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Proposed nomenclature for *Pseudallescheria, Scedosporium* and related genera

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Abstract As a result of fundamental changes in the International Code of Nomenclature on the use of separate names for sexual and asexual stages of fungi, generic names of many groups should be reconsidered. Members of the ECMM/ISHAM working group on *Pseudallescheria/ Scedosporium* infections herein advocate a novel nomenclature for genera and species in *Pseudallescheria*, *Scedosporium* and allied taxa. The generic names *Parascedosporium, Lomentospora, Petriella, Petriellopsis*, and *Scedosporium* are proposed for a lineage within *Microascaceae* with mostly *Scedosporium* anamorphs producing slimy, annellidic conidia. Considering that *Scedosporium* has priority over *Pseudallescheria* and that *Scedosporium prolificans* is phylogenetically distinct from

Taxonomic novelties *Scedosporium minutisporum* (Gilgado et al.) Lackner & de Hoog, *Scedosporium desertorum* (v. Arx & Moustafa) Lackner & de Hoog

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the other *Scedosporium* species, some name changes are proposed. *Pseudallescheria minutispora* and *Petriellidium desertorum* are renamed as *Scedosporium minutisporum* and *S. desertorum*, respectively. *Scedosporium prolificans* is renamed as *Lomentospora prolificans*.

Keywords *Graphium* · *Lomentospora* · *Petriella* · *Scedosporium apiospermum* complex · *Microascaceae* · Nomenclature

Introduction

Until July 2011 the nomenclature of fungi allowed for the use of multiple names describing asexual and sexual stages of the same fungus (Hawksworth 2011). Prior to the era of sequencing and molecular phylogeny, when only morphological and cultural techniques were used, the association of anamorph and teleomorph life cycles of a given fungus was often established with difficulty. Dual nomenclature was a logical option when morphs of a given fungus were seen to propagate independently, but has become superfluous since the respective stages can be linked with the aid of sequence data. A general agreement was reached among mycologists to officially abolish the dual naming system of fungi, as laid down in the 'Amsterdam Declaration on Fungal Nomenclature' and outlined by Hawksworth (2011). The provisions of dual nomenclature, which had been designed especially for fungi, are no longer used. The novel single-name approach certainly has disadvantages in e.g. ecological questions where life cycles and dispersal mechanisms play a role, but will prove to be increasingly useful for (meta)genomic studies, where species are represented by sequence data only.

The present paper discusses the current status of nomenclature of clinically relevant members of the *Microascales* prevalently producing sticky conidia and, when teleomorphic, cleistothecia with deliquescent asci and smooth-walled, one-celled ascospores. They are currently classified in *Scedosporium,*

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Pseudallescheria and related genera. Our aim is to establish a consensus generic naming system for these fungi. In humans, the fungi are primarily responsible for mycetoma and arthritis in healthy individuals, for pulmonary and cerebral infections in near-drowning victims (Tintelnot et al. 2008), and for disseminated infections in patients with severe innate immune disorders or immune suppression (Guarro et al. 2006).

Methods

Index Fungorum (http://www.indexfungorum.org) and MycoBank (http://www.mycobank.org) were used as nomenclatural databases. Original descriptions of the type species of available generic names were analysed. An overview of relevant genera, their type species and their current status is given in Table 1.

Gross phylogenetic positions were verified on the basis of ribosomal LSU and ITS sequence data. After alignment in BioNumerics v. 4.8 a phylogenetic tree covering *Microascales* using rDNA D1/D2 Large Subunit sequences was reconstructed from data retrieved from GenBank and CBS databases, using maximum likelihood method implemented in RaxML and applying Tamura 3-parameter model and G + I substitution rate, nearest-neighbour-interchange, with 500 bootstrap replications; >80 % support was considered statistically significant (Fig. 1). *Fusarium acutatum* CBS 739.97 and *F. proliferatum* CBS 246.61 were used as out-group taxa. To illustrate gross relationships between genera, an ITS-based tree covering *Microascaceae* was reconstructed using sequences retrieved from GenBank and CBS databases by alignment with Muscle using the EMBL-EBI web server and handling in BioEdit v. 7.0.9.0 (Fig. 2). Phylogenetic analyses such as Maximum Likelihood and Maximum Parsimony were performed, and the one using neighbour joining with Kimura 2 parameter in the web server above and with the number of bootstraps set at 1,000 was maintained. For detailed information on strains and GenBank numbers see Supplementary Table 1.

