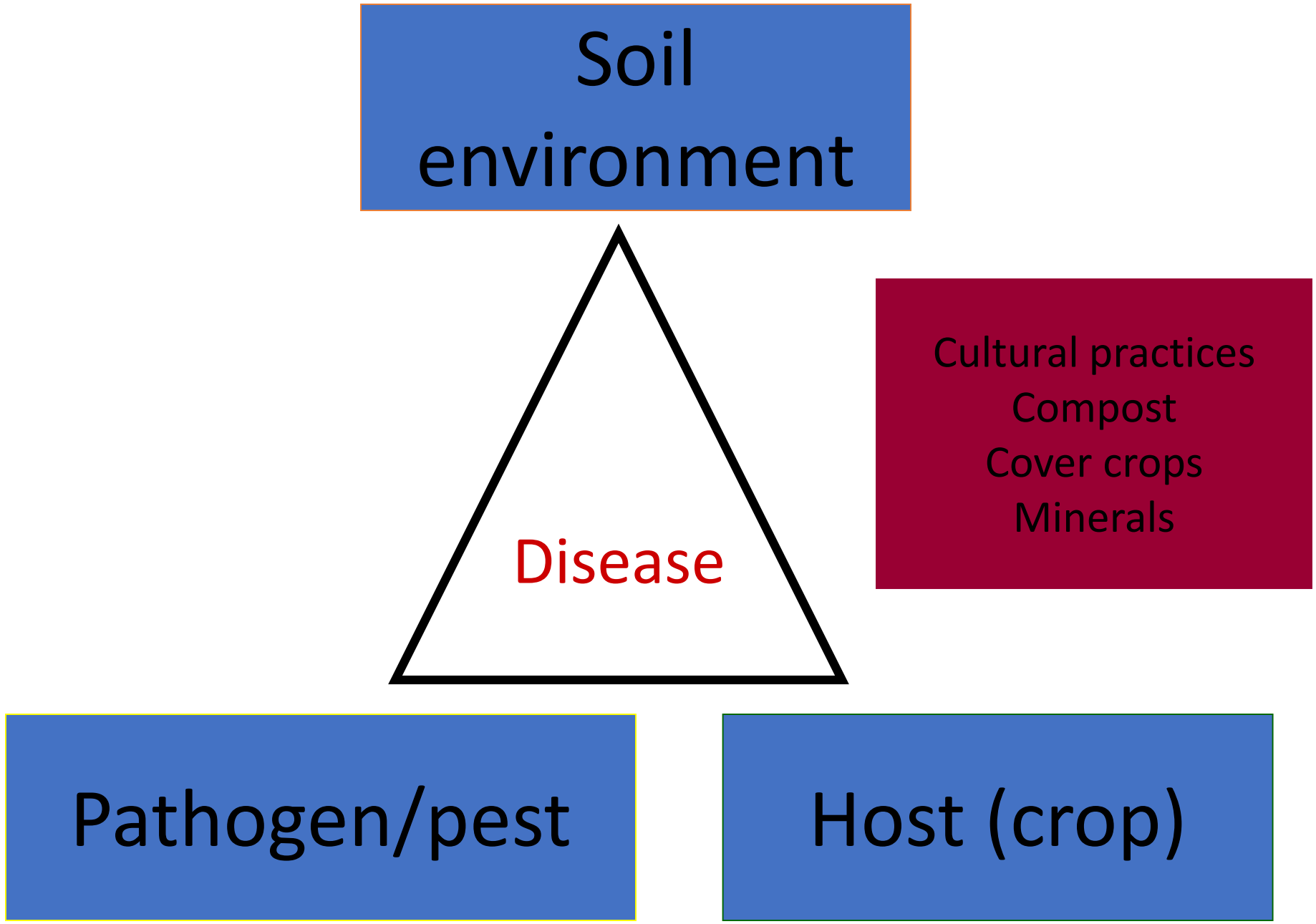
BIOLOGICAL FARMING SYSTEMS

PHILOSOPHY

PRINCIPLES

PRACTICES

PRODUCTS


Soil environment
Disease
Cultural practices
Compost
Cover crops
Minerals
Pathogen/pest
Host (crop)

- Feeding the soil not the plant
- Food for soil is far different than plant food
- Feeding soil also produces soil physical benefit and traps carbon….and feeds plant

- Object is to feed plants by the soil health
- Object is to grow plants to recycle minerals
- Object is to use minerals to grow plants


WALLENSTEIN
MX 80

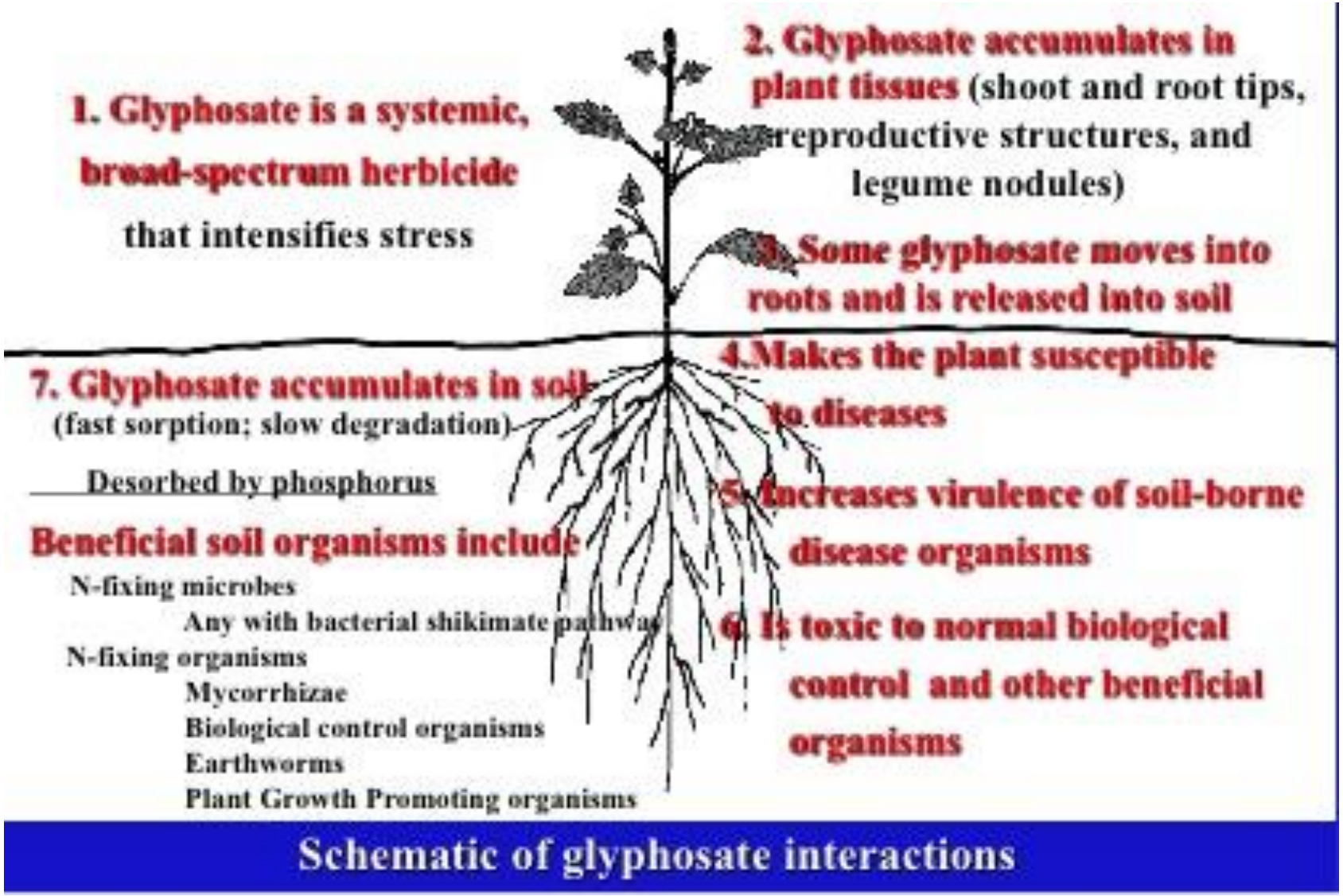
Cultural practices synergistic in prevention of disease and elevating food quality

- Organic matter management
- Humus development is KEY to agroecological sustainability and food quality
- Soil compaction prevention and erosion prevention is KEY to agroecological sustainability
- Cover crops create SOM and humus, decrease tillage and herbicide use, increase mineral availability
- Compost is high % humus, chelated and complex minerals, secondary metabolites, fungi
- Mineral balance in soil
- Biological, chemical and physical benefits to soil
- Plant biomass is greater above and below ground
- Rotation
- diversity of plants & practices over time and space

How much soil biology is there in productive soil?

