Lecture 10

Basidiomycota V

- Agaricomycotina:
  --- Auriculariales, Dacrymycetales, Tremellales, Filobasidiales
  - Pucciniomycotina (rust fungi)
  - Ustilaginomycotina (smut fungi)

Tulasnellales, Auriculariales, Dacrymycetales, Tremellales and Filobasidiales are “heterobasidiomycetes”

Common characteristics
- septate basidia (except in Dacrymycetales: “Y” shaped basidia);
- basidiocarps are simple, often jelly;
- ability to form secondary spores from basidiospores (germination by repetition);
- ability to produce yeast forms;
- various dolipore/parenthosome types.

Systematics

The heterobasidiomycetes are not monophyletic; the name is retained by convenience to indicate taxa with septate or Y shape basidia. These taxa are basal in the Agaricomycotina phylogeny, with the Tremellales and Dacrymycetales to be the earliest diverging lineages.
Auriculariales

Auricularia spp.
- very common
- basidiocarp relatively large, jelly/rubbery, smooth hymenium
- on dead wood
- many edible species (cultivated as early as 600 AD in China)

Auricularia auricula (ear-like fungus)

Auricularia-type basidia
Life-cycle of *Auricularia*.

Note:
- secondary septation of the basidiospores;
- the ‘yeast-like’ behavior (labeled as ‘conidium/conidia’ in Alexopoulos’s figure) and ‘germination by repetition’ of the basidiospores.

**Dacrymycetales**

- “Y shape” basidia
- jelly, on dead wood

*Calocera cornea*
Tremellales

- *Tremella*-type basidia
- dimorphic life cycle
- haploid yeast phase
- dikaryotic phase mycelial with clamp connections
- dolipore septum with 'sacculate, membranous cup
- bifactorial mating system with only two alleles at the A locus, whereas B is multiallelic
- many species parasitic on other fungi; produce small, or no basidiocarp.
- some spp. on wood; produce larger basidiocarps

*Tremella reticulata* (white coral jelly)

*Exidia glandulosa* (black jelly fungus)

*Pseudohydnum gelatinosum*

*Eixidia* and *Pseudohydnum*

- relatively common
- on wood
- *Tremella*-type basidia, but molecular rDNA phylogeny indicates possible closer relationships with *Auricularia* rather than with *Tremella*…
- dolipore-type still unknown
Filobasidiales

- Filobasidilla, the sexual state of the human yeast pathogens Cryptococcus

C. neoformans is an encapsulated yeast
- 4 serotypes; diff. virulence
- var. gattii is associated with Eucalyptus trees in the wild
- brown-rot activity detected

Know more about Cryptococcus neoformans: http://www.bioteach.ubc.ca/Biodiversity/APeachOfAPathogen/
http://www.doctorfungus.org/thefungi/Cryptococcus.htm

Basidiomycota: major evolutionary groups

Agaricomycotina
Macrofungi (mostly)

Ustilaginomycotina
smuts

Pucciniomycotina
rusts

Classification in Hibbett et al., 2007
18S and 25S nuc rDNA phylogeny
Lutzoni et al., 2004)
Basidiomycota: major evolutionary groups

Ustilaginomycotina

- smuts
- teliospores instead of basidioles
- teliospores terminal
- phragmobasidia
- simple pore septum

Pucciniomycotina

- rusts
- teliospores instead of basidioles
- teliospores mostly intercalary
- phragmobasidia
- simple pore septum

With rare exceptions, Pucciniomycotina and Ustilaginomycotina are characterized by the formation of teliospores, which directly produce phragmobasidia and basidiospores; they fungi are also referred as Teliomycetes.

A non-rust Pucciniomycotina that does not form a teliospore

*Septobasidium*(Septobasidiales)

© Photographer: Heino Lepp
**Septobasidium**: associated with scale insects: parasitism or symbiosis?

