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FUNGI OF THE "BARK SIDE"

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YOUNG REVIEWERS:


NATHAN
AGE: 15


OLIVER
AGE: 11


SAMUEL
AGE: 8

You may not pay much attention to fungi growing on the bark of trees in your neighborhood, but there are many fungal species that scientists know have joined the "bark side." The fungi living on bark do many interesting and surprising things. For example, bark fungi may prowl the bark in search of resources or new habitats. Fungi create tiny versions of themselves, called spores, which can use "the force" (of nature, like blowing wind, or flowing water) to move from one place to another on the bark. In this article, we introduce the microscopic war waging on the bark of your neighborhood trees, and present some of the fungi warriors of the bark side. We describe how some fungal spores use the force to stalk the bark (and beyond) during storms and discuss why fungi-bark interactions are another important reason to preserve and protect our trees.

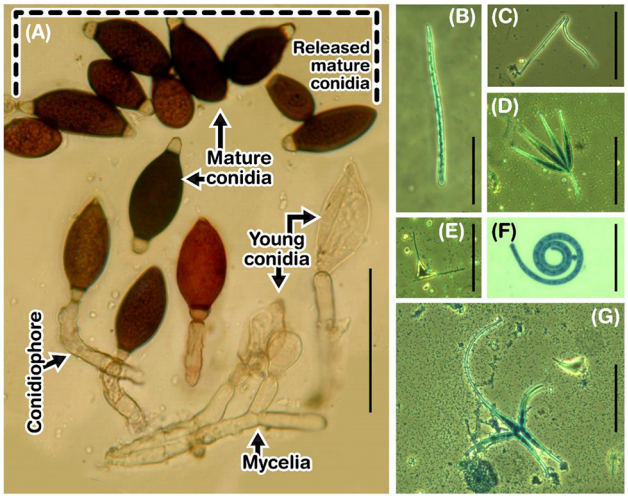

Figure 1

Microscope photographs of fungi and their spores. **(A)** The hyphae of a fungus, its conidia and the arms that sprout conidia, called conidiophores. Conidia come in many forms depending on the species of fungus, including: **(B)** an eel form, **(C)** a caterpillar form, **(D)** a broomstick form, **(E)** a mustache form, **(F)** a spiral form, and **(G)** a many-armed form (Note that the colors result from the different stains used to view the fungi more easily through the microscope). Scale bar = 50 μm. One micrometer is 1,000 times smaller than 1 mm.

PATHOGEN

A microbe, including a fungus, that can cause disease or death.

SAPROTROPH

An organism that feeds on dead or decaying materials.

SPORE

Microscopic living particles that fungi produce to spread and reproduce themselves.

HYPHAE

Fine, thread-like, noodley arms that fungi use to search for resources nearby.

CONIDIUM

A type of spore that fungi create to clone (or asexually reproduce) themselves. Fungi can produce both sexual and asexual spores, but this article focuses on the asexual spores.

FUNGI'S CLONE WAR ON THE BARK SIDE OF TREES

A long time ago in a canopy far, far away....or, more precisely, about 25 million years ago on some tree bark....it was a dark time for a termite, for it had been killed by a fungus. While the fungus feasted on its victim, a tide of tree sap engulfed both fungus and termite, dried into amber, and froze this fungal feast in time. This amber, when found by scientists millions of years later, became the first historical record of any insect-eating fungus [1]. These fungi are still prowling around the bark of forests (or the "bark side") all around you, hunting insects to this day. Tree bark hosts many types of fungi that feast on various sorts of living and dead organisms. Whether a fungus is **pathogenic** (targets living things) or **saprotrophic** (targets dead and decaying things), it must prowl the bark in search of its target, or perish. One way that many fungi search for food or a new habitat is to create a tinier version of themselves, called **spores**, that can use "the force" (a natural force, like wind, or water) to get around.

Fungi can only reach so far with their noodley arms, which are called **hyphae** (Figure 1), so spores that can be swept up by the wind or by some flowing water can help fungi explore new habitats beyond the reach of their hyphal hands. Some spores are genetically identical clones of their fungal parents! These special spores, called **conidia**, not only help their fungal parent to explore, but they can also settle into a new location and reproduce there asexually, meaning without the need for a partner. In this way, conidia help fungi wage their own "clone war" to spread and grow more quickly than other lifeforms that need to reproduce sexually. On the other hand, because conidia cannot control where the winds or waters take them, they can end up anywhere! But the clone army is so numerous that some loss is acceptable. So, if fungal spores end up on the "bark side" of a tree, maybe stuck deep in a crack of the bark, what do they do next?