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Table 1 Generic names of fungi listed in literature as (possibly) belonging to the *Scedosporium* lineage (Group 1a in Fig. 2) of *Microascaceae*. Names of accepted genera of the scedosporium-lineage are printed in bold

Generic names	Type species	Order/family
Acremoniella Sacc. Syll. Fung. 4: 302, 1886	*Acremoniella atra* (Corda) Sacc. = *Harzia acremonioides* (Harz) Cost.	Hypocreales/Ceratostomataceae
Allescheria Sacc. & P. Syd. *non* Hartig. Syll. Fung. 14: 464, 1899	*Allescheria gayoni* (Cost.) Sacc. & P. Syd., according to databases = *Eurotiella* Lindau, but type material probably lost.	Eurotiales/Monascaceae
Allescheria R. Hartig. Centralbl. Gesammte Forstwesen 25: 425, 1899	*Allescheria gayoni* (Costantin ex Laborde) Sacc. & P. Syd. 1899 = *Meria* Vuill. 1896.	Helotiales/Hemiphacidiaceae
Dendrostilbella v. Höhn. Öst. Bot. Z. 55: 22, 1905	*Dendrostilbella prasinulus* v. Höhn. = anamorph of *Claussenomyces prasinulus* (P. Karst.) Korf & Abawi.	Helotiales/Helotiaceae
Enterocarpus Locquin-Linard. Revue Mycol., Paris 41: 510, 1977	*Enterocarpus uniporus* Locquin-Linard.	Microales/Microascaceae
Glenospora Berk. & Desm. J. Hort. Soc., London 4: 255, 1849	*Glenospora curtisii* Berk. & Desm. = *Septobasidium curtisii* (Berk. & Desm.) Boedijn & B.A. Steinm.	Septobasidiales/Septobasidiaceae
Glenosporopsis O.M. Fonseca. Parasitol. Med. 1: 710, 1943	*Glenosporopsis amazonica* O.M. Fonseca. Invalidly published (Carmichael 1962) and of doubtful identity (de Hoog et al. 2000).	Septobasidiales/Septobasidiaceae
Graphium Corda. Ic. Fung. 1: 18, 1837	*Graphium penicillioides* Corda. Large genus of synnematous fungi in *Microascales* for numerous references, see Seifert et al. (Seifert et al. 2011).	Microascales/Graphiaceae Recently the family *Graphiaceae* was introduced (De Beer et al. 2013).
Indiella Brumpt. Arch. Parasitol. 10: 545, 1906	*Indiella mansonii* Brumpt. = sterile species from human eumycetoma, material probably lost (De Hoog et al. 2000).	Sordiales/-
Kernia Nieuwl. Am. Midl. Nat. 4: 379, 1916 About 6 species, for recent reference, see Guarro et al. (2012a).	*Kernia nitida* (Sacc.) Nieuwl.	Microascales/Microascaceae
Lomentospora Hennebert & Desai. Mycotaxon 1: 45, 1974 Monotypic genus for the species widely known as *Scedosporium prolificans* (=*S. inflatum*). Genus not listed by Kirk et al. (2013).	*Lomentospora prolificans* Hennebert & Desai.	Microascales/Microascaceae
Lophotrichus R.K. Benj. Mycologia 41: 347, 1949	*Lophotrichus ampullus* R.K. Benj.	Microascales/Microascaceae
Monosporium Bonord. Handb. Allgem. Mykol. p. 95, 1851	*Monosporium spinosum* Bonord. = illigitimate name (Hughes 1958).	–/–
Parascedosporium Gilgado et al. Int. J. Syst. Evol. Microbiol. 57: 2176, 2007 Genus with two species in Microascaceae (Lackner and De Hoog 2011), not listed by Kirk et al. (2013).	*Parascedosporium tectonae* (C. Booth) Gilgado et al.	Microascales/Microascaceae
Petriella Curzi. Boll. R. Staz. Patalog. Veget. Roma 10: 384, 1930 The genus presently contains five species (Guarro et al. 2012).	*Petriella asymmetrica* Curzi. This species has long been known as Melanospora asymmetrica (Curzi) v. Arx & E. Müll. (Melanosporales, Ceratostomataceae), based on isotype strain CBS 258.31. However, sequence data proved the type strain to be identical to *Petriella sordida*.	Microascales/Microascaceae
Petriellidium Malloch. Mycologia 62: 738, 1970	*Petriellidium boydii* (Shear) Malloch. Younger synonym of Scedosporium, originally described for its teleomorph.	Microascales/Microascaceae

Table 1 (continued)

