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What microorganisms live inside wood?

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Abstract

When you think of microorganisms, what comes to mind? Sore throats, stuffy noses, and coughs? Some microorganisms can cause infections that make us sick. But many microorganisms help us stay healthy. All the microorganisms in a particular environment are part of its microbiome. There are microbiomes in the soil, the ocean, and even the human body! We wanted to explore the microbiomes found in the wood of living trees. We collected wood cores from 150 trees representing 16 species. Then we analyzed the DNA found in the wood. This told us which types of microorganisms lived there. We found that each tree species had its own unique microbiome. We also found that different parts of the wood had different microbiomes. Some of the microorganisms were types known to help plants and trees grow. Knowing more about tree microbiomes can help people maintain and conserve forests.

Introduction

A **biome** is a large area characterized by its climate and specific type of plants and animals. The major biomes include tropical rainforests and temperate forests. The main plants in these biomes are trees, which provide habitat for animals and other plants. These trees are also home to a variety of **microorganisms**. These organisms are too tiny to observe with the human eye. They are part of the tree's **microbiome**.

Microbiomes are communities of organisms and viruses in a particular environment. The organisms of a microbiome can include fungi, bacteria, algae, **protists**, and **archaea**. Microbiomes are everywhere on Earth. They are even found on the outside and inside the human body! Many of these microorganisms help keep you healthy.

We were interested in the microbiomes of trees. We wanted to find out the number and types of microorganisms in tree trunks, which are mostly made of wood. How do the microbiomes of different tree species compare? What about the microbiomes in different parts of the wood? Or the other parts of the tree? This is what we wanted to explore.

The wood of a living tree is home to different microorganisms.

Methods

We collected samples from a research forest in northeastern Connecticut. These samples came from 150 trees representing 16 different species. We took our samples between July 19 and August 12 of 2021.

For each tree, we collected wood samples using an **increment borer**, a type of drill that collects a core about the size of a pencil (Fig. 1). We took our samples from the bark surface to the **pith**, which is the soft, spongy tissue at the center of the tree. We processed the wood samples by splitting them into two sections. The **sapwood** is the outer part of the tree, closest to the bark. It consists of the new rings that trees grow every year to move water and sugar. The **heartwood** is near the pith, in the middle of the tree. Heartwood is old, non-living tissue, from rings many years old. We ground each section into a powder. We then used a kit to extract **DNA** from the microorganisms in the wood. We had the DNA sequenced. This told us the types of fungi, bacteria, and archaea, and the number of each present.

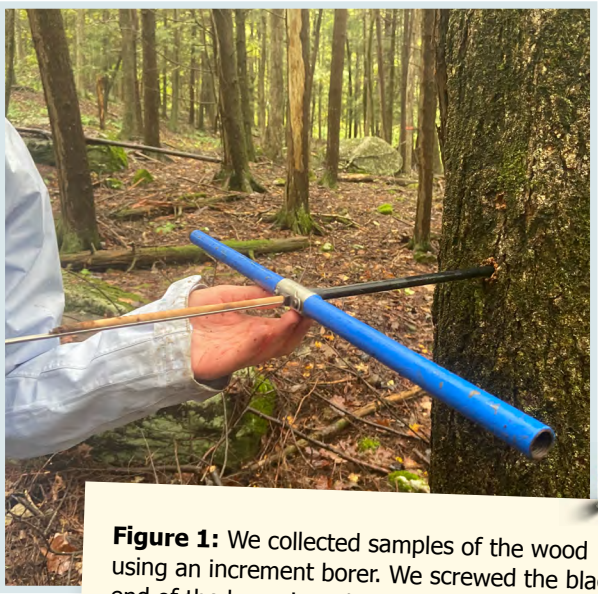


Figure 1: We collected samples of the wood using an increment borer. We screwed the black end of the borer into the tree using the blue handle. You can see the wood sample sitting on the extraction spoon on the left of the photo.
Photo: Jonathan Gewirtzman

