LIVING SOIL

Master Gardener College

George W. Bird, Professor, MSU (June 9, 2012)

Living Soil References

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- Brady, N. and R. Weil. 2002. *Nature and Properties of Soils* (13th ed) Prentice Hall. Upper Saddle River, N.J. 960 pp.
- Cavigelli, M. et al. 2010. *Field Crop Ecology*. MSU Extension Bulletin E-2646. East Lansing. 86 pp.
- Gugino, E. et al. 2009. *Cornell Soil Health Assessment Training Manual*. Cornell Univ. 58 pp.
- Ingham, E., A. Moldenke and C. Edwards. 2000. *Soil Biology Primer*. SWCS, Ankeny, IA. 48 pp.
- Magdoff, F and H. van Es. 2000. *Building Soils for Better Crops* (2nd ed) . USDA/SARE. Beltsville, MD. 230 pp.
- MOA. 1998. *Life in the Soil* (video). MOA Productions. Atami, Japan. 30 minutes.
- Montgomery, D. 2007. *Dirt. The Erosion of Civilizations*. Univ. California Press. Berkeley. 285 pp.
- North Central Cover Crops Council. 2012. *Midwest Cover Crops Field Guide*. Purdue Univ. 136 pp.
- SARE Handbook Nine. 2007. *Managing Cover Crops Profitably* (3rd ed) .USDA. Beltsville, MD. 244 pp.
- Wessels, T. 2006. *The Myth of Progress: Toward a Sustainable Future*. Univ. Vermont Press. Burlington. 131 pp.

Home Work Assignment Discussion

-High quality soil
-Average quality soil
-Low quality soil

Soil Quality

- Resists degradation!
- Responds to management!

MSU Statues

- Sparty
- John Hannah
- Magic Johnson
- **Liberty Hyde Bailey**

Thought Process

Structure + Process = Pattern

Living System (Organism)

- Replicate itself.
- Take-in matter and energy and give-off residuals.
- Be able to respond to its environment.

Five Types of Natural Resources

- Soil (Adam derived from *adama*, meaning earth; Eve derived from *hava* meaning living).
- Water
- Air
- People (*Homo* derived from humus meaning living soil)
- **Other Living Organisms**
  - **Soil-Borne Organisms**
  - **Life in the Soil**

Soil

- Outer most layer of our planet
- Regenerative living system
- Ecosystem (Your lawn of landscape ornamental ecosystem of interest)
- Place where **energy** and **matter** are transformed and transported.

Central Asia
(Tajikistan, Uzbekistan, Kyrgyzstan)

Tajikistan, 2010

Michigan, 2010

Nature of Soil (Phases)

- Liquid (soil water)
- Gas (soil air)
- Solid
  - Mineral matter (sand, silt, clay, loam)
  - Organic matter
    - Dead
    - Decomposing
    - **Living soil-borne organisms**

What organisms colonize our planet?

Three Domains and 23 Kingdoms of Life (Science, Vol. 275:1740) (all but three are microscopic)

Domain No. 1

Bacteria
(6 Kingdoms)

Domain No. 2

Arachaee
(6 Kingdoms)

Domain No. 3

Eukarya
Animals
Plants
Fungi
(8 other Kingdoms)

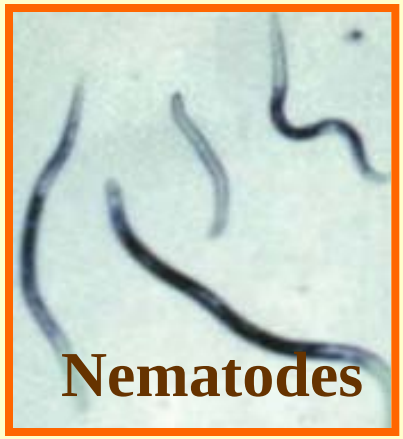
Viruses (chemical messengers)
ssRNA ssDNA
dsRNA ssRNA multiple components

Prions
(Protein fragments)