Generic names	Type species	Order/family
Petriellopsis Gilgado et al. Int. J. Syst. Evol. Microbiol. 57: 2177, 2007 Monotypic genus in *Microascaceae* (Guarro 2012a) not listed by Kirk et al. (2013).	*Petriellopsis africana* (v. Arx & G. Franz) Gilgado et al.	Microascales/Microascaceae
Phaeoscopulariopsis Ota. Jpn. J. Derm. Urol. 28: 405, 1928 Invalid name (Seifert et al. 2011).	Type species not designated.	Microascales/Microascaceae
Phialographium Upadhyay & Kendrick. Mycologia 66: 183, 1974	*Phialographium sagmatosporum* Upadhyay & Kendrick. anamorph of *Grosmannia sagmatospora* (Wright & Cain) Zipfel & de Beer (Seifert et al. 2013).	*Ophiostomatales/ Ophiostomataceae*
Polycytella C.K. Campbell. J. Med. Vet. Mycol. 25: 302, 1987	*Polycytella hominis* C.K. Campbell. Proven to be a degenerate form of *Scedosporium boydii* (Borman et al. 2006).	Microascales/Microascaceae
Pseudallescheria Negroni & I. Fischer. Revta Inst. Bacteriol. Carlos Malbrán 12: 201, 1944 Pleomorphic ascigerous genus of *Microascaceae.* McGinnis et al. (McGinnis et al. 1982) listed *P. shearii* as a synonym of *P. boydii*. Synonym of the older genus *Scedosporium*, not to be recommended for the list of protected names (Kirk et al. 2013).	*Pseudallescheria shearii* Negroni & I. Fischer.	Microascales/Microascaceae
Rhexographium Morelet. Ann. Soc. Sci. Nat. Arch. Toulon Var 47: 90, 1995 Monotypic genus of *Graphiaceae*.	*Rhexographium fimbriasporum* Morelet.	Microascales/Graphiaceae
Scedosporium Sacc. ex Castell. & Chalm. Man. Trop. Med., London p. 1122, 1919 Pleomorphic anamorph genus of *Microascaceae*, not mentioned by Kirk et al. (2013).	*Scedosporium apiospermum* Sacc. ex Castell. & Chalm.	Microascales/Microascaceae

Results and discussion

Six families are currently distinguished within the order *Microascales*: *Ceratocystidaceae, Chadefaudiellaceae, Gondwanamycetaceae*, *Graphiaceae,* and *Halosphaeriaceae*, in addition to the *Microascaceae* that encompasses 20 genera with about 200 species. Of the *Chadefaudiellaceae* and *Gwondanomycetaceae* only fragmentary sequence data are available, which renders a phylogenetic comparison impossible. The families *Graphiaceae* and *Ceratocystidaceae* are monophyletic and supported by high bootstrap values. The *Halosphaeriaceae* form a separate clade and has been suggested to represent a separate order (Sakayaroi et al. 2011). On the basis of LSU data (Fig. 1) the remaining species form a large cluster (89 % bootstrap support) currently classified as *Microascaceae*.

Phenotypically, two approximate groups can be distinguished within the family *Microascaceae*: species with prevalently scedosporium-like anamorphs with slimy conidia, and species with prevalently scopulariopsis-like anamorphs with hygrophobic conidia; *Petriellidium desertorum* has an exceptional type of anamorph reproduction by arthroconidia (von Arx 1973). However, these phenotypic groups lack statistical supported in LSU data (Fig. 1). Also some subgroups, i.e. a cluster containing

