



**VOLUME 1 PART 1
DECEMBER 1997**

Supraordinal taxa of Ascomycota

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Abstract

Eriksson O.E. & Winka K. 1997. Supraordinal taxa of *Ascomycota*. - *Myconet* 1: 1-16. Twenty-one new supraordinal taxa are formally described: subphyla *Taphrinomycotina*, *Saccharomycotina*, and *Pezizomycotina*, superclasses *Leotiomyceta* and *Pezizomyceta*, classes *Arthoniomycetes*, *Chaetothyrio-mycetes*, *Dothideomycetes*, *Eurotiomycetes*, *Lecanoromycetes*, *Leotio-mycetes*, *Neoelectromycetes*, *Pezizomycetes*, *Pneumocystidomycetes*, *Sac-charomycetes*, *Schizosaccharomycetes*, *Sordariomycetes*, and *Taphrino-mycetes*, and subclasses *Hypocreomycetidae*, *Sordariomycetidae*, and *Xylariomycetidae*.

Introduction

The system that we present here is the fourth version of a continuously modified classification of orders and higher taxa of the phylum *Ascomycota* that we publish on the Internet (<http://www.ekbot.umu.se/pmg/outline.html>). It is based on molecular as well as morphological criteria. The first version was published on February 26 1997, the second on March 14, and the third on September 24. New taxa were provisionally used without formal descriptions, but such are provided in the present paper. It should be emphasized that classifications of ascomycete taxa above the ordinal level will be very unstable for many years and it is not yet practical to include them in general purpose classifications of the group, such as *Outline of the ascomycetes* (Eriksson & Hawksworth 1993).

We try to base the classification on monophyletic groups, but in some cases, the diversification probably occurred during a short time span, and we currently lack sufficient molecular and morphological information to unravel the true phylogeny. Therefore, in some cases it has been necessary to accept polytomies, which may or may not be resolved after further studies.

We have only used names for higher taxa that are based on a generic name, e.g. *Saccharomycotina*, *Sordariomycetes*, *Dothideomycetes*, not *Hemiascomycotina*, *Pyrenomycetes*, *Loculoascomycetes* (we have given some of the alternative names within parenthesis). The latter names are common in American literature and are perfectly acceptable according to the International Code of Botanical Nomenclature (Greuter *et al.* 1994), but we see advantages in using names for higher taxa that are based on names of genera. By basing names for higher taxa on names for genera, the higher taxa are connected to type specimens. This eliminates the current ambiguity about application of names for higher taxa.

Molecular data

Aligned SSU rRNA sequences

The SSU rRNA data that we have used for the present version of our system were retrieved from GenBank. Species names and accession numbers are listed in Appendix 1. Our alignment contains sequences from 104 ascomycetes, and for comparison, seven basidiomycetes. New sequences will be added continuously to the alignment, which will necessitate revisions and changes in the system. New updates will be published at irregular intervals, when new information makes changes necessary.

Secondary structure of SSU rRNA

Different models for the secondary structure of SSU rRNA molecules have been proposed. We have used the one developed at Departement Biochemie, Universiteit Antwerpen (see e.g., Van de Peer *et al.* 1996, 1997). In our descriptions of new taxa we have applied the stemloop numbers presented by Neefs *et al.* (1993).

Molecular signatures

The signature nucleotides, that we have used for characterizing the higher taxa of *Ascomycota*, are what we interpret as synapomorphies. The nucleotide numbers used are those in the corresponding *Saccharomyces cerevisiae* sequence (Mankin *et al.* 1986). As an example, under *Hypocreomycetidae* in the text below, "22 614c:u" means "stem-loop 22, nucleotide number 614, normally being c, is u in this group". In this case we interpret c as a plesiomorphous character, u as an apomorphous one.

In some cases, e.g. stemloop 12 site 341, one taxon (suborder *Sordario-mycetidae*) has the same nucleotide (c) as another closely related taxon (subclass *Xylariomycetidae*). In such cases, as a rule, we have provisionally treated this as two separate synapomorphies. Future analyses may show whether a mutation has occurred at one or two separate occasions. In this particular case, a third closely related taxon (suborder *Hypocreomycetidae*) has two other types of nucleotides in this position (plesiomorphous "a" in *Hypocreales*, and synapomorphous "c" in *Microascus*). Several different evolutionary scenarios can be proposed for this. The correct one may finally be inferred by comparing with other informative sites or from studies of other molecules (e.g. LSU rRNA, polymerase II).

Morphological data

All higher taxa recognized in the *Outline* below are characterized by both molecular and morphological characters, except superclass *Leotiomyceta*, sister group of *Pezizomyceta*. The latter has some signatures, whereas *Leotiomyceta* show a variation in the corresponding positions. Morphologically that superclass is characterized by inoperculate or bitunicate asci or modifications of such asci.

Outline

As mentioned above, the following classification is also available on the Internet (<http://www.ekbot.umu.se/pmg/outline.html>) as Version 4. Taxa in bold face are new taxa described below. Orders are according to Eriksson & Hawksworth (1993), with some exceptions indicated in the text.

