

Into the Underworld of Tree Roots *Part 1*

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How do roots grow through the soil? How do they know where the life essential water and minerals are located and how do they “eat and drink” them? In January 2019 I wrote in **Wisdom from the Trees™** about the leaves’ long journey into the soil. Today, I want to take you further on that journey into the underground world of tree roots.

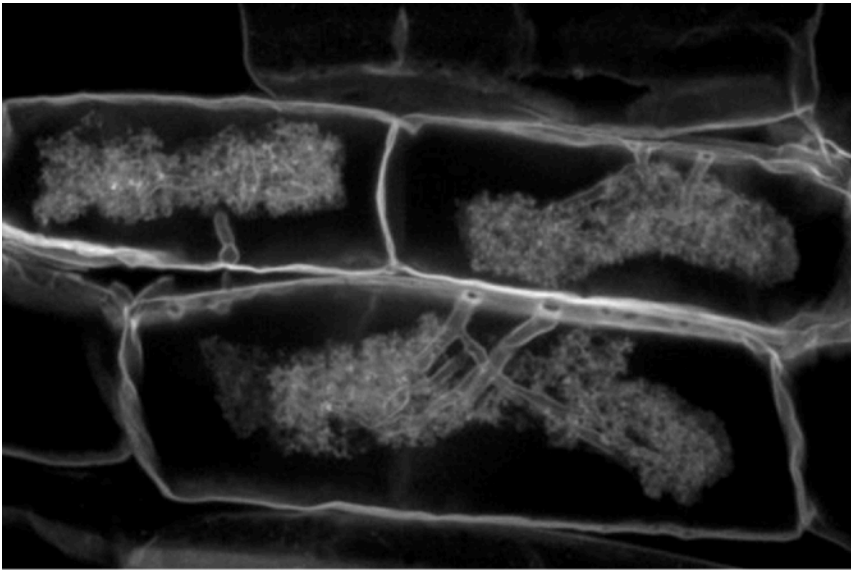
First we don't need to dive very deep to be in the world of tree roots. Trees need to breathe, just like we do, so unless the soil has lots of big air spaces (like in sandy soil) the **majority of roots must live in the top 12 inches**. I know that idea is contrary to the universal public misconception, but if you don't believe me “Google” tree root research done at the Morton Arboretum.

So let's pretend we've shrunk ourselves down to microscopic size, and we're navigating through the soil beneath a tree. We can't see roots pushing their way through the soil to find minerals and water because the roots are so heavily covered with fungus that they are hardly visible. The fungus looks like roots with long twining tendrils surrounding the tree roots and extends many times into the surrounding soil. The connection is so close that it is hard to tell where the root ends and the fungus begins. Biologists just call it **mycorrhizae** which is Latin for fungus roots.

Looking even closer we see that not only is the root covered in fungal tendrils, but the fungus and the roots are surrounded by a skin of millions and billions and trillions of bacteria. If we back away just a few centimeters from this bacterial fungal mass, we do not find such a heavy concentration of fungus or bacteria, **so...** there must be something going on right near the roots. We might ask, are the bacteria eating the fungus and the fungus eating the tree roots? The answer would be “yes, and no”!



These mushrooms are the flowers or fruiting bodies of mycorrhizal fungi



Here we see endomycorrhizal fungi penetrating into the cells of a root.
Photo Courtesy of Larry Petersen, University of Guelph, Canada

To understand, we need to sort of change our perception of “survival of the fittest.” You see plants, fungus, bacteria, and soil insects have been around for an immensely long time. They have learned how to play together, nicely. The plant roots discharge “carbohydrate exudates” which means the roots have leaked just enough sugar water into the soil to ‘call’ the fungus and bacteria to dinner.

They come running or swimming, wouldn't you?

The fungus attaches itself to the roots (by mutual agreement) by directly penetrating the root cells (endomycorrhizal) or the spaces between root cells (ectomycorrhizal). These attachments make water and minerals (soluble minerals) flow freely between the fungus and the root. The plant now has a direct pipeline to water and minerals but it has **increased its reach into the soil by as much as 100 times** more than it would have all by itself!

The fungal branches (or hyphae) don't just extend root surface area, they also secrete enzymes, which cause digestion of organic matter from unavailable compounds into absorbable and usable nutrients for the plants. However, as in all exchanges within nature, we recognize there is a give and take, so, what does the fungus get? It gets the *plant money* which is sugar water or simply put, food.

What about the bacteria? They get food to live on, of course, but what do they give? Bacteria are simple, single celled organisms that specialize in eating, digesting and dying. They gobble up anything that has died, like root hairs (average life span 6 days), worm castings, tree leaves that have been eaten by soil microorganisms, fungus and bacteria that have died (which also have a very short life span). All of these partly digested leaves, and dead materials are rich in essential plant nutrients like Nitrogen, Calcium, Iron, Copper, Zinc, etc. The problem is that the minerals by themselves cannot be carried in water or absorbed by roots. So this is what little gobbler bacteria provide; *plant available minerals*. Simply put, bacteria along with the fungi, secrete **enzymes** that digest stuff, they gobble it up, die and release **water soluble, plant available minerals**.

In turn, these essential minerals are absorbed through the mycorrhizae and transported into the plant roots!!!!

Can you believe it, bacteria even eat rock! One of the hardest minerals for plants to get in a soluble form is phosphorus. So they struck a deal with bacteria and fungi to break up and digest solid rocks for their phosphorus. Then the fungi ship it to tree roots, all in exchange for a little picnic. What a deal!

Well, Ive gotten carried away again with dirt. I hope you've enjoyed our voyage so far. Lesley tells me I have to stop for now but there's still more to show you, so I'll continue the underworld of tree roots next month(s).

*Much of this information is taken from a ground breaking and intriguing book called **Mycorrhizal Planet** by Michael Phillips. It's a great read for those of you who love the natural world.*