		Normal Ag Soils	Healthy Soils	Rhizosphere
Total bacteria	#/g.	1,000,000	600,000,000	1,000,000,000,000
Bacterial Species	#/g.	5,000	25,000	25,000
Total Fungal biomass	ug/g.	5	150	300-500
Fungal Species	#/g.	500	8,000	8,000
Protozoa	/tsp	1,000 or less	up to 1,000,000	up to 1,000,000
Nematodes - beneficial	/tsp	less than 100	Several hundred	500
Arthropods	/m2	500	up to 200,000	up to 200,000
VAM colonization		0	55%	55% - 85%

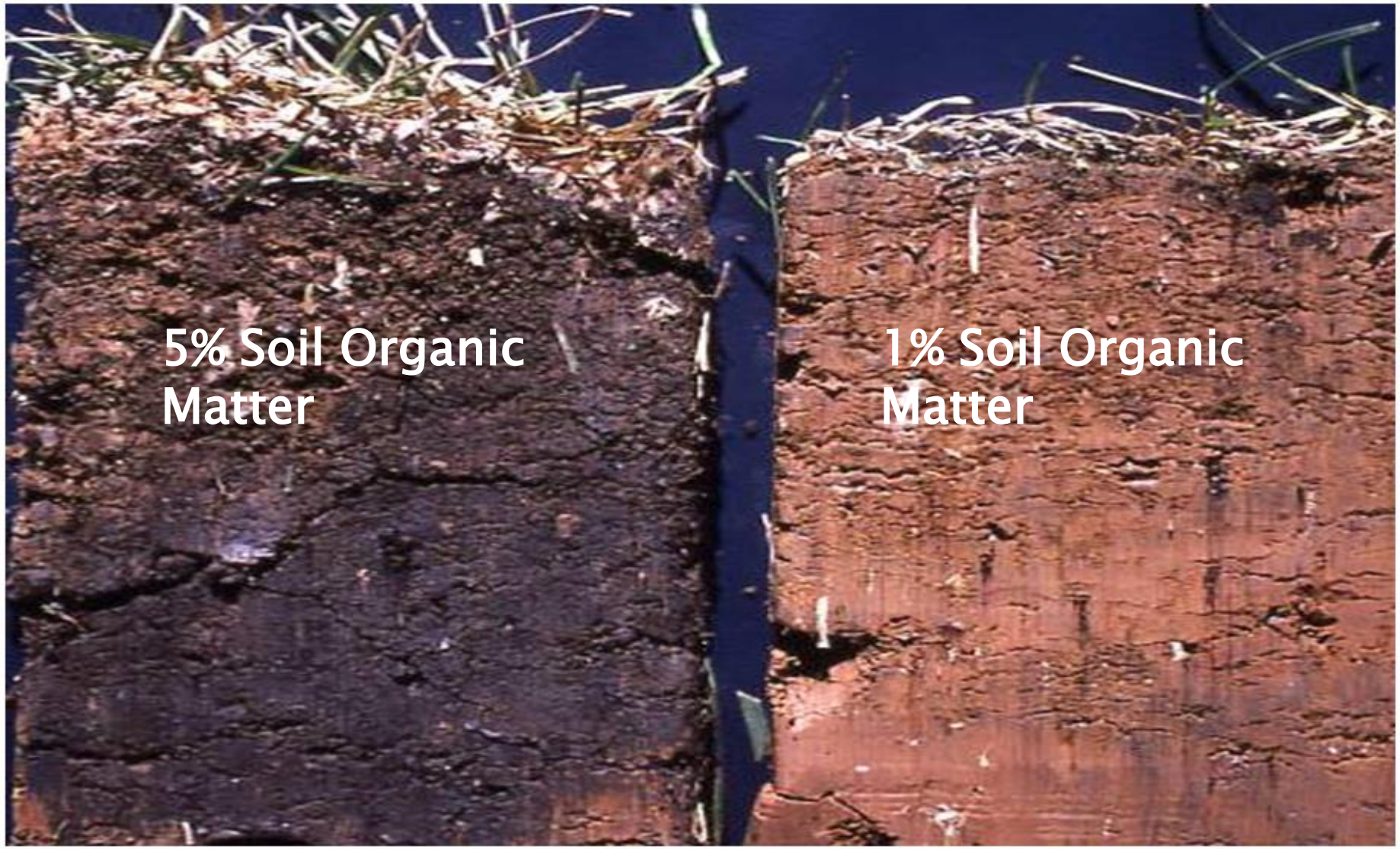
(Info provided by Soil Foodweb)


1. Glyphosate is a systemic, broad-spectrum herbicide that intensifies stress
2. Glyphosate accumulates in plant tissues (shoot and root tips, reproductive structures, and legume nodules)
3. Some glyphosate moves into roots and is released into soil
4. Makes the plant susceptible to diseases
5. Increases virulence of soil-borne disease organisms
6. Is toxic to normal biological control and other beneficial organisms
7. Glyphosate accumulates in soil (fast sorption; slow degradation)
Desorbed by phosphorus
Beneficial soil organisms include
N-fixing microbes
Any with bacterial shikimate pathway
N-fixing organisms
Mycorrhizae
Biological control organisms
Earthworms
Plant Growth Promoting organisms
Schematic of glyphosate interactions

HUBER 2010


SEEK
ALTERNATIVE
ROUTE
This work is being undertaken by
SEE Civil as part of Byron Shire Council's
Replace Five Bridges project

Remember Soil's Potential

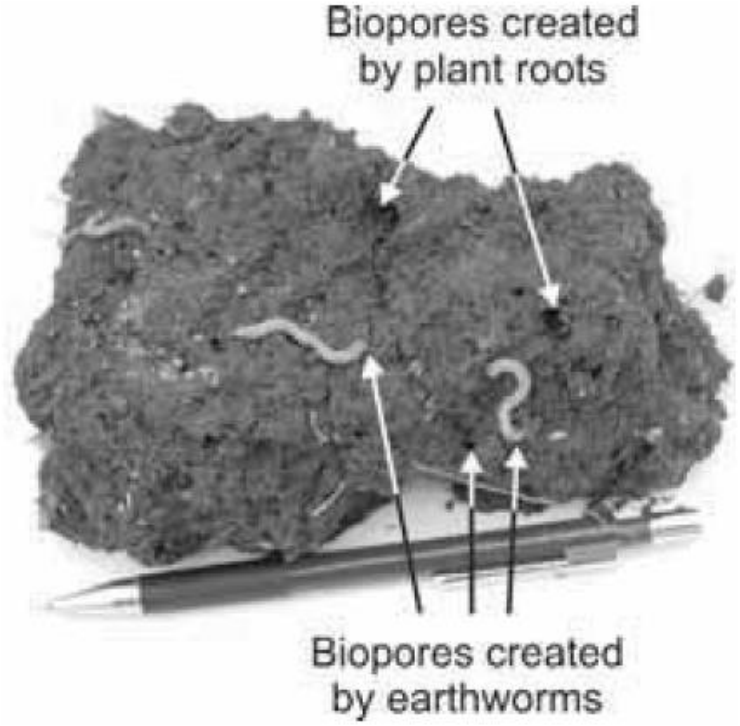


His ancestors accomplished soil improvements that modern science is trying to understand and replicate.

Plants and cultural practices

- **Beneficial soil microbes can INDUCE resistance due to rhizosphere produced, *secondary metabolites***
- **Acquisition of immunity/resistance AFTER initial wound from pathogen stress = PREVENTION**
- **Soil and biologically derived minerals protect and reduce pest damage.**
- **Calcium , Silicon , Potassium and Trace elements**
- **Oversupply of Nitrogen increases susceptibility to pests**

