Understanding the Unsung Heroes: Soil Microbes

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The Dream

**To grow plants
without any
fertilizers, pesticides or irrigation
and protect water quality!**

How plants grow in natural areas

- **Insects and diseases eliminate stressed, unhealthy plants.**
- **Weeds are the 1st step to improving poor soil.**
- **Organic matter (OM) stays in the area.**
- **Soil food web (SFW) activities are directed by the plant.**

Yard "trash" bin

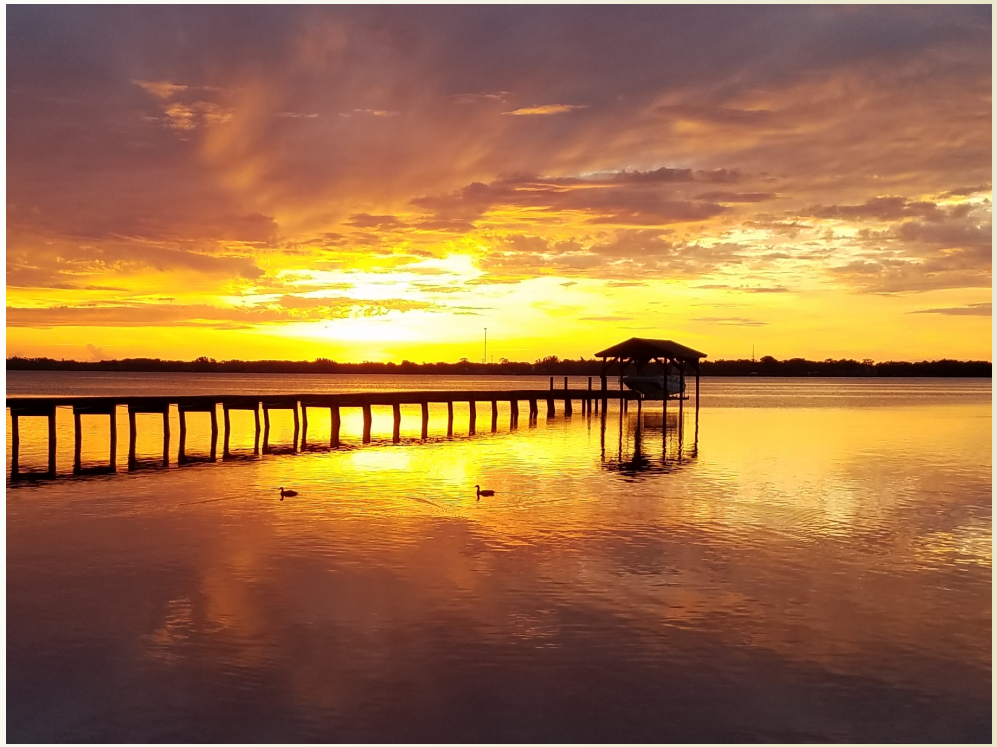
What about weeds?

- Indicates anaerobic soil dominated by bacteria.
- Use of synthetic fertilizers and pesticides will not change dirt into soil.
- Until dirt is inoculated with the SFW, weeds will continue to grow.

Native Spanish needles, *Bidens alba*

SFW services

- Nutrient cycling
- Create OM
- Build soil structure
- Protect plants from insects & diseases
- Protects water quality



Sunrise on the Indian River Lagoon (IRL)

SFW nutrient cycling

- Protozoa & nematodes are predators.
- Releasing nutrients & water for the plants to absorb.
- This is nature's "fertilizer"!

Bacteria eating nematode

Predatory nematodes

- Favorite food are root-eating nematodes!
- Nutritional deficiencies – lack of predators.
- Nematodes are ID by their mouth.

Sign of magnesium deficiency

In nature's garden…

- The plant's in charge of its own destiny.
- Imagine how easy our job could be!

Firebush, *Hamelia patens*, and a bumblebee

How plants control their destiny

- Plants are always throwing a party.
- A plant will share 10-40% of its root exudates.
- When food is served, the microbes come to the rhizosphere - if they're still alive!

Bacteria and fungi at 400x magnification

Plants are smart….

