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A higher-level phylogenetic classification of the *Fungi*

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ABSTRACT

A comprehensive phylogenetic classification of the kingdom *Fungi* is proposed, with reference to recent molecular phylogenetic analyses, and with input from diverse members of the fungal taxonomic community. The classification includes 195 taxa, down to the level of order, of which 16 are described or validated here: *Dikarya* subkingdom nov.; *Chytridiomycota*, *Neocallimastigomycota* phyla nov.; *Monoblepharidomycetes*, *Neocallimastigomycetes* class. nov.; *Eurotiomycetidae*, *Lecanoromycetidae*, *Mycocaliciomycetidae* subclass. nov.; *Acarosporales*, *Corticiales*, *Baeomycetales*, *Candelariales*, *Gloeophyllales*, *Melanosporales*, *Trechisporales*, *Umbilicariales* ords. nov. The clade containing *Ascomycota* and *Basidiomycota* is classified as subkingdom *Dikarya*, reflecting the putative synapomorphy of dikaryotic hyphae. The most dramatic shifts in the classification relative to previous works concern the groups that have traditionally been included in the *Chytridiomycota* and *Zygomycota*. The *Chytridiomycota* is retained in a restricted sense, with *Blastocladiomycota* and *Neocallimastigomycota* representing segregate phyla of flagellated *Fungi*. Taxa traditionally placed in *Zygomycota* are distributed among *Glomeromycota* and several subphyla *incertae sedis*, including *Mucoromycotina*, *Entomophthoromycotina*, *Kickxellomycotina*, and *Zoopagomycotina*. *Microsporidia* are included in the *Fungi*, but no further subdivision of the group is proposed. Several genera of 'basal' *Fungi* of uncertain position are not placed in any higher taxa, including *Basidiobolus*, *Caulochytrium*, *Olpidium*, and *Rozella*.

Introduction

The molecular revolution in fungal taxonomy commenced in the early 1990s, with analyses of PCR-amplified ribosomal RNA genes (White *et al.* 1990). Today, fungal molecular systematics is a mature discipline in which multi-locus datasets, extensive taxon sampling, and rigorous analytical approaches are standard. To gain an overview of the current state of the science it is only necessary to survey the recent 'Deep Hypha' issue of *Mycologia* [2007 ('2006'); **98**], which contains 21 phylogenetic studies, all of which employ multiple genes to some extent (in some cases, multiple rRNA genes) and that address broad relationships in every major group of *Fungi* (except *Microsporidia*). Another recent milestone is the kingdom-level study of James *et al.* (2006), which used a dataset of six genes (nu-SSU, -LSU, and 5.8S rRNA, *rpb1*, *rpb2* and *tef1*) sampled in nearly 200 species from every major clade of *Fungi* (including *Microsporidia*).

As the broad outlines of fungal phylogeny have come into focus, there have been repeated attempts to summarize the state of knowledge and to restructure higher-level classifications. Two important works that have influenced fungal taxonomy in the 21st century are *Ainsworth & Bisby's Dictionary of the Fungi* (9th edn: Kirk *et al.* 2001), which contains a comprehensive kingdom-wide classification down to the level of genus, and *The Mycota VII* (McLaughlin *et al.* 2001a, 2001b), an edited volume with chapters on all major groups of *Fungi*. These publications represented major advances toward a phylogenetic classification of *Fungi*, but they are already out of date. In the five years since the last edition of the *Dictionary* and the *Mycota VII* appeared, more than 360 articles with the keyword 'phylogen*' were published in *Mycologia* and *Mycological Research* alone, and approximately 80 % of the more than 100 000 fungal rRNA gene sequences now in GenBank were deposited (some by molecular ecologists). Recent publications that survey the entire fungal kingdom based on molecular phylogenies include the chapter by Taylor *et al.* (2004) in *Assembling the Tree of Life* (Cracraft & Donoghue 2004), the 'New Higher Level Classification of Eukaryotes' (Adl *et al.* 2005), and the first large collaborative analysis of the Assembling the Fungal Tree of Life (AFTOL) project (Lutzoni *et al.* 2004). Taxonomic studies on individual groups of *Fungi* are too numerous to list. Two notable highlights include proposals to recognize the phylum *Glomeromycota* (Schüßler *et al.* 2001) and to include the *Microsporidia* within the *Fungi* (Keeling *et al.* 2000).

On-line fungal taxonomies are also proliferating. One of the most important on-line general classifications of *Fungi* is that of GenBank (www.ncbi.nlm.nih.gov/Taxonomy), which serves a diverse community of researchers, including ecologists and molecular biologists. Another highly visible on-line classification is that of the Tree of Life Web Project (tolweb.org/tree), which is widely used by teachers and students. The classification of *Ascomycota* is being updated regularly *via* the on-line Myconet series (www.fieldmuseum.org/myconet), and this has been the basis for recent revisions at GenBank, but there is no comparable on-line resource for other major groups of *Fungi*. It is likely that on-line taxonomies will take on even greater prominence in the future, especially as they become integrated with databases of taxonomic names, particularly Index Fungorum (www.indexfungorum.org), MycoBank (www.mycobank.org), and other global biodiversity informatics resources (e.g. Global Biodiversity Information Facility, www.gbif.org).

Although there is broad agreement regarding the composition of the major clades of *Fungi*, there is considerable variation in the names that have been applied to these groups. For example, the clade that is called *Basidiomycetes* in the latest edition of the *Dictionary* is called *Hymenomycetes* at GenBank. Similarly, the clade that is called *Ascomycetes* in the *Dictionary of the Fungi* is called *Pezizomycotina* in Myconet. Such inconsistencies create confusion, especially for students and non-specialists, and they hamper efforts to develop taxonomic databases.

There is consequently a pressing need for the fungal systematics community to adopt a consensus higher-level classification for the *Fungi* that is based on well-supported monophyletic groups, and which can be recommended for general use. This is an opportune moment to create such a classification. With the new multi-locus analyses, many nodes that were not previously resolved are now supported with confidence. The timing is also good because there are multiple projects in progress that seek to create or update broad classifications of the *Fungi*. In particular, a tenth edition of the *Dictionary* is in preparation, as is a fourth edition of an influential textbook of mycology (Alexopoulos *et al.* 1996). The classifications used by GenBank, the Tree of Life Web Project, and Myconet are being revised continuously. If the classifications employed by these and other major taxonomic resources could be unified, it would promote communication and awareness of fungal phylogeny, and provide a framework for future revisions at all taxonomic levels.

This article presents a higher-level classification for all groups of *Fungi*, with reference to recent molecular phylogenetic studies. The authors represent diverse fungal taxonomy projects, including *Ainsworth & Bisby's Dictionary of the Fungi* (Cannon, Kirk, Stalpers), GenBank (Bischoff), Myconet (Eriksson, Lumbsch, Huhndorf), and Alexopoulos' mycology text (Blackwell, Spatafora). Many of the authors are contributors to the *Fungi* pages in the Tree of Life Web Project. Discussions leading to this classification began in 2004, under the auspices of the AFTOL project and the Deep Hypha Research Coordination Network (Blackwell *et al.* 2007), which were supported by the US National Science Foundation. Throughout the development of this classification, every effort has been made to work in a transparent, consultative manner. The first draft classification was presented at the 2005 Deep Hypha meeting (Tucson, AZ) and subsequently was distributed to a group of 100 fungal systematists for comment. The classification was revised based on comments received and was posted on the AFTOL classification project web site (www.clarku.edu/faculty/dhibbett/AFTOL/AFTOL.htm). Additional modifications were made following the 2006 Deep Hypha meeting (Baton Rouge, LA). For example, the classification of the *Pucciniomycotina* was revised to reflect the classification of Bauer *et al.* (2006). The present paper represents a first attempt at a broad-based consensus classification of the *Fungi*. However, the first 20 authors have exercised editorial control and are therefore to be held accountable for errors.

Structure and principles

This classification is restricted to organisms that belong in the monophyletic kingdom *Fungi*, including sexual and asexual forms. It does not consider other organisms formerly included in the kingdom but which are now known not to belong there, even if still studied by mycologists, such as the oomycetes and slime moulds.

The classification adopted here uses a Linnean hierarchy as modified by the *International Code of Botanical Nomenclature* (*Code*) (McNeill *et al.* 2006), and uses seven ranks, including: order (suffix: *-ales*), subclass (*-mycetidae*), class (*-mycetes*), subphylum (*-mycotina*), phylum (*-mycota;* except *Microsporidia*), subkingdom, and kingdom. The rankings of taxa reflect the preferences and past practices of various authors, as well as the need to keep the nested hierarchies of clades and Linnean categories parallel. Taxa placed at the same rank are not necessarily equivalent in age (except sister taxa), number of species, or degree of morphological divergence.

The classification is limited to taxa down to the level of order. In many orders, especially those representing larger groups, such as *Agaricales*, there is still not enough resolution or taxon sampling to structure a comprehensive family-level classification. The challenge of creating family-level classifications is made even more difficult by the *Code* (McNeill *et al.* 2006), which requires that names of taxa at the rank of family or lower follow the principle of priority (which does not apply to higher ranks). Ideally, construction of consensus classifications within many of the orders recognized here will involve the coordinated efforts of groups of taxonomic specialists. It is hoped that the present classification will facilitate those endeavors.

The taxa included here are all supported as monophyletic by at least one published phylogenetic analysis (not applicable to monotypic taxa), with the exception of the *Lahmiales* and *Triblidiales* (*Pezizomycotina*) and *Asellariales* (*Kickxellomycotina*), for which molecular data are not available. Support for the monophyly of each group is summarized in three tables, which list selected phylogenetic studies, the type of data that were analysed, the number of OTUs sampled, and BS frequencies and Bayesian PPs. No attempt has been made to cite all of the relevant studies for each group. The analyses chosen for inclusion in the tables are those that have the greatest numbers of loci or taxa, and that provide the strongest support for monophyly of the clades in question. To supplement the information in the tables, brief comments on synonyms, phylogenetic relationships, and composition are provided below for some taxa, along with bibliographic citations for all taxon names. However, it is beyond the scope of this article to discuss each taxon in detail. For additional literature on the phylogeny and taxonomy of individual taxa, readers should consult the studies listed in the tables and below, and the references therein.

The classification is also presented as a set of three tree diagrams. Taxa of uncertain position are listed as *incertae sedis*, and have been placed at the least inclusive level in the hierarchy where they can be assigned with confidence. There are several nodes resolved in the tree figures that are not reflected in the classification. These unnamed clades, for which there is strong to moderate support in recent studies, include the *Dacrymycetes* plus *Agaricomycetes* (*Basidiomycota*) (Matheny *et al.* 2006, 2007a), *Saccharomycotina* plus *Pezizomycotina* (*Ascomycota*) (James *et al.* 2006; Spatafora *et al.* 2007), and the inoperculate euascomycetes (*Ascomycota*) (e.g. Lumbsch *et al.* 2002). The inoperculate euascomycetes have been recognized as a superclass, the *Leotiomyceta* (Eriksson & Winka 1997; Lumbsch *et al.* 2002), which is a rank that is not employed here, while the *Dacrymycetes* plus *Agaricomycetes* correspond to the subclass *Hymenomycetidae* of Swann & Taylor (1995). The absence of these groups from the present classification should not be interpreted as a judgment on their monophyly. Rather, it reflects a desire to keep the classification simple, and to minimize the number of intercalary ranks (as per the directives of Art. 4.3 of the *Code*). Future revisions to this classification will have to consider how to incorporate additional deep nodes, including those that will be resolved with the application of genome-scale datasets (Galagan *et al.* 2005; Kuramae *et al.* 2006; Robbertse *et al.* 2006). One possibility is to employ an unranked category (with or without a uniform suffix) that could be inserted at any level in the taxonomic hierarchy (Hibbett & Donoghue 1998). For example, an unranked classification was adopted in part by Adl *et al.* (2005).

Overview of the classification

The classification accepts one kingdom, one subkingdom, seven phyla, ten subphyla, 35 classes, 12 subclasses, and 129 orders. Taxa that are described or validated here include *Chytridiomycota*, *Monoblepharidomycetes*, *Neocallimastigomycota*, *Neocallimastigomycetes*, *Dikarya*, *Acarosporales*, *Baeomycetales*, *Candelariales*, *Umbilicariales*, *Lecanoromycetidae*, *Eurotiomycetidae*, *Mycocaliciomycetidae*, *Melanosporales*, *Corticiales*, *Gloeophyllales*, and *Trechisporales*. Thus, about 90 % of the 195 taxon names employed in the present classification have been validly published previously. The clade containing the *Ascomycota* and *Basidiomycota* is classified as the subkingdom *Dikarya* (as used in James *et al.* 2006), reflecting the putative synapomorphy of dikaryotic hyphae (Tehler 1988). All of the other new names are based on automatically typified teleomorphic names. The classification of *Ascomycota* largely parallels that of the Myconet classification, including recent changes that will be adopted in the forthcoming 2007 'Outline of the Ascomycota'. In *Basidiomycota*, the clades formerly called *Basidiomycetes*, *Urediniomycetes*, and *Ustilaginomycetes* in the last edition of *Ainsworth & Bisby's Dictionary of the Fungi* are called the *Agaricomycotina*, *Pucciniomycotina*, and *Ustilaginomycotina*, respectively, as in Bauer *et al.* (2006). This is done to minimize confusion between taxon names and informal terms (basidiomycetes is a commonly used informal term for all *Basidiomycota*) and to refer to the included genera *Agaricus* (including the cultivated button mushroom) and *Puccinia* (which includes barberry-wheat rust). Another significant change in the *Basidiomycota* classification is the inclusion of the *Wallemiomycetes* and *Entorrhizomycetes* as classes *incertae sedis* within the phylum, reflecting ambiguity about their higher-level placements (Matheny *et al.* 2007b).

The most dramatic changes in the classification concern the 'basal fungal lineages', which include the taxa that have traditionally been placed in the *Zygomycota* and *Chytridiomycota*. These groups have long been recognized to be polyphyletic, based on analyses of rRNA, *tef1*, and *rpb1* (James *et al.* 2000; Nagahama *et al.* 1995; Tanabe *et al.* 2004, 2005). The recent multilocus analyses of James *et al.* (2006) and others now provide the sampling, resolution, and support necessary to structure new classifications of these early-diverging groups, although significant questions remain. The *Chytridiomycota* is retained in a highly restricted sense, including

Chytridiomycetes and *Monoblepharidomycetes*. The *Blastocladiales*, a traditional member of the *Chytridiomycota*, is here treated as a phylum, the *Blastocladiomycota*, as in James *et al.* (2007). The *Neocallimastigales*, whose distinctiveness from other chytrids has long been recognized, is also elevated to phylum, based on both morphology and molecular phylogeny. The genera *Caulochytrium*, *Olpidium*, and *Rozella*, which have traditionally been placed in the *Chytridiomycota*, and *Basidiobolus*, which has been classified in the *Zygomycota* (*Entomophthorales*), are not included in any higher taxa in this classification, pending more definitive resolutions of their placements.

The phylum *Zygomycota* is not accepted in this classification, pending resolution of relationships among the clades that have traditionally been placed in the *Zygomycota* (see discussion under *Mucoromycotina*). The traditional *Zygomycota* are here distributed among the phylum *Glomeromycota* and four subphyla *incertae sedis*, including *Mucoromycotina*, *Kickxellomycotina*, *Zoopagomycotina* and *Entomophthoromycotina*. A clade containing the *Glomeromycota* and the *Dikarya* was resolved previously based on ribosomal RNA genes and was classified as the *Symbiomycota* (Tehler *et al.* 2003). That taxon is not included here, because there was not strong support for the clade in the analyses of James *et al.* (2006) or Liu *et al.* (2006). If the *Symbiomycota* is added to this classification, it will need to be assigned a rank between kingdom and subkingdom, or perhaps be classified as an unranked taxon.

Microsporidia, unicellular parasites of animals and protists with highly reduced mitochondria (Germot *et al.* 1997; Hirt *et al.* 1997; Peyretaillade *et al.* 1998), are included here as a phylum of the *Fungi*, based on analyses by Keeling *et al.* (2000), Gill & Fast (2006), James *et al.* (2006), and Liu *et al.* (2006). The latter study concluded that *Microsporidia* are the sister group of the rest of the *Fungi* and should not be classified as true *Fungi*, but that topology does not conflict with the delimitation of the monophyletic *Fungi* as proposed here. The analysis of James *et al.* (2006) suggested that *Rozella*, which was not sampled by Liu *et al.* (2006), is the sister group of the *Microsporidia*. No subdivision of the *Microsporidia* is proposed, owing to a lack of well-sampled multilocus analyses of this group (but see Vossbrinck & Debrunner-Vossbrinck 2005, for an analysis using SSU rRNA genes).

Phylogenetic classification of *Fungi*

Many of the citations and authorities in the list below were obtained from the Index Fungorum databases (www.indexfungorum.org). A brief list of exemplar genera, including the type for automatically typified names, is given for each order (for small orders, all included genera are listed). A number of the genera listed are used in a modern, restricted sense, and readers are urged to consult the primary literature cited below and in the tables for information about current generic concepts. Comprehensive lists of genera and families included in each order will be forthcoming in the *Dictionary of the Fungi* (10th edn; listing on-line at www.indexfungorum.org) and in the next revision of Myconet (for *Ascomycota*). Further information on the names of fungi (not only kingdom *Fungi*) above the rank of order and their places of publication may be found in the preliminary catalogue compiled by David (2002).

In accordance with the practice in recent editions of the *Code*, all scientific names regardless of rank are placed in italic type here except in the first line of the treatment of each accepted taxon where they are given in bold Roman type to make them stand out. When these names are used by other mycologists in their own publications, we wish to encourage the practice of the use of italics as recommended in the Preface to the current *Code* (McNeill *et al.* 2006).

Kingdom: **Fungi** R. T. Moore, *Bot. Mar.* **23**: 371 (1980).
Synonym: *Fungi* T. L. Jahn & F. F. Jahn, *How to Know the Protozoa*: 7 (1949), *nomen invalidum*. (Table 1, Fig 1)

The concept of the *Fungi* as one of six kingdoms of life was introduced by Jahn & Jahn (1949), and a five kingdom system was advanced by Whittaker (1959), but neither of these works included a Latin diagnosis and the name was therefore invalid under the *Code* until the required Latin was provided by Moore (1980). Although Moore did not make a specific reference to Jahn & Jahn's book, he was well aware that the name was in widespread use in the rank of kingdom. Under the current *Code*, Jahn & Jahn are not to be included in the author citation. However, a proposal to change this provision in the *Code* will be made at the next International Botanical Congress (D. L. Hawksworth, unpubl.). If it is approved, the correct citation would be *Fungi* T. L. Jahn & F. F. Jahn ex R. T. Moore (this rule change would also affect the citations of *Ascomycota* and *Basidiomycota*).

Phylum: **Chytridiomycota** M. J. Powell, **phylum nov.**
MycoBank no.: MB 501278
Synonyms: *Archemycota* Caval.-Sm., *Biol. Rev.* **73**: 246 (1998), *pro parte*.

Thallus monocentricus vel polycentricus vel filamentosus; propagatio asexualis zoosporis, flagello retrorsum inserto, kinetosomate et centriolo supervacaneo praeditis, 9 munimentis flagelli, et complexu "microbody-corpore lipideo" descriptis; propagatio sexualis meiosi post copulationem perfecta; apparatus Golgi e cisternis superimpositis constans; tegumentum nuclei mitosi procedente circum polos fenestratum.

Typus: *Chytridium* A. Braun 1851.

Thallus monocentric, polycentric, or filamentous; asexual reproduction by zoospores with a single posteriorly-directed flagellum, both a kinetosome and non-functional centriole, nine flagellar props, and a microbody-lipid globule complex; sexual reproduction with zygotic meiosis where known; Golgi apparatus with stacked cisternae; nuclear envelope fenestrated at poles during mitosis.

Used as a phylum name without Latin diagnosis or description among others by von Arx (1967) and Margulis *et al.* (1990). Equivalent to euchytrids of James *et al.* 2006, the 'core chytrid clade' of James *et al.* (2007), or the 'core chytrid clade' plus the *Monoblepharidales* of James *et al.* (2000). Earlier usages are not indicated in the author citation of the name, because the circumscription adopted here differs significantly from that of those authors.

