Lecture 11

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.
Figure 22-1  Transmission electron micrograph of a median longitudinal section of a dolipore septum of *Tremella globospora*. Note the swollen septal wall surrounding the pore and the system of sacculate membranous cups on either side of the septum. Bar = 0.1 μm. [From Berbee and Wells (1988). Courtesy M. L. Berbee.]

Figure 22-4  TEM of a median section through a septum of *Auricularia*. Note the continuous or nonperforate nature of the septal pole cap (arrowheads). Bar = 0.2 μm. [From Lü and McLaughlin (1991). Courtesy D. J. McLaughlin.]

From Alexopoulos
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

From Kendrick

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

Dacrymyces palmatus

Calocera cornea

Pics G. Barron
Tremellales

- **Tremella**-type basidia
- dimorphic life cycle
- --- haploid yeast phase
- --- dikaryotic phase mycelial with clamp connections
- dolipore septum with ‘sacculate, membraneous cups’ (see next pic)
- 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)  
*Pics G. Barron*  

*Tremella foliacea*
Exidia glandulosa (black jelly fungus)

Pseudohydnum gelatinosum

Exidia 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

- *Filobasidiella*, 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.bioteach.ubc.ca/Biodiversity/APeachOfAPathogen/)
[http://www.doctorfungus.org/thefungi/Cryptococcus.htm](http://www.doctorfungus.org/thefungi/Cryptococcus.htm)
Basidiomycota: major evolutionary groups

Classification in Hibbett et al., 2007

Agaricomycotina
Macrofungi (mostly)

Ustilaginomycotina
smuts

Pucciniomycotina
rusts

Homobasidiomycetes

Auriculariales

Heterobasidiomycetes

Ustilaginomycetes

Urediniomycetes

Agaricus
Coprinus
Schizophyllum
Phanerochaete
Cantharellus

Crytococcus
Tremella
Dacrymyces

Ustilago
Tilletia

Uromyces
Rhodotorula

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

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 gals 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
Gymnosporangium

Peridermium quercinum

pine blister rust (*Cronartium*)

Pics from http://botit.botany.wisc.edu/images/332/Basidiomycota/Teliomycetes/

http://www.forestryimages.org/browse/subthumb.cfm?sub=722
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
Figure 20-26  Life cycle of *Puccinia graminis*: (A) mature, diploid teliospore; (B) basidia with basidiospores; (C) spermogonial stage on barberry; (D) aecial stage on barberry; (E) uredinial stage on wheat; (F) telial stage on wheat. (Drawing by Carol Gubbins Hahn.)
Teliospores (2N)
- most distinctive
--- > taxonomy
- resistant spores

Figure 20-19 Various types of teliospores representing eight genera of rusts: (A) Uromyces, (B) Pileolaria, (C) Puccinia, (D) Uropyxis, (E) Xenodochus, (F) Phragmidium, (G) Nyssospora, (H) Ravenelia. [(B, D, E, H) Redrawn from Cummins by permission from Manual of the Rusts of the United States and Canada, by J. C. Arthur (1934). Purdue Research Foundation, Lafayette, IN.]
Telia and teliospores

---> taxonomy

From Alexopoulos
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 sterigmata (arrowheads) are visible but had not formed spores. (B) Secondary spore that developed on a pointed sterigma (arrowhead) arising from a now-empty basidiospore (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 20-9 Four types of aecia illustrating the forms Caema, Aecidium, Roestelia, and Peridermium. Aecial states may occur in the absence of sexual states as do conidial ascomycetes and other basidiomycetes (Chapter 8)

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
**A: appressorium**

*Figure 20-25* TEM of an appressorium (A) of a basidiospore germling and an infection hypha (H) that penetrated the host epidermis. The wall of the hypha is continuous with an appressorial cone (arrowheads). Bar = 2 μm. [From Mims and Richardson]
Ustilaginomycotina

Characterisitics

- 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
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/
Figure 21-7  Various types of teliospores of smut fungi. [(E–G) Redrawn by permission from *The British Smut Fungi*, by G. C. Ainsworth and Kathleen Sampson (1950), Commonwealth Mycological Institute, Kew, Surrey.]
Figure 21-11  SEM of the promycelium of *Ustilago avenae* bearing four basidiospores. The teliospore is visible at T. Bar = 5 μm. [From O'Donnell (1992). Courtesy K. L. O'Donnell.]