

# **A Cost Effective Solution to Eliminating 67% of Waste Going to the Landfill**

Nancy Warner, The Worm Ladies of Charlestown, Inc.  
[www.wormladies.com](http://www.wormladies.com)

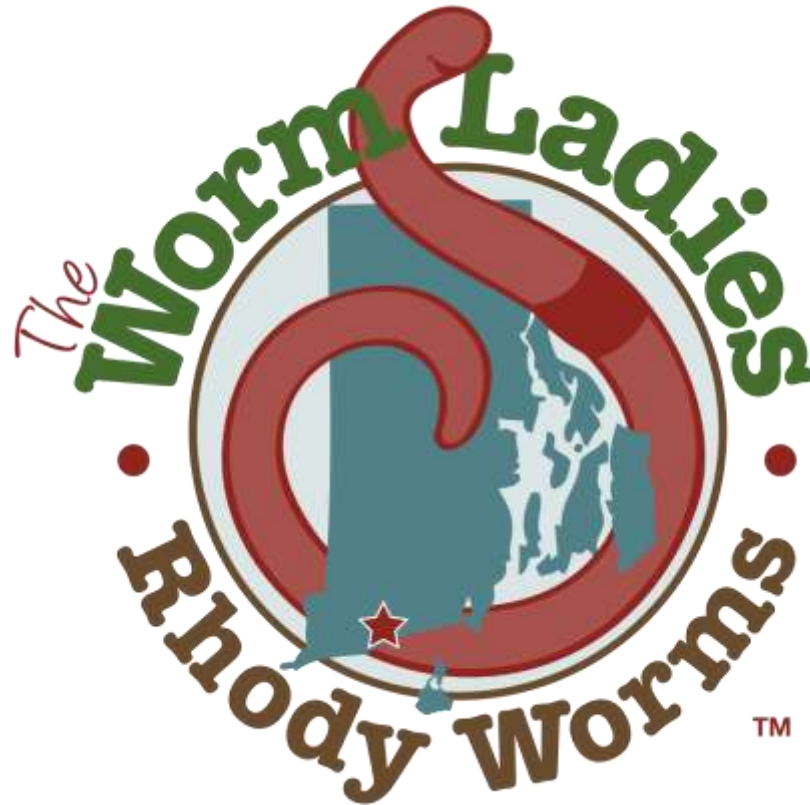
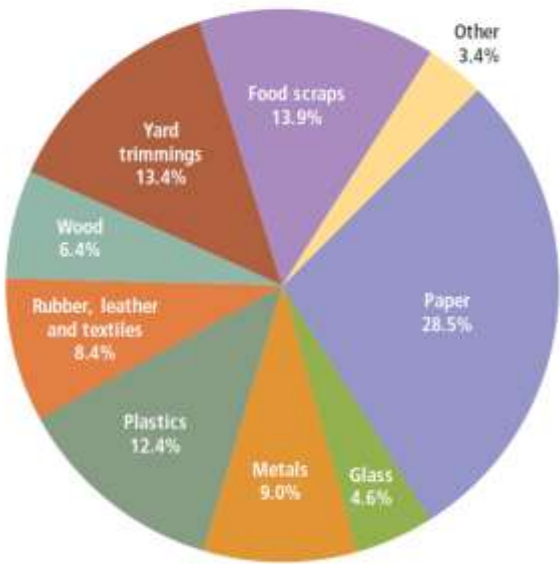


Figure 5. Total MSW Generation (by material), 2010  
250 Million Tons (before recycling)



# What a Waste

- **40%**--in the United States, an estimated 40 percent of food gets thrown away.
- **925 Million** All together, industrialized countries toss 222 million tons of food each year. That's enough to feed 925 million people.
- **50%** The United States' per capita food waste has increased 50 percent since 1974.

# What a Waste

- **14%** Food waste makes up more than 14 percent of the municipal solid waste stream.
- **20%** Food that rots in landfills produces 20 percent of all methane emissions, which contribute to global warming.
- **1/3** Worldwide, roughly a third of all food produced is never eaten.
- [www.heifer.org](http://www.heifer.org)

# The surprising facts about food waste:

- The average family of four produces about 2000 pounds of food waste each year.
- According to the U.S. Environmental Protection Agency, food waste is the third largest category of municipal solid waste (MSW) in the U.S., accounting for about 13 percent of MSW material.
- Americans throw away more than 25 percent of the food we prepare, according to a study by the U.S. Department of Agriculture.

# Composting **All** Food Waste Outdoors

- **Composting Bin**



- **Solar Cone**



# Composting vs. Vermicomposting

- Temperatures differ:
  - Thermophilic
  - Mesophilic
- Different bacteria predominate
- Handle weed seeds differently

# Thermophilic Composting

- Uses high temperatures:  $>140^{\circ}\text{F}$
- Kills low temp bacteria
- Encourages high temp bacteria
- May kill weed seeds
- Needs to be turned periodically to heat up
- Moisture helps but not required



# Mesophilic Vermicomposting

- Needs lower temps: 40° – 80° F the ideal
- Lower temps needed to keep the worms alive
- Worms require moisture
- Can use a thermophilic stage first

# Advantages of Using Worms in your Compost

- Speeds up decay, 6-9 months vs 12-18 months
- No smell when done correctly
- Can be done indoors
- Better end product – Vermicastings
- Fun

# Advantages of using worms in your compost

- Save money by making your own soil enhancer/fertilizer that is organic, no matter what you feed the worms.
- Vermicomposting can be done under your kitchen sink, in your garage or in your yard.
- It is convenient, interesting, easy and fun!
- If each of us takes responsibility to take care of our own waste, the world will be a better place.

