Biology & Diversity of Fungi

(30.1, 30.2, 30.3)

VIDEOS

YouTube

Biology & Diversity of Fungi

(Freeman Ch.31)

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ECOL 182R UofA

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Tucson ~native

University of Arizona (undergrad)
- Ecology & Evolutionary Biology
- Economics

University of Wisconsin, Madison (graduate)
- Zoology, Evolutionary Physiology
- Herpetology & Amphibians

Teaching at UA since 2002
- Herpetology
- Vertebrate Physiology
- Conservation Biology
- Environmental Biology
- Introductory Biology
- Sonoran Desert Discovery

Middle-Third of this course (fungi, plants, ecology...)

Text readings are highly encouraged

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Life can be divided into 3 domains

- Prokaryotes = bacteria + archaea
- Prokaryote was ancestral and only form for billions of years

Prokaryotes are Prokaryotes monophyletic, paraphyletic, polyphyletic?
Eukarya = protists, plants, animals, fungi

are Protists monophyletic, paraphyletic, polyphyletic?

Animals and Fungi are Closely Related Eukaryotes

You wrapped up a discussion on animals with Dr. Schaffer last week. We will therefore start with fungi, then move to prokaryotes and protists, then to plants, etc...

Tree of Life

Opisthokonts (Fungi and Animals are closely related)

Synapomorphies (shared, derived traits)

1. Flagellum - movement
2. Glycogen - sugar storage
3. Chitin - cell walls and other structures

Where did these three traits evolve on the tree?
Chitin
(tough but flexible nitrogen-containing polysaccharide)

- Production of chitin is a shared derived trait for
  - fungi
  - choanoflagellates
  - animals
- Evidence that fungi are closer to animals than plants

How fungi live

- All use absorptive nutrition, secreting digestive enzymes and absorbing the breakdown products

- Most are saprobes (feed on dead matter)
  - Earth's main decomposers (with bacteria)
  - principal decomposers of cellulose & lignin
  - nutrient (re)cyclers
- Some are parasites
- A few are mutualists

Cell structure of multicellular fungi

Vegetative body = mycelium
(plural mycelia)

Composed of threadlike hyphae
(singular hypha)

Fungi
5 or 6 major groups

Saprobic fungi (and bacteria)

Fungus structure

- Hyphae may
  - disperse to look for nutrients
  - clump together to exploit a food source
- Mushrooms are a fruiting (reproductive) structure
- Most unicellular fungi are called yeast
Why are hyphae useful for a decomposer?

- SURFACE AREA
  - for EXTRACELLULAR digestion
  - for ABSORPTION

Fungal hyphae attack a leaf

Hyphae give a large surface:volume ratio, which helps with absorptive nutrition

Symbiotic fungi

Lichens are symbiotic associations of a fungus with a unicellular photosynthetic eukaryote (algae) or cyanobacterium or both.

Lichens are important pioneer species

Symbiosis

What is it?

The term symbiosis (from the Greek: σύν syn “with”; and βίωσις biosis “living”) commonly describes close and often long-term interactions between different biological species. The term was first used in 1879 by the German mycologist Heinrich Anton de Bary, who defined it as “the living together of unlike organisms.” The definition of symbiosis is in flux, and the term has been applied to a wide range of biological interactions. The symbiotic relationship may be categorized as mutualistic, commensal, or parasitic in nature. Others define it more narrowly, as only those relationships from which both organisms benefit, in which case it would be synonymous with mutualism.

Symbiotic fungi

- Mycorrhizae are mutualistic associations of fungi and plant roots
- The fungus obtains organic compounds, while the plant is provided with water and soil nutrients
- Some plants can’t grow without them

Mycorrhizae = mutualistic associations of fungi and plant roots
Fungi increase surface area for nutrient and water absorption by plant
by endomychorrhizal fungi (EMF) forming vesicles around roots and penetrate between root cells.

Nitrogen and Phosphorus often LIMITING in ecosystems.

Fungi are very important cyclers of nutrients.
Especially Carbon, Nitrogen, Phosphorus.

Nitrogen and Phosphorus often LIMITING in ecosystems.

