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RESEARCH ARTICLE

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Taxonomic and phylogenetic re-evaluation of *Microdochium*, *Monographella* and *Idriella*

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Key words

cereals
grasses
phytopathogenic fungi
Sordariomycetes
Xylariales

Abstract Based on morphology and DNA sequence data the taxonomic relationships of *Microdochium*, *Monographella* and *Idriella* were reassessed. *Microdochium* is morphologically and phylogenetically circumscribed, and the sexual genus *Monographella* treated as synonym on the basis that *Microdochium* has more species, is more commonly encountered, and more frequently used in literature. An epitype is designated for *Microdochium phragmites*, and several well-known species are redefined based on their morphology and DNA sequence data (LSU, ITS, BTUB and RPB2). Furthermore, the revision of *Microdochium* led to six new combinations (*M. albescens*, *M. consociatum*, *M. fusariisporum*, *M. maydis*, *M. opuntiae* and *M. stevensonii*) and six new species (*M. citrinidiscum*, *M. colombiense*, *M. fisheri*, *M. neoqueenslandicum*, *M. seminicola* and *M. trichocladiopsis*) being proposed. *Microdochium* s.str. belongs to a monophyletic clade, together with *Idriella lunata* and *Selenodriella*, representing a new family, *Microdochiaceae*, in *Xylariales*. Other species previously accommodated in *Microdochium* belong to different orders in the *Ascomycota*. *Microdochium gracile* belongs to *Sordariomycetes* (incertae sedis) and *Paramicrodochium* is proposed to accommodate this species. *Microdochium tripsaci* belongs to *Ephelis* in *Clavicipitaceae*, while *M. fusarioides* belongs to a new genus, *Microdochiella* in *Orbiliales*. *Idriella* s.str. is a monotypic genus phylogenetically closely related to *Microdochium*. *Idriella* s.l. separates into different genera in *Xylariales* (incertae sedis) including *Castanediella*, *Selenodriella*, *Idriellopsis*, *Neoidriella* and *Paraidriella*, the last three proposed here as new genera.

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INTRODUCTION

Microdochium was introduced with *M. phragmitis* as the type species for a fungus observed on living leaves of *Phragmites australis* in Germany, with globose, erumpent stromata of minute, hyaline cells, small papillate conoid conidiogenous cells and solitary, fusiform to subfalcate, hyaline conidia (Sydow 1924). Currently this genus includes about 20 species (Seifert et al. 2011), but only a few of them are well-known and have been studied in pure culture. Braun (1995) recognised three sections in *Microdochium* based on the type of conidiogenous cells and conidia: *Microdochium* sect. *Gerlachia* for species with annellidic conidiogenous cells with percurrent proliferations; *Microdochium* sect. *Microdochium* for species with sympodial, often subdenticulate conidiogenous cells, and fairly more or less fusiform, straight to somewhat curved or falcate, 0–3-septate or even pluriseptate conidia; and *Microdochium* sect. *Gloeocercospora* for species with sympodial conidiogenous cells, and very long, scolecosporous and pluriseptate conidia. The sexual morphs of *Microdochium* species are known to reside in *Monographella* (*Amphisphaeriaceae*, *Xylariales*) (Parkinson et al. 1981, Samuels & Hallet 1983, Von Arx 1984, Jaklitsch & Voglmayr 2012). *Monographella* species are characterised by the production of perithecia immersed in leaf sheaths in natural substrates. In culture perithecia are superficial, globose, with clavate periphyses, show a peridium composed by isodiametric to subglobose cells of *textura angularis-epidermoidea*, and apically free paraphyses. Asci are oblong to clavate, with eight biseriate ascospores, and with a refractive, amyloid, flat, funnel-shaped apical ring. Ascospores are fusiform or oblong, hyaline, straight or slightly curved, and smooth. *Monographella* presently includes 11 species.

Microdochium and *Monographella* include important plant pathogens, particularly on grasses and cereals. In cold to temperate regions 'Microdochium patch', also known as 'pink snow mould' or 'Fusarium patch', is an economically important disease of wheat and barley, caused by *Microdochium nivale* (previously *M. nivale* var. *nivale*) and *M. majus* (previously *M. nivale* var. *majus*) (Von Arx 1987, Glynn et al. 2005, Jewell & Hsiang 2013). 'Leaf-scald disease' of rice is caused by *Monographella albescens* (Von Arx 1987). Leaf scald has the potential to significantly reduce rice yields through the destruction of leaf surface area, the production of sterile/deformed flowers, and seed decay. *Monographella albescens* has a worldwide distribution, causing considerable yield losses in India, Latin America and West Africa. In Mexico, *Monographella maydis* on *Zea mays* produces a tar-spot disease complex of maize together with *Phyllachora maydis* (Müller & Samuels 1984, Von Arx 1987, Hock et al. 1992). *Microdochium bolleyi* is known to produce root necrosis and decay of grasses (Braun 1995, Hong et al. 2008). *Monographella opuntiae* causes the brown spotting on *Opuntia* (Von Arx 1987, Braun 1995). *Microdochium tripsaci* is responsible for a systematic infection on *Tripsacum laxum* (Von Arx 1987, Braun 1995), while *M. sorghi* causes zonate leaf spots and decay on *Sorghum* species and other *Poaceae* (Von Arx 1987, Braun 1995). Finally, *M. paspali* is known to produce seashore paspalum disease of *Paspalum vaginatum* (Zhang et al. 2015).

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Table 1 Specimens and GenBank accession numbers of DNA sequences used in this study. T = ex-type; ET = ex-epitype.

Species	Voucher	Host/Substrate	Country	GenBank accession numbers			
				LSU	ITS	BTUB	RPB2
Castanediella cagnizarii	CBS 542.96 T	Leaf litter	Cuba	KP858991	KP859054	–	–
	CBS 101043	Leaf litter	Brazil	KP858988	KP859051	–	–
Castanediella couratarii	CBS 579.71 T	Wood	Brazil	KP858987	KP859050	–	–
Ephelis tripsaci	CBS 857.72 T	Leaf sheath of *Tripsacum laxum*	Sri Lanka	KP858978	KP859042	–	–
Idriella lunata	CBS 204.56 T	Root of *Fragaria chiloensis*	USA	KP858981	KP859044	–	–
	CBS 177.57	Unknown	USA	KP858980	KP859043	–	–
	CBS 209.60	Soil	The Netherlands	KP858982	KP859045	–	–
	CBS 736.74	Unknown	Japan	KP858983	KP859046	–	–
Idriellopsis uncinospora	CBS 575.92 T	Decaying leaves	Cuba	KP858989	KP859052	–	–
Microdochiella fusarioidea	CBS 740.83	On oospores of *Phytophthora syringae*	UK	KP858976	KP859040	–	–
	CBS 741.83T	On oospores of *Phytophthora syringae*	UK	KP858975	KP859039	–	–
	CBS 742.83	On oospores of *Phytophthora syringae*	UK	KP858977	KP859041	–	–
Microdochium albescens	CBS 290.79	On *Oryza sativa*	Ivory Coast	KP858950	KP859014	KP859077	KP859123
	CBS 291.79	On *Oryza sativa*	Ivory Coast	KP858932	KP858996	KP859059	KP859105
	CBS 243.83	Seed *Oryza sativa*	Unknown country	KP858930	KP858994	KP859057	KP859103
Microdochium bolleyi	CBS 540.92	Root of *Hordeum vulgare*	Syria	KP858946	KP859010	KP859073	KP859119
	CPC 25994	Wood in Rideau River	Canada	KP858954	KP859018	KP859081	KP859127
Microdochium citrinidiscum	CBS 109067 T	Leaf of *Eichhornia crassipes*	Peru	KP858939	KP859003	KP859066	KP859112
Microdochium colombiense	CBS 624.94 T	On *Musa sapientum*	Colombia	KP858935	KP858999	KP859062	KP859108
Microdochium fisheri	CBS 242.91 T	Stem of *Oryza sativa*	UK	KP858951	KP859015	KP859078	KP859124
Microdochium lycopodinum	CBS 146.68	Air sample	The Netherlands	KP858929	KP858993	KP859056	KP859102
	CBS 109397	On *Phragmites australis*	Germany	KP858940	KP859004	KP859067	KP859113
	CBS 109398	On *Phragmites australis*	Germany	KP858941	KP859005	KP859068	KP859114
	CBS 109399	On *Phragmites australis*	Germany	KP858942	KP859006	KP859069	KP859115
	CBS 122885 T	Leaves of *Lycopodium annotinum*	Austria	KP858952	KP859016	KP859079	KP859125
Microdochium majus	CBS 741.79	On *Triticum aestivum*	Germany	KP858937	KP859001	KP859064	KP859110
Microdochium neoqueenslandicum	CBS 445.95	On *Juncus effusus*	The Netherlands	KP858933	KP858997	KP859060	KP859106
	CBS 108926 T	On *Agrostis* sp.	New Zealand	KP858938	KP859002	KP859065	KP859111
Microdochium nivale	CBS 116205 T	Roots *Triticum aestivum*	UK	KP858944	KP859008	KP859071	KP859117
Microdochium phragmitis	CBS 285.71 ET	On *Phragmites australis*	Poland	KP858949	KP859013	KP859076	KP859122
	CBS 423.78	On *Phragmites communis*	Germany	KP858948	KP859012	KP859075	KP859121
Microdochium seminicola	CBS 122706	Maize kernels	Switzerland	KP858943	KP859007	KP859070	KP859116
	CBS 122707	Maize kernels	Switzerland	KP858947	KP859011	KP859074	KP859120
	CBS 139951 T	Maize kernels	Switzerland	KP858974	KP859038	KP859101	KP859147
	CPC 25993	On *Triticum aestivum*	Canada	KP858953	KP859017	KP859080	KP859126
	CPC 26001	On grain	Canada	KP858961	KP859025	KP859088	KP859134
	CPC 26010	Unknown	Canada	KP858969	KP859033	KP859096	KP859142
	DAOM 250155	Maize kernels	Switzerland	KP858973	KP859037	KP859100	KP859146
	DAOM 250158	Maize kernels	Switzerland	KP858972	KP859036	KP859099	KP859145
	DAOM 250159	Maize kernels	Switzerland	KP858971	KP859035	KP859098	KP859144
	DAOM 250161	On *Triticum aestivum*	Canada	KP858970	KP859034	KP859097	KP859143
	DAOM 250162	On *Triticum aestivum*	Canada	KP858968	KP859032	KP859095	KP859141
	DAOM 250163	Unknown	Canada	KP858967	KP859031	KP859094	KP859140
	DAOM 250165	On grain	Canada	KP858966	KP859030	KP859093	KP859139
	DAOM 250166	On grain	Canada	KP858965	KP859029	KP859092	KP859138
	DAOM 250167	On grain	Canada	KP858964	KP859028	KP859091	KP859137
	DAOM 250168	On grain	Canada	KP858963	KP859027	KP859090	KP859136
	DAOM 250169	On grain	Canada	KP858962	KP859026	KP859089	KP859135
	DAOM 250171	On grain	Canada	KP858960	KP859024	KP859087	KP859133
	DAOM 250172	On grain	Canada	KP858959	KP859023	KP859086	KP859132
	DAOM 250173	On grain	Canada	KP858958	KP859022	KP859085	KP859131
	DAOM 250174	On grain	Canada	KP858957	KP859021	KP859084	KP859130
	DAOM 250175	On grain	Canada	KP858956	KP859020	KP859083	KP859129
	DAOM 250176	On *Triticum aestivum*	Canada	KP858955	KP859019	KP859082	KP859128
Microdochium sorghi	CBS 691.96	Living *Sorghum halepense*	Cuba	KP858936	KP859000	KP859063	KP859109
Microdochium tainanense	CBS 269.76 T	Root of *Saccharum officinarum*	Taiwan	KP858945	KP859009	KP859072	KP859118
	CBS 270.76	Root of *Saccharum officinarum*	Taiwan	KP858931	KP858995	KP859058	KP859104
Microdochium trichocladiopsis	CBS 623.77 T	Rhizosphere of *Triticum aestivum*	Unknown country	KP858934	KP858998	KP859061	KP859107
Neoidriella desertorum	CBS 985.72 T	Soil	Egypt	KP858985	KP859048	–	–
Paraidriella jambosae	CBS 374.90 T	Leaves of *Syzygium jambos*	Cuba	KP858986	KP859049	–	–
Paramicrodochium gracile	CBS 493.70 T	Rabbit dung	The Netherlands	KP858979	–	–	–
Selenodriella cubensis	CBS 683.96	Unknown	Cuba	KP858990	KP859053	–	–
Selenodriella fertilis	CBS 772.83	Dead leaf of *Hakea baxteri*	Australia	KP858992	KP859055	–	–

Microdochium species are recognised as fusarium-like fungi. Nevertheless, the conidiogenous cells in *Microdochium* spp. are not phialidic as in true *Fusarium* species and the conidia have a truncate base rather than 'foot-cells'. Besides, the sexual morphs of *Microdochium* are known to reside in *Monographella*. On the other hand, the close affinity of *Microdochium* to *Idriella* has been discussed by various authors (Sutton et al. 1972, Mouchacca & Samson 1973, Von Arx 1981). *Idriella lunata*, the type species of *Idriella*, which was described as a fungus causing a root rot of strawberry in California, differs in producing dark grey to blackish brown colonies, pale brown conidiophores reduced to conidiogenous cells and short-stalked or sessile, brown chlamydospores (Nelson & Wilhelm 1956). *Microdochium* and *Idriella* are very similar genera that have polyblastic conidiogenous cells and hyaline falcate conidia, with the presence of chlamydospores in culture. Von Arx (1981) differentiated both genera based on their habitat and conidial shape. He accommodated saprobic species with falcate or lunate conidia, dark colonies and chlamydospores in *Idriella*, and retained the phytopathogenic species in *Microdochium*. Nevertheless, morphological and ecological delimitation of *Microdochium* and *Idriella* is problematic and remains obscure, and taxonomic affinities inferred from molecular data have not yet been established. *Idriella* has been linked to *Hymenoscyphus caudatus* in the *Helotiales* (Kimbrough & Atkinson 1972). Currently the genus *Idriella* includes approximately 30 species (Seifert et al. 2011), but few cultures and ex-type strains are available for comparison.

A number of isolates of *Microdochium* have accumulated over the years in the culture collection of the CBS-KNAW Fungal Biodiversity Centre, Utrecht, The Netherlands and in the National Mycological Herbarium from Canada (DAOM), which were formerly identified based on morphology only. The aims of this study were: 1) to characterise these diverse isolates incorporating culture characteristics (macro- and micro-morphology) and molecular data; 2) to delimit the species in *Microdochium*, *Monographella* and *Idriella* based on phylogenetic analysis of multi-gene sequence data and morphological characters; and 3) to resolve taxonomic and nomenclatural uncertainty by providing modern descriptions and designating an epitype for the type species of *Microdochium*.

MATERIALS AND METHODS

Isolates

Isolates used in this study were obtained from CBS-KNAW Fungal Biodiversity Centre (CBS), Utrecht, The Netherlands, which included all available ex-type strains of described species. Additional isolates were obtained from the National Mycological Herbarium from Canada (DAOM) (Table 1). Isolates were cultured on oatmeal agar (OA; Crous et al. 2009b), and incubated at 25 °C under daylight conditions for 3 wk. Reference strains were deposited in the CBS culture collection. Taxonomic information and nomenclature for new species were deposited in MycoBank (www.MycoBank.org; Crous et al. 2004).

DNA isolation, amplification and analyses

Genomic DNA was extracted from fungal colonies growing on 2 % malt extract agar (MEA; Oxoid) using the UltraClean™ Microbial DNA Isolation kit (MoBio Laboratories, Inc., Solana Beach, CA, USA) and Wizard® Genomic DNA purification kit (Promega, Madison, USA), according to the manufacturer's protocols. 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, the first internal transcribed spacer (ITS1), the 5.8S rRNA gene, the second ITS region (ITS2) and ± 900 bp of the 5' end of the 28S rRNA gene. The primers ITS4 (White et al. 1990) and LSU1Fd (Crous et al. 2009a) were used as internal sequence primers to ensure good quality sequences over the entire length of the amplicon. Part of the beta-tubulin gene region (BTUB) was amplified and sequenced using primers Btub526F and Btub1332R (Jewell & Hsiang 2013), and primers RPB150F (Jewell & Hsiang 2013) and fRPB2-7cR (Liu et al. 1999) were used for the RNA polymerase II second largest subunit gene (RPB2). Amplification conditions for ITS and LSU followed Crous et al. (2013) and for BTUB and RPB2 Jewell & Hsiang (2013). The program SeqMan Pro (DNASTAR, Madison, WI, USA) was used to obtain consensus sequences of each isolate. Megablast searches using ITS and LSU sequences were performed against NCBIs GenBank nucleotide sequence database to identify the closest matching sequences, which were added to the sequences alignment. Sequences were aligned with MAFFT v. 7 (Katoh & Standley 2013) using the defaults settings and adjusted by hand in MEGA v. 6.06 (Tamura et al. 2013). To address the phylogenetic relationships among taxa, Bayesian inference (BI) using MrBayes v. 3.2.1 (Ronquist et al. 2012), and for maximum parsimony (MP) and neighbour-joining analysis with the Kimura 2-parameter and the HKY85 substitution model using PAUP v. 4.0b10 (Swofford 2003) were used as described by Crous et al. (2006). For parsimony analysis, alignment gaps were treated as a fifth character state with all characters unordered and of equal weight. The maximum parsimony analysis was performed with the heuristic search option with 100 random taxa additions and tree bisection and reconstruction (TBR) as the branch-swapping algorithm. Branches of zero length were collapsed and all multiple, equally parsimonious trees were saved. Other measures calculated included tree length, consistency index, retention index and rescaled consistency index (TL, CI, RI and RC, respectively). MrModelTest v. 2.2 (Nylander 2004) was used to determine the best nucleotide substitution model settings prior to the Bayesian analysis in MrBayes v. 3.2.1 (Ronquist et al. 2012). Nodal support was assessed by bootstrap analysis from 1 000 replicates. Bootstrap values (BS) equal or higher than 70 % were considered significant. Posterior probabilities for the Bayesian analysis (PP) were determined by calculating 50 % majority rule consensus tree.

Sequences derived in this study were deposited at GenBank, the alignments and trees in TreeBASE (http://treebase.org/treebase-web/home.html). The phylogenetic trees were edited using FigTree v. 1.4.0 and Adobe Illustrator CS5.1.

Morphology

Slide preparations were mounted in clear lactic acid from colonies sporulating on OA. Observations and photomicrographs were made with a Nikon SMZ1500 stereo-microscope, and with a Nikon eclipse Ni microscope, using a Nikon DS-U3 digital camera (Nikon, Tokyo, Japan) and NIS-Elements imaging software v. 4.20. Colony characters and pigment production were noted after 1 and 3 wk of growth on OA incubated at 25 °C. Colony colours (surface and reverse) were treated according to the colour chart of Rayner (1970).

RESULTS

Phylogeny

The LSU alignment was used to determine the generic relationships among *Microdochium*, *Monographella* and *Idriella* (Fig. 1), and the combined ITS, LSU, BTUB and RPB2 alignment (Fig. 2) to confirm species resolution in *Microdochium*.