Phylum **ASCOMYCOTA**

1. Subphylum **Taphrinomycotina** (syn. Archiascomycotina)
 - 1.1.1. Class **Neoelectomycetes**
 - 1.1.1.1. Order Neoelectales

- 1.1.2. Class **Pneumocystidomycetes**
 - 1.1.2.1.1. Order Pneumocystidales
 - 1.1.3. Class **Schizosaccharomycetes**
 - 1.1.3.1.1. Order Schizosaccharomycetales
 - 1.1.4. Class **Taphrinomycetes**
 - 1.1.4.1.1. Order Protomycetales
 - 1.1.4.1.2. Order Taphrinales
2. Subphylum **Saccharomycotina** (syn. Hemiascomycotina)
- 2.1.1. Class **Saccharomycetes**
 - 2.1.1.1.1. Order Saccharomycetales

3. Subphylum **Pezizomycotina** (syn. Euascomycotina)
- 3.1. Superclass **Pezizomyceta**
 - 3.1.1. Class **Pezizomycetes**
 - 3.1.1.1.1. Order Pezizales (incl. Glaziellales)
 - 3.2. Superclass **Leotiomyceta**
 - 3.2.1. Class **Arthoniomycetes**
 - 3.2.1.1.1. Order Arthoniales
 - 3.2.2. Class **Chaetothyriomycetes**
 - 3.2.2.1.1. Order Chaetothyriales
 - 3.2.3. Class **Dothideomycetes**
 - 3.2.3.1.1. Order Dothideales
 - 3.2.3.1.1.1. Suborder Dothideineae
 - 3.2.3.1.1.2. Suborder Pleosporineae
 - 3.2.4. Class **Eurotiomycetes**
 - 3.2.4.1.2. Order Eurotiales
 - 3.2.4.1.2.1. Suborder Eurotiineae (incl. Elaphomycetales)
 - 3.2.4.1.2.2. Suborder Onygenineae
 - 3.2.5. Class **Lecanoromycetes**
 - 3.2.5.1.1. Order Lecanorales
 - 3.2.5.1.1.1. Suborder Lecanorineae (incl. Caliciales)
 - 3.2.5.1.1.2. Suborder Peltigerineae
 - 3.2.6. Class **Leotiomycetes**
 - 3.2.6.1.1. Order Cyttariales
 - 3.2.6.1.2. Order Erysiphales
 - 3.2.6.1.3. Order Leotiales
 - 3.2.6.1.4. Order Rhytismatales
 - 3.2.7. Class **Sordariomycetes**
 - 3.2.7.1. Subclass **Hypocreomycetidae**
 - 3.2.7.1.1. Order Halosphaeriales
 - 3.2.7.1.2. Order Hypocreales
 - 3.2.7.1.3. Order Microascales
 - 3.2.7.2. Subclass **Sordariomycetidae**
 - 3.2.7.2.1. Order Diaporthales
 - 3.2.7.2.2. Order Ophiostomatales
 - 3.2.7.2.3. Order Sordariales
 - 3.2.7.3. Subclass **Xylariomycetidae**
 - 3.2.7.3.1. Order Xylariales (incl. Diatrypales)

Orders of uncertain position:

Calosphaeriales
 Pertusariales
 Coryneliales
 Phyllachorales
 Gyalectales
 Pyrenulales

Laboulbeniales Rhytismatales
Lahmiales Spathulosporales
Lichinales Teloschistales
Medeolariales Triblidiales
Meliolales Trichosphaeriales
Ostropales Trichotheliales
Patellariales Verrucariales

Alphabetical list of taxa

Arthoniales Henssen ex D. Hawksw. & O.E. Erikss.

The order is accepted in the sense of Tehler (1990, 1995), but also includes *Arthothelium*, as synapomorphies with other *Arthoniales* will probably be found in rRNA sequences. The order differs morphologically so much and in so many signature positions from other ascomycetes that it is referred to a separate class, *Arthoniomycetes*. - Fam.: 4.

Arthoniomycetes cl. nov. O.E. Erikss. & Winka

*Holotypus: *Arthoniales* Henssen ex D. Hawksw. & O.E. Erikss.

*Ascomata: apothecia. Hamathecium: paraphysoides. Asci bitunicati, in IKI/KOH plerumque caerulescenti.

* Characteres moleculares (SSU rRNA): **10-1** 222a:g; 253a:g. **11** 267u:c; 288a:g. **12** 328a:u; 331a:g; 334g:u; 340u:a; 343c:a; 352a:g. **18** 529c:a (exc. *Lecanactis*). **23-2** 699u:c

Ascomycota

There are usually no problems to determine whether a fungus belongs to the phylum *Ascomycota* or to the *Basidiomycota*, but some yeasts, endophytes, and fungi that do not produce any kind of diaspores can be difficult to identify to phylum. There are, however, a number of molecular signatures that are diagnostic (see *Basidiomycota*).

Basidiomycota

The following sites in our matrix of SSU rRNA showed differences between *Basidiomycota* and *Ascomycota*:

*Signatures in *Basidiomycota*: **8** 114c:a; 303u:a. **8/9** 126a:g. **9** 140u:a; 150c:u. **11/8'** 291g:c. **12** 335u:a. **13** 369u:a. **17** 480g:a (exc. *Coprinus*). **23/23-1** 638c:u; 640u:c (exc. u in *Boletus*, *Ustilago*). **23-2** 699u:c. **23-2/23-5** 704c:u. **23-7** 785u:c; 792c:u. **23-9'** 848c:u. **25** 883c:u. **23'** 970g:a. **23'/27** 978a:g. **27** 993g:a; 1009c:u. **27/28** 1021c:a (but u in *Sporobolomyces*, *Leuco-sporidium*); 1022a:g. **37** 1239g:u. **41** 1306c:g; 1313g:c. **46** 1482a:g (exc. a in *Ustilago*, *Tilletia*, *Udenomyces*). **46'/45'** 1521u:g. **48** 1589c:u (exc. c in *Ustilago*). 1590a:g (exc. a in *Ustilago*). 1602u:c (exc. u in *Ustilago*).