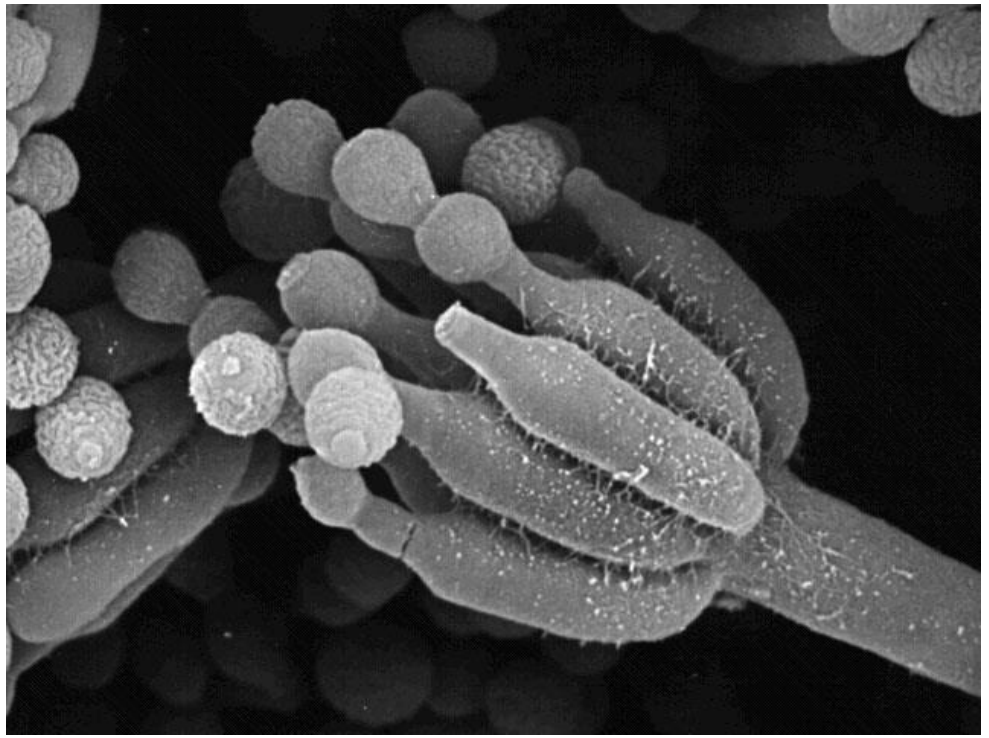
SOIL HEALTH CARD



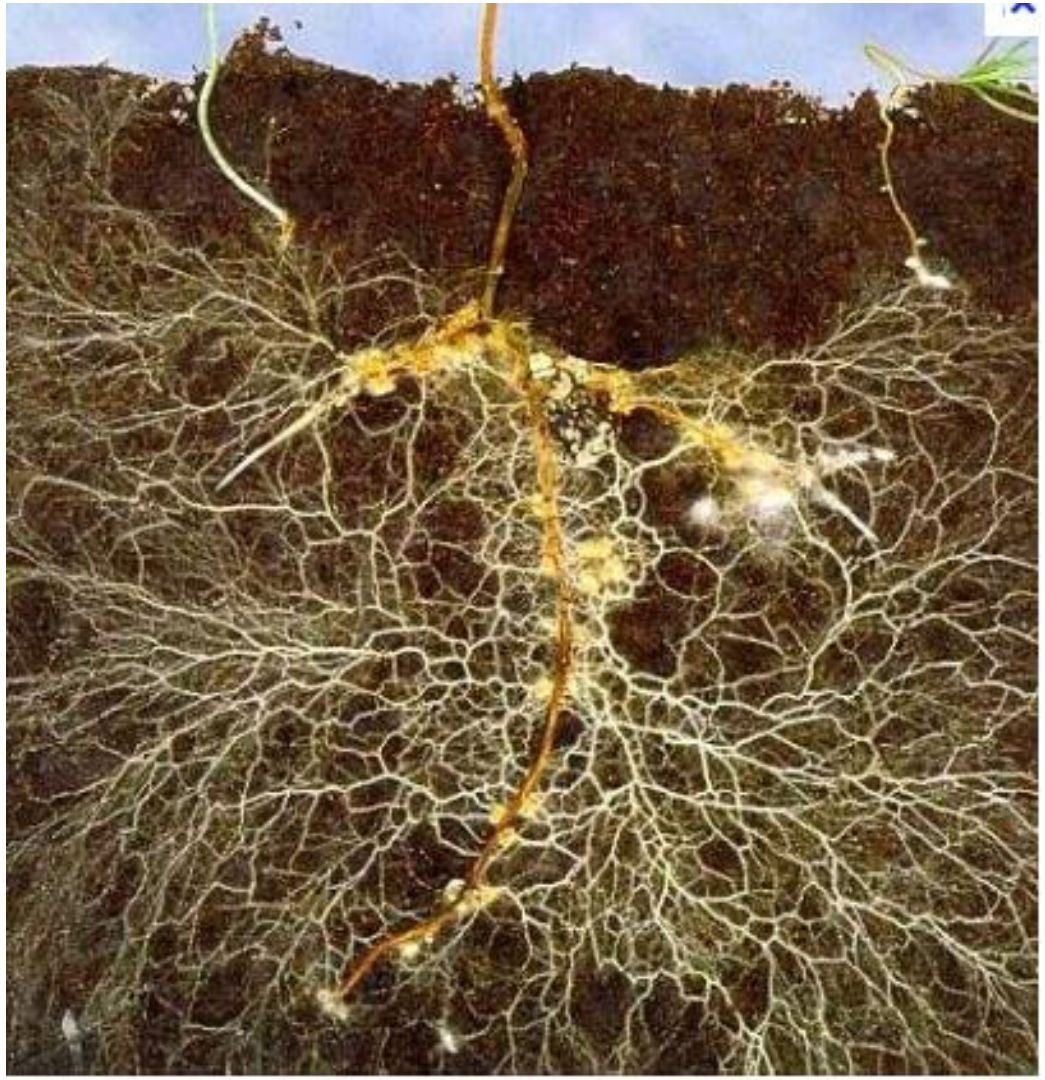
TOOLS:
BIOTURBATION
EARTHWORMS
DIVERSITY OF MACROLIFE
ROOT DEVELOPMENT
GROUND COVER

- IMPROVE SOIL NUTRITION
- LIFT HUMUS AND SOIL CARBON
- IMPROVE NUTRIENT HOLDING AND EXCHANGE CAPACITY
- IMPROVE PHOSPHATE UPTAKE AND AVAILABILITY
- MINIMISE ALUMINIUM AND MANGANESE TOXICITY

In order to understand how biology affects our soils - we need to understand a little about the organisms who live there



Mycorrhizae



CLAY AND ORGANIC MATTER HAVE GREATEST INFLUENCE ON CEC

Clay	Organic matter
10-150 cmol(+)/kg	200-400 cmol(+)/kg

Organic matter has a higher CEC

Note: cmol(+)/kg = meq/100g


CAT
CATERPILLAR
VALLEY
EARTHWORKS

Symbiosis Important

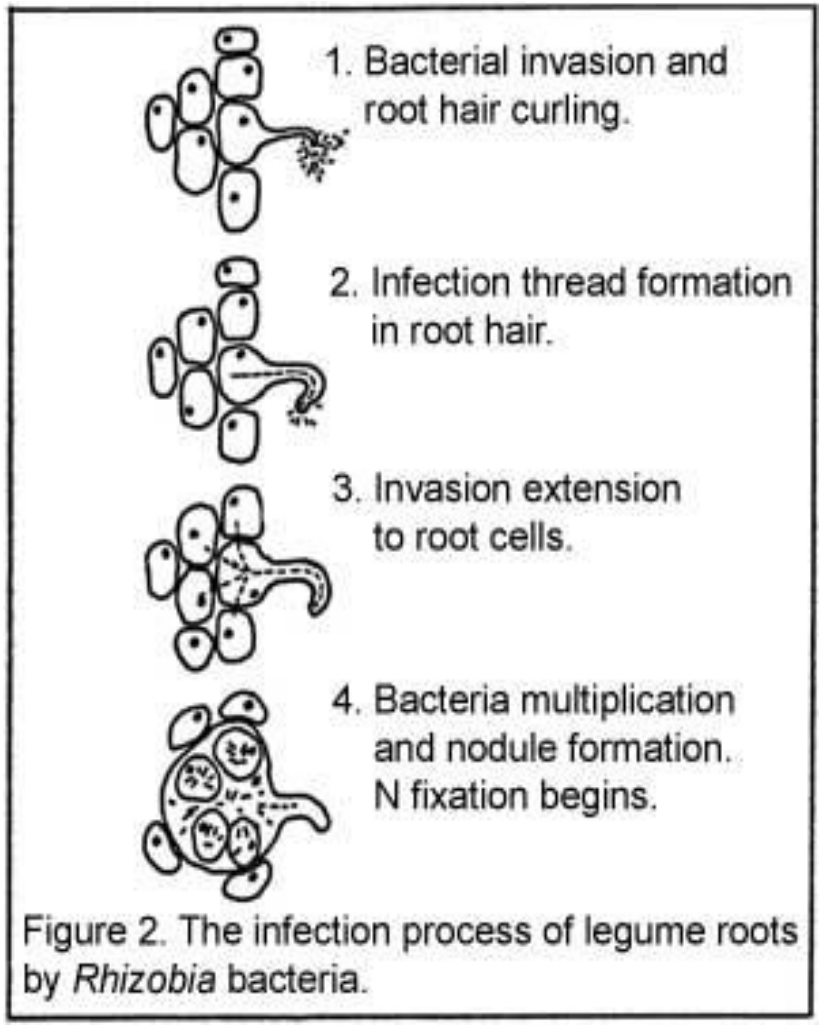
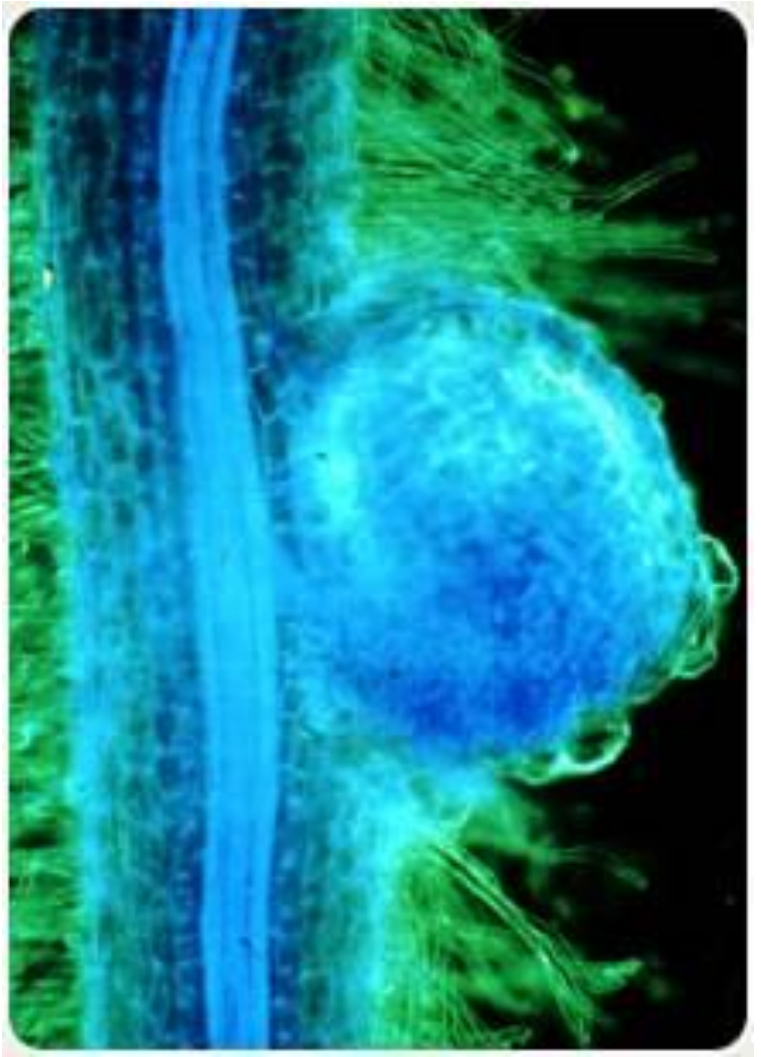