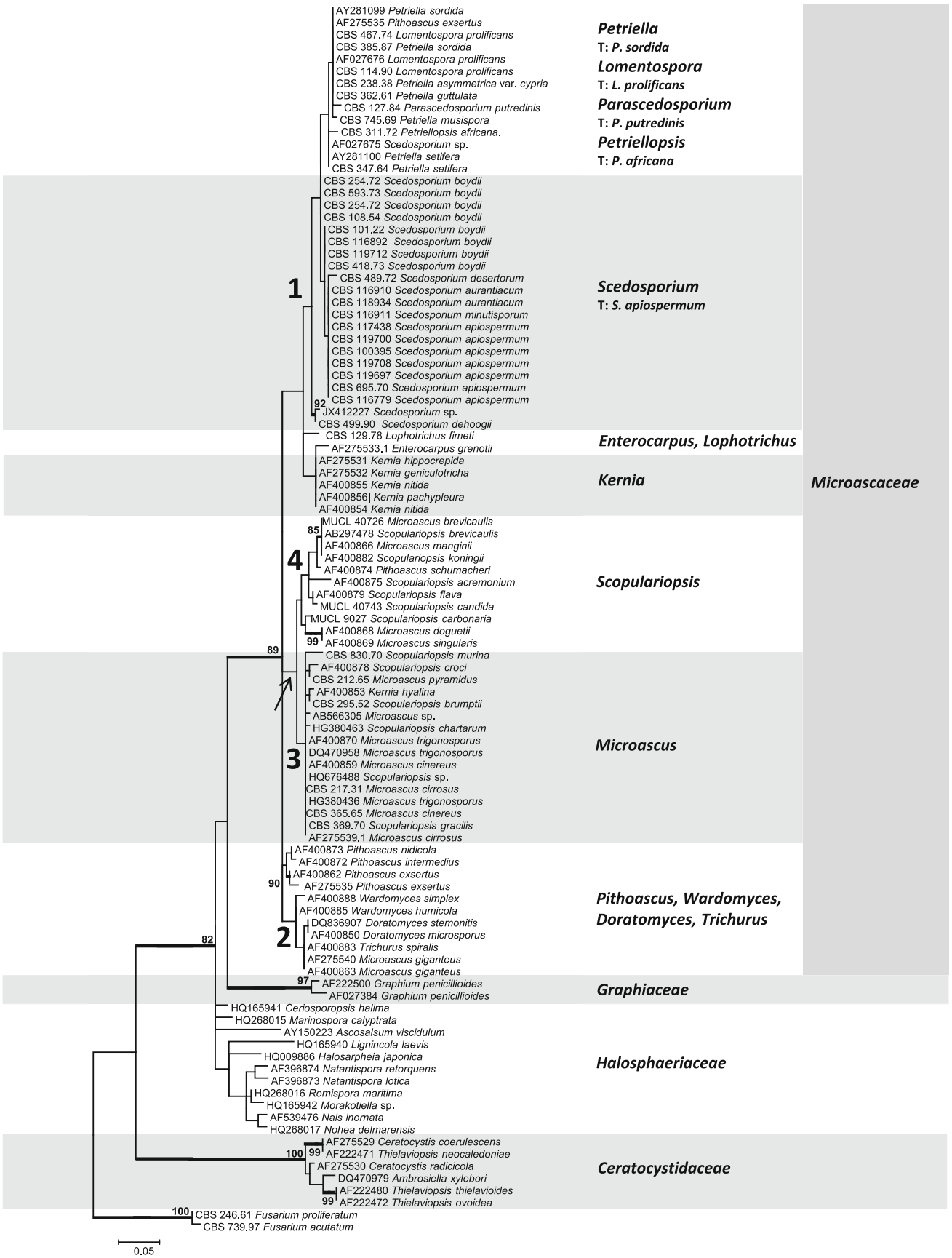
Wardomyces and relatives (group **2**), one with prevalently *Microascus* species (group **3**) and one with prevalently *Scopulariopsis* species (group **4**) have low support. Species identified as *Kernia* with *Enterocarpus* take an intermediate position between the phenotypic series, except for *K. hyalina,* which clusters among *Scopulariopsis* species. Most *Kernia* species have hygrophobic, scopulariopsis-like anamorphs, but *K. hippocrepida* produces slimy conidia similar to those prevalent in the *Scedosporium* lineage (Malloch and Cain 1971). Thus the phenotypic separation of two lineages within *Microascaceae* on the basis of conidial type is not unambiguous, which is in line with the absence of support in the phylogenetic tree.

The ITS tree is suitable to construct an overview of genera within the family *Microascaceae*, with accent on the scedosporium-lineage 'group **1**' (Fig. 2). The main clade (95 % bootstrap support), includes *Enterocarpus, Lophotrichus*, *Parascedosporium*, *Petriella*, *Petriellopsis,* and *Scedosporium*, The *Wardomyces* relationship (group **2**) has 99 % bootstrap support, the genus *Microascus* with purported *Scopulariopsis* anamorphs splits into several entities (groups **3** and **4**), and groups with *Doratomyces* and *Kernia* species are paraphyletic to the *Scedosporium* lineage. Lineage **1a** (95 % bootstrap support) is the group of taxa with prevalently scedosporium-like anamorphs, and the focus of the present paper. Thus, species with slimy conidia form a derived cluster, but do not unambiguously segregate into a separate taxonomic group, confirming LSU data above. The lineages with scedosporium-like and scopulariopsis-like species should therefore remain to be classified in the single family *Microascaceae* (Table 1).

Within the unsupported 'group **1**' of Figs. 1 and 2, *Scedosporium* is the oldest valid generic name, published in 1919 (Castellani and Chalmers 1919) with the type species *Scedosporium apiospermum* (Table 1). Main generic names that have been applied to the dimorphic genus *Pseudallescheria/Scedosporium* are the following: *Allescheria* Sacc. & P. Syd. 1899, *Allescheria* R. Hartig 1899, *Monosporium*, *Pseudallescheria*, *Scedosporium*, and *Petriellidium*. Based on the identity of type species of each genus, the genera *Allescheria* R. Hartig, *Allescheria* Sacc. & P. Syd. and *Monosporium*, can be excluded, as these are either invalid or represent entirely different fungi (Table 1). For reasons of priority the generic name *Pseudallescheria* (1944; Table 1) should be treated as a synonym of *Scedosporium*. This deviates from the proposed list of protected generic names under the Melbourne Code of Botanical Nomenclature (Kirk et al. 2013). It implies transfer of *Pseudallescheria minutispora* to *Scedosporium*. In addition to the latter species, the generic name *Scedosporium* applies to *S. apiospermum*, *S. aurantiacum*, *S. boydii,* and *S. dehoogii. Scedosporium deficiens* (Rainer and Kaltseis 2010) was described without indication of a type specimen and is therefore invalid. The taxonomic status of *P. angusta, P. ellipsoidea,* and *S. deficiens*, is still under investigation (Lackner) and further name changes are therefore considered to be premature. In our ITS data (Fig. 2), based on a small number of strains per species, *S. apiospermum* and *S. boydii* are clearly different, but the two groups are known to form a widely variable cloud of strains without medically relevant differences in e.g. pathology or antifungal susceptibility between entities (Lackner et al. 2014). In routine identification in the clinical laboratory, these molecular siblings might be taken together as a 'complex' (de Hoog et al. 2013), which in this case should be indicated as the '*Scedosporium apiospermum* complex'. *Petriella* is found in two separate clusters. With LSU data the genera *Lomentospora, Parascedosporium,* and *Petriellopsis* are part of *Petriella*, but with ITS unambiguous distinction is achieved (Fig. 2).