(Caliciales Bessey)

This is a heterogeneous order (Tibell 1984). Wedin & Tibell (1997) demonstrated that the *Caliciaceae* were members of *Lecanorales* s. lat., whereas the *Mycocaliciaceae* and *Sphinctrinaceae* were closest to the *Eurotiales* in their analysis, but further taxa (*Chaetothyriales*, etc.) should be included to determine the position of these families - Fam.: 0.

Calosphaeriales M.E. Barr

No seq. publ. - Fam.: 1, *Calosphaeriaceae*, prob. heterogeneous (Samuels & Candoussau 1996; their transfer of *Graphostromataceae* to *Xylariales* is accepted).

Chaetothyriales M.E. Barr

Seq. publ. from *Herpotrichiellaceae*. We have one unpubl. seq. from *Chaetothyriaceae* (MS submitted). - Fam.: at least 2.

Chaetothyriomycetes cl. nov. O.E. Erikss. & Winka

*Holotypus: *Chaetothyriales* M.E. Barr

*Ascomata: pseudothecia. Hamathecium: periphysoides. Asci bitunicati.

*Characteres moleculares (SSU rRNA): **9** 140u:c. **12** 339c:u. **18** 523u:c. **22** 615a:c. **23-1** 653c:u; 655g:u; 660g:u (exc. a in *Capronia mansonii*); 686c:u. **23-6** 748u:c. **24/24'** 881a:g. **24'** 946u:c. **28'** 1100u:c. **22'** 1103u:g. **37** 1222a:u. **42** 1333a: g. **44** 1388a:u. **44'** 1402g:a. **42'** 1411u:a; 1412u:c. **46** 1482a:g. **49** 1676a:g; 1721g:c; 1725c:u.

Coryneliales Seaver & Chard³ⁿ

No seq. publ. - Fam.: 1.

Cyttariales Luttr. ex Gamund^Å

The *Cyttariales* are very closely related to *Leotiales* (Landvik & Eriksson 1994), but differ morphologically (e.g., have pycnidia) and should be recognized as a separate order, at least until we have molecular data from more representatives of the *Leotiomyces* suggesting otherwise. - Fam.: 1.

Diaporthales Nannf.

Close to *Ophiostomatales* and *Sordariales* (Spatafora & Blackwell 1993). - Fam.: 3.

(Diatrypales Chadef. ex D. Hawksw. & O.E. Erikss.)

Tentatively merged with *Xylariales*. Partial seq. (Spatafora & Blackwell 1993). - Fam.: 0.

Dothideales Lindau s.lat.

Most of the species are closely related, but *Dothideales* s.str. are probably distinct from *Pleosporales* (Berbee 1996). Many more key taxa have to be sequenced before we can propose a better classification of the order. Two suborders are provisionally recognized. *Herpotrichiellaceae* should be excluded (Untereiner *et al.* 1995). The same refers to the *Chaetothyriaceae*; see *Chaetothyriales*! - Fam.: c. 60, but several will probably have to be transferred to other orders.

Dothideomycetes cl. nov. O.E. Erikss. & Winka

*Holotypus: *Dothideales* Lindau

*Ascomata: pseudothecia, apothecia vel cleistothecia. Hamathecium: pseudo-paraphyses, paraphysoides, paraphyses, pseudoparenchyma, vel absens. Asci plerumque bitunicati et fissitunicati.

*Characteres moleculares (SSU rRNA): **11** 289u:c (exc. u in *Dothidea*, *Aureo-basidium*). **12** 331a:g (exc. a in *Botryosphaeria*, *Coccodinium*, *Dothidea*, *Aureobasidium*, *Alternaria*); 334g:u (exc. g in *Botryosphaeria*, *Coccodinium*, *Dothidea*, *Aureobasidium*,); 339c:u (exc. c in *Botryosphaeria*, *Coccodinium*, *Dothidea*, *Aureobasidium*, *Alternaria*). **18** 528u:c (exc. u in *Botryosphaeria*, *Coccodinium*, *Dothidea*, *Aureobasidium*). **23'** 971-:u. **48** 1601u:a.

(Elaphomycetales Trappe)

This order should be included in *Eurotiales* on the basis of SSU rRNA data (Landvik *et al.* 1996). Fam.: 0.

Erysiphales Gwynne-Vaughan

Closely related to *Leotiales* (Saenz *et al.* 1994) and *Thelocarpaceae* (Momol *et al.* 1996) in the class *Leotiomyces*. - Fam.: 1.

Eurotiales G.W. Martin ex Benny & Kimbr.
Many seq. publ. - Fam.: 5 (incl. *Elaphomycetaceae*, Landvik *et al.* 1996).

Eurotiomycetes cl. nov. O.E. Erikss. & Winka

*Holotypus: *Eurotiales* G.W. Martin ex Benny & Kimbr.