Figure 2. The infection process of legume roots by *Rhizobia* bacteria.



Living microbial biomass functions in soil

Decomposition of organic matter

- **Retain minerals from OM decomposition**
- **Recycling of immobilized minerals**
- **Plant growth promotion**
- **Plant disease prevention**
- **Aggregation of soil particles**
- **Decomposition of toxins**

Soil food web functions

Year-round beneficial habitat

Mixed field border plantings to provide year-round food for beneficials:

- Carrot family
- Sunflower family
- Cabbage family
- Legume, mint, buckwheat families

Yarrow (left) and wild carrot (right) provide nectar and pollen for adult phases of parasites and predators of many insect pests.

Role of diversity in pest prevention

- **Diversity provides opportunity for coexistence and beneficial interactions between species that can enhance ecosystem sustainability**
- **Diversity provides resource-use efficiency**
- **More natural enemies, harder for grazers to build populations**
- **Diversity serves a number of ecological services for soil such as recycling, detoxification, regulates plant growth**
- **Diversity reduces risk of total loss from one crop**

Why soil-borne pests cause damage

- **Farm cultural practices did not prevent loss of soil health resulting in compaction , erosion , low SOM, unbalanced crop nutrition, which (all) advantages the pest**

  Shift in paradigm, continue with our practices, demonstration, attitude, learning and teaching

- **Lowered HUMUS and soil organic matter levels allow**

  low Diversity-Density in living total soil biomass

- **Side effects of pesticides**

- **Resulting compromised functions provided by the living microbial biomass in soil**

MINERAL NUTRIENTS

Primary Nutrients

Nitrogen (N)
Phosphorus (P)
Potassium (K)

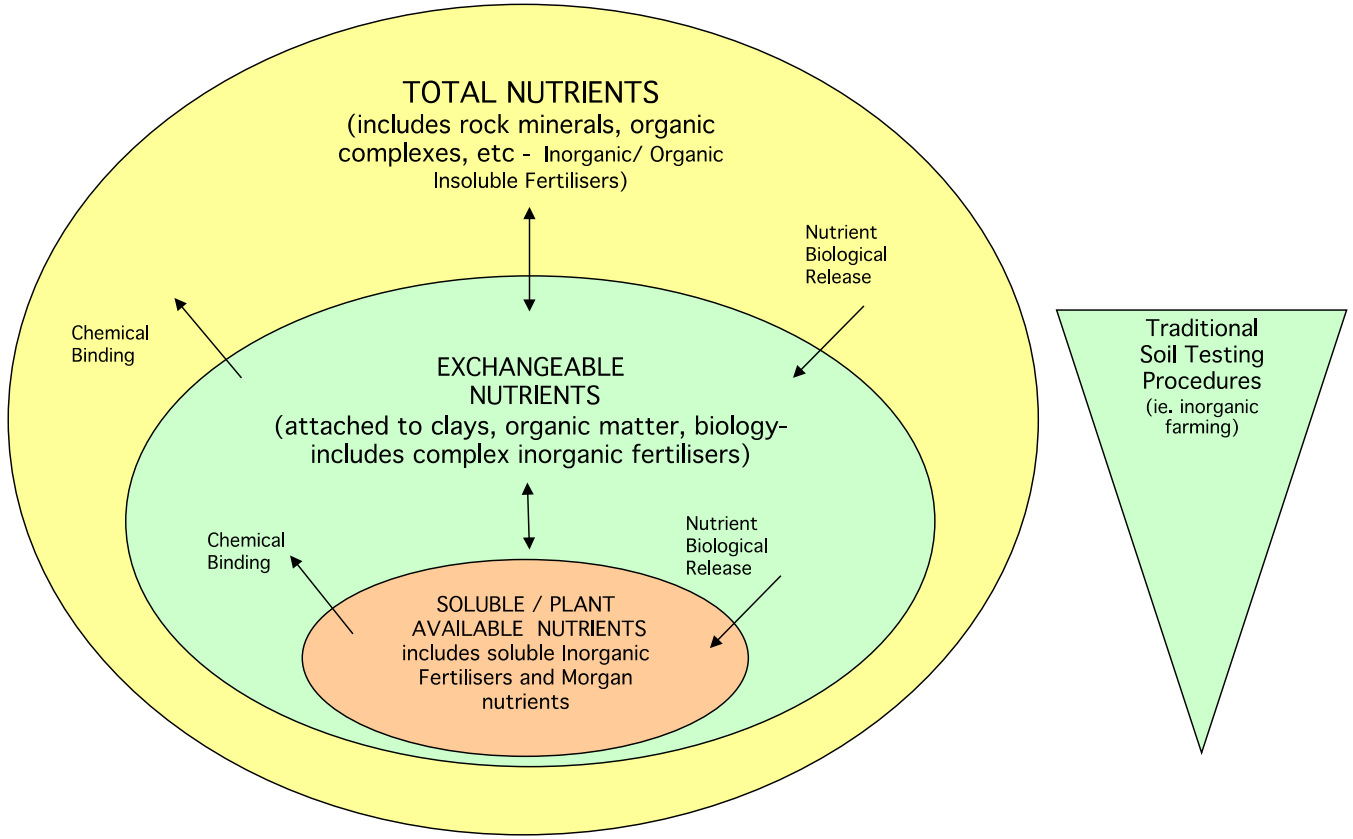
Secondary

Calcium (Ca)
Magnesium (Mg)
Sulfur (S)

Micronutrients

Boron (B)
Chloride (Cl)
Copper (Cu)
Iron (Fe)
Manganese (Mn)
Molybdenum (Mo)
Nickel (Ni)
Zinc (Zn)

Totals – Nutrients



The kind of parent material and the degree of weathering determine the kinds of clays present in the soil

Colloid reactivity is also influenced by parent material and weathering

Benefits of Monitoring Soil/ Leaf

- WHY test soil?
  - Determine what nutrients are lacking?
  - Determine excessive nutrients.
  - Assess nutrient balance.
  - Relate chemistry to physical characteristics.
  - Directly target fertiliser or compost applications.
- Soil testing determines the current nutrient status of your farm soils.
- Leaf testing provides indication of plant nutrient uptake – nutrient cycling and access.

Soil Nutrients

- Analyses typically consists of ‘Available’, ‘Exchangeable’ and/or ‘Soluble/ Plant Available’ Nutrients.
- The largest ‘store’ of nutrients in soil is ‘bound’ and these are the ‘total nutrients’ both macro and micro.
- We can test this ‘store’ but how can we access these nutrients? Biological farming…. Soil biology.
- Large quantity of ‘inorganic fertilisers’ are unavailable or leached from the soil? The ‘totals’ can monitor any buildup of bound nutrients.