Fig. 1 Phylogenetic overview of *Microascales* based on the D1/D2 region of rDNA LSU reconstructed with Maximum likelihood and 500 bootstrap replications; Bootstrap values > 80 % are given with the branches. *Fusarium acutatum*, CBS 739.97 and *F. proliferatum* were selected as out-groups

In the ITS tree (Fig. 2) a polytomy is observed of *Parascedosporium* (100 % bootstrap support), *S. prolificans* (99 % bootstrap support) and two *Petriella* groups (100 % bootstrap support). Within group **1a** (Fig. 2), *Scedosporium prolificans* is separate from the remaining *Scedosporium* species, as noted earlier by Issakainen et al. (Issakainen et al. 1999; Issakainen et al. 2003). The species clusters close to *Petriella setifera,* which also produces scedosporium-like anamorphs, i.e. one-celled, subhyaline, mucoid conidia produced by annellidic conidiogenesis. The isotype culture of *Petriella asymmetrica*, CBS 258.31—the type species of *Petriella*—has been classified in *Melanospora* (von Arx and Müller 1954), but sequence data showed that they are identical with the older species *Petriella sordida*, which hence has been listed as generic type of *Petriella* (Guarro et al. 2012). The position of *Petriella setifera* outside *Petriella* sensu stricto needs further attention. For *S. prolificans* the oldest generic name is *Lomentospora* (Hennebert and Desai 1974). Its significant phylogenetic distance from the remaining *Scedosporium* species is underlined by its microscopic morphology: (a) inflated versus tubular conidiogenous cells in verticillate arrangement, and (b) different colony texture and coloration. The distinction of *S. prolificans* from the remaining *Scedosporium* species is meaningful for clinical practice, because in contrast to *Scedosporium* (c) the species is highly resistant to voriconazole (Lackner et al. 2012). Moreover, (d) *S. prolificans* causes a different disease spectrum, with primarily disseminated infections in immunocompromised