# Darwin

- In fact as long ago as 1881 [Charles Darwin](#) wrote: *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.*

# Red wigglers

- *Eisenia fetida*
- Their specialty is eating raw garbage.
- Eat as much as half their body weight per day.
- Can be kept in captivity
- Reproduce prolifically





# The worms appetite

- One pound of mature worms eat approx. a half-pound a day
- Two pounds of worms for a 2x3 foot bin. (18 gallon)
- No meat or dairy
- Limited amount of citrus, onions



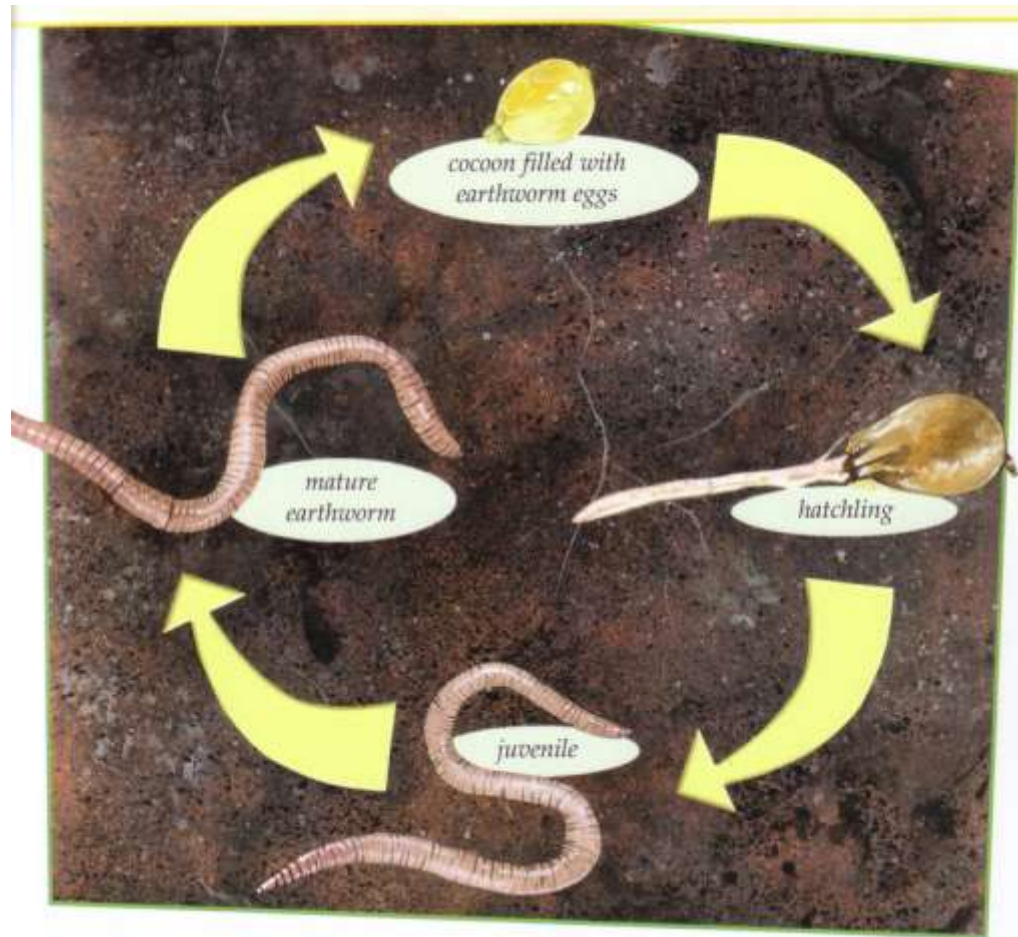
# Food in the compost

- The worms are actually eating the bacteria off of the rotting food.
- Food, like bananas, will need to turn black.
- Food like cantaloupe and watermelon will disappear quickly.
- Egg shells and corn cobs will take a long time.





# The Life Cycle of a Worm





A. NATIVE NIGHTCRAWLER



B. FIELD OR GARDEN WORM



C. DIPLOCARDIA EARTHWORM



D. GREENWORM



COMMERCIALY PRODUCED

E. MANURE WORM



F. RED WORM



(U.S. Department of Agriculture Photo)  
(Approximately 45% of Natural Size)

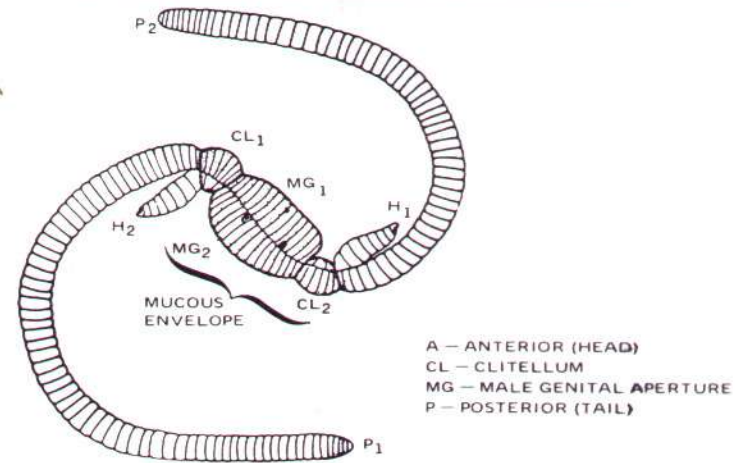
# Potential Worm Population

- 1 mature worm: 1,200 to 1,500 offspring a year.
- 2,000 worms: million worms and capsules in a year
- 2 years: trillion worms and capsules
- Population could double in 60-90 days.