WHY DO FUNGI JOIN THE "BARK SIDE"?

Fungi mostly end up stuck in tree bark because the bark is very sticky. Most of a tree's surfaces are sticky to fungal spores. Trees are so sticky that several hundred kilograms of particles from the air can get stuck in a single city tree each year—that is the weight of a buffalo! The number of particles stuck to the bark can be much greater than the number that sticks to leaves. A recent study in Beijing, China found that one square centimeter of bark captured 50 times more particles (by weight) than the same area of leaf surface [2]. Bark on trunks also captured nearly 90% of all the larger particles (the size of fungal spores or larger) found on the tree. So, it appears that bark is not only a great particle trapper, but it is especially good at trapping particles the size of conidia.

A crack in the bark surface may not seem like a cozy place to us, but it may be a very nice habitat for fungal conidia. We would probably not like how dark it is, for instance. The sun's rays may never fully penetrate to the crack's depths, leaving it frequently damp. Conidia, however, might find the dampness perfect for germinating and beginning to grow hyphae. Even the tiny creatures crawling around the crack may be a welcome sight to fungal conidia. As conidia become fully functioning (pathogenic) fungi, they may welcome their neighbors—by extending hyphal hands to capture and consume them! Bark cracks may also contain dead or decaying matter. In that case, any conidium with saprotrophic tendencies may find this bark graveyard...appetizing.

WHO HAVE WE SEEN ON THE BARK SIDE?

There are many fungi that have been found on the bark side (see some examples in Figure 2), and some of these species are not interested in eating creatures, living, or dead. Instead, they prefer pollen grains, which are loaded with nutrients. Luckily, bark is a great pollen trap! To eat pollen grains, fungal conidia from some species, like *Mycoceros*, use horn-like limbs. Others, like *Retiarius,* can spear pollen grains with a structure resembling a Roman gladiator's trident weapon. Other species, like *Lecophagus*, can capture worms called nematodes, which are 10–100 times longer than a germinating conidium, as these worms squirm across the bark surface. Even celebrities of the fungal world—species starring in popular YouTube videos, for instance—dwell on the bark side. These include *Ophiocordiceps* species, which sneak inside insects, take control of their minds, and then burst through their exoskeletons when the fungus fruits (makes a mushroom)! Thousands of fungus species are known to burst through the exoskeletons of many types of insects, from ants to wasps to grasshoppers. There are also many fungi operating on the bark side in ways that are currently unknown to scientists, like the two *Oncopodiella* species in Figure 2. Perhaps, one day, you will discover what they are up to!

Figure 2

Cartoon representations of fungi engaged in the war on the "bark side" of trees. If you look closely at the bark surface—like, really, microscopically close—you will see fungi competing to consume resources including pollen, nematodes, and insects!