Table 1 – Support for major groups of *Fungi* in selected phylogenetic studies: basal fungi and *Dikarya*

Rank	Taxon	Reference	Data[a]	OTUs[b]	Support[c]
Kingdom	*FUNGI*	Keeling (2003)	*α-tub*, *β-tub*	38	MLBS = 98 NJBS = 94
		Baldauf et al. (2000)	*act*, *α-tub*, *β-tub*, *tef1*	12	MLBS = 85 MPBS = 95
Phylum	*CHYTRIDIOMYCOTA*	James et al. (2007)	LSU, SSU, 5.8S	84	BPP ≥ 0.95
		Seif et al. (2005)	mt-genome	5	BPP = 1 MLBS = 100
Class	*Chytridiomycetes*	James et al. (2006)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	8	BPP ≥ 0.95 MLBS ≥ 70
		James et al. (2007)	LSU, SSU, 5.8S	75	BPP ≥ 0.95 MLBS ≥ 70
		Keeling (2003)	*α-tub*, *β-tub*	5	MLBS = 90 NJBS = 95
Order	*Chytridiales*	James et al. (unpublished)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*, *atp6*	9	MLBS = 98
Order	*Rhizophydiales*	James et al. (2006)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	2	BPP ≥ 0.95 MLBS ≥ 70
		Letcher et al. (2006)	LSU, 5.8S	96	MPBS = 100 BPP = 1
Order	*Spizellomycetales*	James et al. (2007)	LSU, SSU, 5.8S	9	MPBS = 100
Class/Order	*Monoblepharidomycetes*, *Monoblepharidales*	James et al. (2007)	LSU, SSU, 5.8S	9	BPP ≥ 0.95 MLBS ≥ 70 MPBS ≥ 70
		Bullerwell et al. (2003)	*cox* 1,2,3; *cob*, *atp*6,9; *nad* 1,2,3,4, 4L,6	4	MLBS = 100
Phylum/Class/Order	*NEOCALLIMASTIGOMYCOTA*, *Neocallimastigomycetes*, *Neocallimastigales*	James et al. (2007)	LSU, SSU, 5.8S	6	BPP ≥ 0.95 MLBS ≥ 70 MPBS ≥ 70
Phylum/Class/Order	*BLASTOCLADIOMYCOTA*, *Blastocladiomycetes*, *Blastocladiales*	James et al. (2007)	LSU, SSU, 5.8S	10	BPP ≥ 0.95
		Liu et al. (2006)	*rpb1*, *rpb2*	3	BPP = 1 MPBS = 100
Phylum	*MICROSPORIDIA*	James et al. (2006)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	2	BPP ≥ 0.95 MLBS ≥ 70
		Keeling (2003)	*α-tub*, *β-tub*	6	MLBS = 100 NJBS = 97
Phylum/Class	*GLOMEROMYCOTA*, *Glomeromycetes*	James et al. (2006)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	5	BPP ≥ 0.95 MLBS ≥ 70
		Schüßler et al. (2001)	SSU	72	NJBS ≥ 90
Order	*Archaeosporales*	Schüßler et al. (2001)	SSU	5	NJBS ≥ 95
Order	*Diversisporales*	Schüßler et al. (2001)	SSU	32	NJBS ≥ 95
Order	*Glomerales*	Schüßler et al. (2001)	SSU	32	NJBS ≥ 95
Order	*Paraglomerales*	Schüßler et al. (2001)	SSU	3	NJBS ≥ 95
	Subphyla incertae sedis (not placed in any phylum)				
Subphylum	*Mucoromycotina*	James et al. (2006)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	11	BPP = 1
		Tanabe et al. (2004)	*rpb1*	4	NJBS = 82
Order	*Mucorales*	James et al. (2006)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	3	BPP ≥ 0.95 MLBS ≥ 70
		Tanabe et al. (2004)	*rpb1*	3	NJBS = 100
		Keeling (2003)	*α-tub*, *β-tub*	4	MLBS = 96 NJBS = 98
		White et al. (2007)	LSU, SSU, 5.8S	28	BPP = 1 MPBS ≥ 70
Order	*Endogonales*	White et al. (2007)	LSU, SSU, 5.8S	2	BPP = 1 MPBS ≥ 70
Order	*Mortierellales*	White et al. (2007)	LSU, SSU, 5.8S	6	BPP = 1 MPBS ≥ 70
Subphylum/Order	*Entomophthoromycotina*, *Entomophthorales*	James et al. (2006)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	2	BPP ≥ 0.95 MLBS ≥ 70
Subphylum/Order	*Zoopagomycotina*, *Zoopagales*	James et al. (2006)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	2	BPP ≥ 0.95 MLBS ≥ 70
		Tanabe et al. (2004)	*rpb1*	3	NJBS = 86
Subphylum	*Kickxellomycotina*	Tanabe et al. (2004)	*rpb1*	6	NJBS = 84
Order	*Kickxellales*	O'Donnell et al. (1998)	SSU	7	MPBS = 100
Order	*Dimargaritales*	Tanabe et al. (2000)	SSU	3	NJBS = 100

Table 1 (*continued*)

Rank	Taxon	Reference	Data[a]	OTUs[b]	Support[c]
Order	*Harpellales*	Tanabe *et al.* (2004)	*rpb1*	3	NJBS = 98
		O'Donnell *et al.* (1998)	SSU	4	MPBS = 100
Order	*Asellariales*	—	—	—	—
Subkingdom	*DIKARYA*	James *et al.* (2006)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	161	BPP = 1 MLBS = 71
		Steenkamp *et al.* (2006)	act, α-*tub*, β-*tub*, *tef1*	10	BPP = 1 MLBS = 84 MPBS = 82 NJBS = 96
		Seif *et al.* (2005)	mt-genome	10	BPP = 1 MLBS = 100
		Liu *et al.* (2006)	*rpb1*, *rpb2*	27	BPP = 1 MPBS = 100

Taxa with only one subsidiary taxon included (i.e. redundant taxa) are listed on a single line, with rank abbreviations divided by a slash (e.g. the class *Agaricostilbomycetes*, which contains a single order, *Agaricostilbales*, is indicated as Class/Order).
a LSU, SSU, and 5.8S refer to nuclear rRNA genes, whereas mt-LSU and mt-SSU refer to mitochondrial rRNA genes, other genes follow standard abbreviations. Some datasets contain missing sequences.
b Indicates the number of OTUs in the specified clade, not the total number of OTUs in the dataset.
c BS, bootstrap %, jk, jackknife %,WP = weighted parsimony, RML = RaxML, PML = PhyML, ME = minimum evolution, BPP, Bayesian posterior probability, NA, not applicable because the group is monotypic, or only a single species was sampled in the reference study.

Class: **Chytridiomycetes** Caval.-Sm., *Biol. Rev.* **73:** 246 (1998).
Synonym: *Archimycetes* A. Fisch. (Fischer 1892) *pro parte* (included *Olpidiopsis*, *Hypochytrium*).
Type: Chytridium A. Braun 1851.

Reproducing asexually by zoospores bearing a single posteriorly-directed flagellum; zoospores containing a kinetosome and a non-flagellated centriole; thallus monocentric or rhizomycelial polycentric; sexual reproduction not oogamous.

Cavalier-Smith (1998) provided a brief, four-word, Latin description that was not diagnostic for phyla of uniflagellate fungi, and has been revised above. The name *Chytridiomycetes* was also used by Serbinow (1907), Cejp (1957), Sparrow (1958), and Alexopoulos *et al.* (1996). For further discussion of the nomenclatural history of the name, see David (2002).

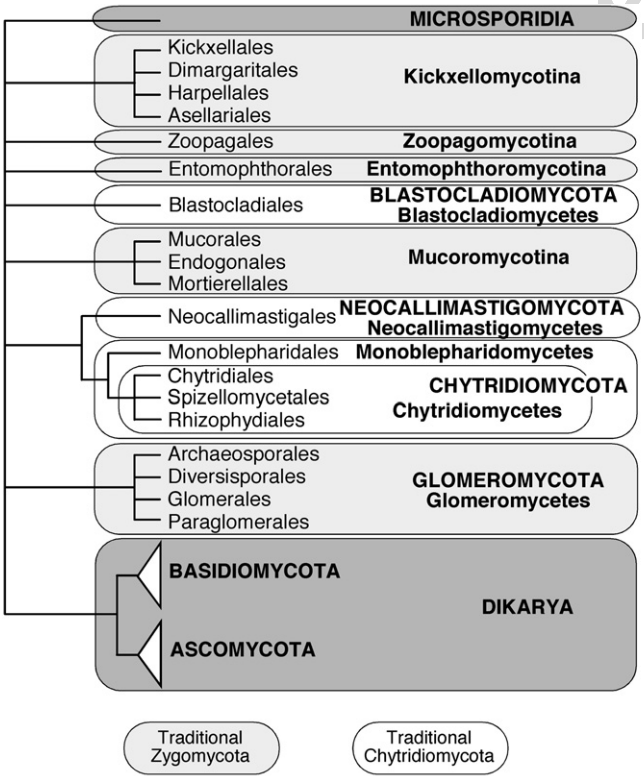

Fig 1 – Phylogeny and classification of *Fungi*. Basal *Fungi* and *Dikarya*. Branch lengths are not proportional to genetic distances. See Table 1 for support values for clades.

Order: **Chytridiales** Cohn, *Jber. schles. Ges. vaterl. Kultur* **57**: 279 (1879).
Emend. Schröter (as 'Chytridineae') *in* Engler & Prantl, *Nat. Pflanzenfam.* **1**: 64 (1892). *Emend.* Barr, *Can. J. Bot.* **58**: 2384 (1980). *Emend.* Letcher & Powell, *Mycol. Res.* **110**: 907 (2006).
Type: Chytridium A. Braun 1851.

Thallus monocentric or polycentric rhizomycelial; zoospores typically with flagellar base containing an electron-opaque plug, microtubules extending from one side of the kinetosome in a parallel array, ribosomes aggregated near the nucleus, kinetosome parallel to non-flagellated centriole and connected to it by fibrous material, nucleus not associated with kinetosome, fenestrated cisterna (rumposome) adjacent to lipid globule.

Exemplar genera: *Chytridium* A. Braun 1851, *Chytriomyces* Karling 1945, *Nowakowskiella* J. Schröt. 1893.

An emmended description is presented above to conform to the circumscription adopted here. Monophyly of this group, as currently delimited, is not certain; *Polychytrium* Ajello 1942 and its allies and *Chytriomyces angularis* Longcore 1992 and its allies may eventually be segregated from *Chytridiales s. str.*

Order: **Rhizophydiales** Letcher, *in* Letcher *et al.*, *Mycol. Res.* **110**: 908 (2006).
Exemplar genera: *Rhizophydium* Schenk 1858, *Kappamyces* Letcher & M.J. Powell 2005, *Terramyces* Letcher 2006,

Boothiomyces Letcher 2006; *Batrachochytrium* Longcore, Pessier & D.K. Nichols 1999 is on a long branch in this clade with no near relatives.

Order: **Spizellomycetales** D. J. S. Barr, *Can. J. Bot.* **58**: 2384 (1980).
Exemplar genera: *Spizellomyces* D. J. S. Barr 1980, *Powellomyces* Longcore, D. J. S. Barr & Désauln. 1995, *Kochiomyces* D. J. S. Barr 1980.

This classification does not include *Caulochytrium*, *Olpidium*, *Rozella*, or the *Rhizophlyctis rosea* clade, which are considered *incertae sedis*.

Class: **Monoblepharidomycetes** J. H. Schaffn., *Ohio Nat.* **9**: 449 (1909), as '*Monoblepharideae*'.
Type: *Monoblepharis* Cornu 1871.

Thallus filamentous, either extensive or a simple unbranched thallus, often with a basal holdfast; asexual reproduction by zoospores or autospores; zoospores containing a kinetosome parallel to a non-flagellated centriole, a striated disk partially extending around the kinetosome, microtubules radiating anteriorly from the striated disk, a ribosomal aggregation, and rumposome (fenestrated cisterna) adjacent to a microbody; sexual reproduction oogamous by means of posteriorly uniflagellate antherozoids borne in antheridia and nonflagellate female gametes borne in oogonia.

Schaffner (1909) used the name '*Monoblepharideae*' as a class but with the ending of a suborder; this must be changed without change of authorship or date of publication (*Code*, Art. 16.3).

Order: **Monoblepharidales** J. Schröt., *in* Engler & Prantl, *Nat. Pflanzenfam.* **1**: 106 (1893), as '*Monoblepharidineae*'.
Emend. Sparrow, *Aquatic Phycomycetes*: 458 (1943).
Emended description as for *Monoblepharidomycetes*.
Exemplar genera: *Monoblepharis* Cornu 1871, *Harpochytrium* Lagerh. 1890, *Oedogoniomyces* Tak. Kobay. & M. Ôkubo 1954.

Phylum: **Neocallimastigomycota** M. J. Powell, **phylum nov**.
MycoBank no.: MB 501279

Thallus monocentricus vel polycentricus; fungi anaerobici, intra tractum digestivum animalium herbivororum vel fortasse in substratis anaerobicis terrestribus vel limnicis; mitochondriis carentes sed hydrogenosomatibus praediti; zoosporae retrorsum uni- vel multiflagellatae, kinetosoma praesens sed centriolum supervacaneum absens; complexus kinetosomati affixus e radio marginali et annulo circumflagellari compositus; microtubuli e radio entendentes circum nucleum radiantes et flabellum posterius formantes; munimenta flagelli absentia; tegumentum nuclei mitosi procedente integrum remanens.
Typus: *Neocallimastix* Vavra & Joyon ex I. B. Heath 1983.

Thallus monocentric or polycentric; anaerobic, found in digestive system of larger herbivorous mammals and possibly in other terrestrial and aquatic anaerobic environments; lacks mitochondria but contains hydrogenosomes of mitochondrial origin; zoospores posteriorly unflagellate or polyflagellate, kinetosome present but non-functional centriole absent, kinetosome-associated complex composed of a skirt, strut, spur and circumflagellar ring, microtubules extend from spur and radiate around nucleus, forming a posterior fan, flagellar props absent; nuclear envelope remains intact throughout mitosis.

Class: **Neocallimastigomycetes** M. J. Powell, **class. nov**.
MycoBank no.: MB 501280
Diagnosis latina ut in *Neocallimastigomycota* (vide supra).
Typus: *Neocallimastix* Vavra & Joyon ex I.B. Heath 1983.

Order: **Neocallimastigales** J. L. Li, I. B. Heath & L. Packer, *Can. J. Bot.* **71**: 403 (1993).
Exemplar genera: *Neocallimastix* Vavra & Joyon ex I.B. Heath 1983, *Caecomyces* J.J. Gold 1988, *Orpinomyces* D.J.S. Barr, H. Kudo, Jakober & K.J. Cheng 1989.

Phylum: **Blastocladiomycota** T. Y. James, *Mycologia* **98**: 867 (2007) ['2006'].
Synonym: *Allomycota* Caval.-Sm., *BioSystems* 14: 465 (1981).

This phylum was proposed to reflect phylogenetic information from a number of molecular studies (James *et al.* 2007; Liu *et al.* 2006).

Class: **Blastocladiomycetes** T. Y. James, *Mycologia* **98**: 868 (2007) ['2006'].
Synonym: *Allomycetes* Caval.-Sm., *Biol. Rev.* **73**: 246 (1998), based on *Allomyces* E. J. Butler 1911.

Cavalier-Smith provided a brief, five-word Latin description for *Allomycetes* that is not diagnostic from other uniflagellate fungi. The name *Allomycetes* was not taken up, because it is appropriate to have a class name based on the same genus as an included ordinal name, and because Cavalier-Smith's 'diagnosis' was vague.

Order: **Blastocladiales** 1910, H. E. Petersen, *Bot. Tidsskr.* **29**: 357 (1909) ('Blastocladiineae').
Exemplar genera: *Allomyces* E. J. Butler 1911, *Blastocladia* Reinsch 1877, *Coelomomyces* Keilin. 1921.

Phylum: **Microsporidia** Balbiani, *C. R. Acad. Sci. Paris* **95**: 1168 (1882).

The nomenclatural status of *Microsporidia* is ambiguous. It has been treated as a phylum under the zoological *Code* (International Commission on Zoological Nomenclature 1999), but there is disagreement about the correct author citation (Larsson 2000; Sprague & Becnel 1998), and it is uncertain if the name would be valid under the botanical *Code*. This uncertainty arises as *Microsporidium* Balbiani 1884 appears to be a later synonym of *Nosema* Naegeli 1857. The present work follows the recommendation of Sprague & Becnel (1998) in attributing *Microsporidia* to Balbiani (1882), but this must be regarded as provisional. Before the status of the *Microsporidia* can be resolved, it will be necessary to decide whether the nomenclature of the group as a whole should be governed by the zoological or the botanical *Code* although the latter now allows names of fungi described under the zoological *Code* to be accepted. The final decision will require input from the community of scientists who study *Microsporidia*.

No subdivision of the group is proposed here, owing to the lack of well-sampled multi-gene phylogenies within the group. However, Vossbrinck & Debrunner-Vossbrinck (2005) proposed a class-level classification of microsporidia, based on small-subunit rRNA gene sequences.

Phylum: **Glomeromycota** C. Walker & A. Schuessler, *in* Schüßler *et al.*, *Mycol. Res.* **105**: 1416 (2001).

Class: **Glomeromycetes** Caval.-Sm., *Biol. Rev.* **73**: 246 (1998), as '*Glomomycetes*'.
Synonym: *Geomycetes* Caval.-Sm., *Biol. Rev.* **73: 247** (1998).

Order: **Archaeosporales** C. Walker & A. Schuessler, *in* Schüßler *et al.*, *Mycol. Res.* **105**: 1418 (2001).
Synonym: *Geosiphonales* Caval.-Sm., *Biol. Rev.* **73**: **247** (1998).
Exemplar genera: *Archaeospora* J.B. Morton & D. Redecker 2001, *Geosiphon* F. Wettst. 1915.

Order: **Diversisporales** C. Walker & A. Schuessler, *Mycol. Res.* **108**: 981 (2004).
Exemplar genera: *Acaulospora* Gerd. & Trappe 1974, *Diversispora* C. Walker & A. Schüßler 2004, *Gigaspora* Gerd. & Trappe 1974, *Pacispora* Oehl & Sieverd. 2004.

Order: **Glomerales** J. B. Morton & Benny, *Mycotaxon* **37**: 473 (1990), as '*Glomales*'.
Exemplar genus: *Glomus* Tul. & C. Tul. 1845.

Order: **Paraglomerales** C. Walker & A. Schuessler, *in* Schüßler *et al.*, *Mycol. Res.* **105**: 1418 (2001).
Exemplar genus: *Paraglomus* J. B. Morton & D. Redecker 2001.

***Subphyla* incertae sedis (*not assigned to any phylum*):**

Subphylum: **Mucoromycotina** Benny, **subphylum nov**.
MycoBank no.: MB 501281

Fungi saprotrophici vel raro mycoparasiti facultativi, gallas facientes, haustoriis carentes, raro ectomycorrhizam facientes. Mycelium ramosum, juvene coenocyticum, maturum aliquando septis microporosis divisum. Reproductio asexualis sporangiis vel sporangiolis vel merosporangiis, raro chlamydosporis vel arthrosporis vel blastosporis effecta. Reproductio sexualis zygosporis plus minusve globosis e suspensoribus oppositis vel appositis formatis effecta.
Typus: *Mucor* Fresen. 1850.

Fungi saprobes, or rarely gall-forming, nonhaustorial, facultative mycoparasites, or forming ectomycorrhiza. Mycelium branched, coenocytic when young, sometimes producing septa that contain micropores at maturity. Asexual reproduction by sporangia, sporangiola, or merosporangia, or rarely by chlamydospores, arthrospores, or blastospores. Sexual reproduction by more or less globose zygospores formed on opposed or apposed suspensors.

This group includes the *Mucorales*, which is the core group of the traditional *Zygomycota*. Monophyly of the traditional *Zygomycota* (including *Mucorales*, *Glomerales*, *Entomophthorales* and *Harpellales*) was suggested by a recent study by Liu *et al.* (2006) using *rpb1* and *rpb2*, but that finding conflicts with results of analyses that included additional loci and taxa, which suggested that the traditional *Zygomycota* is polyphyletic (James *et al.* 2006).

The name *Zygomycota* was first published without a Latin diagnosis by Moreau (1954) and is therefore invalid. At present, this classification does not include *Zygomycota*. When relationships among basal fungal lineages are more clearly resolved, it may be appropriate to resurrect and validate *Zygomycota*, to include *Mucoromycotina* and perhaps other clades.

Order: **Mucorales** Fr., *Syst. Mycol.* **3** (2): 296 (1832).
Exemplar genera: *Mucor* Fresen. 1850 (*pro parte*), *Parasitella* Bainier 1903, *Phycomyces* Kunze 1823, *Pilobolus* Tode 1784, *Rhizopus* Ehrenb. 1821.

Order: **Endogonales** Moreau ex R. K. Benj., *in* Kendrick (ed.), *Whole Fungus* **2**: 599 (1979).
Emend.: Morton & Benny, *Mycotaxon* **37**: 473 (1990).
Synonym: *Endogonales* Moreau, *Encycl. Mycol.* **23**: 1231 (1954), *nomen invalidum*.
Exemplar genera: *Endogone* Link 1809, *Peridiospora* C. G. Wu & S. J. Lin 1997, *Sclerogone* Warcup 1990, *Youngiomyces* Y. J. Yao 1995.

Order: **Mortierellales** Caval.-Sm., *Biol. Rev.* **73**: 246 (1998).
Exemplar genera: *Mortierella* Coem. 1863, *Dissophora* Thaxt. 1914, *Modicella* Kanouse 1936.

Subphylum: **Entomophthoromycotina** Humber, **subphylum nov.**
MycoBank no.: MB 501282

Fungi pathogenici obligate animalibus (praecipue invertebratis) vel plantis cryptogamicis vel saprotrophici, interdum in animalibus vertebratis parasitici. Status somaticus mycelium coenocyticum vel septatum, pariete circumdatum vel protoplasticum, in hospite culturisve saepe corpora hyphalia multinucleata formans; forma protoplastica hyphoidea vel amoeboidea forma variabilis; cystidia et rhizoidea in aliquot speciebus athropodicolis formata. Characteres nuclei, sicut magnitudo, nucleoli magnitudo et locus, praesentia aut absentia heterochromatini intermitotici, familiis distinguendis iuvant. Conidiophora simplicia ramosave. Sporae primariae conidia vera, uninucleatae vel plurinucleatae vel multinucleatae, variis modis vi propulsae vel passive liberatae, conidia secundaria persaepe formata. Sporae perdurantes crassituncatae, bistratosae velut zygosporae post conjugationem velut azygosporae singulae formatae.
Typus: *Entomophthora* Fresen. 1856.

Obligate pathogens of animals (primarily arthropods), cryptogamic plants, or saprobes; occasionally facultative parasites of vertebrates. Somatic state consisting of a well-defined mycelium, coenocytic or septate, walled or protoplastic, which may fragment to form multinucleate hyphal bodies; protoplasts either hyphoid or amoeboid and changeable in shape; cystidia or rhizoids formed by some taxa. Such nuclear characters as overall size, location and comparative size of nucleoli, presence or absence of granular heterochromatin in chemically unfixed interphasic nuclei, and mitotic patterns are important at the family level. Conidiophores branched or unbranched. Primary spores true conidia, uni-, pluri-, or multinucleate, forcibly discharged by diverse possible means or passively dispersed; secondary conidia often produced. Resting spores with thick bi-layered walls form as zygospores after conjugations of undifferentiated gametangia from different or the same hyphal bodies or hypha or as azygospores arising without prior gametangial conjugations.

Order: **Entomophthorales** G. Winter, *Rabenh. Krypt.-Fl.* **1**: 74 (1880).

Exemplar genera: *Entomophthora* Fresen. 1856, *Ballocephala* Drechsler 1951, *Conidiobolus* Bref. 1884, *Entomophaga* Batko 1964, *Neozygites* Witlaczil 1885.