Function of Living Organisms

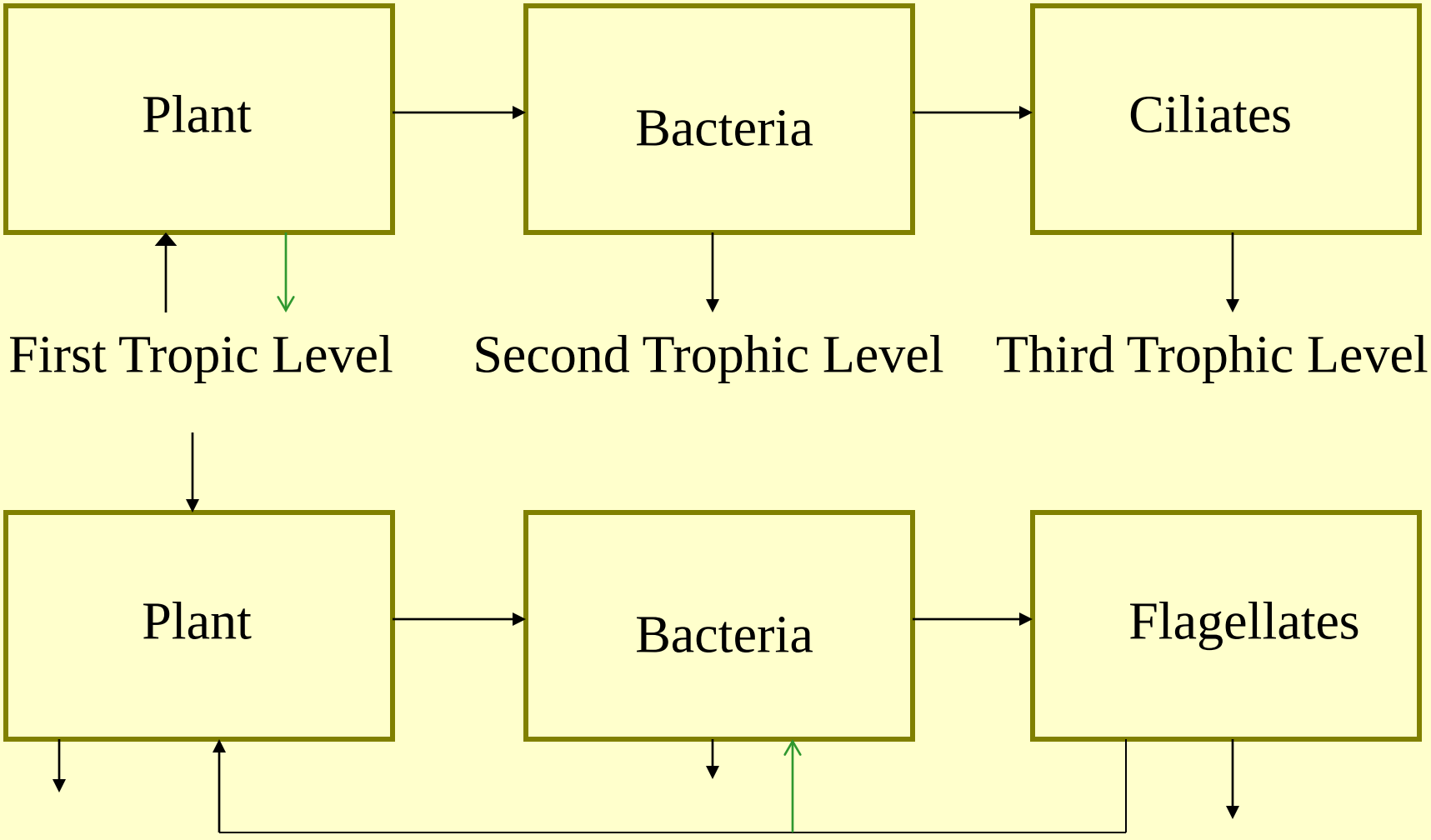
- Producers
  - Autotrophs
- Consumers
  - Heterotrophs