*Ascomata: cleistothecia. Asci pseudoprototunicati.

*Characteres moleculares (SSU rRNA): **9** 148a:c; 150c:u. **12** 350u:g. **23-1** 644c:u (exc. c in *Trichophyton*). 668c:a; 687c:u (exc. c in *Eremascus*); 690g:a (exc. g in *Trichophyton*). **23-5** 715c:g. **23-2'** 724g:c. **23-6** 749u:g. **24/24'** 881a:g. **25** 892a:g; 893u:c; 918a:g; 919u:c. **24'** 946u:c. **37** 1254u:c. **37/38** 1261g:a. **45** 1477a:g. **46** 1482a:g. **45'** 1526u:c. **48** 1585a:g; 1588g:a.

(**Graphidales** C. Bessey)

A majority of the lichenologists have preferred to include this order in *Ostropales*, and, for that reason (at least temporarily), that was accepted by Eriksson & Hawksworth (1993) and Hawksworth *et al.* (1995). - Fam.: 0.

Gyalectales Henssen ex D. Hawksw. & O.E. Erikss.
No seq. publ. - Fam.: 1.

Halosphaeriales Kohlm.

A sequence of *Halosphaeriopsis mediosetigera*, published by Spatafora & Blackwell (1994), nested with high bootstrap value (99%) within *Microascales*. Several partial sequences are now available in GenBank, but no phylogenetic analysis including these has been published. We include both orders in subclass *Hypocreomycetidae*. - Fam.: 1.

Hypocreales Lindau

Type order of the subclass *Hypocreomycetidae*, which also contains *Microascales* and *Halosphaeriales*. *Clavicipitales* and *Hypocreales* are closely related (Spatafora & Blackwell 1993) and have been merged by some authors, e.g. Eriksson & Hawksworth (1993), Rehner & Samuels (1995) and Rossman (1996), but further analyses are necessary. - Fam.: 4; *Clavicipitaceae* and *Hypocreaceae* are the core families; *Nectriaceae* is provisionally accepted as a separate family on the bases of cladistic analyses of rRNA data (Spatafora & Blackwell 1993); *Niessliaceae* is provisionally retained.

Hypocreomycetidae subcl. nov. O.E. Erikss. & Winka

*Holotypus: *Hypocreales* Lindau

*Ascomata: perithecia vel cleistothecia. Hamathecium: periphysoides, periphyses. Asci unitunicati vel pseudoprototunicati.

*Characteres moleculares (SSU rRNA): **7/8** 104a:u. **8/8'** 107c:a. **12** 350u:g. **22** 614c:u; 615a:g. **23-2** 703g:u. **23-2'** 735c:a. **23-7'** 766u:c; 771a:g

Laboulbeniales Engler

Rickia sp., *Laboulbeniaceae*, is closely related to *Pyxidiophora*, *Pyxidiophor-aceae* (bootstrap value 99%, Blackwell 1994), but the relationships of this group to other ascomycetes is unresolved. - Fam.: 5.

Lahmiales O.E. Erikss.

No seq. publ. The single species is odd and relationships can not be inferred from the morphology (Eriksson 1986). - Fam.: 1.

Lecanorales Nannf. (syn. *Caliciales*)

Rather few sequences have been published (e.g. Gargas 1992, Eriksson & Strand 1995, Gargas & Taylor 1995, Gargas *et al.* 1995, Wedin & Tibell 1997), but it seems that a broad

order should be recognized. At present we include two suborders, *Lecanorineae* and *Peltigerineae*, both accepted since long by many lichenologists (e.g. Henssen & Jahns 1974). A more elaborate classification can be suggested when more DNA data are available. - Fam.: c. 44.

Lecanoromycetes cl. nov. O.E. Erikss. & Winka

*Holotypus: *Lecanorales* Nannf.

*Ascomata: apothecia. Hamathecium: paraphyses vel pseudoparaphyses. Asci normaliter bitunicati, in IKI plerumque caerulescenti; endotunica normaliter apicaliter incrassata.

*Characteres moleculares (SSU rRNA): **23/23-1** 638c:a. **23'** 971:-u. **2'** 1139a:c. **45/46** 1479c:a (exc. c in *Peltigerales*). **46** 1501a:g (exc. a in *Peltigerales*). **49** 1673c:u.

Leotiales Carpenter

The superclass *Leotiomyceta*, sister group to the *Pezizomyceta*, is divided into seven classes. One of them is *Leotiomycetes*, with four orders. The position of the genus *Leotia* has been uncertain in some analyses (cf. comments by Gargas & Taylor 1995: 12). - Fam.: c. 12.

Leotiomyceta supercl. nov. O.E. Erikss. & Winka

*Holotypus: *Leotiomycetes* O.E. Erikss. & Winka

*Ascomata: apothecia, perithecia, cleistothecia vel absens. Asci unitunicati (inoperculati), bitunicati vel pseudoprototunicati.

*Characteres moleculares (SSU rRNA): 0.

Leotiomycetes cl. nov. O.E. Erikss. & Winka

*Holotypus: *Leotiales* Carpenter

*Ascomata: apothecia. Hamathecium: paraphyses. Asci unitunicati.

*Characteres moleculares (SSU rRNA): **23'** 971:-u. **49** 1673c:u; 1725c:u.

Lichinales Henssen & BÅ¼del

No seq. publ. - Fam.: 3.

