

## **What Lies Beneath?**

### **The Role of Micro-Life in the Soil**

#### The Soil Food Web

As we come to understand more about how natural systems support healthy plants, we inevitably look at the interactions of life in the soil, known as the soil food web. This is an ever-evolving field of study that continues to grow. In our exploration of the relationship between plants and soil life, we will look at life directly and indirectly connected to the plant and its roots, such as microflora (microscopic plants, bacteria and fungi) and the life that feeds on the same microflora, such as microfauna (microscopic animals including nematodes and protozoa).

First, Let's Take a Look at Microflora.

Microflora are the microscopic organisms associated with a plant's environment or tissues, such as bacteria, fungi, algae and archaea that live on or in plant surfaces (roots, leaves and stems) or in the surrounding soil (like the rhizosphere). Microflora play a critical role in regenerative processes, like building soil structure, retaining water and nutrient cycling and availability.

#### **Microflora: Bacteria**

These single-celled organisms play an important role in nutrient cycling, decomposition and plant growth. There are different genera of bacteria responsible for different processes:

- Nitrogen-fixing bacteria convert atmospheric nitrogen into a plant-useable form (e.g., *Rhizobia*, *Azospirillum*, *Azotobacter*)
- Phosphorus-solubilizing bacteria (e.g., *Pseudomonas*, *Bacillus*)
- Decomposition and soil health bacteria (e.g., *Actinomyces*)

#### **Microflora: Fungi**

Fungi often form symbiotic relationships with plants. Their collaboration with the plant can:

- Enhance nutrient and water uptake (e.g., arbuscular mycorrhizal fungi)
- Improve phosphorus availability (e.g., *Penicillium bilaiae*)
- Improve phosphorus availability with improved shoot growth (e.g., *Aspergillus niger*)
- Bio-control with bio-stimulant (e.g., *Trichoderma asperellum*)

#### **Microflora: Algae**

Algae are photosynthetic organisms that can:

- Fix nitrogen (e.g., *Anabaena* in rice fields)

- Add carbon to soil through decomposition (e.g., *Chlorophyta*, *Xanthophyta*, *Bacillariophyta*)
- Release phosphorus through decomposition (e.g., *Bacillariophyta*)

Algae are commonly found in topsoil or wet conditions.

### **Microflora: Archaea**

These microorganisms are often found in extreme environments but can also be found in soil.

They can:

- Convert ammonia to nitrite (e.g., *Thaumarchaeota*)
- Fix atmospheric nitrogen to ammonia (e.g., *Euryarchaeota*)

Archaea are often found in high salinity and/or low oxygen soils.

## Now, Let's Take a Look at Microfauna

Microfauna are microscopic animal life that interact with plants or inhabit their immediate environment, such as soil and plant surfaces. They include protozoa, nematodes, microarthropods, enchytraeids, and rotifers. They generally feed on organic matter and microflora.

### **Microfauna: Protozoa**

These single-celled organisms include ciliates, flagellates and amoebae. Ciliates typically feed on bacteria, algae and other protozoans, flagellates feed on bacteria, and amoebae feed on bacteria, fungi and algae. When protozoa feed, they release excess nitrogen and phosphorus into the soil by means of their excrement (often referred to as the "poop cycle").

### **Microfauna: Nematodes**

A large grouping of multicellular creatures that are often referred to as roundworms. They include:

- Beneficial (organism-eating)
- Potentially detrimental (root-eating, parasitic)
- Omnivorous species

They are generally found in soil water films and contribute to litter decomposition and nutrient cycling.

### **Microfauna: Microarthropods**

This is a term used to encompass a diverse group of creatures that play a variety of roles in the soil but all have characteristically hard exoskeletons (e.g., insects, arachnids etc.). These creatures employ various feeding strategies, consuming a variety of materials including:

- Root exudates
- Organic matter
- Fecal material
- Bacteria
- Fungi
- Nematodes
- Other microarthropods

These feeding processes can help make more nutrients available to the plants (i.e. the “poop cycle”) and reduce pest pressure.

### **Microfauna: Enchytraeidae**

Sometimes known as pot worms, these very small worms are visible with the naked eye and -- at first glance – can be mistaken for minute, translucent “baby” earthworms. They are commonly found in cool soils with high organic matter. Though not much is known about this group, current research suggests they feed on nematodes and organic matter, adding value to the nutrient cycles in the soil.

### **Microfauna: Rotifers**

These are multicellular creatures that feed on bacteria, fungi, algae and organic material. They live in water films on surface soils and plant litter, contributing to the nutrient cycle by breaking down organic matter. It is believed that these creatures help to maintain microbial balance in the soil.

## In Conclusion

Although this is not an exhaustive list of the massive world of micro-life in the soils, we hope this introduction gets you thinking about the soil food web and the extensive ecosystem that exists below ground. Familiarizing ourselves with soil organisms enables us to look at what is going on with the food webs in our fields to determine what may be missing. If we lack fungi or bacteria, then we are unlikely to find any of the organisms that depend on fungi or bacteria for food. We can use this information to inform our management practices and improve the health of our soils.

## For Further Learning

Check out these links to continue your learning on the soil food web:

- [Soil Biota: In-Depth Overview of Microbes and Fauna](#) (Article)
- [Micro and Macro \(Organisms\) and Their Contributions to Soil Fertility](#) (Article)
- [Soil Organisms, functions and their role in Soil fertility](#) (Article)
- [Soil fauna: occurrence, biodiversity, and roles in ecosystem function](#) (Book Chapter)
- [Important soil microbiota's effects on plants and soils: a comprehensive 30-year systematic literature review](#) (Article)
- [Soil Microarthropods and Soil Health: Intersection of Decomposition and Pest Suppression in Agroecosystems](#) (Article)
- [Soil Microorganisms: Their Role in Enhancing Crop Nutrition and Health](#) (Article)