Insect Pathogenic Fungi
What are Fungi?

- Eukaryotic
- Have a cell wall with Chitin
- Heterotrophic
- Absorptive nutrition
- Have spores
- Many have a network of tubes (Hyphae) form a mycelium
Fungi

• They absorb food from plants or other substrates (things they grow on or within).

• Fungi are found in almost every environment on the planet.
Insect Pathogenic Fungi

• **Insect Pathogenic Fungi** grow within and parasitize insects (and other arthropods including spiders).

• There are many different groups of insect pathogenic fungi.
Major groups of Insect Pathogens

- Entomophthorales
- Ascospshaera
- Hypocreales
Entomophthorales

Most species are pathogens of invertebrate animals. Many are insect pathogens. *Entomophthora* means “insect destroyer”. Spores land on and penetrate a fly’s exoskeleton.

- *Entomophthora muscae* is a common pathogen of flies.
- *E. muscae* causes “summit disease” modifying the behavior of the fly in order to better disperse its spores.
Entomophthora life cycle

1. Source of inoculum
2. Spore
3. Adult fly
4. Spore
5. Spore
6. Fly dies, falls to ground
7. Overwintering structures stay in soil
8. Fly
9. Fly

Summit disease

Soil

Roy et al. 2006 Annual Rev. Entomo.
Ascosphaera

- Many species of Ascosphaera associate with bees, but are not pathogens. However, several species are pathogens of the larval stage of bees (inside the hives), so that they never mature into adults.

- Unlike Entomophthora, spores of Ascosphaera do not penetrate their host via the exoskeleton, but are taken in via the digestive system.

Infection of A. apis causes bee larvae to become “mummies.”
Honey bee Chalkbrood Disease

• Because honey bees are so important to agriculture and their populations are in decline, researchers are looking for ways to stop *Ascosphaera apis* from causing chalkbrood disease.

https://vimeo.com/96828551
Hypocreales

• There are several genera of insect pathogens in Hypocreales. Here are just a few:
  – Cordyceps
  – Ophiocordyceps
  – Metarhizium
  – Beauveria
  – Tolypocladium

• We can refer to most of these as “Cordyceps-like fungi” because they were once called Cordyceps.
Cordyceps-like fungi

• They produce bright or pale colored fruiting structures growing out of their insect hosts.

• Similar to Entomophthora, spores land on and penetrate the insect exoskeleton before completely devouring the internal contents of the host, after which they form fruiting structures.
Cordyceps-like fungi

- Many Cordyceps can produce both Sexual and Asexual fruiting structures.
Cordyceps-like fungi

- Flask shaped fruiting bodies, called **Perithecia**

- Inside perithecia are long **asci** containing ascospores that break apart into tiny partspores
Host association

Cordyceps-like fungi attack many different insect and arachnid hosts. Some species parasitize many different hosts (generalists), while other are very specific in their host association (specialists).
Spider pathogens
Beetle pathogens

This is a generalist species!!
Grasshopper pathogens
Wasp Pathogens
Moth/Butterfly Pathogens
The most expensive fungus...

...and maybe the most famous!

- **Ophiocordyceps sinensis**

- Valued for its use in Traditional Chinese Medicine
Pathogens of scale insects

These dots are actually tiny insects called “Scales” that have been attacked by Cordyceps-like fungi!
Ant Pathogens

Joey Spatafora

Ryan Kepler

Tatiana Sanjuan

Ryan Kepler
“Zombie” Ants

• **Ophiocordyceps unilateralis** manipulates ant behavior in what is called summit disease. Ongoing research seeks to understand how exactly *O. unilateralis* is able to control the ant’s behavior.

• [O. unilateralis video](#)
Discussion

• What other fungal pathogen causes summit disease? Why do you think this is a common theme in insect pathogenesis?
Want to know more?

- [http://Cordyceps.us](http://Cordyceps.us)
Collecting Insect Pathogens

You can find them too!!
What you will need

- Perseverance
- A keen eye
- A small shovel or spade
- A hand lens
- A collection box
- A knife (optional)
- Field notebook
Biocontrol

• Insect pathogenic fungi can and are being used as biocontrol of unwanted insects.

• *Metarhizium* (Hypocreales) is one fungus that has already been used in biocontrol of grasshoppers and other insects.

• *Metarhizium* is a generalist insect pathogen. What are the potential benefits and risks of using such a pathogen in biocontrol? Discuss.
Pathogens of Cordyceps

Here, one kind of Cordyceps (called Polycephalomyces) is parasitizing O. nutans!!

This is Ophiocordyceps nutans fruiting from a stink bug it has killed.
Photo Credits/ Web Addresses

- Slide 6 – E. muscae by Hans Hillewaert https://commons.wikimedia.org/wiki/File:Entomophthora_muscae_on_Scathophaga_stercoraria_(lateral_view).jpg
- Slide 8 – Bee research by Kyle Gabriel, Georgia State University
- Slide 15 – Bottom two photos from Johnson et al. 2009 Mycological Research
- Slide 16 – Beauveria on Beetle from Sung et al. 2007 Studies in Mycology