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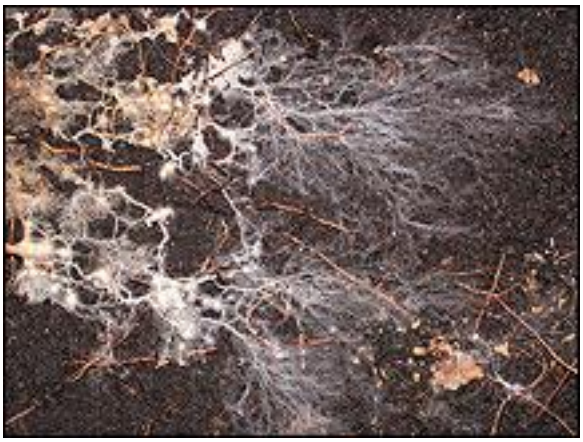
Blue Collar Fungi

Tree care, beneficial soil organisms, and the urban landscape

By Mike Amaranthus Ph.D.



Left: White hyphae of Rhizopogon mycorrhizae attached to conifer root systems scour the soil for nutrients and water.

All photos provided by Mycorrhizal Applications, Inc..For more info on mycorrhizal fungi go to www.mycorrhizae.com

Considering its critical importance to tree care, it is no surprise that tree care professionals have increased understanding of the living soil. This includes a myriad of soil life that supports a healthy tree, including microscopic beneficial bacteria, fungi, protozoa, nematodes, and a wide variety of soil arthropods and worms. Their numbers in healthy soils are nothing less than staggering. A teaspoon of forest soil can contain miles of fungal filaments and several billion bacteria.

Root exudates from trees in the form of carbohydrates, proteins and other compounds wake up, attract and feed specific beneficial bacteria and fungi. These sticky compounds are the jam and jelly that form the basis of the soil food web. At the foundation of the food web, bacteria and fungi consume plant root exudates and, in turn, are eaten by bigger microbes such as nematodes and protozoa. Nematodes and protozoa themselves enter the food chain, providing sustenance for a wide variety of other organisms in the soil.

Right: A mycorrhizal colonized pine root

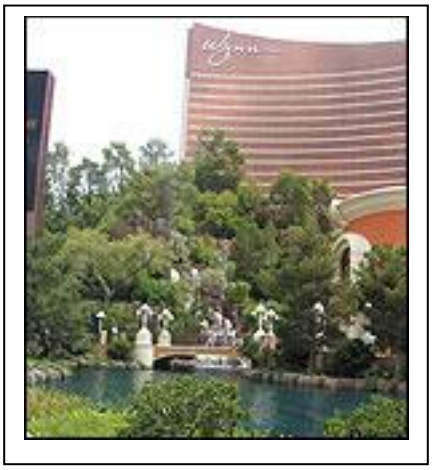
Bacteria and fungi are like small bags of fertilizer, retaining in their bodies nitrogen, phosphorus and other nutrients that are assimilated from root exudates. Bacteria and fungi are consumed by other microbes that digest what they need to survive, and excrete valuable compounds and nutrients into the soil. Trees roots then readily absorb these materials. These beneficial soil

organisms are critical to a wide variety of functions beyond nutrient cycling. They also perform essential roles in maintaining healthy root systems, good soil structure, drought protection, salt tolerance, and protection against a wide variety of environmental extremes.

The organisms in the soil food web will do much of the work in maintaining tree health. These billions of soil organisms are the blue collar workforce that works continuously throughout the year doing heavy chores, supplying nutrients and water, loosening soil and building defense systems below ground.

My-co-RISE-ee

To get trees firmly established in landscapes, it is important to know about a special relationship that exists between tree roots and certain types of fungi called mycorrhizae (pronounced my-co-RISE-ee; literally fungus “myco” root “rhiza”). These fungi are a major component of a multitude of hard-working armies of beneficial soil organisms largely invisible to us beneath the soil surface. These soil populations are an integral component of sustainable plant communities where organisms depend upon one another in strange and complex ways. The mycorrhizal relationship is a symbiotic relationship, meaning that both the plant and the fungus benefit. Nearly all trees, and approximately 95 percent of all higher plants, depend on mycorrhizal relationships.



Left: These large pine plantings in Las Vegas were treated with a mycorrhizal inoculum to aid their establishment.

Mycorrhizal fungi are not glamorous organisms. They don’t build cities, drive race cars or have interesting social lives. These hard-working fungi do, however, provide the cornerstone for sustainability for our forest communities. They provide the moisture and nutrients needed to keep trees in our natural areas healthy and functioning through tiny absorptive threads called hyphae. The fact is, we could not survive a day without them. Without their diligent munching in the soil, trees in native ecosystems all over the world would go hungry and die of thirst. Without the oxygen, carbon accumulation and fiber that trees produce, in short order, we too would follow.

Until recently, fungi, including some 5,000 mycorrhizal species, were nearly always treated as botanical objects. The truth is that fungi have little in common with plants. They reproduce, breathe, and build themselves in ways far different than the world of plants. Structurally their cells are built with chitin, the same material in the claws of mammals and shells of insects. In fact, recent DNA results indicate that fungi share a common ancestry with insects — not plants.

Unlike plants, fungi don’t photosynthesize. They lack chlorophyll necessary to fix the sun’s energy. Instead, fungi grow directly on their food source, digesting materials with powerful enzymes. For example, mycorrhizal fungal filaments using a variety of specific enzymes can extract tightly bound minerals from the soil that roots themselves cannot hope to capture.

Ancient workers

Mycorrhizal fungi got along for about 460 million years without our help and successfully orchestrated the invasion of the earth's surface by plants. Until mycorrhizal fungi penetrated the roots of primitive aquatic plants they lacked the tools to successfully colonize soils on the harsh earth's surface. The marriage of primitive plant and fungus unleashed the evolutionary leap that produced the "greening" of our earth.

