# A Fruitful Affair: How plant-fungi relationships affect diversity

By Emma Kull

The encompassing ecosystem we call Earth is constantly responding to challenges brought on by you, me, and the rest of the human race. The greatest tool an ecosystem can possess in the face of unpredictable human intervention is biodiversity, and an underground network of plant-helping fungi just might be the key to understanding how diversity is shaped.

When an ecosystem is home to many different plant species, it is more resilient to change or sudden disaster than it would be without species variety. Consider the Irish Potato Famine—historical evidence that disaster strikes when we rely on only one crop species to get the job done. Similar consequences are observed in wild plant communities that become monopolized by one species. This monopolization occurs when plants competing for resources cannot keep up with one particular species. It is clear that understanding how plants can coexist in a community is important, and this requires studying the underlying processes that determine such coexistence. Though literature on that very subject abounds, studies to date are all leaving out one key ingredient: fungi. Fungi species have a special relationship with a chosen plant partner in which the host plant provides the fungus with carbon, while the fungus increases the plant's nutrient absorption capabilities. Known as mycorrhizae, this symbiotic resource exchange between plant and fungus is thought to have major consequences regarding plant diversity, yet quantitative research to support this theory is lacking. A study by Jiang and associates (Jiang, Moore, Priyadarshi, & Classen, 2017) sheds new light on this previously uninvestigated hypothesis.

Previous studies looking into plant diversity have found that greater variety in plant species leads to a competition over limited resources. Plant species differ in their ability to absorb certain nutrients. Traditionally, theories surrounding resource competition between plants is centered around this species-specific trait. That is, which plants are better at absorbing which nutrients, and which nutrients are most important to that plant? When observing a community of plants in coexistence, we can then assume that we are witnessing an intricate assembly of plant species varieties whose inherent competitive traits fall into some sort of equilibrium. Though logical, this hypothesis is missing a piece of the puzzle, as it disregards the support received by certain plants through their mycorrhizal fungi. Could a plant that would normally struggle to compete with it's neighboring species find itself surviving in, or even monopolizing, its community with the help of a fungi partner? This question proposes a shift in traditional theory.

The relationship between a host plant and its fungi in the context of plant coexistence is not completely unrecognized, though commonly overlooked. There have been previous studies and postulations on the matter. The problem? They all lack concrete mathematical models. Though conceptual models are useful, and certainly serve as a good jumping off point, they do little in the likes of argumentative proof. We cannot introduce mycorrhizal-fungi as a potential point of intervention in biodiversity crises if our understanding of the resulting impacts is underdeveloped. A study with quantitative data and tested models is necessary to fill this gap in knowledge, which is exactly what was accomplished by new research performed by Jiang et al.

To truly understand how diversity is mediated by plant-fungi relationships, Jiang et al., developed a model and analyzed coexistence patterns in different scenarios. The derived mathematic model is complex and difficult to evaluate. However, under the assumption that these calculations were correctly preformed, the model can be used to look at how plants compete for resources with mycorrhizae as a variable. The scenarios performed in the research are dependent on the way a plant species determines how much carbon to give to its fungus. The study looks at two different strategies for carbon allocation. This adds a layer of complexity to the research that has previously not been explored.

The model can be applied to multiple plants. In this research it is applied to two species, which are labeled plant x and plant y. The first scenario in the research looks at how plant x and plant y, when applied to the model, compete for a resource. Both plants have similar demand for this resource, but different competitive traits. In this scenario, with no mycorrhizal interaction, plant y drove out plant x, meaning there was no coexistence. This aligns with the hypothesis that in order for plants to coexist, each species must have different nutrient demands. This can be thought of like a group of kids who have a bowl full of candy to share amongst themselves. If every kid is only interested in Hershey's, the one kid who is able to grab all the Hershey's the quickest will 'win', leaving everybody else with nothing. However, if each kid wants a different type of candy, the group of kids can all get what they want without too much arguing.

The addition of the mycorrhizae into a different scenario is where we see new findings. If plant x, who could not compete against plant y for a certain resource in the first scenario, receives a helping hand by a mycorrhizal fungus, can these two plants now coexist? The model showed that, yes, it is possible for these two plants to coexist when mediated by the new plant-fungi relationship. The research then concluded that in a scenario in which plant with low competitive capabilities is colonized by a mycorrhizal fungus, this fungus contributed positively to coexistence.

Mycorrhizal mediation in coexistence is not always positive, though, depending on the specific interaction. According to the study, the effect of mycorrhizal fungi on a dominant plant would actually have a negative effect on coexistence. The existence of the symbiotic relationship on a plant that is not struggling would only make that plant a stronger competitor, creating exclusion among other species. This is why the intricacy of the mathematical model is crucial to its accuracy. If we want to increase diversity in a system by intervening in mycorrhizal relationships, the analyses of the effects would need to take into account several variables, as described in the study.

This study defines important data for the field of biodiversity, but I would argue that it leaves us with many unanswered questions. If this model is to be applied to real-world plant communities, how can we account for the openness of any uncontrolled ecosystem? How do other forms of interaction, say with animals, effect the model? I would like to see further research into how such a model could help us mitigate biodiversity in failing ecosystems. For example, if an invasive species of plant began dominating an ecosystem, could we potentially use this data to introduce mycorrhizal fungi that would suppress the invasive species or support native species?

Ecological studies work to simplify complex systems, and because of this, it can be easy for us to desire research that is not feasible to obtain. We can’t fit every dynamic variable on Earth into one study, though technically any natural ecosystem is interacting in some way with these variables. I would prefer to see this research applied to more specific scenarios, but I would not attempt to diminish the significance of these findings. In the constant hunt for innovations in protecting biodiversity, each new model is a step in the right direction. This research already has implications for diversity of plant communities, and I would imagine that it will eventually lead to applications in larger biodiversity contexts.

Reference:

Jiang, J., Moore, J. A. M., Priyadarshi, A., & Classen, A. T. (2017). doi: https://doi.org/10.1002/ecy.1630