Spore Dispersal in Fungi

How Do Fungi Get Around?

1. Although relatively few in species, fungi are everywhere.
2. The mycelia of some fungi are potentially able to produce up to "billions and billions" of spores.
3. Not all will give survive, but sheer numbers ensure some will.
4. Examples from various groups of fungi.

5. Majority of fungi disseminate their spores by wind.
6. A sample of air may contain:
   a. As few as 200 m$^3$.
   b. As many as 2 million m$^3$.
   c. Typically 10,000 – 20,000 m$^3$.

Ustilago maydis (Corn Smut)

A gall that is about 1 in$^3$ may contain approximately 25 billion spores!

Ganoderma applanatum (Artist Fungus)

A typical size fruiting body may disperse 5.4 trillion spores over a six month period.

Bread Mold, A Microscopic Fungus

Rhizopus stolonifer, sporangia. Each sporangium may contain up to 50,000 spores.
How Do Fungi Get Around?

7. Spores must also have mechanism by which they are dispersed.
8. A number of mechanisms have evolved in fungi to disperse spores:
   a. Wind
   b. Water
   c. Insects
   d. Animals
   e. Active mechanism of fungus

Wind: Air Borne Spores

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Wind: Air Borne Spores

1. Wind dispersed spores borne in large number.
2. Spores are "dry" spores and hydrophobic. Why?
3. Most studied group of spores. 
   a. Aerobiology deals with particles transported in air.
   b. That fungal spores can cause allergies was not known until 1924.
   c. Mostly caused by common microscopic fungi = molds.

Wind: Air Borne Spores

3. Most studied group of spores.
   (continued)
   a. Literally thousands of tons of spores of two most common air borne fungi, Cladosporium and Penicillium, have been measured in air.
   b. Air samples may contain approximately 200,000 spores/meter$^3$
   c. Observe that particles are suspended in light beam.

Wind: Air Borne Spores

4. Effectiveness of air dispersal demonstrated in experiment by Christensen (1975).
   a. Experiment utilized Cladosporium resinae, as a marker fungus.
   b. Species only found on resin permeated soil or wood impregnated with coal tar creosote, i.e., telephone poles and in diesel fuel.

Wind: Air Borne Spores

Cladosporium resinae, a mold with very specific nutritional requirement.

Wind: Air Borne Spores

4. Effectiveness of air dispersal demonstrated in experiment by Christensen (1975). (continued)
   c. Species released in Plant Pathology Building at University of Minnesota. A building with four floors and no central air conditioning.
4. Effectiveness of air dispersal demonstrated in experiment by Christensen (1975). (continued)

d. Cladosporium resinae selected since its spores were unlikely to be in the air during experiment.
   i. In order to grow C. resinae, special medium with creosote required.
   ii. Creosote medium also prevented other fungi from growing.

e. In order to ensure that C. resinae was not already in the air.
   i. Plates with creosote medium exposed in building, and soil and wood samples before experiment.
   ii. Marker fungus, C. resinae was not isolated!

Thus, C. resinae not present in plant material and in soil.
Wind: Air Borne Spores

Thus, *C. resinae* not present in air and experiment sight.

4. Effectiveness of air dispersal demonstrated in experiment by Christensen (1975). (continued)
   f. Experiment was in two parts:
      i. Plates exposed from 1st to 4th floor, at 5 minute intervals, in labs and hallway.
      ii. Seven sets of plates exposed from 1st to 4th floor, at intervals of 0-5, 5-10, 10-20, 20-30, 30-60, 60-120 and 120-240 minutes.

4. Effectiveness of air dispersal demonstrated in experiment by Christensen (1975). (continued)
   g. Results of experiment on web:
      i. Each colony recorded on plates after incubation period were assumed to have arisen from single spores.
      ii. Colonies recorded on all floors. As expected, more colonies on 1st than 4th floor.

4. Effectiveness of air dispersal demonstrated in experiment by Christensen (1975). (continued)
   h. Experiment demonstrates ability of air borne spores to stay afloat.
      i. Summary of results

5. An experiment that you can do:
   a. Place mature mushroom, in box, about 10" high, 36" long.

Wind: Air Borne Spores

Basidium ejects basidiospores and falls between gills to be carried away by wind.

