

STANDARD DEVIATIONS: Invasion of the Body Snatchers

Greetings,

In all the attempts to make the dead live again, science *usually* takes a back seat to the gore—at least until the latest popular iteration of **zombies**. Fungal zombies are making science.



{It's alive!}

[Cordyceps](#) — or “Zombie Fungus” — are a fungus that thrive in six continents, in a variety of habitats, from tropical forests to high Tibetan plateaus. There are thousands of different types of cordyceps and each infects a specific species of insect.

The name Cordyceps comes from the Latin words: *cord* and *ceps*, respectively, meaning “club” and “head.” This Latin conjunction accurately describes the appearance of these club fungi, whose stroma and fruit body extend from the mummified carcasses of insects they colonize.





{Cordyceps infected insets.}

When a Cordyceps fungus attacks a host, the mycelium invades and eventually replaces the host tissue, while the elongated fruit body, **ascocarp**, may be cylindrical, branched, or of complex shape. Spores from the zombie fungus infect the insect's brain, and the fruiting body will erupt from that insect's head and body. Spores burst from the fungus and infect any insect of the same species unlucky enough to be nearby.

But that's not all.

Another fungus, from a different order, also creates a zombie.



Massospora cicada infects 13 and 17 year cicadas. Infection results in a "plug" of spores that replaces the end of the cicada's abdomen while it is still alive, leading to infertility, disease transmission, and a strange promiscuity in the infected cicada.

This fungus synchronizes its life cycle with the underground nymph and replaces the abdomen of the molting adult.



{Cicada infected with *M. cicadina*.}

But, infected cicadas display sexual responsiveness, and copulation occurs between infected and healthy cicadas. The rot even affects the pitch of the male's call and excited males will happily(?) copulate with infected males. This ensures that the fungal spores are spread liberally.

The fungus infects the early nymph and they live together, underground, for years, suggesting a symbiosis that may not be apparent in the outcome.

M. cicadina has been observed and studied since the mid-nineteenth century:

Insects "begin to Sing or make a noise from first they come out of the Earth till they die. The hindermost part rots off, and it does not appear to be any pain to them, for they still continue on Singing till they die" ~ Maryland Historical Society, 1845.

Are these zombie-fungi pathogens?

While these killer fungi sound like they're straight out of a horror movie, they do have an overall positive impact on their environment because they keep insect populations from growing out of control. And the relationships between the fungus and the insects may be more symbiotic than we think. Evidence is emerging that the relationships are mutualistic, not parasitic.



Fungal metabolites are renowned for medicinal benefits. **Cyclosporin and Erythromycin** are macrolides with bacteriostatic properties, killing or inhibiting bacterial growth. With a wider spectrum than penicillin, macrolides have been shown to be effective against *Legionella pneumophila*, mycoplasma, mycobacteria, some rickettsia, and chlamydia.

Fungal compounds are being studied for antitumor activity, cholesterol synthesis, lipid metabolism, enzyme inhibition, agricultural uses, and psycho-pharmaceuticals. *Cordyceps subsessilis*, has been used to derive immunosuppressive drugs used in organ transplants.

The *Massospora* compounds that affect cicadas are under scrutiny as anti-depressants, along with psilocybin (another fungal metabolite with medicinal promise).

Cordyceps harvested in Tibet are some of the most expensive natural products around, and regarded as the cornerstone of Chinese medicine for centuries for health and fertility.



{ *Ophiocordyceps sinensis* growing out of a caterpillar. ~75,000\$/Kg. }

Besides the immune-enhancing effects, [fungal therapies](#) for renal failure, hypertension, COPD, coronary and cerebral circulation, hepatitis B and C, and other conditions are being studied. Human clinical trials have demonstrated the effectiveness of Cordyceps in combating decreased sex drive and virility. No human toxicity has been reported.

Neither plant nor animal, fungal organisms—including lichen, mildew, mushrooms, molds, rusts, smuts, and yeasts—are found in nearly every possible terrestrial habitat, even aboard the International Space Station. There are millions of species of fungi, and the biomass of fungi exceeds humanity by several orders of magnitude. According to the Centers for Disease Control and Prevention, a few hundred fungal species cause illness in people, ranging from allergies and asthma, to skin rashes and infections, to deadly infections of the bloodstream or lungs. But these are not the evil zombie-makers you might think. Our relationship with fungus is much more



entwined than we understand. We may find that fungal species hold the key to controlling our diseases.

There are more species of animals than any other group of organisms, so it is not surprising that fungi have come to form mutualistic relationships with many of them. Even humans know the value of teaming up with fungi, and have done so for the making of bread, alcohol, medicines, and a future that even science fiction may not foresee.

Have a great week and be safe,

Bryan

