Fungal Troops Could Stem the Tide and Curb Populations of Devastating Insects in the Midwest

By: Alyssa Peck

Did you know that half of the cells in your body are actually microorganisms living within you?[1] In fact, bacteria and microorganisms prove to be very important when it comes to human health, and are ever present within our own bodies. One of the sources of "other" cells are fungal endophytes, endo- meaning inside, and -phyte meaning plant. Though they do contain "-phyte" in the name, they can reside in pretty much any host, as insects and even soil are able to carry and exchange endophytes. These organisms can go from being mutually beneficial in some of their hosts to detrimental in others. They can also be completely commensal, meaning that they do not help or hurt their host. Usually these organisms can be passed not just from parents to their kids, but can be passed to and from other individuals outside of their family!

Recently, studies have shown that a destructive worm called the Fall Armyworm (*Spodoptera frugiperda*) terrorizing midwestern farmers also has microbial communities, and there has been talk of using pathogenic microorganisms to harm populations of these worms, along with other pests. Plans for this are new, and the amount of research to be done before these processes are used is significant.

Of course, the Fall Armyworm also has potentially harmful plant pathogens, which it may be able to spread. Scientists at the University of Minnesota, Monica Watson and Kathryn Bushley, led an experiment that involved seeing what kinds of fungal symbionts, or fungal organisms in close relationship with other organisms, were in different parts of the environment in which Fall Armyworms live. They took samples of the leaves of plants that armyworms feed on, such as sorghum, or *Sorghum bicolor*, and from the soil environment around the plants. They also sampled actual Fall Armyworms, and they were able to culture and gather a large variety of fungal symbionts from them.

They were hoping to glean more information about these microbial communities. To start, they wanted to know: What kinds of communities were more popular in insects, vs. plants, vs. soil? Are there more fungal symbionts in certain parts of the ecological compartment? Do they all have similar microbial communities? Are they obviously exchanging fungal endophytes amongst themselves? Do other sources of fungal symbionts, such as plants, soil, or other insects, contribute more to the community within insects? They set out to be able to better explain these ideas.

We already know that when insects eat plants, they transfer some of their microbial communities to the plant. We also know that when plants have openings created by insects, it is easier to contract more microbes. We want to know if eating the sorghum plants causes more diversity in the insect's microbial community as well. To investigate these questions, the microbiologists analyzed different parts of 2 separate communities. To find the answers to their questions, they had to look at fungal symbionts in the soil, insects, and infested and uninvested sorghum leaves.

Think of a large field of sorghum as you would a country buffet, but for insects. You can sample any of the leaves, but it is unlikely that you will be able to sample all of them. This is what makes certain leaves "infested" vs. "uninfested". They found that the differences between the fungal communities inside infested vs. uninfested leaves was not dramatically different, and this information actually ends up suggesting that the fall armyworms don't impact the leaves' fungal communities much at all. They knew this because most of the fungal symbionts in the infested leaves were also found in the uninfested leaves. There was only one species that was specific to the infested leaves.

They also discovered that fungal communities in insects, soil, and sorghum leaves are all pretty different. The fungal communities in insects are especially divergent. In fact, other insects actually affect the fungal communities of individual fall armyworms more than either what they eat (the sorghum leaves), or what they live in (the soil). Despite the fact that they spend much more time in contact with leaves and soil, they actually exchange much more fungus with each other. This data suggests that insects are not getting infected by their soil surroundings. The soil seems to have very different, diverse and abundant fungal communities, and the scientists did not have the same findings in the insects at all.

These findings may make it difficult for a fungal symbiont to be spread via soil or via plant, which would have been the easiest form of pesticides for farmers. If this way won't work, then how will they use the findings to help curb growth in fall armyworm populations?

Luckily, there were some interesting and unexpected findings that could be beneficial for future plans in insecticides. It turns out that other insects were contributing the most to insect fungal communities. The individual fall armyworms sampled were seen to have the most similar endophyte communities with each other, and the soil and leaf sources did not match up nearly as often. Now the question remains, did they receive the fungi from their parents, or did they get them from each other?

Again, the scientists ran analyses that indicated low contributions of fungi to insects from the plants they ate and the soil in which they inched through, but there was evidence that some fungi come from other insects nearby, whether through a process called vertical or horizontal transmission. These terms are much simpler than they sound. Vertical transmission means that the fungi were passed from parents to their offspring. Horizontal means that the fungi are from non-relatives, and that they got the endophyte or endophytes after they were already born.

Upon further investigation, the scientists concluded that it was probably horizontal transmission from other insects that played the most key role for the microbiomes in the fall armyworm insects. This is good news for potential uses of endophytes to halt predation in agriculture. If horizontal transmission is the easiest way to spread fungal endophytes, then it would probably be the easiest way to limit dense fall armyworm swarms using fungal endophytes.

Though the closest similarity was to other insect sources, there were a few fungal communities in the insects sampled that were also found in the infested and uninfested leaves. This shows that some fungal symbionts are probably gathered through other means as well, not just by other insect exposures.

Each of the 3 main branches studied had distinct fungal communities. Watson and Bushley propose that it is likely that the fungal symbionts in consumed plants and in the dirt surrounding them likely does get into the insects' systems, but they are not allowed to stay. They theorize that fall armyworms are able to selectively filter through the fungal types that they are exposed to. This indicates that it will not be just any fungal endophyte that can take down the insects in our sorghum and corn fields. It will have to be one that fall armyworms allow to reside in their bodies. This study also shows that it is likely going to be easier to expose the worms to pathogenic fungi through other insects, which would first have to be infected with this fungus and then released into the field.