The LSU dataset consists of 124 aligned sequences, including the outgroup *Sarcoleotia globosa* and 898 characters, of which 467 constitute unique site patterns. Based on the results of Mr-

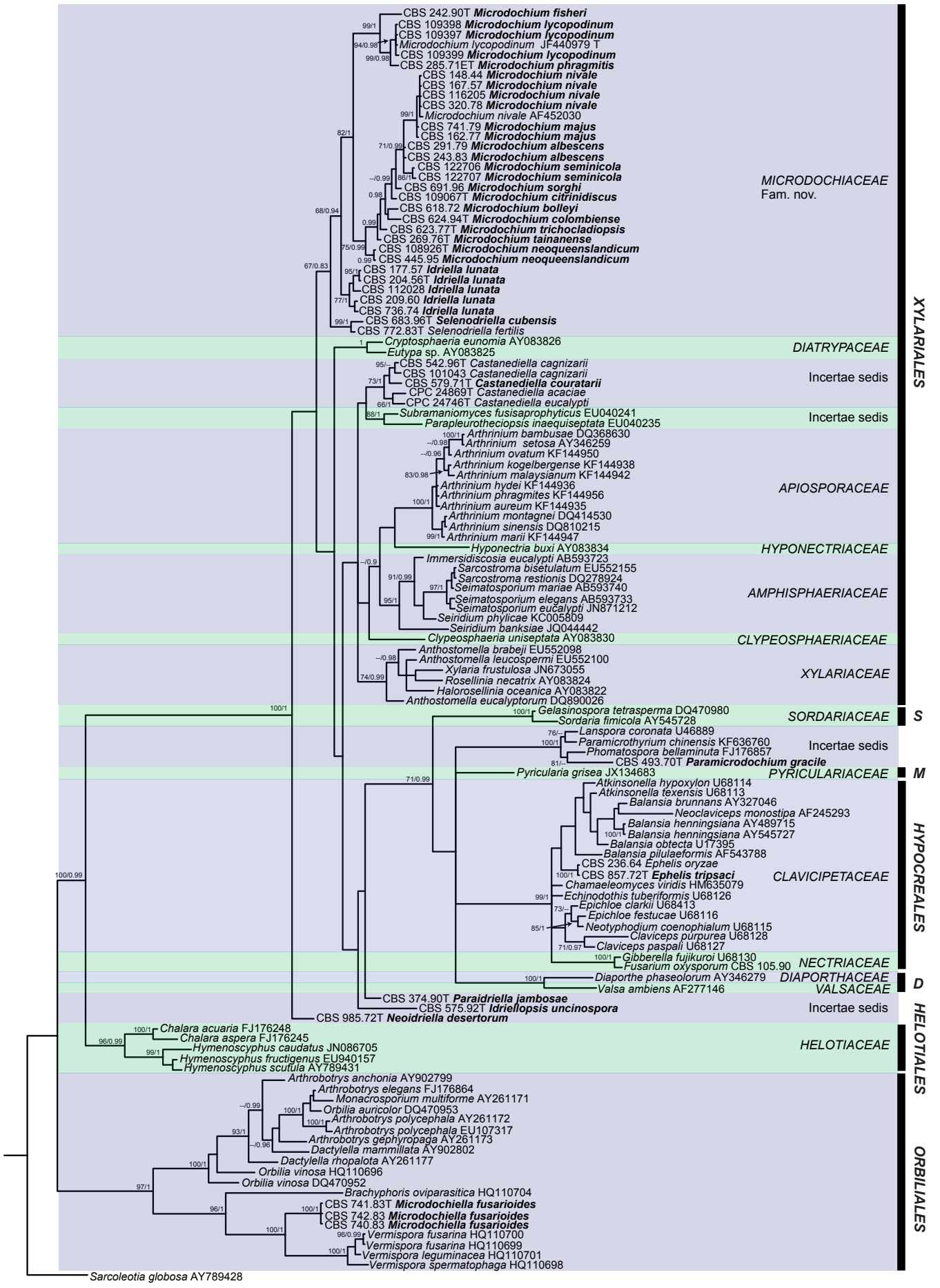

Fig. 1 Maximum parsimony tree based on LSU data. Maximum parsimony bootstrap support values followed by Bayesian Posterior Probabilities are shown at the nodes. Orders and families are shown to the right of the tree and the scale bar indicates the number of changes. The tree was rooted with *Sarcoleotia globosa*. T = ex-type strain, ET = ex-epitype strain. D = *Diaporthales*, M = *Magnaporthales*, S = *Sordariales*.

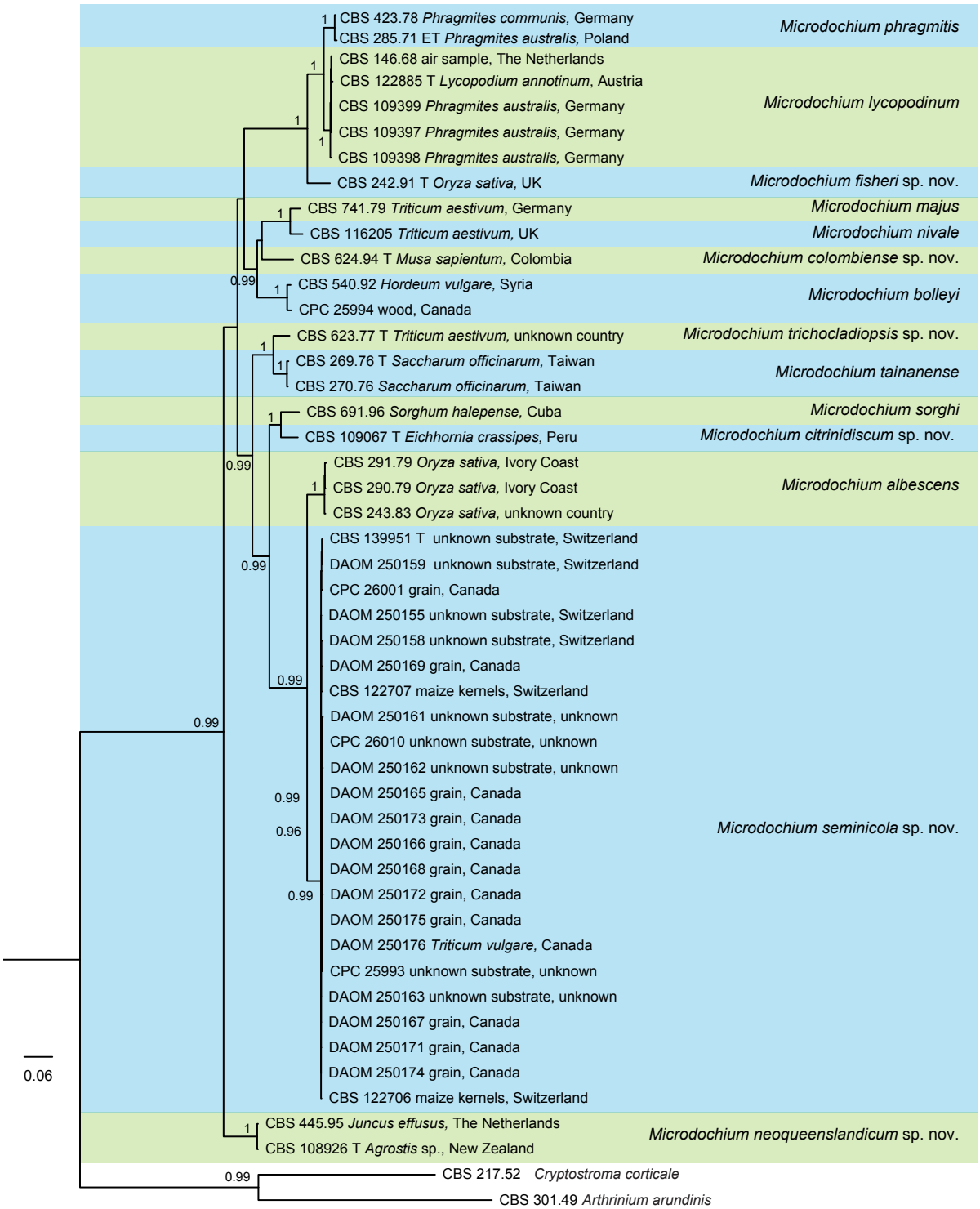

Fig. 2 Bayesian phylogenetic tree inferred from the DNA sequence data from four loci (ITS, LSU, BTUB and RPB2) of *Microdochium* species. Bayesian posterior probabilities above 0.95 are indicated at the nodes and the scale bar indicates the number of expected mutations per site. Species names are shown to the right of the tree. The tree was rooted to *Cryptostroma corticale* (CBS 217.52) and *Arthrinium arundinis* (CBS 301.49). T = ex-type strain; ET = ex-epitype strain.

Modeltest, the GTR+I+G model with inverse gamma-distributed was selected as best fit model for Bayesian analyses. In the MP analyses 455 characters were constant, 111 were variable and parsimony uninformative while 332 were parsimony informative. A maximum of 1 000 equally most parsimonious trees were retained from this analysis (Tree length = 2 067, CI = 0.368, RI = 0.831 and RC = 0.305). The resulting MP tree is presented in Fig. 1 together with PP and BS values. The majority of the strains clustered in the *Xylariales*. However, *Microdochium gracile* CBS 493.70, is placed *incertae sedis* in the *Sordariomycetes* together with *Lanspora coronata*, *Paramicrothyrium chinensis* and *Phomatospora bellaminuta*. *Microdochium tripsaci* CBS 857.72 clusters in *Clavicipitaceae* (*Hypocreales*), and *Microdochium fusarioides* CBS 740.83, CBS 741.83 and CBS 742.83, clusters in *Orbiliales*.

The phylogenetic tree delimited seven families in *Xylariales*, one of which is described here as new (*Microdochiaceae* including *Microdochium* s.str., *Idriella* s.str. and *Selenodriella*), and six previously included families namely *Apiosporaceae*, *Amphisphaeriaceae*, *Clypeosphaeriaceae*, *Diatrypaceae*, *Hyponectriaceae* and *Xylariaceae*. Some species previously included in *Idriella*, viz. *Idriella desertorum* CBS 985.72, *Idriella jambosae* CBS 374.90 and *Idriella uncinospora* CBS 575.92, were placed *incertae sedis* in the *Sordariomycetes* phylogenetically distant from the type species of *Idriella*, *I. lunata*, and represent novel genera described in the taxonomy section. *Idriella couratarii*

CBS 579.71 groups in a subclade in *Xylariales* with the recently described genus *Castanediella* (Crous et al. 2015), and is proposed here as a new combination.

Microdochium s.str. was analysed in more detail using multilocus data composed of 48 isolates including *Arthrinium arundinis* and *Cryptostroma corticale* as outgroups, and their aligned sequences of four genes, ITS, LSU, BTUB and RPB2. This dataset consisted in total of 2 955 characters (526 bp from the ITS, 831 bp from LSU, 772 bp from BTUB and 826 bp from RPB2) of which 871 constitutes unique site patterns. This phylogenetic tree (Fig. 2) delimited 14 species clades, seven of which represent novel species, described in the Taxonomy section below.

TAXONOMY

Orbiliales, incertae sedis

Microdochiella Hern.-Restr. & Crous, *gen. nov.* — MycoBank MB811866

Etymology. In reference to its morphological similarity with the genus *Microdochium*.

Type species. *Microdochiella fusarioides* (D.C. Harris) Hern.-Restr. & Crous.

Mycelium immersed and superficial, hyphae hyaline, septate. *Conidiophores* erect, hyaline, loosely branched. *Conidiogenous cells* polyblastic, terminal and intercalary, sympodial, denticulate, hyaline. *Conidia* solitary, dry but with a droplet of moisture at the mid-point of each conidium, hyaline, narrow-falcate, septate, truncate base and narrowly rounded at the apex. *Chlamydospores* subglobose to ellipsoidal, forming intercalary chains. *Sexual morph* unknown.

Microdochiella fusarioides (D.C. Harris) Hern.-Restr. & Crous, *comb. nov.* — MycoBank MB811867

Basionym. Microdochium fusarioides D.C. Harris, Trans. Brit. Mycol. Soc. 84: 358. 1985.

Type details. UK, East Malling research station, on oospores of *Phytophthora syringae*, Oct. 1980, *D.C. Harris* (holotype IMI 281715).

Description & illustration — See Harris (1985).

Specimens examined. UK, East Malling research station, on oospores of *Phytophthora syringae*, Oct. 1980, *D.C. Harris*, living ex-type culture CBS 741.83; other living cultures CBS 740.83 and CBS 742.83.

Notes — In the phylogenetic tree three strains of *M. fusarioides* formed a well-supported clade related but clearly separated from *Vermispora* in *Orbiliales*. Asexual morphs in this fungal order are characterised by holoblastic conidiogenesis, absence of yeast-like budding, and some of them can produce trapping organs, although non-predacious and freshwater fungi are also frequently found in *Orbiliales* (Li et al. 2005, Chen et al. 2007, Yu et al. 2011). *Vermispora* and *Microdochiella* are similar morphologically, but they have different ecological preferences. The genus *Vermispora* includes five species isolated from soil, dead leaves and eggs of nematodes (Chen et al. 2007). Although the genus is apparently monophyletic, no live material of the type species, *V. grandispora*, exists. Here we introduce *Microdochiella* to include one atypical microdochium-like species growing on oospores of *Phytophthora syringae* (Harris 1985). Phylogenetically *Microdochiella* is clearly distinct from *Vermispora*. The three strains of *M. fusarioides* remained sterile in culture.

Sordariomycetes, Hypocreales, Clavicipitaceae

Ephelis tripsaci (D. Mulder & Arx) Hern.-Restr. & Crous, *comb. nov.* — MycoBank MB811868; Fig. 3

Basionym. *Microdochium tripsaci* D. Mulder & Arx, Sydowia 34: 32. 1981.

Mycelium immersed or superficial, hyphae branched, septate, hyaline. *Sporodochia* white buff to olivaceous black, 276–510 µm diam, solitary to aggregated, often confluent at base, *textura intricata-epidermoidea*, 1.5–4 µm diam; hymenium with hyaline to pale brown cells, dark sporodochia with crystals (white to yellow) and extracellular brown pigments (umber to chestnut). *Conidiophores* branched, hyaline, smooth. *Conidiogenous cells* holoblastic, sympodial, terminal or lateral on aerial mycelium, straight or flexuous, cylindrical, 13–86 × 1–2 µm, hyaline. *Conidia* in whorls at the tips of conidiogenous cells, acicular, vermiform-subulate or obclavate, 12–22.5 × 1.5–3 µm, unicellular, hyaline, smooth-walled, apically rostrate and curved, base truncate, 1 µm diam.

Culture characteristics — Colonies on OA reaching 12–14 mm diam in 3 wk, velvety to powdery, white, margin with rhizoids. Sporodochia formed after 2 wk near the inoculum, vinaceous buff to grey olivaceous.

Specimen examined. Sri Lanka, on leaf sheath in *Tripsacum laxum*, Oct. 1972, *D. Mulder* (holotype CBS H-22144; living culture ex-type CBS 857.72).

Notes — The isolate CBS 857.72 groups in a clade with *Ephelis oryzae* CBS 236.64 and other members of *Clavicipitaceae* (Fig. 1). *Ephelis tripsaci* was initially included in *Microdochium*. Nevertheless, the isolate CBS 857.72 fits with the *Ephelis* concept, based on molecular and morphological data. Blast search of ITS resulted in a 99 % of similarity with AB038564 of *Ephelis japonica*, CBS 236.64 of *Ephelis oryzae* and several other unidentified *Ephelis* spp. Conidial morphology in *E. tripsaci* is slightly different from *E. japonica* and *E. oryzae*, having shorter and wider conidia (in *E. japonica* they are 20–30 × 0.7–1 µm, and in *E. oryzae* 20–35 × 1 µm, in *E. tripsaci* 12–22.5 × 1.5–3 µm). *Ephelis* has been reported as asexual morph occurring in different genera in *Clavicipitaceae* (*Hypocreales*) mainly in *Atkinsonella*, *Balansia*, *Myriogenispora* and *Nigrocornus* (Kuldau et al. 1997, White et al. 2003, Seifert et al. 2011). Phylogenetic studies demonstrated that species of *Atkinsonella*, *Balansia* and *Myriogenispora* with *Ephelis* asexual states form a monophyletic clade (Kuldau et al. 1997). Further taxonomic studies are clearly needed on these genera.

Sordariomycetes, incertae sedis

Paramicrodochium Hern.-Restr. & Crous, *gen. nov.* — MycoBank MB811869

Etymology. Named after its morphological similarity to, but being distinct from, *Microdochium*.

Type species. *Paramicrodochium gracile* (Mouch. & Samson) Hern.-Restr. & Crous.

Mycelium immersed and superficial, hyphae hyaline, septate, smooth. *Conidiophores* slightly differentiated, branched, hyaline. *Conidiogenous cells* polyblastic, occasionally monoblastic, terminal and intercalary, sympodial, denticulate, cylindrical, lageniform, straight or curved. *Conidia* solitary, dry, hyaline, unicellular, smooth, filiform to falcate, straight or curved, truncate at base, tapering towards the apex. *Sexual morph* unknown.

