Diverse Soil Structure
Is Divers Habitat!

B – Bacteria
A – Actinomycetes
My – Mycorrhizae
H – Saprophitc fungus
N – Nematode
CP – Ciliate protozoa
FP – Flagellate protozoa
M – Mite

< 1mm
Soil Structural Stability - particles held & “glued” together

Disturb soil as little as possible!
Effect of OM on structure stability

Before wetting

High O.M.  Low O.M.

After wetting

High O.M.  Low O.M.
Soil is habitat!
Soil Microhabitats

Everything is everywhere and the milieu selects — Martinus Beijerinck
How biota diameter relates to particle size and pore size?

- Microflora and microfauna are similar in size to fine sand and clay.
It's their world!

Live in the tiniest pores in soil

We just die in it!
Nematodes

 Protozoa

 Microfauna

Live in small pores in soil

20-200 kg/ha!
Microfauna

Protozoa

- Most abundant of all soil \textit{fauna}
- One-celled
- Feed on bacteria (live and move in water films)
- Up to 30\% of all mineralized N from protozoa
Mesofauna
Live in medium size pores in soil
Mesofauna

- Heterotrophs (detritivores, predators)
- Feed on fungi, protozoa, nematodes, mites
- Important in regulating populations of everything smaller
pseudoscorpion

Mesofauna
Worms

Voles!

Live in large pores in soil

Macrofauna
“It may be doubted whether there are many other animals which have played so important a part in the history of the world, as have these lowly organized creatures.” Charles Darwin 1881
# Earthworm casts vs. soil

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Earthworm casts</th>
<th>Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>% silt &amp; clay (gizzard action)</td>
<td>38.8</td>
<td>22.2</td>
</tr>
<tr>
<td>Bulk density</td>
<td>1.11 g/cm³</td>
<td>1.28 g/cm³</td>
</tr>
<tr>
<td>Structural stability</td>
<td>849 (raindrops)</td>
<td>65 (raindrops)</td>
</tr>
<tr>
<td>CEC (cmolₖ/kg)</td>
<td>13.8</td>
<td>3.5</td>
</tr>
</tbody>
</table>

From Table 10.4 of text

Worms increase availability of mineral nutrients to plants by:

1. Physical/chemical breakdown organic materials
2. Bioaccumulation: Collect, concentrate, & assimilate nutrients into their body tissue
Fungi – tens of thousands of spp.

- The major agent of decay in acid envrons
- Network of hyphae: improves soil structure
- Decomposition of cellulose!!!
- Can compete with higher plants for N
Aggregates held together by:

1. Fungal hyphae
2. Bacterial “glues”
3. Organic matter
Fungi – tens of thousands of spp.

- The major agent of decay in acid environs
- Network of hyphae: improves soil structure
- Decomposition of cellulose!!!
- Can compete with higher plants for N

- Chemo Heterotrophs – energy and carbon from dead or living biomolecules (trap nematodes!)
Fungi – tens of thousands of spp.

- The major agent of decay in acid environs
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Chemo Heterotrophs – energy and carbon from living (trap nematodes!) or dead biomolecules
- 3 groups, yeast, mold, mushrooms
- Mycorrhizae - symbiotic relationships with most plants
- Produce chemicals that are toxic (or otherwise...)
ONIONS
ON547 Copra Hybrid
STORAGE ONION
104 days. A great storage onion! A medium sized, round, dark yellow type with ivory flesh. Stays flavorful stored up to 7 months. Sampler / 1 gram
$1.95 - Packed for 2003

ONIONS Allium cepa
SCALLIONS Allium fistulosum
Sowing Indoors-Start up to 100 seeds in a 4-6 inch pot. Place in a warm location and keep moist. If you cannot transplant outside before the tops reach 5 inches, then cut back the tops to 3 inches.
Sowing Outdoors-Direct-sown crops will be more uniform. Sow when soil temperatures are at least 55°F.
Growing Tips-Thin bulbing onions 5-7 inches between plants and bunching onions 2 inches between plants.
Fertilization Tips-Before transplanting or seeding, apply 1/3 cup of our blended organic fertilizer per 5 row feet.
Mycorrhize inoculant (see our catalog) may help produce larger bulbs.
Insect Prevention Tips-Because onions have a pungent odor, they repel many pests that may visit your garden. Many gardeners integrate onions throughout their garden for this reason.
Seed Specs-Min. germ. standard: 75%. Usual seed life: 1 year.
Some varieties are suitable for winter gardening. See winter catalog.