Soil as a Habitat

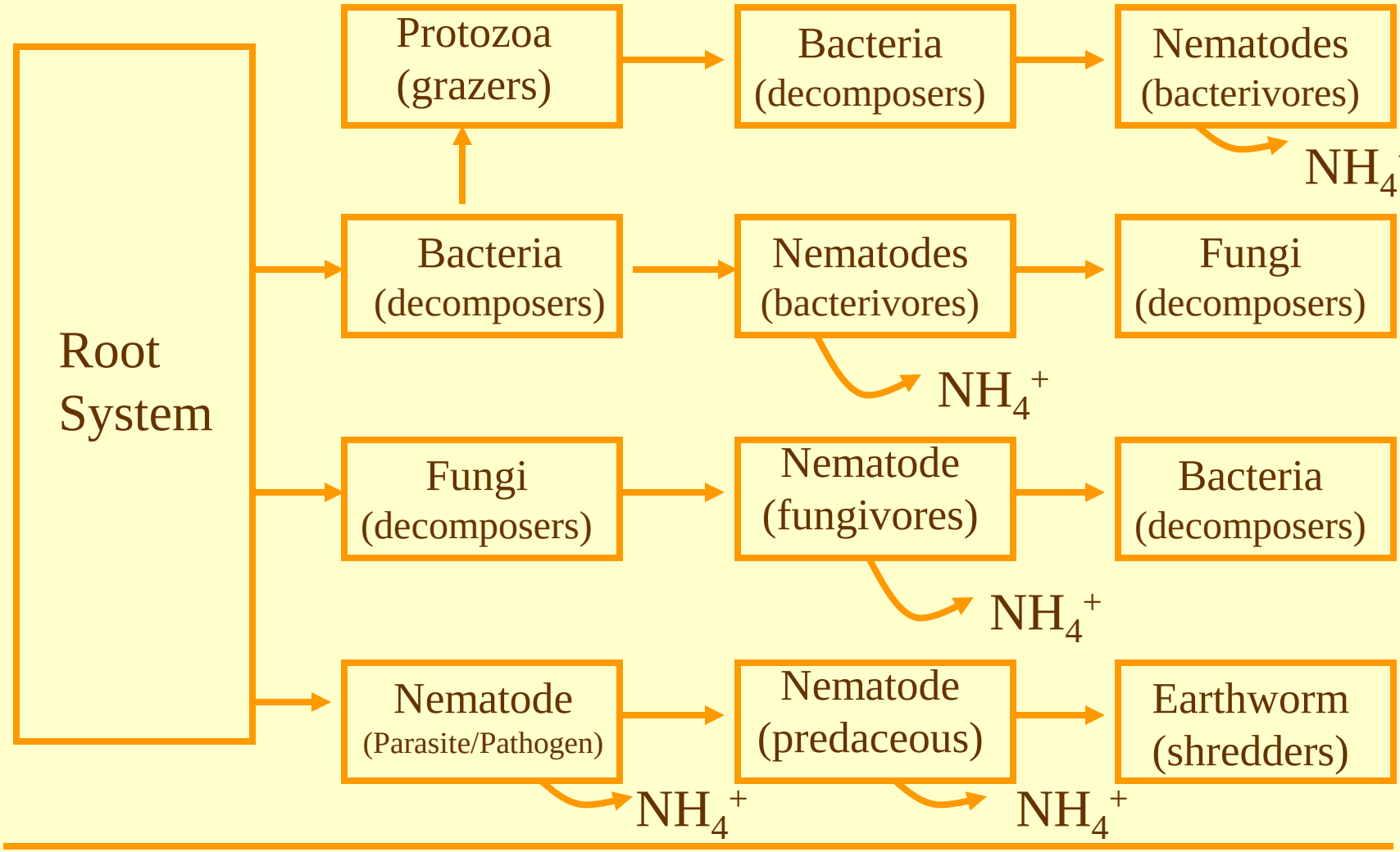


Ecosystem Structure Example

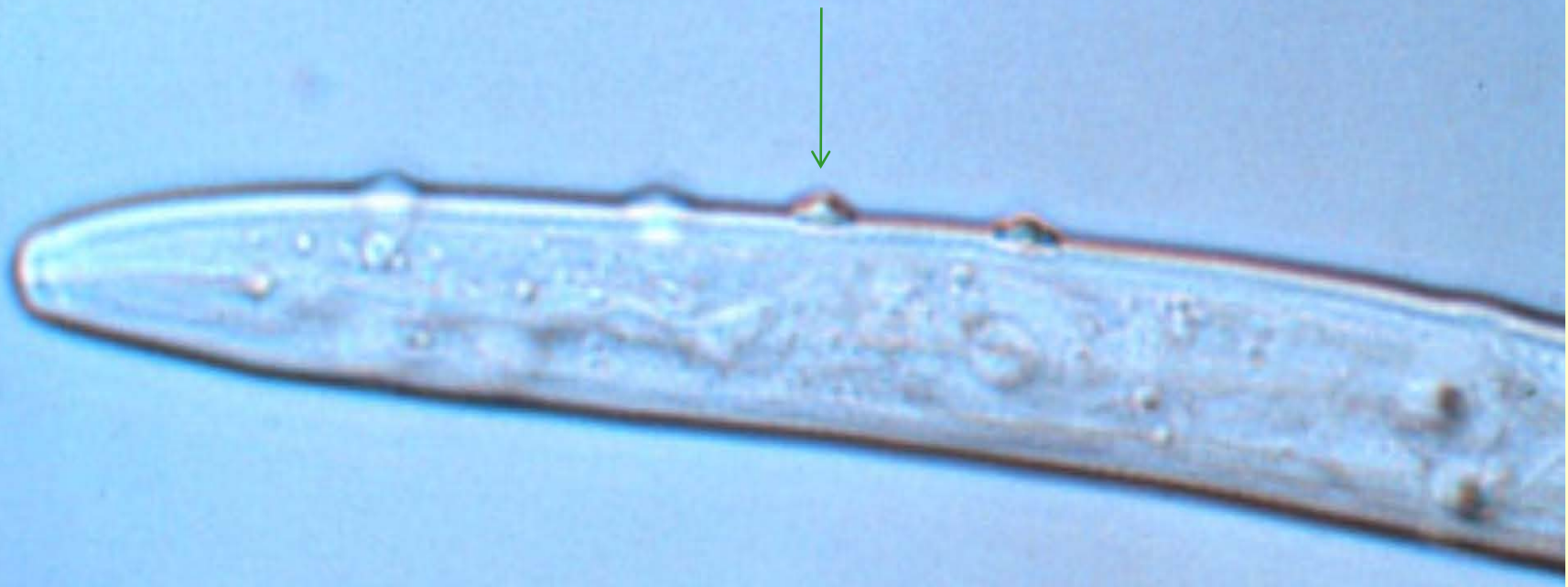
(food chain transport and transformation of matter and energy)