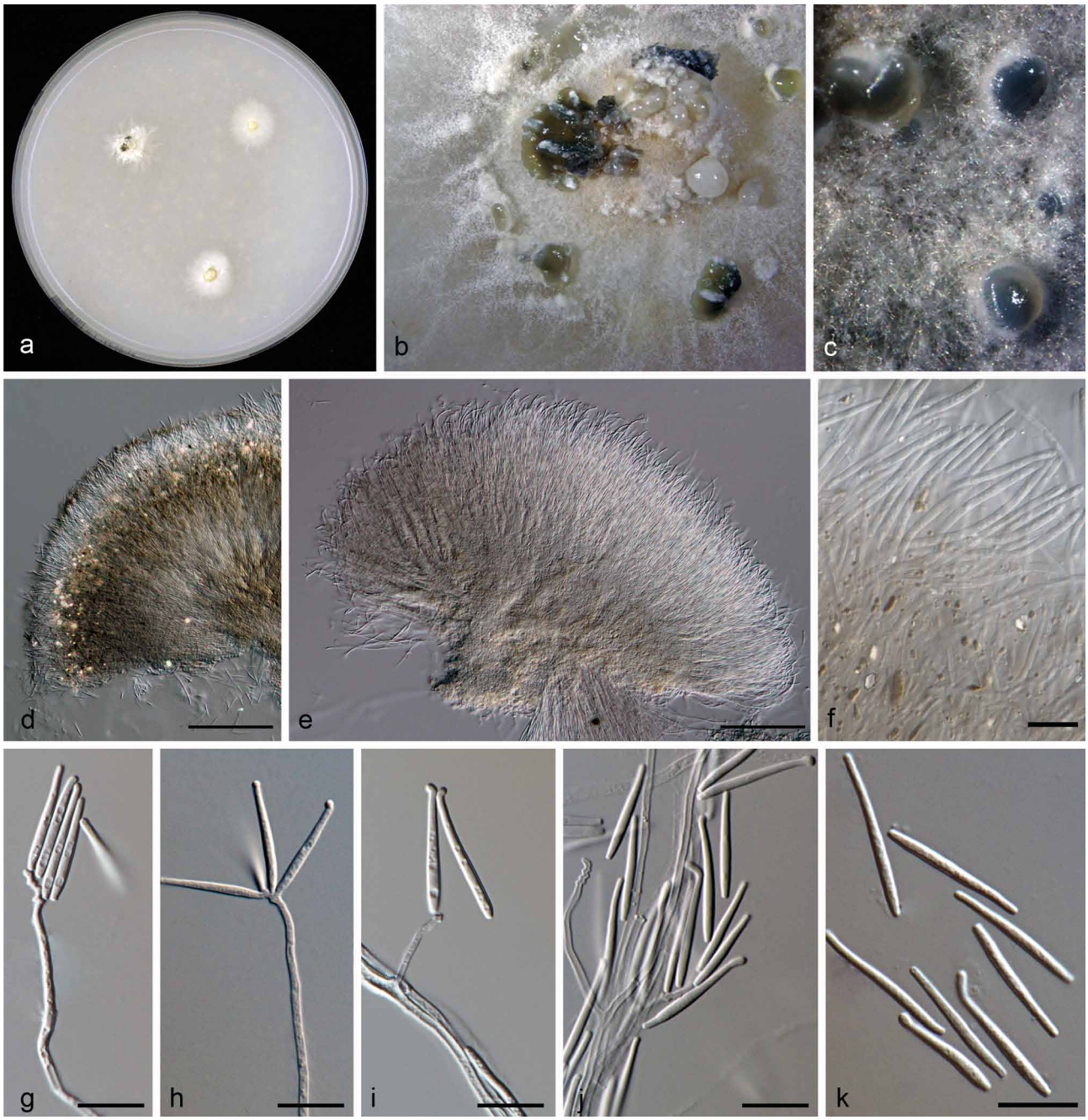

Fig. 3 *Ephelis tripsaci* (from ex-type, CBS 857.72). a. Colony on OA at 25 °C in 3 wk; b, c. colony overview; d, e. sporodochia; f. extracellular pigments and crystals; g–j. conidiogenous cells; k. conidia. — Scale bars: d, e = 100 µm; f–k = 10 µm.

Paramicrodochium gracile (Mouch. & Samson) Hern.-Restr. & Crous, *comb. nov.* — MycoBank MB811870; Fig. 4

Basionym. *Microdochium gracile* Mouch. & Samson, Rev. Mycol. (Paris) 37: 270. 1973.

Mycelium immersed and superficial, hyphae septate, hyaline. *Conidiogenous cells* mainly terminal, mono- and polyblastic, denticulate, straight or curved, cylindrical to slightly inflated in the median region, 7–31.5 × 1.5–3 µm, hyaline, smooth. *Conidia* acicular, falcate, 11–18 × 0.8–1.5 µm, unicellular, hyaline, apex pointed, base truncate.

Culture characteristics — Colonies on OA 20 mm diam in 4 wk. Flat, aerial mycelium absent, with concentric rings, flesh to white at the periphery, margin entire; reverse saffron. On MEA, 25–30 mm diam after 4 wk. Convex, funiculose, peach, margin fimbriate; reverse scarlet.

Specimen examined. The Netherlands, Baarn, Groeneveld, isolated from rabbit dung, 1970, *G.S. de Hoog*, (CBS H-22138, living culture ex-type CBS 493.70 (as *Microdochium gracile*).

Notes — The strain CBS 493.70 grouped *incertae sedis* (*Sordariomycetes*) in a clade distant from *Xylariales*. *Paramicrodochium* is introduced here to accommodate a microdochium-like taxon isolated from a rabbit dung sample collected in The Netherlands. According to the phylogenetic analysis this taxon does not cluster with *Microdochium* s.str. *Paramicrodochium gracile* was placed as the sister clade of *Lanspora coronata*, *Paramicrothyrium chinensis* and *Phomatospora bellaminuta*. These obscure fungi are sexual morphs without any known asexual morph. *Paramicrothyrium chinenses* is a fungus that grows on dead leaves found in China and produces thyrothecial ascomata (Wu et al. 2011). *Lanspora coronata* is a marine species that grows on driftwood collected in Seychelles (Hyde & Jones 1986). *Phomatospora bellaminuta* was isolated from senescent culms of *Juncus roemerianus* in North Carolina (USA) and also considered a marine fungus (Kohlmeyer et al. 1995). Additional samples are needed in order to assess the higher taxonomical rank and to understand the ecology and geographic distribution of species in this clade.

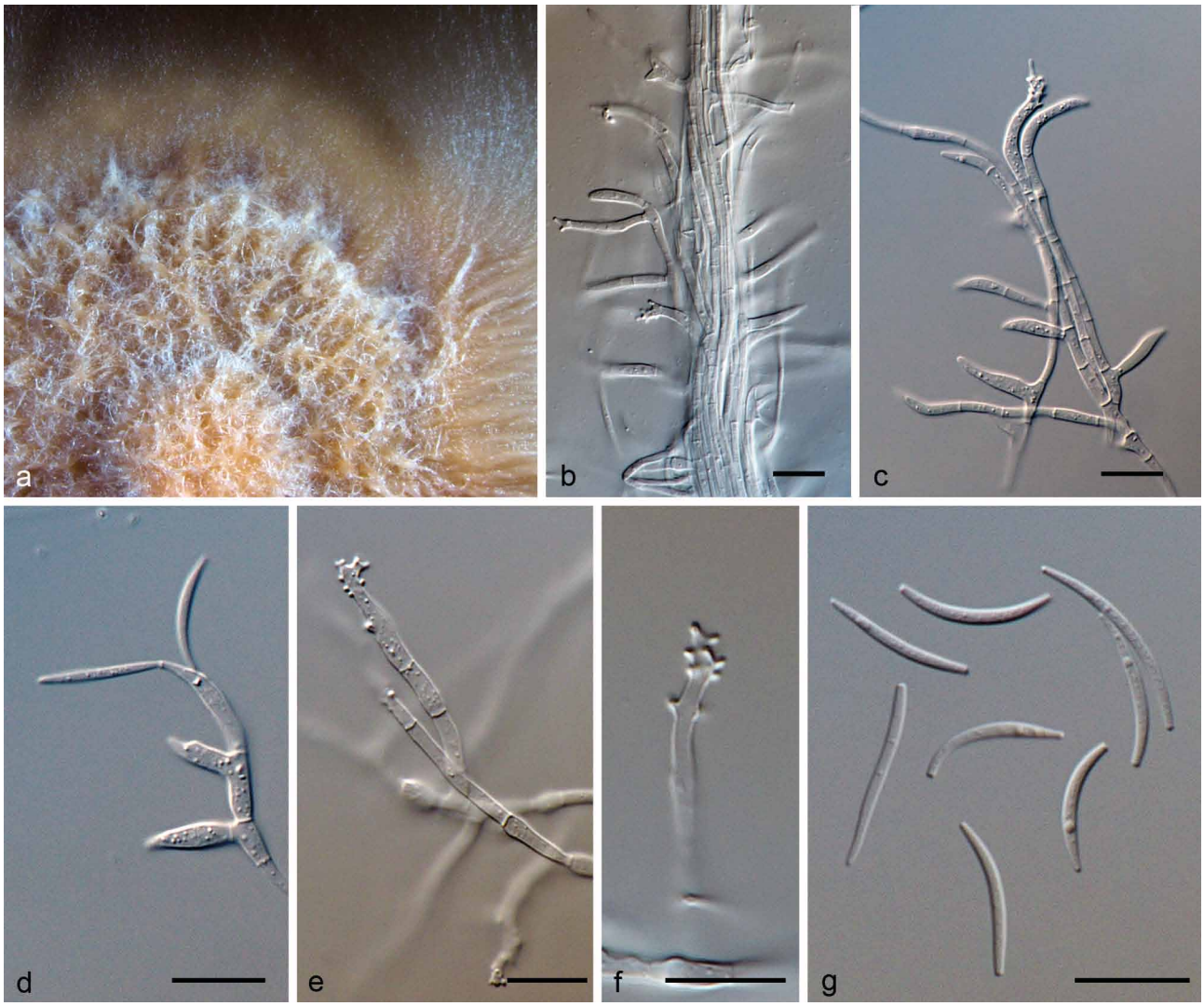

Fig. 4 *Paramicrodochium gracile* (from ex-type, CBS 493.70). a. Colony on OA at 25 °C in 4 wk; b–f. conidiogenous cells; g. conidia. — Scale bars: b–g = 10 µm.

Sordariomycetes, Xylariales

Microdochiaceae Hern.-Restr., Crous & J.Z. Groenew., *fam. nov.* — MycoBank MB811871

Saprobic, endophytic or pathogenic; on leaves, seeds and soil. *Sexual morph*. *Stroma* present or absent. *Ascomata* perithecial. *Asci* cylindrical, oblong, clavate, with amyloid funnel-shaped apical ring and 8 biseriate or uniseriate ascospores. *Ascospores* ellipsoid or oblong, fusoid, hyaline to pale brown. *Asexual morph*. *Conidiomata* if present, sporodochial. *Conidiophores* solitary or aggregated, mono- or biverticillate. *Conidiogenous cells* solitary or in whorls, polyblastic, sympodial, denticulate, cylindrical often ampulliform, lageniform with elongated necks and minute annellides from percurrent proliferations, hyaline to pale brown. *Conidia* lunate, oblong, fusiform or cylindrical, straight or curved, hyaline, flattened at base. *Chlamydospores* if present, brown.

Type genus. Microdochium Syd.

Included genera — *Idriella*, *Microdochium* and *Selenodriella*.

Idriella P.E. Nelson & S. Wilh., Mycologia 48: 550. 1956

Mycelium immersed and superficial, hyphae hyaline to brown, septate, smooth. *Conidiophores* brown, non-septate. *Conidiogenous cells* polyblastic, terminal, denticulate, lageniform to cylindrical. *Conidia* dry, in heads, hyaline, unicellular, smooth, lunate, curved. *Chlamydospores* brown, uni- or pluricellular. *Sexual morph* unknown.

Type species. Idriella lunata P.E. Nelson & S. Wilh.

Idriella lunata P.E. Nelson & S. Wilh., Mycologia 48: 550. 1956 — Fig. 5

Specimens examined. Japan, Kamakura, unknown substrate, Dec. 1974, *K. Takano*, living culture CBS 736.74. – The Netherlands, isolated from soil, Oct. 1960, *J.C. Went*, living culture CBS 209.60. – Unknown, unknown substrate, 12 Jan. 1957, *P.E. Nelson*, living culture CBS 177.57. – USA, Santa Clara, California, on diseased roots of *Fragaria chiloensis*, Sept. 1950, *P.E. Nelson*, living culture ex-type CBS 204.56.

Notes — *Idriella lunata* was introduced for a fungus growing on infected roots on *Fragaria chiloensis* (Nelson & Wilhelm 1956) and the genus currently comprises 30 species (Matsushima 1971, Von Arx 1981, Castañeda-Ruiz & Kendrick 1991, Rodrigues & Samuels 1992). Nevertheless, our phylogenetic analyses suggest that *Idriella* is a monotypic genus, and species formerly described in this genus as *I. desertorum*, *I. jambosae* and *I. uncinospora*, depict new genera. Although the phylogenetic position of these new genera is still unclear, they do not belong to the *Microdochiaceae*, but appear as members of *Sordariomycetes* with uncertain position (Fig. 1).

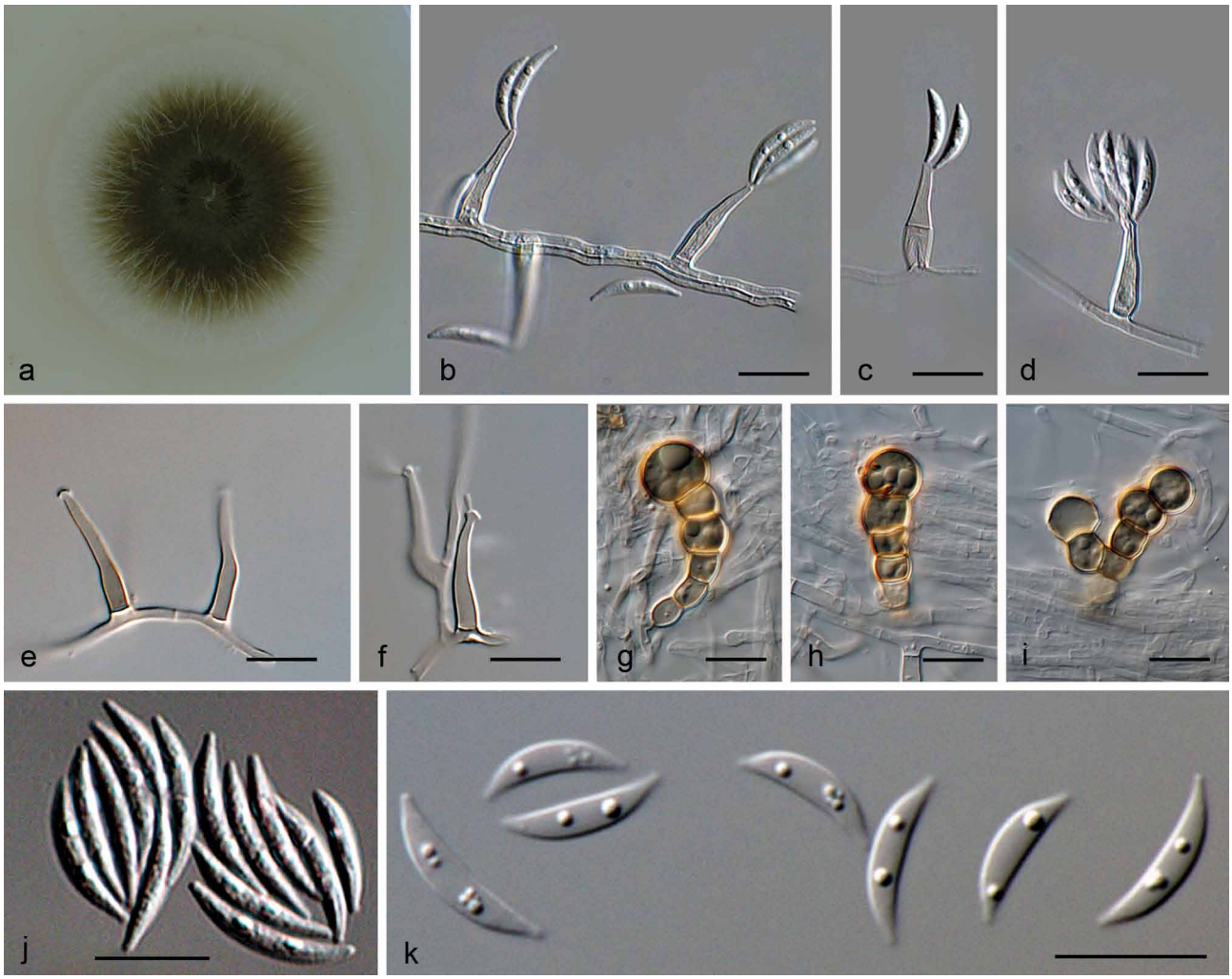

Fig. 5 *Idriella lunata* (a–d, j from ex-type CBS 204.56; e from CBS 177.57; g–i, k from CBS 404.78). a. Colony overview on OA at 25 °C in 3 wk; b–f. conidiogenous cells; g–i. chlamydospores; j, k. conidia. — Scale bars: b–k = 10 µm.

Microdochium Syd., Ann. Mycol. 22: 267. 1924

= *Monographella* Petr., Ann. Mycol. 22: 144. 1924.
= *Griphosphaerella* Petr., Ann. Mycol. 25: 209. 1927.
= *Gloeocercospora* D.C. Bain & Edgerton, Trans. Brit. Mycol. Soc. 57: 358. 1971.
= *Gerlachia* W. Gams & E. Müll., Netherlands J. Agric. Sci. 86: 49. 1980.

Type species. *Microdochium phragmitis* Syd.

Mycelium immersed, branched, septate, hyphae hyaline to pale brown. *Sporodochia*, if present, epidermal, subepidermal, erumpent through stomata, through rupture of the outer epidermal wall and cuticle, or by specialized egression hyphae through the outer epidermal wall; hyaline, pseudoparenchymatic, spreading after egress. *Conidiophores* more or less verticillate, often slightly differentiated, reduced to conidiogenous cells, hyaline, smooth. *Conidiogenous cells* holoblastic, discrete, hyaline, smooth, solitary or aggregated in small sporodochia. Two kinds: with sympodial proliferation, cylindrical or slightly tapering, or clavate, denticulate with one or more apical denticles. Or with percurrent proliferation (annellidic), subcylindrical, obpyriform, ampulliform to lageniform. *Conidia* dry or in slimy mass, unicellular or multiseptate, hyaline, smooth, lunate, falcate, fusiform, filiform, obovoid or subpyriform, straight or curved, apex rounded, base flattened. Sometimes the conidia originate directly from hyphae. *Chlamydospores* terminal or intercalary, solitary, in chains or grouped in clusters, brown. *Sexual morph* monographella-like, on natural substrate. *Ascomata* perithecial, immersed, subepidermal, solitary or in groups, pale brown to black, globose, subglobose to oval with central, papillate and often acute ostiole, ostioles usually more distinctly pigmented than the perithecial body, filled with slightly clavate periphyses. *Peridium* brown, thin-walled, thickened and darker around the ostiole, in view face *textura angularis-epidermoidea*. *Paraphyses* filamentous, apically free, thin-walled. *Asci* unitunicate, oblong to clavate with 8 bi- to multiseriate ascospores, apex with an amyloid, refractive, flat, funnel-shaped ring. *Ascospores* clavate, fusoid or oblong, hyaline to brownish, straight or curved, smooth and septate.

Microdochium albescens (Thüm.) Hern.-Restr. & Crous, *comb. nov.* — MycoBank MB812167

Basionym. *Metasphaeria albescens* Thüm., Die Pilze der Reispflanze 12: 5. 1889.

≡ *Griphosphaerella albescens* (Thüm.) Arx, Gen. Fungi Sporul. Cult., Edn 3 (Vaduz): 174. 1981.
≡ *Monographella albescens* (Thüm.) V.O. Parkinson, Sivan. & C. Booth, Trans. Brit. Mycol. Soc. 76: 64. 1981.
= *Metasphaeria oryzae-sativae* Hara, Diseases of the Rice Plant (Japan): 151. 1918.
= *Rhynchosporium oryzae* Hashioka & Yokogi, Contrib. Lab. Plant Disease Sci. Fac. Agric. Gifu Univ. 6: 51. 1955.
≡ *Gerlachia oryzae* (Hashioka & Yokogi) W. Gams, in Gams & Müller, Neth. J. Pl. Path. 86: 50. 1980.
≡ *Microdochium oryzae* (Hashioka & Yokogi) Samuels & I.C. Hallett, Trans. Brit. Mycol. Soc. 81: 481. 1983.
= *Micronectriella pavgii* R.A. Singh, Friesia 11: 238. 1978.