Subphylum: **Zoopagomycotina** Benny, **subphylum nov.**
MycoBank no.: MB 501283

Fungi endo- vel ectoparasitici microanimalium vel fungorum. Corpus vegetativum ex thallo simplici ramoso vel nonramoso vel mycelio nonseptato plus minusve extense ramoso constans. Ectoparasitae haustoria intra hospitem formantes. Reproductio asexualis arthrosporis, chlamydosporis vel sporangiolis uni- vel multisporis perfecta; sporangiosporae sporangiolorum multispororum in catenenis (merosporangiis) simplicibus vel ramosis dispositae. Reproductio sexualis zygosporis paene globosis perficitur; hyphae sexuales hyphis vegetativis similes vel plus minusve ampliatae.

Typus: *Zoopage* Drechsler 1935.

Endo- or ectoparasites of microanimals and fungi. Vegetative body consisting of a simple, branched or unbranched thallus or more of less extensively branched mycelium. Ectoparasites forming haustoria inside the host. Asexual reproduction by arthrospores, chlamydospores or uni- or multispored sporangiola; sporangiospores of multispored sporangiola formed in simple or branched chains (merosporangia). Sexual reproduction by nearly globose zygospores; sexual hyphae similar to the vegetative hyphae or more or less enlarged.

The description of this group is based mostly on the validating description for the *Zoopagales* by Benjamin (1979), except that arthrospores have been added, based on Barron's (1975) report of arthrospores in *Helicocephalum* Thaxt. 1891.

Order: **Zoopagales** Bessey ex R.K. Benj., *in* Kendrick (ed.), *Whole Fungus* **2**: 590 (1979).

Synonym: *Zoopagales* Bessey, *Morph. Tax. Fungi* : 177 (1950), *nomen invalidum*.

Exemplar genera: *Cochlonema* Drechsler 1935, *Rhopalomyces* Corda 1839, *Piptocephalis* de Bary 1865, *Sigmoideomyces* Thaxt. 1891, *Syncephalis* Tiegh. & G. Le Monn. 1873, *Zoopage* Drechsler 1935.

Subphylum: **Kickxellomycotina** Benny, **subphylum nov**.
MycoBank no.: MB 501284

Fungi saprotrophici vel mycoparasitici vel obligate symbiotici. Thallus in nonnullis generibus e tenaculo fungos alios parasitans et haustoriis penetrans; mycelium septatum, ramosum vel simplex; septa in medio excavata et obturata. Reproductio asexualis merosporangiis uni- vel bisporis vel trichosporis vel arthrosporis effecta. Reproductio sexualis zygosporis globosis, biconicis vel allantoideis circinatis effecta.

Typus: *Kickxella* Coem. 1862.

Fungi saprobes, mycoparasites, or obligate symbionts. Thallus arising from a holdfast on other fungi as a haustorial parasite, or branched, septate, subaerial hyphae. Mycelium branched or unbranched, regularly septate. Septa with median, disciform cavities containing plugs. Asexual production by 1- or 2-spored merosporangia, trichospores, or arthrospores. Sexual reproduction by zygospores that are globose, biconical, or allantoid and coiled.

Order: **Kickxellales** Kreisel ex R. K. Benj., *in* Kendrick (ed.), *Whole Fungus* 2: 610 (1979).

Synonym: *Kickxellales* Kreisel, *Grundz. nat. Syst. Pilze*: 65 (1969), *nomen invalidum*.

Exemplar genera: *Kickxella* Coem. 1862, *Coemansia* Tiegh. & G. Le Monn. 1873, *Linderina* Raper & Fennell 1952, *Spirodactylon* R. K. Benj. 1959.

Order: **Dimargaritales** R. K. Benj., *in* Kendrick (ed.), *Whole Fungus* **2**: 607 (1979).

Exemplar genera: *Dimargaris* Tiegh. 1875, *Dispira* Tiegh. 1875, *Tieghemiomyces* R. K. Benj. 1959.

Order: **Harpellales** Lichtw. & Manier, *Mycotaxon* **7**: 441 (1978).

The taxa in this order have been referred to as '*Trichomycetes*'. However, *Trichomycetes* is no longer a useful phylogenetic taxon because it describes a polyphyletic group. The use of the term should be restricted to ecological rather than phylogenetic groupings, and not capitalized or italicized, i.e. as 'trichomycetes'.

Exemplar genera: *Harpella* L. Léger & Duboscq 1929, *Furculomyces* Lichtw. & M. C. Williams 1992, *Legeriomyces* Pouzar 1972, *Smittium* R. Poiss. 1937.

Order: **Asellariales** Manier ex Manier & Lichtw., *Mycotaxon* **7**: 442 (1978).

Exemplar genera: *Asellaria* R. Poiss. 1932, *Orchesellaria* Manier ex Manier & Lichtw. 1968.

Asellariales are retained in the *Fungi* here due to their ultrastructural characteristics (Benny & White 2001; Manier 1973; Moss 1975; Saikawa *et al.* 1997). Unpublished *rpb1* and *rpb2* data also support their placement in the *Kickxellomycotina* (T. Y. James & M. M. White, unpubl.).

Subkingdom: **Dikarya** Hibbett, T. Y. James & Vilgalys, **subregnum nov**.

MycoBank no.: MB 501285

Synonyms: *Neomycota* Caval.-Sm., *Rev. Biol.* **73**: 209 (1998).

Carpomycetaceae Bessey, Univ. Studies, Univ. Nebr. **7**: 294 (1907).

Fungi unicellulares vel filamentosi, flagellis carentes, saepe stadium dikaryoticum includentes. *Ascomycota* et *Basidiomycota* complectens.

Unicellular or filamentous *Fungi*, lacking flagella, often with a dikaryotic state. The least-inclusive clade that contains *Ascomycota* and *Basidiomycota*.

The name alludes to the putative synapomorphy of dikaryotic hyphae (Tehler 1988) and was applied by James *et al.* (2006) without formal description. Kendrick (1985) and Tehler *et al.* (2003) referred to this group as the *Dikaryomycota*, but the termination '*–mycota*' denotes the rank of phylum under the *Code*. Cavalier-Smith (1998) referred to this group as *Neomycota*. *Dikarya* is used here, because it is more descriptive and is consistent with recent use (James *et al.* 2006; Tehler *et al.* 2003; Kendrick 1985).

Phylum: **Ascomycota** Caval.-Sm., *Biol. Rev.* 73: 247 (1998), as '*Ascomycota* Berk. 1857. stat. nov.'

Synonyms: *Ascomycetes* Berk., *Intr. Crypt. Bot.*: 270 (1857), rank uncertain; Whittaker (1959: 220).

Ascomycota Bold, *Morph. Pl.*: 7, 180 (1958), *nomen invalidum*; Hawksworth *et al.* (1995: 30), Eriksson & Winka (1997: 4), etc, *nomina nuda*.

Basic type: *Peziza* Fr. 1822.

(Table 2, Fig 2) Cavalier-Smith was not the first to propose the phylum name *Ascomycota*. It appears to have been used first by Bold (1957: 7, 180), but without a Latin diagnosis. The name was in widespread use before its validation by Cavalier-Smith, and its usage was popularized by its employment in the eighth edition of the *Dictionary*, which is listed in Cavalier-Smith's (1998) bibliography. The Latin diagnosis provided by Cavalier-Smith consisted of only two words: 'sporae intracellulares'. It is questionable whether this description is diagnostic for the *Ascomycota*, but as a validating diagnosis it is acceptable under the *Code*. No detailed reference to the basionym was given, but is provided here. We also propose a basic type, *Peziza*, as we can not be sure that the phylum will not be split in the future when more molecular data and material of ascomycetes and basidiomycetes have been sequenced. Hawksworth *et al.* (1995) and Eriksson & Winka (1997: 4) used the phylum names *Ascomycota* and *Basidiomycota*; the latter authors listed 31 nucleotide signatures in the nSSU rDNA genes in *Basidiomycota*. Since then many more sequences have become available, also from many other genes that support monophyly of *Ascomycota* and *Basidiomycota*.

The subdivision of *Ascomycota* used in the present paper is based on the system of Eriksson & Winka (1997), which differs in many respects from that of Cavalier-Smith (1998).

Subphylum: **Taphrinomycotina** O. E. Erikss. & Winka, *Myconet* **1**: 11 (1997).

Class: **Taphrinomycetes** O. E. Erikss. & Winka, *Myconet* **1**: 11 (1997).

Order: **Taphrinales** Gäum. & C. W. Dodge, *Comp. morph. fun.*: 159 (1928).

Exemplar genera: *Taphrina* Fr. 1815, *Protomyces* Unger 1832.

Class: **Neolectomycetes** O. E. Erikss. & Winka, *Myconet* **1**: 8 (1997).

Order: **Neolectales** Landvik, O. E. Erikss, Gargas & P. Gustafss., *Syst. Ascom.* **11**: 114 (1993).

Exemplar genus: *Neolecta* Speg. 1881.

Class: **Pneumocystidomycetes** O. E. Erikss. & Winka, *Myconet* **1**: 9 (1997).

Order: **Pneumocystidales** O. E. Erikss., *Syst. Ascom.* **13**: 170 (1994).

Exemplar genus: *Pneumocystis* P. Delanoë & Delanoë 1912.

Class: **Schizosaccharomycetes** O. E. Erikss. & Winka, *Myconet* **1**: 10 (1997).

Order: **Schizosaccharomycetales** O. E. Erikss., Svedskog & Landvik, *Syst. Ascom.* **11**: 146 (1993).

Exemplar genus: *Schizosaccharomyces* Linder 1893.

Subphylum: **Saccharomycotina** O. E. Erikss. & Winka, *Myconet* **1**: 10 (1997).

Class: **Saccharomycetes** O. E. Erikss. & Winka, *Myconet* **1**: 10 (1997).

Order: **Saccharomycetales** Kudryavtsev, *System Hefen*: 270 (1960).

Growth usually by individual yeast cells, often accompanied by pseudohyphae and/or true hyphae. Cell walls predominately of β-glucan. Ascomata not formed; one to many ascospores formed in asci that often are converted from individual cells or borne on simple ascophores. Mitotic and meiotic nuclear divisions within an intact nuclear membrane. Enveloping membrane system in ascospore delimitation associated independently with postmeiotic nuclei. Asexual reproduction by holoblastic budding, conidia or fission (arthrospores).

Exemplar genera: *Saccharomyces* Meyen ex E. C. Hansen 1838, *Candida* Berkhout 1923, *Dipodascopsis* L. R. Batra & Millner 1978, *Metschnikowia* T. Kamieński 1899.

Subphylum: **Pezizomycotina** O. E. Erikss. & Winka, *Myconet* **1**: 9 (1997).

Class: **Arthoniomycetes** O. E. Erikss. & Winka, *Myconet* **1**: 4 (1997).

Order: **Arthoniales** Henssen & Jahns ex D. Hawksw. & O. E. Erikss, *Syst. Ascom.* **5**: 177 (1986).

Synonym: *Arthoniales* Henssen & Jahns, *Lichenes*: 123 (1973) ['1974'], *nomen invalidum*.

Hawkworth & Eriksson (*loc. cit.*) listed only Henssen, but cited the book by Henssen & Jahns (*loc. cit.*) as place for the original but invalid description so both should be cited although Henssen contributed the taxonomic system to the book.

Exemplar genera: *Arthonia* Ach. 1806, *Chrysothrix* Mont. 1852, *Dirina* Fr. 1825, *Roccella* DC. 1805.

Class: **Dothideomycetes** O. E. Erikss. & Winka, *Myconet* **1**: 5 (1997).

Table 2 – Support for major groups of *Fungi* in selected phylogenetic studies: *Ascomycota*

Rank	Taxon	Reference	Data	OTUs	Support
Phylum	ASCOMYCOTA	James *et al.* (2006, fig. 1)	SSU, LSU, 5.8S, *rpb1*, *rpb2*, *tef1*	111	MLBS = 94 BPP = 1
		Spatafora *et al.* (2007, fig. 2)	LSU, SSU, *rpb1*, *rpb2*, *tef1*	177	WPBS =< 50 MLBS = 100 BPP = 1
		Lutzoni *et al.* (2004, fig. 2)	LSU, SSU	276	NJBS = 67 BPP = 1
Subphylum	*Taphrinomycotina*	James *et al.* (2006, fig. 2)	SSU, LSU, 5.8S, *rpb1*, *rpb2*, *tef1*	4	MLBS = 98 BPP = 1
		Spatafora *et al.* (2007, fig. 2)	LSU, SSU, *rpb1*, *rpb2*, *tef1*	8	WPBS =< 50 MLBS = 98 BPP = 1
		Liu *et al.* (2006, fig. 3)	*rpb1*, *rpb2*	3	BPP = 1
		Sugiyama *et al.* (2007, fig. 2)	LSU, SSU *rpb2*, β-*tub*	11	BPP = 1
		Kurtzman & Sugiyama (2001, fig. 7)	SSU	8	NJBS = 54
Class/Order	*Taphrinomycetes*, *Taphrinales*	Sugiyama *et al.* (2007, fig. 2)	LSU, SSU *rpb2*, β-*tub*	6	BPP = 1
		Kurtzman & Sugiyama (2001, fig. 7)	SSU	4	NJBS = 100
		Nishida & Sugiyama (1994, fig. 1)	SSU	5	NJBS = 100
Class/Order	*Neolectomycetes*, *Neolectales*	Lutzoni *et al.* (2004, fig. 2)	LSU, SSU	1	NA
		Sugiyama *et al.* (2007, fig. 2)	LSU, SSU, β-*tub*, *rpb2*	2	BPP = 1
		Landvik *et al.* (2001, fig. 1)	β-*tub*	2	MPBS = 100
Class/Order	*Pneumocystidomycetes*, *Pneumocystidales*	Sugiyama *et al.* (2007, fig. 2)	LSU, SSU, β-*tub*, *rpb2*	1	NA
		Lutzoni *et al.* (2004, fig. 2)	LSU, SSU	1	NA
Class/Order	*Schizosaccharomycetes*, *Schizosaccharomycetales*	Sugiyama *et al.* (2007, fig. 2)	SSU, LSU, *rpb2*, β-*tub*	1	NA
		Lutzoni *et al.* (2004, fig. 2)	LSU, SSU	2	BPP = 1.0 NJBS = 100
	Taphrinomycotina incertae sedis (not placed in any subphylum)				
Genus	*Saitoella*	Sugiyama *et al.* (2007, fig. 2)	SSU, LSU, *rpb2*, β-*tub*	1	NA
		Nishida & Sugiyama (1994, fig. 1)	SSU	1	NA
Subphylum/Class/Order	*Saccharomycotina*, *Saccharomycetes*, *Saccharomycetales*	Spatafora *et al.* (2007, fig. 2)	LSU, SSU, *rpb1*, *rpb2*, *tef1*	12	WPBS = 55 MLBS = 100 BPP = 1
		Suh *et al.* (2007, fig. 2)	LSU, SSU	87	MPBS = 99 BPP = 1
Subphylum	*Pezizomycotina*	James *et al.* (2006, fig. 1)	SSU, LSU, 5.8S, *rpb1*, *rpb2*, *tef1*	46	BPP = 1 MLBS = 94
		Robbertse *et al.* (2006, figs. 4,5,6)	Genomes	11	MPBS = 94-100 NJBS = 100 MLBS = 100
		Spatafora *et al.* (2007, fig. 2)	LSU, SSU, *rpb1*, *rpb2*, *tef1*	157	WPBS = 100 MLBS = 97 BPP = 1
Class/Order	*Arthoniomycetes*, *Arthoniales*	Spatafora *et al.* (2007, fig. 2)	LSU, SSU, *rpb1*, *rpb2*, *tef1*	4	WPBS = 100 MLBS = 100 BPP = 1
		Lumbsch *et al.* (2005, fig. 1)	LSU, SSU, mt-SSU, mt-LSU	6	MPBS = 100 BPP = 1.0
Class	*Dothideomycetes*	Schoch *et al.* (2007, fig.1)	LSU, SSU, *rpb2*, *tef1*	96	BPP = 1 MPBS < 50 MLBS = 70
		Spatafora *et al.* (2007, fig. 2)	LSU, SSU, *rpb1*, *rpb2*, *tef1*	17	WPBS < 50 MLBS = 84 BPP = 1
		Kruys *et al.* (2006, fig. 1)	LSU, SSU, mt-SSU	51	BPP > 0.95 MPBS < 50
Subclass	*Dothideomycetidae*	Schoch *et al.* (2007, fig. 1)	LSU, SSU, *rpb2*, *tef1*	26	BPP = 1 MPBS > 50 MLBS > 0.7

Table 2 (*continued*)

Rank	Taxon	Reference	Data	OTUs	Support
		Kruys *et al.* (2006, fig. 1)	LSU, SSU, mt-SSU	11	BPP > 0.95 MPBS < 50
Order	*Capnodiales*	Schoch *et al.* (2007, fig. 1)	LSU, SSU, *rpb2*, *tef1*	11	BPP = 1 MPBS > 70 MLBS > 70
Order	*Dothideales*	Schoch *et al.* (2007, fig. 1)	LSU, SSU, *rpb2*, *tef1*	9	BPP = 1 MPBS > 70 MLBS > 70
		Kruys *et al.* (2006, fig. 1)	LSU, SSU, mt-SSU	4	BPP > 0.95 MPBS = 100
		Lindemuth *et al.* (2001)	LSU, SSU	6	MLBS = 91 NJBS = 100
Order	*Myriangiales*	Schoch *et al.* (2007, fig. 1)	LSU, SSU, *rpb2*, *tef1*	5	BPP = 1 MPBS > 70 MLBS > 70
Subclass/Order	*Pleosporomycetidae*, *Pleosporales*	Schoch *et al.* (2007, fig. 1)	LSU, SSU, *rpb2*, *tef1*	48	BPP = 1 MPBS > 70 MLBS > 70
		Kruys *et al.* (2006, fig. 1)	LSU, SSU, mt-SSU	35	BPP = 1 MPBS = 100
	Dothideomycetes incertae sedis (not placed in any subclass)				
Order	*Botryosphaeriales*	Schoch *et al.* (2007, fig. 1)	LSU, SSU, *rpb2*, *tef1*	8	BPP = 1 MPBS > 70 MLBS > 70
Order	*Hysteriales*	Schoch *et al.* (2007, fig. 1)	LSU, SSU, *rpb2*, *tef1*	3	BPP = 1 MPBS > 70 MLBS > 70
Order	*Patellariales*	Pang *et al.* (2002, fig. 26)	SSU	1	NA
		Inderbitzin *et al.* (2001, fig. 18)	SSU	1	NA
Order	*Jahnulales*	Pang *et al.* (2002, fig. 26)	SSU	6	MPBS = 100
Class	*Eurotiomycetes*	Spatafora *et al.* (2007, fig. 2)	LSU, SSU, *rpb1*, *rpb2*, *tef1*	11	WPBS = 89 MLBS = 84 BPP = 1
		Geiser *et al.* (2007, fig. 1)	SSU, LSU, *rpb1*, *rpb2*, *tef*	49	BPP = 1 MPBS = 100 WPBS = 100 MLBS = 100
		Ekman & Tønsberg (2002, fig. 1)	SSU	13	BPP = 0.99
		Del Prado *et al.* (2006, fig. 1)	LSU, mt-SSU	15	BPP = 1
		Lumbsch *et al.* (2005, fig. 1)	LSU, SSU, mt-SSU, mt-LSU	11	BPP > 0.95 MPBS > 70
		Lutzoni *et al.* (2004, fig. 5)	LSU, SSU, mt-SSU, *rpb2*	8	BPP = 1 BBS = 61
		Reeb *et al.* (2004, fig. 1)	SSU, LSU, *rpb2*	7	BPP = 1 BBS = 89
Subclass	*Chaetothyriomycetidae*	Reeb *et al.* (2004, fig. 1)	SSU, LSU, *rpb2*	5	BPP = 1 BBS = 100 MLBS = 100
		Lutzoni *et al.* (2004, fig. 5)	LSU, SSU, mt-SSUSSU, *rpb2*	5	BPP = 1 BBS = 100 NJBS = 99 MPBS = 98
		Del Prado *et al.* (2006, fig. 1)	LSU, mt-SSU	11	BPP = 1
		Spatafora *et al.* (2007, fig. 1)	SSU, LSU, *rpb1*, *rpb2*, *tef*	6	BPP = 1 MLBS = 100 WPBS > 70
		Geiser *et al.* (2007, fig. 1)	SSU, LSU, *rpb1*, *rpb2*, *tef*	21	BPP = 1 MPBS = 100 WPBBS = 100 MLBS = 100
Order	*Chaetothyriales*	Lutzoni *et al.* (2004, fig. 2)	LSU, SSU	5	BPP = 1 NJBS = 94

(*continued on next page*)

Table 2 (continued)

