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Why do invasive species do so well?

Authors:
Jennifer Bowen, Patrick Kearns, Jarrett Byrnes, Sara Wigginton, Warwick Allen, Michael Greenwood, Khang Tran, Jennifer Yu, James Cronin and Laura Meyerson

Associate Editors:
Lindsey Hall and Gogi Kalka

Abstract

Did you know that several different kinds of *microbes* live in our bodies, and that they perform lots of important functions? For example, they can help us fight harmful infections and help us to get all the goodness out of the food we eat.

Plants also have special relationships with microbes, particularly those that live around their roots. These microbes can help the plant to fight disease and are important to make them fitter and stronger.

We studied a species of grass to see what was affecting the makeup of the microbial communities that lived around their roots. This will help us to understand how plants and microbes interact when an *invasive* plant is introduced to an environment.

Introduction

We know that different species of plants have different microbial communities living around their roots. We also know that the interaction between the *host* plant and its microbial communities is an important factor in a plant's *fitness*.

But, we know less about the differences in microbial communities within a plant species, especially with invasive plants. Knowing more about them would help us to understand why some *lineages* - closely related types - of the same species are more successful than others.

We studied a grass species, the common reed (*Phragmites australis*) (Fig. 1). It's a great plant to study because you can easily find it all over the world.

In North America, there are three lineages of the same reed species that we looked at in our study.

These are:

Native – the original lineage of the species, from North America

Gulf – a second lineage that has grown in North America for thousands of years

Figure 1: The common reed (*Phragmites australis*) is a species of grass found in wetlands all across the US. Photo credit: Darkone

Introduced – an invasive lineage that people brought from Europe at least 150 years ago

We classified both the Native and Gulf grasses as *native* lineages, because there is evidence that both were present in North America before Europeans arrived there, and have been isolated from other lineages until recently.

We wanted to see how the microbial communities of the different lineages changed as plants grew further away from each other, and to understand how plants and microbes interact in invasive species.

Our main research questions were:

- Are there different microbial communities in the different lineages of grass?
- Do these microbial communities influence plant productivity?

Methods

We ran two experiments to see how the native and invasive grasses altered the composition of the microbial communities in the plants' rooting zone.

1) Field survey

We collected soils in the rooting zones of many plants from each of the three lineages. We took samples from 21 different locations across the whole of the United States.

Included in this were rooting zone soil samples collected from populations of Native and Introduced grasses that grew next to each other under the same environmental conditions. This allowed us to compare the importance of either lineage, or distance between plants to the microbial communities.

2) Greenhouse experiment

We selected different populations from the same lineages of reed grasses and then made cuttings from them. The cuttings were *clones* - genetically identical individuals- allowing us to control for *genetic variation*. We then planted the cuttings in separate pots, which contained special soil that was completely uniform (there were no differences in the soil between pots). We then grew the plants under the same greenhouse conditions for 4 months (Fig. 2).

Finally, we harvested the plants, pulling them out from the soil and collecting the soil close to their roots. We dried the aboveground and belowground part of each plant and weighed it to measure its *biomass*.

For both experiments, we examined the microbial communities to assess which microbes were more likely to be affecting the fitness of the plants.