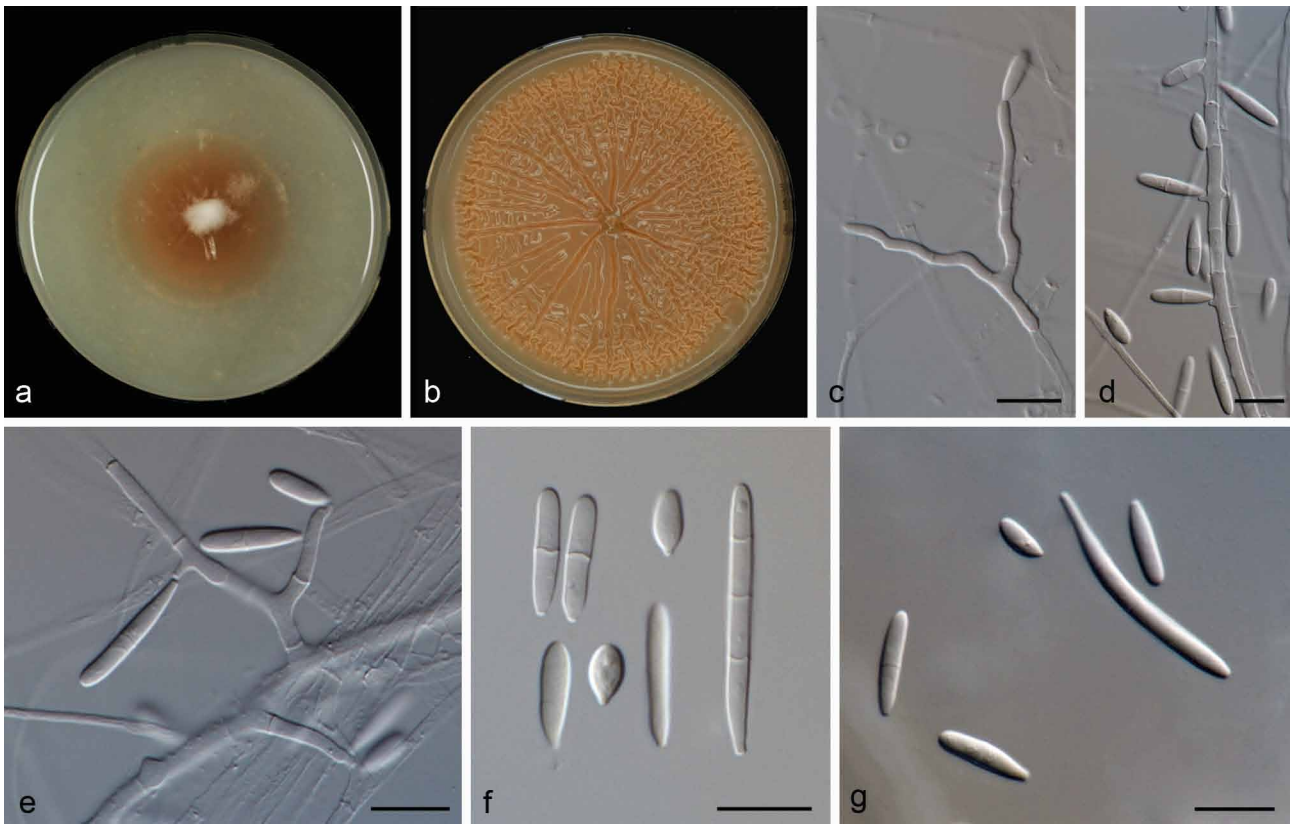

Fig. 6 *Microdochium citrinidiscum* (from ex-type, CBS 109067). a. Colony on OA at 25 °C in 1 wk; b. colony on OA at 25 °C in 3 wk; c–e. conidiogenous cells; f, g. conidia. — Scale bars: c–g = 10 µm.

Microdochium citrinidiscum Hern.-Restr. & Crous, *sp. nov.* — MycoBank MB811872; Fig. 6

Etymology. Latin *Citrinus*- meaning orange and *discus*- disk; in reference to their orange slice colony appearance.

Mycelium mostly immersed, hyphae hyaline, septate, smooth, 1.5–4 µm wide. *Conidiophores* undifferentiated. *Conidiogenous cells* terminal or intercalary, mono- or polyblastic, denticulate, cylindrical, 11–29 × 1.5–2 µm. *Conidia* cylindrical, clavate, obovoid, 0–3-septate, 7–31 × 2–3 µm, base usually flattened 0.5–1 µm. Sometimes born directly from the mycelial hyphae. *Chlamydospores* not observed.

Culture characteristics — Colonies on OA 40 mm diam after 1 wk, centre aerial mycelium cottony, white, periphery scarce aerial mycelium, saffron, margin diffuse, reverse saffron, no exudate or soluble pigment produced. After 3 wk radially folded to rugose, shiny, dark saffron, margin diffuse, reverse cinnamon.

Specimen examined. Peru, Ucayali, Yarinacocha, Isla de Amor, on leaf of *Eichhornia crassipes*, 21 Oct. 1998, *H.C. Evans*, isolated by *D.H. Djeddour* (No. W1916f) (holotype CBS H-22132; living culture ex-type CBS 109067).

Notes — This species forms a clade with CBS 691.96 (listed in the CBS database as *M. sorghi*, not an ex-type culture). Unfortunately, the latter isolate remains sterile and only produces black sclerotia in culture. *Microdochium sorghi* is a widespread fungus that causes zonate leaf spots on *Sorghum* and other species of *Poaceae*. *Microdochium sorghi* is different from *M. citrinidiscum* in having larger conidia (50–125 × 1–3 µm, in culture) with up to 10 septa. Furthermore, it is characterized by producing sclerotial bodies in both natural substratum and in culture (Von Arx 1987, Braun 1995). In contrast, *M. citrinidiscum* is only known from Peru growing on leaves of *Eichhornia crassipes*, has smaller conidia (7–31 × 2–3 µm) with up to 3 septae, and lacks sclerotia in culture.

Microdochium colombiense Hern.-Restr. & Crous, *sp. nov.* — MycoBank MB811873; Fig. 7

Etymology. Named after the country where this fungus was collected, Colombia.

Mycelium mostly immersed; hyphae hyaline, septate, 1.5–2.5 µm wide. *Conidiogenous cells* of two types: some polyblastic, ampulliform, with percurrent proliferations, 5–11.5 × 2.5–3.5 µm, neck up to 4.5 µm long, 1–1.5 µm wide, others cylindrical up to 13 µm long, 1–2 µm wide. *Conidia* lunate, fusiform, allantoid or reniform, straight or curved, 5–8 × 1.5–2.5 µm, 0(–1)-septate, base truncate. Sometimes produced directly on mycelial hyphae. *Chlamydospores* not observed.

Culture characteristics — Colonies on OA 40 mm diam after 1 wk, flat, salmon, no exudate or soluble pigment produced, margin diffuse or entire; reverse saffron. After 3 wk 90 mm diam, flat, orange peach, radially striate.

Specimen examined. Colombia, on *Musa sapientum*, Jan. 1995, *L. Verbruggen* (holotype CBS H-22133; living culture ex-type CBS 624.94).

Notes — *Microdochium colombiense* forms a sister clade to *M. nivale* and *M. majus*, and is morphologically distinguished from those species by their conidial morphology. *Microdochium colombiense* has smaller conidia (5–8 × 1.5–2.6 µm) than those of *M. majus* (6–15 × 2–4 µm) and *M. nivale* (5–36 × 2–4.5 µm). Furthermore, conidia in *M. colombiense* are mostly aseptate (rarely 1-septate), while in *M. majus* and *M. nivale* conidia are mostly 3-septate (up to 10- or 7-septate, respectively). Although *M. colombiense* resembles *M. neoqueenslandicum*, they are phylogenetically distinct (Fig. 2). Additionally, the colony growth rate at 30 °C after 1 wk was about 10 mm in *M. colombiense* (CBS 624.94) and 35–37 mm in *M. neoqueenslandicum* (CBS 445.95 and CBS 108926) under the same conditions. At lower temperatures (12, 18 and 24 °C) the grow rate was similar for both species.

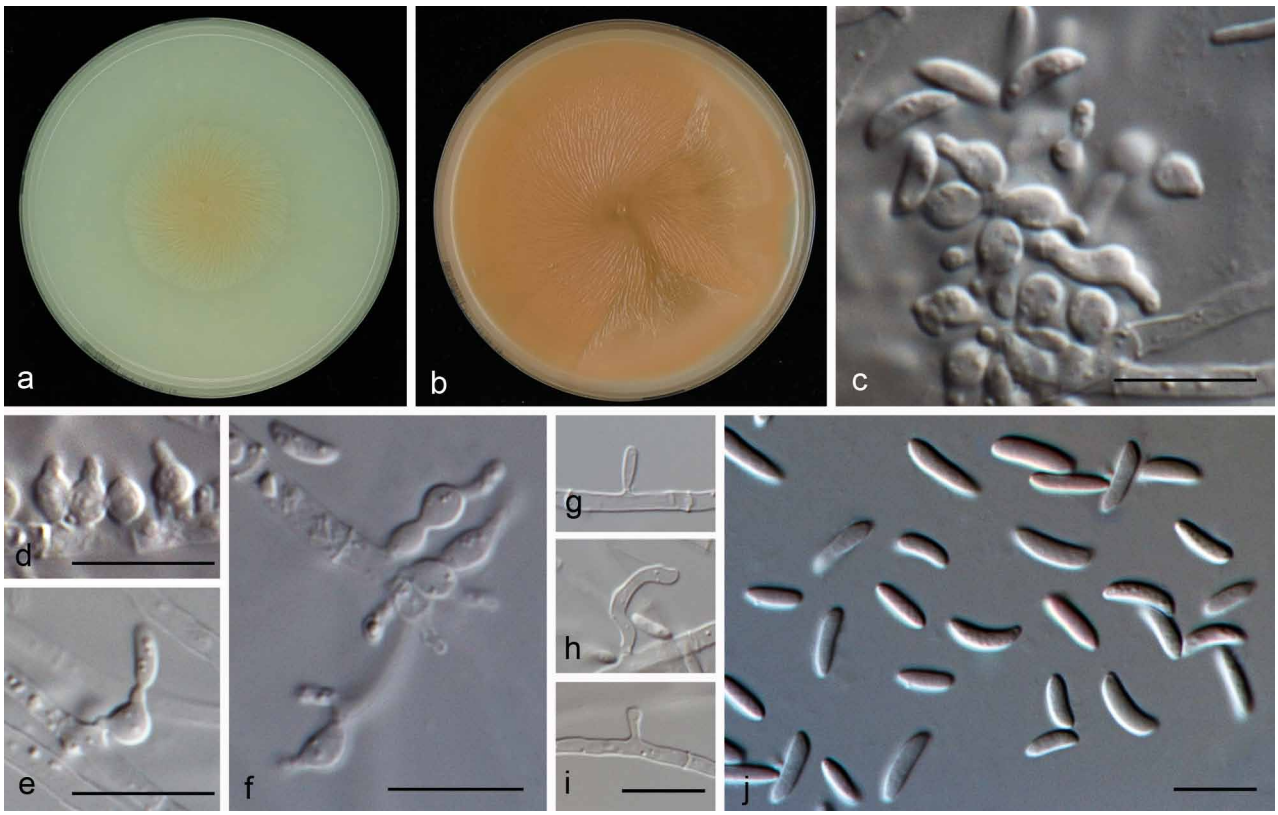

Fig. 7 *Microdochium colombiense* (from ex-type, CBS 624.94). a. Colony on OA at 25 °C in 1 wk; b. colony on OA at 25 °C in 3 wk; c–f. conidiogenous cells ampulliform with percurrent proliferations; g–i. conidiogenous cells cylindrical to clavate; j. conidia. — Scale bars: c–j = 10 µm.

Fig. 8 *Microdochium fisheri* (from ex-type, CBS 242.91). a. Colony on OA at 25 °C in 1 wk; b. colony on OA at 25 °C in 3 wk; c, d. conidiophores; e–g. conidiogenous cells; h. conidia. — Scale bars: c–h = 10 µm.

Microdochium consociatum (Rehm) Hern.-Restr. & Crous, *comb. nov.* — MycoBank MB811967

Basionym. *Leptosphaeria consociata* Rehm, Hedwigia Beibl.: 149. 1896. = *Monographella consociata* (Rehm) O.E. Erikss. & J.Z. Yue, Mycotaxon 38: 205. 1990.

Microdochium fisheri Hern.-Restr. & Crous, *sp. nov.* — MycoBank MB811874; Fig. 8

Etymology. Named in honour of P.J. Fisher, who collected this fungus in the UK.

Mycelium superficial and immersed; hyphae hyaline, branched, septate. *Conidiophores* slightly differentiated, bifurcate, hyaline, smooth. *Conidiogenous cells* terminal, sympodial, denticulate, cylindrical, 19–60 × 1.5–2 µm, hyaline, smooth. *Conidia* solitary, dry, fusiform, obovoid, subpyriform, to clavate, 7–12 × 3–4 µm, 0–1-septate, hyaline, tapering to a subtruncate hilum; hilum unpigmented. *Chlamydospores* not observed.

Culture characteristics — Colonies on OA 45–50 mm diam after 1 wk, powdery to velvety, aerial sporulation, centre salmon, periphery peach, margin entire; reverse salmon.

Specimen examined. UK, on stem of *Oryza sativa* (greenhouse-grown plant, endophytic), June 1990, *P.J. Fisher* (holotype CBS H-22142; living culture ex-type CBS 242.90).

Notes — Isolate CBS 242.90 forms a separated branch as the sister clade of *M. phragmites* and *M. lycopodinum*. Originally, the isolate CBS 242.90 was identified as *Arthrobotrys foliicola* (no ex-type isolate available) which is morphologically similar, but *A. foliicola* was originally described with pale brown, sympodial, and nodose proliferations in the conidiophores, terminal and intercalary, swollen conidiogenous cells, hyaline conidia with brown septa, appearing pale brown in mass (Matsushima 1975). *Microdochium fisheri* is different since it has hyaline, tapering conidiophores, with denticulate conidiogenous cells and hyaline conidia, without pigment at the septa, appearing salmon in mass.

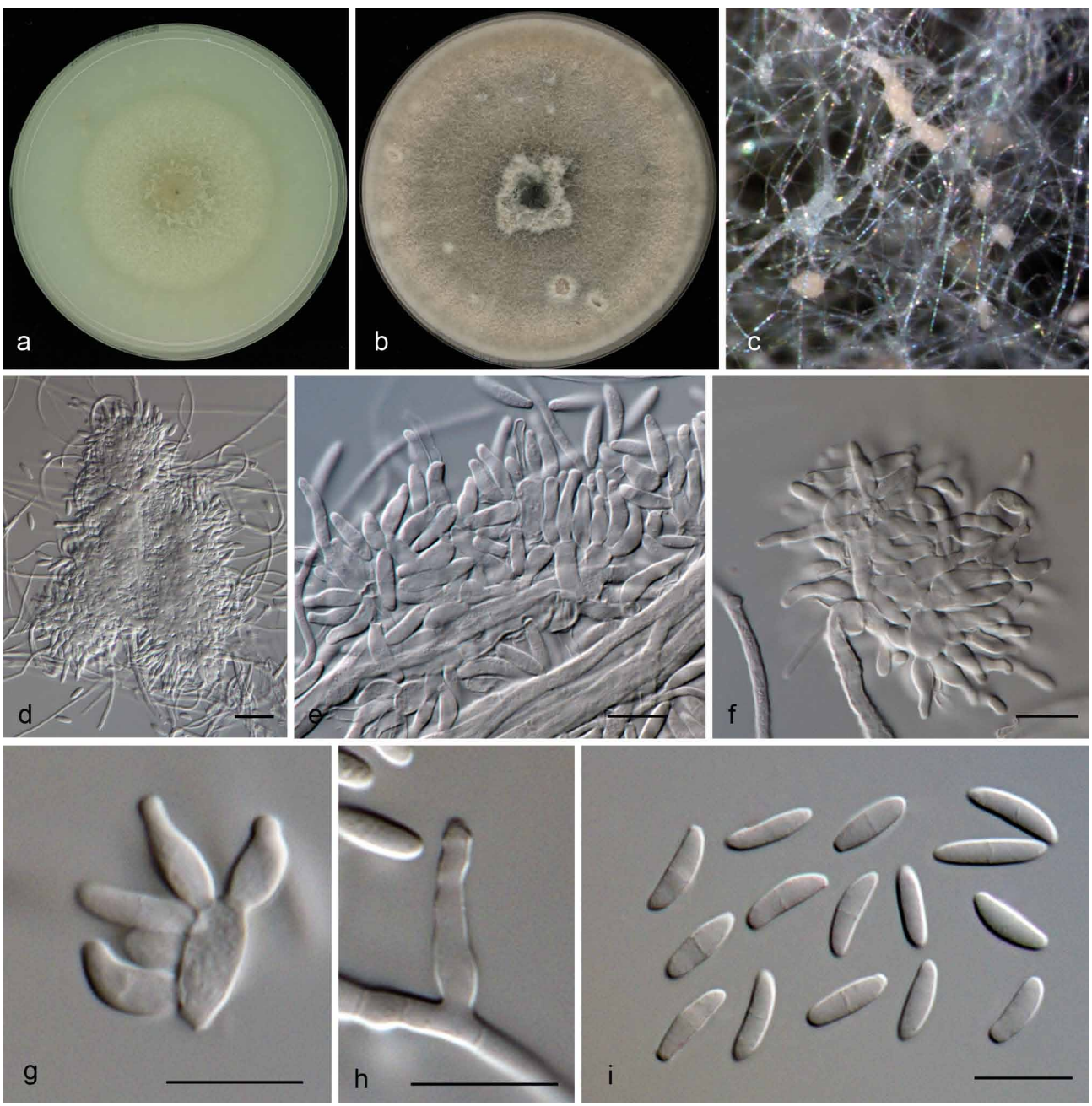

Fig. 9 *Microdochium lycopodinum* (from CBS 109398). a. Colony on OA at 25 °C in 1 wk; b. colony on OA at 25 °C in 3 wk; c. colony overview; d–f. aggregated conidiophores; g, h. conidiogenous cells; i. conidia. — Scale bars: d = 25 µm; e–i = 10 µm.

Microdochium fusariisporum (Ellis & Everh.) Hern.-Restr. & Crous, *comb. nov.* — MycoBank MB811968

Basionym. *Rhopographus fusariisporus* Ellis & Everh., Erythea 2: 23. 1894.

≡ *Exarmidium fusariisporum* (Ellis & Everh.) Theiss. & Syd., Ann. Mycol. 13: 424. 1915.

≡ *Monographella fusariispora* (Ellis & Everh.) M.E. Barr, Mycotaxon 46: 63. 1993.

Microdochium lycopodinum (Jaklitsch, Siepe & Voglmayr) Hern.-Restr. & Crous, *comb. nov.* — MycoBank MB811969; Fig. 9, 10

Basionym. Monographella lycopodina Jaklitsch, Siepe & Voglmayr, Fung. Diversity 52: 86. 2012.

Description of sexual morph — Jaklitsch & Volgmayr (2012).