Rank	Taxon	Reference	Data	OTUs	Support
		Liu & Hall (2004, fig. 3)	*rpb2*	5	BPP = 1 MPBS = 96
		Spatafora et al. (2007, fig. 1)	SSU, LSU, *rpb1*, *rpb2*, *tef*	4	BPP = 1 MLBS = 100 WPBS > 70
		Geiser et al. (2007, fig. 1)	SSU, LSU, *rpb1*, *rpb2*, *tef*	9	BPP = 1 MPBS = 100 WPBBS = 100 MLBS = 100
Order	*Pyrenulales*	Lutzoni et al. (2004, fig. 8)	LSU, SSU, mt-SSU, *rpb2*	2	BPP = 1 NJBS = 100 WPBS = 100
		Reeb et al. (2004, fig. 1)	LSU, SSU, *rpb2*	2	BPP = 1 BBS = 100 MLBS = 100
		Schmitt et al. (2004, fig. 1)	LSU, mt-SSU	2	BPP = 1
		Geiser et al. (2007, fig. 1)	SSU, LSU, *rpb1*, *rpb2*, *tef*	5	BPP = 1 MPBS = 100 WPBBS = 100 MLBS = 100
Order	*Verrucariales*	Wedin et al. (2006, fig. 1)	LSU, mt-SSU	3	BPP = 1 MPjk = 100
		Geiser et al. (2007, fig. 1)	SSU, LSU, *rpb1*, *rpb2*, *tef*	7	BPP = 1 MPBS = 100 WPBBS = 100 MLBS = 100
		Lutzoni et al. (2004, fig. 2)	LSU, SSU	3	BPP = 1 NJBS = 98
		Gueidan et al. (2007, fig. 2)	LSU, SSU, *rpb1*	83	BPP = 1 MLBS = 100 MPBS = 100
Subclass	*Eurotiomycetidae*	Geiser et al. (2007, fig. 1)	SSU, LSU, *rpb1*, *rpb2*, *tef*	24	BPP = 1 MPBS = 100 WPBBS = 98 MLBS = 100
		Lutzoni et al. (2004, fig. 2)	LSU, SSU	11	NJBS = 96 BPP = 1
Order	*Coryneliales*	Winka (2000, fig. 1)	SSU	2	MPBS = 100 NJBS = 100
		Inderbitzin et al. (2004, fig. 14)	SSU	1	NA
		Geiser et al. (2007, fig. 1)	SSU, LSU, *rpb1*, *rpb2*, *tef*	3	BPP = 1 MPBS = 100 WPBBS = 100 MLBS = 100
Order	*Eurotiales*	Geiser et al. (2007, fig. 1)	SSU, LSU, *rpb1*, *rpb2*, *tef*	9	BPP = 1 MPBS = 100 WPBBS = 100 MLBS = 100
Order	*Onygenales*	Geiser et al. (2007, fig. 1)	SSU, LSU, *rpb1*, *rpb2*, *tef*	12	BPP = 1 MPBS = 65 WPBBS = 68 MLBS = 88
Subclass/Order	*Mycocaliciomycetidae*, *Mycocaliciales*	Tibell & Vinuesa (2005, fig. 1)	LSU	20	BPP = 1
		Geiser et al. (2007, fig. 1)	SSU, LSU, *rpb1*, *rpb2*, *tef*	4	BPP = 1 MPBS = 100 WPBBS = 100 MLBS = 100
		Ekman & Tønsberg (2002, fig. 1)	SSU	4	BPP = 1
Class	*Laboulbeniomycetes*	Weir & Blackwell (2001, fig. 2)	SSU	4	MPBS = 100
		Henk et al. (2003, fig. 1)	SSU	6	MPBS = 100
Order	*Laboulbeniales*	Weir & Blackwell (2001, fig. 1)	SSU	3	MPBS = 100
		Henk et al. (2003, fig. 2)	SSU	3	MPBS = 57
Order	*Pyxidiophorales*	Weir & Blackwell (2001, fig. 2)	SSU	1	NA
		Henk et al. (2003, fig. 2)	SSU	2	MPBS = 99

Table 2 (*continued*)

Rank	Taxon	Reference	Data	OTUs	Support
Class	*Lecanoromycetes*	Lutzoni *et al.* (2004, fig. 5)	LSU, SSU, *rpb2*, mt-SSU	34	BPP = 1 BBS = 56
		Spatafora *et al.* (2007, fig. 2)	LSU, SSU, *rpb1*, *rpb2*, *tef1*	38	WPBS < 50 MLBS = 93 BPP = 1
		Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	264	RMLBS > 70 BS BPP > 0.95
		Hofstetter *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	82	RMLBS > 70 BPP > 0.95
Subclass/Order	*Acarosporomycetidae*, *Acarosporales*	Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	15	RMLBS > 70 % PMLBS > 70 % BPP > 0.95
		Reeb *et al.* (2004, fig. 1)	LSU, SSU, *rpb2*	14	MLBS = 100 BPP = 100
		Lutzoni *et al.* (2004, fig. 4)	LSU, SSU, *rpb2*	14	BPP = 1 NJBS = 100 MPBS = 100
Subclass	*Lecanoromycetidae*	Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	71	RMLBS > 70 % PMLBS > 70 % BPP > 0.95
		Hofstetter *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	54	RMLBS > 70 BPP > 0.95
		Reeb *et al.* (2004, fig. 1)	LSU, SSU, *rpb2*	14	MLBS = 73 BPP = 100
Order	*Lecanorales*	Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	86	RMLBS > 70 BS BPP > 0.95
		Hofstetter *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	30	RMLBS > 70 BPP > 0.95
		Lumbsch *et al.* (2004, fig. 1)	LSU, mt-SSU	14	BPP = 1
		Lücking *et al.* (2004, fig. 3)	LSU, mt-SSU	8	BPP = 1
Order	*Peltigerales*	Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	46	RMLBS > 70 BSBPP > 0.95
		Miądlikowska & Lutzoni (2004, fig. 1)	LSU, SSU	59	MPBS < 70 BPP = 0.92
		Wilklund & Wedin (2003, fig. 1)	LSU, SSU	31	Bjk = 99
Order	*Teloschistales*	Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	13	RMLBS > 70 BPP > 0.95
Subclass	*Ostropomycetidae*	Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	58	RMLBS > 70 BS BPP > 0.95
		Grube *et al.* (2004, fig. 1)	mt-SSU	30	BPP > 0.95
		Reeb *et al.* (2004, fig. 1)	LSU, SSU, *rpb2*	16	MLBS = 100 BPP = 100
Order	*Agyriales*	Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	8	RMLBS > 70 BS BPP > 0.95
		Lücking *et al.* (2004, fig. 3)	LSU, mt-SSU	11	BPP = 1
		Lutzoni *et al.* (2004, fig. 2)	LSU, SSU	4	BPP = 1 NJBS = 100
		Wedin *et al.* (2005, fig. 1)	LSU, mt-SSU	8	MPjk = 83 BPP = 0.99
Order	*Baeomycetales*	Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	4	RMLBS > 70 PMLBS > 70 BPP > 0.95
		Wedin *et al.* (2005, fig. 1)	LSU, mt-SSU	3	MPjk = 99 BPP = 1.0
Order	*Ostropales* s.l.	Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	21	RMLBS > 70 BS BPP > 0.95
		Schmitt *et al.* (2005, fig. 1)	LSU, mt-SSU	12	BPP = 1
		Wedin *et al.* (2005, fig. 1)	LSU, mt-SSU	13	Bjk = 94 BPP = 0.97

(*continued on next page*)

Table 2 (continued)

Rank	Taxon	Reference	Data	OTUs	Support
		Lutzoni *et al.* (2004, fig. 4)	LSU, SSU, *rpb2*	10	BPP = 1 NJBS = 74 MPBS = 84
		Reeb *et al.* (2004, fig. 1)	LSU, SSU, *rpb2*	9	MLBS = 99 BPP = 1 BBS = 1
Order	*Pertusariales*	Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	21	RMLBS > 70 BSBpp > 0.95
		Lücking *et al.* (2004, fig. 3)	LSU, mt-SSU	7	BPP = 1
		Schmitt *et al.* (2005, fig. 1)	LSU, mt-SSU	14	BPP = 1
		Lutzoni *et al.* (2004, fig. 2)	LSU, SSU	11	BPP = 1
	Lecanoromycetes incertae sedis (not placed in any subclass)				
Order	*Candelariales*	Wedin *et al.* (2005, fig. 1)	LSU, mt-SSU	3	Jk = 100 BPP = 0.96
		Hofstetter *et al.* (2007, fig. 1)	LSU, SSU, mt-SSU, *rpb1*, *rpb2*	2	RMLBS > 70 BPP > 0.95
		Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, mt-SSU, *rpb1*, *rpb2*	3	RMLBS > 70 PMLBS > 70 BPP > 0.95
Order	*Umbilicariales*	Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	16	BSBSBPP > 0.95
		Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	9	RMLBS > 70 PMLBS > 70 BPP > 0.95
		Hofstetter *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	8	RMLBS > 70 BPP > 0.95
		Reeb *et al.* (2004, fig. 1)	LSU, SSU, *rpb2*	4	MLBS = 70 BPP = 1 BBS = 88
Class	*Leotiomycetes (w/o Geoglossaceae)*	Spatafora *et al.* (2007, fig. 2)	LSU, SSU, *rpb1*, *rpb2*, *tef1*	22	WPBS = 100 MLBS = 100 BPP = 1
		Wang *et al.* (2006, fig. 1)	LSU, SSU, 5.8S	50	BPP = 1
		Wang *et al.* (2007, fig. 2)	LSU, SSU, 5.8S	78	MPBS = 61 BPP = 1
Order	*Cyttariales*	Wang *et al.* (2007, fig. 1)	SSU, LSU, 5.8S	1	NA
Order	*Erysiphales*	Rossman *et al.* (2004, fig. 2)	LSU	12	MPBS > 55
		Wang *et al.* (2007, fig. 1)	SSU, LSU, 5.8S	16	MPBS = 63 BPP = 0.97
		Takamatsu (2004, fig. 2)	SSU	10	NJBS = 99
Order	*Helotiales (w/o Geoglossaceae)*	Wang *et al.* (2007, fig. 1)	SSU, LSU, 5.8S	40	BPP < 0.90
Order	*Rhytismatales*	Rossman *et al.* (2004, fig. 2)	LSU	4	MPBS > 55
		Wang *et al.* (2007, fig. 1)	SSU, LSU, 5.8S	5	MPBS = 100 BPP = 1
Order	*Thelebolales*	de Hoog *et al.* (2005, fig. 3)	SSU	11	MPBS = 56
Class/Order	*Lichinomycetes, Lichinales*	Spatafora *et al.* (2007, fig. 2)	LSU, SSU, *rpb1*, *rpb2*, *tef1*	1	NA
		Miądlikowska *et al.* (2007, fig. 1)	LSU, SSU, *rpb1*, *rpb2*, mt-SSU	2	RMLBS > 70 PMLBS > 70 BPP > 0.95
		Reeb *et al.* (2004, fig. 1)	LSU, SSU, *rpb2*	3	MLBS = 100 BBS = 100 BPP = 1
Class/Order	*Orbiliomycetes, Orbiliales*	Spatafora *et al.* (2007, fig. 2)	LSU, SSU, *rpb1*, *rpb2*, *tef1*	2	WPBS = 100 MLBS = 100 BPP = 1
Class/Order	*Pezizomycetes, Pezizales*	Spatafora *et al.* (2007, fig. 2)	LSU, SSU, *rpb1*, *rpb2*, *tef1*	14	WPBS = 54 MLBS = 99 BPP = 1
		Lutzoni *et al.* (2004, fig. 2)	LSU, SSU	21	BPP = 0.96 NJBS = 70
Class	*Sordariomycetes*	Spatafora *et al.* (2007, fig. 2)	LSU, SSU, *rpb1*, *rpb2*, *tef1*	47	WPBS = 100 MLBS = 100 BPP = 1

Table 2 (continued)

Rank	Taxon	Reference	Data	OTUs	Support
		Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	106	MPBS = 100 WPBS = 100 MLBS = 100 BPP = 1
		Lutzoni *et al.* (2004, fig. 2)	LSU, SSU	66	BPP = 1 NJBS = 97
Subclass	*Hypocreomycetidae*	Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	42	MPBS = 92 WPBS = 96 MLBS = 90 BPP = 1
		Lutzoni *et al.* (2004, fig. 2)	LSU, SSU	26	NJBS < 50 BPP = 1
		Huhndorf *et al.* (2004b, figs. 38, 39)	LSU	21	MPBS = 67 BPP >= 0.95
Order	*Coronophorales*	Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	2	MPBS < 50 WPBS < 50 MLBS = 96 BPP = 1
		Huhndorf *et al.* (2004b, figs. 38, 39)	LSU	16	WPBS = 99 BPP ≥ 95
		Miller & Huhndorf (2005, fig. 7)	LSU, β-*tub*, *rpb2*	2	WPBS = 100 BPP ≥ 95
Order	*Hypocreales*	Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	21	MPBS = 91 WPBS = 90 MLBS = 72 BPP = 1
		Castlebury *et al.* (2004, fig. 1)	LSU, SSU	31	MPBS = 70 BPP = 1
Order	*Melanosporales*	Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	2	MPBS = 100 WPBS = 100 MLBS = 100 BPP = 1
Order	*Microascales* (incl. *Halosphaeriales*)	Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	15	MPBS = 74 WPBS = 86 MLBS = 85 BPP = 1
		Lutzoni *et al.* (2004, fig. 2)	LSU, SSU	10	NJBS = 80 BPP = 1
		Campbell *et al.* (2003, fig. 3)	LSU, SSU	40	MPBS = 100 BPP = 1
		Kohlmeyer *et al.* (2000, fig. 1)	LSU, SSU	16	MPBS = 97
Subclass	*Sordariomycetidae*	Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	54	MPBS = 82 WPBS = 85 MLBS = 77 BPP = 1
		Lutzoni *et al.* (2004, fig. 2)	LSU, SSU	36	NJBS < 50 BPP = 0.97
Order	*Boliniales*	Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	4	MPBS = 100 WPBS = 100 MLBS = 100 BPP = 1
		Huhndorf *et al.* (2004a, fig. 1)	LSU	3	WPBS = 99 BPP < 95
		Miller & Huhndorf (2005, fig. 7)	LSU, β-*tub*, *rpb2*	2	WPBS = 100 BPP ≥ 95
Order	*Chaetosphaeriales*	Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	3	MPBS = 100 WPBS = 100 MLBS = 100 BPP = 1
		Miller & Huhndorf (2005, fig. 7)	LSU, β-*tub*, *rpb2*	2	WPBS = 100 BPP ≥ 95
		Shenoy *et al.* (2006, fig. 3)	LSU, *rpb2*	4	MPBS = 100

(*continued on next page*)

Table 2 (*continued*)

Rank	Taxon	Reference	Data	OTUs	Support
Order	*Coniochaetales*	Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	3	MPBS = 93
					WPBS = 100
					MLBS = 87
					BPP = 1
		Miller & Huhndorf (2005, fig. 7)	LSU, β-*tub*, *rpb2*	2	WPBS = 100
					BPP ≥ 95
		Miller & Huhndorf (2004, fig. 10)	LSU	3	WPBS = 98
					BPP ≥ 95
Order	*Diaporthales*	Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	19	MPBS = 95
					WPBS = 94
					MLBS = 77
					BPP = 1
		Castlebury *et al.* (2002, fig. 1)	LSU	82	MPBS = 100
					NJBS = 100
		Lutzoni *et al.* (2004, fig. 2)	LSU, SSU	10	NJBS = 100
					BPP = 1
		Miller & Huhndorf (2005, fig. 7)	LSU, β-*tub*, *rpb2*	2	WPBS = 100
					BPP ≥ 95
		Miller & Huhndorf (2004, fig. 10)	LSU	3	WPBS = 100
					BPP =≥ 95
Order	*Ophiostomatales*	Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	3	MPBS = 100
					WPBS = 100
					MLBS = 100
					BPP = 1
		Hausner & Reid (2004, fig. 1)	SSU	3	NJBS = 99
		Wingfield *et al.* (1999, fig. 3)	LSU	4	MPBS = 99
Order	*Sordariales*	Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	17	MPBS = 80
					WPBS = 77
					MLBS = 84
					BPP = 1
		Huhndorf *et al.* (2004a, fig. 1)	LSU	22	WPBS =< 50
					BPP < 95
		Miller & Huhndorf (2005, fig. 7)	LSU, β-*tub*, *rpb2*	41	WPBS = 65
					BPP ≥ 95
Subclass/Order	*Xylariomycetidae, Xylariales*	Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	8	MPBS = 98
					WPBS = 99
					MLBS = 78
					BPP = 1
		Shenoy *et al.* (2006, fig. 1)	LSU	16	MPBS = 92
	Sordariomycetes incertae sedis (not placed in any subclass)				
Order	*Calosphaeriales*	Vijaykrishna *et al.* (2004, fig. 1)	SSU	3	MPBS = 100
		Réblová *et al.* (2004, fig. 1)	LSU	6	MPBS = 53
		Réblová (2006, fig. 1)	SSU	2	MPBS = 68
Order	*Lulworthiales (incl. Spathulosporales)*	Zhang *et al.* (2007, fig. 2)	LSU, SSU, *rpb2*, *tef1*	2	MPBS = 100
					WPBS = 100
					MLBS = 100
					BPP = 1
		Campbell *et al.* (2005, fig. 1)	LSU, SSU	56	BPP = 1
		Inderbitzin *et al.* (2004, fig. 15)	LSU	15	MPBS = 100
					NJBS = 91
					BPP = 86
		Kohlmeyer *et al.* (2000, fig. 1)	LSU, SSU	7	MPBS = 100
Order	*Meliolales*	Saenz & Taylor (1999, fig. 1)	LSU	2	MPBS = 100
Order		Vijaykrishna *et al.* (2004, fig. 1)	SSU	2	MPBS < 50
Order	*Phyllachorales*	Inderbitzin *et al.* (2004, fig. 14)	SSU	1	NA
Order	*Trichosphaeriales*	Réblová & Seifert (2004, fig. 1)	LSU	8	MPBS < 50
	Pezizomycotina incertae sedis (not placed in any class)				
Order	*Lahmiales*	Eriksson (1986)	—	—	—
Order	*Medeolariales*	Inderbitzin *et al.* (2004, fig. 14)	SSU	1	NA
Order	*Triblidiales*	Eriksson (1992)	—	—	—

See Table 1 for explanation.

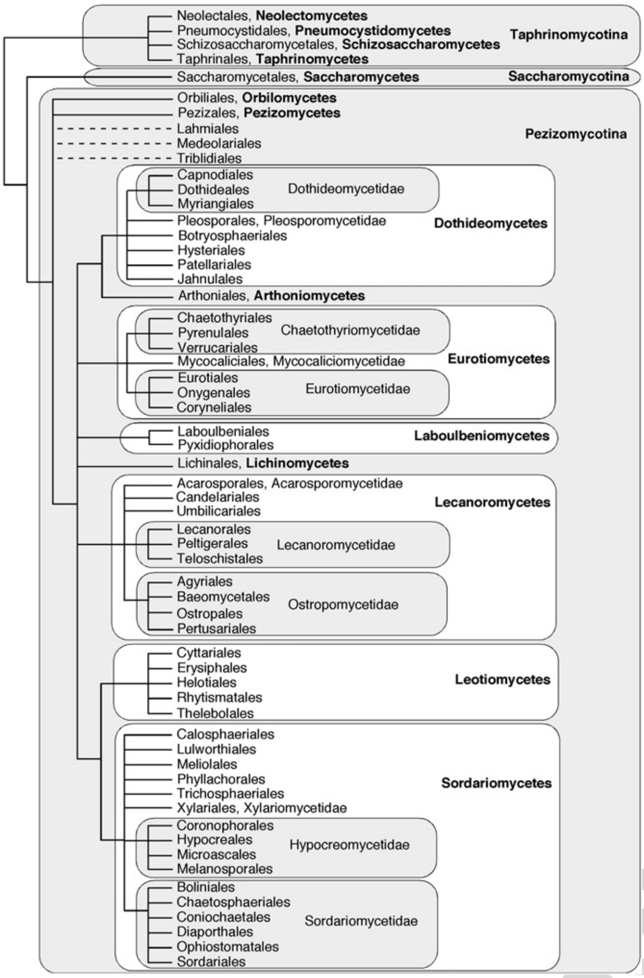

Fig 2 – Phylogeny and classification of *Fungi*. *Ascomycota*. See Table 2 for support values for clades. Dashed lines indicate taxa that are of uncertain placement.

Subclass: **Dothideomycetidae** P. M. Kirk, P. F. Cannon, J. C. David & Stalpers ex Schoch *et al.*, *Mycologia* **98**: 1047 (2007) ['2007'].

Order: **Capnodiales** Woron., *Annls Mycol.* **23**: 177 (1925).
Exemplar genera: *Capnodium* Mont. 1848, *Scorias* Fr. 1825, *Mycosphaerella* Johanson 1884.

Order: **Dothideales** Lindau, *in* Engler & Prantl (eds), *Nat. Pflanzenfam.* **1**(1): 373 (1897).
Exemplar genera: *Dothidea* Fr. 1818, *Dothiora* Fr. 1849, *Sydowia* Bres. 1895, *Stylodothis* Arx & E. Müll. 1975.

Order: **Myriangiales** Starbäck, *K. svenska Vetensk-Akad. Handl.*, *Bih.*, Afd. III **25**: 37 (1899).
Exemplar genera: Myriangium Mont. & Berk. 1845, *Elsinoë* Racib. 1900.

Subclass: **Pleosporomycetidae** C. L. Schoch, Spatafora, Crous & Shoemaker, *Mycologia* **98**: 1049 (2007) ['2006'].

Order: **Pleosporales** Luttr. ex M. E. Barr, *Prodr. Class Loculoasc.*: 67 (1987b).
Synonym: *Pleosporales* Luttr., *Mycologia* **47**: 520 (1955), *nomen invalidum*.
Exemplar genera: *Pleospora* Rabenh. ex Ces. & De Not. 1863, *Phaeosphaeria* I. Miyake 1909, *Lophiostoma* Ces. & De Not. 1863, *Sporormiella* Ellis & Everh.1892, *Montagnula* Berl. 1896.

Dothideomycetes *incertae sedis* (not placed in any subclass)

Order: **Botryosphaeriales** C. L. Schoch, Crous & Shoemaker, *Mycologia* **98**: 1051 (2007) ['2006'].
Exemplar genera: *Botryosphaeria* Ces. & De Not. 1863, *Guignardia* Viala & Ravaz 1892.

Order: **Hysteriales** Lindau *in* Engler & Prantl (eds), *Nat. Pflanzenfam.* **1**: 265 (1896), as '*Hysteriinae*'.
Exemplar genera: *Hysterium* Pers. 1797, *Hysteropatella* Rehm. 1890.

Order: **Patellariales** D. Hawksw. & O. E. Erikss., *Syst. Ascom.* **5**: 181 (1986).
Exemplar genus: *Patellaria* Fr. 1822.

Order: **Jahnulales** Ka-Lai Pang, Abdel-Wahab, El-Shar., E. B. G. Jones & Sivichai, *in* Pang *et al.*, *Mycol. Res.* **106**: 1033 (2002).
Exemplar genera: *Aliquandostipite* Inderb. 2001, *Jahnula* Kirschst. 1936, *Patescospora* Abdel-Wahab & El-Shar. 2002.

Class: **Eurotiomycetes** O. E. Erikss. & Winka, *Myconet* **1**: 6 (1997).