AY281099 Petriella sordida
AF275535 Pithoascus exsertus
CBS 467.74 Lomentospora prolificans
CBS 385.87 Petriella sordida
AF027676 Lomentospora prolificans
CBS 114.90 Lomentospora prolificans
CBS 238.38 Petriella asymmetrica var. cypria
CBS 362.61 Petriella guttulata
CBS 127.84 Parascedosporium putredinis
CBS 745.69 Petriella musispora
CBS 311.72 Petriellopsis africana.
AF027675 Scedosporium sp.
AY281100 Petriella setifera
CBS 347.64 Petriella setifera
Petriella
T: P. sordida
Lomentospora
T: L. prolificans
Parascedosporium
T: P. putredinis
Petriellopsis
T: P. africana
CBS 254.72 Scedosporium boydii
CBS 593.73 Scedosporium boydii
CBS 254.72 Scedosporium boydii
CBS 108.54 Scedosporium boydii
CBS 101.22 Scedosporium boydii
CBS 116892 Scedosporium boydii
CBS 119712 Scedosporium boydii
CBS 418.73 Scedosporium boydii
CBS 489.72 Scedosporium desertorum
CBS 116910 Scedosporium aurantiacum
CBS 118934 Scedosporium aurantiacum
CBS 116911 Scedosporium minutisporum
CBS 117438 Scedosporium apiospermum
CBS 119700 Scedosporium apiospermum
CBS 100395 Scedosporium apiospermum
CBS 119708 Scedosporium apiospermum
CBS 119697 Scedosporium apiospermum
CBS 695.70 Scedosporium apiospermum
CBS 116779 Scedosporium apiospermum
JX412227 Scedosporium sp.
CBS 499.90 Scedosporium dehoogii
1
92
Scedosporium
T: S. apiospermum
CBS 129.78 Lophotrichus fimeti
AF275533.1 Enterocarpus grenotii
Enterocarpus, Lophotrichus
AF275531 Kernia hippocrepida
AF275532 Kernia geniculotricha
AF400855 Kernia nitida
AF400856 Kernia pachypleura
AF400854 Kernia nitida
Kernia
MUCL 40726 Microascus brevicaulis
AB297478 Scopulariopsis brevicaulis
AF400866 Microascus manginii
AF400882 Scopulariopsis koningii
AF400874 Pithoascus schumacheri
AF400875 Scopulariopsis acremonium
AF400879 Scopulariopsis flava
MUCL 40743 Scopulariopsis candida
MUCL 9027 Scopulariopsis carbonaria
AF400868 Microascus doguetii
AF400869 Microascus singularis
85
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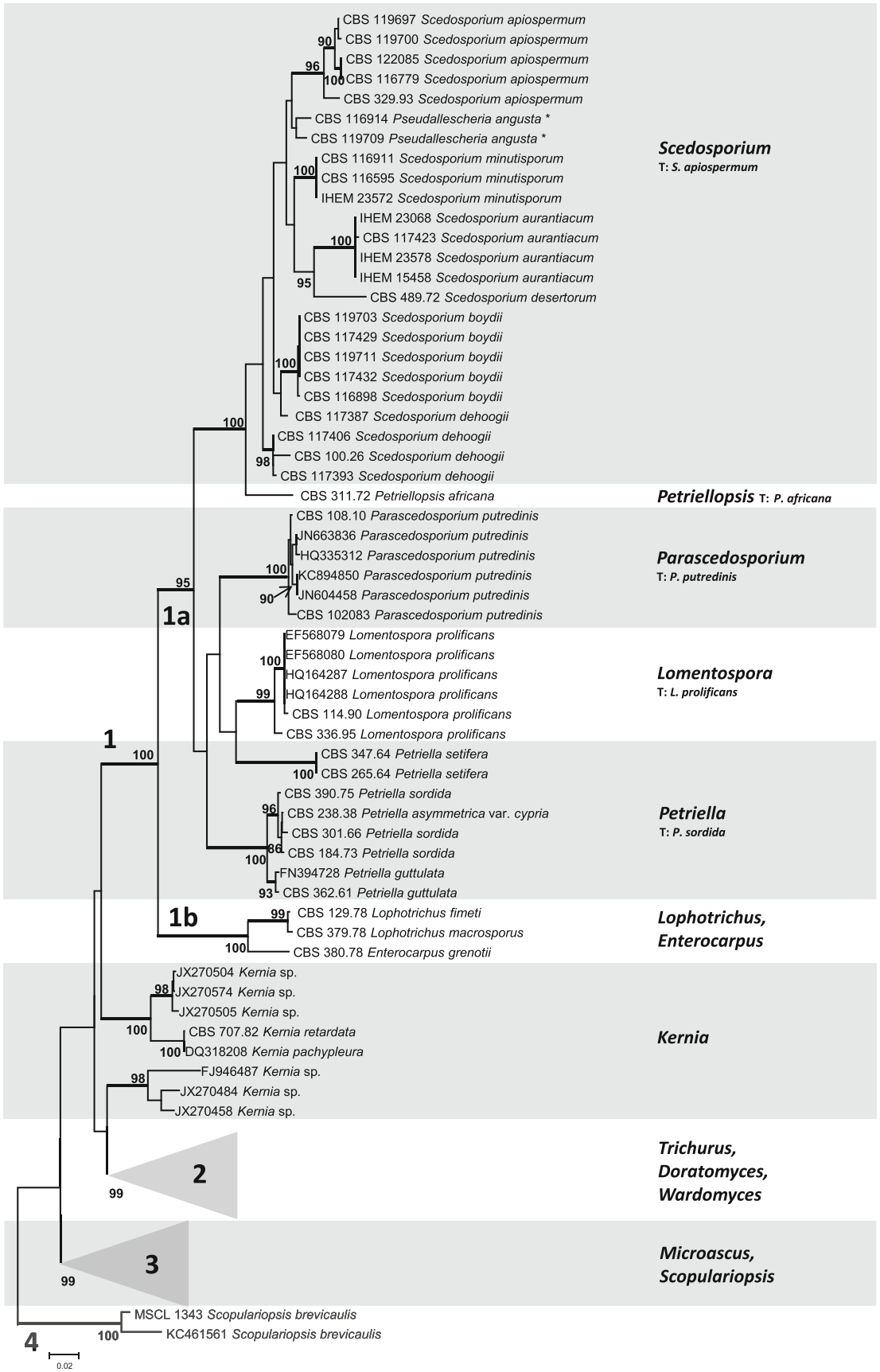
Scopulariopsis
89
CBS 830.70 Scopulariopsis murina
AF400878 Scopulariopsis croci
CBS 212.65 Microascus pyramidus
AF400853 Kernia hyalina
CBS 295.52 Scopulariopsis brumptii
AB566305 Microascus sp.
HG380463 Scopulariopsis chartarum
AF400870 Microascus trigonosporus
DQ470958 Microascus trigonosporus
AF400859 Microascus cinereus
HQ676488 Scopulariopsis sp.
CBS 217.31 Microascus cirrosus
HG380436 Microascus trigonosporus
CBS 365.65 Microascus cinereus
CBS 369.70 Scopulariopsis gracilis
AF275539.1 Microascus cirrosus
3
Microascus
AF400873 Pithoascus nidicola
AF400872 Pithoascus intermedius
AF400862 Pithoascus exsertus
AF275535 Pithoascus exsertus
AF400888 Wardomyces simplex
AF400885 Wardomyces humicola
DQ836907 Doratomyces stemonitis
AF400850 Doratomyces microsporus
AF400883 Trichurus spiralis
AF275540 Microascus giganteus
AF400863 Microascus giganteus
90
2
82
Pithoascus, Wardomyces,
Doratomyces, Trichurus
97
AF222500 Graphium penicillioides
AF027384 Graphium penicillioides
Graphiaceae
HQ165941 Ceriosporopsis halima
HQ268015 Marinospora calyptrata
AY150223 Ascosalsum viscidulum
HQ165940 Lignincola laevis
HQ009886 Halosarpheia japonica
AF396874 Natantispora retorquens
AF396873 Natantispora lotica
HQ268016 Remispora maritima
HQ165942 Morakotiella sp.
AF539476 Nais inornata
HQ268017 Nohea delmarensis
Halosphaeriaceae
AF275529 Ceratocystis coerulescens
AF222471 Thielaviopsis neocaledoniae
AF275530 Ceratocystis radicicola
DQ470979 Ambrosiella xylebori
AF222480 Thielaviopsis thielavioides
AF222472 Thielaviopsis ovoidea
100
99
99
Ceratocystidaceae
CBS 246.61 Fusarium proliferatum
CBS 739.97 Fusarium acutatum
100
0.05
Microascaceae