Medeolariales Korf

No seq. publ. - Fam.: 1.

Meliolales GÅ¼m. ex D. Hawksw. & O.E. Erikss.

Clusters within *Sordariomycetes* ("Pyrenomycetes", Saenz & Taylor 1994, unpubl. seq.). - Fam.: 1.

Microascales Luttr. ex Benny & Kimbr.

This order and *Halosphaeriales* are probably the sister group of *Hypocreales* (cf. Spatafora & Blackwell 1993) in the subclass *Hypocreomycetidae*. - Fam.: 2.

Neolectales Landvik, O.E. Erikss., Gargas & P. Gustafsson

This is the only order characterized by fruit bodies in the subphylum *Taphrinomycotina* and is placed in a separate class, *Neolectomycetes*. SSU rRNA seq. have been publ. by Landvik *et al.* (1993), Landvik (1996) and O'Donnell *et al.* (1996). - Fam.: 1.

Neolectomycetes cl. nov. O.E. Erikss. & Winka

*Holotypus: *Neolectales* Landvik, O.E. Erikss., Gargas & P. Gustafsson

*Ascomata claviformia, stipitata. Sine hamathecium.

*Characteres moleculares (SSU rRNA): **6/6'** 73u:a. **8/8'** 114c:a. **10-1** 228g:gat; 253a:g. **11**

283c:u. **12** 350u:a; 351c:u. **14** 396g:gg. **23/23-1** 638c:u. **23-7** 785:c. **25** 918a:g. **27** 990g:a. **29** 1051u:c. **45** 1476g:a. **46** 1482a:g. **45'** 1527c:u.

Onygenales Cif. ex Benny & Kimbr.

Sister group of *Eurotiales* (Berbee & Taylor 1992a) in the class *Eurotiomycetes*. - Fam.: 4.

Ophiostomatales Benny & Kimbr.

Close to *Diaporthales* (Spatafora & Blackwell 1994; partial seq.). - Fam.: 2.

Ostropales Nannf.

Position uncertain. One partial seq. of *Stictis radiata* available. Relationships with *Graphidales* uncertain, but this order is provisionally included here (q.v.). - Fam.: 7.

Patellariales D. Hawksw. & O.E. Erikss.

Accepted here in the sense of Kutorga & Hawksworth (1997). A partial SSU rRNA sequence has been published by Spatafora *et al.* (1995), placing the order close to *Dothideales* and *Pleosporales*, but without high bootstrap values. - Fam.: 2.

Peltigerales W. Watson

Clusters with *Lecanorales* in cladistic analyses (Eriksson & Strand 1995) and included as suborder *Peltigerineae*. - Fam.: 4, but position of *Placynthiaceae* is uncertain.

Pertusariales M. Choisy ex D. Hawksw. & O.E. Erikss.

No seq. publ. - Fam.: 2.

Pezizales C. Bessey (syn. *Glaziellales*, *Tuberales*)

This is the type order of the subphylum *Pezizomycotina* (*Eumycotina*). Other ascomycetes are placed in the two subphyla *Saccharomycotina* (budding yeasts) and *Taphrinomycotina* (the "archiascomycetes", "basal ascomycetes"). It contains all fruit body producing ascomycetes excl. *Neolecta*. The subphylum is divided into two superclasses, *Pezizomyceta* with the single order *Pezizales*, and *Leotiomyceta* with rest of the taxa in the subphylum. The order has been paraphyletic in some analyses (e.g., Landvik *et al.* 1993) with the type genus *Peziza* as an aberrant taxon. *Glaziellales* is a synonym of *Pezizales* (Landvik & Eriksson 1995). The same refers to *Tuberales* (Trappe 1979, Landvik & Eriksson 1995). - Fam.: c. 15; *Thelebolaceae* to *Leotiomycetes* (Momol *et al.* 1996).

Pezizomyceta supercl. nov. O.E. Erikss. & Winka

*Holotypus: *Pezizomycetes* O.E. Erikss. & Winka

*Characteres ut in *Pezizomycetes*.

Pezizomycetes cl. nov. O.E. Erikss. & Winka

*Holotypus: *Pezizales* C. Bessey

*Ascomata: apothecia vel cleistothecia. Asci operculati vel pseudoprototunicati.

*Characteres moleculares (SSU rRNA): **10-1** 253a:g. **13** 377g:u (exc. g in *Glaziella*). **23-2/23-5** 704?:c (exc. a in *Barssia*, gap in *Helvella*). **23'** 971-:u (exc. gap in *Cookeina*, *Urnula*). **37** 1255u:a.

Pezizomycotina subphyl. nov. O.E. Erikss. & Winka

*Holotypus: *Pezizomycetes* O.E. Erikss. & Winka

*Ascomata: apothecia, perithecia, cleistothecia vel absens. Asci operculati, in-operculati vel pseudoprototunicati.

*Characteres moleculares (SSU rRNA): **4'/17** 478a:-; 479-:u.

Phyllachorales M.E. Barr

No seq. publ. It is uncertain whether *Glomerella* is closely related to *Phyllachora*, but *Glomerella* sequences cluster the genus with other unitunicate pyrenomycetes (Spatafora & Blackwell 1995). - Fam.: 2.

Pneumocystidales O.E. Erikss.