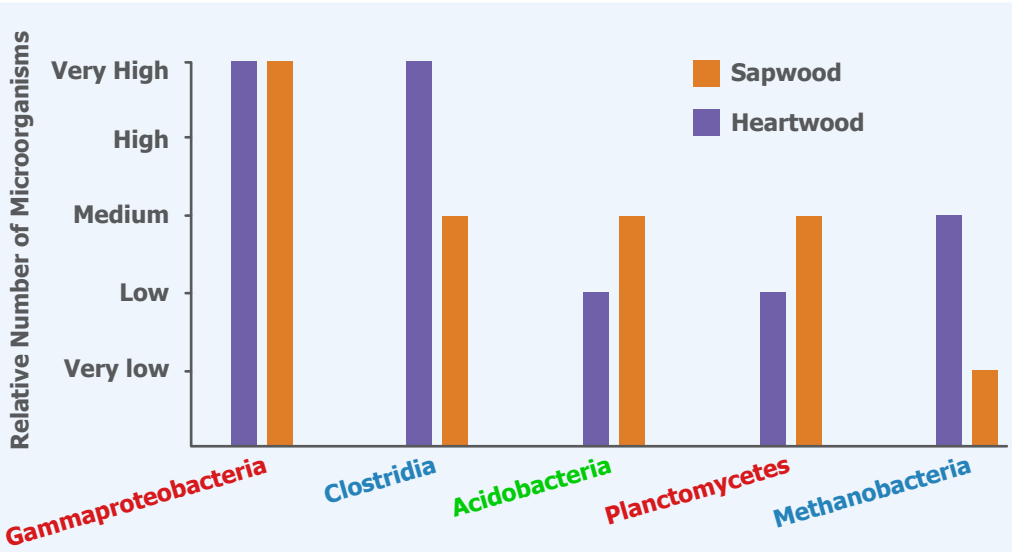
Results

We calculated that the average tree has nearly one trillion bacterial cells. The number of bacteria was different among species. The trees with the highest number were maples. The lowest number occurred in the black cherry and the Eastern hemlock. There are even more cells when you count fungi, and even more still when you count the microbes living in leaves, branches, and roots.

We found that the number of bacteria in the heartwood and sapwood was about the same for 11 of the 16 species. The red maple and black birch showed a much higher number of bacteria in their heartwood. White ash, Eastern white pine, and red oak showed a much higher number of bacteria in their sapwood. The type of microorganisms also differed. Heartwood had more **anaerobic** bacteria. Sapwood had more **aerobic** bacteria (Fig. 2).

Figure 2: A comparison of the relative numbers of five types of microorganisms found in the heartwood and sapwood of our tree wood samples. Some of the microorganisms were **aerobic**, some **anaerobic**, and some both **aerobic and anaerobic**.

Which microorganism(s) did we find in higher numbers in the heartwood compared to the sapwood?



Discussion

We found that tree species have their own unique microbiomes. Differences in wood composition could cause this. Maples contain more stored **carbohydrates** than other tree species. This encourages bacteria to grow because they can use these carbohydrates for energy. Other trees have high levels of antibacterial chemical substances. They kill bacteria or make it harder for them to grow. These trees had fewer bacteria.

The oxygen levels in heartwood and sapwood can also help explain the differences in microbiomes. Heartwood has little to no oxygen available. That is why anaerobic bacteria are more common. Sapwood has more oxygen, so it has more aerobic bacteria. There were also differences in fungi between heartwood and sapwood.

We found that some fungi and bacteria can form **mutualistic relationships** with trees. These microorganisms can produce substances that help the tree. These substances include chemical messengers that tell the tree to grow, make seeds, and respond to stress. They can also include substances that protect against disease. Scientists need to conduct more research about these beneficial bacteria and fungi. Understanding more about microbiomes can help us conserve forests in the future.

Conclusion

Tree wood microbiomes are important for forest health. Similarly, your body's microbiomes are important for your health. You can support healthy microbiomes inside and outside your body. How? By giving them the food and environment that they need. You can do this by:

- eating high-fiber foods, such as fruits and vegetables.
- choosing naturally sweet food, such as honey and berries, instead of processed sugars.
- getting plenty of sleep.
- keeping stress low whenever possible.

By taking care of your body, you also take care of your microbiomes. And in return, these microorganisms will help keep you healthy!

Check your understanding

1. Why did we extract DNA from the wood and analyze it?
2. Why do tree species have different microbiomes from each other?
3. Why did we think that the heartwood and sapwood had different types of bacteria?
4. Fungi and bacteria can form mutualistic relationships with trees. Can you think of another example of a mutualistic relationship? Explain how the relationship benefits both organisms.
5. With a partner, research and make a list of the benefits of microorganisms. Which benefit do you think is the most important? Explain your answer.
6. Make a mini poster to teach others about microbiomes and their importance.

Glossary of Key Terms

Aerobic - requires oxygen.

Anaerobic - occurs without oxygen.

Archaea - single-celled organisms that are different from bacteria. They often live in extreme environments.

Biome - a large area characterized by its climate and specific types of plants and animals.

Carbohydrates - tiny molecule building blocks in food – specifically sugars, starches, and fiber – that act as the main fuel source to give living things energy.

DNA - the unique material that carries information about how every living thing will look and function.

Heartwood - the older, harder wood of trees. It usually has a darker color and is surrounded by sapwood. It provides structure to the tree.

Increment borer - a tool that works a bit like a corkscrew, twisting into a tree trunk to remove a core of wood from inside.

Microbiome - a community of bacteria, archaea, and fungi in a particular place. It can also include algae and sometimes viruses.

Microorganisms - living organisms that are too small to be observed by the unaided human eye.

Mutualistic relationship - when two organisms of different species benefit one another. Bacteria in the human stomach have a mutualistic relationship because they help the person digest their food and the person provides food and shelter.

Pith - soft, spongy cells at the center of the tree trunk. They usually store and transport water and nutrients throughout the tree.

Protists - organisms with a clearly defined nucleus that are not an animal, plant, or fungus.

Sapwood - the younger, softer wood of trees. It usually has a lighter color and surrounds the heartwood. It transports water and minerals to the top of the tree.

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