Lecture 12

Ascomycota I

- major characteristics
- major lineages
- Taphrinomycotina

Ascomycota

Major characteristics
- > 30,000 known species, of which about 40% are lichenized;
- A monophyletic group, sister to Basidiomycota (i.e., the two groups share a common ancestor)

Mycelium
- a single, simple perforation (septum) connects cells and permits cytoplasmic movements between cells;
- presence of a Woronin body in each cell (seen from EM only), that possibly serves to “close” the septum under certain conditions (the exact function of the Woronin body is still not known).
- frequent anastomosis of hyphae;
- haploid, generally single nucleate cells during most of the life cycle;

Asexual stage = anamorph stage
- vigorous asexual reproduction in most taxa by formation of conidia (products of conidiogenesis, formed by a conidiophore);
- high diversity in conidia and conidiophore shape, and conidial formation.

Sexual stage = teleomorph stage
- karyogamy, follows immediately by meiosis and often also by a mitosis, occurs in a cell called ascus (plural = asci)
- ascomata = “the fruiting body”, in which asci are formed.

Many species have two different names:
- one name form the anamorph;
- one name form the teleomorph;
For many species, we still don’t know their anamorph <-> teleomorph connection ( => holomorph), if any.
Ascus formation

- two genetically different but compatible haploid mycelia fuse (anastomosis) and form a dikaryotic N+N ascogonium

- formation of crozier hooks (see next slide) from the ascogonium;

- migration of nuclei into a protoascus; Karyogamy, immediately followed by meiosis and often a mitosis --> 8 spores are typically formed.
Four types of ascomata

- **Apothecium**
- **Perithecium**
- **Pseudothecium**
- **Cleistothecium**

From Kendrick

“Pyrenomycetes”

“Discomycetes”

Four types of asci

- **Prototunicate**
  - no active spore-shooting
  - mostly found in cleistothecium and hypogeous ascomata.

- **Unitunicate**
  - single wall
  - two types:
    1. **Oerculate**: operculum opens at maturity to discharge spores
    2. **Inoperculate**: apical ring acts as a “sphincter” for spore discharge

- **Bitunicate**
  - At maturity the thin outer wall splits, and the thick inner wall absorbs water and expands upward to release the ascospores.

From Kendrick
Four kind of asci

+ Four kind of ascomata

= Multiple possible combination

=> taxonomic segregation at order/family levels traditionally based on these combinations.

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Three major groups of Ascomycota

**Taphrinomycotina (= Archiascomycetes; ‘archi’~‘archea’ = ancient)**
- lack ascomata (one exception: *Neolecta*); unitunicate asci
- yeast stage common;

Recognized only recently from molecular evidence (Nishida and Sugiyama 1994):

=> their basal (ancient) nature is indicated from both molecular phylogenetic evidence and their simple life style and morphology.

**Saccharomycotina (= Hemiascomycetes)**
- lack ascomata; unitunicate asci
- the “true” budding yeasts (--> Saccharomycetes, or the Saccharomycetales in traditional classification systems), but also includes filamentous forms in modern classification (--> Hemiascos-).

**Pezizomycotina (= Euascomycetes)**
- Ascomata observed when sexual stage known;
- more complex morphology; ---> ‘higher’ ascomycetes
- includes most lichen-forming fungi
- includes ca. 90% of the known Ascomycota species
The Taphrinomycotina, if including Pneumocystis and Neolecta, is paraphyletic.

Note the discrepancy between mitochondrial and nuclear phylogenies at higher levels within the Ascomycota.
- Is one tree wrong?
- Are they both correct and indicate a different evolutionary history between these two genomic compartments?

The mitochondrial tree suggests that more complex forms (Euascomycetes) are more basal than simpler growth forms and yeasts. This raises several questions, e.g.:
- Evolution by simplification?
- Lichenized (symbiotic) basal (= more ancient)?
Taphrinomycotina

- ancient group with simple morphology
- probably paraphyletic

Taphrinomycotina: Major taxa

*Schizosaccharomyces*: fission yeasts

*Pneumocystis*: agent of pneumonia

*Taphrina*: plant pathogen; common; cause serious diseases of plant generally of leaves, mostly in the Rosaceae and some trees (e.g., oak, poplar)
- asci forms but no ascomata;
- anamorph: a budding yeast named *Lalaria*.
- in standard lab cultures, only the yeast form develops.
- Taphrinales: 9 genera, 120 species

*Neolecta*
- Forms ascomata (only exception in the group)
Ascomycota : Taphrinomycota

*Taphrina caerulescens* leaf blisters of oak
http://www.invasive.org/browse/subject.cfm?sub=767

*Taphrina deformans* (Peach Leaf Curl)
http://www.caf.wvu.edu/kearneysville/plants/disease_descriptions/omplfcrl.html

- dikaryotic, in contrast to most ascomycetes.
- budding of ascospores = ‘yeast-like’
Ascomycota : Taphrinomycota

Schizosaccharomyces: fission yeast
- fermentation
- *S. pombe*:
  - model yeast for genetic studies
  - 2nd complete fungal genome ever sequenced

Life cycle of *Schizosaccharomyces pombe*

[Diagram of the life cycle of *Schizosaccharomyces pombe*]
Ascomycota: Taphrinomycotina

- *Pneumocystis*
  - formerly classified in the Tripanosomes
  - life cycle still unclear for many species

Cysts in lung tissue

- *Pneumocystis jiroveci*
  (= *P. carinii*): agent of pneumonia; genome sequencing underway.

Ascomycota: Taphrinomycotina: Neolecta


Several independent molecular phylogenetic analyses have indicated that the genus *Neolecta* has a unique position within the Ascomycota. It is the only taxon outside the core-group of filamentous, ascoma-forming ascomycetes (=Pezizomycotina) that also has the ability to form ascomata.

Light and electron microscope studies indicate that both the hymenial structure and ascomata ontogeny in *Neolecta* spp. are unique. Ascogenous hyphae in *N. vitellina* branched repeatedly and successively to produce asci. Non-ascogenous hyphae were multinucleate, often with nuclei in pairs.

Ascosporogenesis was initiated by nuclear fusion followed by a meiotic and mitotic division to form eight nuclei. The ascus apex was thin with an annular subapical thickening. Ascospores were forcibly released through a 'split' in the ascus apex. Woronin bodies were frequently associated with hyphal septa. Attempts to culture *N. vitellina* were unsuccessful.