Territorial Seed Company
P.O. Box 158, Cottage Grove, Oregon 97424

Phone orders and catalog requests: 541-942-9647
Fax orders: 888-657-3131
Web site: http://www.territorial-seed.com
N capture (mycorrhizal fungi)
(Fungus Root)

- Soil fungi that form symbiotic relationship with plant roots
- Extend root surface area for uptake of nutrients
  - Fungus transfers nutrients (N,P,K) to plant
  - Especially important for phosphorous uptake because it is immobile in the soil
- Plant provides fungus with carbon (root exudates)

Mycorrhizae “infecting” a plant root and extracting nutrients from rock particles.
Crops with mycorrhizal associations

- onions
- corn
- cotton
- wheat
- soybeans
- potatoes
- alfalfa
- sugarcane
- cassava
- rice
- most vegetables
- beets
- apples
- grapes
- citrus fruit
- trees (lumber and fiber)
- cacao
- coffee
- rubber

Oregon industries: Wine! Christmas trees!
Cost to plant – 5-10% of photosynthate production
Benefit to plant - 10X the absorptive surface

Cost to Mycorrhizae – nutrient shuttle to plant
Benefit to Mycorrhizae – get sugars directly from plant
Douglas Fir Trees with and without mycorrhizae inoculation

(without)

(with)
Bacteria – 1 billion -1 trillion/g soil (up to 20,000 spp.)

• Exist in both forest and grassland soils
• Aerobic, anaerobic, and facultative forms
• Autotrophic and heterotrophic forms
• Most do best under high Ca\(^{2+}\), high pH
• Do best when soil temp 20-40C (68-100F) but seldom killed by temp extremes
**Actinomycetes** - fungus-like, *filamentous* bacteria, huge numbers in soil; second only to “regular” bacteria

- Historically classified as fungi - misnomer
- Specialized group of soil bacteria - (unicellular, no nuclear membrane)
- **Aerobic heterotrophs** – decompose OM – humus-forming, also parasitic/symbiotic relationships with some plants
- Produce antibiotic compounds to competition etc. (side benefit – Actinomycetes drugs e.g. streptomycin)
- Super resistant to hostile environment
- Sporulate – smell “good” after rain

![Diagram of the nitrogen cycle with Sun, Producers, Decomposers, Consumers, and Humus]

geosmins - dimethyl-9-decalols
Filamentous bacteria which produces the antibiotic, Streptomycin.

Thanks bacteria!!!

Bacteria and N fixation
Types of Biological Nitrogen Fixation ($N_2$ from atmosphere)

Free-living (asymbiotic)
- Cyanobacteria
- *Azotobacter*

Associative
- Rhizosphere—*Azospirillum*
- Lichens—cyanobacteria (with fungi)
- Leaf nodules

Symbiotic – nodule forming
- Legume-rhizobia
- Actinorhizal-*Frankia*
Nodulation in Legumes

Frankia – alder trees
Rhizobia – legumes
Complex, mutually beneficial relationships
Soil Food Web

(See also Fig 10.2 in text)

Read pages 240-246
The diagram illustrates the flow of energy and nutrients in an ecosystem. The primary producers, such as plants, algae, lichens, and bacteria, capture solar energy and produce plant debris (detritus). This debris is decomposed by saprophytic fungi and actinomycetes, which release nutrients back into the soil. The mineral nutrients are essential for the growth of primary producers. Heat energy loss is also depicted, indicating the dissipation of energy in the system.

The soil fauna, including earthworms and other shredders, feed on the plant debris, breaking it down further. Feaces and dead bodies of soil fauna are degraded by bacteria, fungi, and actinomycetes, releasing nutrients back into the soil. Some of these nutrients are used by primary producers for growth.

Secondary consumers include organisms such as nematodes, mites, springtails, and earthworms, which feed on the decomposed plant debris and other soil fauna. Their role is crucial in maintaining the balance of the ecosystem by controlling the population of primary consumers.

Higher level consumers are at the top of the food chain, including mammals and birds, which feed on the secondary consumers and other prey. The diagram highlights the intricate web of interactions and dependencies within the ecosystem, emphasizing the importance of each component in maintaining ecological balance.
Soil is habitat!
Soil!