SL271

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Soils & Fertilizers for Master Gardeners: Organisms in the Soil[1]

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This article is part of a series entitled *Soils and Fertilizers for Master Gardeners*. The rest of the series can be found at http://edis.ifas.ufl.edu/topic_series_soils_and_fertilizers_for_master_gardeners. A glossary can also be found at http://edis.ifas.ufl.edu/MG457.

Introduction and Purpose

The soil is home to a vast array of living organisms that play an important role in soil formation and function. For example, soil organisms are responsible for the decomposition of plant and animal residues and the formation of organic matter (humus). While some of the larger soil organisms receive a lot of attention, many organisms go unnoticed because of their microscopic size or because they live out of sight beneath the soil surface. This publication discusses different types of organisms and their impact on the soil environment.

The Soil Food Web

Organisms that live all or part of their lives in the soil are interconnected through the soil food web (Figure 1). The food web represents the conversion of energy and nutrients from organisms on one level to organisms on another level. The levels of the food web are called trophic levels, which include primary producers, primary consumers, secondary consumers, and tertiary consumers.

The primary producers are the first trophic level of the soil food web. Organisms in this trophic level are photosynthesizers, including plants, mosses, algae, lichens and photosynthetic bacteria. Organisms in the second trophic level are called the primary consumers. Primary consumers obtain energy by eating primary producers or the residues they produce. Herbivores (e.g., slugs, nematodes, insects and mice) consume live plants, while detrivores (e.g., bacteria and fungi) feed on dead plant tissue. As we move up the food web, the next trophic level contains the secondary consumers. These organisms, which include bacteria, fungi, centipedes, mites, and spiders, feed on the primary

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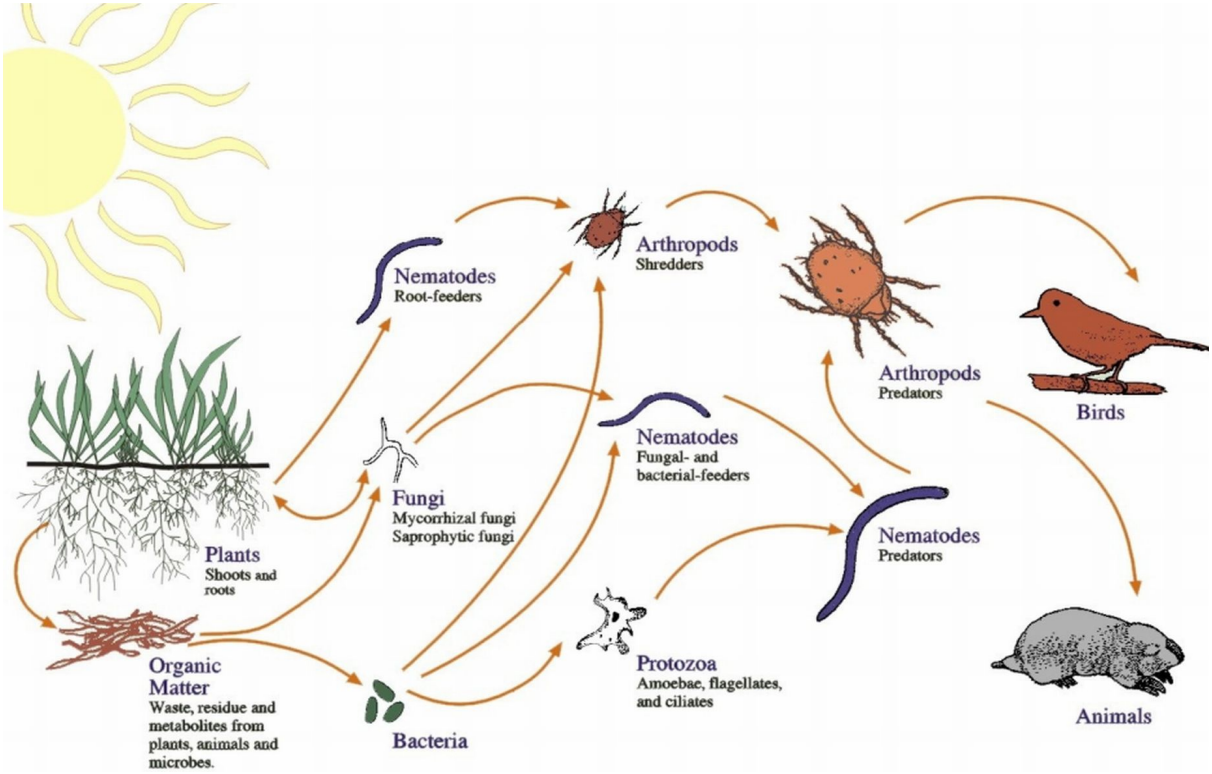

Figure 1. The soil food web. Credits: USDA-NRCS

consumers. The primary and secondary consumers can also become prey for the higher-level consumers (e.g., tertiary consumers), including beetles, earthworms, ants, moles, and even birds.

