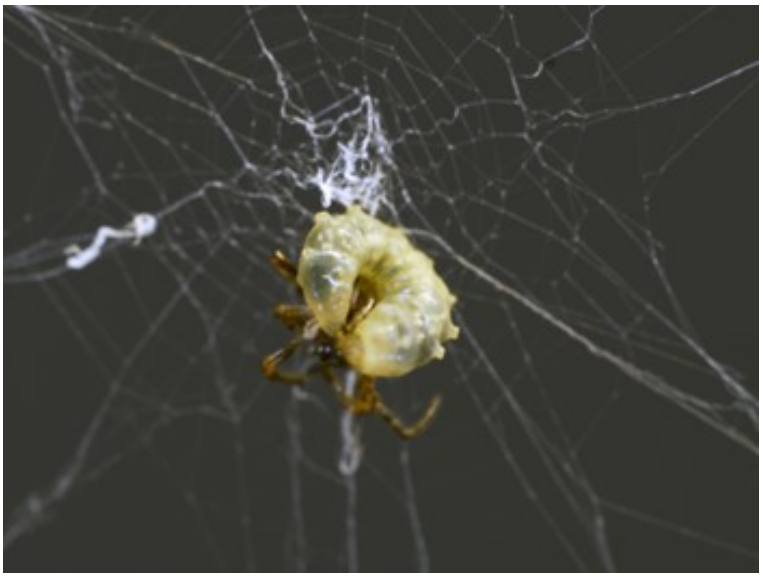
Zombies are real!

This is no Halloween make-believe story. Real zombies are out there — maybe in your own backyard!

A zombie crawls through the forest. When it reaches a good spot, it freezes in place. A stalk slowly grows from its head. The stalk then spews out spores that spread, turning others into zombies.

This is no Halloween story about the zombie apocalypse. It's all true. The zombie isn't a human, though. It's an ant. And the stalk that emerges from its head is a fungus. Its spores infect other ants, which lets the zombie cycle begin anew.



Underneath that worm-like thing is a spider — now a zombie. The wasp larva on its back controls the spider's brain, forcing it to spin a special web. That new web will protect the larva as it develops into an adult wasp.
Keizo Takasuka

In order to grow and spread, this fungus must hijack an ant's brain. However weird this might seem, it isn't all that unusual. The natural world is full of zombies under mind control. Zombie spiders and cockroaches babysit developing wasp larvae — until the babies devour them. Zombie fish flip around and dart toward the surface of the water, seeming to beg for birds to eat them. Zombie crickets, beetles and praying mantises drown themselves in water. Zombie rats are drawn to the smell of the pee of cats that may devour them.

All of these "zombies" have one thing in common: parasites. A parasite lives inside or on another creature, known as its host. A parasite may be a fungus, a worm or another tiny creature. All parasites eventually weaken or sicken their hosts. Sometimes, the parasite kills or even eats its host. But death of the host isn't the freakiest goal. A parasite might get its host to die in a certain place, or be eaten by a certain creature. In order to accomplish these tricks, some parasites have evolved the ability to hack into the host's brain and influence its behavior in very specific ways.

How do parasites turn insects and other animals into the walking almost-dead? Every parasite has its own method, but the process usually involves altering chemicals within the victim's brain. Researchers are working hard to identify which chemicals are involved and how they end up so bizarrely altering their host's behavior.

Brains, brains! Ant brains!

A fungus doesn't have a brain. And worms and single-celled critters obviously aren't very smart. Yet somehow they still control the brains of larger, and smarter, animals.

"It blows my mind," says Kelly Weinersmith. She is a biologist who studies parasites at Rice University in Houston, Texas. She is particularly interested in "zombie" creatures. True zombies, she points out, aren't exactly like the type you find in horror stories. "In no way are these animals coming back from the dead," she says. Most real zombies are doomed to die — and some have very little control over their actions.

One parasite causes infected rats to become attracted to the smell of cat pee. This helps the parasite because it needs a cat to eat the rat for its life cycle to continue.

The horsehair worm, for instance, needs to emerge in water. To make this happen, it forces its insect host to leap into a lake or swimming pool. Often, the host drowns.

Toxoplasma gondii (TOX-oh-PLAZ-ma GON-dee-eye) is a single-celled creature that can only complete its life cycle inside a cat. But first, this parasite must live for a time in a different animal, such as a rat. To ensure this part-time host gets eaten by a cat, the parasite turns rats into cat-loving zombies.

In Thailand, a species of fungus — *Ophiocordyceps* — can force an ant to climb almost exactly 20 centimeters (about 8 inches) up a plant, to face north and then to bite down on a leaf. And it makes the ant do this when the sun is at its highest point in the sky. This provides ideal conditions for the fungus to grow and release its spores.

Biologist Charissa de Bekker wants to better understand how that fungus exerts that mind control over the ants. So she and her team have been studying a species related to the *Ophiocordyceps* fungus in Thailand. This U.S. cousin is a fungus native to South Carolina. It, too, forces ants to leave their colonies and climb. These ants, though, bite down on twigs instead of leaves. This is likely due to the fact that trees and plants in this state lose their leaves in the winter.

De Bekker began these studies at Pennsylvania State University in University Park. There, her team infected a few species of ant with the South Carolina fungus. The parasite could kill all of the different ants she introduced to it. But the fungus made plant-climbing zombies only out of the species that it naturally infects in the wild.

To figure out what was going on, de Bekker's team collected new, uninfected ants of each species. Then, the researchers removed the insects' brains. "You use forceps and a microscope," she says. "It's sort of like that game Operation."

A fungus grows out of the head of this now-dead zombie ant. South Carolina photographer Kim Fleming discovered affected ants in her backyard. When scientists saw her photos, they realized she had probably discovered a new fungus. If correct, the zombifying species will probably be named after Fleming!

Kim Fleming and Charissa de Bekker

The researchers kept the ant brains alive in small Petri dishes. When the fungus was exposed to its favorite brains (that is, ones from the ants that it naturally infects in the wild), it released thousands of chemicals. Many of these chemicals were completely new to science. The fungus also released chemicals when exposed to unfamiliar brains. These chemicals, however, were completely different. The researchers published their results in 2014.

The experiments at Penn State by de Bekker's team were the first to create ant zombies in the lab. And the researchers only succeeded after setting up artificial 24-hour cycles of light and darkness for the zombies and their parasites.

It will take more work to learn how the parasite's chemicals lead to zombie behavior in ants. "We are very much in the beginning of trying to figure this out," says de Bekker. She now studies ant zombies at Ludwig Maximilian University in Munich, Germany. There, she is now probing how that daily cycle of sunlight and darkness affects zombification.