CBS 119697 Scedosporium apiospermum
CBS 119700 Scedosporium apiospermum
CBS 122085 Scedosporium apiospermum
CBS 116779 Scedosporium apiospermum
CBS 329.93 Scedosporium apiospermum
CBS 116914 Pseudallescheria angusta *
CBS 119709 Pseudallescheria angusta *
CBS 116911 Scedosporium minutisporum
CBS 116595 Scedosporium minutisporum
IHEM 23572 Scedosporium minutisporum
IHEM 23068 Scedosporium aurantiacum
CBS 117423 Scedosporium aurantiacum
IHEM 23578 Scedosporium aurantiacum
IHEM 15458 Scedosporium aurantiacum
CBS 489.72 Scedosporium desertorum
CBS 119703 Scedosporium boydii
CBS 117429 Scedosporium boydii
CBS 119711 Scedosporium boydii
CBS 117432 Scedosporium boydii
CBS 116898 Scedosporium boydii
CBS 117387 Scedosporium dehoogii
CBS 117406 Scedosporium dehoogii
CBS 100.26 Scedosporium dehoogii
CBS 117393 Scedosporium dehoogii
Scedosporium
T: S. apiospermum
CBS 311.72 Petriellopsis africana
Petriellopsis T: P. africana
CBS 108.10 Parascedosporium putredinis
JN663836 Parascedosporium putredinis
HQ335312 Parascedosporium putredinis
KC894850 Parascedosporium putredinis
JN604458 Parascedosporium putredinis
CBS 102083 Parascedosporium putredinis
Parascedosporium
T: P. putredinis
1a
EF568079 Lomentospora prolificans
EF568080 Lomentospora prolificans
HQ164287 Lomentospora prolificans
HQ164288 Lomentospora prolificans
CBS 114.90 Lomentospora prolificans
CBS 336.95 Lomentospora prolificans
Lomentospora
T: L. prolificans
1
CBS 347.64 Petriella setifera
CBS 265.64 Petriella setifera
CBS 390.75 Petriella sordida
CBS 238.38 Petriella asymmetrica var. cypria
CBS 301.66 Petriella sordida
CBS 184.73 Petriella sordida
FN394728 Petriella guttulata
CBS 362.61 Petriella guttulata
Petriella
T: P. sordida
1b
CBS 129.78 Lophotrichus fimeti
CBS 379.78 Lophotrichus macrosporus
CBS 380.78 Enterocarpus grenotii
Lophotrichus,
Enterocarpus
JX270504 Kernia sp.
JX270574 Kernia sp.
JX270505 Kernia sp.
CBS 707.82 Kernia retardata
DQ318208 Kernia pachypleura
FJ946487 Kernia sp.
JX270484 Kernia sp.
JX270458 Kernia sp.
Kernia
2
Trichurus,
Doratomyces,
Wardomyces
3
Microascus,
Scopulariopsis
MSCL 1343 Scopulariopsis brevicaulis
KC461561 Scopulariopsis brevicaulis
4
0.02