**Pucciniomycotina** (rusts)

**General characteristics**

- Ca. 5,000 known species distributed in ca. 150 genera
- **all parasites on plants** including many cultivated crops
- generally do not kill the host plant but use repeated infection
  ----> decrease crop productivity
  ----> cause galls or cankers that decrease timber value
- only a few have been successfully cultured in vitro on artificial media (--> obligate biotrophs)
- lacks basidiocarp: germination of basidia from **teliospores**
- complex life cycle
  ---- up to 5 stages in the more complex case
  ---- most species need two different plants (often taxonomically unrelated) to complete their life cycle:
  -------> "primary” and "alternate” host”. By definition: telial (=teliospore-forming) stage = primary host;
  ------->various degree of host specificity

**Major taxa**

- *Puccinia graminis* primary host = various cereals; alternate host = *Berberis vulgaris*
- *Cronartium spp.* canker on pine, oaks etc. (primary host); berries as secondary hosts
- *Gymnosporangium* spp.: cedars, junipers as primary host
Stage 0: spermogonia bearing spermatia N and receptive hyphae N

Stage I: aecia bearing aeciospores (N+N)  
Stage II: uredinia bearing urediniospores (N+N) (disease propagation)  
Stage III: telia bearing teliospores (2N)  
Stage IV: basidia bearing basidiospores (N)

Not all species produce all the stages described above
Teliospores (2N)
- most distinctive
  --> taxonomy
- resistant spores
Telia and teliospores

--- taxonomy

**Figure 20.22** LMs. (A) Basidium of a rust fungus bearing two basidiospores. Note that two nuclei (N) are present in each spore. Two other stromata (arrowheads) are visible but had not formed spores. (B) Secondary spore that developed on a pointed stroma (arrowhead) arising from a now-empty basidium (BS). Bars = 5 μm. [From Mims and Richardson (1990).]
*Puccinia graminis*

Spermogonial stage on *Berberis* (intermediate host)

http://www.dipbot.unict.it/sistematica/Puc_eci.html

Aecia and aeciospores (N+N)

*Figure 20.4* Four types of aecia illustrating the forms *Conoma*, Aecidium, Rosella, and *Puccinia*. Aecial stages may occur in the absence of sexual states as do conidial acervulinae and other basidiospores. (Chapter 6) From Alexopoulos.
Urediniospores N+N
(=uredospores)

Multiple re-infection of the primary host
--> disease propagation

Figure 20-12 Diagrammatic summary of the recognition, signal, and parasitic phases of the infection process involving a urediniospore entering the stoma of the host. [From Mendgen et al. (1988). Courtesy K. Mendgen.] From Alexopoulos

Figure 20-25 TEM of an appressorium (A) of a basidiospore germinating and an infection hypha (H) that penetrated the host epidermis. The wall of the hypha is continuous with an appressorial basal knot (arrowheads). Bar = 2µm. From Meyer and Fricker. From Alexopoulos.
Ustilaginomycotina

Characteristics
- Ca. 1,200 known species; ca. 50 genera
- all parasites on plants including many cultivated crops, especially cereals
  - reported on ca. 4,000 plant species
  - generally infect flowers
- only a few have been successfully cultured in vitro on artificial media (→ obligate biotrophs)
- lacks basidiocarp: germination of basidia from teliospores
- relatively simple life cycle

Major taxa
- *Ustilago maydis* on corn,
- *Tilletia caries, T. tritici, T. indica* on wheat
- *Microbotryum violaceum*: teliospores produces in anthers of Caryophyllaceae (*Silene* spp.) → sterility; attracts insects for dissemination

From Alexopoulos
Smut on corn caused by *Ustilago maydis*
- edible in a young stage!
- genome sequencing ongoing

http://botit.botany.wisc.edu/images/332/Basidiomycota/Teliomycetes
http://botit.botany.wisc.edu/toms_fungi/march98.html/

Smut on sugarcane

http://edis.ifas.ufl.edu/SC008

From Alexopoulos

Figure 21-7 Various types of teleospores of smut fungi. [[E-G] Redrawn by permission from The British Smut Fungi by G. C. Ainsworth and Kathleen Sampson (1930). Commonwealth Mycological Institute, Kew, Surrey] From Alexopoulos
Figure 21.11 SEM of the hyphomycete of Ustilago graminea