

The Microscopic Food Chain in Our Gardens

Garden soil is alive, a micro-ecosystem beneath our feet. This dark environment is home to several commonly known creatures: earthworms, insects, and burrowing animals. But these large residents are vastly outnumbered by the smallest residents, the microscopic inhabitants of the soil – microorganisms.

Soil microorganisms are abundant and diverse. A single gram of topsoil (about 1/4 teaspoon) can contain the following quantities of microorganisms:

Bacteria	100 million to 1 billion
Actinomycetes	10 to 100 million
Fungi	100,000 to 1 million
Algae	10,000 to 100,000
Protozoa	10,000 to 100,000
Nematodes	10 to 100

Like other living creatures, microorganisms spend most of their lives eating each other and the remains of larger organisms and plants. They range in size from one-celled bacteria, algae, fungi, and protozoa, to more complex nematodes and micro-arthropods. Microorganisms are an integral part of a complex, microscopic food chain in our garden, a soil food web. This web also includes earthworms, insects, small animals, and plants.

All plants benefit from a healthy soil food web. How? Several ways: larger soil organisms aerate the soil, bringing in air, water, and surface organic materials. Smaller soil microorganisms release energy, nutrients, and carbon dioxide when they feed, creating soil organic matter. Plants use soil organic matter as their main source of energy and nutrients. This exchange between microorganisms and plants occurs in the narrow region of soil directly around plant roots. This region is called the rhizosphere, and is teeming with bacteria that feed on proteins and sugars released by roots, as well as sloughed-off plant cells. Other microorganisms that feed on bacteria are also concentrated in the rhizosphere. In turn, plant roots feed on the by-products of active soil microbes. Survival of all these organisms is interdependent. Hearty plants require good soil – good soil is created by hearty soil organisms.

The number of active soil organisms is determined by several factors: seasonal weather changes, soil temperature, moisture, aeration, pH, soil type, and food sources. Not all organisms are active at the same time. Microorganisms are most active in warmer weather, while earthworms are most active around 50 degrees. Because organic matter is at the base of the soil food web – rich, organic soils generally have more organisms than those lacking in organic matter.

Almost all gardening practices affect the number of soil organisms, but it is a complex, difficult to understand relationship. Studies have found that tillage, the use of fertilizers and pesticides, and amending with organic

matter all affect soil organisms. In-depth information about this complex soil food web can be found at the [USDA's Natural Resources Conservation Service](#).

Fun Facts about Soil

From the Soil Quality Institute, Natural Resources Conservation Service, United States Department of Agriculture

The tips of small plant roots move through the soil with a twisting screw-like motion. Mature trees can have as many as 5 million active root tips.

- Although the soil surface appears solid, air moves freely in and out of it. The air in the upper 8 inches of a well-drained soil is completely renewed about every hour.
- The plants growing in a 2-acre wheat field can have more than 30,000 miles of roots, greater than the circumference of the Earth.
- One cup of soil may hold as many bacteria as there are people on Earth.
- A teaspoon of farm soil may contain tens of yards of fungi. The same amount of soil from a coniferous forest may hold tens of miles of fungi.
- Nematodes are amazingly diverse. Twenty thousand species have been described, but it is thought that 500,000 species may exist. Five thousand soil species have been described.
- Earthworms move soil from lower strata up to the surface and move organic matter from the soil surface to lower layers. Where earthworms are active, they can turn over the top 6 inches of soil in ten to twenty years.

Resources

Tugel, A.J., A.M. Lewandowski, eds. (February 2001 – last update). [Soil Biology Primer](#). USDA Natural Resources Conservation Service. Retrieved February 4, 2003.

Cogger, Craig. Soils and Fertilizers. *Sustainable Gardening*, The Oregon-Washington Master Gardener Handbook, EM 8742, October 1999: 35-60.