Left:. Pine trees subjected to drought conditions: (top) Mycorrhizal inoculated trees compared to (bottom) non-inoculated trees.

Since the early days, these hard-working fungi have been amazingly prolific. Miles of fungal filaments can explore a single thimbleful of healthy forest soil. They pluck phosphorus, nitrogen and micronutrients out of the soil with a specific arsenal of designer enzymes just right for the job. Mycorrhizal fungi process waste and make it usable again, purify our water, and keep our plant communities productive. The wide variety of trees you plant in the ground will thrive when given the right source of mycorrhizal inoculum.

Myco what?

Mycorrhizae, in general, are not easy to categorize. When the specialized soil fungus penetrates into or around the plant root it is no longer considered "plant material" and no longer a "fungus." The resulting organism is a symbiotic hybrid of both, forming a relationship in which both plant and fungus benefit. The name is difficult to spell and difficult to pronounce, which no doubt has contributed to its obscurity. But a simple understanding of the role these organisms play in tree nutrition should certainly have earned these extraordinary entities a more immediate share of the attention they deserve.

Mycorrhizae attach themselves to the roots of plants and radiate out into the soil and help their host tree absorb water and nutrients. In return, the host tree feeds the fungi with sugars, proteins, amino acids and other organic substances. Fungi are made up of filaments called hyphae. A mass of hyphae is a mycelium, which can grow very rapidly. A fungus colony can produce more than a kilometer of new mycelium in 24 hours! This growth form has a very high surface area, one of the attributes that makes the symbiotic relationship so successful. Mycorrhizae can spread their net of hyphae far and wide in the soil, penetrating tiny spaces in the soil where plant roots can't go. In addition, fungi are also capable of breaking down, or converting, some nutrients such as nitrogen and phosphorus to forms usable by plants.

Water, a precious resource

Mycorrhizal fungi are involved with a wide variety of activities that benefit tree establishment and growth. For example, the same extensive network of fungal filaments important to nutrient uptake is also important in water uptake and storage. In non-irrigated conditions, mycorrhizal trees are under far less drought stress than non-mycorrhizal trees. Landscapes containing healthy populations of mycorrhizal fungi require less water because tiny fungal hyphae can access reservoirs of water in small spaces within the soil that roots themselves are too thick to enter. As water in landscapes becomes more limiting, there has never been a better time to utilize these blue collar fungi for water conservation.

Is there mycorrhizae at my site?
Like air and water, the soil is a precious resource. However, it is not an unchanging resource. On the contrary, the quality and quantity of soil in any one location can change markedly in a relatively short time span. Such changes may result from human activities related to site preparation and maintenance. Events that seriously disturb soil can substantially reduce or eliminate these beneficial microbes.

Left: A granular mycorrhizal inoculant.

Soils from natural and undisturbed forest areas generally contain robust and diverse populations of mycorrhizal fungi. Research shows, however, that compaction, erosion, grading, topsoil removal, overgrazing and the use of soilless mixes in growing operations often eliminate mycorrhizae completely. Many of the top-performing mycorrhizal fungi do not disperse their spores in the wind and move by growing root-to-root or by consumption by wildlife species. In a disturbed habitat, the effectiveness of the return of mycorrhizae is dependent on the quality and proximity of undisturbed habitats containing suitable fungi and their associated animal vectors. Many cases have been documented where plants in disturbed urban and suburban environments have not formed mycorrhizae many years after outplanting and are surviving only through intensive care and maintenance.

How do I use mycorrhizal inoculants most effectively?
Mycorrhizal inoculants are not a silver bullet, but are another tool available to the tree care professional. Inoculums containing mixtures of species of mycorrhizal fungi often give the best response. Mycorrhizal inoculum comes in tablet, powder, gel, liquid and granular forms. Look for products that have many species of mycorrhizal fungi present. This improves performance across a variety of plant, soil and climatic conditions. An important factor is to get the mycorrhizal propagules near the root systems of target trees. Inoculum can be incorporated into the planting hole at the time of transplanting, watered-in or injected into the soil profile of existing trees or directly dipped on bare root systems using gels.

The form and application of the mycorrhizal inoculum depends upon the needs of the applicator. Most mycorrhizal propagules will stay dormant until root activity begins.

Blue collar reality

Establishing plants on disturbed sites requires an understanding of the many soil processes important in facilitating uptake, storage and cycling of nutrients and water by the target plant species. In natural forests, these activities are largely performed by a diversity of fungi, working hard below the living soil surface. In past decades, clearing of natural areas and disturbances in suburban and urban environments have substantially reduced mycorrhizal populations.

Above: The large ficus tree above toppled during Hurricane Charley. Mycorrhizal inoculum greatly aided the re-establishment of the tree seen 13 months later. Photos courtesy of MycorrhizalProducts.com

Getting.plants established is often a great challenge. Numerous tight or tenuous links between plants and soil microorganisms are broken. These linkages include nature's blue collar fungi that have helped allow trees to survive and thrive in natural environments for millions of years without the use of fertilizers, pesticides and irrigation. As tree care professionals gain increased appreciation of the living soil, they are more frequently incorporating mycorrhizal considerations into their prescriptions and practices.

Dr. Mike Amaranthus spent more than 20 years with Oregon State University and the U.S. Department of Agriculture where he wrote more than 60 research papers on mycorrhizae. He is the recipient of the USDA Highest Honors for scientific achievement and has been featured on several major national and international programs. He is president and chief scientist for Mycorrhizal Applications, Inc., located on the Web at ***www.mycorrhizae.com****.*