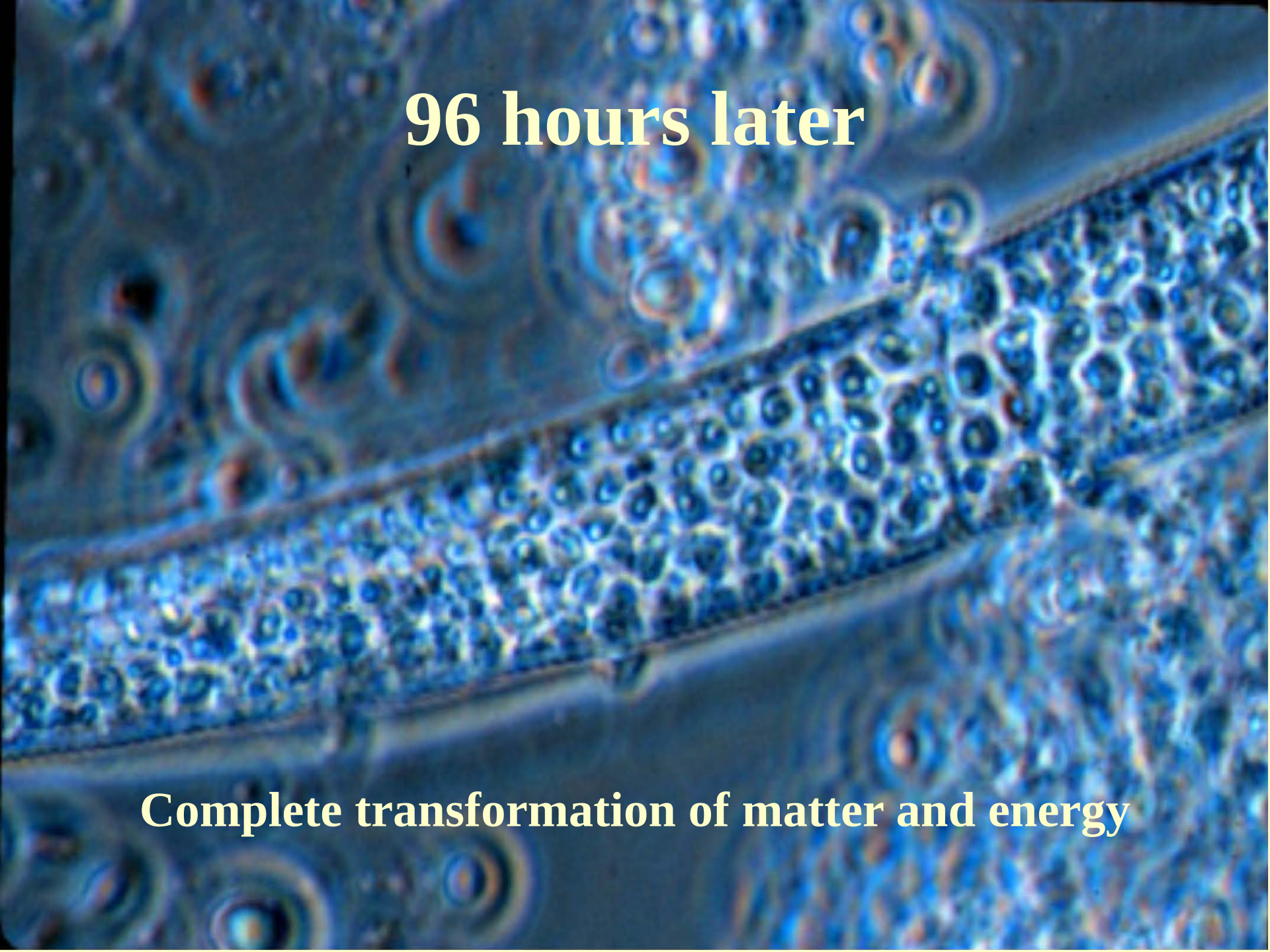
Example of a Below-Ground Food Web



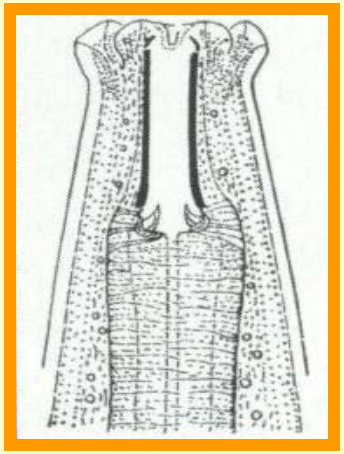
Nematode being colonized by bacteria



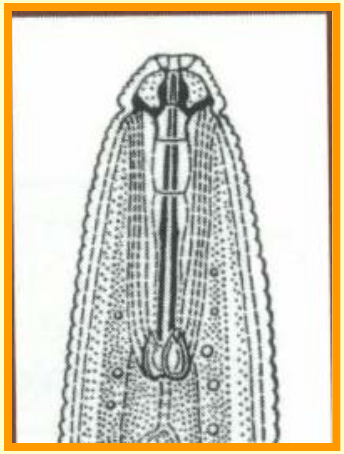
The microbes eat first!


