USDA
United States Department of Agriculture

NATURAL RESOURCES CONSERVATION SERVICE

11A

SOIL TECH NOTES

Biological Underground Community

PROBLEM: "I always thought fungus meant a wet soil or nasty soil. I guess I need them in the soil too? I know my residue doesn't seem to get broken down!"

DECOMPOSERS:

- Bacteria, Actinomycetes, and fungi degrade plant residue, organic compounds, and some pesticides.
- Bacteria usually work on easily degradable compounds.
- Fungi degrade more complex, longer carbon-chain compounds.
- Actinomycetes (filamentous bacteria) are somewhat intermediary.

GRAZERS AND PREDATORS:

- Protozoa, nematodes "graze" on bacteria or fungi. Help to control populations of both.
- They release plant-available nutrients as they consume microbes.
- "Generalists" will prey on any microbial species, while others are very specific as to which ones.

LITTER TRANSFORMERS:

- Arthropods, such as insects, spiders, mites, springtails, centipedes, and millipedes shred and consume plant litter and other organic matter.
- This shredding greatly increases the surface area and makes more accessible to decomposers.
- The OM in their fecal pellets is also more physically and chemically accessible to microbes now.
- Ants, termites, and earthworms physically change the soil habitat by chewing and burrowing through the soil.
- Microbes actually living in their "gut" break down plant residues consumed along with the soil.

MUTUALISTS:

- Mycorrhizal fungi, nitrogen-fixing bacteria, and a few others form a mutually beneficial association with plants.
- Mycorrhiza are associations with plants in which the fungus supplies nutrients and perhaps water to the plant and the plant supplies food to the fungi.

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WHAT CONTROLS THIS BIOLOGICAL COMMUNITY?

Soil biology activity is determined by factors at three different levels.

1. At the scale of ***individual organisms***, activity is determined by conditions such as temperature and moisture in the microbial habitats.
2. At the scale of ***populations***, activity is determined by the amount of habitat diversity, the type of habitat disturbances, and the diversity and interactions of various soil populations.
3. At the scale of ***biological processes***, functions such as nutrient cycling are affected by the interaction of biological populations with physical and chemical soil properties.

EXAMPLE: Effect of tillage on earthworms at each scale.

- At *individual* organism scale: Single tillage event could kill as many as 25% of individual earthworms.
- At *population* scale: Single tillage pass may have little effect after a few months as the earthworms reproduce and rebuild the population.
- At *soil processes* scale: Tillage will weaken the soil structure over time and reduce the amount of surface residue available to fungi and earthworms. As fungal and earthworm activity declines, soil stability declines and alters the microhabitats for all other soil organisms.

MICROSCALE FACTORS:

Environmental factors that affect activity levels may vary over a very short distance in the soil.
Each can be impacted by climate, soil texture, time of day, season of the year, management factors, etc.

FOOD – "Primary producers" use photosynthesis to make their own food from sunlight and CO2.

"Consumers" are organisms that use organic compounds as their source of both carbon and energy.
All soil organisms also require varying amounts of macronutrients and micronutrients.
Amounts and availability of all these nutrients and quality of nutrient sources will favor some organisms over others!

OXYGEN – Most soil organisms are obligate aerobes, meaning they require oxygen.

Some bacteria are obligate anaerobes, meaning they require oxygen-free conditions to function.
Many organisms are facultative anaerobes, meaning they can function either as aerobes or anaerobes depending on environmental conditions.

Aerobic respiration is the most common form of metabolism and produces more energy per unit.

PHYSICAL FACTORS – Moisture, temperature, light, pH, salinity, etc. are also factors that determine biological activity.

Each species has different optimal conditions. In general, bacterial activity is highest at temperatures between 68 degrees (F) and 104 degrees (F), pH levels between 6 and 8, and when pore spaces are 50 to 60% water-filled.

Porosity, aeration, and moisture levels are linked. Large organisms such as nematodes, require large pore spaces to move. Others, such as protozoa and smaller nematodes, are essentially aquatic and need water films present on and between soil structural units in which to move.