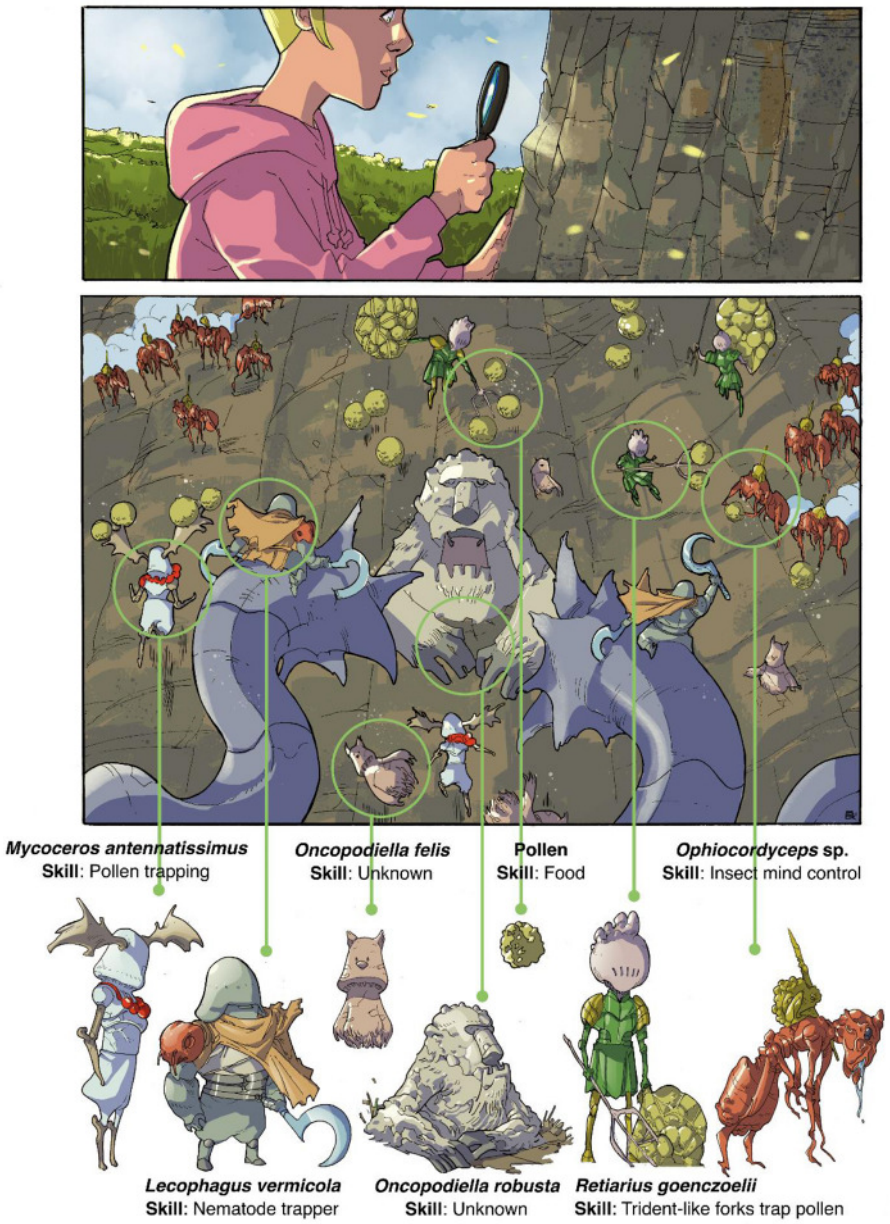

Figure 2

WHY SHOULD WE KEEP AN EYE ON THESE FUNGI?

Generally, scientists keep an eye on fungi because fungi play important roles throughout the natural and human environment, such as breaking down dead stuff or creating medicines. In forests, fungi can help or hurt trees. For example, some fungi can partner with roots to help plants find resources in the soils, but other fungi attack and eat leaves. Scientists would like to better understand the role the bark side plays in the life cycle of fungi. For example, many spores from bark fungi can surf on rainwater as it flows down the bark in a process called stemflow. Is riding this bark-side water slide an important step in how these fungi roam the forest in search of resources?

Healthy trees are important for our neighborhoods to cycle water, shelter animals and even our mental and physical health [3]. Scientists are interested in how bark fungi affect tree health. Some scientists have found that the bark water slide, loaded up with insect-eating fungal spores, may help trees to control pests [4]! The tree's bark also provides the first line of defense against pathogens, much like our skin does. Many fungi of the bark side help keep trees healthy by eating tiny nematodes or pathogenic fungi that could penetrate or infect the "tree skin" and cause disease. On the other hand, not all bark fungi are friendly to trees. So, it is important for scientists to identify which bark fungi can become pathogenic to a tree if its bark is broken by human activities, such as a car accident or someone carving their name. These human activities not only damage the bark, but also give potential pathogens an opportunity to attack the tree! Thus, keeping an eye on the fungi of the bark side and how they use the force (of nature), can help us keep trees healthy.

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YOUNG REVIEWERS

NATHAN, AGE: 15
I am a passionate learner in science, especially in biology. I also love to explore different topics and enrich myself. I work to become a doctor in the future.

OLIVER, AGE: 11
I enjoying being out in nature and playing with my friends. My favorite hobbies are bike riding and fossil hunting. I also like learning about science and how things work. When I am older I want to either be an ecological designer or paleontologist and hopefully help save the planet!

SAMUEL, AGE: 8
I enjoying being out in nature and playing with my friends. My favorite hobbies are bike riding and learning about airplanes. In school my favorite subject is maths. I am also on the school eco council. I think it is really important to look after our planet.

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