

# STANDARD DEVIATIONS: Fungus, Friend or Foe?

Greetings,

Any time you have broken bread, popped open a cold one, or (heaven forbid) had to take a dose of penicillin you have benefitted from mutualism with a fungus.

Leaf-cutting ants are just one of many animals to cultivate fungi. Certain groups of mound-building termites do exactly the same thing, using fungi related to those used by ants.



{Underground fungus cultures of *Atta mexicana* leafcutter ants.}

A group of insects have become symbionts with fungus. "Ambrosia beetles" burrow into the wood of freshly-fallen trees where they create extensive systems of tunnels. The beetles inoculate these with a specific fungus, the ambrosia, that they carry in special structures called **mycangia**. They then lay eggs in the tunnels and the developing larvae feed exclusively on the ambrosia. Certain wood wasps, weevils, and stag beetles do a this with species specific fungi.

When the beetle bores into a host plant, it releases the fungus from its mycangium. The fungus becomes a plant pathogen. The fungus grows quickly in the plant as the main food of beetle. The offspring of beetle mature, fill their mycangia with fungus and hunt for new host plants.





{Mycangia of ambrosia beetle *Xylosandrus crassiusculus*.}

Many fungi take advantage of the mobility of animals to carry their spores long distances. In some cases, the animal is lured in by a reward such as a sweet substance. If so, the simple act of spore transport moves into the realm of mutualism.

Fungal mutualism in humans is an important but under-appreciated part of our biome. Only a small fraction (~2%) of the published research address our mycobiome. And yet, fungus have evolved specialized biomes in our gut, our lungs, our oral cavity, and our skin. They are essential to the balance we think of as health.

There are around fifty fungal genera in the gut alone. Most are beneficial, helping with digestion and the contributions of the overall biome. We use their ability to break down starches and their antimicrobial properties while providing them nutrition and shelter. It's the moments when that balance is disrupted that fungal pathologies become significant.

Our immune systems help to keep the balance in check, but a compromised immune system and invasive, opportunistic species can cause problems.



Here are some of our known fungal residents:

- *Aspergillus*: *Aspergillus* is a group of molds that peak in the fall and winter and are commonly found in our homes. Some are pathogenic and capable of producing mycotoxins, specifically the toxin *patulin*, which is associated with several pulmonary diseases.
- *Candida*: *Candida albicans* is commonly found in the gut, where overgrowths cause problematic health imbalances. Resistance in *C. auris* is emerging as a real concern.
- *Cladosporium*: *Cladosporium* includes some of the most common molds in our environment. It rarely has a negative effect on healthy people, but can cause allergies, asthma and, in rare cases, severe infections with fatal outcomes.
- *Cryptococcus*: The majority of cryptococcal species live in the soil and are not harmful to humans. It only became recognized as a major threat to human health with the onset of AIDS. While mostly known as a disease of the immunocompromised, we've seen outbreaks of cryptococcosis in otherwise healthy individuals in North America and Canada.
- *Fusarium*: *Fusarium* is a very common soil fungi that can be found all over the world. Typically, these fungi affect crops because they love wet conditions. But *Fusarium* infection can be deadly to people with weak immune systems, such as cancer patients, people suffering from HIV/AIDS or people that have undergone organ transplantation. The lack of an immune response means the infection is easily disseminated and quickly reaches vital organs. In fact, *the 90-day mortality rate of cancer patients diagnosed with fusariosis is 80%*.
- *Mucor*: *Mucor* is an ancient mold also present in the digestive system. Maybe you've seen them:



{*Mucor* rot on fruit.}

The vast majority of *Mucor* species don't have negative health implications for humans due to their inability to grow in warm environments. Mucormycosis pneumonia is one of the most dangerous *Mucor*-related infections.



- *Penicillium*: the *Penicillium* genus includes some of the most common fungi in the world. Dr. Fleming's contribution aside, *Penicillium* is a common allergen, causing allergies such as hypersensitivity pneumonitis and hay fever. It can also trigger or worsen asthma symptoms, and some produce Volatile Organic Compounds (VOC) and/or human toxins.
- *Pneumocystis*: *Pneumocystis* is found all over the world in both humans and animals. It's another fungus that takes advantage of weakened immunity. Thirty-40% of those are AIDS related but it is easily spread through airborne transmission and affects other conditions, like cancer, autoimmune, transplant, and chronic lung disease patients.
- *Saccharomyces*: Let's toast *Saccharomyces* as one of the most useful types of fungus. This brewer's yeast is used in making bread, cheese, kombucha, kefir, ginger beer, wine, and beer. **Perhaps the biggest danger in this organism is the consequence of our actions under its influence.**

In general, we coexist with fungus in mutualistic and symbiotic harmony. Occasionally, fungi are contaminants, pathogens of consequence, and killers. Bleach, phenols, and quaternary ammonia compounds are effective disinfectants on the bench, but antifungal pharmaceuticals are required to treat disease. Resistance to antifungal agents is a risk that may lead to a greater threat from our fungal friends.

Have a great week and be safe,

Bryan

