The Soil Food Web

Exploring the Roles of Macro-Life in the Soil

What Is Soil?

Soil is a complex, living ecosystem that supports plant growth, regulates environmental processes, and sustains agricultural production. It is home to an immense diversity of organisms that influence soil structure, fertility, and resilience.

Types of Soil Organisms

The organisms involved in the soil food web can be categorized into two primary groups:

Micro-organisms: Tiny life forms, like bacteria, fungi, and protozoa, that cannot be seen with the naked eye.
Macro-organisms: Larger organisms, such as earthworms, insects, and small mammals, that are visible.

Diagram of the Soil Food Web

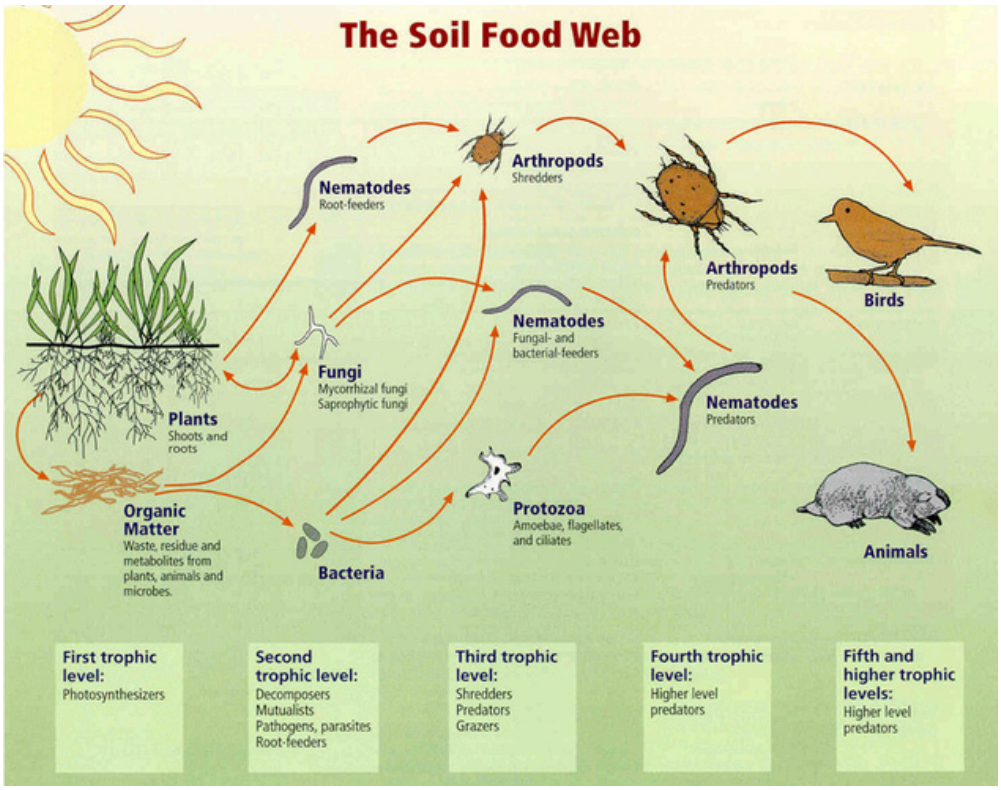

Image Source: USDA Agricultural Research Service 1999.

The soil food web describes how energy and nutrients flow through soil ecosystems. It consists of several interconnected levels:

- Primary producers
- Primary consumers
- Secondary consumers
- Higher-level consumers

Primary Producers: The Photosynthesizers

The foundation of the soil food web begins with the first trophic level, consisting of photosynthesizers (i.e., plants) and organic matter. Plants play a crucial role in capturing carbon from the atmosphere and converting sunlight into energy through photosynthesis. This process produces oxygen and sugars, which fuel plant growth and development.

However, plants require more than just energy from photosynthesis to thrive. They also need essential nutrients such as nitrogen, phosphorus, and potassium, which cannot be produced through photosynthesis. This is where soil microorganisms and their ability to recycle organic matter into plant available nutrients come into play.

Primary Consumers: The Consumers of Plants

Bacteria and fungi are essential components of the soil food web. They break down organic matter — such as dead organisms, plant materials (i.e., leaves, chaff, etc.), and animal wastes. They transform the nutrients contained in their food source into forms that plants can absorb.

As organic matter is decomposed by the soil food web, essential elements like carbon, oxygen, nitrogen, and phosphorus are released into the soil. However, these nutrients are not immediately available to plants. Bacteria and fungi consume these nutrients, which are effectively stored within their bodies. When these microorganisms are themselves consumed by other organisms — such as protozoa, nematodes, and arthropods — the excess nutrients that these predators do not need are excreted back into the soil in a plant-available form. This process, known as nutrient mineralization, is a key step in the natural cycling of nutrients.

Secondary Consumers: Predators

Predators consume other organisms to gain nutrients. These include nematodes and protozoa (such as flagellates, amoebae, and ciliates). Their primary role is nutrient mineralization, which occurs as they consume bacteria and fungi, breaking them down and releasing essential nutrients into the soil in plant-available forms. Like all predators, their feeding behaviors also help to regulate the populations of their prey (i.e., bacteria and fungi) ensuring the ecosystem remains in balance.

Higher-Level Consumers: Level Four

The soil food web consists of higher-level consumers that help regulate populations and maintain ecosystem balance. The fourth trophic level includes earthworms, macro-arthropods like beetles and centipedes, and omnivorous nematodes, which feed on secondary consumers such as predatory nematodes and protozoa. These organisms also contribute to nutrient cycling and improve soil structure by breaking down organic matter.

Higher-Level Consumers: Level Five

The fifth trophic level consists of top predators, including larger predatory arthropods and certain nematodes, which help control other predator populations and prevent imbalances in the food web. Larger burrowing animals, such as rodents and birds, also interact with the soil ecosystem by modifying soil structure, redistributing organic matter, and influencing macro-organism populations.

Thank you for reading!