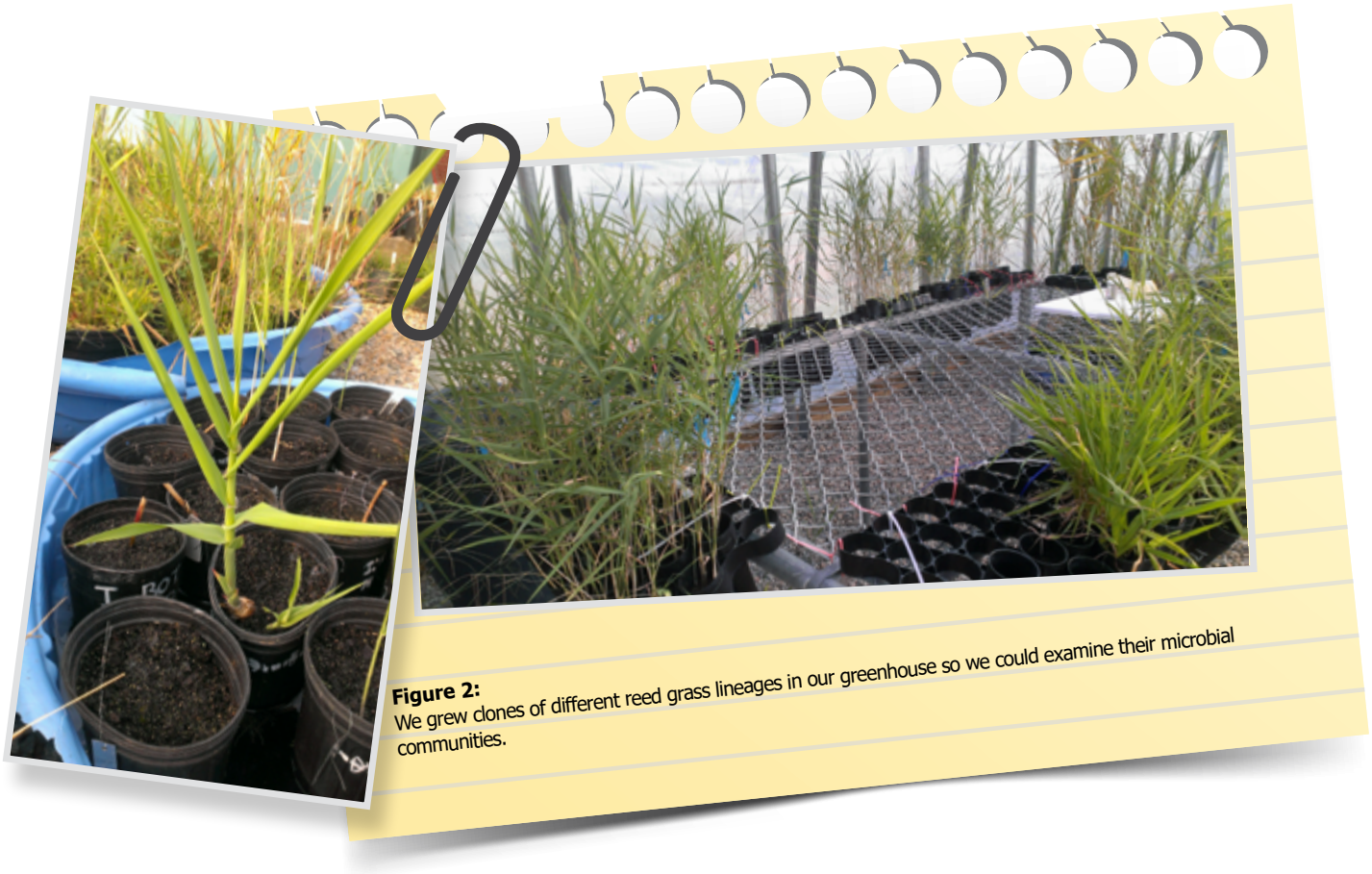

Figure 2:
We grew clones of different reed grass lineages in our greenhouse so we could examine their microbial communities.

Results

Field survey

The microbial communities were similar within lineages, but different among lineages, no matter where in North America we collected plants and soil from.

The Gulf and Native grasses had more similar microbial communities within their lineages than the Introduced lineage (Figure 3 a, b, c).

Microbial communities in Native and Introduced grasses living next to each other were less similar than communities from within the same lineage collected over 3000 km apart (Fig. 3 b, c, d).

The microbial communities of the Introduced grass became less similar to each other as the distance between them increased. We didn't see this pattern in the Native or Gulf grasses (Fig. 3 a, b, c).

Greenhouse experiment

The microbial communities of our three lineages were highly different. In the Introduced (invasive) grass, we found less evidence of plant-microbe interactions to defend the plant against enemy attack. Lineage had the biggest effect on plant fitness, measured as the biomass of the aboveground part of the plant.