Important Soil Organisms

Each trophic level of the soil food web is comprised of several types of organisms. This section will describe some of the most prevalent and important soil organisms; however, it is important to note that there are many other types of organisms that exist in the soil.

Earthworms

Earthworms are very important soil inhabitants. While not required for a soil to be healthy, they are an indicator of soil quality. The burrowing and ingestion of soil materials by earthworms helps to physically mix the soil, decompose plant materials, and cycle nutrients. The casts of earthworms can also improve soil structure by enhancing aggregation. Earthworm activity is usually low in Florida's sandy soils.

Arthropods

Arthropods are animals with an exoskeleton, such as insects, crustaceans, and arachnids. In the soil, arthropods are responsible for physically shredding organic materials, stimulating microbial activity, and cycling nutrients. Soil arthropods are categorized based on their function in the soil. Large arthropods like millipedes and termites are shredders that chew up dead plant materials. Herbivores like mole crickets feed on plant roots. Shredders and herbivores can become pests when their populations are high. Predator arthropods, including centipedes and spiders, help to control the populations of other soil arthropods. Some arthropods eat soil fungi and bacteria.

Nematodes

Nematodes are non-segmented worms, most that live in soil are microscopic. Many nematodes feed on bacteria, fungi, algae, or are predators of microscopic animals. Other nematodes are parasites of animals or plants. In the soil, nematodes assist with nutrient cycling, are a source of food for other soil organisms, and can suppress or cause disease. While

root-feeding nematodes can cause plant disease, fungal-feeding, bacterial-feeding, and predatory nematodes often work to suppress plant diseases or pests.

Soil Protozoa

Protozoa are single-celled, mobile organisms that are important for nutrient cycling and regulating populations of bacteria in the soil. Protozoa, which are larger than bacteria, are often abundant in soils. Protozoa populations can reach up to 1 million per teaspoon of soil in highly fertile soils. When they feed on bacteria or other protozoa, these organisms often release excess nitrogen in a form that can be used by plants. Protozoa depend on soil moisture to feed and for movement. Therefore, soil moisture influences the type and size of protozoa in the soil. Soil protozoa are often most active near plant roots.

Soil Fungi

Fungi are a diverse group of microorganisms that are abundant in the soil. Most fungi (e.g., molds and mushrooms) are multi-cellular and grow in long strands called hyphae, but a few species like yeast are single-celled. Fungi play an important role in the nutrient cycling, organic residue decomposition, and disease suppression. Decomposers, mutualists and pathogens are the three main groups of soil fungi. The decomposers are responsible for the breakdown of dead organic material. Mutualist fungi will colonize plant roots and provide nutrients to the plant in exchange for carbon (an energy source). The pathogens cause disease or death when they colonize and feed on living organisms like plant roots or nematodes.

Bacteria

Bacteria are microscopic, single-celled organisms that are abundant in soils. In fact, a teaspoon of soil can contain up to 20,000 different species of bacteria. In the soil, bacteria are important for nutrient cycling, disease suppression, and even pollutant cleanup. Soil bacteria can also improve soil structure by enhancing the formation of aggregates. Similar to soil fungi, soil bacteria are categorized as decomposers, mutualists and pathogens. There is also a fourth type of bacteria called chemoautotrophs. Decomposer species are responsible for the breakdown of organic residues. Some mutualist bacteria species are capable of converting nitrogen in the atmosphere to a form that is available to plants. These nitrogen-fixing bacteria colonize the roots of plants called legumes (e.g., clover, soybean, alfalfa). Chemoautotrophs obtain energy from nitrogen, sulfur, or iron compounds rather than from carbon. These bacteria are often capable of decomposing harmful chemicals like oil and pesticides that find their way into the soil.

Factors Affecting Soil Organism Populations

The type and number of organisms present the soil environment is directly related to the availability of food. However, other factors like climate, vegetation, and soil pH also impact the type and quantity of organisms present. For example, forests usually have more diverse soil organism populations than disturbed areas (e.g., cultivated fields, urban areas). Highly disturbed soils, such as those found in urban areas, typically have smaller numbers of soil organisms than forest or grassland soils. Also, soil organisms are usually more active in areas with a warm, moist climate than in areas with cold or dry climates. Typically, soil microorganisms (e.g., bacteria and fungi) account for most of the biological activity in soils.

Summary

Soil organisms are related to each other based on the soil food web. The food web represents the conversion of energy and nutrients from organisms on one level to organisms on another level. Organisms at lower trophic levels act as a source of food and energy for organisms at higher trophic levels. There are several types of organisms occupying each of the soil food web trophic levels. Important groups of soil organisms are earthworms, nematodes, protozoa, fungi, and bacteria. These organisms play an important role in the cycling of nutrients, formation of soil organic matter and soil structure, and suppression of diseases. While most soil organisms are beneficial, some are responsible for plant diseases.

References

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