Mineral Nutrition of Higher Plants

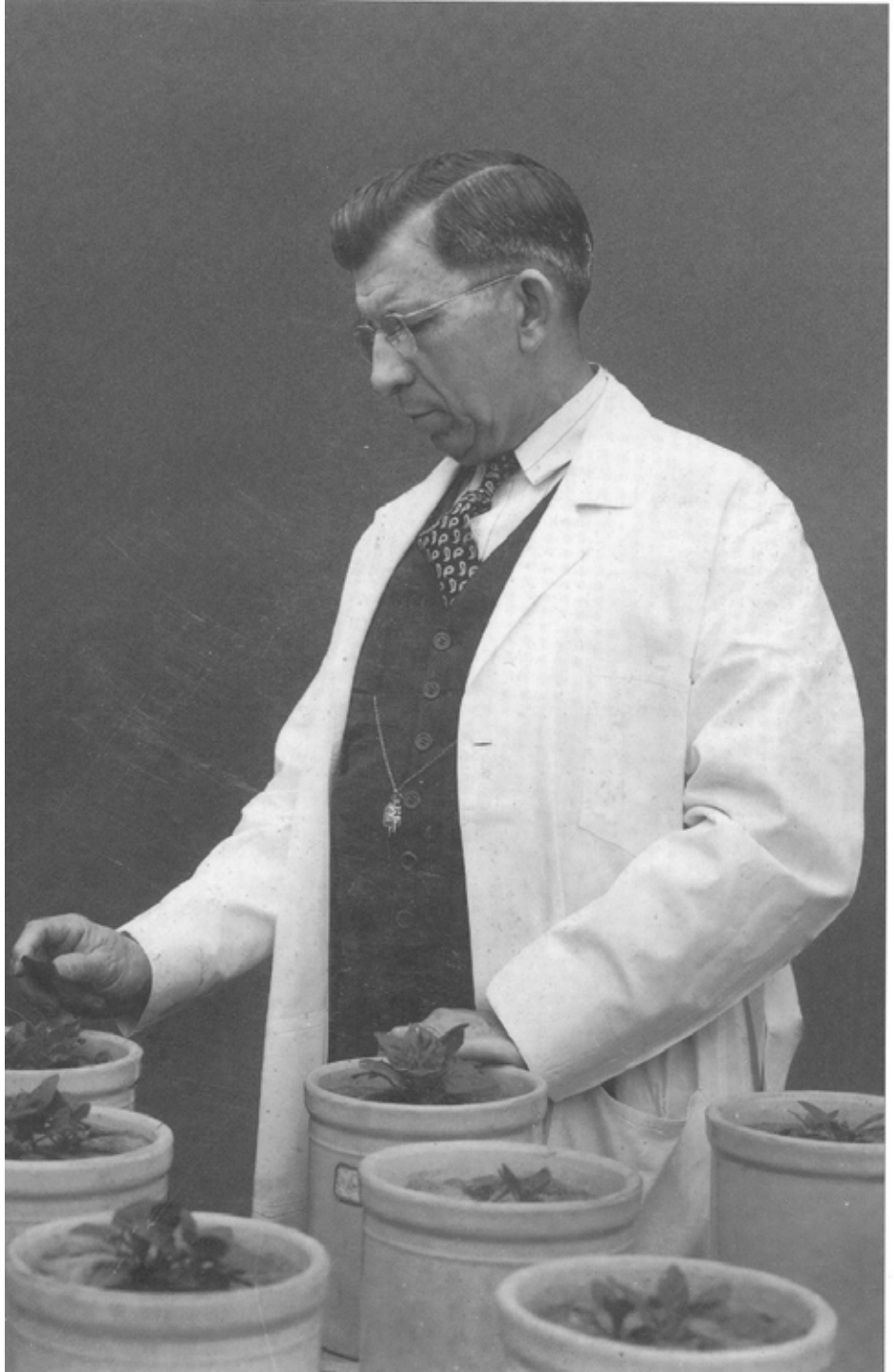
SECOND EDITION

Horst Marschner

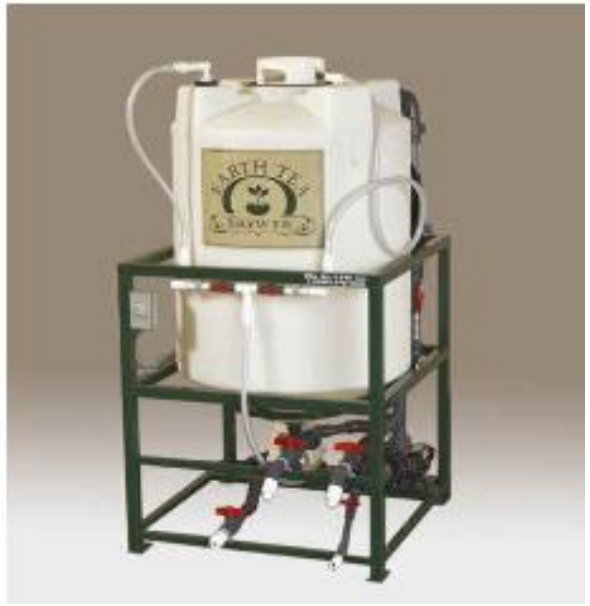
ACADEMIC PRESS

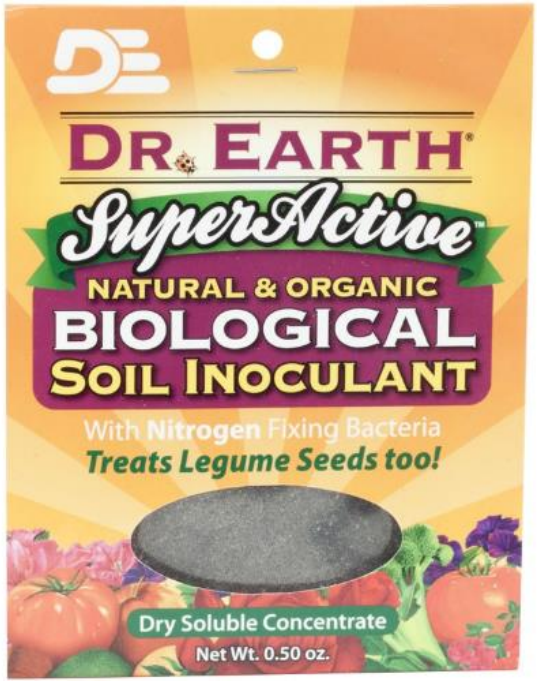
The Albrecht Approach

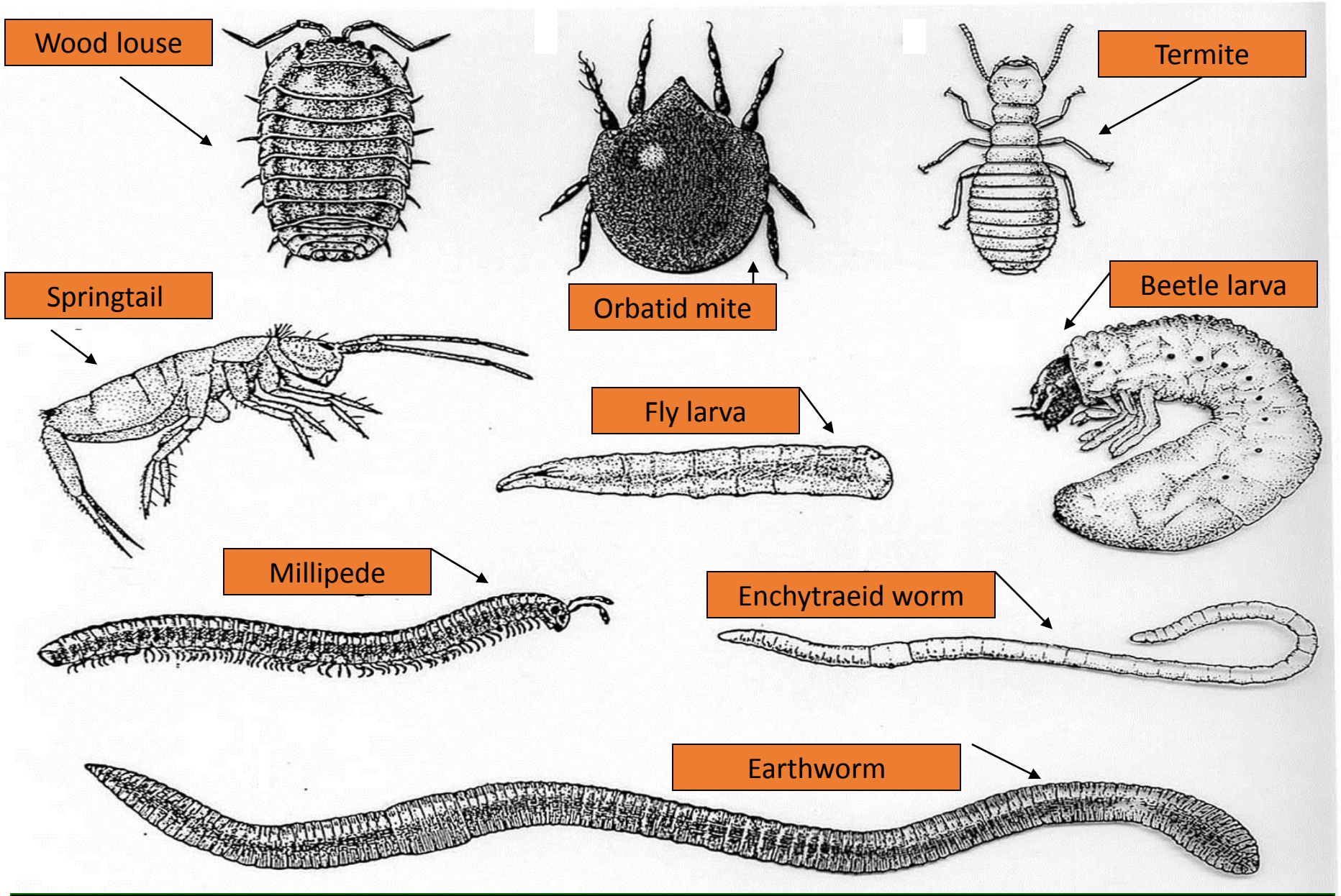
William A. Albrecht, PhD



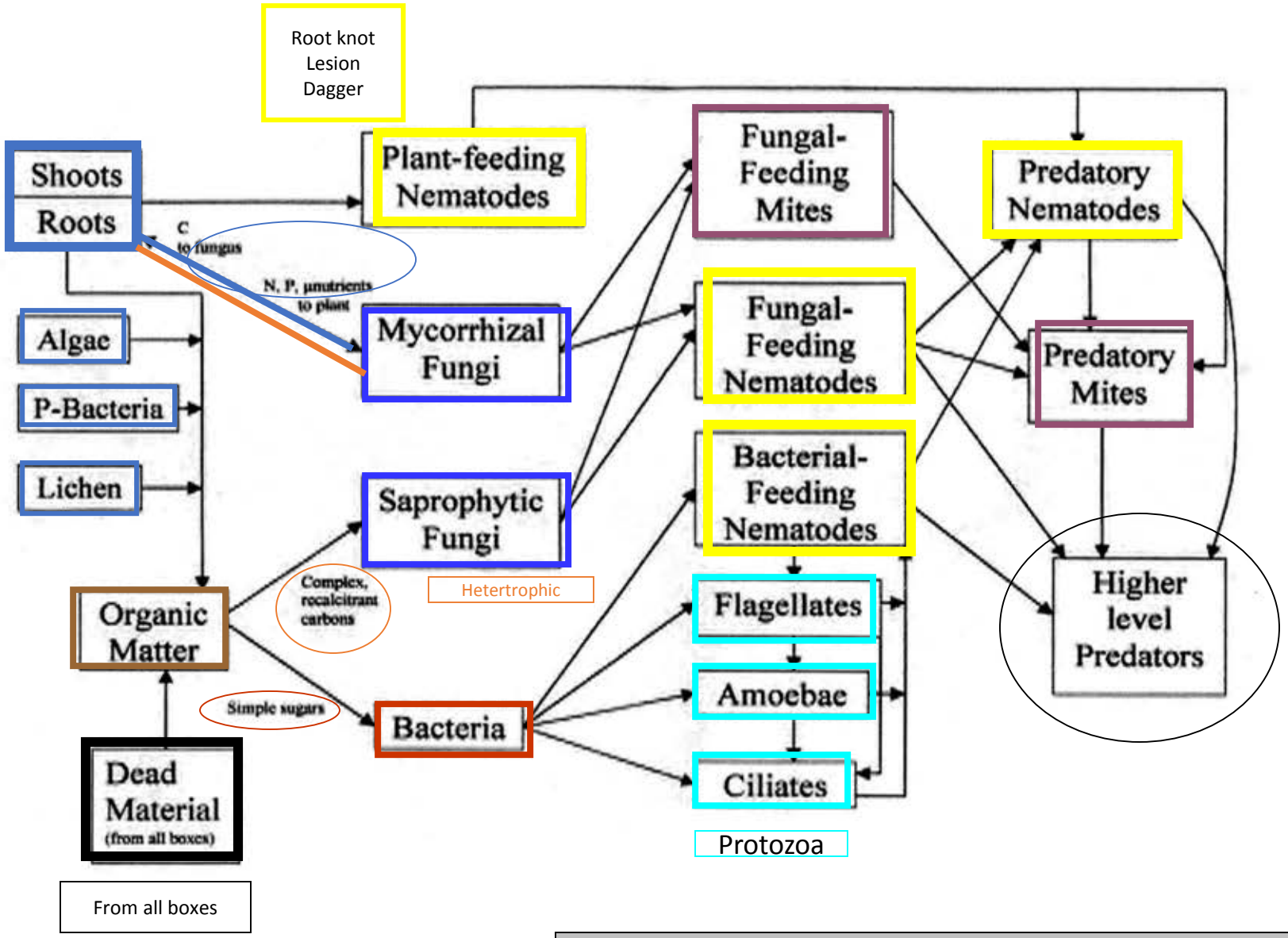
Biological stimulants







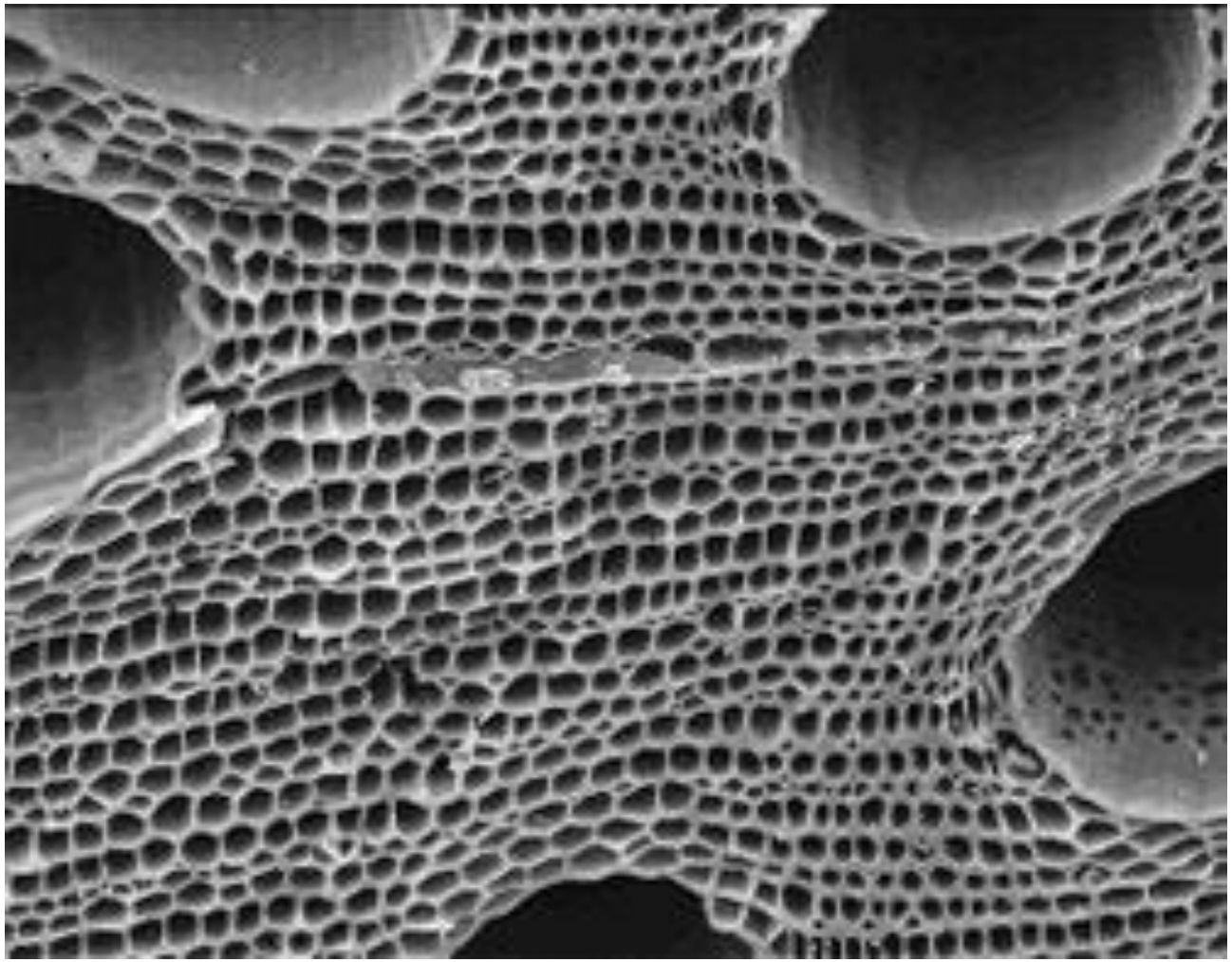
9 soil surface dwelling animals



Soil food web showing energy flow

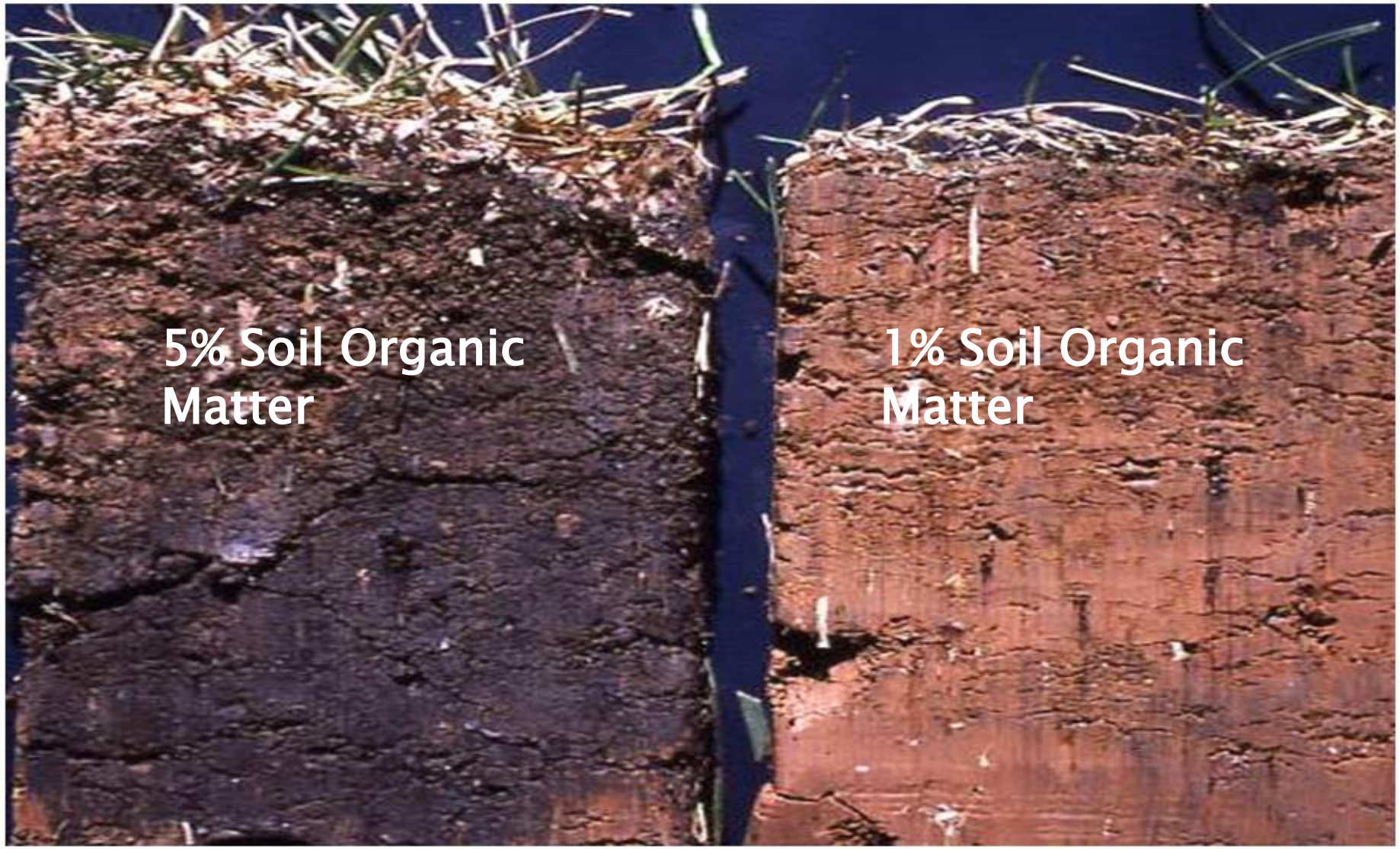
http://www.soilfoodweb.com/images/basicweblarge.jpg

Biochar a Soil Reef?