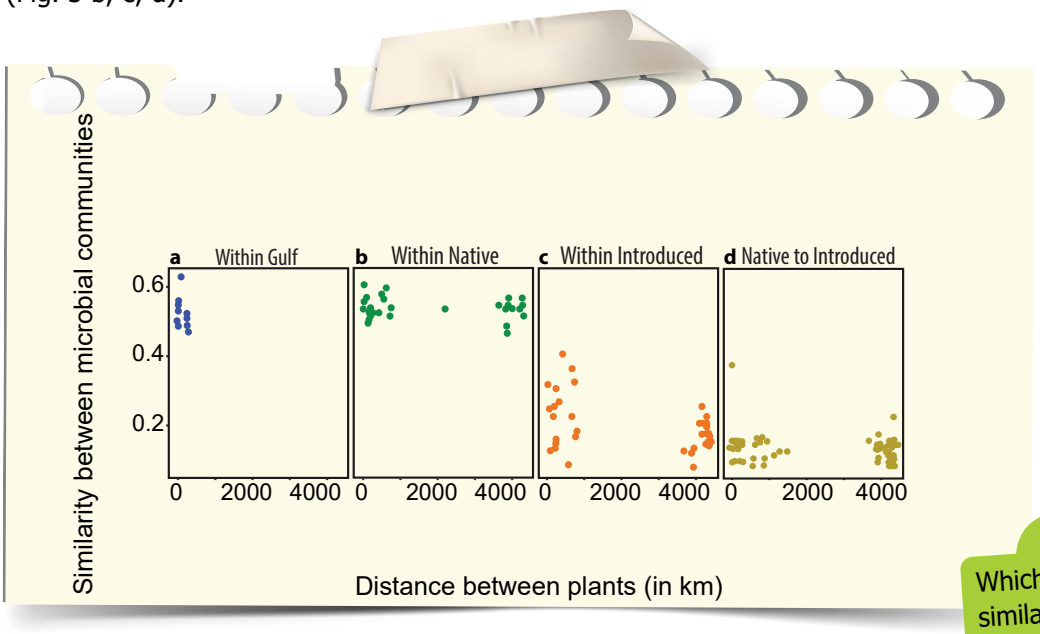

Figure 3:
Similarity between microbial communities within lineages, or between lineages, based on the distance between plants. A higher number shows greater similarity and a lower number shows less similarity between the microbial communities.

Which lineage showed the least similarity between its root microbial communities?

Discussion

Our experiments clearly showed that the lineage of grass within the same species had the greatest effect on both the fitness of the plants as well as the makeup of the microbial communities around their roots.

The microbial communities of the introduced populations of reed grasses were less exposed to enemy attacks than the native grasses. However, our greenhouse experiment showed that it was lineage, and not microbial communities, that had the greatest effect on individual plant growth.

Globally, the spread of invasive species has reduced *biodiversity* and changed how ecosystems work. Our study shows another possible impact of species invasions – the invasive plants may change the microbial communities in the soil.

Microbes are important in making an *ecosystem* function properly, so if an invasive plant changes the microbial communities, it may affect the roles that the microbes carry out. We must therefore find out how these lineage-specific changes in the microbial community translate to changes in ecosystem function in locations where the non-native invasive grass grows.

Conclusion

Invasive species can harm our environment and economy. So what can we do to make sure that we don't help them spread in the wild? Here are some simple tips:

- Clean your hiking gear to stop the spread of seeds.
- Consider buying native species for your yard instead of introduced ones.
- Keep a hold of your pet fish, turtle or snake! Many invasive species started off as someone's pet before that person let them out into the wild.
- Care for your cat. Feral cats are major causes of decline in small native species. If you have a tomcat, ask your parents if he's *neutered* so that he can't make any more feral cats.

Glossary of Key Terms

Biodiversity – the variety of living organisms in an ecosystem. A high biodiversity (many type of plants, animals and microbes) helps the ecosystem to live longer.

Biomass – the mass amount of living matter. We measure this by drying the material we are interested in to remove all the water, and then weighing it. In our study, we measured the biomass of the aboveground and belowground part of the plants.

Clones – genetically identical individuals (in our case, grasses).

Ecosystem – a community of animals, plants and microbes that interact with each other, and their physical environment.

Fitness – the genetic contribution by an individual's descendants to future generations of a population.

Genetic variation – difference in gene material. Individual grasses that aren't clones vary in their genes.

Host plant – here: the plant that the microbes live around. In our study the microbes lived around the roots of the host plant.

Invasive species – non-native species that can reproduce and survive in a new habitat far away from their native ones, without the help of humans. Once present, they can spread to a degree that causes damage to the environment, the economy or human health.

Lineage – different groups of populations of the same species that have evolved from a common ancestor to have distinct traits or live in different environments. The grass species in our study had three lineages, or subspecies.

Microbes – tiny living creatures, like bacteria and fungi, that we can only see with a microscope.

Native species – species that were not intentionally or accidentally introduced by humans into a particular ecosystem.

Neutering – a method to sterilize animals to prevent the birth of unwanted litters of animals.

Rhizosphere – an area containing the plant roots and their surrounding soil. It is in this area that the microbial communities we studied lived.

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Check your understanding

1 We found evidence that the Introduced lineage of grass was less exposed to enemy attack. Why might this help it to be more competitive?

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2 In our greenhouse experiment, we made sure that the soil was completely the same in all the pots and regularly moved the pots around as the plants grew. Why do you think we did this?

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3 In our greenhouse experiment, we grew each plant in a separate pot. Why do you think this might have prevented us from seeing which lineage of grass would be the most competitive in the wild?

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4 Can you think of any other invasive species in the US? They could be plants, fish, insects… What effect do they have on our environment?