- Exudates of simple sugars for bacteria & complex foods for fungi.
- Bacteria create alkaline glues, lowering the pH.
- Fungi create more acid soils.
- pH levels can vary throughout the root system.

The base of the SFW are bacteria & fungi.

Fungi to Bacteria (F:B) Ratio

- The F:B ratio determines the plants that are selected for.
- Biology supplies the nutrients best.
- There's no waste (leaching) of nutrients which protects water quality.

As the plant community…

- Perennial, woody plants, more fungi will be in the soil.
- Trees are mycorrhizal dependent!
- 2 types - endo and ectomycorrhizae.
- Ectomycorrhizae are symbiotic with ~2-5% of plants - <u>evergreen</u> woody plants.

Ectomycorrhizae near an olive and crape myrtle tree

Endomycorrhizae

- **Symbiotic with ~85% of plants, herbaceous plants (most vegetables, row crops, etc.) and deciduous woody plants.**

***Glomus intraradices* help St. Augustinegrass grow better!**

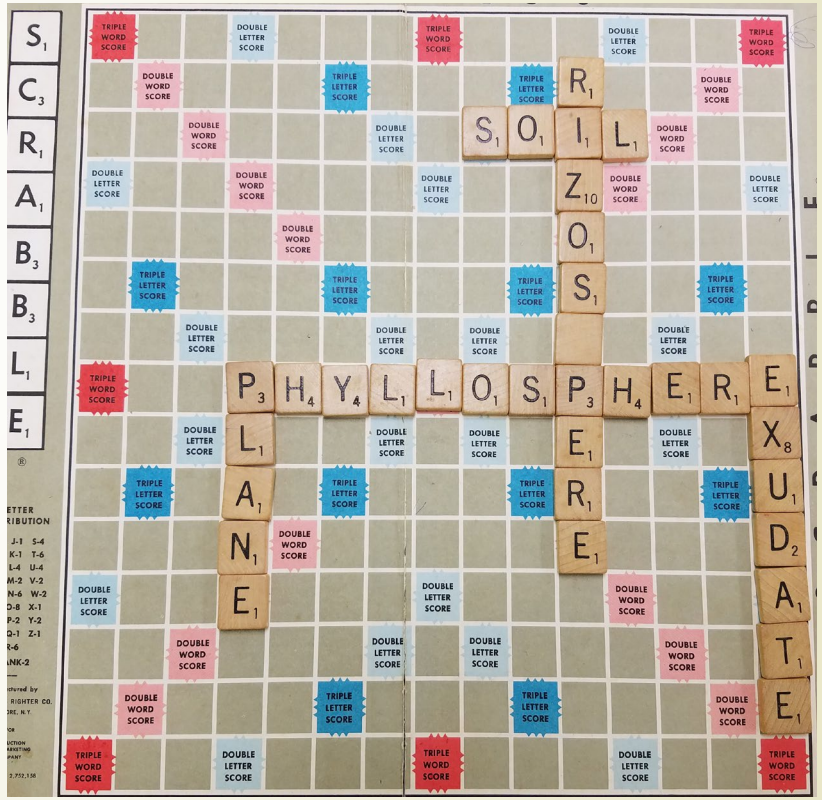
Mycorrhizae

- Gathers nutrients, especially phosphorus, and water.
- Reaches a much larger area of soil than roots can.
- Provides complete, balanced set of nutrients on an as-needed basis.

Ectomycorrhizal fruit body in asphalt parking lot!

Soil Food Web

- Also found over all plant surfaces (phyllosphere)
- Including the foliage (phylloplane)
- Stem (caulosphere)
- Flowers (anthosphere)
- Fruit (carposhere)



Nutrient cycling also occurs on the plant surfaces.

Free pest control

- **If at least 70% of the phyllosphere is covered by the SFW, there will be no issues with insects or diseases.**

Native elderberry, *Sambucus nigra* subsp. *canadensis*, with aphids

What is dirt?

- What remains after the SFW is destroyed.
- Weeds, diseases and insect problems are indicators of dirt.

Soil disturbance kills the SFW!

Human practices

- Tilling/plowing
- Synthetic/inorganic fertilizers (salts!)
- Pesticides
- Hardpan (see below)
- Compaction*

Anyone have heavy clay soil?