Fungi are way cool...
...so is biology!

Zygomycota Pilobolus kleinii
50,000 fps
2 to 25 m s⁻¹ corresponding accelerations of 20,000 to 180,000 g
propelled spores over distances of up to 2.5 meters

The fastest spores travelled more than 1 million times their own body length in one second.

180,000 G vs.

Fungal reproduction can be complex

• Sexual OR asexual
• Life cycles distinguish 4/5 phyla

Predatory fungus!
Fungus capturing a nematode worm

What parts of you are Diploid?
Haploid?

Alternation of Generations

Both the haploid and the diploid have multicellular forms.

Compare to Haplontic and Diplontic.
Fungal Sexual reproduction

- Some fungi have more than 2 mating types
- Mating types don’t look different
- Mating can only occur between different mating types, preventing self-fertilization
- Sexual reproduction when hyphae (or motile cells in chytrids) of different mating types meet and fuse

Dikaryotic Lifestage

- Unique to fungi
- Two haploid (n) cells fuse, but not their nuclei = n + n dikaryote
- Plasmogamy (cell fusion) followed later by Karyogamy to produce Diploid (2n) Zygote
- Life cycles distinguish 4/5 phyla...

Important points about sex and reproduction

- **Sex** = 2 nuclei fusing, followed by meiosis
- **Reproduction** = one individual giving rise to multiple: can be sexual or asexual
- Genetic recombination = any gene exchange: not just sex, also nonreproductive processes such as conjugation
- **Dikaryotic** individuals include 2 fused individuals, but not fused nuclei
- "Spores" can be sexual or asexual, reproductive or not: normally a small, tough cell with potential to become new organism. Often capable of latency. Can be plant, bacterial, protist, or fungal.

Haplontic life cycle

- **Haploid** is dominant, multicellular structure
- Often diploid only very briefly as a zygote
- **Meiosis** produces haploid nuclei again
- Haploid spores divide mitotically to form haploid hyphae

Fungal asexual reproduction

- **Cell division** by unicellular fungi
  - equal division (fission)
  - production of a daughter cell (budding)

- Simple breakage of the mycelium
**Asexual reproduction via spores**

Production of haploid spores within sporangia

**Fungal spores are everywhere**

- Every breath we take is full of fungal spores (~10,000/m³ of air)
- Most humans only succumb to fungal pathogens when immunocompromised

**Plants are not so lucky...**

Parasitic fungus *Ustilago maydis* (corn smut)

Fungus (aka mold, mildew, etc.) causes lots of crop damage
- Dutch Elm disease
- Chestnut blight

**Neither was this ant**

Spores of this fungus don’t germinate until ingested by an ant

**Basidiomycete life cycle**

The basidium is the characteristic sexual reproductive structure of the basidiomycetes. Basidiospores form outside the basidium.
Basidiomycete life cycle

The mushrooms that we eat are dikaryotes!

Yeast are fungi

- All five fungal phyla have unicellular species
- Those of all phyla except chytrids are called yeasts
- The yeast *Saccharomyces cerevisiae* makes CO₂ and ethanol during fermentation
- Used for bread and beer

Chytrids

"basal group"

Includes *Batrachochytrium dendrobatidis* (Bd) causing amphibian die-offs

Chytrid Fungi

A chytrid fungus (*Batrachochytrium dendrobatidis: Bd*) has been implicated in the worldwide decline of numerous amphibian species. Frogs infected with this fungus suffer chytridiomycosis, a disease affects amphibian skin and is often fatal. Chytrid zoospores can survive in damp conditions and may be transported between frog populations in muddy clothing and footwear.

- water balance
- respiration
- immune system

Five Fungi Phyla

~1 bya

Chytridia
dendrobatis

Chytridiomycota

Zygomycota

Glamazymycota

Ascomycota

Basidiomycota

Crown fungi

Life cycle of the basidiomycete *Cortenellus shiitake*
African Clawed Frog?

Glomerocytes

Important mycorrhizae associations with plants

Ascomycetes


Basidiomycetes

Named after basidiocarp, Which we know as a mushroom