Mycelium immersed and superficial, hyphae hyaline to pale brown, septate, smooth or verruculose, 1.5–6 µm diam. *Conidiophores* more or less mono- to biverticillate, metulae doliiform to clavate, aggregated in slimy masses in the aerial mycelium often reduced to conidiogenous cells born directly from the hyphae. *Conidiogenous cells* holoblastic, with percurrent proliferations, ampulliform to lageniform, subcylindrical, 4–12 × 2.5–3.5 µm. *Conidia* hyaline, fusiform or with one side straighter than the other, lunate, 8–15.5 × 2.5–4 µm, 0–1-septate, truncate base, rounded apex. Some conidia are borne directly on the mycelial hyphae. *Chlamydospores* not observed. *Sclerotia* superficial on the agar, brown to dark brown, *textura angularis.*

Culture characteristics — Colonies on OA reaching 50–54 mm after 1 wk. White cottony, lanose to flocosse, buff to rosy buff, margin effuse. After 3 wk with aerial mycelium profuse, olivaceous grey with some white to saffron patches, aerial

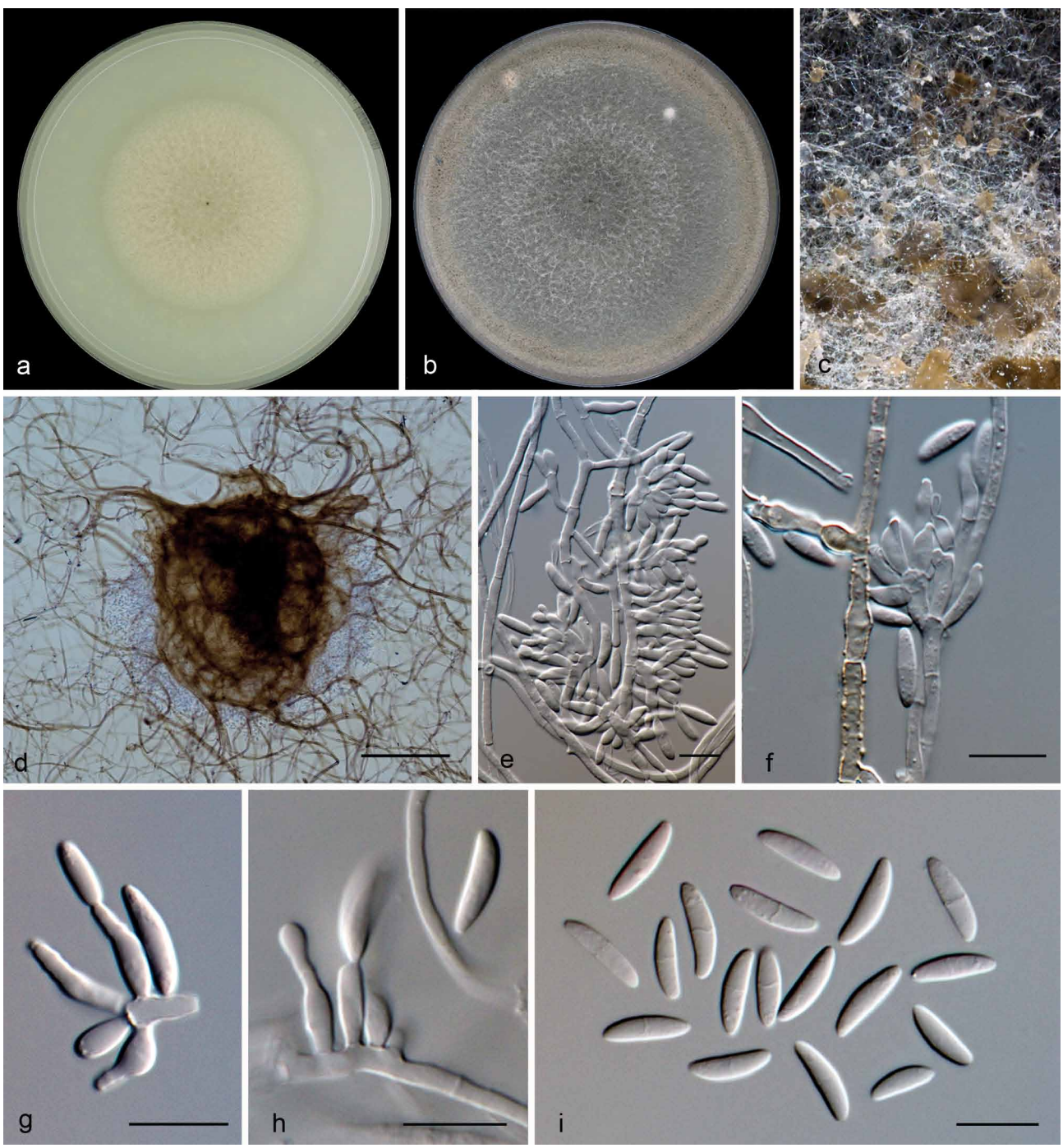

Fig. 10 *Microdochium lycopodinum* (from CBS 109399). a. Colony on OA at 25 °C in 1 wk; b. colony on OA at 25 °C in 3 wk; c. colony overview; d. sporodochia with brown mycelium; e, f. aggregated conidiophores; g, h. conidiogenous cells; i. conidia. — Scale bars: d = 100 µm; e–i = 10 µm.

sporulation in aggregated slimy masses, rosy buff to umber; reverse greenish black with some white patches.

Specimens examined. Austria, Oberösterreich, St. Willibald, Salletwald, on leaves of *Lycopodium annotinum*, 19 July 2009, *H. Voglmayr* (living culture ex-type CBS 125585). – Germany, Konstanz, on *Phragmites australis*, May 1997, *W. Leibinger*, living cultures CBS 109397, CBS 109398, CBS 109399. – The Netherlands, Sellingen, isolated from an air sample, Dec. 1967, *A. Kikstra* (No. 1062), living culture CBS 146.68.

Notes — The clade *M. lycopodinum* is represented by five isolates with *M. phragmitis* as sister clade. The ex-type culture of *M. lycopodinum*, CBS 122885, and CBS 146.68 remained sterile. Isolate CBS 109397 was morphologically degenerated, as colonies lacked aerial mycelium and sporodochia, conidiogenous cells were scarce and small, and sclerotial bodies were present. The other two strains, CBS 109398 and CBS 109399 (Fig. 9, 10), showed colonies with abundant aerial mycelium, producing superficial sporodochial-like structures, with verticillate conidiophores and abundant conidiogenous cells and conidia. *Microdochium lycopodinum* was originally described as sexual morph growing in leaves of *Lycopodium annotium* in Austria and Germany (Jaklitsch & Volgmayr 2012). Nevertheless, original cultures were sterile and no asexual morph has been reported. According to our phylogenetic analysis based in four genes (Fig. 2), isolates CBS 146.68, CBS 109397, CBS 109398 and CBS 109399 represent the same phylogenetic species as *M. lycopodinum*. Here we newly describe the asexual morph of *M. lycopodinum*.

Microdochium maydis (E. Müll. & Samuels) Hern.-Restr. & Crous, *comb. nov.* — MycoBank MB811970

Basionym. Monographella maydis E. Müll. & Samuels, Nova Hedwigia 40: 114. 1984.

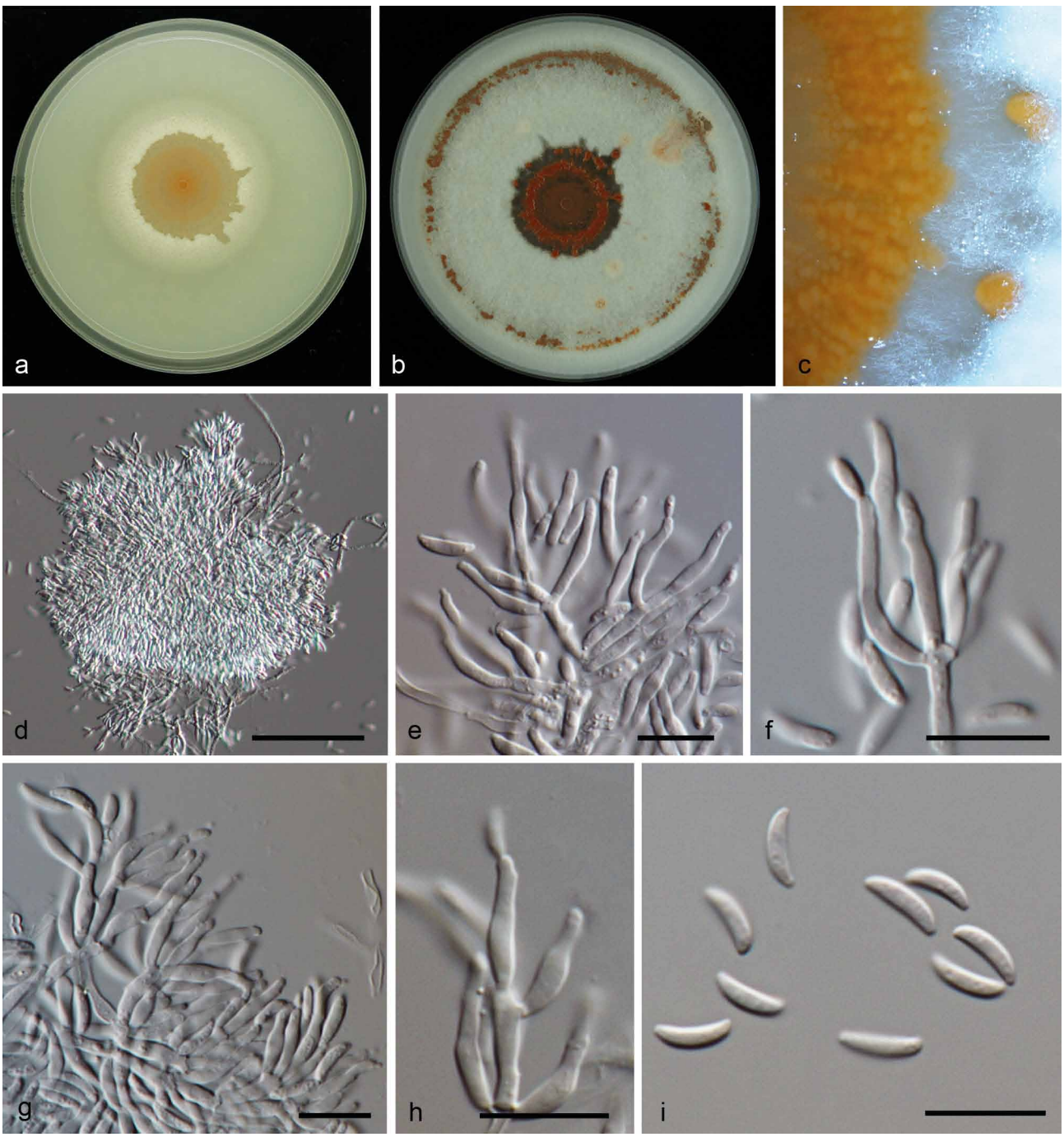

Fig. 11 *Microdochium neoqueenslandicum* (from ex-type, CBS 108926). a. Colony on OA at 25 °C in 1 wk; b. colony on OA at 25 °C in 3 wk; c. colony overview; d. sporodochia; e–h. conidiophores with conidiogenous cells; i. conidia. — Scale bars: d = 25 µm; e–i = 10 µm.

Microdochium neoqueenslandicum Hern.-Restr. & Crous, *sp. nov.* — MycoBank MB811875; Fig. 11

Etymology. Named after its resemblance to *Microdochium queenslandicum*.

Mycelium immersed or superficial, hyphae hyaline, septate, smooth. *Sporodochia* slimy, orange. *Conidiophores* more or less mono- or biverticillate, metulae clavate to cylindrical. *Conidiogenous cells* polyblastic, with percurrent proliferations, ampulliform, lageniform to subcylindrical, 4.5–10 × 2–3.5 µm, neck up to 4 µm long, 1–1.5 µm diam, solitary or in whorls. *Conidia* lunate, allantoid, curved, with one side straighter than the other, 0(–1)-septate, 4–9 × 1.5–3 µm, base flattened. Sometimes produced directly on the mycelial hyphae. *Chlamydospores* not observed.

Culture characteristics — Colonies on OA 40–47 mm diam after 1 wk, centre flat, creamy, with concentric rings, peach to salmon, periphery with cottony aerial mycelium, white, margin diffuse, entire. After 3 wk with concentric rings scarlet of sporodochia, alternate with a dense zone of white, cottony aerial mycelium, exudate hyaline. No aerial mycelium nor sporodochia were observed in degenerated cultures.

Specimens examined. New Zealand, Waihi, Waihi Golf Club, on *Agrostis* sp., 24 Jan. 2000, *A. Ellis* (Holotype CBS H-22136; living culture ex-type CBS 108926). – The Netherlands, Brecklenkamp, Twente, on *Juncus effusus*, 6 Apr. 1995, *E. Brouwer*, living culture CBS 445.95.

Notes — *Microdochium neoqueenslandicum* is represented by two isolates, CBS 108926 and CBS 445.95, and clustered basal to other *Microdochium* species (Fig. 2). *Microdochium neoqueenslandicum* is distinct from *M. queenslandicum* by having shorter and wider conidia (7.5–11 × 1.8–2.2 µm in *M. queenslandicum*). *Microdochium queenslandicum* is only known from a forest soil sample collected in Australia. Unfortunately, no living material of *M. queenslandicum* was available for study. In our phylogenetic tree *M. neoqueenslandicum* is represented by two strains isolated from grasses, *Agrostis* sp. and *Juncus effuses*, the former from New Zealand and the latter from the Netherlands, suggesting that this species has a wide distribution. The isolate CBS 445.95 was macro- and micromorphologically degenerated, since colonies lacked aerial mycelium and sporodochia, and conidiogenous cells were scarce and smaller in size.

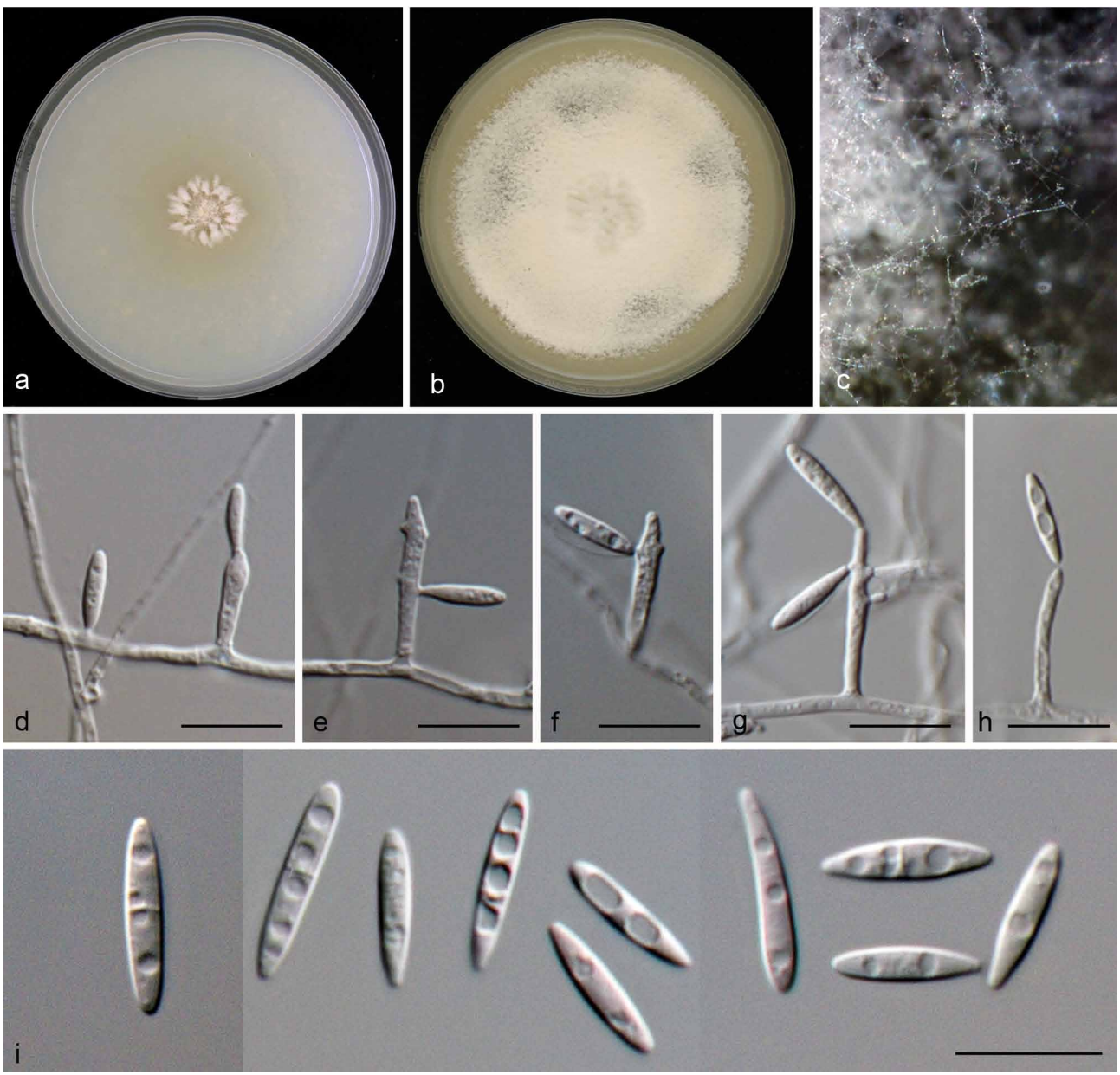

Fig. 12 *Microdochium phragmitis* (from ex-epitype, CBS 285.71). a. Colony on OA at 25 °C in 1 wk; b. colony on OA at 25 °C in 3 wk; c. colony overview; d–h. conidiogenous cells; i. conidia. — Scale bars: d–i = 10 µm.

Microdochium opuntiae (Ellis & Everh.) Hern.-Restr. & Crous, *comb. nov.* — MycoBank MB811971

Basionym. *Sphaerella opuntiae* Ellis & Everh., J. Mycol. 4: 97. 1888.
≡ *Mycosphaerella opuntiae* (Ellis & Everh.) Dearn., Bull. New York State Mus. Nat. Hist. 205: 55. 1919.
≡ *Monographella opuntiae* (Ellis & Everh.) Arx, Trans. Brit. Mycol. Soc. 83: 374. 1984.
= *Gloeosporium lunatum* Ellis & Everh., Proc. Acad. Nat. Sci. Philadelphia 43: 82. 1891.
≡ *Fusarium lunatum* (Ellis & Everh.) Arx, Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk., sect. 2. 51: 101. 1957.

Microdochium phragmitis Syd., Ann. Mycol. 22: 267. 1924 — Fig. 12, 13

Description based on CBS 285.71 after 1 wk on OA at 24 °C. *Mycelium* superficial and immersed, hyphae hyaline, septate, 1–2 µm wide. *Conidiogenous cells* terminal, sympodial, denticulate, hyaline, smooth, cylindrical to clavate, sometimes navicular, 6–24 × 1.5–3 µm. *Conidia* dry, solitary, fusiform, navicular or clavate, 0–1-septate, 10–14.5 × 2–3 µm, guttulate. *Chlamydospores* not observed.

Culture characteristics — Colonies on OA 37 mm diam after 1 wk. Floccose, white in the centre, sparse aerial mycelium, buff to the periphery, margin effuse; reverse buff. After 3 wk velvety.