This order was described by Eriksson (1995) to save the present concept of *Schizosaccharomycetales* (Eriksson *et al.* 1993). The life cycles are very similar, judged from the descriptions in the literature. The former are parasites in lungs of mammals, the latter are saprotrophs on fruits, etc. - Fam.: 1.

Pneumocystidomycetes cl. nov. O.E. Erikss. & Winka

*Holotypus: *Pneumocystidales* O.E. Erikss.

*Fungi unicellulares. Cellulae in alveolis mammalium aggregatae et parasiticae, tenuitunicati, uninucleatae, per fissionem divisae. Asci crassitunicati, tetra- vel octospori. Ascosporae globosae, postremo falcatae.

*Characteres moleculares (SSU rRNA): **6** 73u:g. **8** 114c:a. **9/10** 177u:a. **10-1/11** 261u:c; 262u:g. **11** 283c:u. **18** 526a:g. **3'/22** 611u:c. **23/23-1** 637c:u. **23/23-1** 640u:a; **23-1** 644c:a; 645c:u; 652g:c; 660g:u; 662-657ttttt (*Saccharomyces cerevisiae*):cgtagt. **23-2** 699u:c. **23-2/23-5** 704g:a; 706a:u. **23-5'/23-2'** 731g:a. **23-2'/23-6** 741c:ua. **23-6** 753a:g. **23-8** 810g:a. **23-9** 819g:a. **23-8'** 833u:c. **23-9'** 850g:a; 851c:u; 852c:u. **25** 912g:a. **27** 1039g:ga. **28'** 1096 u:c. **22'** 1103u:c. **35/36** 1197g:a. **37** 1257g:a. **40** 1292g:a. **43** 1349c:a; 1365 g:a. **44** 1396c:g. **46** 1501g:a. **45'/47** 1535c:a. **47'/33'** 1570g:a. **32'/49** 1635c:ca; 1638c:u. **49** 1672c:u; 1725g:a; 1731c:u.

Molecular data (SSU rRNA) give some support for a close relationship with *Schizosaccharomycetales*, but in some positions *Pneumocystis* agrees better with other basal ascomycetes and in some analyses the order does not cluster with the fission yeasts (cf. Nishida *et al.* 1993, Gargas *et al.* 1995). In rather many positions *Pneumocystis* differs from all other members of the suphyllum *Taphrino-mycotina*. Therefore, the order is tentatively referred to a separate class.

Protomycetales Luttr. ex D. Hawksw. & O.E. Erikss.

This order is very close to *Taphrinales*, as inferred from molecular data (Nishida *et al.* 1993), but they differ so much morphologically that a separation at the ordinal level is reasonable. - Fam.: 1.

Pyrenulales Fink ex D. Hawksw. & O.E. Erikss.

The order is provisionally kept separate from *Dothideales* s.lat., until we have molecular data from more representatives of that order and from *Pyrenulales*. They have been assumed to be more closely related to "*Melanommatales*" than to "*Pleosporales*" and some other orders included in *Dothideales* s.lat. (Eriksson & Hawksworth 1993), but molecular data from several representatives of these loculoascomycete orders indicate that they are closely related, and it is probable that *Pyrenulales* will cluster with that group when molecular data will be available for inclusion in the analyses. - Fam.: 5.

Rhytismatales M.E. Barr ex Minter

One seq. publ. of *Rhytisma* (Landvik 1996). The genus is nested within *Leotiales* in that paper, and we tentatively refer the *Rhytismatales* to the class *Leotiomyces*, but more seq. are required before we can infer its position more precisely. - Fam.: 3.

Saccharomycetales Kudrjanzev

This is the single order in the subphylum *Saccharomycotina* and the class *Saccharomycetes*. The budding yeasts appear to be a monophyletic taxon. They have

branched off more recently than the *Taphrinomycotina* in some analyses (Berbee & Taylor 1992b, etc.), but they have many odd molecular features, and their position in the phylogenetic tree is uncertain. - Fam.: 8.

Saccharomycetes cl. nov. O.E. Erikss. & Winka.

*Holotypus: *Saccharomycetales* O.E. Erikss., Svedskog & Landvik

*Characteres moleculares (SSU rRNA): **13** 369u:a. **18** 529c:a. **23-2/23-5** 704c:c (exc. g in *Dipodascopsis*). **23-9'** 851c:u. **24'** 955u:c (exc. u in *Dipod-ascopsis*). **23'** 970g:a. **27** 995c:u (exc. c in *Dipodascopsis*). **43** 1338g:a (exc. g in *Pichia*). **38'/36'** 1445u:c (exc. u in *Dipodascopsis*). **45** 1475a:g. **46** 1482a:g. **46'/45'** 1521u:g. **45'** 1528u:c.

Saccharomycotina subphyl. nov. O.E. Erikss. & Winka

*Holotypus: *Saccharomycetes* O.E. Erikss. & Winka

*Characteres moleculares (SSU rRNA): ut in *Saccharomycetes*.

Schizosaccharomycetales O.E. Erikss., Svedskog & Landvik

This order was shown by Eriksson *et al.* (1993) to differ in many respects from *Saccharomycetales* (see also Szipisky 1995), but the position relative the other taxa in subphylum *Taphrinomycotina* is uncertain, and this order is referred to a separate class, *Schizosaccharomycetes*. - Fam.: 1.