The circumscription of this class and the classification within the *Eurotiomycetes* presented here are derived from the phylogenetic re-delimitation of this class by Ekman & Tønsberg (2002), Lutzoni *et al.* (2004) and Geiser *et al.* (2007), reflecting the inference of shared ancestry between *Eurotiomycetes*, comprising *Coryneliales*, *Onygenales* and *Eurotiales* and *Chaetothyriomycetes*. Three subclasses, *Chaetothyriomycetidae*, *Eurotiomycetidae*, and *Mycocaliciomycetidae*, are defined to represent the major lineages within *Eurotiomycetes*.

Subclass: **Chaetothyriomycetidae** Doweld, *Prosyllabus:* LXXVIII (2001).

Lichenized, parasitic, and saprobic ascomycetes with mostly bitunicate/fissitunicate to evanescent asci, produced in perithecial ascomata arranged superficially or immersed in a thallus. Thalli often produced on the surfaces of rocks, lichens, decaying plant material and other substrata. Ascospores variable, from colourless to pigmented, simple to muriform. Hamathecium, when present, consisting of pseudoparaphyses. Pigments, when present, generally related to melanin. Asexual stages with phialidic and annellidic anamorphs observed in non-lichenized taxa.

Order: **Chaetothyriales** M. E. Barr, *Mycotaxon* **29**: 502 (1987).
Exemplar genera: *Capronia* Sacc. 1883, *Ceramothyrium* Bat. & H. Maia 1956, *Chaetothyrium* Speg. 1888.

Order: **Pyrenulales** Fink ex D. Hawksw. & O. E. Erikss., *Syst. Ascom.* **5**: 182 (1986).
Synonym: *Pyrenulales* Fink, *Ohio St. Univ. Bull.* **19**(28): 107 (1951), *nomen invalidum*.
Exemplar genera: *Pyrenula* Ach. 1814, *Pyrgillus* Nyl. 1858.

Order: **Verrucariales** Mattick ex D. Hawksw. & O. E. Erikss., *Syst. Ascom.* **5**: 183 (1986).
Synonym: *Verrucariales* Mattick, *in* Engler, *Syll. Pflanzenfam.* (12 edn): 208 (1954), *nomen invalidum*.
Exemplar genera: *Agonimia* Zahlbr. 1909, *Dermatocarpon* Eschw. 1824, *Polyblastia* A. Massal. 1852, *Verrucaria* Schrad. 1794.

Subclass: **Eurotiomycetidae** Geiser & Lutzoni, **subclass. nov.**
MycoBank no.: MB 501287

Fungi saprotrophici vel parasitici vel mycorrhizales; asci globosi in toto ascomate sparsi, raro hymenium formantes; asci plerumque evanescentes, nonnumquam bitunicati. Ascosporae plerumque unicellulares, lenticulares, nonnumquam globosae vel ellipsoideae. Ascomata, si formata, plerumque cleistothecialia vel gymnothecialia, saepe textura stromatica circumdata. Structurae hamatheciales absentes. Gametangia plerumque indistincta e glomere hyphali constantia. Fungi saepe laete colorati. Anamorphae variabiles, seu phialidicae seu arthroconidiales.
Typus: *Eurotium* Link 1809.

Saprotrophic, parasitic and mycorrhizal. Ascomata, when present, usually cleistothecial/gymnothecial, globose, often produced in surrounding stromatic tissue and brightly coloured; hamathecial elements lacking; gametangia usually undifferentiated and consisting of hyphal coils. Asci usually evanescent, sometimes bitunicate, scattered throughout the ascoma, rarely from a hymenium. Ascospores usually single-celled, lenticular, sometimes spherical or elliptical. Anamorphs variable, including phialidic and arthroconidial forms.

This name was employed by Lutzoni *et al.* (2004) and Geiser *et al.* (2007), in the same sense as the present classification, but without a formal diagnosis.

Order: **Coryneliales** Seaver & Chardón, *Scient. Surv. P. Rico*: 40 (1926).
Exemplar genera: *Corynelia* Ach. 1823, *Caliciopsis* Peck 1880.

Order: **Eurotiales** G. W. Martin ex Benny & Kimbr., *Mycotaxon* **12**: 23 (1980).
Synonym: *Eurotiales* G. W. Martin, *Std. nat. Hist. Iowa Univ.* **18**(Suppl.): 16 (1941), *nomen invalidum*.
Exemplar genera: *Eurotium* Link 1809, *Emericella* Berk. 1857, *Talaromyces* C. R. Benj. 1955, *Elaphomyces* Nees 1820, *Trichocoma* Jungh. 1838, *Byssochlamys* Westling 1909.

Order: **Onygenales** Cif. ex Benny & Kimbr., *Mycotaxon* **12**: 8 (1980).
Synonym: *Onygenales* Cif., *Atti Ist. Bot. Univ. Pavia, ser.* 5, **14**: 238 (1957), *nomen invalidum*.
Emend. Currah *Mycotaxon* **24**: 13 (1985).
Exemplar genera: *Onygena* Pers. 1799, *Gymnoascus* Baran. 1872, *Arthroderma* Curr. 1860.

Subclass: **Mycocaliciomycetidae** Tibell. **subclass nov.**
MycoBank no.: MB 501288

Parasitae vel commensales in lichenibus vel saprotrophici. Ascomata disciformia, stipitata vel sessilia. Excipulum cupulatum, saltem partim scleroticum hyphis stipitis simile. Dispersio sporarum activa, raro passiva et tum mazedio parce evoluto. Asci unitunicati, cylindrici, vulgo apice distincte incrassato, 8-spori. Ascosporae pallidae ad atrofuscae, ellipsoidales, nonseptatae vel transversaliter 1–7-septatae. Paries sporae atrofuscus, laevis vel ornamento intra plasmalemma formato. Derivata acidi vulpinici in speciebus paucis praesentia. Anamorphae coelomycetum et hyphomycetum variae praesentes.
Typus: Mycocalicium Vain. 1890.

Parasites or commensals on lichens or saprobes. Ascomata disciform, stalked or sessile. Excipulum cupulate, and like the stalk hyphae at least in part sclerotized. Spore dispersal active, more rarely passive and ascomata then with a moderately developed mazaedium. Asci unitunicate, cylindrical, mostly with a distinctly thickened apex, 8-spored. Ascospores pale to blackish brown, ellipsoidal or spherical to cuboid, non-septate or transversely 1–7-septate. Spore wall pigmented, smooth or with an ornamentation formed within the plasmalemma. Vulpinic acid derivatives occur in a few species. A variety of coelomycetous and hyphomycetous anamorphs occur.

Order: **Mycocaliciales** Tibell & Wedin, *Mycologia* **92**: 579 (2000).
Exemplar genera: *Mycocalicium* Vain. 1890, *Chaenothecopsis* Vain. 1927, *Stenocybe* (Nyl.) Körb. 1855, *Sphinctrina* Fr. 1825.

Class: **Laboulbeniomycetes** Engl., *Syll. Pflanzenfam.* (2nd edn): 46 (1898).

Order: **Laboulbeniales** Lindau, *in* Engler & Prantl (eds), *Nat. Pflanzenfam.* **1**(1): 491 (1897), as '*Laboulbeniineae*'.
Exemplar genera: *Laboulbenia* Mont. & C.P. Robin 1835, *Rickia* Cavara 1899, *Ceratomyces* Thaxt. 1892.

Order: **Pyxidiophorales** P. F. Cannon, *in* Kirk *et al.*, *Ainsworth & Bisby's Dict. Fungi* (9th edn): xi (2001).
Exemplar genus: *Pyxidiophora* Bref. & Tavel 1891.

Class: **Lecanoromycetes** O. E. Erikss. & Winka, *Myconet* **1**: 7 (1997).

Subclass: **Acarosporomycetidae** Reeb, Lutzoni & Cl. Roux, *Mol. Phylogen. Evol.* **32**: 1053 (2004).

Order: **Acarosporales** Reeb, Lutzoni & Cl. Roux, **ord. nov.**
MycoBank no.: MB 501289

Ascomycetes lichenisati algas virides thallo continentes. Ascomata immersa vel sessilia, disciformia vel perithecioidea. Excipulum hyalinum, annulatum. Hymenium non-amyloideum. Paraphyses mediocriter vel infirme ramosae, septatae, mediocriter vel infirme anastomosantes. Asci unitunicati, non-amyloidei vel satis infirme amyloidei, polyspori. Ascosporae hyalinae, non-septatae, non-halonatae.
Typus: *Acarospora* A. Massal. 1852.

Lichen-forming ascomycetes with chlorococcoid photobiont. Ascomata immersed or sessile, disciform or perithecioid. True exciple hyaline, annulate. Hymenium non-amyloid. Paraphyses moderately to poorly branched, septate, moderately to poorly anastomosing. Asci functionally unitunicate, lecanoralean, non-amyloid or with slightly amyloid tholi, polyspored, generally with more than 100 ascospores per ascus. Ascospores hyaline, small, non-septate, non-halonate.

The members of this order were formerly classified within the *Lecanorales*, but Reeb *et al.* (2004) and Lutzoni *et al.* (2004) demonstrated that the *Acarosporaceae* diverged earlier than the *Lecanoromycetidae* and *Ostropomycetidae*. This early divergence within the *Lecanoromycetes* was confirmed by Wedin *et al.* (2005) and Miądlikowska *et al.* (2007).

Exemplar genera: *Acarospora* A. Massal. 1852, *Pleopsidium* Körb. 1855, *Sarcogyne* Flot. 1851.

Subclass: **Lecanoromycetidae** P. M. Kirk, P. F. Cannon, J. C. David & Stalpers ex Miądl., Lutzoni & Lumbsch, **subclass. nov.**
MycoBank no.: MB 501290
Synonym: *Lecanoromycetidae* P. M. Kirk, P. F. Cannon, J. C. David & Stalpers, *Ainsworth & Bisby's Dict. Fungi* (9th edn): xi (2001), *nomen invalidum*.

Ascomycetes lichenisati algas virides vel cyanobacteria thallo continentes. Ascomata immersa, sessilia vel elevata, generaliter disciformia. Excipulum hyalinum vel pigmentatum, annulatum vel cupulatum. Hymenium amyloideum vel non-amyloideum. Paraphyses simplices vel ramosae, septatae, anastomosantes vel non-anastomosantes. Asci bitunicati, unitunicati vel prototunicati, non-amyloidei vel amyloidei, generaliter octospori, sed etiam 1- ad multispori. Ascosporae hyalinae vel brunneae, non-septatae, vel septate usque ad muriformes, halonatae vel non-halonatae.

Typus: *Lecanora* Ach. 1809.

Lichen-forming ascomycetes with green algal or cyanobacterial photobiont. Ascomata immersed, sessile or stalked, usually disciform. True exciple hyaline or pigmented, annulate or cupulate. Hymenium amyloid or non-amyloid. Paraphyses simple or moderately to richly branched, septate, anastomosing or not. Asci bitunicate, functionally unitunicate, or prototunicate, lecanoralean, non-amyloid or amyloid, mostly 8-spored, but varying from 1- to poly-spored. Ascospores hyaline or brown, non-septate, trans-septate or muriform, halonate or non-halonate.

This subclass includes the bulk of lichenized discomycetes and corresponds to the phylogenetic circumscription of this subclass by Reeb *et al.* (2004), Lutzoni *et al.* (2004) and Miądlikowska *et al.* (2007). It is in agreement with the *Lecanorales* of Lumbsch *et al.* (2004) and Wiklund & Wedin (2004). The orders *Peltigerales* and *Teloschistales* are here accepted at the ordinal level, following Miądlikowska & Lutzoni (2003) and Miądlikowska *et al.* (2007).

Order: **Lecanorales** Nannf., *Nova Acta R. Soc. Scient. Upsal*, ser. 4 **8**(2): 68 (1932).

Exemplar genera: *Cladonia* Hill. ex P. Browne 1756, *Lecanora* Ach. 1809, *Parmelia* Ach. 1803, *Ramalina* Ach. 1809, *Usnea* Dill. ex Adans. 1763

Order: **Peltigerales** Walt. Watson, *New Phytologist* **28**: 9 (1929).

Exemplar genera: *Coccocarpia* Pers. 1827, *Collema* F. H. Wigg. 1780, *Nephroma* Ach. 1810, *Pannaria* Del. ex Bory 1828, *Peltigera* Willd. 1787.

Order: **Teloschistales** D. Hawksw. & O. E. Erikss., *Syst. Ascom.* **5**: 183 (1986).

Exemplar genera: *Caloplaca* Th. Fr. 1861, *Teloschistes* Norman 1853, *Xanthoria* (Fr.) Th. Fr. 1860.

Subclass: **Ostropomycetidae** Reeb, Lutzoni & Cl. Roux, *Mol. Phylogen. Evol.* **32**: 1055 (2004).

Order: **Agyriales** Clem. & Shear, *Gen. Fungi*: 141 (1931).

Exemplar genera: *Agyrium* Fr. 1822, *Placopsis* (Nyl.) Linds. 1867, *Trapelia* M. Choisy 1929, *Trapeliopsis* Hertel & Gotth. Schneid. 1980.

Order: **Baeomycetales** Lumbsch, Huhndorf & Lutzoni, **ord. nov.**
MycoBank no.: MB 501291

Ascomycetes lichenisati algas virides thallo continentes. Ascomata elevata vel raro sessilia, disciformia. Excipulum hyalinum vel pigmentatum, annulatum vel cupulatum. Hymenium non-amyloideum. Paraphyses ramosae, septatae. Asci unitunicati, non-amyloidei vel satis infirme amyloidei, octospori. Ascosporae hyalinae, non-septatae vel septatae, halonatae vel non-halonatae.

Typus: *Baeomyces* Pers. 1794.

Lichen-forming ascomycetes with chlorococcoid photobiont. Ascomata sessile or rarely stalked, disciform. True exciple hyaline or pigmented, annulate or cupulate. Hymenium non-amyloid. Paraphyses moderately to richly branched, septate. Asci unitunicate, non-amyloid or with slightly amyloid tholi, 8-spored. Ascospores hyaline, non-septate or trans-septate, halonate or non-halonate.

Baeomycetales was shown to differ from *Agyriales* by Kauff & Lutzoni (2002) and this was confirmed by Miądlikowska *et al.* (2007) and Lumbsch *et al.* (2007).

Exemplar genera: *Ainoa* Lumbsch & I. Schmitt 2001, *Baeomyces* Pers. 1794, *Phyllobaeis* Gierl & Kalb 1993.

Order: **Ostropales** Nannf., *Nova Acta R. Soc. Scient. Upsal.*, ser. 4 **8**(2): 68 (1932).

This order includes also taxa formerly classified in separate orders, such as *Gomphillales*, *Graphidales*, *Gyalectales* and *Trichotheliales*.

Exemplar genera: *Ostropa* Fr. 1825, *Stictis* Pers. 1799, *Gyalecta* Ach. 1808, *Gomphillus* Nyl. 1855, *Graphis* Adans. 1763., *Odontotrema* Nyl. 1858, *Porina* Müll. Arg. 1883, *Thelotrema* Ach. 1803.

Order: **Pertusariales** M. Choisy ex D. Hawksw. & O. E. Erikss., *Syst. Ascom.* **5**: 181 (1986).
Synonym: *Pertusariales* M. Choisy, *Bull. mens. Soc. linn. Lyon* **18**: 12 (1949), *nomen invalidum*.

This order may not be monophyletic as currently circumscribed, with *Ochrolechiaceae* and some groups of the heterogeneous *Pertusaria* clustering in a separate clade, but without support. Nonetheless, a cluster of taxa in a 'core' group of *Pertusariales* has been strongly supported as monophyletic in phylogenetic analyses by Miądlikowska *et al.* (2007), Lücking et al. (2004), Schmitt et al. (2005), Lutzoni et al. (2004), and Grube et al. (2004).

Exemplar genera: *Coccotrema* Müll. Arg. 1888, *Icmadophila* Trevis. 1853, *Ochrolechia* A. Massal. 1852, *Pertusaria* DC. 1805.

Lecanoromycetes *incertae sedis* (not placed in any subclass):

Order: **Candelariales** Miadl., Lutzoni & Lumbsch, **ord. nov.**
MycoBank no.: MB 501292

Ascomycetes lichenisati algas virides thallo continentes. Ascomata sessilia, disciformia. Excipulum hyalinum, annulatum. Hymenium amyloideum. Paraphyses ramosae, septatae. Asci unitunicati, amyloidei, ad typum *Candelariae* dictum pertinentes, octo- vel saepe multispori. Ascosporae hyalinae, non-septatae vel raro 1-septatae.

Typus: *Candelaria* A. Massal. 1853.

Lichen-forming ascomycetes with chlorococcoid photobiont, predominantly nitrophilous. Thallus of various morphology, yellow to orange (pulvinic acid derivatives). Ascomata apothecial, sessile, with or without a distinct margin, yellow to orange. The ascomatal wall formed from densely septate twisted hyphae. paraphyses mostly simple. Excipulum hyaline, hymenium amyloid. Asci unitunicate of *Candelaria*-type with the amyloid lower part of the apical dome and broad apical cushion, often multispored. Ascospores hyaline, aseptate, rarely 1-septate.

Candelariales was shown to differ from *Lecanorales* by Wedin et al. (2005) and this was confirmed by Hofstetter et al. (2007) and Miądlikowska et al. (2007).

Exemplar genera: *Candelaria* A. Massal. 1853, *Candelariella* Müll. Arg. 1894.

Order: **Umbilicariales** Lumbsch, Hestmark & Lutzoni, **ord. nov.**
MycoBank no.: MB 501293

Ascomycetes lichenisati algas virides thallo continentes. Ascomata sessilia, raro immersa usque ad pauce elevata, plerumque atra, irregularia, disciformia. Excipulum pigmentatum, annulatum. Hymenium amyloideum. Paraphyses simplices vel paulum ramosae, septatae. Asci unitunicati, tholo inconspicue amyloideo, 1–8-spori. Ascosporae hyalinae vel brunneae, non-septatae usque ad muriformes.

Typus: *Umbilicaria* Hoffm. 1789.

Lichen-forming ascomycetes with chlorococcoid photobiont. Ascomata sessile, or rarely immersed or stalked, mostly black, irregular, disciform. True exciple pigmented, annulate. Hymenium amyloid. Paraphyses simple or slightly branched, septate, apically thickened. Asci unitunicate, with slightly amyloid tholi, 1–8-spored. Ascospores hyaline or brown, non-septate to muriform.

Exemplar genera: *Lasallia* Mérat 1821, *Umbilicaria* Hoffm. 1789.

Class: **Leotiomycetes** O. E. Erikss. & Winka, *Myconet* **1**: 7 (1997).
Excluding *Geoglossaceae* (Wang et al. 2006).

Order: **Cyttariales** Luttr. ex Gamundí, *Darwiniana* **16**: 502 (1971).

Synonym: *Cyttariales* Luttr., *Univ. Miss. Stud.* **24**(2): 109 (1951), *nomen invalidum*.

Exemplar genus: *Cyttaria* Berk. 1842.

Order: **Erysiphales** H. Gwynne-Vaughan, *Fungi, Ascom., Ustilag., Ured.*: 78 (1922).

Exemplar genera: *Erysiphe* R. Hedw. ex DC. 1805, *Blumeria* Golovin ex Speer 1975, *Uncinula* Lév. 1851.

Order: **Helotiales** Nannf., *Nova Acta R. Soc. Scient. Upsal., ser.* 4 **8**(2): 68 (1932).

Based on current character and taxon sampling (Wang et al. 2006, 2007; Spatafora et al. 2007), the monophyly of *Helotiales s. lat.* is not well supported. There exists a minimum of five helotialean lineages that are intermixed with other leotiomycetan taxa (e.g. *Cyttariales*, *Erysiphales*) resulting in a paraphyletic *Helotiales s. lat.* The interrelationships of these taxa are poorly resolved, however, thus preventing the synthesis of an accurate phylogenetic classification at this time. *Leotiomycetes* represents one of the more undersampled higher taxa among the *Ascomycota*, and it is likely that future sampling will result in a phylogenetic classification of a more restricted *Helotiales* and the recognition of additional orders based on current helotialean families (e.g. *Leotiaceae* or *Helotiaceae*, *Sclerotiniaceae*).

Exemplar genera: *Mitrula* Fr. 1821, *Hymenoscyphus* Gray 1821, *Ascocoryne* J.W. Groves & D.E. Wilson 1967.

Order: **Rhytismatales** M. E. Barr ex Minter, *in* Hawksworth & Eriksson, *Syst. Ascom.* **5**: 182 (1986).

Synonym: *Rhytismatales* M. E. Barr, *Mem. N. Y. Bot.Gdn* **28**: 6 (1976), *nomen invalidum*.

Exemplar genera: *Rhytisma* Fr. 1818, *Lophodermium* Chevall. 1826, *Cudonia* Fr. 1849.

Order: **Thelebolales** P. F. Cannon, *in* Kirk et al., *Ainsworth & Bisby's Dict. Fungi* (9th edn): xi (2001).

Exemplar genera: *Thelebolus* Tode 1790, *Coprotus* Korf ex Korf & Kimbr. 1967, *Ascozonus* (Renny) E.C. Hansen 1876.

Class: **Lichinomycetes** Reeb, Lutzoni & Cl. Roux., *Mol. Phylogen. Evol.* **32**: 1055 (2004).

Order: **Lichinales** Henssen & Büdel, *in* Hawksworth & Eriksson, *Syst. Ascom.* **5**: 138 (1986).

Exemplar genera: *Heppia* Nägeli ex A. Massal. 1854, *Lichina* C. Agardh 1817, *Peltula* Nyl. 1853.

Class: **Orbiliomycetes** O. E. Erikss. & Baral, *in* Eriksson et al., *Myconet* **9**: 96 (2003).

Order: **Orbiliales** Baral, O. E. Erikss., G. Marson & E. Weber, *in* Eriksson et al., *Myconet* **9**: 96 (2003).

Exemplar genera: *Orbilia* Fr. 1849, *Hyalorbilia* Baral & G. Marson 2000.

Class: **Pezizomycetes** O. E. Erikss. & Winka, *Myconet* **1**: 8 (1997).

Order: **Pezizales** J. Schröt., *in* Engler & Prantl (eds), *Nat. Pflanzenfam*. **1**: 173 (1894), as '*Pezizineae*'.

Exemplar genera: *Peziza* Fr. 1822, *Glaziella* Berk. 1880, *Morchella* Dill. ex Pers. 1794, *Pyronema* Carus 1835, *Tuber* F.H. Wigg. 1780.