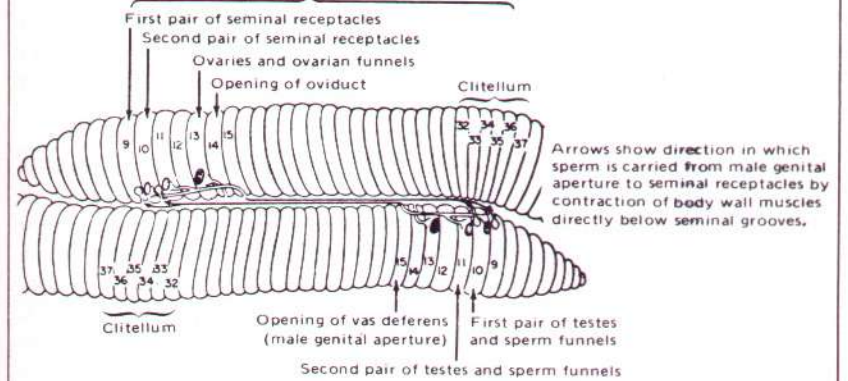






**B - SCHEMATIC VIEW**

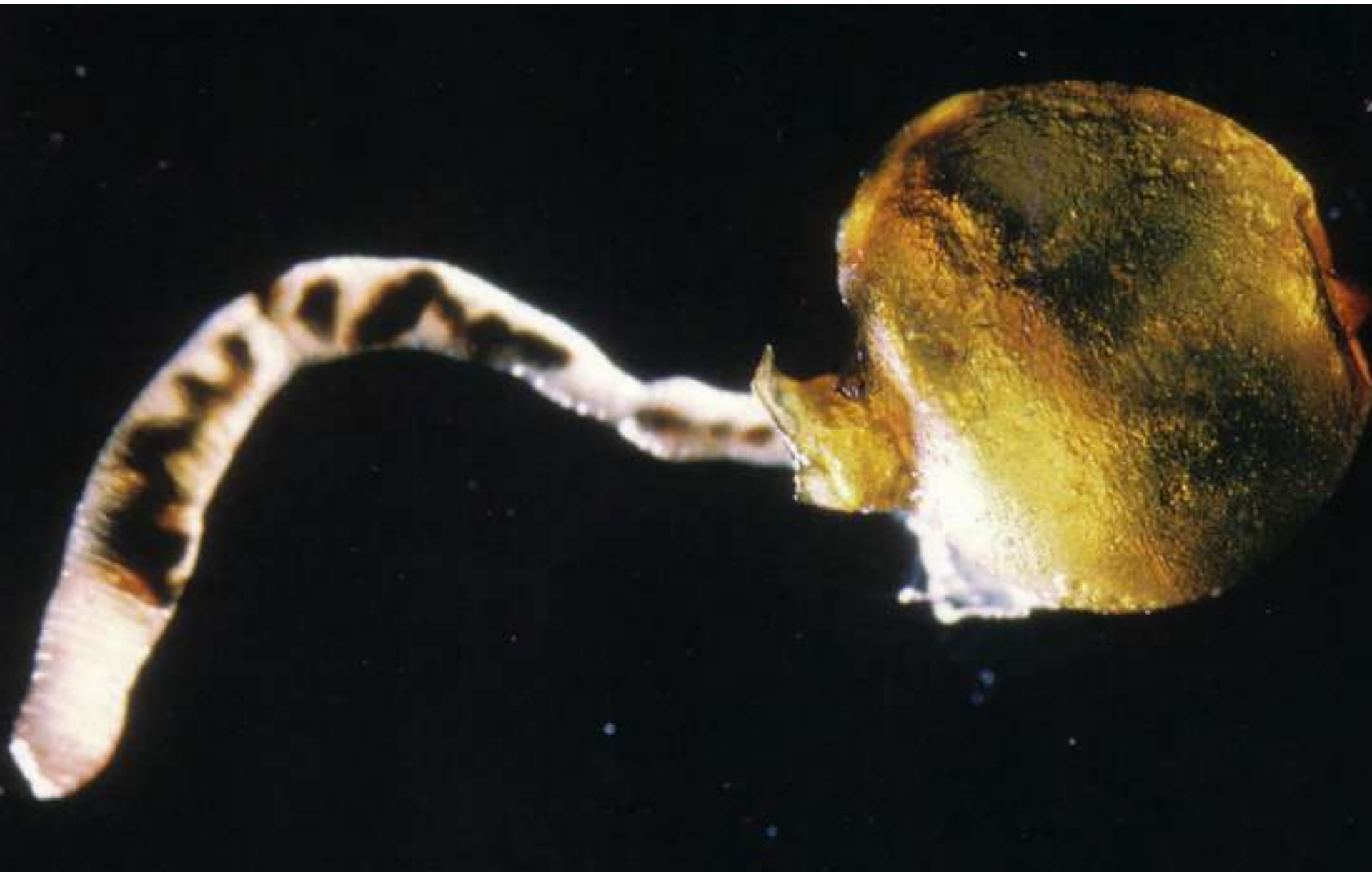
In this region the partners are firmly bound together by the mucous envelope secreted by their clitella



