conical, not geniculate, usually unbranched, rarely branched, 13–45 × 3–4(–5) µm, slightly to distinctly attenuated towards the apex, tapered, aseptate, rarely with a single septum, pale brown to pale medium brown, smooth or minutely verruculose, walls unthickened, often somewhat constricted near the base. *Conidiogenous cells* integrated or conidiophores usually reduced to conidiogenous cells, subcylindrical to conical, proliferation sympodial, with a single or several subdenticulate to denticulate conidiogenous loci mostly crowded at or towards the apex, protuberant, truncate, 0.8–1.2 µm wide, thickened and darkened-refractive. *Conidia* solitary, straight to curved, ellipsoid, fusiform to obclavate, distinctly tapered towards the apex, apiculate, (12–)15–32 × 3.5–5.5 µm, (0–)1–2(–3)-septate, mainly 1-septate, usually constricted at the septa, pale brown to pale medium brown, asperulate to verruculose, walls unthickened or almost so, tips always hyaline, thinner-walled and smooth, forming mucoid appendages, often only visible as a thickened frill, base somewhat rounded or slightly bulbous, hila often situated on short peg-like prolongations, truncate, 0.8–1(–1.2) µm wide, thickened, darkened-refractive; microcyclic conidiogenesis occurring, conidia forming secondary conidiophores.

Synanamorph micronematous. *Conidiophores* reduced to conidiogenous cells, numerous, occurring as short lateral prolongations of hyphae, antenna or telescope-like, cylindrical, unbranched, conidiogenesis unclear, at times appearing phialidic, or having one to two apical scars; up to 5 µm long, 1–1.5 µm wide, aseptate, subhyaline, smooth. *Conidia* of the micronematous anamorph quite different from the conidia formed by the macronematous conidiophores, solitary, obovoid, ellipsoid to somewhat fusiform, 5–9 × 2.5–3 µm, aseptate, pale to pale medium brown, verruculose, somewhat attenuated towards the base, hila flat, unthickened to somewhat thickened, appearing to have the ability to form a slime appendage at the apex.

Cultural characteristics: Colonies on OA iron-grey to olivaceous due to abundant sporulation (surface); reverse black, velvety; margin regular to undulate, feathery; aerial mycelium absent or sparse, sporulation profuse.

Specimen examined: **Cuba**, isolated from air, 2 Oct. 1994, R.F. Castañeda, INIFAT C94/114, **holotype**, CBS-H 5624, H-5639, **isotypes**, culture ex-type CBS 218.95 = INIFAT C94/114 = MUCL 39155 = IMI 367520.

Notes: Within the course of the recent phylogenetic studies in *Herpotrichiellaceae* and *Venturiaceae* the type culture of *Zeloasperisporium hyphopodioides* has been included since it was deposited at the CBS as "*Fusicladium hyphopodioides*". When the culture was re-examined, the described short appressorium-like, inflated hyphopodia with slightly warted to lobed apices (Castañeda *et al.* 1996) could be recognised as conidiogenous cells of a synanamorph forming a second conidial type. In addition,

the conidial tips are hyaline, unthickened and smooth, and have the ability to form mucoid appendages that are often only visible as a thickened frill. These two features, viz., the synanamorph and the conidia with mucoid appendages, easily distinguish this genus from morphologically similar genera such as *Fusicladium*, *Asperisporium* Maubl., and *Passalora* Fr. Phylogenetically *Zeloasperisporium* clusters basal to the *Venturiaceae*.

DISCUSSION

The present paper was initiated to clarify the status of *Cladophialophora* and *Pseudocladosporium* spp., which appear morphologically similar. Confusion occurs when strains with this morphology are identified based solely on microscopic and cultural characteristics. The results clarify that *Cladophialophora* is allied to the *Herpotrichiellaceae* and *Pseudocladosporium* (= *Fusicladium*) to the *Pleosporales* (*Dothideomycetes*). The plant-pathogenic *Cladophialophora* species compose a separate clade within the order (Fig. 1). Another, somewhat remote chaetothyrialean clade contains extremotolerant, rock-inhabiting species around the genus *Coniosporium* Link (Cluster 5 of Haase *et al.* 1999). Both clades are significantly distinct from the prevalently hyperparasitic or oligotrophic, frequently opportunistic species of the remainder of the order (Fig. 1). This remainder includes all *Capronia* teleomorphs sequenced to date, and is thus likely to represent the family *Herpotrichiellaceae*. The ecological trends in each of the main clades of *Chaetothyriales* are thus quite different (Braun 1998).

Several novelties are introduced within the preponderantly plant-associated clade of *Chaetothyriales*, including two new species associated with leaf spots. *Cladophialophora* is distinguished from *Polyscytalum*, which clusters outside the *Herpotrichiellaceae*, and appears allied to *Phlogicylindrium* Crous, Summerb. & Summerell, a recently introduced genus for species occurring on *Eucalyptus* leaves (Summerell *et al*. 2006). Surprisingly *Heteroconium chaetospira* clusters in the *Herpotrichiellaceae*, and is placed in *Cladophialophora* as a distinctively pigmented member of the genus. Some species of *Cladophialophora* and *Exophiala* are newly described from a range of substrates such as fruit juices, drinking water and leaf litter, revealing the potential of these materials as ecological sources of inoculum for taxa associated with opportunistic human and animal infections.

Furthermore, *Pseudocladosporium* belongs to the *Venturiaceae*, and is best treated as a synonym of *Fusicladium*, along with other genera as proposed by Schubert *et al.* (2003) and Beck *et al.* (2005). Although numerous isolates of the *Venturiaceae* were included for study, it was surprising to find relatively little variation within the family, suggesting that previously proposed teleomorph genera such as *Apiosporina*, *Metacoleroa* and *Caproventuria* should be best treated as synonyms of *Venturia*. The *Venturiaceae* is further extended with the inclusion of a novel sister clade of hyphomycetes with a pseudocladosporium-like morphology, which are also referred to as *Fusicladium*, thus widening the generic concept of the latter to encompass all pseudocladosporium-like anamorphs within the family. Some species assigned to *Anungitopsis* proved to cluster within the *Venturiaceae*, but the type species of the latter genus, *A. speciosa*, clustered elsewhere and possesses distinct conidiogenous loci, i.e., *Anungitopsis* cannot be reduced to synonymy with *Fusicladium*. The anamorphs of this sister clade of the main *Venturia* clade are morphologically rather close to taxa assigned to *Anungitea*. However, species of *Anungitea* and *Fusicladium* are morphologically barely distinguishable (Schubert *et al.* 2003), but the true affinity of *Anungitea* depends on its type species of which cultures and sequence data are not yet available.

Several anamorph genera with divergent morphologies were found to cluster together, suggesting that these are either different synanamorphs of the same teleomorph genus, or that they may represent cryptic clades that will diverge further once additional species are added in future studies. Although the *Herpotrichiellaceae* appeared to represent quite a diverse assembledge of morphotypes, the *Venturiaceae* were again surprisingly uniform.

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