Glaziella has been described several times, *inter alia* as a zygomycete. Gibson *et al.* (1986) demonstrated it was an ascomycete and proposed a new family and order close to *Pezizales*, but small subunit rRNA gene sequences show that it should be included in *Pezizales* (Landvik & Eriksson 1994).

Class: **Sordariomycetes** O. E. Erikss. & Winka, *Myconet* **1**: 10 (1997).

Subclass: **Hypocreomycetidae** O. E. Erikss. & Winka, *Myconet* **1**: 6 (1997).

Order: **Coronophorales** Nannf., *Nova Acta R. Soc. Scient. Upsal, ser*. 4 **8**: 54 (1932).

Exemplar genera: *Nitschkia* G.H. Otth ex P. Karst. 1873, *Scortechinia* Sacc. 1885, *Bertia* De Not. 1844, *Chaetosphaerella* E. Müll. & C. Booth 1972.

Order: **Hypocreales** Lindau, *in* Engler & Prantl (eds), *Nat. Pflanzenfam*. **1**: 343 (1897).

Exemplar genera: *Hypocrea* Fr. 1825, *Nectria* (Fr.) Fr. 1849, *Cordyceps* (Fr.) Link 1833, *Claviceps* Tul. 1853, *Niesslia* Auersw. 1869.

Order: **Melanosporales** N. Zhang & M. Blackw., **ord. nov.**
MycoBank no.: MB 501294

Ascomata perithecialia vel nonnumquam ostiolo carentia; peridium ascomatis e basi glomeris ascogonialis oriundum, translucidum; centrum pseudoparenchymaticum, paraphysibus absentibus; asci unitunicati, evanescentes; ascosporae fuscae, poro germinationis utrinque praeditae; anamorphae hyphomycetales. Fungi saepe mycoparasitici.

Typus: *Melanospora* Corda 1837.

Ascoma perithecial or secondarily cleistothecial, peridium derived from base of an ascogonial coil, translucent; centrum pseudoparenchymatous, paraphyses absent in development; asci unitunicate, evanescent; ascospores dark, with germ pores at both ends; anamorphs hyphomycetous; often mycoparasitic.

Exemplar genus: *Melanospora* Corda 1837.

Order: **Microascales** Luttr. ex Benny & Kimbr., *Mycotaxon* **12**: 40 (1980).

Synonym: *Microascales* Luttr., *Univ. Miss. Stud*. **24**(2): 108 (1951), *nomen invalidum*.

The group as recognized here includes members of the *Halosphaeriales*. In Zhang *et al.* (2007) and Tang *et al.* (2007), the *Halosphaeriales* were maintained separate from the *Microascales*.

Exemplar genera: *Microascus* Zukal 1885, *Petriella* Curzi 1930, *Halosphaeria* Linder 1944, *Lignincola* Höhnk 1955, *Nimbospora* J. Koch 1982.

Subclass: **Sordariomycetidae** O. E. Erikss. & Winka, *Myconet* **1**: 10 (1997).

Order: **Boliniales** P. F. Cannon, *in* Kirk *et al.*, *Ainsworth & Bisby's Dict. Fungi* (9th edn): x (2001).

Exemplar genera: *Camarops* P. Karst. 1873, *Apiocamarops* Samuels & J. D. Rogers 1987.

Order: **Calosphaeriales** M. E. Barr, *Mycologia* **75**: 11 (1983).

This order has not been placed in a subclass but the work of Réblová *et al.* (2004) shows that it may be related to the *Diaporthales*. Members of this group were not included in Zhang *et al.* (2007) or Tang *et al.* (2007).

Exemplar genera: *Calosphaeria* Tul. & C. Tul. 1863, *Togniniella* Réblová, L. Mostert, W. Gams & Crous 2004, *Pleurostoma* Tul. & C. Tul. 1863.

Order: **Chaetosphaeriales** Huhndorf, A. N. Mill. & F. A. Fernández, *Mycologia* **96**: 378 (2004).

Exemplar genera: *Chaetosphaeria* Tul. & C. Tul. 1863, *Melanochaeta* E. Müll., Harr & Sulmont 1969, *Zignoëlla* Sacc. 1878, *Striatosphaeria* Samuels & E. Müll. 1979.

Order: **Coniochaetales** Huhndorf, A. N. Mill. & F. A. Fernández, *Mycologia* **96**: 378 (2004a).

Exemplar genera: *Coniochaeta* (Sacc.) Cooke 1887, *Coniochaetidium* Malloch & Cain 1971.

Order: **Diaporthales** Nannf., *Nova Acta R. Soc. Scient. upsal., ser*. 4 **8**: 53 (1932).

Exemplar genera: *Diaporthe* Nitschke 1870, *Gnomonia* Ces. & De Not. 1863, *Cryphonectria* (Sacc.) Sacc. & D. Sacc. 1905, *Valsa* Fr. 1849.

Order: **Ophiostomatales** Benny & Kimbr., *Mycotaxon* **12**: 48 (1980).

Exemplar genera: *Ophiostoma* Syd. & P. Syd. 1919, *Fragosphaeria* Shear 1923.

Order: **Sordariales** Chadef. ex D. Hawksw. & O. E. Erikss., *Syst. Ascom*. **5**: 182 (1986).

Synonym: *Sordariales* Chadef., *in* Chadefaud & Emberger, *Traité Bot*. **1**: 594 (1960), *nomen invalidum*.

Exemplar genera: *Sordaria* Ces. & De Not. 1863, *Podospora* Ces. 1856, *Neurospora* Shear & B.O. Dodge 1927, *Lasiosphaeria* Ces. & De Not. 1863, *Chaetomium* Kunze 1817.

Subclass: **Xylariomycetidae** O. E. Erikss. & Winka, *Myconet* **1**: 12 (1997).

Order: **Xylariales** Nannf., *Nova Acta R. Soc. Scient. Upsal., ser*. 4, **8**: 66 (1932).

Exemplar genera: *Xylaria* Hill ex Schrank 1789, *Hypoxylon* Bull. 1791, *Anthostomella* Sacc. 1875, *Diatrype* Fr. 1849, *Graphostroma* Piroz. 1974.

Sordariomycetes *incertae sedis* (not placed in any subclass)

Order: **Lulworthiales** Kohlm., Spatafora & Volkm-Kohlm., *Mycologia* **92**: 456 (2000).

This order includes members formerly placed in the *Spathulosporales*.

Exemplar genera: *Lulworthia* G. K. Sutherl. 1916, *Lindra* I.M. Wilson 1956.

Order: **Meliolales** Gäum. ex D. Hawksw. & O. E. Erikss., *Syst. Ascom*. **5**: 180 (1986).

Synonym: *Meliolales* Gäum., *Pilze* (2nd edn): 158 (1964), *nomen invalidum*.

Exemplar genus: *Meliola* Fr. 1825.

Order: **Phyllachorales** M. E. Barr, *Mycologia* **75**: 10 (1983).

Exemplar genus: *Phyllachora* Nitschke ex Fuckel 1870.

Order: **Trichosphaeriales** M. E. Barr, *Mycologia* **75**: 11 (1983).

Exemplar genus: *Trichosphaeria* Fuckel 1870.

Pezizomycotina *incertae sedis* (not placed in any class)

Order: **Lahmiales** O. E. Erikss., *Mycotaxon* **27**: 357 (1986).

Exemplar genus: *Lahmia* Körb. 1861.

Order: **Medeolariales** Korf, *in* Eriksson *Mycotaxon* **15**: 232 (1982).

Exemplar genus: *Medeolaria* Thaxt. 1922.

Order: **Triblidiales** O. E. Erikss., *Syst. Ascom*. **11**: 9 (1992).

Exemplar genera: *Huangshania* O. E. Erikss. 1992, *Pseudographis* Nyl. 1855, *Triblidium* Rebent. 1804.

Phylum: **Basidiomycota** R. T. Moore, *Bot. Mar*. **23**: 371 (1980).

Synonyms: *Basidiomycota* Bold, *Morph. Pl*.: 7, 198 (1958), *nomen invalidum*;

Basidiomycetes Whittaker (1959: 220), *nomen invalidum*. (Table 3, Fig 3) As in the case of *Fungi*, Moore (1980) validated a name that had already been used by Bold (1957), but he did not cite Bold's work.

Subphylum: **Pucciniomycotina** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr*. **5**: 45 (2006).

Equivalent to *Urediniomycetes* (Kirk *et al*. 2001; Swann & Taylor 1995; Swann *et al*. 2001). The classification of *Pucciniomycotina* employed here parallels that of Bauer *et al*. (2006) and Aime *et al*. (2007).

Class: **Pucciniomycetes** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr*. **5**: 48 (2006).

Equivalent to *Urediniomycetidae* (Swann *et al*. 2001).

Order: **Septobasidiales** Couch ex Donk, *Persoonia* **3**: 243 (1964).

Synonym: *Septobasidiales* Couch, *Gen. Septobasidium*: 65 (1938), *nomen invalidum*.

Exemplar genera: *Septobasidium* Pat. 1892, *Auriculoscypha* D. A. Reid & Manim. 1985.

Order: **Pachnocybales** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr*. **5**: 48 (2006).

Exemplar genus: *Pachnocybe* Berk. 1836.

Order: **Helicobasidiales** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr*. **5**: 48 (2006).

Exemplar genera: *Helicobasidium* Pat. 1885, *Tuberculina* Tode ex Sacc. 1880.

Order: **Platygloeales** R. T. Moore, *Mycotaxon* **39**: 247 (1990).

Equivalent to *Platygloeales s. str*. (Swann *et al*. 2001).

Exemplar genera: *Platygloea* J. Schröt. 1887 *s. str*., *Eocronartium* G.F. Atk. 1902.

Order: **Pucciniales** Clem. & Shear, *Gen. Fungi* (2nd edn): 147 (1931).

Equivalent to *Uredinales*.

Exemplar genera: *Puccinia* Pers. 1801, *Uromyces* (Link) Unger 1832.

Class: **Cystobasidiomycetes** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr*. **5**: 46 (2006).

Equivalent to the *Erythrobasidium–Naohidea–Sakaguchia* clade (Swann *et al*. 2001) and *Cystobasidiaceae* lineage (Weiß *et al*. 2004a). Genera of *Cystobasidiomycetes* that are not placed in any order include *Sakaguchia* Y. Yamada, K. Maeda & Mikata 1994, and *Cyrenella* Goch. 1981 (Aime *et al*. 2007; Bauer *et al*. 2006).

Order: **Cystobasidiales** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr*. **5**: 46 (2006).

Exemplar genera: *Cystobasidium* (Lagerh.) Neuhoff 1924, *Occultifur* Oberw. 1990, *Rhodotorula* F.C. Harrison 1927 *pro parte*.

Order: **Erythrobasidiales** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr*. **5**: 46 (2006).

Exemplar genera: *Erythrobasidium* Hamam. Sugiyama & Komag. 1988, *Rhodotorula* F. C. Harrison 1927 *pro parte*, *Sporobolomyces* Kluyver & C. B. Niel 1924 *pro parte*, *Bannoa* Hamam. 2002.

Order: **Naohideales** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr*. **5**: 46 (2006).

Exemplar genus: *Naohidea* Oberw. 1990.

Class: **Agaricostilbomycetes** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr*. **5**: 45 (2006).

Equivalent to *Agaricostilbomycetidae* (Swann *et al*. 2001; Weiß *et al*. 2004a).

Order: **Agaricostilbales** Oberw. & R. Bauer, *Sydowia* **41**: 240 (1989).

Exemplar genera: *Agaricostilbum* J. E. Wright 1970 (emend. Wright, Bandoni & Oberw. 1981), *Chionosphaera* D. E. Cox 1976, *Kondoa* Y. Yamada, Nakagawa & I. Banno 1989 (*emend*. Fonseca, Sampaio, Inácio & Fell 2000).

Order: **Spiculogloeales** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr*. **5**: 45 (2006).

Equivalent to *Mycogloea* group (Weiß *et al*. 2004a).

Exemplar genera: *Mycogloea* L. S. Olive 1950, *Spiculogloea* P. Roberts 1996, *Sporobolomyces* Kluyver & C. B. Niel 1924 *pro parte*.

Table 3 – Support for major groups of Fungi in selected phylogenetic studies: Basidiomycota

Rank	Taxon	Reference	Data	OTUs	Support
Phylum	*BASIDIOMYCOTA*	James *et al.* (2006)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	50	BPP = 1 MLBS = 80
Subphylum	*Pucciniomycotina*	Matheny *et al.* (2007a, fig. 4)	SSU, LSU, 5.8S, *rpb1*, *rpb2*, *tef1*	17	BPP = 1 MPBS = 100
		Aime *et al.* (2007, fig. 2)	LSU, SSU	109	BPP = 1 MPBS = 100
Class	*Pucciniomycetes*	Matheny *et al.* (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	7	BPP > 0.95 MPBS > 70
		Matheny *et al.* (2007a, fig. 5)	LSU, SSU, 5.8S	24	BPP = 0.97 MPBS ≥ 70
		Aime *et al.* (2007, fig. 2)	LSU, SSU	19	BPP = 1 MPBS = 100
		Aime *et al.* (2007, fig. 3)	LSU, SSU	41	MPBS = 86
Order	*Septobasidiales*	Arun Kumar *et al.* (2007, fig. 7)	LSU, SSU	4	BPP = 1 MPBS = 100
Order	*Pachnocybales*	Bauer *et al.* (2006, fig. 1)	LSU	1	NA
		Berres *et al.* (1995, fig. 4)	LSU	1	NA
Order	*Helicobasidiales*	Aime *et al.* (2007, fig. 2)	LSU, SSU	2	BPP = 1 MPBS = 96 NJBS = 98
		Aime *et al.* (2007, fig. 3)	LSU, SSU	10	MPBS = 87
Order	*Platygloeales*	Aime *et al.* (2007, fig. 2)	LSU, SSU	4	BPP = 1 MPBS = 100 NJBS = 100
		Aime *et al.* (2007, fig. 3)	LSU, SSU	8	MPBS = 99
		Matheny *et al.* (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	2	BPP > 0.95 MPBS > 70
Order	*Pucciniales*	Aime *et al.* (2007, fig. 2)	LSU, SSU	12	BPP = 1 MPBS = 100 NJBS = 100
		Aime (2006)	LSU	46	MPBS = 99
		Wingfield *et al.* (2004)	SSU	72	MPBS < 50
		Matheny *et al.* (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	5	BPP > 0.95 MPBS > 70
Class	*Cystobasidiomycetes*	Aime *et al.* (2007, fig. 2)	LSU, SSU	27	BPP = 1 MPBS = 100 NJBS = 96
		Sampaio (2004, fig. 1)	LSU	11	BPP = 0.92
		Sampaio (2004, fig. 2)	LSU	26	BPP = 0.98
Order	*Cystobasidiales*	Nagahama *et al.* (2006, fig. 2)	LSU, SSU, 5.8S, *tef1*	9	MLBS = 100
		Aime *et al.* (2007, fig. 2)	LSU, SSU	12	BPP = 1 MPBS = 100 NJBS = 100
		Sampaio (2004, fig. 2)	LSU	8	BPP = 1
Order	*Erythrobasidiales*	Nagahama *et al.* (2006, fig. 2)	LSU, SSU, 5.8S, *tef1*	21	MLBS = 72
		Aime *et al.* (2007, fig. 2)	LSU, SSU	14	BPP = 1 MPBS = 83 NJBS = 91
		Sampaio (2004, fig. 2)	LSU	18	BPP = 1
Order	*Naohideales*	Aime *et al.* (2007, fig. 3)	LSU, SSU	2	MPBS = 98
		Weiß *et al.* (2004)	LSU	3	BPP = 0.94 NJBS < 50
Class	*Agaricostilbomycetes*	Aime *et al.* (2007, fig. 2)	LSU, SSU	25	BPP = 1 MPBS < 70 NJBS < 70
		Bauer *et al.* (2006, fig. 2)	LSU, SSU	4	NJBS = 89
		Matheny *et al.* (2007a, fig. 5)	LSU, SSU, 5.8S	8	BPP = 1 MPBS > 70
Order	*Agaricostilbales*	Aime *et al.* (2007, fig. 2)	LSU, SSU	22	BPP = 1 MPBS = 100 NJBS = 100
		Aime *et al.* (2007, fig. 2)	LSU, SSU	34	MPBS = 98
		Sampaio (2004, fig. 1)	LSU	7	BPP = 1
		Sampaio (2004, fig. 2)	LSU	23	BPP = 1

(continued on next page)

Table 3 (continued)

Rank	Taxon	Reference	Data	OTUs	Support
		Fell et al. (2001)	LSU	24	MPBS = 64
Order	*Spiculogloeales*	Aime et al. (2007, fig. 2)	LSU, SSU	3	BPP = 1 MPBS = 100 NJBS = 100
		Aime et al. (2007, fig. 3)	LSU, SSU	7	MPBS = 74
		Bauer et al. (2006, fig. 2)	LSU, SSU	2	NJBS = 90
Class	*Microbotryomycetes*	Aime et al. (2007, fig. 2)	LSU, SSU	31	BPP = 1 MPBS = 100 NJBS = 100
		Aime et al. (2007, fig. 3)	LSU, SSU	60	MPBS = 74
		Matheny et al. (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	6	BPP > 0.95 MPBS > 70
		Sampaio (2004, fig. 2)	LSU	49*	BPP = 0.87
		Fell et al. (2001)	LSU	78	MPBS = 75
Order	*Heterogastridiales*	Bauer et al. (2006, fig. 2)	LSU, SSU	1	NA
Order	*Microbotryales*	Aime et al. (2007, fig. 2)	LSU, SSU	4	BPP = 1 MPBS = 99 NJBS = 94
		Aime et al. (2007, fig. 3)	LSU, SSU	12	MPBS = 82
Order	*Leucosporidiales*	Aime et al. (2007, fig. 2)	LSU, SSU	3	BPP = 0.98 MPBS = 85 NJBS = 100
		Aime et al. (2007, fig. 3)	LSU, SSU	9	MPBS = 67
Order	*Sporidiobolales*	Aime et al. (2007, fig. 2)	LSU, SSU	13	BPP = 1 MPBS = 74 NJBS = 68
		Aime et al. (2007, fig. 3)	LSU, SSU	17	MPBS = 69
		Sampaio (2004, fig. 2)	LSU	20	BPP = 0.98
Class/Order	*Atractiellomycetes*, *Atractiellales*	Aime et al. (2007, fig. 2)	LSU, SSU	4	BPP = 1 MPBS = 80 NJBS = 96
		Aime et al. (2007, fig. 3)	LSU, SSU	8	MPBS = 68
		Bauer et al. (2006, fig. 2)	LSU, SSU	7	NJBS = 68
Class/Order	*Classiculomycetes*, *Classiculales*	Aime et al. (2007, fig. 2)	LSU, SSU	2	BPP = 1 MPBS = 100 NJBS = 100
		Weiß et al. (2004, figs. 1–2)	LSU	2	BPP = 1 NJBS = 99
Class/Order	*Mixiomycetes*, *Mixiales*	Aime et al. (2007, fig. 2)	LSU, SSU	1	NA
		Bauer et al. (2006, fig. 2)	LSU, SSU	1	NA
Class/Order	*Cryptomycocolacomycetes*, *Cryptomycocolacales*	Aime et al. (2007, fig. 3)	LSU, SSU	1	NA
		Bauer et al. (2006, fig. 1)	LSU	2	NJBS = 100
Subphylum	Ustilaginomycotina	Matheny et al. (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	24	BPP = 1 MPBS = 100
		Matheny et al. (2007a, fig. 5)	LSU, SSU, 5.8S	59	BPP = 1 MPBS > 70
Class	Ustilaginomycetes	Bauer et al. (2006, fig. 2)	LSU, SSU	21	NJBS = 100
		Matheny et al. (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	12	BPP > 0.95 MPBS > 70
		Matheny et al. (2007a, fig. 5)	LSU, SSU, 5.8S	25	BPP = 1 MPBS > 70
		Begerow et al. (2007, fig. 1)	LSU, ITS, *atp6*, *βtub*	53	BPP = 1 MPBS = 83 NJBS = 77
		Bauer et al. (2001, figs. 33–34)	LSU	36	MPBS = 79 NJBS = 93
		Fell et al. (2001, fig. 24)	LSU	27	NJBS = 86
Order	*Urocystales*	Begerow et al. (2007, fig. 1)	LSU, ITS, *atp6*, *βtub*	5	BPP = 1 MPBS = 66 NJBS = 96
		Matheny et al. (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	1	NA
		Bauer et al. (2001, figs. 33–34)	LSU	9	MPBS = 95[3] NJBS = 96[3]

Table 3 (*continued*)

