Biology of FUNgi

Lecture 5
Towards the true fungi - Chytridiomycetes and Zygomycetes

A look back

• What were the cellular slime molds? What united them? Why were they important?

• What were true slime molds? What united them? Why were they important?

• What were the water molds? Why were they important?
Phylum Oomycota – oomycetes

Life of an oomycete - diploid zoospores, gametangia...

- Oospore
- Karyogamy
- Zoosporangiophore
- Plasmogamy
  Meiosis occurs in antheridia and oogonia
- Antheridium
- Oogonium

Fungus of the day - Neocallimastix sp.

Taxonomy: Phylum (subphylum) Chytridiomycota
Order - Neocallimasticales
Family - Neocallimasticeae
Common names: -

- Ruminant endosymbiont. Collected from ruminant poop, from the stomach fluids or saliva.
- Neocallimastix atypical chytrid: anaerobic and polyflagellate. Survives in air by resistant cysts (resting spores).
- The very existence of the rumen chytrids was unknown until 1980’s - thought to be protozoa.

Typical chytridiomycete zoospore - uniflagellate. Neocallimastix - polyflagellate
Fungus of the day - *Neocallimastix sp.*

Lower fungi - coenocytic thalli (bundle of hyphae, like mycelium)

Reproduction by zoospores which are released from zoosporangia.

Zoospore = flagellated motile cell.

A look ahead.

- What are the true fungi?
- What are the lower fungi?
- How did the true fungi evolve?
Non-fungi vs. true fungi

True fungi - crown eukaryotes, more related to animals than to plants.

Non-fungi - protistan. Several different divergence events.

Plunge into the true fungi

- Basidiomycota
- Ascomycota
- Zygomykota
- Chytridiomycota
- Animalia
Pertinent evolutionary characters in the true fungi

**Ancestral traits**
- Chitin
- Glycogen
- Posterior flagellum

**Loss of phagotrophy**

**Loss of flagella**

**Dikaryotic stage**

**Septate mycelium**

**Basidiomycota**
- Basidiospores
- Doliopore septum
- Clamp connections

**Ascomycota**

**Zygomycota**

**Chytridiomycota**

**Animalia**

From the base to the top of the tree - Phylum Chytridiomycota

**What are the chytrids?**

The only members in the kingdom Fungi with motile cells in some stage in the life history.

Mainly uniflagellate - remember *Neocallimastix* though - with a single posteriorly-oriented whiplash flagellum

**Zoosporangia of Allomyces arbuscula**
From the base to the top of the tree - Phylum Chytridiomycota

What are the chytrids?

Thallus is coenocytic. May be mycelial or just an elongated single hyphae. Septa are absent or infrequent. Present regularly at the base of the reproductive organ - like in *Saprolegnia*. Many endobiotic chytrids may have extremely reduced thallus, i.e., none at all.

Sporangium and discharging zoospores of *Rhizophydatum* sp.

The zygote may encyst - form a resting spore - or forms resting sporangium, or possibly both. This also explains how *Neocallimastix* survives in poop.

Cell wall materials are mainly chitin.

Sporangium and hyphae of *Spizellomyces* sp.

Sporangium of *Spizellomyces* sp. Note discharge papillae.
From the base to the top of the tree - Phylum Chytridiomycota

Where do the chytrids occur and what do they do?

As is evident, the zoospore dispersal requires water.

Quite a few aquatic chytrids, but only limited number in marine environments.

Despite the requirement for water, common also in terrestrial environment.

Most chytrids are saprobic - examples include cellulose and keratin decomposing species
Some chytrids are plant pathogens: *Synchytrium endobioticum* – the black wilt of potatoes

*Synchytrium endobioticum* germinating prosorus - sorus initiator  
*Synchytrium endobioticum* causes the black wart disease of taters  
*Synchytrium endobioticum* in potato

Sporangium and hyphae of *Spizellomyces* sp. on pine pollen
From the base to the top of the tree - Phylum Chytridiomycota

*Neocallimastix* - anaerobic and exists in the rumen of the herbivores, potentially another example of mutualistic symbiosis.

They can be hard to detect because of the small size and the fact that chytrids may escape usual isolation techniques used for the bacteria and fungi.

Phylum Chytridiomycota - *Allomyces* as an example for a life cycle

This is very similar to primitive plant reproduction - alteration of generations - haplothallus/diplothallus
Zygomycetes - Reminder of the character evolution

Ancestral traits
Chitin
Glycogen
Posterior flagellum

Phylum Zygomycota - the conjugating fungi
General characteristics

What unites zygomycetes is the production of a thick-walled resting spore - the zygospore.

The zygospore forms as a result of fusion of two gametangia which will remain as the suspensor cells once zygospore forms.

Zygomycetes are generally coenocytic. When septa are present they usually lack pores with the specialized plugs like in asco- and basidiomycetes.

Asexual reproduction usually occurs via sporangia-borne mitotic spores.

A zygospore suspended between the suspensor cells - Syzygites sp. - a parasite of mushrooms.

An asexual sporangium of Absidia corymbifera.
Phylum Zygomycota - the conjugating fungi

General characteristics

The zygomycetes can be either homo- or heterothallic (one individual can give rise to sexual structures or two different mating types required for sexual reproduction).

They can also form a zygospore parthenogenetically. The resulting azygospore is similar to a real zygospore (does this involve meiosis and recombination events?) but has usually just a single suspensor cell.

Some zygospores are wrapped in an elaborate hyphal construction. *Absidia spinosa* and *Phycomyces blakesleeanus* as examples.

Phylum Zygomycota - the conjugating fungi

Where and how to look for the zygomycetes

As a group the Zygomycetes can be isolated from a variety of substrates including soil, dung, fruit, grain, plant tissues, and animal tissues.

Nutritionally they range from saprotrophism through weak parasitism of plants to very specialized parasitism and predation of animals.

Some have been called “sugar fungi” because they lack a good arsenal of enzymes which would allow degradation of complex carbohydrates.
Phylum Zygomycota - the conjugating fungi

Where and how to look for the zygomycetes

The human diseased condition involving zygomycetes is known as zygomycosis. Usually zygomycetes invade only tissues of immunocompromized individuals. Alternatively, zygomycetes may be involved as secondary infections associated with burns or trauma. Some of the Entomophthorales (the insect-feeding zygomycetes) may infect physiologically and immunologically normal humans (*Basidiobolus ranarum* is an example of such).

*B. ranarum* can be a causal agent of human infections. Asexual sporangia.

**Absidia corymbifera** is among those fungi which may facultatively colonize human hosts.

Finally, zygomycetes are probably the most common mycorrhizal partner (Glomomyces?). It has been estimated that 95% of plants belong to families which have been recorded to be mycorrhizal. Most of these plants form so-called arbuscular mycorrhizae.

*Mycorrhizal structures, arbuscules and vesicles in a colonized onion (Allium) root.*

*Gigaspora gigantea* is an example of a mycorrhizal zygomycete. These spores do not form through anastomosis of two mycelia; they rather appear to be formed terminally on a hyphae as an azygospore.
Phylum Zygomycota - the conjugating fungi - life cycle

*Rhizopus stolonifer* - an example of a heterothallic zygomycete.

Phylum Zygomycota - the conjugating fungi - life cycle

Let’s look at some fancy microscopy: *Phycomyces* sp.
Summary

• Lower fungi - chytridiomycetes and zygomycets
• Chytridiomycetes - the only flagellated true fungi.
• Zygomycetes - conjugation fungi with the conjugating spore and mitotic sporangia.