Soil Food Web: The Soil Ecology of who eats who and their relationship with plant roots
Ideas worth spreading

Rob Knight

Jonathan Eisen
“The plant you see above ground is actually in a complex symbiosis with the soil microbes in the root zone (rhizosphere). If you don’t know what organisms are present in your soil and on your plant leaves, much of your soil and crop management is being left to chance”

Dr. Elaine Ingham, 2004
President, Soil Food Web Inc.
Corvallis, OR
The Quality of the compost is all about the LIFE

We want Aerobic conditions to maintain that life
The Soil Food Web

Nematodes
- Root-feeders

Arthropods
- Shredders
- Predators

Fungi
- Mycorrhizal fungi
- Saprophytic fungi

Nematodes
- Fungal- and bacterial-feeders

Protozoa
- Amoebae, flagellates, and ciliates

Bacteria

Plants
- Shoots and roots

Organic Matter
- Waste, residue and metabolites from plants, animals, and microbes

First trophic level:
- Photosynthesizers

Second trophic level:
- Decomposing Mutualists
- Pathogens, Parasites
- Root-feeders

Third trophic level:
- Shredders
- Predators
- Grazers

Fourth trophic level:
- Higher level predators

Fifth & higher trophic level:
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Animals

Birds
**Salivary Glands**
These produce a **CARBOHYDRASE** enzyme called **SALIVARY AMYLASE**

**Stomach**
1) It **PUMMELS THE FOOD** with its muscular walls.
2) It produces the **PROTEASE** enzyme.
3) It produces **HYDROCHLORIC ACID** for two reasons:
   a) To **kill bacteria**
   b) To give the **right pH** for the protease enzyme to work (pH2 - acidic).

**Oesophagus**
Your gullet.

**Sphincters**
*Rings of muscle* which are squeezed shut most of the time.

**Liver**
Where **BILE** is produced.
Bile **EMULSIFIES FATS** and neutralises stomach acid (to make conditions right for the enzymes in the small intestine).

**Gall bladder**
Where **bile is stored**, before it’s injected into the intestine.

**Pancreas**
Produces all three enzymes: **PROTEASE, CARBOHYDRASE** and **LIPASE**.

**Large intestine**
Where **excess water is absorbed** from the food.

**Rectum**
Where the **faeces are stored** before they bid you a fond farewell through the anus.

**Small intestine**
1) Produces all the three enzymes: **PROTEASE, CARBOHYDRASE** and **LIPASE**.
2) This is also where the "food" is **absorbed into the blood**.
3) The inner surface is covered with **villi** to **increase the surface area**, it’s also very long.
Have to go under the microscope, can't use certain testing methods. Plate counts, etc.
The biology lives in the root zone of plants

The RHIZOSPHERE area around the root of the plant is the most active area for biological activity.

This is where the SOIL PARTY is taking place!
80% of what is going on is below ground in the roots.

Not 80% of the root mass, but 80% of the plant’s energy.

Photosynthesis and reproduction use only 20% of the plant’s total energy.
There is a soil party going on!

A teaspoon of good garden soil contains billions of microbes that were only recently discovered.

These microbes make the soil a sponge and also cycle nutrients so plants can thrive.
Plants are in control of who attends the SOIL PARTY

Plants send out “Invitations”
Party Guest #1
Bacteria!

- First to arrive or wake up with water
- No feet, so needs a taxi
- Decomposers eat and cannot release
Biological Nitrogen Fixation
FUN GUYS!
Fungi

✓ Recognized above ground as mushrooms (flowers)

✓ Pre-eminent powers of decomposition

✓ Specialized fungi called mycorrhizae form partnerships with tree roots.
David Reid

Ecto-Mycorrhizal fungi on pine seedling

How much more of the soil can the plant get nutrients from?
Stable Carbon Sequestration
Party Guest #2
Protozoa!

- Love to eat bacteria
- Amoebae, Flagellates and Ciliates
- Swim around rapidly
- Eating bacteria releases nutrients into soil
Party Guest #3
Nematodes!

✓ Love to eat bacteria & protozoa

✓ Swim vigorously

✓ Create plant available nutrients
Party Guest #4
Organic matter!