96 hours later
Complete transformation of matter and energy

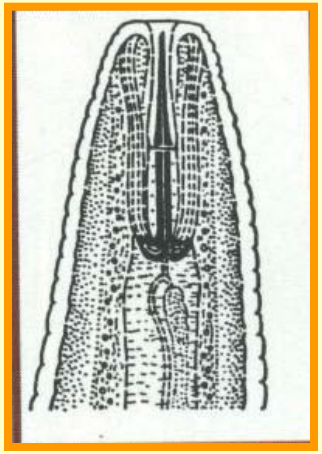
Nematode Feeding Types



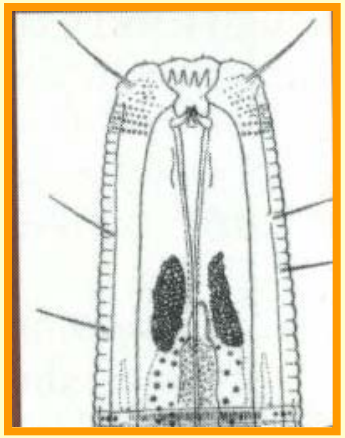
Bacterial Feeders



Plant Feeders

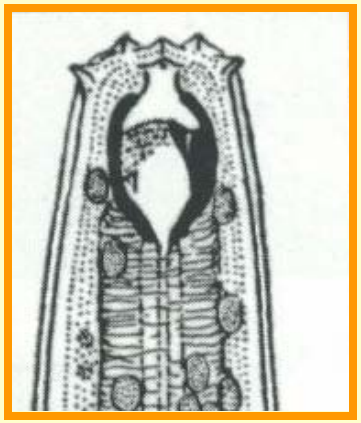


Fungal Feeders



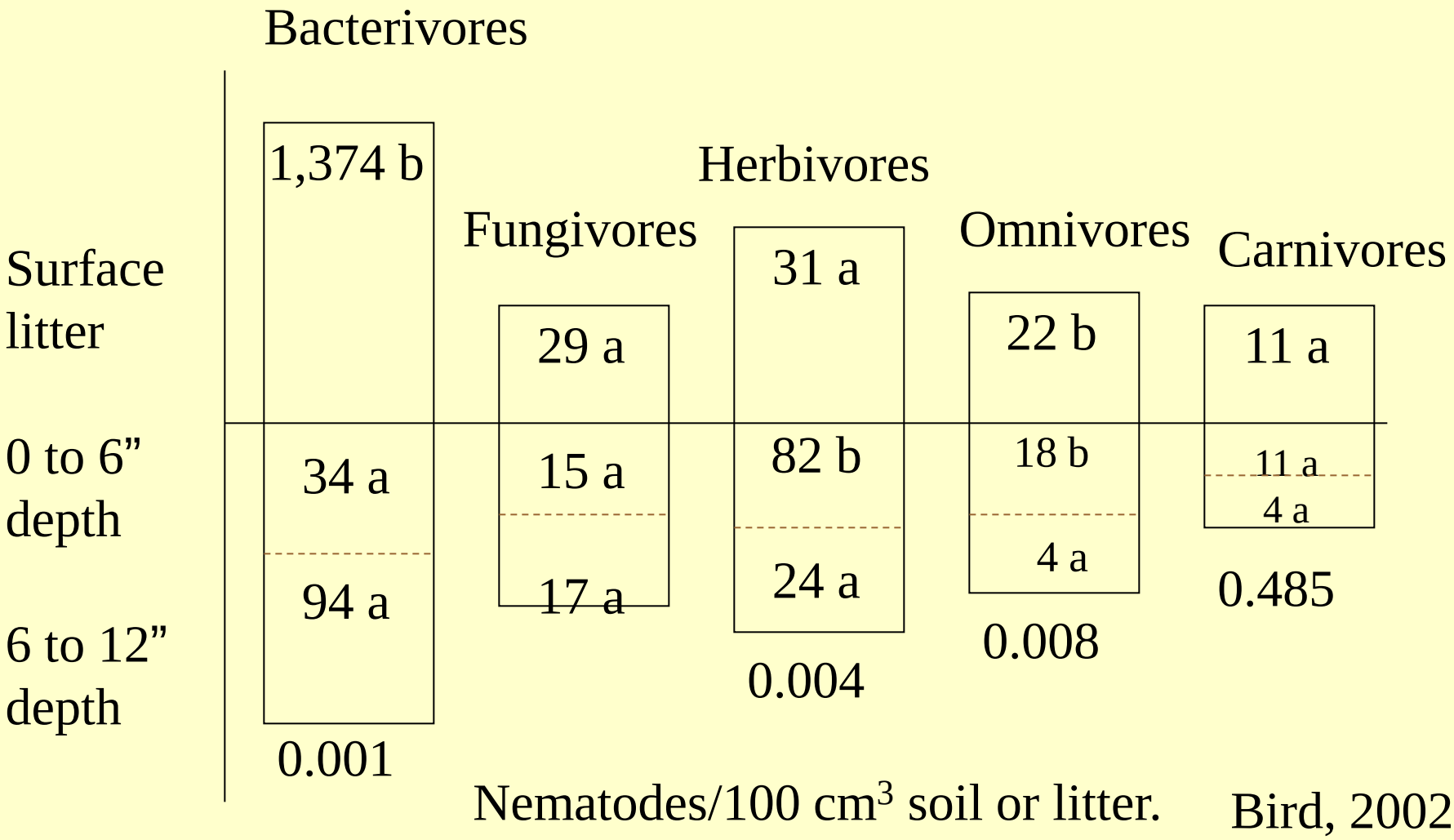
Algal Feeders

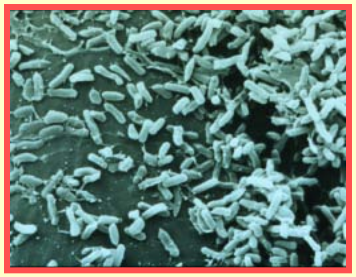
Omnivores



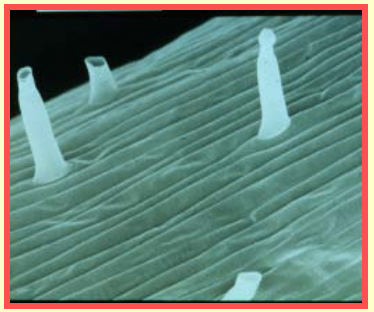
Carnivores

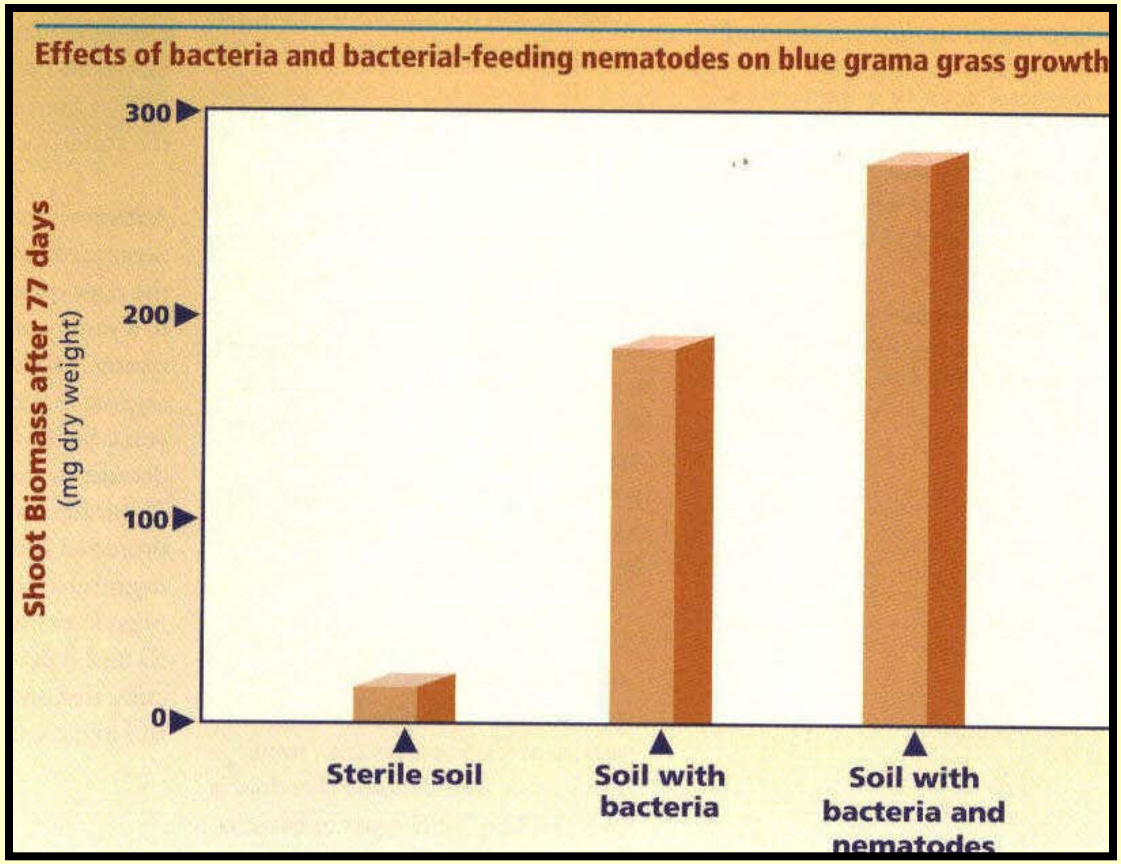
Where are nematodes located in soil?