◀ **Fig. 2** Phylogenetic overview of *Microascaceae* based on sequences of ITS region of the rDNA reconstructed with Muscle using the EMBL-EBI web server and handeled in BioEdit v. 7.0.9.0. Analysis was performed using Neighbor joining with Kimura 2 parameter model, midpoint rooting, and with 1000 bootstrap replications. Names with * regarded as ambigious

patients versus occurrence of the *Scedosporium apiospermum* complex being associated with near-drowning syndrome (Guarro et al. 2006), and as causative agent of eumycotic mycetomas. In animal models (e) *S. prolificans* was shown to be more virulent (Ortoneda et al. 2002). As such, the separation of *Lomentospora* from *Scedosporium* is supported from an evolutionary as well as from a medical perspective. The recommended name for *S. prolificans* is therefore *Lomentospora prolificans*.

Many species of lineage **1a** (Fig. 2) are polymorphic, strains exhibiting differentially named morphological stages: *Scedosporium* for a hyphomycetous anamorph, '*Graphium*' for a synnematous anamorph, and *Pseudallescheria* for the teleomorph. Species that regularly exhibit a teleomorph have been described in the respective teleomorph genus (e.g., *Pseudallescheria minutispora*), whereas close relatives without known teleomorph are known under their anamorph genus name (e.g., *Scedosporium aurantiacum*). An overview of the presence or absence, as well as of the names of anamorphic, synanamorphic and teleomorphic stages is given in Table 2. With the priority of *Scedosporium* over *Pseudallescheria,* this name will now be applied for the holomorph. It may be useful, however, to maintain the former anatomic system to indicate ecologically different types of dispersal. The pseudallescheria-stage (indicated with roman, non-capitalized letters) observed in many species of *Scedosporium* serves sexuality, and a graphium-like stage has been speculated to have another vector of dispersal (Dowding 1969; Guarro 2012). It should be noted, however, that the genus *Graphium* sensu stricto is a member of the family *Graphiaceae* and thus unrelated.

In conclusion, *Lomentospora, Lophotrichus, Parascedosporium, Petriella, Petriellopsis,* and *Scedosporium* will remain the correct generic names in lineage **1a** prevalently covering members of *Microascaceae* with slimy conidia. *Pseudallescheria minutispora* and *Scedosporium prolificans* need to be renamed. The ambiguous taxonomic validity of *Pseudallescheria angusta* as an intermediate between *S. apiospermum* and *S. boydii* (Lackner et al. 2014) to be the result of an ongoing process of sympatric speciation and hence difficult to classify. Based on the above, the following name changes are proposed:

Scedosporium minutisporum (Gilgado et al.) Lackner & de Hoog, **comb. nov**., MycoBank MB 807326

Basionym: *Pseudallescheria minutispora* Gilgado et al.—J. Clin. Microbiol. 43: 4938, 2005.

Scedosporium desertorum (v. Arx & Moustafa) Lackner & de Hoog, **comb. nov**., MycoBank MB807329

Basionym: *Petriellidium desertorum* v. Arx & Moustafa—Persoonia 7: 371, 1973 ≡ *Pseudallescheria desertorum* (v. Arx & Moustafa) McGinnis et al.—Mycotaxon 14: 98, 1982.

Table 2 Proposed generic and specific names and subsequent synonyms in *Scedosporium* and related genera

Genus name	Epithet	Commonly used synonymous names	Synamorphs/Teleomorph +/–
Lomentospora	*prolificans*	*Scedosporium prolificans, Scedosporium inflatum*	scedosporium-like/–
Lophotrichus	*fimeti*	*Petriellidium fimeti, Pseudallescheria fimeti*	*Scedosporium, 'Graphium'*/+
	macrosporus	–	*Scedosporium*/+
Scedosporium	*apiospermum*	*Pseudallescheria apiosperma*	*Scedosporium, 'Graphium'*/+
	aurantiacum	–	*Scedosporium*/–
	boydii	*Allescheria boydii*, *Petriellidium boydii, Pseudallescheria boydii, Polycytella hominis*	*Scedosporium, 'Graphium'*/+
	dehoogii	–	*Scedosporium*
	minutisporum	*Pseudallescheria minutispora*	*Scedosporium*/+
	desertorum	*Pseudallescheria desertorum*	arthroconidia
Parascedosporium	*putredinis*	*Graphium putredinis, Rhinocladium lesnei, Graphium lesnei, Graphium tectonae*	*'Graphium'*
Petriellopsis	*africana*	*Petriellidium africanum*, *Pseudallescheria africana*	*Scedosporium*
Petriella	*guttulata*	*Microascus guttulatus*	*Scedosporium, 'Graphium'*
	setifera	*Lophotrichus setifera*, *Microascus setifera*	*Scedosporium, 'Graphium'*
	sordida	*Petriella asymmetrica, Melanospora asymmetrica*	*Scedosporium, 'Graphium'*
	musispora	–	scopulariopsis-like

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