Rank	Taxon	Reference	Data	OTUs	Support
Order	*Ustilaginales*	Matheny *et al.* (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	10	BPP > 0.95 MPBS > 70
		Matheny *et al.* (2007a, fig. 5)	LSU, SSU, 5.8S	23	BPP > 0.95 MPBS > 70
		Begerow *et al.* (2007, fig. 1)	LSU, ITS, *atp6*, β*tub*	46	BPP = 1 MPBS < 60 NJBS < 60
Class	Exobasidiomycetes	Matheny *et al.* (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	12	BPP > 0.95 MPBS < 50
		Begerow *et al.* (2007, fig. 1)	LSU, ITS, *atp6*, β*tub*	35	BPP < 0.60 MPBS < 60 NJBS < 60
		Bauer *et al.* (2001, figs. 33–34)	LSU	36	MPBS = 85 NJBS = 56
Order	*Doassansiales*	Matheny *et al.* (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	1	NA
		Matheny *et al.* (2007a, fig. 5)	LSU, SSU, 5.8S	4	BPP > 0.95 MPBS > 70
		Begerow *et al.* (2007, fig. 1)	LSU, ITS, *atp6*, β*tub*	4	BPP = 1 MPBS = 84 NJBS = 77
		Bauer *et al.* (2001, figs. 33–34)	LSU	5	MPBS = 96 NJBS = 97
Order	*Entylomatales*	Matheny *et al.* (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	4	BPP > 0.95 MPBS > 70
		Begerow *et al.* (2007, fig. 1)	LSU, ITS, *atp6*, β*tub*	3	BPP = 1 MPBS < 60 NJBS < 60
		Bauer *et al.* (2001, figs. 33–34)	LSU	9	MPBS = 72 NJBS = 91
Order	*Exobasidiales*	Matheny *et al.* (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	2	BPP > 0.95 MPBS > 70
		Matheny *et al.* (2007a, fig. 5)	LSU, SSU	6	BPP > 0.95 MPBS > 70
		Begerow *et al.* (2007, fig. 1)	LSU, ITS, *atp6*, β*tub*	8	BPP = 1 MPBS < 60 NJBS = 61
Order	*Georgefischeriales*	Matheny *et al.* (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	2	BPP > 0.95 MPBS > 70
		Begerow *et al.* (2007, fig. 1)	LSU, ITS, *atp6*, β*tub*	5	BPP < 0.60 MPBS < 60 NJBS < 60
		Bauer *et al.* (2001, figs. 33–34)	LSU	9	MPBS = 86 NJBS = 65
Order	*Microstromatales*	Matheny *et al.* (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	1	NA
		Matheny *et al.* (2007a, fig. 5)	LSU, SSU, 5.8S	3	BPP > 0.95 MPBS > 70
		Begerow *et al.* (2007, fig. 1)	LSU, ITS, *atp6*, β*tub*	5	BPP = 1 MPBS = 63 NJBS = 67
Order	*Tilletiales*	Matheny *et al.* (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	2	BPP > 0.95 MPBS > 70
		Matheny *et al.* (2007a, fig. 5)	LSU, SSU, 5.8S	7	BPP > 0.95 MPBS > 70
		Begerow *et al.* (2007, fig. 1)	LSU, ITS, *atp6*, β*tub*	5	BPP = 1 MPBS = 76 NJBS = 64
	Ustilaginomycotina incertae sedis (not placed in any class)				
Order	*Malasseziales*	Matheny *et al.* (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	1	NA
		Begerow *et al.* (2007, fig. 1)	LSU, ITS, *atp6*, β*tub*	2	BPP = 1 MPBS = 100 NJBS = 100

(*continued on next page*)

Table 3 (*continued*)

Rank	Taxon	Reference	Data	OTUs	Support
		Bauer *et al.* (2001, figs. 33–34)	LSU	4	MPBS = 100 NJBS = 100
Subphylum	*Agaricomycotina*	Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	125	BPP = 1 MPBS = 95
Class	*Tremellomycetes*	Matheny *et al.* (2007a, fig. 4)	SSU, LSU, 5.8S, *rpb1*, *rpb2*, *tef1*	5	BPP > 0.95 MPBS = 50-69
		Fell *et al.* (2001, figs. 19, 22)	LSU	139	MPBS = 100
Order	*Cystofilobasidiales*	Matheny *et al.* (2007a, fig. 5)	LSU, SSU, 5.8S	5	BPP = 1 MPBS ≥ 70
		Fell & Scorzetti (2004, fig. 1)	LSU	16	BPP = 1 MPBS = 83
Order	*Filobasidiales*	Fell *et al.* (2001, figs. 19, 22)	LSU	34	MPBS = 96
Order	*Tremellales*	Matheny *et al.* (2007a, fig. 5)	LSU, SSU, 5.8S	5	BPP ≥ 0.95 MPBS ≥ 70
		Fell *et al.* (2001, figs. 19, 22)	LSU	89	MPBS = 56
Class/Order	*Dacrymycetes*, *Dacrymycetales*	Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	4	BPP = 1 MPBS = 100
		Weiß & Oberwinkler (2001, fig. 6)	LSU	9	NJBS = 99
Class	*Agaricomycetes*	Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	119	BPP = 1 MPBS = 95
		James *et al.* (2006)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	37	BPP = 1 MLBS = 92
Subclass	*Agaricomycetidae*	Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	63	BPP = 1 MPBS = 96
		Binder & Hibbett (2007, fig. 2)	LSU, SSU, 5.8S, mt-LSU, *atp6*	47	BPP > 0.98 MLBS = 88
		Binder *et al.* (2005, fig. 1)	LSU, SSU, mt-LSU, mt-SSU	46	MPBS = 62
Order	*Agaricales*	Matheny *et al.* (2006, fig. 2)	LSU, SSU, 5.8S	230	BPP = 0.84
		Matheny *et al.* (2006, fig. 3)	LSU, SSU, 5.8S, *rpb1*, *rpb2*	238	BPP = 1 MPBS = 43
		Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	41	BPP = 1 MPBS = 76
		Moncalvo *et al.* (2002, fig. 2)	LSU	786	MPBS < 50
Order	*Atheliales*	Larsson *et al.* (2004, fig. 1)	LSU	8	MPBS = 97
		Binder *et al.* (2005, fig. 4)	LSU, SSU, mt-LSU, mt-SSU	3	MPBS = 75
Order	*Boletales*	Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	11	BPP = 1 MPBS = 100
		Binder & Hibbett (2007, fig. 2)	LSU, SSU, 5.8S, mt-LSU, *atp6*	42	BPP > 0.98 MLBS = 99
		Binder & Hibbett (2007, fig. 3)	LSU	301	BPP > 0.98
Subclass	*Phallomycetidae*	Hosaka *et al.* (2007, fig. 2)	LSU, mt-SSU, *atp6*, *rpb2*, *tef1*	222	BPP = 1 MPBS = 98
		Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	3	BPP = 1 MPBS = 100
Order	*Geastrales*	Hosaka *et al.* (2007, fig. 2)	LSU, mt-SSU, *atp6*, *rpb2*, *tef1*	21	BPP = 1 MPBS = 59
Order	*Gomphales*	Hosaka *et al.* (2007, fig. 2)	LSU, mt-SSU, *atp6*, *rpb2*, *tef1*	61	BPP = 1 MPBS = 63
Order	*Hysterangiales*	Hosaka *et al.* (2007, fig. 2)	LSU, mt-SSU, *atp6*, *rpb2*, *tef1*	99	BPP = 1 MPBS = 98
Order	*Phallales*	Hosaka *et al.* (2007, fig. 2)	LSU, mt-SSU, *atp6*, *rpb2*, *tef1*	41	BPP = 1 MPBS = 84
	Agaricomycetes incertae sedis (not placed in any subclass):				
Order	*Auriculariales*	Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	3	BPP = 1 MPBS = 100
		Weiß & Oberwinkler (2001, fig. 6)	LSU	43	NJBS < 60
Order	*Cantharellales*	Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	11	BPP = 1 MPBS = 69
		Moncalvo *et al.* (2007, fig. 1)	LSU, SSU, mtSSU, *rpb2*	29	BPP < 0.50 MPBS < 50
		Binder *et al.* (2005, fig. 4)	LSU, SSU, mt-LSU, mt-SSU	31	MPBS < 50
Order	*Corticiales*	Larsson *et al.* (2004, fig. 1)	LSU	7	MPBS = 96

Table 3 (*continued*)

Rank	Taxon	Reference	Data	OTUs	Support
		Binder *et al.* (2005, fig. 4)	LSU, SSU, mt-LSU, mt-SSU	8	MPBS = 81
Order	*Gloeophyllales*	Thorn *et al.* (2000, fig. 5)	LSU	5	MPBS = 71
		Binder *et al.* (2005, fig. 4)	LSU, SSU, mt-LSU, mt-SSU	6	MPBS = 54
	Hymenochaetales	Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	7	BPP = 1 MPBS = 63
		Larsson *et al.* (2007, fig. 3)	LSU, 5.8S	174	BPP = 1
		Wagner & Fischer (2002, fig. 2)	LSU	104	NJBS = 100
Order	*Polyporales*	Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	16	BPP = 1 MPBS = 85
		Binder *et al.* (2005, fig. 4)	LSU, SSU, mt-LSU, mt-SSU	122	MPBS < 50
Order	*Russulales*	Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	8	BPP = 1 MPBS = 99
		Larsson & Larsson (2003, fig. 1)	LSU, 5.8S	127	MPBS = 96
		Miller *et al.* (2007, fig. 2)	LSU, ITS	143	MPBS = 100
Order	*Sebacinales*	Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	2	BPP = 1 MPBS = 100
		Weiß & Oberwinkler (2001, fig. 6)	LSU	9	NJBS = 99
Order	*Thelephorales*	Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	2	BPP = 1 MPBS = 100
		Binder *et al.* (2005, fig. 4)	LSU, SSU, mt-LSU, mt-SSU	13	MPBS = 97
		Larsson *et al.* (2004, fig. 1)	LSU, 5.8S	11	MPBS = 86
Order	*Trechisporales*	Matheny *et al.* (2007b, fig. 6)	LSU, SSU, 5.8S, *rpb2*, *tef1*	2	BPP = 1 MPBS = 100
		Binder *et al.* (2005, fig. 4)	LSU, SSU, mt-LSU, mt-SSU	20	MPBS = 69
		Larsson *et al.* (2004, fig. 1)	LSU, 5.8S	12	MPBS = 99
	Basidiomycota incertae sedis (*not placed in any subphylum*):				
Class/Order	*Wallemiomycetes*, *Wallemiales*	Matheny *et al.* (2007a, fig. 4)	LSU, SSU, 5.8S, *rpb1*, *rpb2*, *tef1*	3	BPP > 0.95 MPBS > 70
		Matheny *et al.* (2007a, fig. 5)	LSU, SSU, 5.8S	3	BPP = 1 MPBS > 70
Class/Order	*Entorrhizomycetes*, *Entorrhizales*	Matheny *et al.* (2007a, fig. 5)	LSU, SSU, 5.8S	3	BPP = 1 MPBS > 70
		Bauer *et al.* (2001, figs. 33–34)	LSU	2	MPBS = 100 NJBS = 100

See Table 1 for explanation.

Class: **Microbotryomycetes** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr.* **5**: 47 (2006).

Equivalent to *Microbotryomycetidae* (Swann *et al.* 2001; Weiß *et al.* 2004a). The backbone of the *Microbotryomycetes* remains poorly resolved, and several genera of *Microbotryomycetes* are not placed in any order, including *Colacogloea* Oberw. & R. Bauer 1991, *Atractocolax* R. Kirschner, R. Bauer & Oberw. 1999, *Krieglsteinera* Pouzar 1987, *Camptobasidium* Marvanová & Suberkr. 1990, *Kriegeria* Bres. 1891 and certain species of the polyphyletic genera *Sporobolomyces* Kluyver & C. B. Niel 1924 *pro parte*, *Rhodotorula* F. C. Harrison 1927 *pro parte*, and *Leucosporidium* Fell, Statzell, I. L. Hunter & Phaff 1970, and others (Aime *et al.* 2007; Bauer *et al.* 2006; Sampaio *et al.* 2003; Weiß *et al.* 2004a).

Order: **Heterogastridiales** Oberw., R. Bauer & Bandoni R. J., *Mycologia* **82**: 57 (1990).

Exemplar genus: *Heterogastridium* Oberw. & R. Bauer 1990.

Bauer *et al.* (2006) placed *Colacogloea*, *Atractocolax* and *Krieglsteinera* in the *Heterogastridiales*. However, analyses of Bauer *et al.* (2006) and Aime *et al.* (2007) suggest that *Heterogastridium* and *Colacogloea* do not form a clade, while *Atractocolax* and *Krieglsteinera* have yet to be sampled in molecular phylogenetic studies.

Order: **Microbotryales** R. Bauer & Oberw., *in* Bauer *et al.*, *Can. J. Bot.* **75**: 1309 (1997).

Exemplar genera: *Microbotryum* Lév. 1847, *Ustilentyloma* Savile 1964.

Order: **Leucosporidiales** J. P. Samp., M. Weiß & R. Bauer, *in* Sampaio *et al.*, *Mycol. Progr.* **2**: 61 (2003).

Exemplar genera: *Leucosporidiella* J. P. Samp. 2003, *Leucosporidium* Fell, Statzell, I. L. Hunter & Phaff 1970, *Mastigobasidium* Golubev 1999.

Order: **Sporidiobolales** J. P. Samp., M. Weiß & R. Bauer, *in* Sampaio *et al.*, *Mycol. Progr.* **2**: 66 (2003).

Exemplar genera: *Sporidiobolus* Nyland 1949, *Sporobolomyces* Kluyver & C. B. Niel 1924, *Rhodosporidium* I. Banno 1967, *Rhodotorula* F. C. Harrison 1927 *pro parte*.

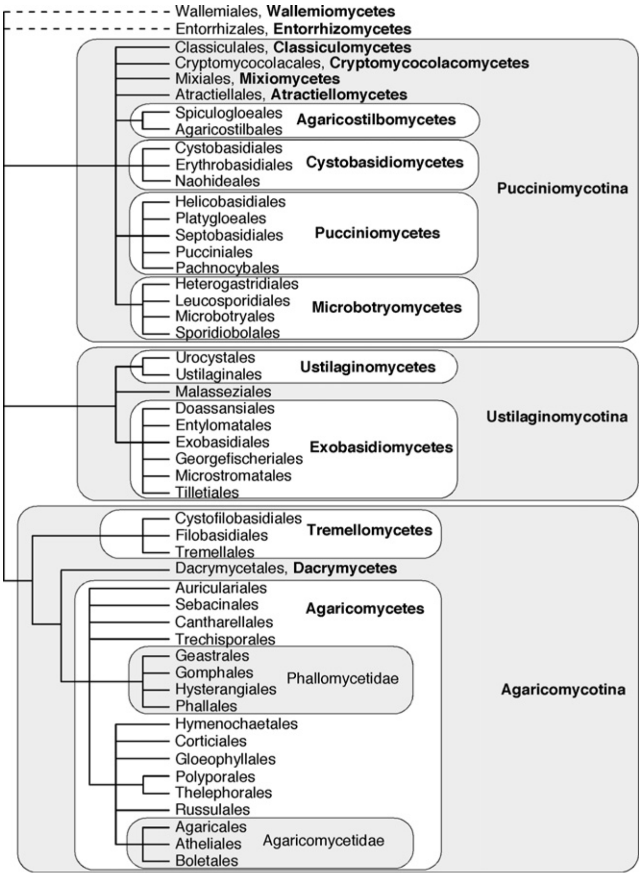

Fig 3 – Phylogeny and classification of *Fungi. Basidiomycota*. See Table 3 for support values for clades. Dashed lines indicate taxa that are of uncertain placement.

Class: **Atractiellomycetes** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr.* **5**: 45 (2006).

Order: **Atractiellales** Oberw. & Bandoni, *Can. J. Bot.* **60**: 1740 (1982).

Emend. Oberw. & Bauer, *Sydowia* 41: 239 (1989).

Exemplar genera: *Atractiella* Sacc. 1886, *Saccoblastia* A. Møller 1895, *Helicogloea* Pat. 1892, *Phleogena* Link 1833.

Class: **Classiculomycetes** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr.* **5**: 46 (2006).

Order: **Classiculales** R. Bauer, Begerow, Oberw. & Marvanová, *Mycologia* **95**: 763 (2003).

Exemplar genera: *Classicula* R. Bauer, Begerow, Oberw. & Marvanová 2003, *Jaculispora* H. J. Huds. & Ingold 1960.

Class: **Mixiomycetes** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr.* **5**: 47 (2006).

Order: **Mixiales** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr.* **5**: 47 (2006).

Exemplar genus: *Mixia* C. L. Kramer 1959 [‘1958’].

Class: **Cryptomycocolacomycetes** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr.* **5**: 46 (2006).

Order: **Cryptomycocolacales** Oberw. & R. Bauer, *Mycologia* **82**: 672 (1990).

Exemplar genera: *Cryptomycocolax* Oberw. & R. Bauer 1990, *Colacosiphon* R. Kirschner, R. Bauer & Oberw. 2001.

Subphylum: **Ustilaginomycotina** R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr.* **5**: 45 (2006).

Equivalent to *Ustilaginomycetes* (Bauer *et al.* 1997, 2001; Swann & Taylor 1995).

The classification of *Ustilaginomycotina* employed here largely parallels that of Begerow *et al.* (2007), with the primary differences being that here the *Entorrhizomycetes* are classified as *incertae sedis* among *Basidiomycota* (rather than being a class within *Ustilaginomycotina*).

Class: **Ustilaginomycetes** R. Bauer, Oberw. & Vánky, *Can. J. Bot.* **75**: 1311 (1997).

Emend. Begerow, Stoll & Bauer, *Mycologia* **98**: 908 (2007) [‘2006’].

Equivalent to *Ustilaginomycetidae* Jülich as emmended by Bauer & Oberwinkler (Bauer *et al.* 1997, 2001; Weiß *et al.* 2004a).

Order: **Urocystales** R. Bauer & Oberw., *in* Bauer *et al.*, *Can. J. Bot.* **75**: 1311 (1997).

Exemplar genera: *Urocystis* Rabenh. ex Fuckel 1870, *Ustacystis* Zundel 1945, *Doassansiopsis* (Setch.) Dietel 1897.

Melanotaenium de Bary 1874 has also been placed in this order (Bauer *et al.* 2001; Weiß *et al.* 2004a), but analyses of Begerow *et al.* (2007) and Matheny *et al.* (2007b) have supported its transfer to *Ustilaginales*.

Order: **Ustilaginales** G. Winter, *Rabenh. Krypt.-Fl.* 2nd ed. **1**(1.1): 73 (1880), as ‘*Ustilagineae*’.

Emend. Bauer & Oberwinkler, *in* Bauer *et al.*, *Can. J. Bot.* **75**: 1311 (1997).

Exemplar genera: *Ustilago* (Pers.) Roussel 1806, *Cintractia* Cornu 1883.

Thecaphora Fingerh. 1836 has also been placed in this order (Bauer *et al.* 2001), but analyses of Begerow *et al.* (2007) and Matheny *et al.* (2007b) have suggested that it is not nested in *Ustilaginales*. *Thecaphora* may be the sister group of *Urocystales* (Matheny *et al.* 2007b).

Class: Exobasidiomycetes Begerow, Stoll & R. Bauer, *Mycologia* 98: 908 (2007) [‘2006’].

Equivalent to *Exobasidiomycetidae* Jülich 1981 *emend.* Bauer & Oberwinkler, except for exclusion of *Malasseziales* (Bauer *et al.* 1997, 2001; Weiß *et al.* 2004a).

Monophyly of the *Exobasidiomycetidae*, as delimited here, is supported with high Bayesian posterior probability in analyses of *rpb1*, *rpb2*, and *tef1*, and nuclear lsu, ssu, and 5.8S ribosomal genes (Matheny *et al.* 2007b), but it is weakly supported in analyses using *atp6*, β-tubulin, and nuc-lsu ribosomal RNA genes (Begerow *et al.* 2007). See comments regarding *Malasseziales*.

Order: **Doassansiales** R. Bauer & Oberw., *in* Bauer *et al.*, *Can. J. Bot.* **75**: 1312 (1997).

Exemplar genera: *Doassansia* Cornu 1883, *Rhamphospora* D. D. Cunn. 1888, *Nannfeldtiomyces* Vánky 1981.

Order: **Entylomatales** R. Bauer & Oberw., *in* Bauer *et al*., *Can. J. Bot.* **75**: 1311 (1997).

Exemplar genera: *Entyloma* de Bary 1874, *Tilletiopsis* Derx 1948.

Begerow *et al*. (2007) erected the monotypic order *Ceraceosorales* Begerow, Stoll & R. Bauer for *Ceraceosorus bombacis* (B. K. Bakshi) B. K. Bakshi 1976, which was weakly supported as the sister group of *Tilletiopsis albescens* Gokhale 1972. The *Ceraceosorus-T. albescens* clade was placed as the sister group of *Entylomatales*, again with weak support. *Ceraceosorales* is not included in the present classification, pending more robust resolution of the relationships among *Ceraceosorus*, *Tilletiopsis*, and *Entyloma*.

Order: **Exobasidiales** Henn., *in* Engler & Prantl (eds), *Nat. Pflanzenfam*. **1**(1**): 103 (1897), as '*Exobasidiineae*'.

Emend. Bauer, Oberwinkler & Vánky, *Can. J. Bot.* **75**: 1312 (1997).

Exemplar genera: *Exobasidium* Woronin 1867, *Clinoconidium* Pat. 1898, *Dicellomyces* L. S. Olive 1945.

Order: **Georgefischeriales** R. Bauer, Begerow & Oberw., *in* Bauer *et al*., *Can. J. Bot.* **75**: 1311 (1997).

Exemplar genera: *Georgefischeria* Thirum. & Naras. *emend*. Gandhe 1980, *Phragmotaenium* R. Bauer, Begerow, A. Nagler & Oberw. 2001, *Tilletiaria* Bandoni & B. N. Johri 1972, *Tilletiopsis* Derx 1948 *pro parte*.

Order: **Microstromatales** R. Bauer & Oberw., *in* Bauer *et al*., *Can. J. Bot.* **75**: 1311 (1997).

Exemplar genera: *Microstroma* Niessl 1861, *Sympodiomycopsis* Sugiy., Tokuoka & Komag. 1991, *Volvocisporium* Begerow, R. Bauer & Oberw. 2001.

Order: **Tilletiales** Kreisel ex R. Bauer & Oberw., *in* Bauer *et al*., *Can. J. Bot.* **75**: 1311 (1997).

Exemplar genera: *Tilletia* Tul. & C. Tul. 1847, *Conidiosporomyces* Vánky 1992, *Erratomyces* M. Piepenbr. & R. Bauer 1997.

Ustilaginomycotina *incertae sedis* (not placed in any class):

Order: **Malasseziales** R. T. Moore, *Bot. Mar*. **23**: 371 (1980).

Emend. Begerow, Bauer & Boekhout, *Mycol. Res*. **104**: 59 (2000).

Exemplar genus: *Malassezia* Baill. 1889.

Analyses of the protein-coding genes *rpb1*, *rpb2*, and *tef1*, alone or in combination with nuclear LSU, SSU, and 5.8S ribosomal genes, suggest that *Malasseziales* are included in the *Ustilaginomycetes*, but analyses of nuclear ribosomal genes alone or in combination with *atp6* and β-tubulin suggest that *Malasseziales* is in the *Exobasidiomycetes* (Bauer *et al*. 2001; Begerow *et al*. 2007; Matheny *et al*. 2007b; Weiß *et al*. 2004a).

