Soil Biology: The Life Below

Jessica Gigot Ph.D.
Science Faculty, Northwest Indian College
Owner/Operator, Harmony Fields
Food Sovereignty Summit
Green Bay, WI
April 2013
What is Soil?

- Physical properties
  - Structure, texture
- Chemical properties
  - Nutrients, water
- Biological properties
Soil Biology Overview

- Agroecology
- Soil Food Web
- Soil Organisms
- Nutrient Cycling
- Healthy Farm Soils
Agroecology

Farm Systems
• Resilient
• Low-Input
• Habitat
• Non-toxic
• Biodiverse

Jean-Francois Millet
Soil is Alive!

- The soil is an ecosystem
- A diversity of organisms live in soil or on plant roots exclusively
- Organic matter in soil feeds soil organisms
Soil Food Web

http://soilfoodweb.ca/about_us.html
Soil Food Web

- Web of organisms that live in soil
- Will vary by location and throughout soil profile
- Organisms feed off of organic matter

Clean Samish, WA Dept Ecology
Soil Organism Habitat

- Roots
- Litter
- Humus
- Soil particles
- Pore space

Food Sources

- Root exudates
- Fresh/dead plants
- Active organic matter
- Labile organic matter
- Other organisms
Complex Organic Matter

http://soils.usda.gov/sqi/
Soil Organisms?

- Fungi
- Bacteria
- Nematodes
- Arthropods
- Earthworms
Fungi

- Multicellular organisms
- Hyphae = micrometers
- Kingdom Fungi
- Mycelium and spores

Photo: B. Frey

http://soils.usda.gov/sqi/
Fungi

Role in Soil:
- Decomposer
- Mutualists
- Pathogens

http://mycorrhizas.info/ecm.html
Bacteria

- Single celled organisms
- 4/100,000 of an inch wide
- Prokaryotes
- Rod-shaped with various forms

Bacteria

Role in Soil:
- Nutrient cycling
- Disease suppression
- Water dynamics
Nematodes

- Microscopic round worms
- 1/500 of an inch
- Various food sources
- Identified by mouth shape
Nematodes

- Nutrient cycling
- Grazing
- Feed on various food sources
  - Bacterial feeders, fungal feeder, omnivores, predatory

http://faculty.yc.edu/ycfaculty/ags105/week10/soil_organisms/soil_organisms4.html
Arthropods

- Many different types of bugs
  - Millipedes
  - Centipedes
  - Beetles
  - Springtails
  - Mites
  - Symphylan
Earthworms

- 23 families
- Primary decomposers

Role in soil:
- Create soil structure
- Aggregate soil
- Nutrient cycling
- Shred plant roots
What are soil organisms doing?

- Transferring energy
- Ingesting nutrients
- Making nutrients available
- Creating soil structure
Nitrogen Cycle

http://www.microbiologyonline.org.uk
Carbon Cycle

http://www.microbiologyonline.org.uk
Determine soil quality

- High in organic matter
- Diversity of microorganisms
- Slow release of nutrients over time
- Needs organic matter inputs
- Reduced cultivation is ideal
Soil Organic Matter

- Soil organisms
- Soil type
- Organic matter inputs
- Tillage
- Crop rotation
Case Study: Communities

- Nematode communities → indicator
- Various food sources available
- Rapid and easy monitoring compared to fungi and bacteria
- Shift in community can indicate soil health changes
Nematode Community Research

[Diagrams of nematodes: Rhabditis, Diplogaster, Acrobeles, Mononchus, Plectus, Actinolaimus, Tylenchus, Rotylenchus, Criconema, Xiphinema]

[Pie chart: Plant parasites, Fungivores, Animal parasites, Bacterivores, Predators]

www.els.net, left; www.unl.edu, right
Case Study: Pathogens

- Pathogen → agent of disease
- Bacteria and Fungi
- Not all soil organisms are good
- Make sure you are not encouraging pathogens
Root rot

- Complex of soil pathogens
- Influenced by host genetics
- Environment/soil condition affect disease
- Create a “disease suppressive” soil
Developing a disease suppressive soil

Pathogen biology and ecology

Biocontrol mechanisms
- Antagonism
- Predation
- Exploitation
- Resistance

Integrated soil management
Healthy Farm Soils

- Unique and productive food web
- Control of soil pathogens and food pathogens
- Meets fertility needs
• Food Seminars
• Sustainable Gardening
• Western food crops
• Native plants and medicine
• Student & Group Projects
• Blog
  13moonsgarden.wordpress.com
Soil biology review

- Soil Food Web
- Soil Organisms
- Nutrient Cycling
- Healthy Farm Soils
Questions?