Specimens examined. Germany, Berlin, Brandenburg, on leaves of *Phragmites communis*, Nov. 1919, *H. Sydow* (holotype K-IMI 193888; Sydow, Mycotheca germanica 2250). – Poland, Bialowiesza National Park, on *Phragmites australis*, Sept. 1966, *W. Gams* (epitype designated here CBS H-22135, MBT200934, living culture ex-epitype CBS 285.71). – The Netherlands, Nijkerk, on a leaf of *Phragmites australis*, unknown date, *P. Reinecke*, CBS H-22134, CBS 423.78 living culture.

Notes — The ex-epitype strain CBS 285.71 and CBS 423.78 clustered together (1 PP) in the combined tree (Fig. 2). Nevertheless, the strain CBS 423.78 (Fig. 13) differs from the ex-epitype strain CBS 285.71 (Fig. 12) in its colony appearance and micro-morphological characters. CBS 423.78 produces pionnotal sporodochia, conidiogenous cells lageniform with

Fig. 13 *Microdochium phragmitis* (from CBS 423.78). a. Colony on OA at 25 °C in 1 wk; b. colony on OA at 25 °C in 3 wk; c, d. colony overview with orange, slimy sporodochia; e–g. sporodochia; h, i. conidiophores with conidiogenous cells; j, k. conidia. — Scale bars: e = 50 µm; f–k = 10 µm.

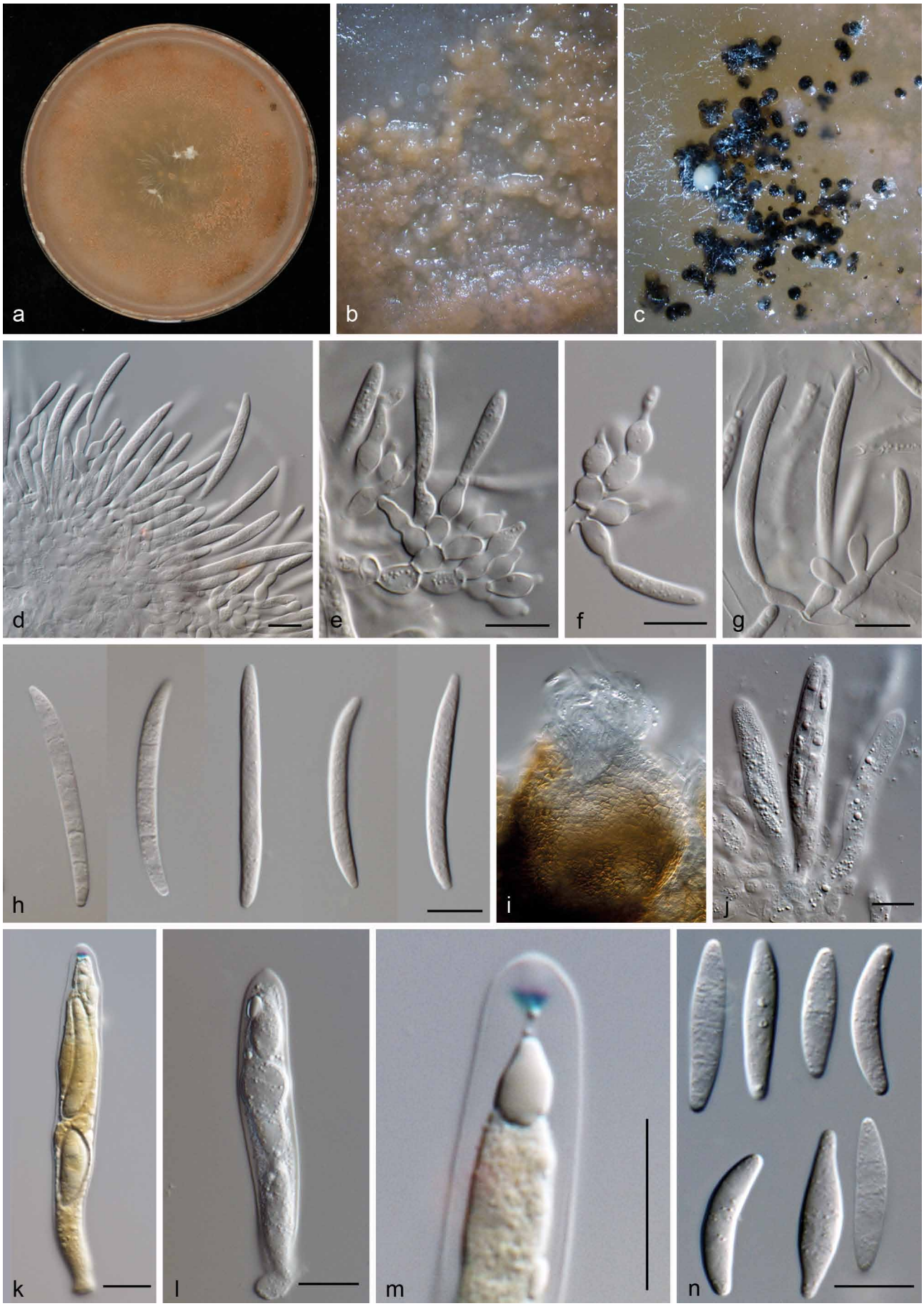

Fig. 14 *Microdochium seminicola* (from ex-type, CBS 139951). a. Colony on OA at 25 °C in 3 wk; b. colony overview of the sporodochia; c. colony overview of the ascomata; d. sporodochia; e–g. conidiophores with conidiogenous cells and conidia attached; h. conidia; i. ascomata; j–l. asci (k and m in Melzer' reagent); m. ascus ring in Melzer's reagent; n. ascospores — Scale bars: d–h; j–n = 10 µm; i = 50 µm.

annellidic percurrent proliferations, conidia produced in slimy mass, fusiform, 12.5–16 × 3–3.5 µm and obovoid, unicellular, 4.5–8.5 × 2–4 µm. Molecularly those strains were very similar, their ITS sequences were identical and the other genes only differ in 5, 3 and 1 bp in their BTUB, RPB2 and LSU sequences, respectively, which would indicate they are the same phylogenetic species. Considering the polymorphism in *Microdochium* and the difficulties to delimit species in this group we refer to CBS 423.78 as *M. phragmites.*

Microdochium seminicola Hern.-Restr., Seifert, Clear & B. Dorn, *sp. nov*. — MycoBank MB812168; Fig. 14

Etymology. Latin *seminicola-* meaning growing on seeds.

Mycelium immersed and superficial, hyphae hyaline, septate, smooth. *Sporodochia* slimy, peach, minute to essentially pionnotal. *Conidiophores* more or less biverticillate, metulae doliiform. *Conidiogenous cells* solitary or in whorls, ampulliform to lageniform, with percurrent proliferations, 5–11 × 3–4 µm, the neck 1–1.5 µm wide. *Conidia* cylindrical to fusiform, straight or curved, 19–54 × 3–4.5 µm, (0–)3(–5)-septate, hyaline, tapering at the apex, occasionally curved at the tip, base usually flattened. *Chlamydospores* not observed. *Sexual morph. Perithecia* submerged or superficial on the agar, solitary or in groups, spherical to subspherical, 110–149 µm diam, pale brown to brown, *textura angularis-epidermoidea*. *Paraphyses* filiform, hyaline. *Asci* basal, 41–66.5 × 7.5–11 µm, oblong, narrowly clavate, fusiform, with 8 ascospores, short stipe and amyloid, funnel-shaped apical ring. *Ascospores* fusiform, oblong, sometimes navicular or allantoid, 12–22 × 3–5 µm, 0–3-septate, not constricted at the septa, hyaline, smooth.

Culture characteristics — Colonies on OA 90 mm diam after 1 wk, centre with some puffs of white aerial mycelium, periphery scarce aerial mycelium, salmon to saffron with slimy, peach spots, reverse similar; no exudate or soluble pigment produced. After 3 wk centre with some puffs of white aerial mycelium, saffron with slimy, peach, brick or dark brick spots.

Specimens examined. Canada, Alberta, on barley, 1995, *R. Clear*, DAOM 250164; Manitoba, on grain, 2001, *R. Clear*, DAOM 250175, DAOM 250174, DAOM 250173, DAOM 250172, DAOM 250171, DAOM 250169, CPC 26001; Manitoba, Brandon, on *Triticum aestivum*, 2006, DAOM 250162, DAOM 250161; Saskatchewan, on grain, 1984, *R. Clear*, CPC 25993; Saskatchewan, on grain, 2001, *R. Clear*, DAOM 250168, DAOM 250167, DAOM 250166, DAOM 250165; Saskatchewan, on *Triticum aestivum*, 10 Jan. 2002, *R. Clear*, DAOM 250176; unknown substrate, 16 June 2005, *R. Clear*, DAOM 250163. – Switzerland, Reckenholz, on maize kernels, 2005, *B. Dorn* (holotype CBS H-22139; living culture ex-type CBS 139951 = CPC 26019); 2006, *B. Dorn*, DAOM 250159, DAOM 250158; 2007, *B. Dorn*, DAOM 250155; unknown date, *B. Dorn*, CBS 122706, CBS 122707.

Notes — The *M. seminicola* clade is represented by 23 strains collected mainly in Canada and Switzerland. Most strains remained sterile. Conidiophores and conidia observed in CBS 139951 and CBS 122706 were very similar. The sexual morph was only observed in CBS 139951. *Microdochium seminicola* was phylogenetically closely related to *M. albescens* (Fig. 2). Nevertheless, *M. albescens*, the causal agent of leaf-scald disease of rice, is different from *M. seminicola*. *Microdochium albescens* has larger ascospores with more septa (14–30 × 3.5–7.5 µm, 1–5-septate), and the asexual morph has falcate conidia, 11–16 × 3.5–4.5 µm conidia that are 0–3-septate but usually 1-septate, (Parkinson et al. 1981) while *M. seminicola* has smaller ascospores with fewer septa (12–22 × 3–5 µm, up to 3-septate), and the asexual morph has larger conidia with more septa (23–54 µm long, up to 5-septate, usually 3-septate). Morphologically *M. seminicola*, which has been isolated from maize in Switzerland, also resembles *M. maydis*. However, conidia of *M. maydis* are smaller with more septa (20–46 × 3–4 µm, 3–9-septate). In addition, *M. maydis* was isolated from maize leaves whereas, although *M. seminicola* occurs on maize kernels, it is most often isolated from harvested grain,

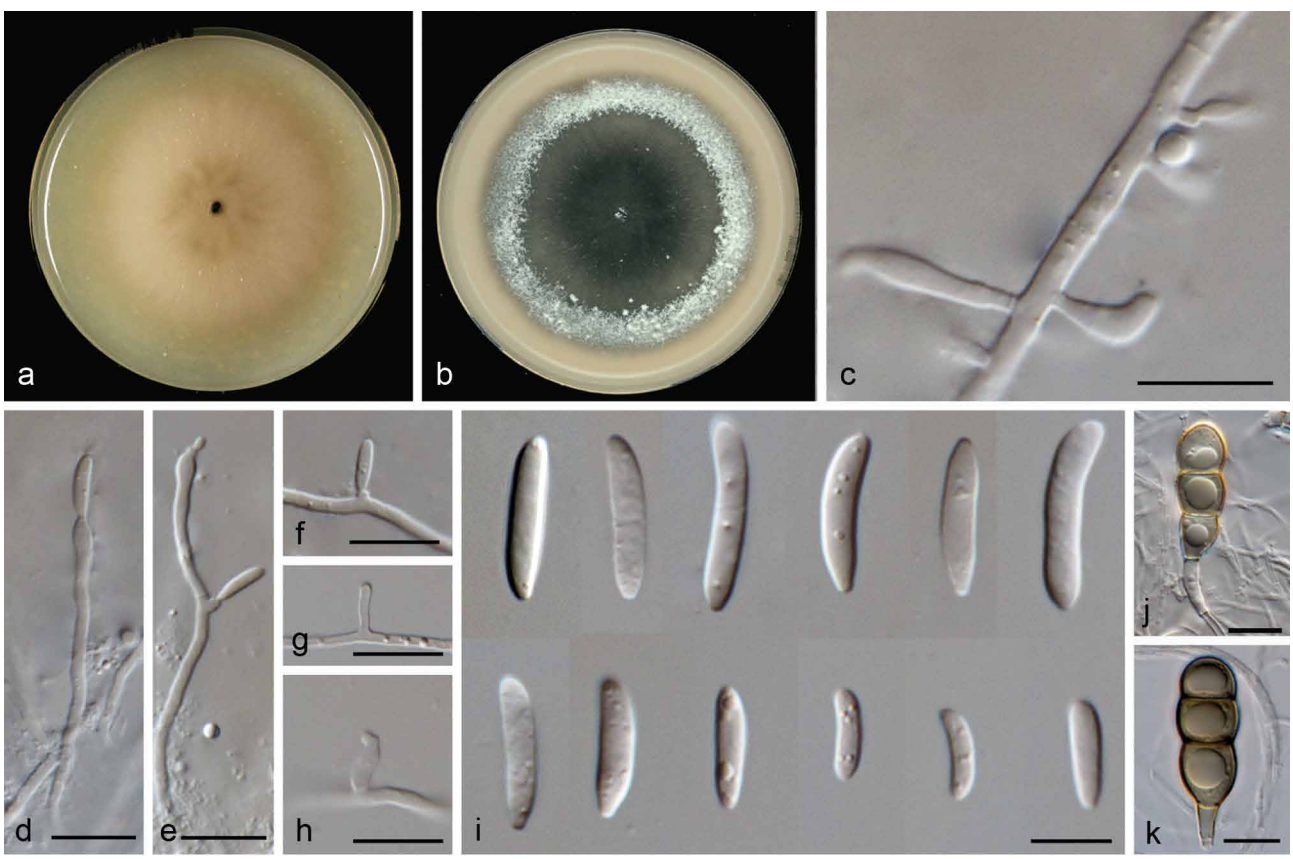

Fig. 15 *Microdochium trichocladiopsis* (from ex-type, CBS 623.77). a. Colony on OA at 25 °C in 1 wk; b. colony on OA at 25 °C in 3 wk; c–h. conidiogenous cells; i. conidia; j, k. chlamydospores. — Scale bars: c–k = 10 µm.

including oats, barley, and wheat grain, and rarely canola seed. Unfortunately, there are no cultures or molecular data available for *M. maydis*.

For decades, Canadian seed testing laboratories have been puzzled by the sporadic occurrence, sometimes at frequencies of 3–4 % within a seed lot, of this fast growing fungus, with white to pinkish colonies that superficially resemble those produced by some *Fusarium* species. However, the colonies often remain sterile on PDA, the medium used in most seed testing procedures. A few orange sporodochia are sometimes produced, but this sporulation disappears after one or two transfers, resulting in sterile, relatively fast-growing light orange colonies.

Microdochium stevensonii (Petr.) Hern.-Restr. & Crous, *comb. nov.* — MycoBank MB811972

Basionym. *Griphosphaerella stevensonii* Petr., Ann. Mycol. 25: 209. 1927.
≡ *Griphosphaeria stevensonii* (Petr.) E. Müll. & Arx, Phytopathol. Z. 24: 355. 1955.
≡ *Monographella stevensonii* (Petr.) Arx, The genera of fungi sporulating in pure culture: 174. 1981.

Microdochium trichocladiopsis Hern.-Restr. & Crous, *sp. nov.* — MycoBank MB811876; Fig. 15

Etymology. *Trichocladiopsis*, referring to the chlamydospores of this taxon that superficially resemble conidia of *Trichocladium* species.

Mycelium mostly immersed, hyphae hyaline, branched, smooth. *Conidiogenous cells* sparse, solitary, cylindrical to clavate, straight, often curved at the tip, hyaline, smooth, 4–37.5 × 2–3 µm. *Conidia* oblong, fusiform to obovoid, straight or curved, 6–18 × 2–3.5 µm, 0(–1)-septate, base usually flattened. *Chlamydospores* abundant, terminal, obovoid, pyriform to clavate, trichocladium-like, 1–3(–5)-septate, brown to dark brown, basal cells often paler, constricted at the septa, sometimes with a pale brown frill at the base.

Culture characteristics — Colonies on OA 80 mm diam after 1 wk, flat, lacking aerial mycelium, rosy buff, black near to the inoculum, margin diffuse, reverse similar. After 3 wk, centre with sparse to absent aerial mycelium, radially striate, dark grey olivaceous, periphery aerial mycelium floccose white, margin diffuse, saffron, reverse olivaceous grey with concentric rings of pale mouse grey.

Specimen examined. Unknown country, from rhizosphere of *Triticum aestivum*, unknown date, *J.W.L. van Vuurde* (holotype CBS H-22137; living culture ex-type CBS 623.77).

Notes — Isolate CBS 623.77 formed a clade with two isolates of *M. tainanensis*, CBS 269.76 and CBS 270.76. Both species are clearly distinguished morphologically. In *M. tainanensis* the conidia are lunate and smaller (10–15 × 2–3 µm), while *M. trichocladiopsis* produces oblong to fusiform and larger conidia (4–37.5 × 2–3 µm). Species in this clade (Fig. 2) are associated with roots and produce brown chlamydospores. *Microdochium trichocladiopsis* was isolated from the rhizosphere of *Triticum aestivum* and has chlamydospores with up to 5 septa, while both isolates of *M. tainanense* were isolated from roots of *Saccharum officinarum*, and have aseptate chlamydospores (De Hoog & Hermanides-Nijhof 1977).

Selenodriella cubensis Hern.-Restr. & Crous, *sp. nov.* — MycoBank MB811877; Fig. 16

Etymology. Named after the country where this fungus was collected, Cuba.

Mycelium immersed and superficial, hyphae hyaline to pale brown, branched, septate, smooth. *Conidiophores* erect, setiform, branched at the apex, brown at the base, becoming hya-

Fig. 16 *Selenodriella cubensis* (from ex-type, CBS 683.96). a. Colony on OA at 25 °C in 1 wk; b, d–f. conidiophores; c. conidia; g–j. conidiogenous cells. — Scale bars: b–j = 10 µm.

line at the apex, 49–87 × 2.5–4 µm. *Conidiogenous cells* cylindrical to lageniform, sympodial, denticulate, terminal, in whorls at the apex or solitary on the mycelial hyphae, hyaline to subhyaline, 13–39 × 2–4 µm. *Conidia* lunate, asymmetrical, 10–20 × 2–3 µm, unicellular, hyaline, smooth-walled, guttulate. *Chlamydospores* not observed. *Sexual morph* unknown.

Culture characteristics — Colonies on OA 17–19 mm diam in 1 wk. Zonate, velvety to powdery, buff in the centre; sparse aerial mycelium, umber towards the periphery; margin diffuse.

Specimen examined. Cuba, unknown substrate, June 1996, *R.F. Castañeda* (holotype INIFAT C96/30; living culture ex-type CBS 683.96; CBS H-22143 dry culture).