Natural causes

- Flood
- Fire
- Mud/landslides
- Hardpan
- Tsunami
- Volcanic eruption

As agriculture evolved…

- We had no way of knowing the soil microbes existed.
- Last century was considered the century of chemistry.
- This century is the century of microbiology.

Nematode trapping fungus

SFW needs aerobic conditions

- If anaerobic conditions occur rapidly, they die.
- If anaerobic conditions occur slowly, the microbes go into a resting state to survive.

Talk about disturbance/compaction

- Construction sites are excellent examples of maximum soil disturbance.
- Disturbance makes the successional process go backwards.

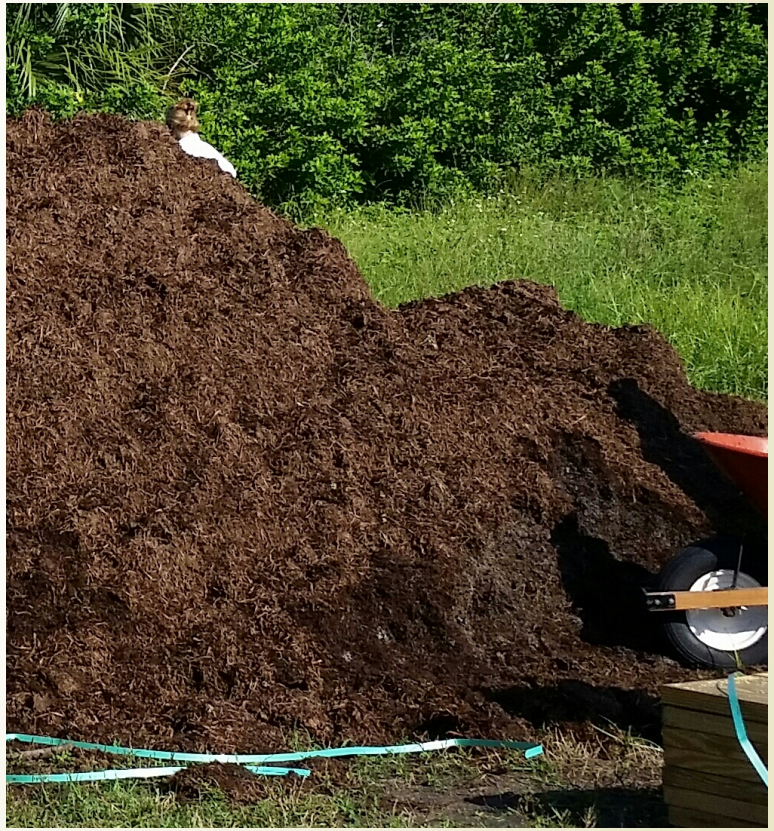
Ways to re-establish the SFW

- Thermal composting
- Vermicomposting
- Compost tea
- Compost extract

European red wigglers are our friend

Why compost?

- To grow the correct SFW.
- Organic matter is good, but not enough.
- Without the SFW, the OM will eventually disappear.
- The SFW is what transforms dirt into soil.



Mushroom compost is organic matter

Thermal composting basics

- Minimum 3’x3’ pile.
- % of ingredients determine the F:B ratio.
- Green foods for bacteria.
- Brown foods for fungi.
- High N foods heat up the pile.
- Manure must be composted before using.

Beware of compost units with sides & lids

Compost ingredients

- 10% high nitrogen to heat up the pile.
- 30% green plant material for the bacteria.
- 60% woody/brown material for the fungi
- Monitor temperature – (i.e. REOTEMP, etc.)

