Lecture 14

Ascomycota IV

Sordariomycetes

Lutzoni et al., 2004, American Journal of Botany
Sordariomycetes

- contains most of the traditional Pyrenomycetes [= ascomata are perithecium] (Sordariomycetidae) and Loculoascomycetes (Dothideomycetidae)

- also contains at least two groups of independently derived lichenized fungi: Arthoniomycetidae and Lichinomycetidae.

Sordariomycetidae

Major groups:
- Sordariales
- Diaporthales
- Hypocreales
- Meliolales
- Xylariales

Sordariomycetidae: Sordariales

• Includes most of the traditional Pyrenomycetes:
  - ascomata = perithecia
  - acsi unitunicate, inoperculate (= no “lid” but with an apical ring or “sphincter”)

  - generally produce solitary, dark or pallid perithecia; but sometimes perithecia are grouped in a stroma

  - in some species of Sordaria and Podospora, the “neck” of the perithecium is phototrophic;

  - mostly saprobic on cellulosic substrates including herbivore dung and decaying plant;

• Also includes some taxa with cleistothecium and evanescent asci; e.g., Chaetomium
Podospora
- “neck” of the perithecium is phototrophic;
- very common on herbivore dung;
- perithecium with paraphyses among the asci;
- asci may contain many ascospores e.g. 16, 32, 64, 128 … up to 2,048!
- ascospores with an apical germ pore, and gelatinous (sticky) appendages;
- Phialophora anamorphs

Sordariomycetidae: Sordariales

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Sordariomycetidae: Sordariales

Sordaria:
- positively phototropic “neck”;
- active spore discharge;
- several known “wild” mutants in spore colors ----> crossing / Mendelian genetic studies

Sordariomycetidae: Sordariales

Phialophora

Sordaria:
- positively phototropic “neck”;
- active spore discharge;
- several known “wild” mutants in spore colors ----> crossing / Mendelian genetic studies

Progeny of a dark-spored ‘wild-type’ strain crossed with a pale-spored mutant.
**Chaetomium**

- **common cellulolytic genus** that damages fabrics and paper, especially in the tropics.
- **cleistothecium w/ periphyses** and conspicuous **hyphal appendages**
- cylindric asc that lack an apical ring ---> deliquescence permits spore release
- **Botryotrichum** anamorphs

**Neurospora**

- the "Drosophila" of filamentous fungi: the science of haploid genetics was founded on *Neurospora crassa*

- see Kendrick, Chap. 10 for more info on fungal genetics
  ---- topics includes
  - nuclear division
  - marker genes and crossing-over
  - sexual compatibility - bipolar/tetrapolar
  - intersterility
  - parasexuality
  - extranuclear inheritance
  - genetics and plant pathology -
  - recombinant DNA and gene cloning
  - gene expression in yeast and filamentous fungi
  - molecular taxonomy and population genetics
  - genome projects
  - **mycoviruses**
Sordariales

*Neurospora*

- "black mildew fungi";
- small and homogenous group;
- primarily tropical: disease on cacao, plams etc.
- form a thick, dark, velvety mycelium on the surfaces of plants;
- obligate parasite on vascular plants;
- taxonomy mostly based on host relationships (probably artificial system)

From Alexopoulos

From Kendrick

Sordariomycetidae: Meliolales

- periphyses
- several perithecioid ascomata are usually immersed in a single stroma;
- paraphyses are often absent;
- asci with amyloid apical ring, become free inside the ascoma, and then autolyse (paradoxical situation).
- several important plant pathogens

**Major taxa**

*Gaeumannomyces graminis*
- commonly causes *whiteheads* of wheat.
- rots the roots of afflicted plants, and causes premature drying out of the plant, sometimes reducing yields to zero.