Subphylum: **Agaricomycotina** Dowell *Prosyllabus* LXXVII (2001).

Homonym: *Agaricomycotina* R. Bauer, Begerow, J. P. Samp., M. Weiß & Oberw., *Mycol. Progr*. **5**: 45 (2006). Equivalent to *Hymenomycetes* (Swann & Taylor 1995) or *Basidiomycetes* (Kirk *et al*. 2001; Hibbett 2007).

Class: **Tremellomycetes** Dowell, *Prosyllabus*: LXXVII (2001).

Dimorphic fungi. Fruiting bodies gelatinous or absent, parenthesomes sacculate or absent, basidia septate or nonseptate. The least inclusive clade containing *Tremellales*, *Filobasidiales* and *Cystofilobasidiales*.

Equivalent to *Tremellomycetidae sensu* Swann & Taylor (1995) and Weiß *et al*. (2004a). The name *Tremellomycetidae* was earlier published by Locquin (1984), but without a Latin diagnosis, and it is therefore invalid under the *Code*.

Order: **Cystofilobasidiales** Fell, Roeijmans & Boekhout, *Int. J. Syst. Bacteriol*. **49**: 911 (1999).

Exemplar genera: *Cystofilobasidium* Oberw. & Bandoni 1983, *Mrakia* Y. Yamada & Komag. 1987, *Itersonilia* Derx 1948.

Order: **Filobasidiales** Jülich, *Biblthca Mycol*. **85**: 324 (1981).

Exemplar genera: *Filobasidiella* Kwon-Chung 1976, *Cryptococcus* Vuill. 1901 (*pro parte*).

Order: **Tremellales** Fr., *Syst. Mycol*. **1**: 2 (1821), as '*Tremellinae*'.

As delimited here, the group includes *Trichosporonales* Boekhout & Fell 2001 (Fell *et al*. 2001) and *Christianseniales* F. Rath 1991 (Wells & Bandoni 2001). *Filobasidiales*, which Weiß *et al*. (2004a) included in *Tremellales s. lat*., has been resolved as the sister group of *Tremellales* (Fell *et al*. 2001; Matheny *et al*. 2007b; Swann & Taylor 1995).

Exemplar genera: *Tremella* Pers. 1794, *Trichosporon* Behrend 1890, *Christiansenia* Hauerslev 1969.

Class: **Dacrymycetes** Dowell, *Prosyllabus*: LXXVII (2001)

Fruiting bodies gelatinous, basidia furcate (rarely unisporous), parenthesomes imperforate.

Containing the single order *Dacrymycetales* (Wells & Bandoni 2001).

Order: **Dacrymycetales** Henn., *in* Engler & Prantl (eds), *Nat. Pflanzenfam*. **1**(1**): 96 (1898), as '*Dacryomycetineae*'.

Exemplar genera: *Dacrymyces* Nees 1861, *Calocera* (Fr.) Fr. 1828, *Guepiniopsis* Pat. 1883.

Class: **Agaricomycetes** Dowell, *Prosyllabus*: LXXVII (2001)

Fruiting bodies hymenomycetous or gasteroid, basidia two- to eight-spored, parenthesomes perforate or imperforate. The least-inclusive clade containing *Auriculariales*, *Sebacinales*, *Cantharellales*, *Phallomycetidae* and *Agaricomycetidae*.

This group is approximately equivalent to *Homobasidiomycetes sensu* Hibbett & Thorn (2001) plus *Auriculariales* and *Sebacinales*.

Subclass: **Agaricomycetidae** Parmasto, *Windahlia* **16:** 16 (1986).
Synonym: *Basidiosporeae* Bessey, Univ. Studies, Univ. Nebr. **7**: 306 (1907).

The least-inclusive clade containing *Agaricales*, *Boletales* and *Atheliales*.

The delimitation of *Agaricomycetidae* adopted here differs from that of Parmasto (1986), who described *Agaricomycetidae* as a subclass of *Cantharellomycetes* Parm. 1986. For example, many of the resupinate forms in the *Agaricomycetidae* were placed by Parmasto in the *Corticiomycetes* Parm. 1986. The name *Agaricomycetidae* was also published by Locquin (1984), but without a Latin diagnosis and it is therefore invalid under the *Code*.

Order: **Agaricales** Underw., *Moulds, Mildews Mushrooms*: 97 (1899).

Equivalent to euagarics clade (Hibbett & Thorn 2001).

Exemplar genera: *Agaricus* L. 1753, *Coprinus* Pers. 1797, *Pleurotus* (Fr.) P. Kumm. 1871.

Order: **Atheliales** Jülich, *Biblthca Mycol.* **85**: 343 (1981).

Equivalent to athelioid clade (Binder *et al.* 2005; Larsson *et al.* 2004).

Exemplar genera: *Athelia* Pers. 1822, *Piloderma* Jülich 1969, *Tylospora* Donk 1960.

Order: **Boletales** E.-J. Gilbert, *Livres Mycol.* **3**: 83 (1931).

Equivalent to bolete clade (Binder & Hibbett 2006; Hibbett & Thorn 2001).

Exemplar genera: *Boletus* Fr. 1821, *Scleroderma* Pers. 1801, *Coniophora* DC. 1815, *Rhizopogon* Fr. & Nordholm 1817.

Subclass: **Phallomycetidae** K. Hosaka, Castellano & Spatafora, *Mycologia* **98**: 955 (2007) ['2006'].

Equivalent to *Phallales sensu* Kirk *et al.* (2001), and the gomphoid-phalloid clade (Hibbett & Thorn 2001; Hosaka *et al.* 2007).

Order: **Geastrales** K. Hosaka & Castellano, *Mycologia* **98:** 957 (2007) ['2006'].

Exemplar genera: *Geastrum* Pers. 1794, *Radiigera* Zeller 1944, *Sphaerobolus* Tode 1790.

Order: **Gomphales** Jülich, *Biblthca Mycol.* **85**: 348 (1981).

Exemplar genera: *Gomphus* (Fr.) Weinm. 1826, *Gautieria* Vittad. 1831, *Ramaria* Holmsk. 1790.

Order: **Hysterangiales** K. Hosaka & Castellano, *Mycologia* **98**: 956 (2007) ['2006'].

Exemplar genera: *Hysterangium* Vittad. 1831, *Phallogaster* Morgan 1893, *Gallacea* Lloyd 1905, *Austrogautieria* E. L. Stewart & Trappe 1985.

Order: **Phallales** E. Fisch., *in* Engler & Prantl (eds), *Nat. Pflanzenfam.* **1**(1**): 276 (1898).

Equivalent to *Phallomycetidae* Locq. (Locquin 1984), which was invalidly published, owing to the absence of a Latin diagnosis.

Exemplar genera: *Phallus* Junius ex L. 1753, *Clathrus* P. Micheli ex L. 1753, *Claustula* K. M. Curtis 1926.

Agaricomycetes *incertae sedis* (not placed in any subclass):

Order: **Auriculariales** J. Schröt., *in* Cohn (ed.), *Krypt.-Fl. Schlesien* **1**: 382 (1889).

Exemplar genera: *Auricularia* Bull. ex Juss. 1789, *Exidia* Fr. 1822, *Bourdotia* (Bres.) Trotter 1913.

Order: **Cantharellales** Gäum., *Vergl. Morph. Pilze*: 495 (1926).

Equivalent to the cantharelloid clade (Hibbett & Thorn 2001; Moncalvo *et al.* 2007). The *Cantharellales* as delimited here includes *Tulasnella*, which is distinguished by unusual basidia with inflated sterigmata, and has been classified in a separate order, *Tulasnellales* Rea 1922 (e.g. Weiß *et al.* 2004a). Extreme evolutionary rate heterogeneity in the nuclear ribosomal RNA genes of *Tulasnella*, *Cantharellus* and *Craterellus* is a source of error in phylogenetics of *Cantharellales*. Analyses of Matheny *et al.* (2006) suggest that *Tulasnella* is nested within the *Cantharellales*, but it could also be the sister group to *Cantharellales s.str.* (Moncalvo *et al.* 2007). If so, then it may be appropriate to segregate *Tulasnellales* from *Cantharellales s.str.*

Exemplar genera: *Cantharellus* Fr. 1821, *Botryobasidium* Donk 1931, *Craterellus* Pers. 1825, *Tulasnella* J. Schröt. 1888.

Order: **Corticiales** K. H. Larss., **ord. nov.**
MycoBank no.: MB 501299

Basidiomata resupinata, effuso-reflexa vel discoidea; hymenophora laevia; systema hypharum monomiticum; dendrohyphidia raro absentia; basidia saepe e probasidiis oriuntur. Cystidia presentia vel absentia. Sporae hyalinae, tenuitunicatae, albae vel aggregatae roseae.

Typus: Corticium Pers. 1794.

Basidiomycetes with effused or discoid (*Cytidia*) basidiomata, a smooth hymenophore, and a monomitic hyphal system with clamped, rarely simple-septate, hyphae. Dendrohyphidia common. Species with or without cystidia. A probasidial resting stage is present in many species. Spores smooth, in masses white to pink. Saprotrophic, parasitic, or lichenicolous.

Equivalent to *Vuilleminiales* Boidin *et al.* 1998 and the corticioid clade (Binder *et al.* 2005; Larsson *et al.* 2004). Boidin *et al.* (1998) explicitly included *Corticium* in their new order, as a member of the family *Vuilleminiaceae* Maire 1902. Jülich (1981) also placed *Corticium* in *Vuilleminiaceae* but referred them to *Aleurodiscales* Jülich 1981. *Corticium* is the type of *Corticiaceae* Herter 1910, a family name conserved against *Vuilleminiaceae*. The introduction of *Corticiales* as a new name for this order is, therefore, the preferred option.

Exemplar genera: *Corticium* Pers. 1794, *Vuilleminia* Maire 1902, *Punctularia* Pat. 1895.

Order: **Gloeophyllales** Thorn, **ord. nov.**
MycoBank no.: MB 501300

Basidiomata annua vel perennia, resupinata, effuso-reflexa, dimidiata vel pileata; hymenophora laevia, merulioidea, odontioidea vel poroidea. Systema hypharum monomiticum, dimiticum vel trimiticum. Hyphae generativae fibulatae vel efibulatae. Leptocystidia ex trama in hymenium projecta, hyalina vel brunnea, tenuitunicata vel crassitunicata. Basidiosporae laeves, hyalinae, tenuitunicatae, ellipsoideae vel cylindricae vel allantoideae, inamyloideae. Lignum decompositum brunneum vel album.

Typus: Gloeophyllum P. Karst. 1882.

Fruiting bodies perennial or annual and long-lived, with hymenium maturing and thickening over time. Stature resupinate, effused-reflexed or dimidiate, with smooth, wrinkled, dentate, lamellate or regularly poroid hymenophore, or pileate-stipitate with lamellae. (Aborted, coralloid or flabelliform fruiting bodies may be formed under conditions of darkness or high carbon dioxide concentration). Leptocystidia or hyphoid hairs originating in the context and extending into or protruding from the hymenial layer (or lamellar margin in *Neolentinus*) are common; these often with thick brown walls and brownish incrustation. Context brown (but pallid in *Neolentinus*) and generally darkening in potassium hydroxide (the brownish incrustation in *Boreostereum* turning green in potassium hydroxide). Monomitic (if so, with sclerified generative hyphae), dimitic, or trimitic; generative hyphae with or without clamp connections. Basidiospores hyaline, ellipsoid to cylindrical or suballantoid, with thin, smooth walls, and neither amyloid, dextrinoid nor cyanophilous. Where this is known, basidiospores are binucleate and sexuality is heterothallic and bipolar (but tetrapolar in *V. berkeleyi*).

Causing brown rots (*Gloeophyllum*, *Neolentinus*, *Veluticeps*) or stringy white rot (*Boreostereum*, *Donkioporia*) of wood of gymnosperms, monocots and dicots. Occurrence on 'wood in service' (e.g. railway ties, paving blocks, wooden chests) seems to be common (in *Donkioporia*, *Gloeophyllum*, *Heliocybe* and *Neolentinus*); often on charred wood (*Boreostereum* and *Veluticeps*).

Equivalent to *Gloeophyllum* clade (Binder *et al.* 2005).

Exemplar genera: *Gloeophyllum* P. Karst. 1882, *Neolentinus* Redhead & Ginns 1985, *Veluticeps* (Cooke) Pat. 1894.

Order: **Hymenochaetales** Oberw., *in* Frey *et al.* (eds), *Beitr. Biol. niederen Pflanz.*: 89 (1977).

Equivalent to the hymenochaetoid clade (Hibbett & Thorn 2001; Larsson *et al.* 2007).

Exemplar genera: *Hymenochaete* Lév. 1846, *Phellinus* Quél. 1886, *Trichaptum* Murrill 1904.

Order: **Polyporales** Gäum., *Vergl. Morph. Pilze*: 503 (1926).

Equivalent to polyporoid clade (Hibbett & Thorn 2001).

Exemplar genera: *Polyporus* Fr. 1815, *Fomitopsis* P. Karst. 1881, *Phanerochaete* P. Karst. 1889.

Order: **Russulales** Kreisel ex P. M. Kirk, P. F. Cannon & J. C. David, *in* Kirk *et al.*, *Ainsworth & Bisby's Dict. Fungi* (9th edn): xi (2001).

Equivalent to the russuloid clade (Hibbett & Thorn 2001; Larsson & Larsson 2003; Miller *et al.* 2007).

Exemplar genera: *Russula* Pers. 1796, *Aleurodiscus* Rabenh. ex J. Schröt. 1888, *Bondarzewia* Singer 1940, *Hericium* Pers. 1794, *Peniophora* Cooke 1879, *Stereum* Pers. 1794.

Order: **Sebacinales** M. Weiß, Selosse, Rexer, A. Urb. & Oberw., *Mycol. Res.* **108**: 1007 (2004b).

Exemplar genera: *Sebacina* Tul. 1871, *Tremellodendron* G. F. Atk. 1902, *Piriformospora* Sav. Verma, Aj. Varma, Rexer, G. Kost & P. Franken 1998.

Order: **Thelephorales** Corner ex Oberw., *Sydowia* **78**: 361 (1976).

Equivalent to the thelephoroid clade (Hibbett & Thorn 2001).

Exemplar genera: *Thelephora* Ehrh. ex Willd. 1787, *Bankera* Coker & Beers ex Pouzar 1955, *Polyozellus* Murrill 1910.

Order: **Trechisporales** K. H. Larss., **ord. nov.**
MycoBank no.: MB 501301

Basidiomata resupinata, stipitata vel clavarioidea. Hymenophora laevia, grandinioidea, hydnoidea vel poroidea. Systema hypharum monomiticum vel dimiticum. Hyphae fibulatae, septa hypharum interdum inflata (ampullata). Cystidia praesentia vel absentia. Basidia 4-6 sterigmata formantia. Sporae laeves vel ornatae. Species lignicolae vel terricolae.

Typus: *Trechispora* P. Karst. 1890.

Basidiomycetes with effused, stipitate or clavarioid basidiomata. Hymenophore smooth, grandinioid, hydnoid or poroid. Hyphal system monomitic, hyphae clamped, subicular hyphae with or without ampullate septa. Cystidia present in some species, mostly lacking. Basidia with four to six sterigmata. Spores smooth or ornamented. On wood or soil.

Equivalent to *Hydnodontales* Jülich 1981 and trechisporoid clade (Binder *et al.* 2005; Larsson *et al.* 2004). *Hydnodon* Banker 1913 was recently placed in synonymy under *Trechispora* (Ryvarden 2002) and this synonymy is supported by molecular data (K.H. Larsson, unpubl.). The introduction of a new name for the group, a name that connects to the clade name already established and that is based on the most species-rich genus is, therefore, justified.

Exemplar genera: *Trechispora* P. Karst. 1890, *Sistotremastrum* J. Erikss. 1958, *Porpomyces* Jülich 1982.

Basidiomycota ***incertae sedis*** (not placed in any subphylum):

Class: **Wallemiomycetes** Zalar, de Hoog & Schroers, *Antonie van Leeuwenhoek* **87**: 322 (2005).

Analyses of *rpb1*, *rpb2*, *tef1*, and nuc-lsu, nuc-ssu, and 5.8S ribosomal RNA genes suggest that the *Wallemiomycetes* is the sister group of the rest of the *Basidiomycota* (possibly along with *Entorrhizomycetes*, see below), but subsets of this dataset produce alternative placements (Matheny *et al.* 2007b; Zalar *et al.* 2005).

Order: **Wallemiales** Zalar, de Hoog & Schroers, *Antonie van Leeuwenhoek* **87**: 322 (2005).

Exemplar genus: *Wallemia* Johan-Olsen 1887.

Class: **Entorrhizomycetes** Begerow, Stoll & R. Bauer, *Mycologia* **98**: 908 (2007) ['2006'].

Equivalent to *Entorrhizomycetidae* R. Bauer & Oberw. (Bauer *et al.* 1997). So far, only ribosomal RNA genes have been sequenced in *Entorrhizomycetes*. Analyses with broad sampling across all groups of *Basidiomycota* and including *Ascomycota* and *Glomeromycota* as outgroups suggest that *Entorrhizomycetes* is not nested within any subphylum, and may be the sister group of the rest of the *Basidiomycota* (Matheny *et al.* 2007a; also see Begerow *et al.* 1997).

Order: **Entorrhizales** R. Bauer & Oberw., *in* Bauer *et al.*, , *Can. J. Bot.* **75**: 1311 (1997).

Exemplar genus: *Entorrhiza* C. A. Weber 1884.

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Note added in proof

After this article went to press, the authors became aware of the following publication, which includes alternative citations for many of the names included here: Doweld A, 2001. *Prosyllabus tracheophytorum: Tentamen systematis plantarum vascularium (Tracheophyta)*. Geos, Moscow.

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RESEARCH HIGHLIGHTS

ORGANIC CHEMISTRY

Ring leaders

Angew. Chem. Int. Edn doi:10.1002/anie.200701551 (2007)

Chemists in the United States report an improved procedure for preparing boronate esters — starting materials for making the many molecules that contain linked aromatic rings.

The preferred route to boronate esters is from readily available aryl chlorides. But existing processes require high temperatures and don't work for all substrates. By changing the catalysts used, Stephen Buchwald and his colleagues at the Massachusetts Institute of Technology, Cambridge, prepared boronate esters from aryl chlorides at room temperature. Their method also works for a wider range of molecules than the previous method.

Finally, they react two aryl chlorides together, through a boronate ester intermediate, to create 'biaryl' compounds. This is the first time that this desirable transformation has been achieved directly from two aryl chlorides.

Assorted fungi

Mycol. Res. **3,** 509-547 (2007)

A concerted effort by 67 researchers based in 13 countries to sort out the taxonomy of fungi has reached its conclusion. The hope is that the new classification, which divides the kingdom Fungi into 195 taxa, will clear up naming confusion in the literature and bring about consistency across online databases.

To devise the classification, David Hibbett of Clark University in Worcester, Massachusetts, and his colleagues sorted through molecular data on different fungal species and examined the history of their nomenclature. Their effort, part of the 'Assembling the Fungal Tree of Life' project, should provoke some changes. For example, the researchers propose that the phylum Zygomycota, which includes the 'sugar' moulds found on fruit, is disbanded and its taxa shared among other groups.

D. HIBBETT

CHEMICAL BIOLOGY

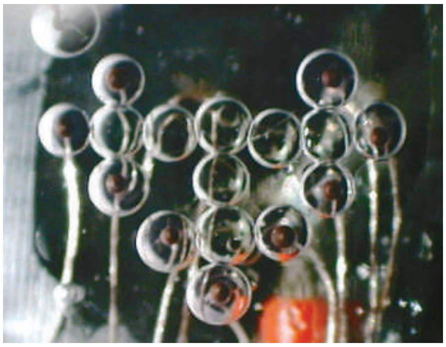
Smart drops

J. Am. Chem. Soc. doi:10.1021/ja072292a (2007)

Artificial cell-like compartments can be linked into networks that act as devices, show Matthew Holden of the University of Oxford and his co-workers.

Each compartment is a water droplet, typically less than 1 millimetre across, surrounded by a lipid monolayer and immersed in oil (pictured below). When two droplets stick together, they are separated by a cell-membrane-like lipid bilayer, which can host membrane proteins such as ion channels that allow communication between the 'cells'.

The researchers created a chain of three droplets containing solutions of different ions with channels in the connecting walls to pump the ions. This acted as a 'biobattery', generating a current. Also, a network of droplets connected through the light-sensitive proton pump bacteriorhodopsin offered an electrochemical light-meter that mimics light-detecting retinal cells.



M. HOLDEN

MEDICINE

Brain boost

Lancet **369,** 2097–2105 (2007)

A preliminary gene-therapy trial has improved brain function in patients with Parkinson's disease.

Parkinson's disease causes neuronal degeneration, loss of motor control, and reduced levels of an important neurotransmitter known as GABA. Matthew During of Ohio State University in Columbus and his colleagues placed a gene important for GABA production, called glutamic acid decarboxylase, into a virus. They then injected the virus into a specific region of the brain, on one side only, in 12 patients with Parkinson's disease.

The phase I trial was designed to test safety rather than efficacy, but brain scans and motor-control tests showed that function in the injected side of the brain improved relative to the side that had not received the gene. No patients died or developed new neurological deficits.

CANCER BIOLOGY

To drug the undruggable

EMBO J. doi:10.1038/sj.emboj.7601744 (2007)

An antibody fragment can hit a cancer target that many have been deemed 'undruggable', say scientists in the United Kingdom.

Mutations that activate Ras proteins show up in as many as 30% of cancers, but the difficulty of blocking their protein–protein interactions inside the cell had made them seem intractable targets.

Terence Rabbitts, now at the Leeds Institute of Molecular Medicine, and his colleagues report that an antibody fragment, dubbed iDab#6, jams mutant Ras by blocking a key interaction site. In mice injected with human tumour cells, tumour growth stopped if the cells expressed the antibody fragment.

Delivering the genetic material to express iDab#6 in human patients would be a challenge, but the team's characterization of the Ras–antibody interaction may also help small-molecule drug development.

CELL BIOLOGY

Numbing the pain

Neuron **54,** 905–918 (2007)

Intense pain can switch off the ion channels that sense it by flipping a molecular toggle,