**C - MAGNIFIED VIEW OF COPULATION**







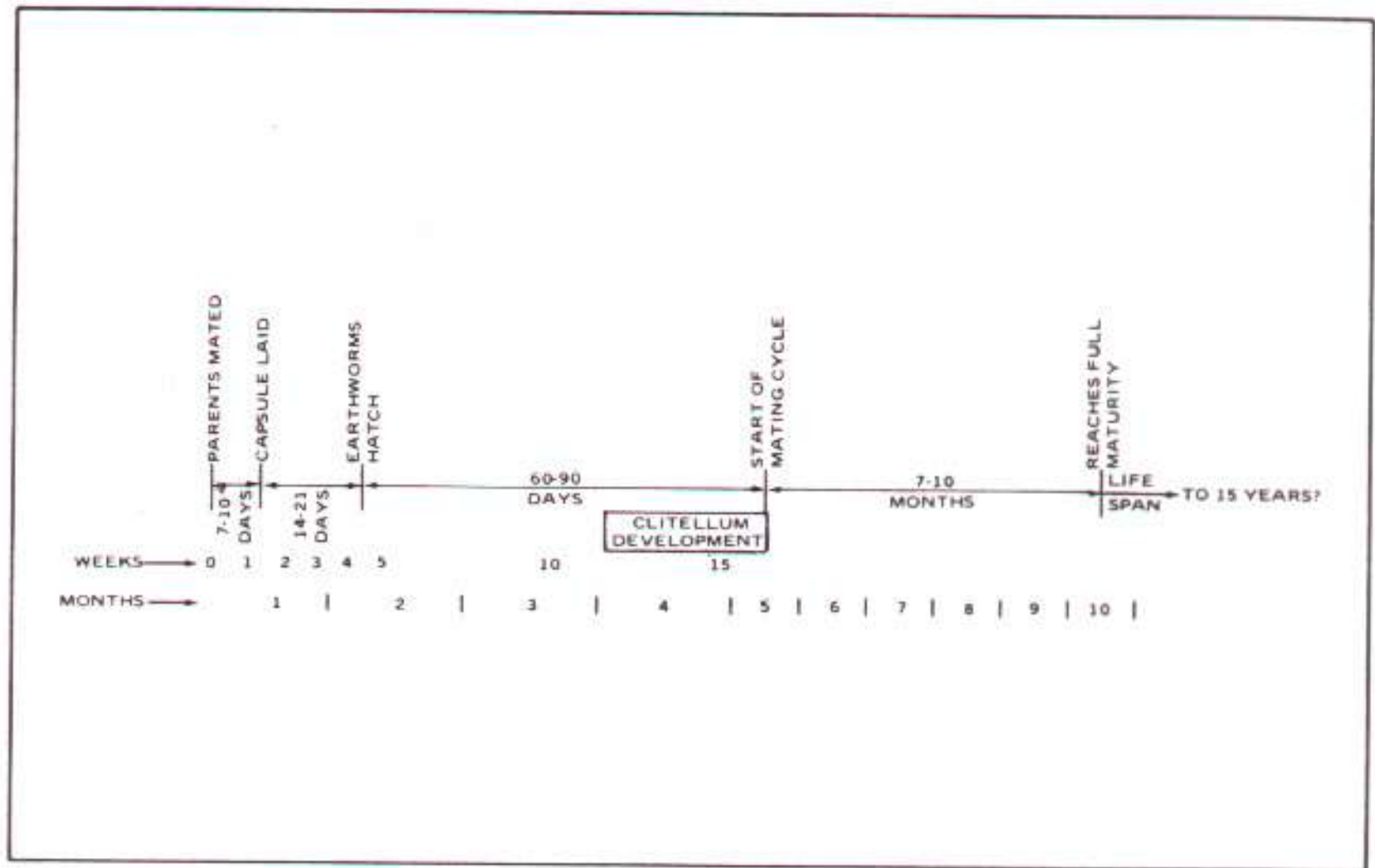


Figure 2-5. Earthworm Life Cycle Under Ideal Conditions

# Making a Home for Your Worms

- Indoor bins....
  - Worms need air
  - Need bedding
  - Need moisture control
- Outdoor bins...
  - Need good drainage
  - Worms able to go down below frost line

# Indoor Bins



# Worm Bins



# The bedding



# Worm Bedding

- Shredded newspaper
- Peat moss
- Coir
- Shredded cardboard









# Putting the worms in the bin

- Pockets in the bedding
- Cover garbage
- Cardboard, bedding, leaves, etc.

# Worm Castings

- Increase diversity in the soil
- Fine particulate matter produced by worms
- Better moisture and nutrient holding capacity
- Contains plant available nutrients
- Contains plant growth regulators (hormones)
- Holds soil together





# Worm Harvester



# Compost teas

- Compost tea puts the microbiology back into the soils.
- Actively aerated compost teas are usually easy to apply—to both soil and leaf surfaces—and are put right where they are needed.
- Compost leachate—liquid that leaches out of compost when it is pressed.

# Compost teas

- Modern compost teas are aerobic mixtures. If the tea is properly made, it is a concentrate of beneficial, aerobic microbes. The bacterial population, for example grows from 1 billion in a teaspoon of compost to 4 billion in a teaspoon of an actively aerated compost tea. These teas are made by adding castings to dechlorinated water and aerating the mix for one day.

# Tea vs Leachate

- Leachate is excess moisture from the bin
- Tea is made from castings





# Miracle Brew







**"Our Organic Miracle Brew"**

...for healthy, well nourished plants

The recipe:  
5 gallon bucket of water  
1/2 pound of castings  
1-2 teaspoons molasses  
2 teaspoons dried kelp  
1/2 teaspoon humic acid

Attach the air stone to the tubing to the pump. Set the pump outside the bucket and place the air stone in the bucket of water. Plug in and let the pump run for an hour to eliminate any chlorine. Fill an old stocking with the castings, molasses, kelp and humic acid and clip the top of the bag. Place the bag in the bucket. Run the pump for 24 hours. Pour the mixture into the sprayer.

Spray the brew on the leaves or pour the brew directly on the soil. When used repeatedly, the tonic revitalizes soil and allows the cultivation of plants organically. Use the brew within 24 hours.

[www.wormladies.com](http://www.wormladies.com)

# Miracle Brew

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# Troubleshooting

- Bin is too wet/bin is too dry
- Bin smells
- Fruit flies
- Worms aren't reproducing
- Worms are dying
- Worms disappear
- Mold is in my bin