*Magnaporthe grisea (anamorph *Pyricularia oryzae*)
- common rice pathogen (rice blast);

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*Sordariomycetidae: Diaporthales*

*Cryphonectria*

*C.parasitica*
- devastating disease chestnut blight: almost wiped out chestnuts from eastern North America (3.6 million hectares ravaged between 1904 and 1960)
- chestnuts:
  --- nuts production;
  --- valuable timber;
- the pathogen was probably introduced from eastern Asia
- symptoms:
  --- bark cancers
  --- wilting of foliage
- the fungus appeared later in Europe (1938) and also cause significant damages, but was eventually controlled.
- hypovirulent strains contain a ds-RNA virus,
- virus used to contain the disease
- full story: Kendrick Chap. 12
The causal agent of chestnut blight is a fungal pathogen of *Castanea* and to a minor extent on *Quercus* species. In Europe this disease lost its severity due to the natural spread of the dsRNA hypovirus CHV1. This hypovirus can be transmitted through hyphal anastomosis, resulting in conversion of the recipient strain to the hypovirulent phenotype (*in vitro* demonstration of transmissible hypovirulence). Transmission of the hypovirus is limited by a vegetative incompatibility system in *C. parasitica*. Ongoing studies of the fungal population structure (vc type diversity, sexual and asexual reproduction) and of the diversity of the hypovirus will yield information on the dispersal and establishment of hypovirulence as well as on introduction pathways. This provides the basis for biocontrol measures.

http://www.wsl.ch/forest/wus/phytopath/reschestnut/images/hvcanker.jpg

**Sordariomycetidae: Hypocreales**

- **ascomata** pale to brightly colored (yellow - red);
- **asci unitunicate**, with thick apex, **inoperculate**;
- conidia produce from phialidic conidiophores
- endophytes / parasites of plants, parasites of animals and other fungi.

Major genera

**Nectria**
- perithecia generally bright orange - red, produce on the surface of a cushion-shaped stroma;
- **two-celled ascospores**
- phialidic anamorphs include *Fusarium* (elongate, crescent-shaped multiseptate conidia) and *Tubercularia* (very small, one-celled conidia).
- canker on trees; wilt disease;
- mycotoxin production.

From Alexopoulos

**Figure 12-1** Life cycle of *Nectria cinnabarina*. [Modified from Alexopoulos (1962) by K. W. Schieß.]
Hypomyces
- white to orange fungi, parasite on fleshy mushrooms ⇒ causes abortion of the development of the hymenium;
- produce soft, hyaline to brightly colored perithecia sunken in a loose, thick, cottony, hyphal mat;
- ascospores are one or two-celled.

Hypomyces completus
“Lobster mushrooms”
Hypomyces lactifluorum on Russulaceae

Hypocrea
- common
- cushion-shaped or effused, small stromata on wood;
- asci contain eight two-celled ascospores in a single series;
- ascospores are constricted at the septum and may break into part spores so that the ascus appears to have sixteen spores at maturity;
- anamorphs include Gliocladium and Trichoderma

--- Trichoderma: very common, especially in forest soil; used in biological control of pathogenic fungi, e.g., in commercial production of the button mushroom (Agaricus).

Trichoderma viride

Hypocrea virens
http://nt.ars-grin.gov/shablweb/research/Publications/Hvirens/index.cfm
Sordariomycetidae: Hypocreales

Epichloe
- grass disease; common; white, powdery mycelium;
- endophyte.

Epichloe typhina
Early (left) and late stage of infection (right)

http://www.bioimages.org.uk/HTML/R58444.HTM

Sordariomycetidae: Hypocreales

Claviceps
- pathogens on cereals;
- C. purpurea = ergot of rye; LSD; 100x more concentrate than in Psilocybe.

Ergotism: The disease became well-known in the Middle Ages when it was known as St. Anthony's Fire due to the fact that a religious order dedicated to St. Anthony cared for those with severe symptoms. Some of the alkaloids produce vaso-constriction which results in insufficient blood flow to legs and arms, a condition that produces an extreme burning sensation, blackening, and may result in loss of the limb. Many died, particularly in countries where the consumption of rye bread, primarily by the poor, was high.