Lower magnification of basidiospores falling between the gills.
Wind: Air Borne Spores

Ascomycota fruiting body with asci and ascospores.

Wind: Air Borne Spores

Ascospores disperse when pressure within “shoots” spores through operculum.

Wind: Air Borne Spores

Expectation is that all spores would drop directly below mushroom, but not the case.

Wind: Air Borne Spores

Top view of spores on cardboard box bottom. Some spores stay afloat and land on opposite end of box.

Wind: Air Borne Spores

6. Ability of spores to stay afloat, indoors, is reason why allergies worst indoors, for some. Worst when sweeping and vacuuming.

5. Some mechanisms of spore dispersal utilized in puffballs.

Puffballs With Flexible Peridium

*Lycoperdon perlatum*: Species has a flexible peridium with an apical ostiole where spores are dispersed when peridium is depressed.
**Puffballs With Flexible Peridium**

*Geastrum tripex* (Earthstar): Species has a flexible inner peridium with an apical ostiole and a thick, tough outer peridium that dehisces at maturity to form a star-shape.

**Puffballs With Flexible Peridium**

*Geastrum tripex* dispersing spores following depression of peridium.

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**Puffballs With Thick Rigid Peridium**

*Peridium*

*Scleroderma levae*: Peridium dehisces before basidiospores can be dispersed by wind.

**Puffballs With Thick Rigid Peridium**

*Pisolithus tinctorius*: After disintegration of peridium, basidiospores also dispersed by wind.

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**Peridium Dehiscent**

*Battarraea steveni*: Peridium has a circumscision dehiscence, which removes the entire top portion of the peridium when dispersing its basidiospores.

**How Far and How High?**

1. Some spores are believed to disperse species worldwide.
2. Some spores have been found as high as 36,000-71,000 feet
**Water Dispersed Spores**

1. Unlike air borne spores, water dispersed spores are **hydrophilic**. They readily absorb water.
2. Spores are usually also borne in slime and are carried away in mass, passively.
   a. Some spores have long appendages or are coiled.
   b. Shapes give high surface tension to stay afloat. Air also may be trapped.
3. Zoospores have flagella, can swim, but **not** important in dispersal.
4. Zoospores **chemotactic**: Movement towards chemical stimulus.
   a. Stimulus normally towards food source.

**Insect (Fly) Dispersal**

*Aeroe rubra*: One of several stinkhorns, in Hawai‘i. The foul odor attracts flies. Spores, in slime, adhere to their bodies.

*Phallus rubicundus*
**Insect (Fly) Dispersal**

*Dictyophora cinnabarina*

**Mimicry (Pseudoflowers)**

*Puccinia monoica*, a plant pathogen that induces pseudoflower formation

**Mimicry (Pseudoflowers)**

What appeared to be yellow flowers, in the previous picture were only leaves that were induced by the fungus to mimic a flower and attract pollinators.

Pollinator actually facilitates sexual reproduction in fungus.

**Bird’s Nest Fungi Dispersal**

1. This group of fungi gets its name from its resemblance to a bird’s nest.
2. The mechanism here is more variable than others we have discussed and cannot be specifically classified.

**Bird's Nest Structure**

Cyathus pallidus

Peridium

Peridiole contains basidiospores and is the unit that is dispersed
**Bird’s Nest Structure**

- Peridiole
- Purse
- Middle piece
- Sheath

**Peridiole Dispersal**

1. Once attached, the peridiole can grow on the substrate that it is attached.
2. Or if it is growing on herbaceous plant material, it may be consumed by a foraging animal.
3. The peridiole passes through the animal's digestive system unharmed and can begin to grow on the dung pad.

**Funicular cord wraps completely around nearby plant.**
Animal Dispersal

1. Some puffballs are buried underground and do not have an obvious mechanism for dispersal.
2. These fungi are typically dug up by animals and taken elsewhere to be eaten and later dispersed.

Animal Dispersal

Rhizopogon: An example of a common puffball that is probably dispersed by foraging animals.

Animal Dispersal

Tuber sp.: The "Truffle" is probably the most famous example of a fungus that is animal dispersed.