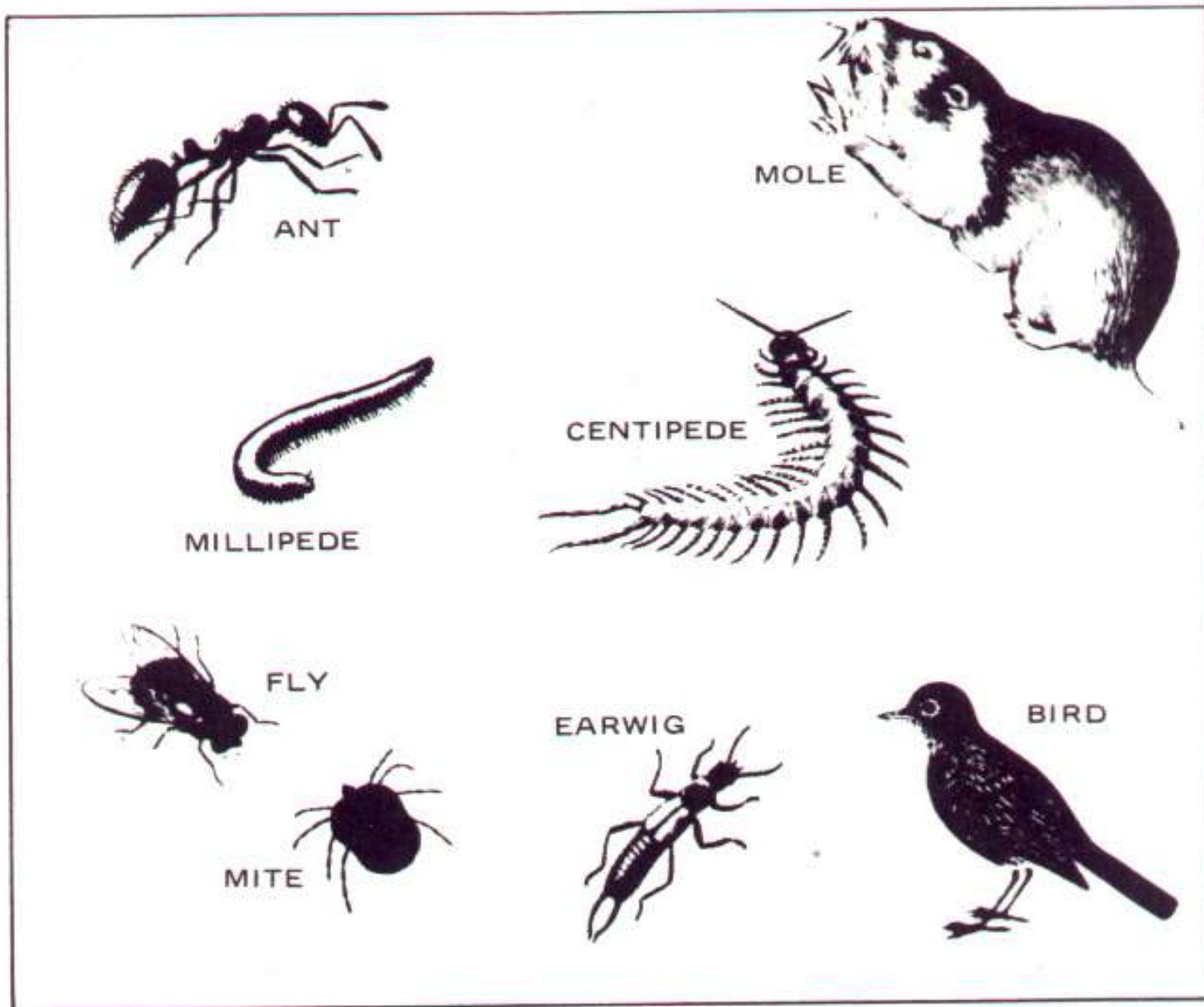
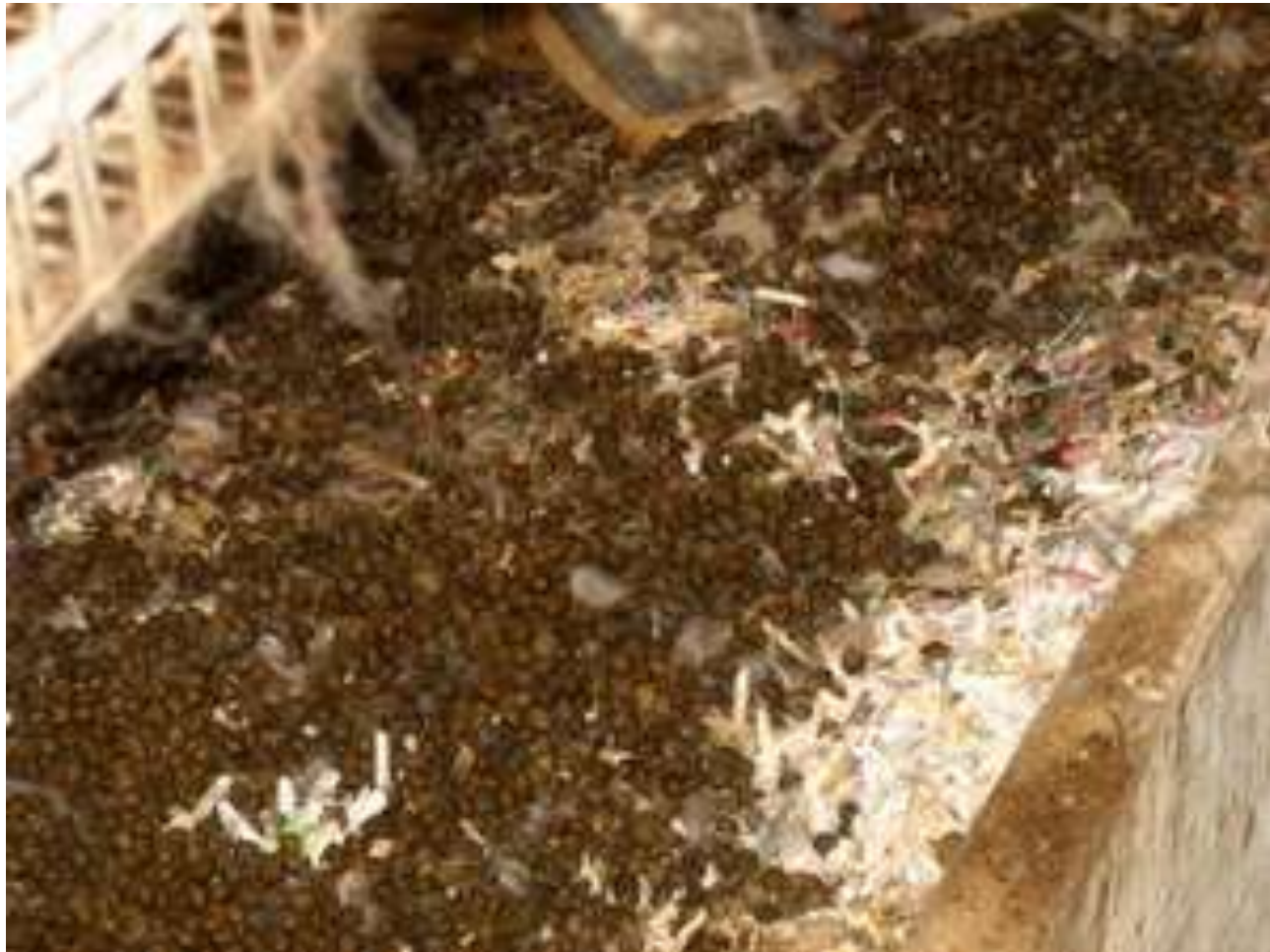


Figure 5-1. Enemies, Insects, and Pests

# The Worm Ladies Worm Farm



# BUNNY CONDO



# Cape Cod Worm Farm





# Commercial worm farms







## Feeding





## Harvesting









## Harvesting Worm Castings







## SUITABLE ORGANIC WASTES FOR EARTHWORM PROCESSING

### FARM

- Chicken
- Turkey
- Duck
- Horse
- Cattle
- Pig
- Rabbit

### INDUSTRIAL/URBAN

- Brewery
- Potato
- Paper
- Sewage
- Restaurant
- Food market
- Yard waste (leaves and grass)

## OPTIMAL CONDITIONS FOR BREEDING *EISENIA FETIDA* IN ORGANIC WASTES

### FACTOR

### REQUIREMENTS

- TEMPERATURE

- PREFERRED

- 15-25 °C (59-77°F)