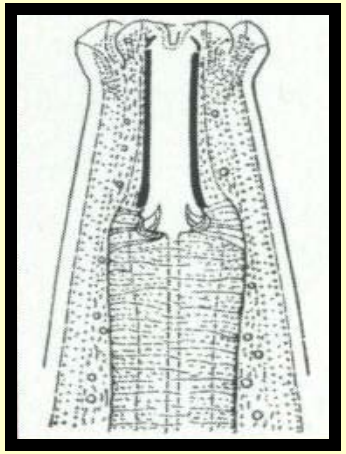


Primary Productivity





Ingham, R. *et al*. 1985. Ecological Monographs 55:199-140.



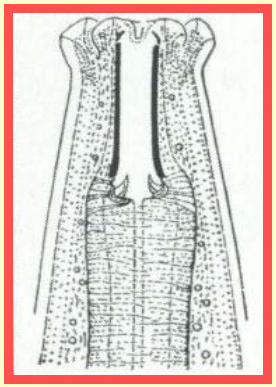
Chemistry

- Organic Chemistry
  - Co-valent bonding (sharing electrons)
- Inorganic Chemistry
  - Ionic bonding (unlike charges bond)

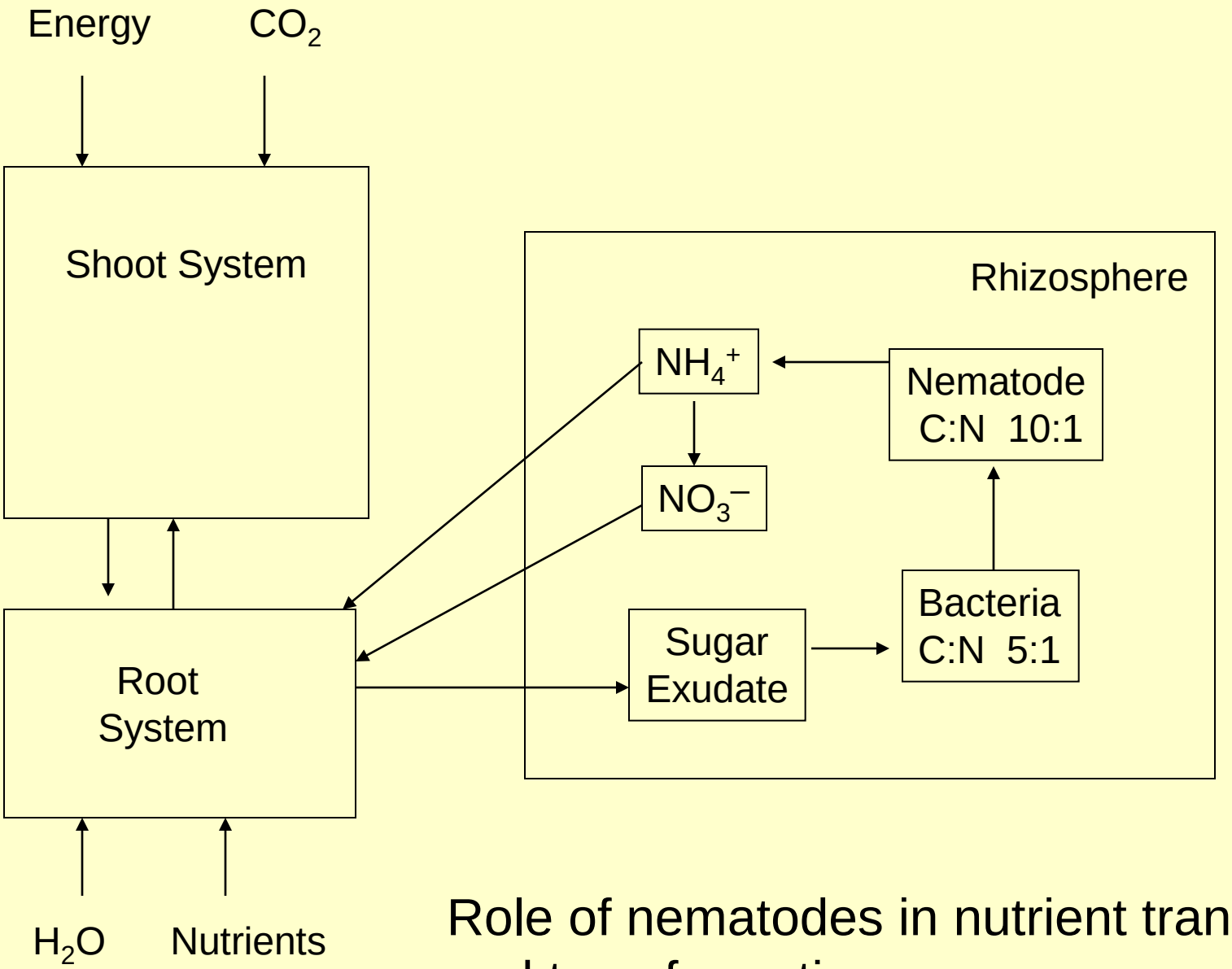
Bacteria (Consumer/Decomposers)

- ≈ 5:1 (C:N ratio)
- Feed/Metabolize
- Immobile C and N
- Mineralize C and N
- Replicate
- Hybernate
- Die (consumed)

Nematodes (Consumers)



