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Wild Ones
NATIVE PLANTS, NATURAL LANDSCAPES

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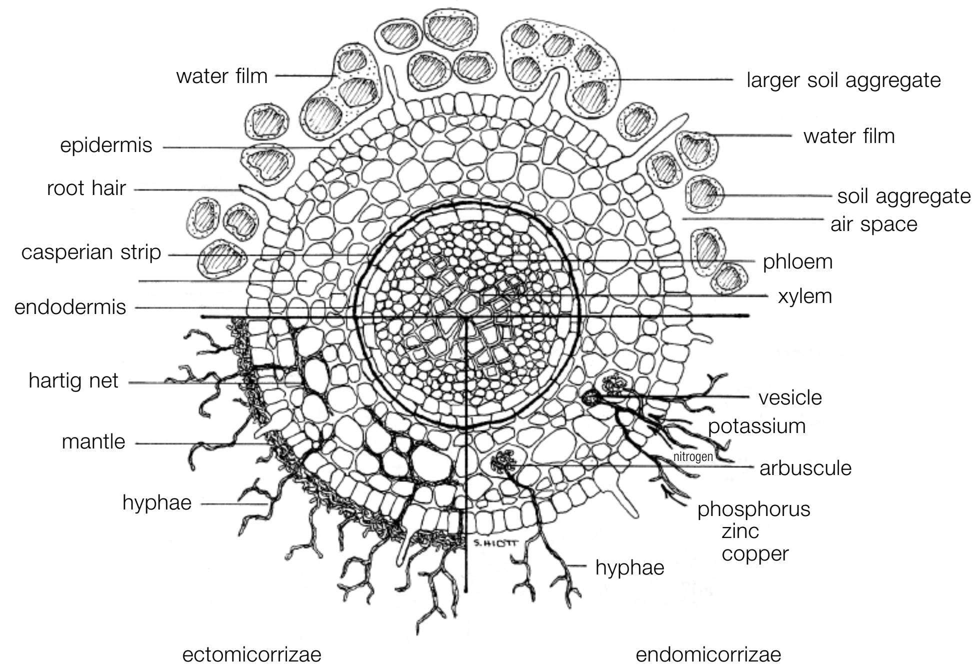
cross-section of root without mycorrhizae



Three views of a cross section of plant root, illustrating two predominant types of soil mycorrhizae.
Drawing © 2009, by Sally Hiott.

A MYSTERY EXPLORED: Part 5 By Maryann Whitman

MYCORRHIZAE AND PLANTS

It is this relationship that lets our established native plants flourish without being watered or artificially fertilized.

This is a follow-up to "Thinking About Mycorrhizae," which appeared in the January/February issue of the *Wild Ones Journal*. Please consult the illustration as you read the article.

Getting to know about mycorrhizae is one of the most important things that a native plant person can accomplish. It is almost entirely because of this relationship that our native plants don't need to be artificially fertilized or watered after they are established. A plant, on its own, has access to a limited pool of nutrients, and these have to be carried by water. The plant is not capable of the chemistry necessary to break down organic molecules in the soil – fungi are. Plant roots can extend into a limited range of the soil; fungal hyphae can be meters long, branched, growing upward and sideways as necessary. Even the tiniest roots of plants are twenty times thicker than the hyphae of fungi, so they are not as able to absorb some exceptionally thin films of water-bearing nutrients – something the hyphae can do easily. (Think of a fat straw and a thin straw taking up the last bit of soda in the bottom of a glass.)

We frequently refer to the extensive volumes of roots that our native plants grow. This attribution to all native plants can be somewhat misleading. Think about the roots of plants that grow, not in the deep prairie soils of Iowa, but in thin, poor, rocky soils in upstate New York, and the desert soils of the Southwest. These plants, too, are able to survive and

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prosper because of their relationship with the fungi in the soil. Plants in very rich, moist, organic soils can do without mycorrhizae and in fact often do. Plants that are heavily fertilized can also do without mycorrhizae.

The mycorrhizal fungi, on the other hand, need their relationship with plants in order to have access to the carbon-rich products of photosynthesis. They also survive better through a northern winter if they have live roots available – roots of the sort that our native perennial grasses, trees, and forbs provide. The undisturbed soil that carries no fungicides or other chemicals which can surround our native plants is also a definite plus.

The word is mycorrhiza

A mycorrhiza is the term for the relationship between a fungus and a green plant. This strange relationship borrows from both partners for its name: "myco" comes from the same Greek root as mycology, the study of mushrooms; the "rhiza" comes from the Greek word for root. (The extra "r" is stuck in to make the word easier to pronounce – a massive failure, I think.)