- LIMITS

- 0-35 °C (32-95 °F)

- MOISTURE CONTENT

- PREFERRED

- 80-90%

- LIMITS

- 60-90%

- AMMONIA

- LOW (<0.5 mg/g)

- SALT CONTENT

- LOW < 0.5%

- pH

- >5 and < 9

- OXYGEN

- AEROBIC











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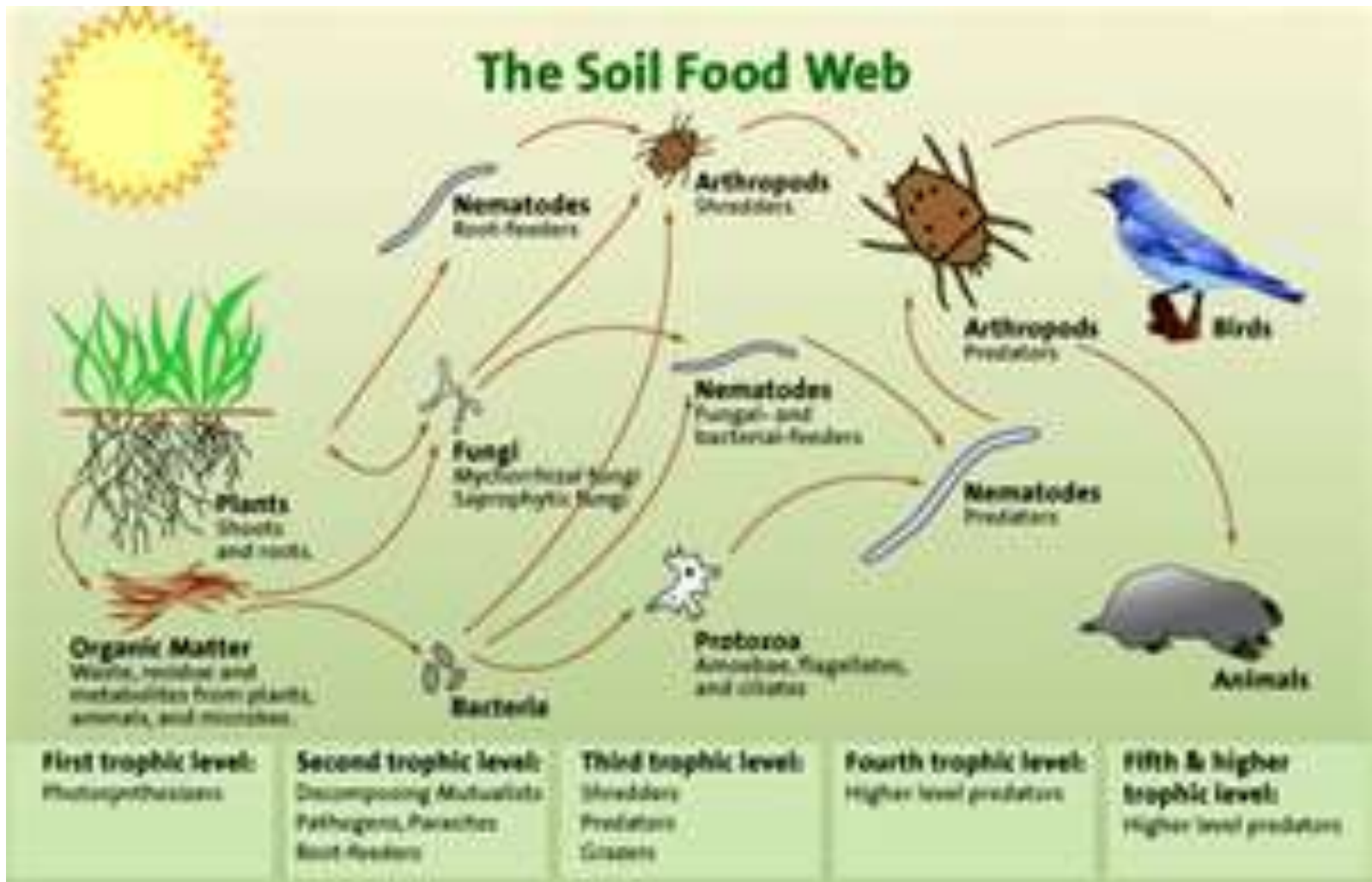
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- **Worms Eat My Garbage**, by Mary Appelhof
- **Worms Eat Our Garbage, Classroom Activities for a Better Environment**, by Mary Appelhof, Mary Frances Fenton, and Barbara Loss Harris
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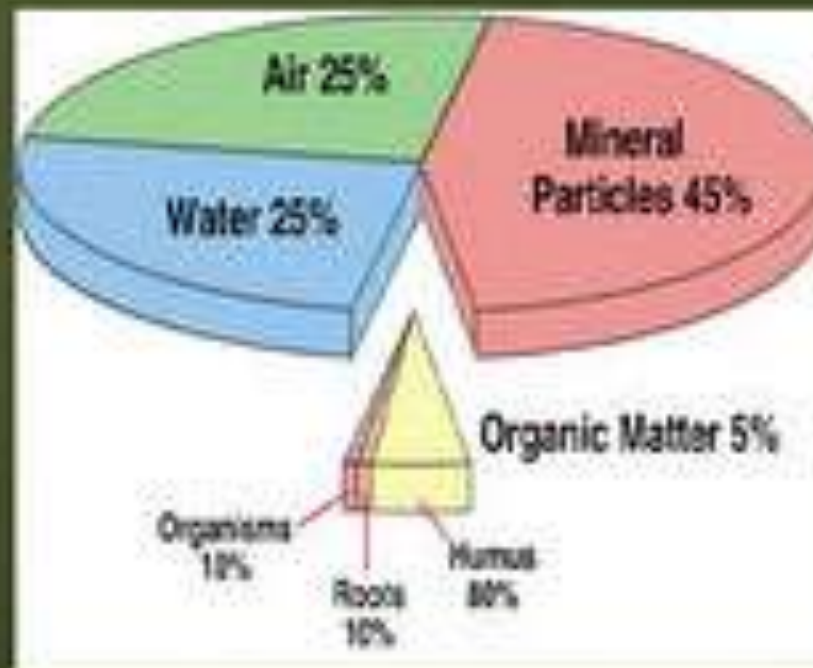
# The Soil Food Web