Schizosaccharomycetes cl. nov. O.E. Erikss. & Winka

*Holotypus: *Schizosaccharomycetales* O.E. Erikss., Svedskog & Landvik

*Characteres moleculares (SSU rRNA): **10-1** 248u:g. **12** 351c:u. **17** 483a:g; 490u:c; 495u:c. **18** 529c:a. **23/23-1** 638c:u. **23-1** 654c:u. **25** 918a:u. **29** 1047g:a. **22'** 1103u:c. **2'** 1138a:g. **37** 1257g:a.

Sordariales Chadef. ex D. Hawksw. & O.E. Erikss.

Type order of the class *Sordariomycetes*, subclass *Sordariomycetidae*, to which also the *Diaporthales* and *Ophiostomatales* belong (q.v.). Two other subclasses are recognized, *Hypocreomycetidae* and *Xylariomycetidae*. The branching order of the three subclasses is unresolved. - Fam.: 9; incl. *Boloniaceae* (Andersson *et al.* 1995).

Sordariomycetes cl. nov. O.E. Erikss. & Winka

*Holotypus: *Sordariales* Chadef. ex D. Hawksw. & O.E. Erikss.

*Ascomata: perithecia. Hamathecium: paraphyses, periphyses. Asci unitunicati vel pseudoprototunicati.

*Characteres moleculares (SSU rRNA): **6/6'** 82u:c. **10-1** 217a:u. **12** 331a:g; 334g:u. **13** 364g:a; 366a:g; 367a:g; 374u:c; 379u:c; 380u:a. **14** 388g:a; 409c:u. **23-2** 698u:c (exc. u in *Chaetomiaceae*, *Sordariaceae*). **37** 1222a:g. **46** 1482a:g.

Sordariomycetidae subcl. nov. O.E. Erikss. & Winka

*Holotypus: *Sordariales* Chadef. ex D. Hawksw. & O.E. Erikss.

*Characteres moleculares (SSU rRNA): **12** 324u:c; 327u:c; 328a:u; 333a:c; 340u:a; 341a:g; 350u:a. **46** 1501a:g (exc. a in *Ophiostoma*).

Spathulosporales Kohlm.

No seq. publ., but the order appears to be morphologically distinct and no close relatives can be inferred. - Fam.: 2.

Taphrinales Gãum. ex C.W. Dodge

SSU rRNA seq. of *Taphrinales* are very similar to those of *Protomycetales*, but the two

orders are kept separate on the bases of morphological differences. They are placed in a separate class, *Taphrinomycetes*. - Fam.: 1.

Taphrinomycetes cl. nov. O.E. Erikss. & Winka

*Holotypus: *Taphrinales* GÅsum. ex C.W. Dodge

*Characteres moleculares (SSU rRNA): **9** 148a:c (exc. a in *Saitoella*). **12** 351c:u; 352a:g (exc. a in *Saitoella*). **13** 369u:a (exc. u in *Saitoella*). **18** 529c:a (exc. c in *Saitoella*). **3'/22** 611u:c (exc. u in *Saitoella*). **23** 632u:c (exc. u in *Saitoella*). **23-1** 668c:u; **24/24'** 879g:a (exc. g in *Saitoella*). **25** 890c/u:g; 919u:c. **24'** 948c:u (exc. c in *Saitoella*); 966a:g (exc. a in *Saitoella*). **33/34** 1166g:a (only *Protomyceales*); 1167g:a (only *Protomyceales*); 1168 (only *Protomyceales*). **37** 1239g:u (exc. g in *Saitoella*). **46'/45'** 1521u:g (exc. u in *Taphrina populina*). **45'/47** 1535c:a (exc. c in *Saitoella*). **49** 1671g:c.

This name was discussed as a possible name for a class of ascomycetes at a contributed symposium on the higher taxa of *Ascomycota* during the Fifth International Mycological Congress in Vancouver 1994. In print, however, it seems to have appeared only in a textbook by Petersen (1995), but without any valid diagnosis.

Taphrinomycotina subphyl. nov. O.E. Erikss. & Winka

*Holotypus: *Taphrinomycetes* O.E. Erikss. & Winka

*Characteres moleculares (SSU rRNA): **12** 335u:a. **20'/21'** 581u:c (exc. u in *Neolecta*). **23-1** 649 c:u; 685g:a (g in *Pneumocystis*). **25** 883c:u. **23'** 970g:a. **22'** 1103u:c (exc. u in *Neolecta*). **37** 1255u:c. **44** 1390c:u. **44'** 1402g:a. **45** 1475a:g (exc. a in *Pneumocystis*). **46** 1482a:g (exc. a in *Pneumocystis*). **46** 1501a:g (exc. a in *Pneumocystis*). **45'** 1528u:c (exc. u in *Pneumocystis*).

This may be a paraphyletic taxon, as already stated by Nishida & Sugiyama (1994, as class *Archiascomycetes*). It was first discovered to be a separate group by Berbee & Taylor (1992a).

Teloschistales D. Hawksw. & O.E. Erikss.

No seq. publ., but analyses of molecular data will probably cluster the order with *Lecanorales*. - Fam.: 3.

Triblidiales O.E. Erikss.

No seq. publ. The order may be close to *Graphidales* (Eriksson 1992, i.e. *Ostropales*) or it should possibly be included in the *Rhytismatales* (Magnez 1997). - Fam.: 1.