Earthworms

Remember Soil's Potential




SEEDER
NETWORKSEEDER.COM.AU

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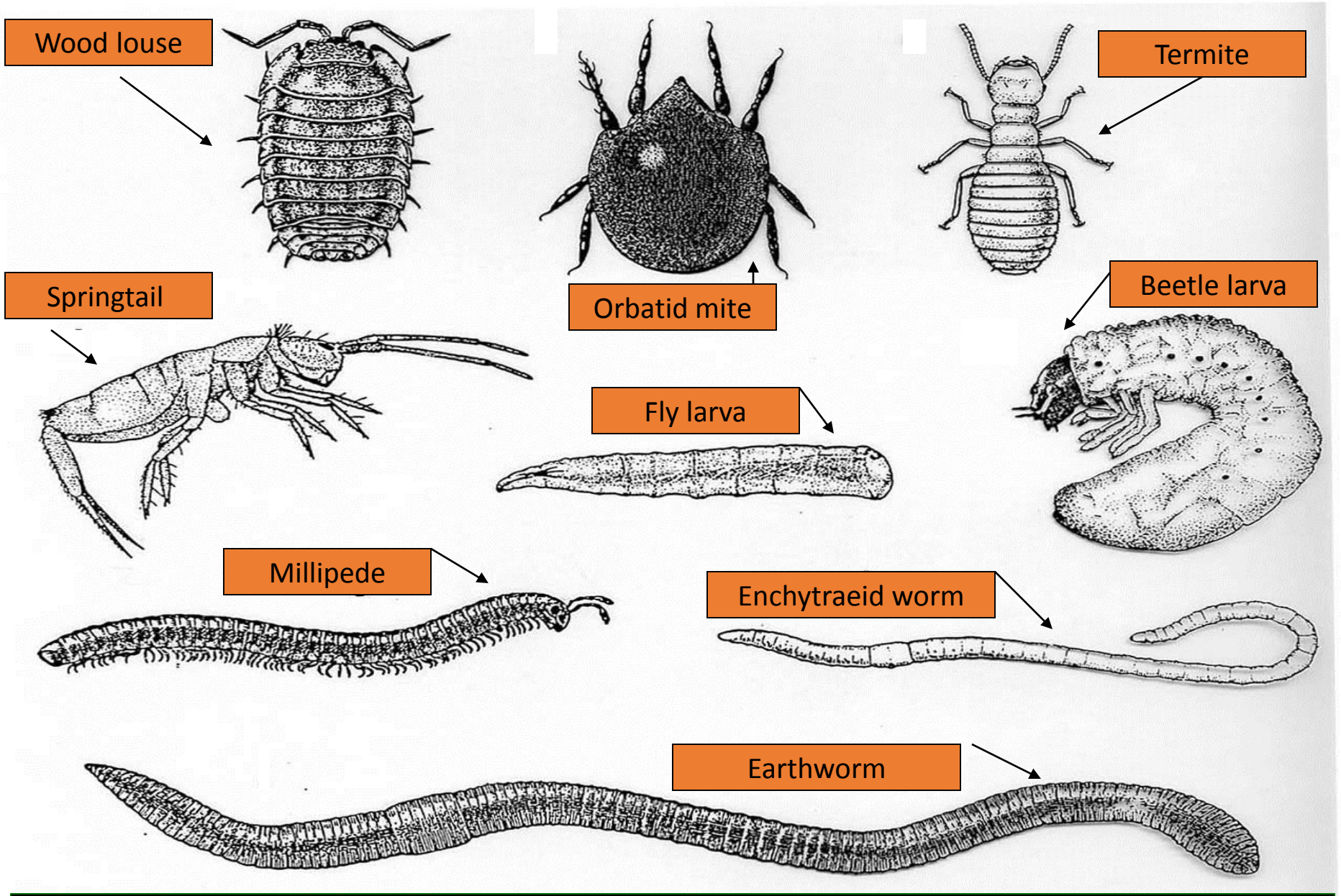


9 soil surface dwelling animals

Suppression of soil borne diseases is a result of:

- **Manipulation of native antagonists**

  cover crops, compost, mineral balance and cultural practices

  Feed the soil…..it's all about FOOD AND CONDITIONS FOR BENEFICIALS

- **Introduction of antagonists**

  compost and inoculants eg Trichoderma , Bacillus subtilis

- **Antagonists ability to survive and grow is dependent on FOOD for the soil food web processes**

- **Antagonists ability to survive and grow is dependent on SOIL health, structure, carbohydrate**

Plants have *active* means to protect against disease

Hypersensitivity response

Physiological, molecular and biochemical events activate genes leading to production of secondary metabolites:

- **Antibiotic phytoalexins and phenolics of low molecular weight**
- **Hydrogen peroxide and oxidative enzymes**
- **Chitinases, B-1,3-glucanases (degrades fungi chitin)**
- **Lignin and hydroxyproline-rich glycoprotein synthesis**
- **Antioxidants Resveratrol and Anthocyanins**