Notes — The isolate CBS 683.96, formerly identified as *Idriella tropicalis*, is better accommodated in *Selenodriella*, since it produces setiform conidiophores, and conidiogenous cells and branches are disposed in whorls along the main axis of setiform conidiophores as in species of *Selenodriella*. It differs from *Idriella*, which shows conidiophores reduced to conidiogenous cells. The only available strain of *Selenodriella cubensis* clustered phylogenetically close to *Selenodriella fertilis* (CBS 772.83) in *Microdochiaceae*. *Selenodriella fertilis*, the type species of the genus, and *S. cubensis*, differs mainly in the arrangement of the conidiogenous cells. In *S. fertilis* they are arising in groups in the middle part of the conidiophores (Pirozynski & Hodges 1973), while in *S. cubensis* the conidiogenous cells are disposed at the apex of the conidiophores. Conidial morphology is slightly different in both species; in *S. cubensis* conidia are pointed at both ends, while in *S. fertilis* they are flat at the base and rounded at the apex.

Sordariomycetes, Xylariales, incertae sedis

Castanediella couratarii (C. Ram) Hern.-Restr. & Crous, *comb. nov.* — MycoBank MB812166; Fig. 17

Basionym. *Idriella couratarii* C. Ram (as '*couratorii*'), Brotéria Ci. Nat. 39: 27. 1970.

Mycelium immersed and superficial, hyphae branched, septate, hyaline and brown. *Conidiophores* mostly branched, pale brown. *Conidiogenous cells* lageniform to cylindrical, solitary or in whorls, straight or flexuous, hyaline to pale brown, 10.5–37 × 2–3.5 µm. *Conidia* lunate, hyaline, 9.5–19 × 2–3 µm. *Chlamydospores* not observed.

Culture characteristics — Colonies on OA reaching 30 mm diam in 2 wk. Fluffy aerial mycelium, zonate, rosy vinaceous in the centre, white to the periphery, margin grey-sepia.

Specimen examined. Brazil, on dead wood, Aug. 1971, *J.L. Bezerra* (holotype IMUFPe 2222; living culture ex-type CBS 579.71 = ATCC 22642; CBS H-22141 dry).

Notes — *Castanediella* was recently introduced with *C. acacia* as type species (Crous et al. 2015). The main distinguishing character between *Castanediella* and *Idriella* is in their conidiophore morphology. Conidiophores in *Castanediella* are commonly branched, while in *Idriella* conidiophores are mostly reduced to conidiogenous cells. The two genera are also phylogenetically distinct (Fig. 1).

Idriellopsis Hern.-Restr. & Crous, *gen. nov.* — MycoBank MB811882

Etymology. In reference to its morphological similarity with the genus *Idriella*.

Type species. *Idriellopsis uncinospora* (R.F. Castañeda & W.B. Kendr.) Hern.-Restr. & Crous.

Mycelium immersed and superficial, hyphae septate, branched, smooth-walled, brown or pale brown. *Conidiophores* differentiated, unbranched inflated or globose at the apex, brown at the base, almost hyaline at the apex, smooth-walled. *Conidiogenous cells* polyblastic, terminal, integrated, with conspicuous denticles. *Conidia* falcate, curved, with one side straighter that the other, tapered at the base, rounded at the apex 0–1-septate, hyaline, smooth-walled. *Chlamydospores* not observed. *Sexual morph* unknown.

Idriellopsis uncinospora (R.F. Castañeda & W.B. Kendr.) Hern.-Restr. & Crous, *comb. nov.* — MycoBank MB811883; Fig. 18

Basionym. *Idriella uncinospora* R.F. Castañeda & W.B. Kendr., Univ. Waterloo Biol. Ser. 35: 68. 1991.

Description on natural substrate — Castañeda-Ruiz & Kendrick (1991).

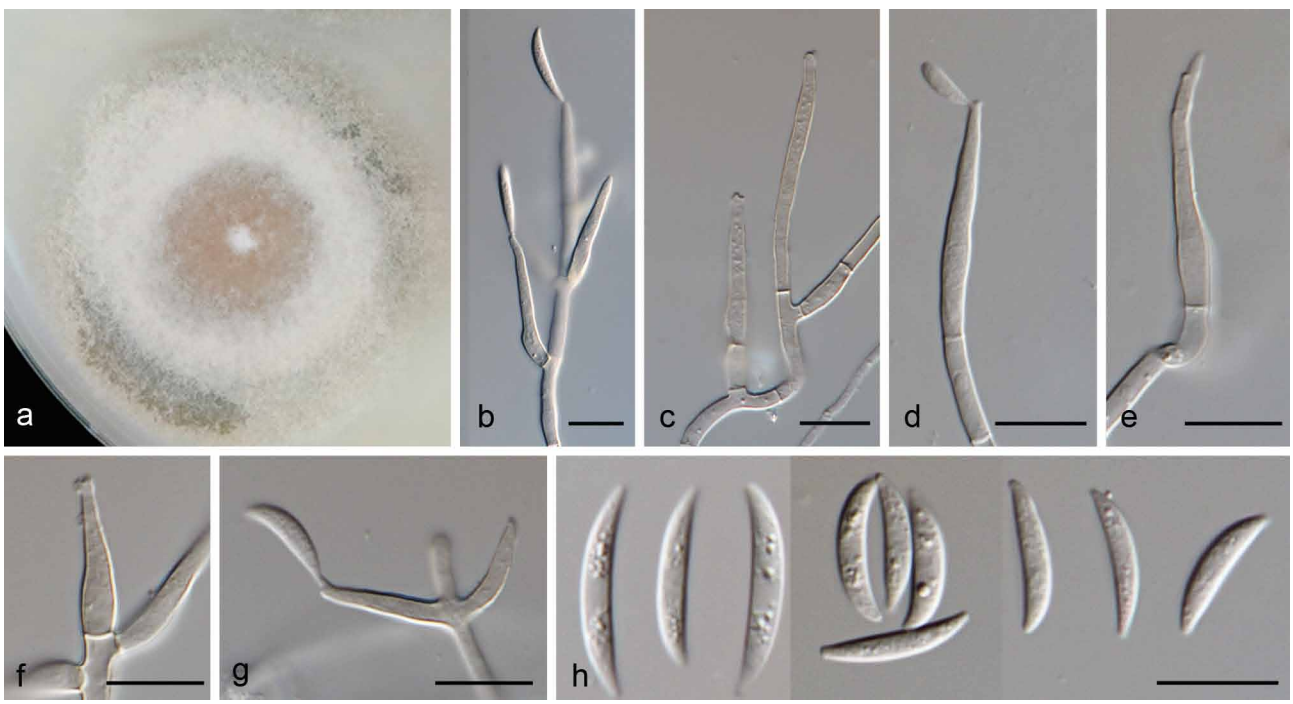

Fig. 17 *Castanediella couratarii* (from ex-type, CBS 579.71). a. Colony on OA at 25 °C in 1 wk; b–g. conidiogenous cells; h. conidia. — Scale bars: b–h = 10 µm.

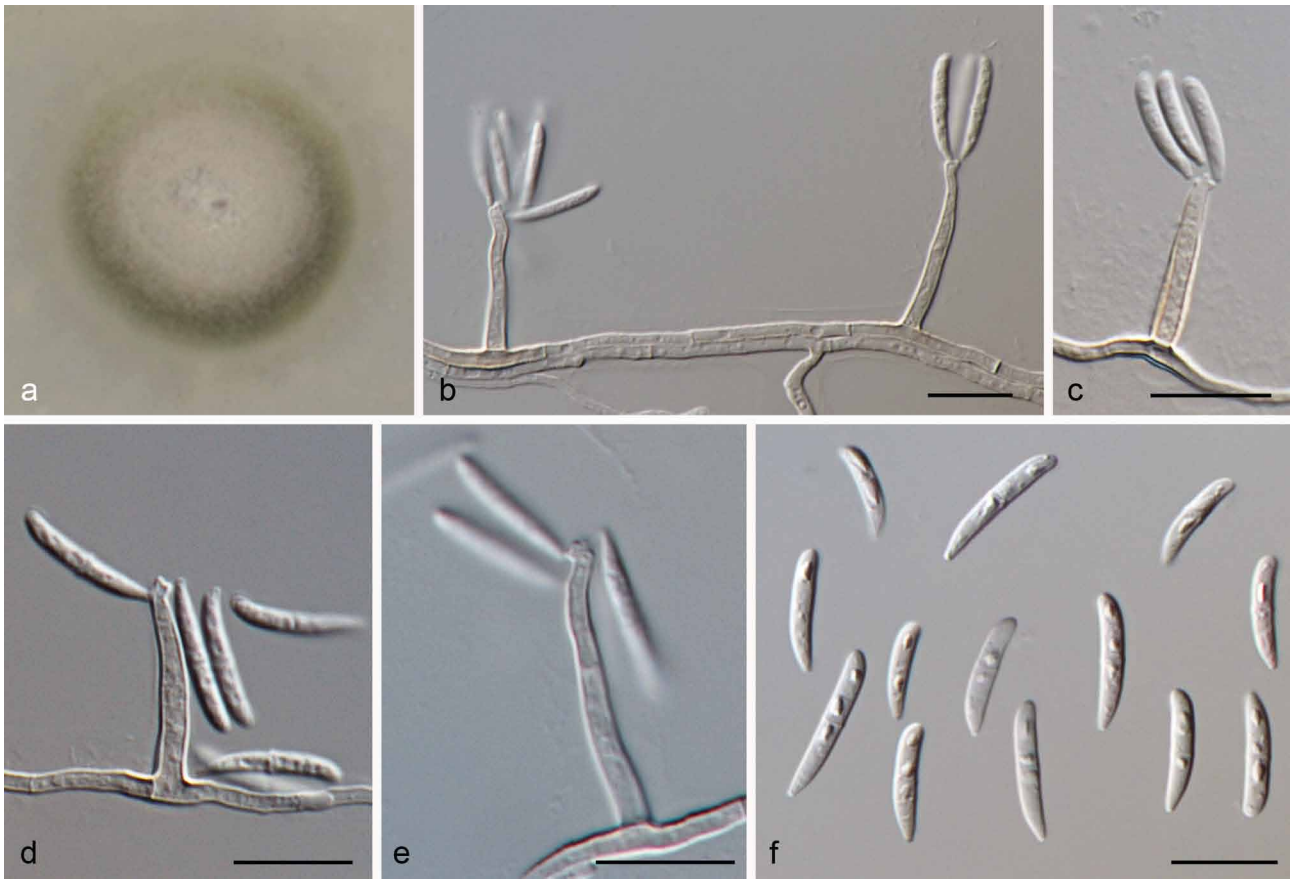

Fig. 18 *Idriellopsis uncinospora* (from ex-type, CBS 575.92). a. Colony on OA at 25 °C in 1 wk; b–e. conidiogenous cells; f. conidia. — Scale bars: b–f = 10 µm.

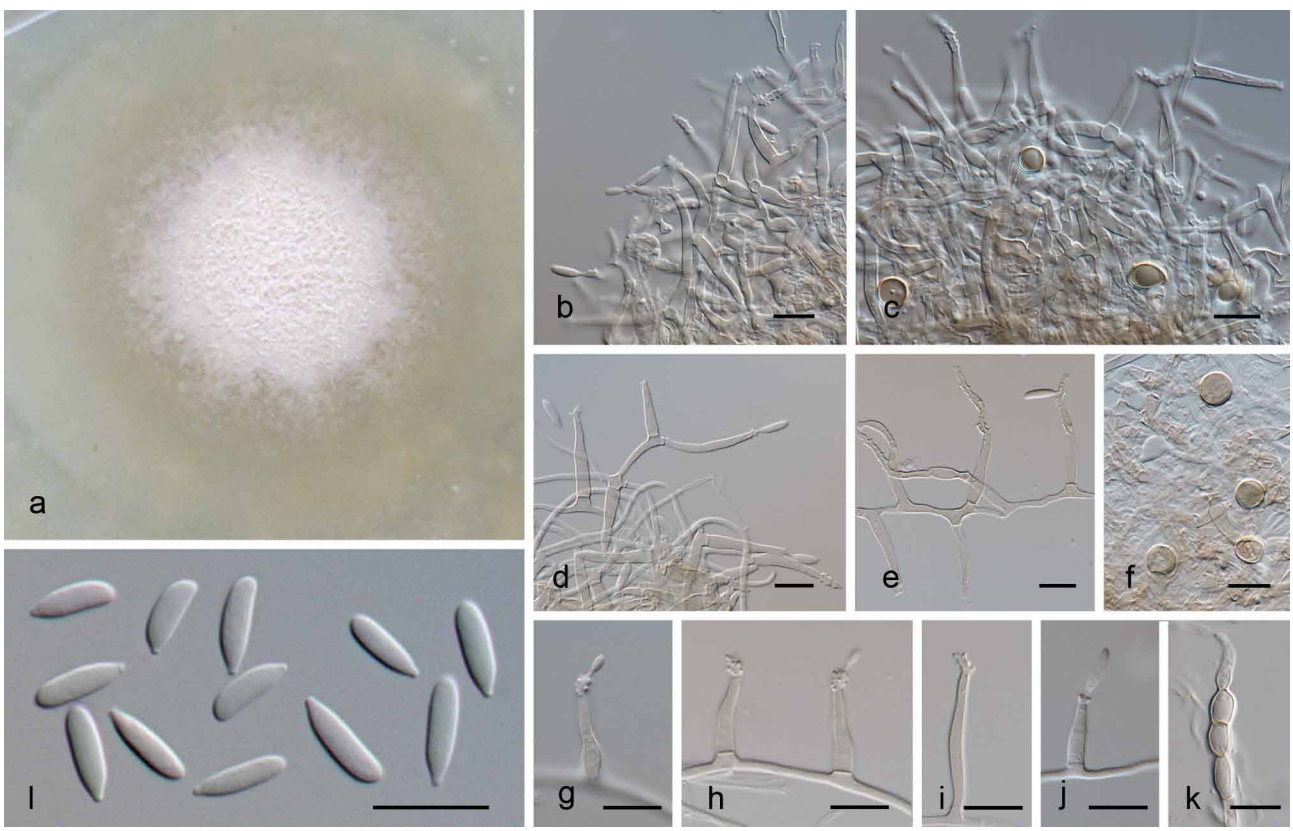

Fig. 19 *Neoidriella desertorum* (from ex-type, CBS 985.72). a. Colony on OA at 25 °C in 1 wk; b–e, g–j. conidiogenous cells; f, k. chlamydospores; l. conidia. — Scale bars: b–l = 10 µm.

Mycelium immersed and superficial, hyphae branched, septate, hyaline to pale brown. *Conidiophores* simple, pale brown at the base, subhyaline to hyaline at the apex, 0–1-sepate, 13–35 × 2–3.5 µm. *Conidiogenous cells* polyblastic, denticulate, cylindrical and inflated at the apex, 11–21 × 2–3.5 µm, pale brown, subhyaline to hyaline at the apex. *Conidia* subfalcate, curved, tapered at the base, rounded and curved at the apex, 0–1-septate, guttulate, smooth-wall, hyaline, 9–15 × 1.5–2 µm. *Chlamydospores* not observed.

Culture characteristics — Colonies on OA reaching 16–23 mm diam in 3 wk, flat, powdery, pale mouse grey, margin olivaceous or buff, diffuse.

Specimen examined. Cuba, Santiago de Las Vegas, on dead leaf, 18 Feb. 1991, *R.F. Castañeda* (holotype INIFAT C91/69; living culture ex-type CBS 575.92; CBS H-22145 dry).

Notes — *Idriellopsis uncinospora* is phylogenetically distant (Fig. 1) from *Idriella* s.str., although morphologically, it appears similar with pale brown conidiophores, denticulate conidiogenous cells and curved conidia. Nevertheless, the conidial morphology is slightly different, since in *I. uncinospora* conidia are 0–1-sepate and have truncate bases with obtuse and curved apices, whereas in *Idriella* s.str. conidia are non-septate and have acuminate bases and apices. *Idriellopsis uncinospora* is represented by one isolate (CBS 575.92), originally described growing on dead leaves from Cuba (Castañeda-Ruiz & Kendrick 1991).

Neoidriella Hern.-Restr. & Crous, *gen. nov.* — MycoBank MB811884

Etymology. In reference to its similarity with the genus *Idriella*.

Type species. *Neoidriella desertorum* (Nicot & Mouch.) Hern.-Restr. & Crous.

Mycelium immersed and superficial, hyphae hyaline to pale brown, branched, septate, smooth. *Conidiophores* mostly simple, pale brown. *Conidiogenous cells* sympodial, denticulate, terminal. *Conidia* unicellular, hyaline, cylindrical to obovoid, smooth-walled. *Chlamydospores* intercalary or terminal, pale brown. *Sexual morph* unknown.

Neoidriella desertorum (Nicot & Mouch.) Hern.-Restr. & Crous, *comb. nov.* — MycoBank MB811885; Fig. 19

Basionym. *Idriella desertorum* Nicot & Mouch., Rev. Mycol. (Paris) 36: 192. 1972.

Mycelium immersed and superficial, hyphae hyaline to pale brown, branched, septate, smooth. *Conidiophores* simple or branched, pale brown. *Conidiogenous cells* cylindrical, wider at the base, sympodial, denticulate, terminal or lateral, straight or flexuous, 10.5–38 × 2–4 µm, with rachis, 4–21.5 × 1–3 µm. *Conidia* cylindrical to obovoid, 7–10 × 2–3 µm, unicellular, hyaline, smooth-walled, base tapered, apex rounded. *Chlamydospores* mostly globose, 5.5–9 µm diam, uni- or pluricellular, intercalary or terminal, pale brown. *Sexual morph* unknown.

Culture characteristics — Colonies on OA reaching 35–40 mm diam in 3 wk. Zonate, centre velvety to cottony, rosy buff; periphery glabrous, ocreous; margin entire.

