Urban Harvest
Growing gardens. Enriching lives.

The Soil Food Web

Bob Randall

There are few gardening practices upon which all gardeners agree, and one of these is that there are many beneficial results from adding dead organic matter to the soil. In recent years, scientists at many universities have begun to understand exactly why. What they are learning confirms some truths that organic gardening advocates have long believed: only use organic fertilizers and avoid the use of pesticides.

Above ground we are accustomed to the idea of a food web. Collards get their energy from sun, air, and soil. Collards in turn are eaten by cabbage looper worms, and these are eaten by predaceous wasps and blackbirds. Below ground, a similar web is in action. Most of us are familiar with the visible part of this web: the earthworms, centipedes, and millipedes, but much of it is too small to see. Microbes, after all, are microscopic.

Oregon State's Elaine Ingham has been studying microbes for years. What follows is a summary of her findings. The web beneath the soil is amazingly complex, but it is possible to understand important principles without soil science training.

Put simply, plants consist of roots and shoots. The shoots obtain energy from the sun and the roots obtain nutrients and water from the soil. Roots help shoots grow and vice versa. Roots also obtain inorganic nitrogen such as nitrates from two kinds of organisms that feed on dead organic matter: bacteria and saprophytic fungi.

Dead plant shoots and roots therefore make it possible for living plants to get inorganic nitrogen. Bacteria consume the easily digested materials such as grass while the fungi consume the harder to digest woody materials. Prairies and lawns, therefore, have mainly bacterial decomposers, while forests have saprophytic fungi. According to Ingham, the best garden soils have nearly equal weights of bacteria and fungi.

Bacteria and saprophytic fungi cannot use most of the organic materials they consume so 60% of the carbon becomes carbon dioxide in the air. The remainder becomes organic matter (humus), or is released in soil as inorganic nitrogen.

Plant roots also get nitrogen from mychorrhizae, a type of fungus that lives on plant roots such as corn, peas, apples, and citrus, and feeds these plant roots nitrogen and phosphorous in return for

energy. Mychorrhizae can be very long, so plants with these fungi get nutrients that the roots could never reach.
Bacteria in turn are consumed by three types of the single celled organisms known as protozoa. Flagellate protozoa are eaten by amoebae or cilated protozoa, and all of these are eaten by omnivorous nematodes. Bacteria are also eaten by bacteria-eating nematodes.

Biologically, nematodes are a phylum of threadlike worms. There are biological orders of nematodes in the soil as different from each other as are elephants and cats.

Besides the orders of omnivorous nematodes and bacteria-eating nematodes, there are orders of root eating-nematodes and fungus-eating nematodes. The root-eaters are a well known pest of many garden crops. The fungus eaters consume mycorrhizal and saprophytic fungi.

Saprophytic fungi are also eaten by simple mites and other micro-arthropods. Mites are eight legged tiny creatures related to other arachnids like spiders. Micro-arthropods have one hundred times as much carbon compared to nitrogen as do fungi, so when they eat saprophytic fungi they give off a great deal of nitrogen for roots.

Species in all of the nematode orders mentioned above are then eaten by another order: the predaceous nematodes. Predaceous nematodes and all the other nematodes are then eaten by nematode eating mites and these in turn are eaten by predaceous mites. Predaceous mites also eat the various types of nematodes, as well as the simple mites and micro-arthropods.

"The Soil Food Web" is certainly well named. Just as in a spider web, there are connections everywhere. If you provide lots of organic matter, you are feeding, directly and indirectly, many organisms that will provide important nutrients to plant roots.

If you rake, blow, or carry away plant material, you stop this process. If you apply fungicides, miticides, nematicides or other poisons to the soil, you may kill an entire food web. According to Ingham, "If the soil has received heavy treatments of pesticides, chemical fertilizers, soil fungicides or fumigants that kill these organisms, the tiny critters die, or the balance between the pathogens and beneficial organisms is upset, allowing the opportunist, disease-causing organisms to become problems."

2311 Canal Street, Suite 200, Houston, Texas 77003, 713.880.5540, urbanharvest.org