5–gallon buckets work great additional info. in handout

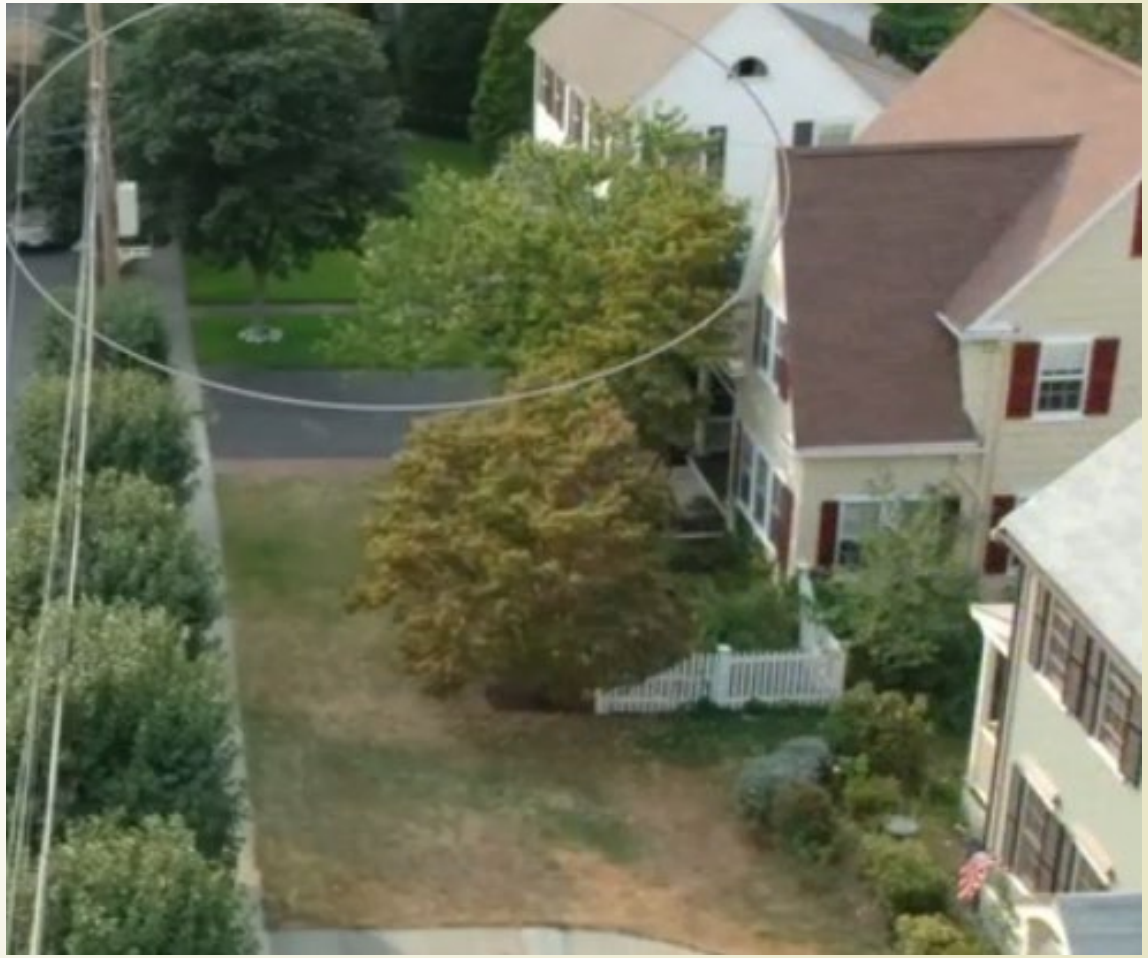
Mixing the ingredients

- Mix ingredients on a tarp.
- Work in batches - 1 bucket high N, 3 green and 6 of brown.
- Moisten the material to ~50% moisture.
- Pitchfork the materials into the wire ring.
- Continue until all mixed and added.

To test moisture level, just a little water should be squeezed out

How much compost?

- Only 10 lbs. of compost was needed to inoculate this 7,500 ft^2 yard.
- Or 1 ton per acre.
- Fungi are lacking the most in agricultural soils.



Vermicomposting

- **European red wigglers, *Eisenia fetida*, are best because they live in the leaf litter.**
- **Feed them food scraps, <u>green plants and brown/woody materials</u> .**
- **Best if the bin <u>doesn't</u> produce worm "tea".**

Red wigglers from Doc's bait store on Merritt Island

Worm castings are great

- Contain a variety of nutrients.
- Contain soil microbes.
- Great source of organic matter.
- Did you know - worms eat the microbes on the food & not the food.