Sclerotia of C. purpurea contain three families of alkaloids: secoergolenes, ergolines, and lysergic acid derivatives (lsd). Together, the toxic alkaloids are psychoactive and produce vasoconstriction; however, these same effects may be medicinally useful when administered in the correct dosage to induce labor, prevent post-partum hemorrhage, and treat migraine.

(from Spatafora)
Sordariomycetidae: Hypocreales

**Cordyceps**
- insect parasites ("killers");
  --- potential use as insecticide? If so, still needs to be developed as such;
- parasites on hypogeous ascocarps of *Elaphomyces*.

Hirsutella formicatum

anamorph

Sordariomycetidae: Xylariales

- dark, leathery, woody, or carbonaceous **perithecial** or, occasionally, **cleistothecial** ascocarps, often **embedded in a stroma**;
- asci usually with an apical ring; the ring may become blue (amyloid) in iodine;
  ---- asci within a perithecium mature at different times, so that ascospores of different ages can be found in the same ascocarp over a long period of time;
- **anamorphs** can be formed from the same stoma than teleomorphs;
- ascospores are hyaline or dark, one or few-celled and may have germination pores.
- **periphyses** typically are present in the neck of perithecial forms.

Major genus: **Xylaria**
- saprobic or weak parasites on woody plants and usually have erect elongated stromata;
- conidia formed on the surface of the stroma well before perithecia develop

*Xylaria hypoxylon* : a very common species.


http://www.uoguelph.ca/~gbarron/SAC%20Fungi/xylaria.htm
Sordariomycetidae : Xylariales

Xylaria polymorpha, “dead man's fingers”. Common species on dead wood.

Daldinia grandis

Horizontal section of the stroma showing back perithecia formed in the periphery.


Sordariomycetes clade: Dothideomycetidae (= Dothideomycetes)

- paraphyletic group

- part of the traditional Loculoascomycetes
- other members of the traditional Loculoascomycetes (Pyrenulales, Chaetothyriales, Verrucariales) form the Chaetothyriomycetidae clade - more later;

Loculoascomycetes: Generalities

- Fructification: Ascostromata = secondary formation of locules inside a stroma --- quite variable in form;
  --------- may be multilocular or unilocular. When they are unilocular, it may be extremely difficult to distinguish them from a true perithecium unless the development is studied. Unilocular ascostroma are also called a pseudothecium (Greek pseudo = false + theke = box).

[A matter of definitions: paraphyses and periphyses, which by definition arise from non-stromatic structures, are not produced in Loculoascomycetes --- if sterile, similar structures are produced, they are called pseudoparaphyses and periphysoids instead; the different wording stress the fact that they are analogous, rather than homologous structures]
Loculoascomycetes: Generalities - cont.

Asci

- **bitunicate** (= two separable wall layers generally functional in ascus dehiscence);
  ---- several distinct types of bitunicate asci can be distinguished --> taxonomic differentiation;

- asci are produce within locules in the preformed (asco)stroma (= ascomarp);

Bitunicate asci of *Pleospora*

http://www.biodiversity.ac.psiweb.com/pics/0000308_.htm

Dothideomycetidae

- very diverse group; still poorly known;
- many plant pathogens, including many anamorphs

Some examples

*Apiosporina morbosa*

extremely common; causes **black knot**, mostly on rosaceous trees, especially wild cherry and damson plum; pseudothecial ascomata (below, left) developing on conspicuous black fungal stromata (below, right).

From Kendrick
Dothideomycetidae

**Botryosphaeria dothidea**

- cause canker on *Eucalyptus, Pinus, Cupressus* and several fruit trees or shrubs including berries, grapes etc.
- conidiophores often develop on the same stroma as the ascomata

http://www.crem.fct.unl.pt/botryosphaeria_site/botryosphaeria_dothise_2.htm


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Dothideomycetidae

Diseases caused by **Botryosphaeria spp.** ("black death, or “black rot”

http://www.tigulliovino.it/malattie/malattie_black_dead_arm.htm

http://www.caes.state.ct.us/PlantPestHandbookFiles/pphA/pphappd.htm