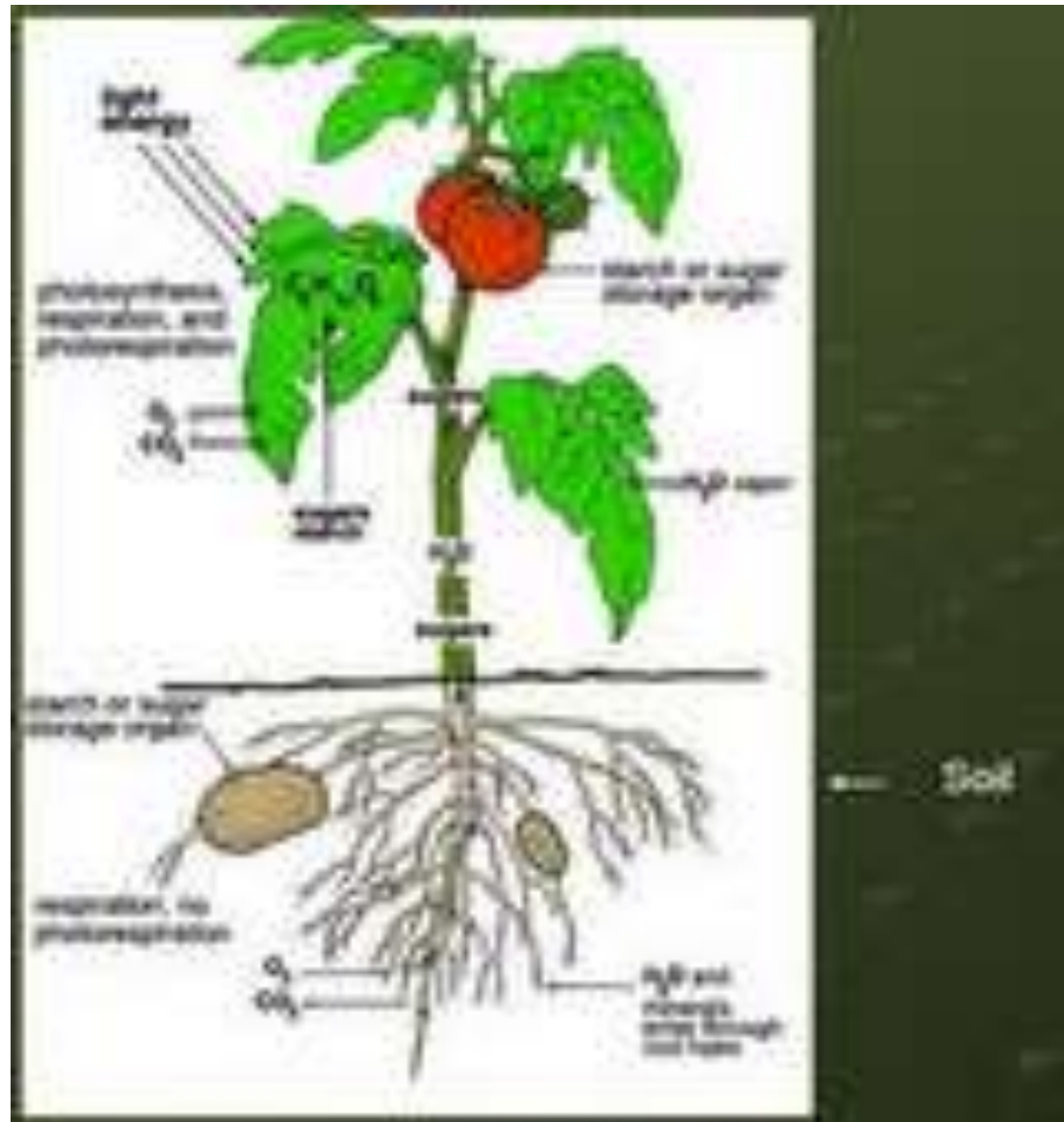
- Soil health, then means that organisms in the soil are present and doing the work they are supposed to do to support the growth of plants.
- Soil teems with microscopic life, each type of creature performing its own function in the soil food web. Plants differ in the way they acquire nutrients. A vibrant mix of microbiology is essential for healthy soil and healthy plants.