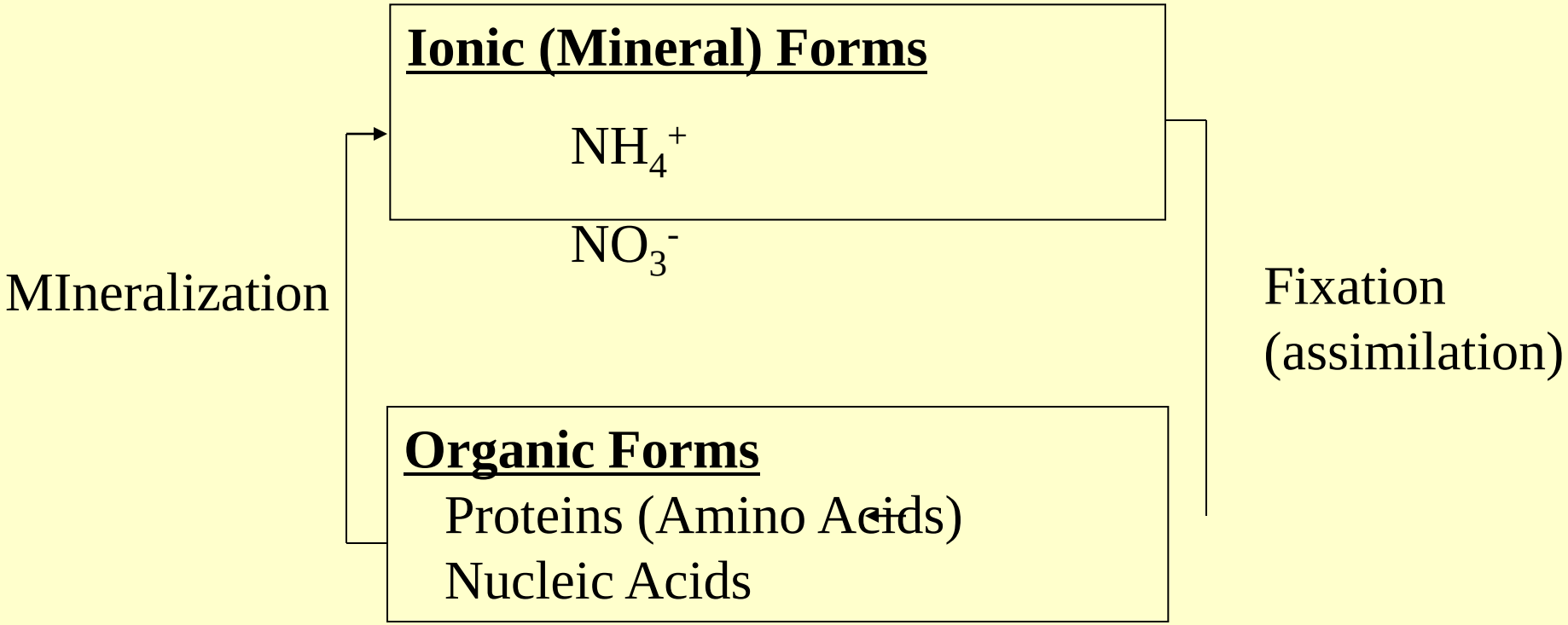
- 10:1 (C:N ratio)
- Feed (Bacterivores)
- Release NH_4^+
- Mobilize C and N
- Reproduce
- Hybernate
- Die



Role of nematodes in nutrient transport and transformation

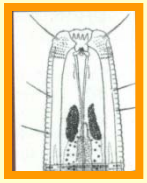
Bird, 2002

Mineralization-Fixation
Nitrogen Transport and Transformation



Bird, 2004

Bacterivore



Algavore

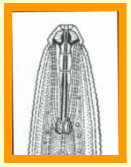
n

Enrichment Index

0

SQTB Non-stable but Nutrient Enriched	**SQTA** Stable, Enriched and Regenerative
SQTF Non-stable and Nutrient Depleted	**SQTC** Stable, but Nutrient Depleted

Carnivore



Herbivore

Structural

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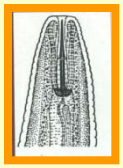
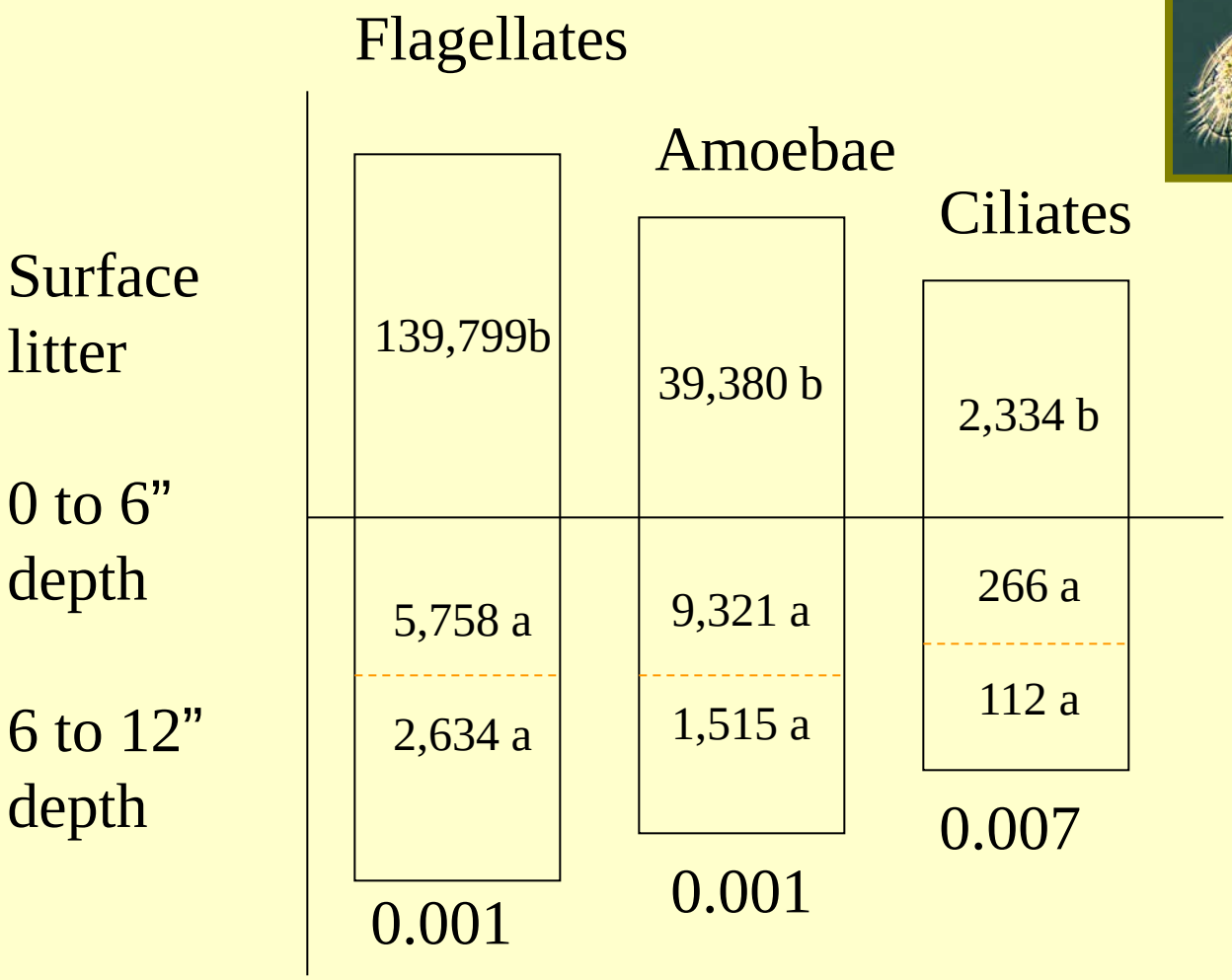