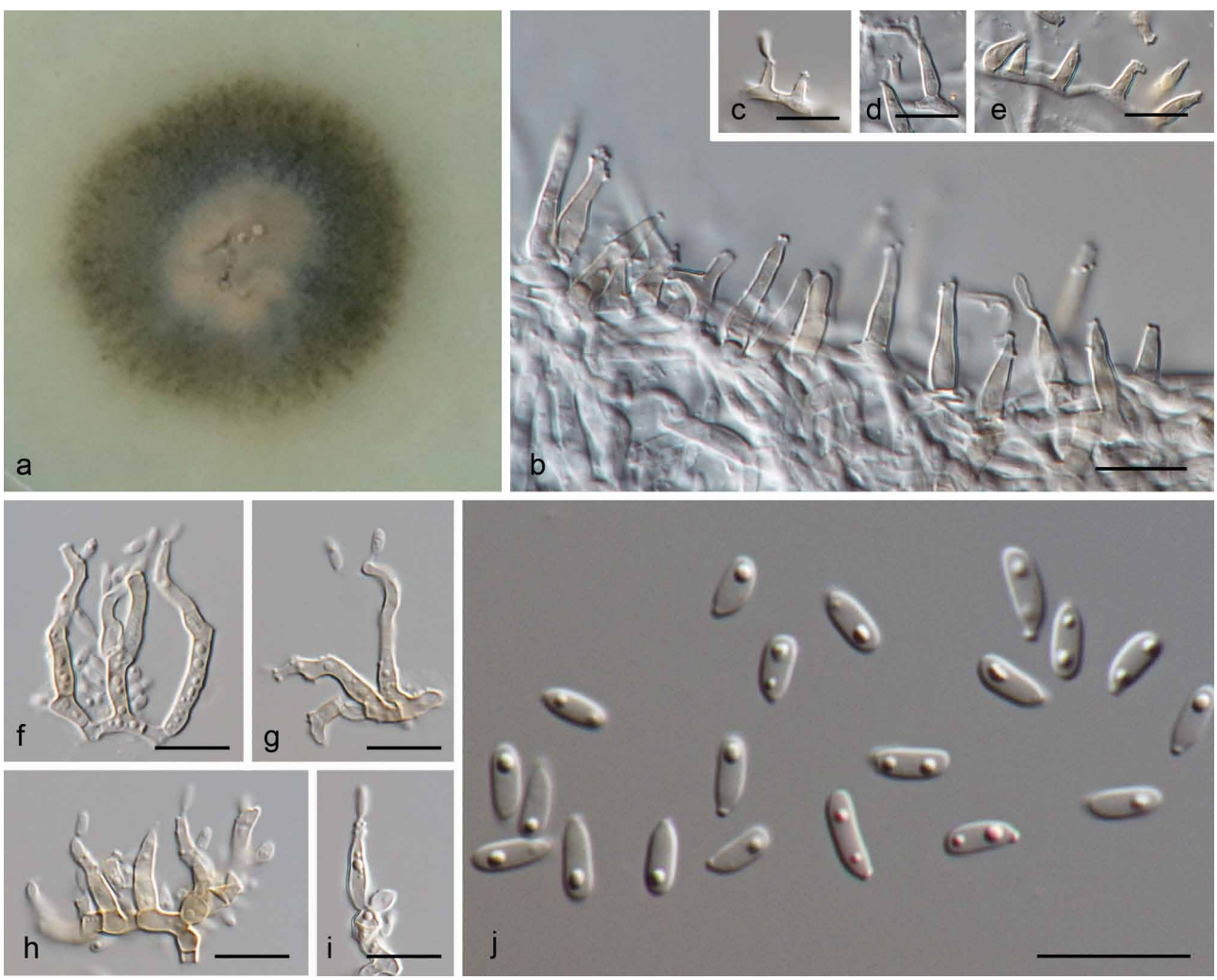

Fig. 20 *Paraidriella jambosae* (from ex-type, CBS 374.90). a. Colony on OA at 25 °C in 1 wk; b–i. conidiogenous cells; j. conidia. — Scale bars: b–j = 10 µm.

Specimen examined. Egypt, Western Desert, from desert soil, Nov. 1972, *J. Mouchacca* (holotype CBS H-7247; living culture ex-type CBS 985.72 = ATCC 26429 = IMI 171136 = LCP 2115).

Notes — The single available isolate of this species clustered on a separate branch in *Xylariales*, separated from the type species of the genus *Idriella*. The conidiophores in *N. desertorum* are mostly reduced to conidiogenous cells as in *Idriella*, but the conidial shape in *N. desertorum* is obovoid to clavate tapering at the base, different from *Idriella* that has lunate conidia. Furthermore, the conidiogenous cells develop a rachis with conspicuous denticles.

Paraidriella Hern.-Restr. & Crous, *gen. nov.* — MycoBank MB811886

Etymology. In reference to its similarity with the genus *Idriella*.

Type species. *Paraidriella jambosae* (R.F. Castañeda & W.B. Kendr.) Hern.-Restr. & Crous.

Mycelium immersed and superficial, hyphae hyaline to pale brown, branched, septate, smooth. *Conidiophores* pale brown, mostly reduced to conidiogenous cells. *Conidiogenous cells* cylindrical to lageniform, sympodial, denticulate, terminal. *Conidia* unicellular, hyaline, cylindrical to oblong, smooth-wall. *Chlamydospores* not observed. *Sexual morph* unknown.

Paraidriella jambosae (R.F. Castañeda & W.B. Kendr.) Hern.-Restr. & Crous, *comb. nov.* — MycoBank MB811887; Fig. 20

Basionym. *Idriella jambosae* R.F. Castañeda & W.B. Kendr., Univ. Waterloo Biol. Ser. 35: 68. 1991.

Description on natural substrate — Castañeda-Ruiz & Kendrick (1991).

Mycelium immersed and superficial, hyphae hyaline to pale brown, branched, septate, smooth. *Conidiophores* pale brown, 0–1-sepate. *Conidiogenous cells* cylindrical to lageniform, inflated at the apex, sympodial, denticulate, terminal, straight or flexuous, 10–25 × 2–3 µm. *Conidia* unicellular, hyaline, cylindrical to oblong, asymmetrical, 4–5.5 × 1–1.5 µm, smooth-walled, 1–2 guttulate, base tapered, apex rounded. *Chlamydospores* not observed. *Sexual morph* unknown.

Culture characteristics — Colonies on OA reaching 22–28 mm diam in 3 wk, flat, velvety, zonate centre rosy buff, periphery isabelline, margin fimbriate.

Specimen examined. Cuba, San Juan y Martínez, Pinar del Rio, Cuchillas de San Simon, on fallen leaves of *Syzygium jambos* (= *Jambosa vulgaris*), 24 Mar. 1990, *R.F. Castañeda* (holotype CBS H-22146; living culture ex-type CBS 374.90)

Notes — *Paraidriella jambosae* is represented by the only available isolate of this species, and clustered on a separate branch in *Xylariales*. The only obvious morphological difference with *Idriella* lies in its conidia, which are cylindrical to oblong, tapered at the base and rounded at the apex in *Paraidriella*, differing from *Idriella* that has lunate conidia with pointed ends. However, phylogenetically both genera are clearly distinct.

DISCUSSION

Monographella for many years was considered the sexual morph of *Microdochium*. Nevertheless, with the implementation of 'one fungus one name' nomenclature, we propose to retain *Microdochium* as genus name. *Microdochium* and *Monographella* were described in the same journal volume in Annales Mycologici in 1924. Nevertheless, *Microdochium* has more species, is more commonly encountered, and the name is more frequently used in literature.

Microdochium and *Idriella* are morphologically similar, as well as phylogenetically related as shown in the present analyses (Fig. 1). Previous studies connected *Idriella* with *Hymenoscyphus* in *Helotiales* (Kimbrough & Atkinson 1972) and *Microdochium* with *Amphisphaeriaceae* (Parkinson et al. 1981, Samuels & Hallet 1983, Von Arx 1984, Jaklitsch & Voglmayr 2012). *Amphisphaeriaceae* is a large heterogeneous family which possesses pestalotiopsis-like asexual morphs characterised by holoblastic conidiogenous cells that produce septate, brown or hyaline conidia with appendages at both ends (Tanaka et al. 2011, Maharachchikumbura et al. 2014). Nevertheless, in our phylogenetic tree, *Microdochium* and *Idriella* formed a separate clade in *Xylariales* distinct from other families (Fig. 1). Based on the results of our phylogenetic analyses *Microdochium*, *Idriella* and *Selenodriella* correspond to a new family introduced here as *Microdochiaceae*. This new family is characterised by asexual morphs that produce polyblastic, sympodial or annellidic conidiogenous cells with hyaline conidia without appendages and sexual morphs that are monographella-like.

Species of *Microdochium* and *Idriella* are phytopathogenic and saprobic, differentiated morphologically mainly by the pigmentation of their conidiogenous cells, which are hyaline in *Microdochium* and pale brown in *Idriella*. The conidial shape seems to be another taxonomic important feature, while in *Idriella* the conidia are lunate with pointed ends, in *Microdochium* the conidial shape is more variable from cylindrical, fusoid or oblong, to lunate, straight or curved, with truncate bases and apices mainly rounded. The formation of chlamydospores was observed in both genera, but not seen in all *Microdochium* species. Nevertheless, morphological characters used to delimit species in *Microdochium* including conidiomatal structure, conidiogenous cells and conidia were frequently found degenerated in cultures. For example in *M. phragmites*, the type species of the genus represented by two strains with morphological differences; one of them shows denticulate conidiogenous cells and the other one produces annellidic conidiogenous cells. Nevertheless they were genetically similar. Sporodochia and ascomata commonly described from natural substrates in cultures were poorly developed or absent in some cultures. On the other hand sexual and asexual connections as in *M. lycopodinum* were based only on molecular data. Furthermore, some species are morphologically very similar and difficult to distinguish based on literature, as in the case of *M. neoqueenslandicum* and *M. colombiense*. Species boundaries drawn in the present study were based primarily in statistically well-supported branches in multi-locus phylogenies. By combining DNA sequences with morphological analyses, we were able to delimit and propose six new species among the fungi formerly recognised in *Microdochium*, namely *Microdochium citrinidiscum*, *M. colombiense*, *M. fisheri*, *M. neoqueenslandicum*, *M. seminicola* and *M. trichocladiopsis*, which differed from other species in the genus (Table 2). Since *Monographella* is treated as synonym of *Microdochium*, we furthermore propose six new combinations in *Microdochium* as *M. albescens*, *M. consociatum*, *M. fusariisporum*, *M. maydis*, *M. opuntiae* and *M. stevensonii.*

For an accurate species identification of *Microdochium* species, a molecular analysis is required. The four gene regions used in this study were chosen based on their previous use in molecular studies (Jaklitsch & Voglmayr 2012, Jewell & Hsiang 2013, Zhang et al. 2015). LSU was only usefull for generic placement, since it was not able to separate *M. seminicola*, *M. albescens*, *M. majus* and *M. nivale*. Although phylogenetic analyses of the individual gene regions of ITS, BTUB and RPB2 (results not shown) were able to resolve 14 species in *Microdochium* with varying statistical support they proved to be suitable barcoding markers for species identification. The phylogeny based on BTUB showed longer distances between

Table 2 Overview of morphological characters of *Microdochium* spp.

	Asexual morph					Sexual morph				
	Conidia			Conidiogenous cells		Chlamydo-spores	Perithecia	Asci	Ascospores	
Taxa	Shape	Size (µm)	# septa	Type - Shape	Size (µm)	Type	Size/Diameter (µm)	Size (µm)	Size (µm)	# septa
M. albescens	falcate, slightly to strong curved, apex pointed	11–16 × 3.5–4.5	0–1(–3)	percurrent, subcylindrical, doliiform to obpyriform	6–15 × 1.5–4	not observed	150–180 × 90–120	40–85 × 8–12	14–23 × 3.5–4.5	1–3(–5)
M. bolleyi	crescent	5.5–8.5 × 1.6–2.2	0	sympodial, cylindrical or ampulliform, with rachides	2–4.5 × 2–3.5	present, multicellular	not reported	not reported	not reported	not reported
M. caespitosum	falcate, pointed	25–30 × 1.5–2	1	sympodial, ampulliform	7.5–15 × 2.5–5	not reported	not reported	not reported	not reported	not reported
M. citrinidiscum	cylindrical, clavate, obovoid	7–31 × 2–3	0–3	sympodial, denticulate, cylindrical	11–29 × 1.5–2	not observed	not reported	not reported	not reported	not reported
M. colombiense	lunate, fusiform, allantoid or reniform, straight or curved	5–8 × 1.5–3	0(–1)	polyblastic, ampulliform, with per-current proliferations, or cylindrical	5–13 × 2.5–3.5	not observed	not reported	not reported	not reported	not reported
M. consociata	not described	present – not described	present – not described	present – not described	present – not described	present – not described	110–300	90–120 × 21–25	32–38 × 8–11	3–6
M. fisheri	obovoid, subpyriform, to clavate, fusiform	7–12 × 3–4	0–1	sympodial, denticulate, cylindrical	19–60 × 1.5–2	not observed	not reported	not reported	not reported	not reported
M. fusariisporium	not reported	not reported	not reported	not reported	not reported	not reported	165–220 × 137–165	45–65 × 8–9	20–32 × 3–3.5	1–3
M. griseum	falcate, pointed at both ends	20–30 × 2–2.5	0	sympodial, apical, ampulliform, up to 5 denticles	< 30 × 1–4.5	not reported	not reported	not reported	not reported	not reported
M. intermedium	fusiform, falcate	8–15 × 3–4.5	1–2	sympodial, cylindrical or ampulliform with short denticulate rachides	10–20 × 3–4	not reported	not reported	not reported	not reported	not reported
M. lycopodinum	fusiform or with one side straighter than the other, lunate	8–15 × 2.5–3.5	0–1	ampulliform to lageniform, sub-cylindrical, percurrent proliferations	4–12 × 2.5–3.5	not observed	80–190	37–66 × 5–7.5	9–24 × 2–3.5	1(–2–3)
M. majus	falcate, slightly to strong curved, apex pointed, base wedge-shaped	19–37 × 3.5–4.5	(1–)7	percurrent, apical, subcylindrical, doliiform to obpyriform	6–15 × 2.2–4	not reported	300 × 170	50–70 × 7–9	9.5–17 × 3–4.5	1–3
M. maydis	cylindrical to slightly clavate, apex obtuse, base narrowed, mostly curved	20–46 × 3–4	3–9	percurrent, apical, doliiform, ampulli-form to obpyriform	15–20 × 10	not reported	200–250 × 100–200	80–90 × 10–12	18–25 × 3.5–5	1–3
M. neoqueenslandicum	lunate, allantoid, curved, with one side straighter than the other	4–9 × 1.5–3	0(–1)	ampulliform, lageniform to subcylindrical, polyblastic, percurrent proliferations	4.5–10 × 2–3.5	not observed	not reported	not reported	not reported	not reported
M. nivale	falcate, slightly to strong curved, apex pointed, base wedge-shaped, base obtuse to round	5–36 × 2–4.5	3(–1–7)	percurrent, apical, subcylindrical, doliiform to obpyriform	6–15 × 2.2–4	not reported	300 × 170	50–70 × 7–9	10–17 × 3.5–4.5	1(–3)
M. opuntiae	not reported	not reported	not reported	not reported	not reported	not reported	100–112	> 60 × 8–9	20–22 × 3.5	1
M. palmicola	filiform, straight to slighlty flexuous, apex rounded	7–16 × 1	0	sympodial, apical, ampulliform to lageniform	6–13 × 2.5–5(–7)	not reported	not reported	not reported	not reported	not reported
M. paspali	falcate, apex pointed	7–20.5 × 2.5–4.5	0–3	percurrent, ampuliform, lageniform to cylindrical	6.5–15.5 × 2.5–4	not reported	not reported	not reported	not reported	not reported
M. passiflorae	falcate	28–50 × 3–3.5	1–6	sympodial, apical, cylindrical to doliiform	10–15 × 3–4	not reported	200–250	57–120 × 9–11	15–25 × 4–5	1–3

M. phragmitis	narrowly ellipsoid-fusiform, slightly curved, somewhat falcate apex obtuse to subacute, tapered, base somewhat obconically	10–16 × 2–3.5	0–1	sympodial, apical, ampulliform to lageniform	5–12(–30) × 2.5–3	not observed	not reported	not reported	not reported	not reported
M. punctum	fusiform, straight, apex rounded to subacute	20–30 × 3–5	1	subcylindrical, ampulliform, conical to geniculate-sinuous	5–8(–15) × 2–3	not reported	not reported	not reported	not reported	not reported
M. queenslandicum	lunate	7.5–11 × 1.8–2	0	sympodial, apical, ampulliform	4–7 × 2–3	not reported	not reported	not reported	not reported	not reported
M. seminicola	cylindrical to fusiform, straight or curved	19–54 × 3–4.5	(0–)3(–5)	ampulliform to lageniform, with percurrent proliferations	7–9.5 × 3–4	not observed	110–149	41–66 × 7.6–11	12–22 × 3–4.5	0–3
M. sorghi	filiform, narrowly acicular fusiform, obclavate	20–90 × 1.5–4.5	1–7(–10)	sympodial, occasionally percurrent. Ovoid, ampulliform to obclavate	5–13 × 3–4	not reported	not reported	not reported	not reported	not reported
M. stevensonii	not reported	not reported	not reported	not reported	not reported	not reported	150–260	45–65 × 11–13	14–21 × 5–6.5	1–2
M. stoveri	cylindrical to fusiform, often curved, apex rounded	13–39 × 2–3	0–2	sympodial, apical, cylindrical	6.5–15 × 2.5–3.5	not reported	120 × 90	75–115 × 18–28	23–30 × 5.5–6.5	3–4
M. tainanense	lunate	10–15 × 2–3	0–1	sympodial, apical, cylindrical or ampulliform with conspicuous rhachides	3–10 × 1–3	not observed	not reported	not reported	not reported	not reported
M. trichocladiopsis	oblong, fusiform to obovoid, straight or curved	6–18 × 2–3.5	0(–1)	cylindrical to clavate, straight often curved at the tip	4–37 × 2–3	present, trichocladium like	not reported	not reported	not reported	not reported
M. triticicola	fusiform, straight	5–14 × 2.5–4	(0–)1	sympodial, apical, ampulliform, lageniform to cylindrical	6.5–35 × 2.5–3.5	not reported	not reported	not reported	not reported	not reported

species and higher support values. This locus was the most informative of the three gene regions studied, which is in agreement with previous studies in other xylariaceous genera (Hsieh et al. 2005, Læssøe et al. 2013). After this revision *Microdochium* s.str. includes 29 species, of which the main morphological characters are summarised in Table 2. Some previously published species of *Microdochium* and *Idriella* clustered outside the *Microdochiaceae*. These include the isolate CBS 493.70, which was originally recognised as *Microdochium gracile*, and is shown here to represent *Paramicrodochium gracile* gen. et comb. nov. (*Sordariomycetes* incertae sedis), and the isolate CBS 857.72, which was originally included as *Microdochium tripsaci*, and shown here to represent *Ephelis tripsaci* comb. nov. (*Clavicipitaceae*, *Hypocreales*), and CBS 740.83, CBS 741.83 and CBS 742.83, which were originally described as *Microdochium fusarioides*, and are shown here to represent *Microdochiella fusarioides* gen. et comb. nov. (*Orbiliales*) (Fig. 1). In addition we propose three new genera based on species formerly described as *Idriella*, but shown to be phylogenetically distinct genera introduced as *Idriellopsis* to accommodate *Idriella uncinospora* (CBS 575.92); *Neoidriella* to accommodate *Idriella desertorum* (CBS 985.72); and *Paraidriella* to accommodate *Idriella jambosae* (CBS 374.90). Furthermore, one new species is proposed in *Selenodriella* for *S. cubensis* (former identified as *Idriella tropicalis*) and a new combination *Castanediella couratarii* to accommodate *Idriella couratarii* CBS 579.71 was introduced.

For delineating those new idriella-like genera, besides phylogenetic differences, slight morphological differences were observed. *Idriella* is defined by having conidiophores reduced to pale brown, denticulate conidiogenous cells, with lunate, nonseptate conidia, pointed at both ends, and dark chlamydospores. Idriella-like genera can be separated based on the branching pattern of their conidiophores and conidial shape and septation. *Castanediella* has branched conidiophores, conidiogenous cells with scars instead of denticles, and filiform, 0–1-septate conidia (Crous et al. 2015). *Idriellopsis* has conidiophores reduced to conidiogenous cells, falcate, curved and rounded at the apex, 0–1-septate conidia. *Neoidriella* has conidiophores that are mostly reduced to a conidiogenous cells, with unicellular, cylindrical to oblong, tapered bases and rounded apices and chlamydospores. *Paraidriella* has conidiophores that are mostly reduced to conidiogenous cells, with cylindrical to oblong, asymmetrical conidia.

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