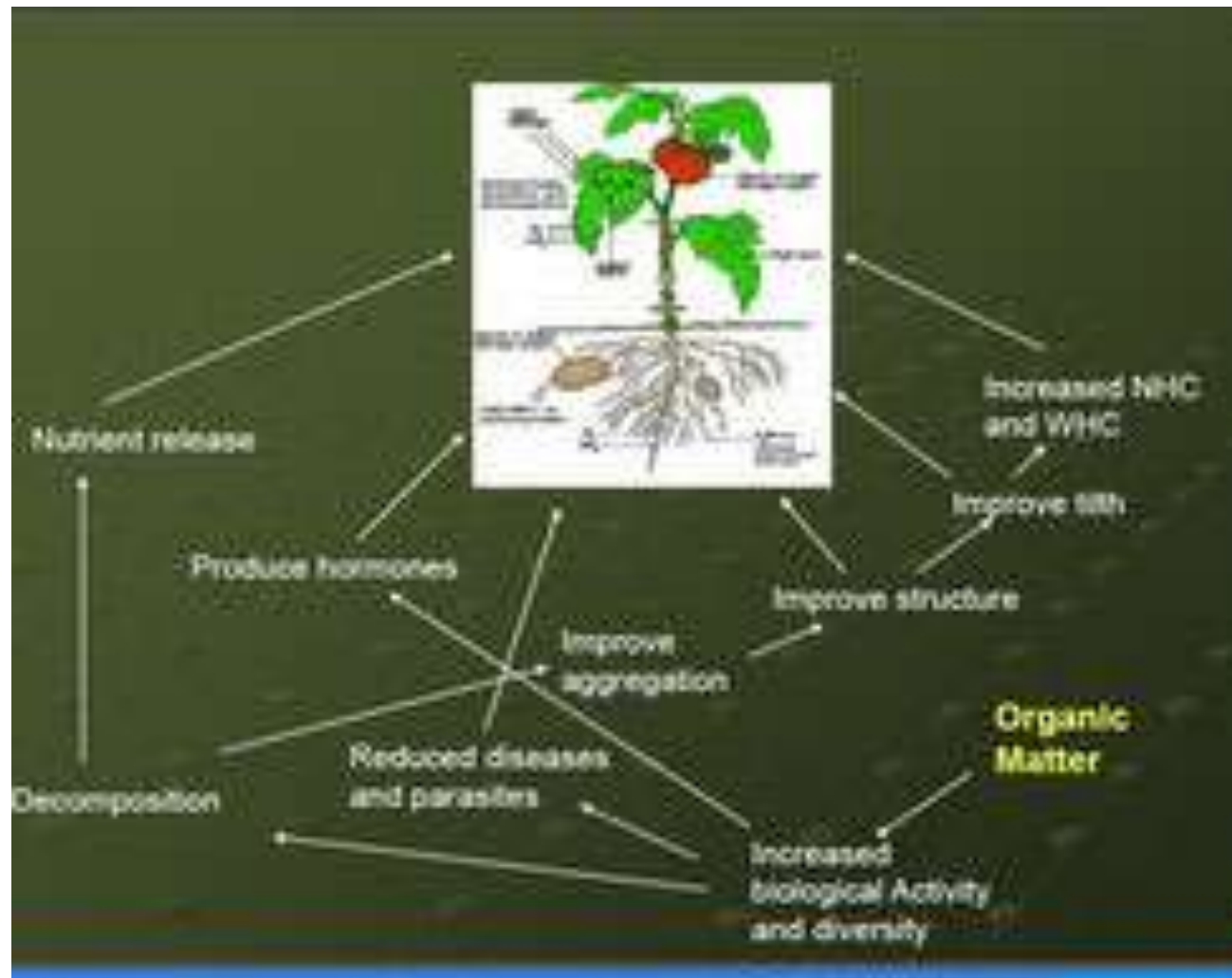
# The Soil Food Web



# Soil composition

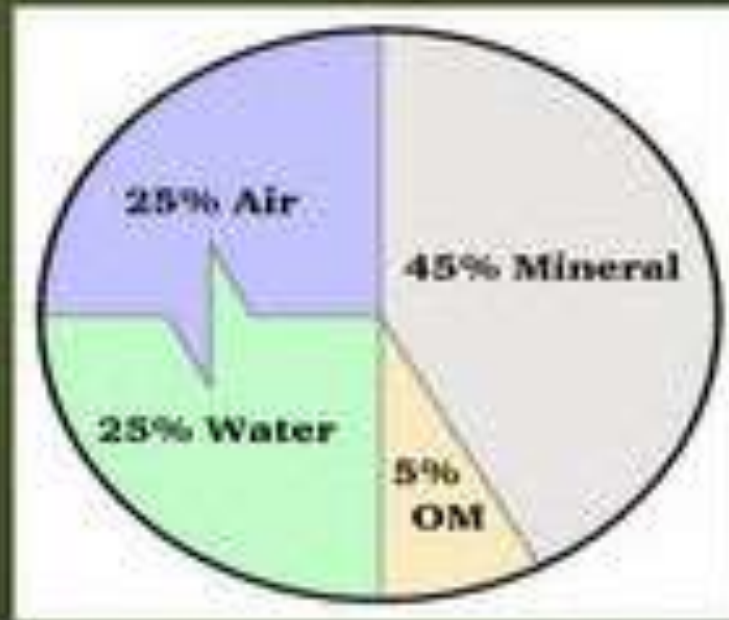








## A typical soil



# Bacteria

- Bacteria are single-celled microorganisms that are vital for cycling nutrients in the soil. There are thousands of species of bacteria. In general, beneficial bacteria are usually aerobic, requiring oxygen to survive, while disease-causing ones thrive in low-oxygen environments.
- Many species of bacteria serve as decomposers, eating up dead plant matter and concentrating the nutrients to their bodies—one of the first steps in returning those plant building blocks to the soil.

# Bacteria

- Bacteria bind all kinds of compounds in organic forms that will not leach of the soil.
- Another group of bacteria collaborates with legumes to capture or “fix” atmospheric nitrogen and add it to the soil.

# Fungi

- Fungi are strandlike microorganisms that help hold soil particles together and improve soil structure. They consume the harder-to-digest organic materials, such as dead leaves, pine needles, and fallen tree trunks.
- One type of fungi establishes mutually beneficial mycorrhizal relationships with plants, which allows the fungi to hold and transfer nutrients directly to plant roots.
- While many species of fungi are beneficial, others are responsible for plant diseases.

# Protozoa

- Protozoa include microorganisms like flagellates, amoebae, and ciliates, all of which eat bacteria. As protozoa consume bacteria, they release excess nutrients in soluble forms that can be utilized by plants.
- Protozoa also work with bacteria and fungi to build air passageways, letting oxygen, water, and roots move easily through the soil.



# Nematodes

- Nematodes suffer from a bit of bad press. Most people have only heard of root-feeding nematodes and therefore think all nematodes are bad.
- But many—the majority, in fact—of these small worm-like creatures are a boon to the garden.
- Beneficial nematodes help protect roots from disease, help build soil structure, and release nutrients in plant-available, soluble forms, right in the root system.

# Microarthropods

- Microarthropods are an assortment of very tiny organisms that include soil mites, springtails, and soil dwelling insects. There are many different kinds of these critters, but, in general, their function is to eat fungi, or each other, and release nutrients in a plant-available form.

# Balance

- We need members from each of these groups of organisms in our soil working in concert with each other and the plants they feed.
- To a large extent, plants control and select for the growth of the microorganisms they need.

# Soil Food Web

- Gardening and farming that rely on heavy doses of synthetic chemicals and fertilizers destroys beneficial life in the soil, leaving plants without this important support system.
- Chemically maintained soils have been reduced to dirt over the course of a half-century, with little or no beneficial life to combat disease organisms or insect pests, and nothing left in the soil to cycle nutrients.

# Soil Food Web continued

- The best way to obtain and nourish the full set of life-sustaining microbes is by adding locally made compost. Worm castings provide a greater diversity of beneficial organisms. The worms consume the pathogens and pests.
- Good compost will then replace the life—and the foods that feed life—currently missing from many gardens, and will turn the dirt back into living soil.
- Elaine Ingham, PH.D., with Amanda Kimble-Evans