Trichosphaeriales M.E. Barr

No seq. publ., but the order probably belongs in the Class *Sordariomycetes*, as can be inferred from the morphology (unitunicate asci, etc.). - Fam.: 1.

Trichotheliales Hafellner & Kalb

No seq. publ. - Fam.: 1.

Verrucariales Mattick ex D. Hawksw. & O.E. Erikss.

No seq. publ. - Fam.: 2.

Xylariales Nannf.

Single order of the subclass *Xylariomycetidae* in the class *Sordariomycetes*. The *Diatrypales* are tentatively included in *Xylariales*. - Fam.: 5 fam.; as in Hawksworth *et al.* (1995) + *Diatrypaceae* and *Graphostromataceae* (see Samuels & Candoussau 1996)

Xylariomycetidae subcl. nov. O.E. Erikss. & Winka

*Holotypus: *Xylariales* Nannf.

*Ascomata: perithecia. Hamathecium: paraphyses, periphyses vel physes absentes. Asci unitunicati vel pseudoprototunicati.

*Characteres moleculares (SSU rRNA): **12** 327u:c; 341a:g; 350u:a. **49** 1673 c:u.

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APPENDIX 1

Sequences (with accession numbers in GenBank) used in our alignment

ASCOMYCOTA

Acanthostigmella brevispina L35291
 Alternaria brassicicola U05197
 Arthonia radiata U23537
 Ascosphaera apis M83264
 Aspergillus fumigatus M60300
 Aureobasidium pullulans M55639
 Barssia oregonensis U42657
 Blumeria graminis L26253
 Botryosphaeria rhodina U42476
 Byssochlamys nivea M83256
 Calicium adpersum U86694
 Camarops microspora Z49783
 Capronia mansonii X79318
 Capronia pilosella U42473
 Ceramothyrium linnaeae AF022715
 Chaetomium elatum M83257
 Cladonia merochlorophaea Z14025
 Claviceps purpurea U44040
 Coccodinium bartschii U77668
 Cookeina sulcipes U62010
 Cordyceps capitata U44041
 Cryphonectria cubensis L42439
 Cucurbitodthis pithyophila U42480
 Cucurbitaria berberidis U42481

Debaryomyces hansenii X62649
Dendrographa leucophaea U23538
Diaporthe phaseolorum L36985
Dipodascopsis uninucleata U00969
Dothidea hippophaeos U42475
Dothidea insculpta U42474
Eremascus albus M83258
Eupenicillium javanicum U21298
Eurotium rubrum U00970
Exophiala dermatidis X79315-X79317
Fonsecaea pedrosoi L36997
Glaziella aurantiaca Z49753
Gyromitra esculenta Z30238
Helvella lacunosa U42654
Herpotrichia diffusa U42484
Hirsutella thompsonii U32406
Hydnotrya cerebriformis U42649
Hypomyces chrysospermus M89993
Lecanactis abietuna U23539
Lecanora dispersa L37535
Leotia lubrica L37536
Leptosphaeria bicolor U04202
Leptosphaeria doliolum U04205
Leptosphaeria maculans U04233
Leucostoma persoonii M83259
Lophiostoma crenatum U42485
Malbranchea filamentosa L28065
Microascus cirrosus M89994
Mycocalicium albonigrum L37538
Mycosphaerella mycopappi U43449
Neolecta irregularis Z47721
Neolecta vitellina Z27393
Nephroma arcticum X89219
Neurospora crassa M11033
Obolarina dryophila Z49784
Ophiostoma schenckii M85053
Ophiostoma stenoceras M85054
Ophiostoma ulmi M83261
Peltigera neopolydactyla X89218
Peziza badia L37539
Phaeosphaeria (Sept.) nodorum U04236
Pichia membranaefaciens X58055
Pleospora herbarum U05201
Pleospora rudis U00975
Pneumocystis carinii L27658
Porpidia crustulata L37540
Protomyces inouyei D11377
Protomyces lactucae-debilis D14164
Protomyces macrosporus D85143
Protomyces pachydermus D85142
Pseudohalonectria lignicola U31812
Pyrenophora tritici-repentis U42486
Rhizina undulata U42664
Rhytidhysterium rufulum U20506
Rhytisma salicinum U53370
Saccharomyces cerevisiae V01335

Saccharomyces unisporus Z75582
Saitoella complicata D12530
Schisatomma pericleum U23540
Schizosaccharomyces pombe X54866
Schizosaccharomyces japonicus Z32848
Sclerotinia sclerotiorum X69850
Setosphaeria rostrata U42487
Solorina crocea X89220
Sordaria fimicola X69851
Stictis radiata U20610
Sphaerophorus globosus L37532
Spathularia flavida Z30239
Sporormia lignicola U42478
Symbiotaphrina buchneri D49656
Taphrina deformans U00971
Taphrina populina D14165
Taphrina wiesneri D12531
Thelebolus stercoreus U49936
Thermoascus crustaceus M83263
Trichophyton rubrum X58570
Uncinocarpus reesii L27991
Urnula hiemalis Z49754
Westerdykella dispersa U42488
Xylaria carpophila Z49785

BASIDIOMYCOTA

Boletus satanas M94337
Coprinus cinereus M92991
Leucosporidium scottii X53499
Sporobolomyces roseus X60182
Sympodiomyces paphiopedili D14006
Tilletia caries U00972
Ustilago hordei U00973