Fungivore

Omnivore



Vertical distribution and population density of organisms associated with eight cherry orchards in northern Michigan.

Bird, 2002

Flagellates

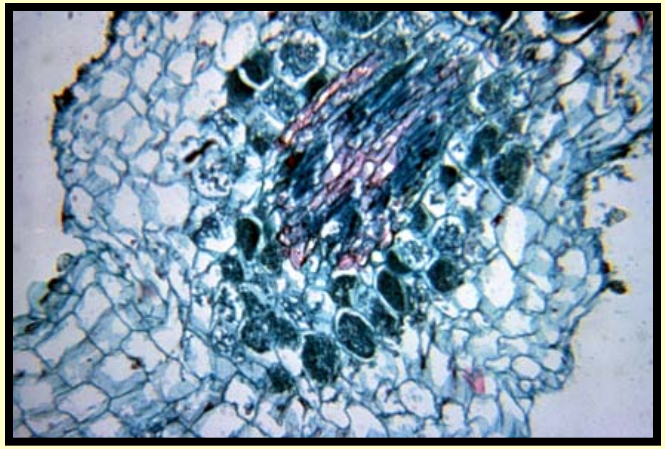
	Organic	Conventional
Surface litter	258,344	21,235
0 to 6” depth	6,991	4,524
6 to 12” depth	2,342	2,928

Comparative distributions and population densities of organisms associated with four organic and four conventional Michigan cherry orchards.

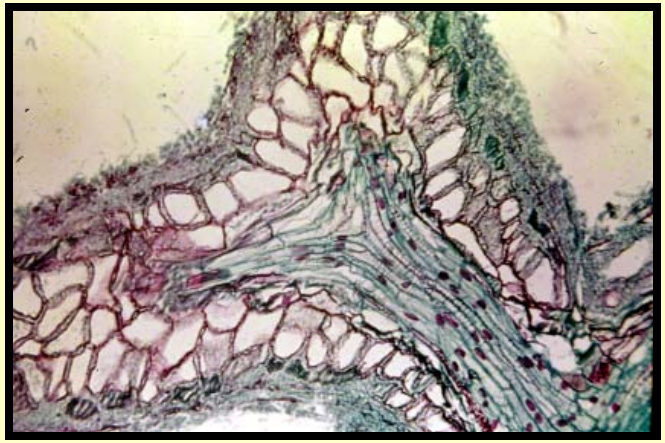
Bird, 2002

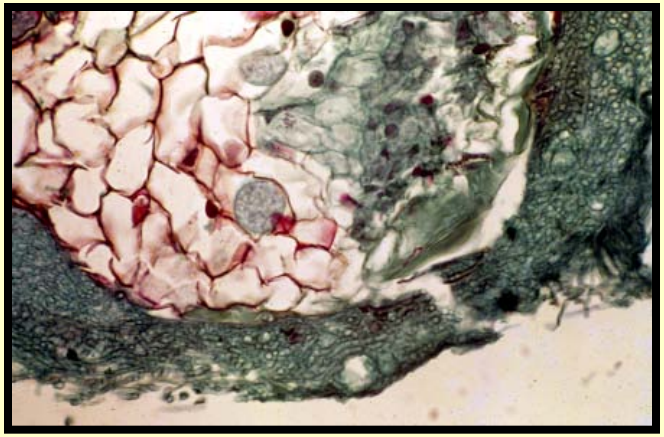
Mycorrhizal Fungi

Endomycorrhizae



Ectomycorrhizae





Soil can be a sleepy place, but when activated it is dynamic and a place where organisms interact to transform-transport matter and energy.

Structure + Process→Pattern?

An Eleventh Commandment

Walter Clay Lowdermilk (1939)

-Thou shalt inherit the holy earth as a faithful steward conserving its resources and productivity from generation to generation.

-Thou shalt safeguard

thy fields from ***soil*** *erosion,*
thy living waters from drying up,
thy forests from desolation, and
protect thy hills from overgrazing by the herds,

- that thy descendants may have abundance forever.

- If any shall fail in this stewardship of the land,

thy fruitful fields shall become sterile stony ground or wasting gullies, and
thy descendants shall decrease and
live in poverty or
perish from off the face of the earth.

Sustainable Systems:

- Regenerative in nature through ecological interdependence and partnerships,

- Based on families, vibrant local communities and a philosophy of intergenerational equity,

- Generate appropriate wealth through work,

- Foster a commerce with morality, and

- Provide leadership for politics with principles.