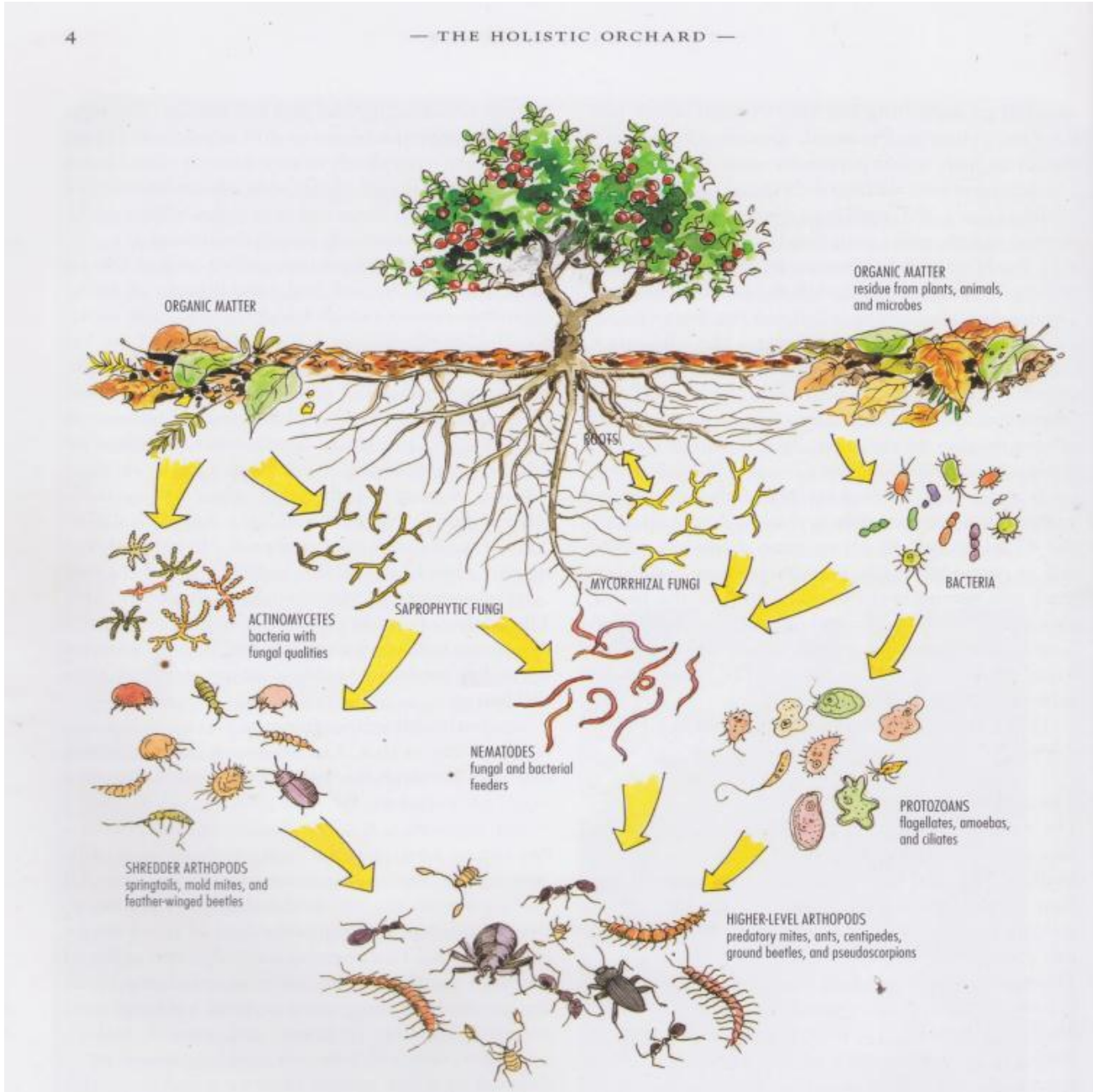
Plants have *passive* means to protect against disease

Pre-formed barriers and anti-microbial compounds

- **Cuticle**
- **Wax (lipids)**
- **Callus, bark, lignin, tannins, pigments**
- **Physically hard and chemically toxic**

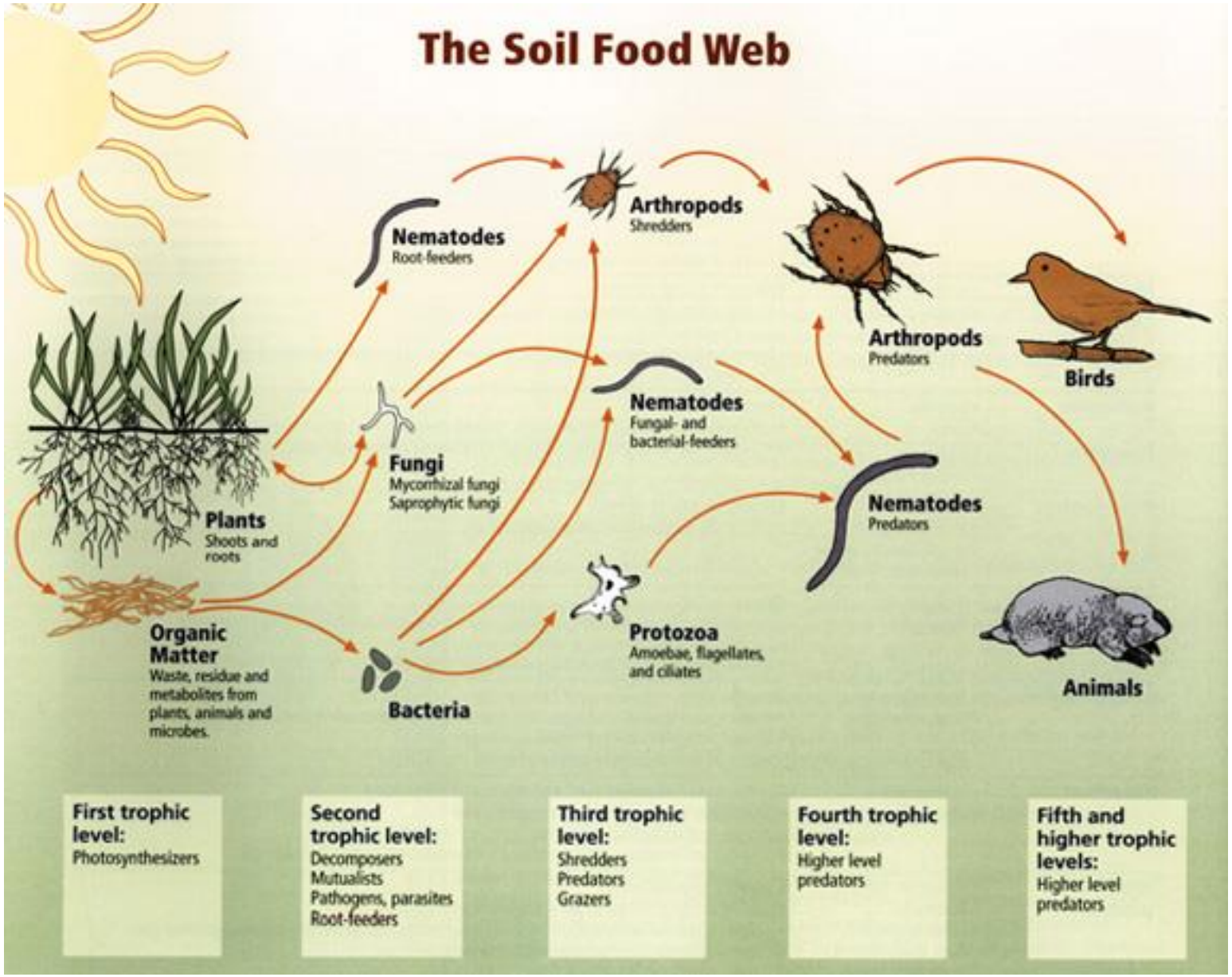
Developing a holistic Organic preventative farming system

- **Transition rather than instant change**
- **Focus on soil health and cultural practices**
- **Feed the soil** soil is substrate limited
- **Grow large volumes of plant biomass**
- **Balance air-water in soil** structure SOM
- **Relentless learning**
- **Recognize opportunity in the chaos**
- **Accepting change and practicing tolerance**



Interdependent and interconnected networks of organisms interact to make life possible. The soil food web encompasses the microbes and arthropods that ultimately

Relationship to soil quality?



PREVENTION

IMPROVE SURFACE STRUCTURE
INCREASE WATER CYCLE FUNCTIONS
SURFACE TEMPERATURE AND ROOT GROWTH

LOW LIGHT TOLERANCE

KNOWLEDGE

ROOT SYSTEM DESIGN
BIOLOGY INCREASES

NUTRIENT HOLDING AND EXCHANGE
SOIL STRUCTURE

SOIL IMPROVEMENT PROJECT

TWEED SHIRE COUNCIL