From evidence in fossil records it seems that mycorrhizae played an integral role in the evolution of land plants. While we are currently aware of seven or eight types of mycorrhizae, the arbuscular mycorrhizae (AM) were actually an ancestral "characteristic" of all land plants – and then came roots. Nevertheless, AM are still around today.

Several orders of fungi are capable of forming AM. One order *(Glomales)*, are the most common, and can be found everywhere on the planet. These fungi form the most frequent type of mycorrhiza. *Ninety percent of all plant families contain arbuscular mycorrhizae species*.

Arbuscular mycorrhizal relationship

In this type of mycorrhizal relationship the plant root is a habitat for the fungus. In arbuscular mycorrhizae the fungus penetrates into the roots of a plant, growing between the root cells, into the part of the root where the products of photosynthesis, carbohydrates, are stored – the cortex. To exchange nutrients absorbed from the soil for the carbohydrates, the fungal hyphae penetrate the cell walls and grow into tree-like structures called "arbuscules." The plant cells cooperatively accommodate this intrusion. Both plant and fungus maintain their integrity; the cytoplasmic fluids do not comingle – they do not actually "swap spit." It is through this extensive membrane interface that nutrient transfer between plant and fungus occurs, in molecular form. Phosphorus is thought to be the principle nutrient provided, though other micronutrients and even nitrogen can be involved.

Ectomycorrhizal relationship

Another type of mycorrhiza is termed ectomycorrhizal (EM) because of the way it interacts with a plant. A great diversity of fungal species are capable of forming EM, but, oddly, a relatively small group of plant taxa are involved. While arbuscular mycorrhizae are found in about ninety percent of plant families encompassing grasses, forbs, and some woodies, ectomycorrhizae are found in about ten percent of plant families, and the vast majority of them are woody (almost all the members of the oak and pine families).

Ectomycorrhizal fungi on plant roots, with long, thread-like hyphae extending into the soil. Photo courtesy of Paula Flynn, Iowa State University Extension.

In EM the fungus covers the outside of the plant root with a layer – a mantle of hyphae, that lie in contact with the ectoderm – the absorptive cells of the root, with intermittent hyphal penetrations into the root, between the storage, cortical cell walls. In the case of EM the cortical cells too, may be surrounded by a "fabric" of hyphae called a "Hartig net." The fungus and the plant essentially fuse walls, while maintaining their integrity; the hyphae do not penetrate the plant cell walls. A single tree may be host to dozens of fungal partners on different parts of its root system. The fungal species are not dedicated to single plants. Unlike AM, most EM fungi produce "rhizomorphs" in the soil – thick bundles of many hyphae which have the tensile strength to extend meters into the soil before they branch out into feeder hyphae. Additionally, EM fungi often secrete auxins, growth hormones that can influence direction of root growth and branching.

Fungi as decomposers

The fungi that form ectomycorrhizal relationships, and others that are not mycorrhizal, are evolutionarily newer than arbuscule-producing fungi – and have enzyme systems unknown in plants. These enzymes are capable of breaking down organic matter, and as a result, these fungi predominate in the litter layer. Fungi are the only organisms that are capable of efficiently breaking down lignin in dead wood, into a fluid that they can ingest. When the fungal hyphae die, all these reconstituted nutrients and minerals are released into the soil, feeding other microbiota and ultimately plants. The nutrients may also be taken directly to plants. The value of fungi as decomposers cannot be overstated. Life on this planet would be quite different without them.

So what does all this mean to our native plants? Let's go back to the May/June 2008 issue of the *Journal*, wherein appeared this paragraph:

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Have you ever wondered why we can say that our native plants don't need to be fertilized or, for that matter, have any chemicals thrown at them? Is it something inherent in the plants? Is it something that we, the native planting caretakers, do? Is it something about the medium they grow in? All are good possibilities.

With our better understanding of the soil food web, which includes the mycorrhizal fungi, we are in a better position to answer all those questions.

On the other hand, if you like to collect mushrooms keep this in mind: A lot of ectomycorrhizal fungi also produce mushroom bodies. Ectomycorrhizae occur primarily in oak, pine, and spruce trees. Along with open fields, hickories, maples, and black cherries have primarily arbuscular mycorrhizae: No mushrooms. ●

One of the best sites I have found on the web is:
http://americanmushrooms.com/

Another excellent site: www.mykoweb.com/articles.html

My sincere thanks to Sandy Scheine of the Oakland (MI) Chapter, who read this article and made valuable suggestions. She is a mushroom person and the Education Committee Chair for the North American Mycological Association.