Compost Tea

- Brewed for 28-48 hours.
- Foods needed to build the populations of beneficial microbes.
- Great for disease control.
- Thorough coverage of the underside of the leaf.
- Bacteria produce lots of glues and will stick anywhere.

Must stay aerobic entire time

Compost tea

- Bacteria reproduce the quickest, every 20 minutes.
- Fungi reproduce every 1-3 hours.
- Protozoa reproduce every 8-12 hours.
- Use a microscope to make sure that the good guys are there, in high enough numbers.

Xtreme Gardening Tea Brews

When to spray compost tea

- For annuals, when first set of true leaves are produced.
- The second spray is one month later.
- The third and final spray is one month after that.

Spraying compost tea on perennials

- 1st spray is when the buds swell in the spring.
- 2nd spray is one month later.
- 3rd spray is one month after that.
- What drips will benefit the soil.

Compost extract

- A pound of compost is placed in a compost bag.
- Then placed in a bucket of rainwater.
- The bag is briskly massaged for 20-30 minutes.
- This removes the microbes from the compost.
- The solution can be sprayed or poured immediately on the soil.

What if you don’t compost?

- Use organic fertilizers.
- Don’t use pesticides. Try ATTRA website.
- Purchase products with beneficial microbes.
- Apply worm castings regularly.

Bushdoctor’s Kangaroots

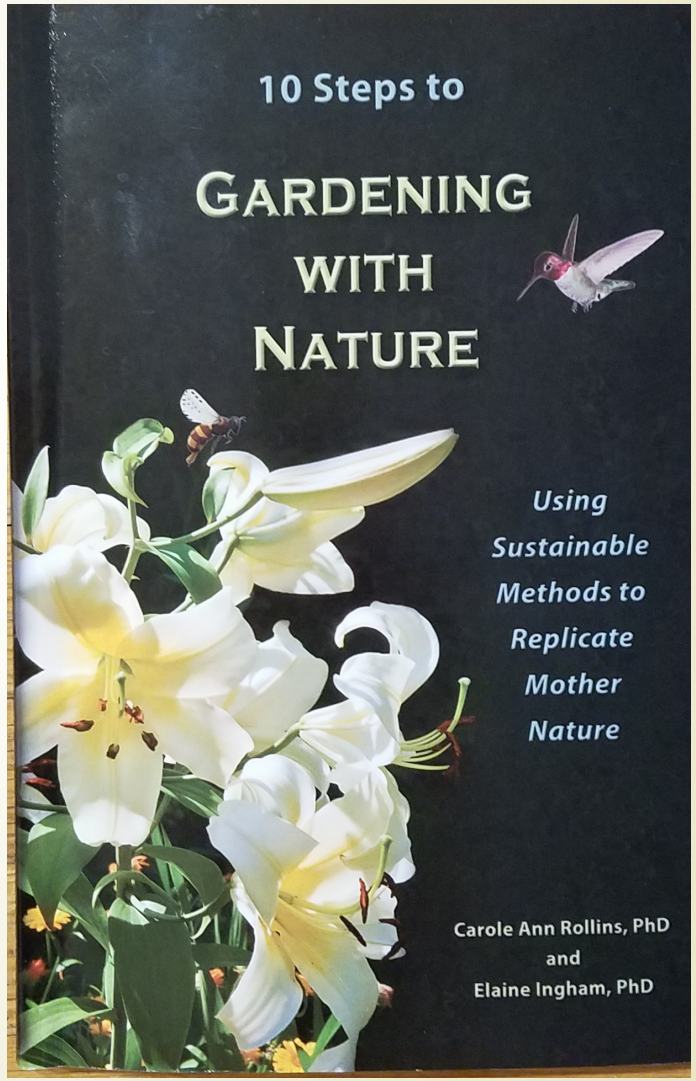
Other practices to adopt

- Increase diversity of plants in lawn and landscape beds.
- Keep soil disturbance to a minimum.
- Keep the soil covered with plants, mulch, etc.

The more living roots, the more exudates for the SFW

10 Steps to Gardening with Nature

This is the book that started me on this fascinating journey



Any Questions?

We must do things differently to get different results!