✓ 'control box' of nature's nutrient cycle

✓ plant remains on the soil surface are broken down by microorganisms to form organic matter

✓ nutrients within are transformed to an available form by the many soil organisms and chemical processes in the soil
Party Animals
- Earthworms

- Well known soil aerators - dig deep into clay soil
- Break down dead organic matter – decomposition
- Positive interactions with bacteria & fungi.
Predators
Plant eaters
Soil aerators

Party Animals - Insects, mites

Ground Beetle
Orabatid mite
Sow Bugs

Ants
Millipedes
Good soil biology builds:

- a plant defense shield
- sequesters carbon
- holds water in root zone
Tilling or Plowing the soil is the equivalent of an earthquake, hurricane, tornado and forest fire occurring simultaneously to the world of soil organisms.

The United States Department of Agriculture, 2010
Bacteria:Fungi Ratio

- Bacteria dominated
  - Alkaline
  - Nitrates
- F:B balance
  - Neutral pH
  - Nitrates/Ammonium
- Fungi dominated
  - Acidic
  - Ammonium

Vegetation:
- conifer old growth
- deciduous
- shrubs
- crops
- vegetables
- early grasses
- weeds
What can a Forest teach us?
Soil Types

**Sand** - largest particle in the soil. does not hold many nutrients.

**Silt** - soil particle whose size is between sand and clay. when wet it feels smooth but not sticky.

**Clay** - smallest of particles. smooth when dry and sticky when wet. holds a lot of nutrients. does not let air and water pass through it well.
Aggregation
Macro Elements
N - Nitrogen
P - Phosphorous
K - Potassium

Secondary Elements
Ca - Calcium
Mg - Magnesium
S - Sulphur

Micro Elements
Fe - Iron
B - Boron
Zn - Zinc
Cu - Copper
Mn - Manganese
Mo - Molybdenum
# pH of Common Substances

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- **Battery Acid** (Hydrochloric)
- **Stomach Acid**
- **Lemon Juice**
- **Vinegar**
- **Coke and Pepsi**
- **Grapefruit and Orange Juice**
- **Apples, Dr. Pepper Soda**
- **Tomato Juice, Beer**
- **Acid Rain, 7-UP Soda**
- **Black Coffee, Pepto Bismol**
- **Healthy Skin, Hair and Nails**
- **Urine, Saliva, Milk**
- **"Pure" Water, Blood**
- **Shampoos (7.0 to 10.0)**
- **Baking Soda, Seawater, Eggs**
- **Perm Solutions (6.5 to 9.5)**
- **Toothpaste, Hand Soap**
- **Milk of Magnesia, Mild Detergent**
- **Household Ammonia and Cleaners**
- **Soapy Water**
- **Hair Straighteners (11.5 to 14.0)**
- **Bleach, Oven Cleaner**
- **Liquid Drain Cleaner, Caustic Soda**

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✓ Have flagella and swim around

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- weeds
- early grasses
- vegetables
- crops
- shrubs
- deciduous
- conifer old growth
How do we encourage a soil party?

Create opportunities for oxygen

Add organic matter (compost)
Compaction

Well-structured soil

Compacted soil

Sponge or Brick
Minimal Disturbance
Soil Health is a lot like Human Health.

If your sick, you can take a pill for your problem, but maybe you need to exercise or change your diet a bit.
We take away....
…we Must give back!
So.....
what exactly is compost??
Carbon (Browns)
Nitrogen (Greens)
Water
Air
Worm Poop
What else can we do with top notch compost and vermicompost??
What about Fertilizers and Pesticides?
C:N = 25-30:1

Bacterial
20% High N
45% Green
35% Woody

C:N = 35-40:1

Fungal
15% High N
35% Green
50% Woody
What's the deal with Plants Anyway?
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Let’s look at a more down graded solution
This is your Potato......
This is your potato ..... on scab
Jerremie and Rita Clyde

Once flowering, keep your soil moisture at 50% holding capacity. Dry, wet, dry, wet, this is not good

Rotate every two years, never go more then 3.

Good Seed, “I like to use John Mills from Eagle Creek”

Scab resistance varieties: Cheiftan, Norland, Viking, Gold Rush and Russet Burbank

Sunning your seed and don’t cut them in half if you don’t need to
The Soil Food Web

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  - Mycorrhizal fungi
  - Saprophytic fungi

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Tuesday, September 20, 2011
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Worm Poop
What else can we do with top notch compost and vermicompost??
Living Soil Solutions

Mike Dorion
“The Compost Kid”
mike@livingsoil.ca
403-605-6669
www.livingsoil.ca

Like us on the ol Facebook to stay in the know!
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