Adventist Agricultural Association
4th Annual Convention
2018
Session 1

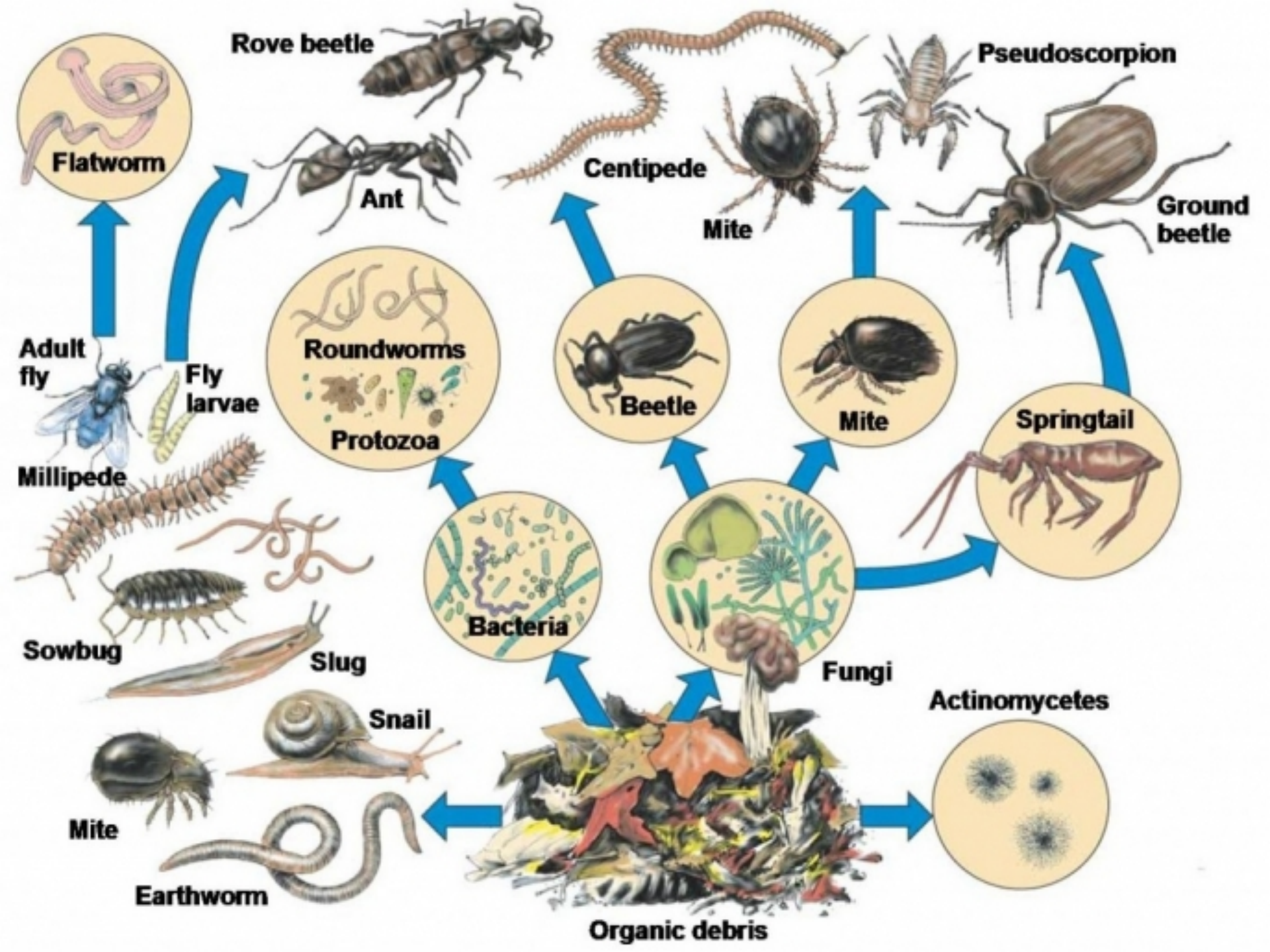
Soil the plant stomach

PRESENTED BY:

MICHAEL ROCKY TREVIZO

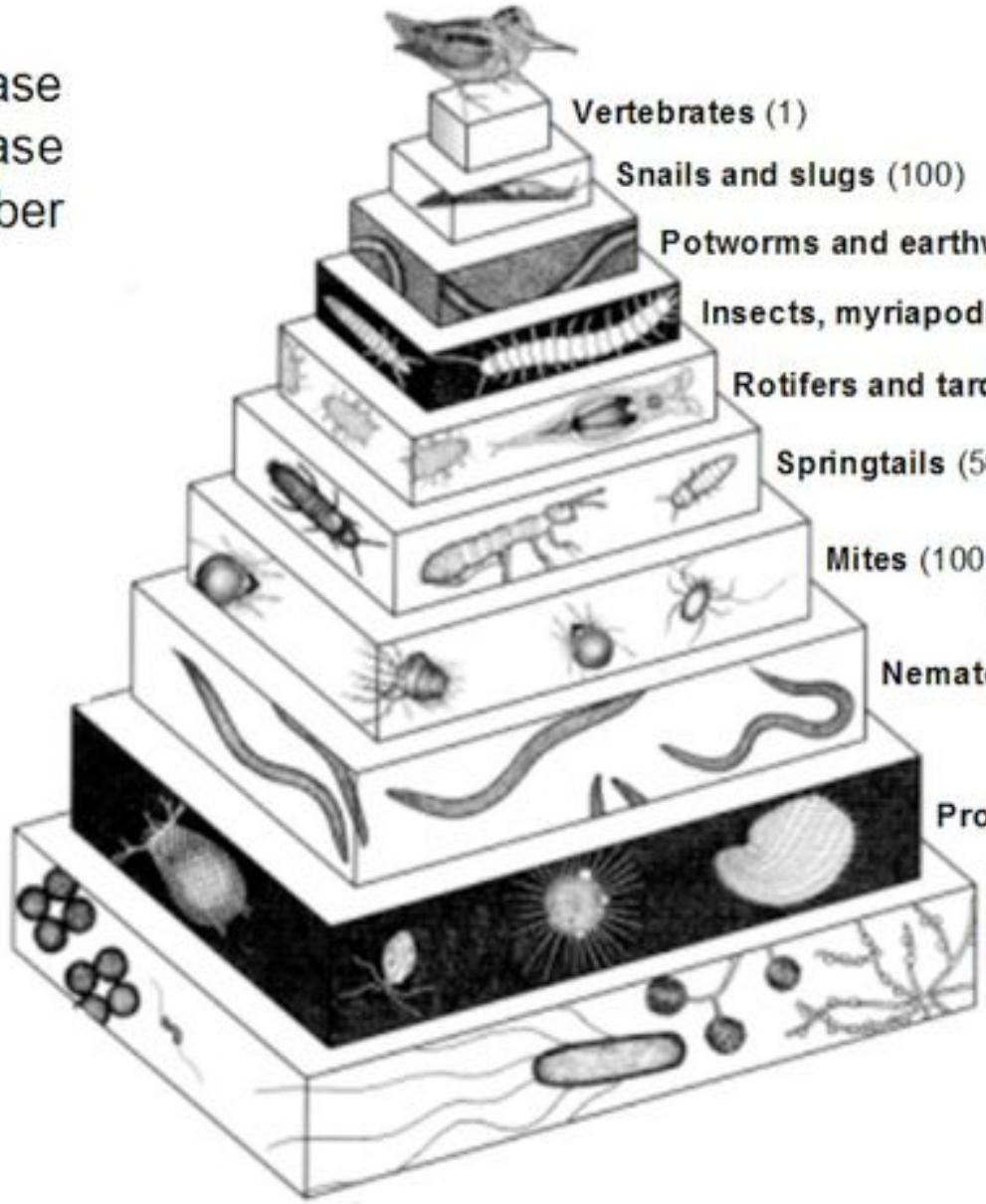
The Soil Food Web

First trophic level:	Second trophic level:	Third trophic level:	Fourth trophic level:	Fifth & higher trophic level:
Photosynthesizers	Decomposing Mutualists Pathogens, Parasites Root-feeders	Shredders Predators Grazers	Higher level predators	Higher level predators


Rove beetle
Pseudoscorpion
Flatworm
Centipede
Ant
Mite
Ground beetle
Roundworms
Protozoa
Beetle
Mite
Springtail
Adult fly
Fly larvae
Millipede
Bacteria
Fungi
Sowbug
Slug
Snail
Actinomycetes
Mite
Earthworm
Organic debris

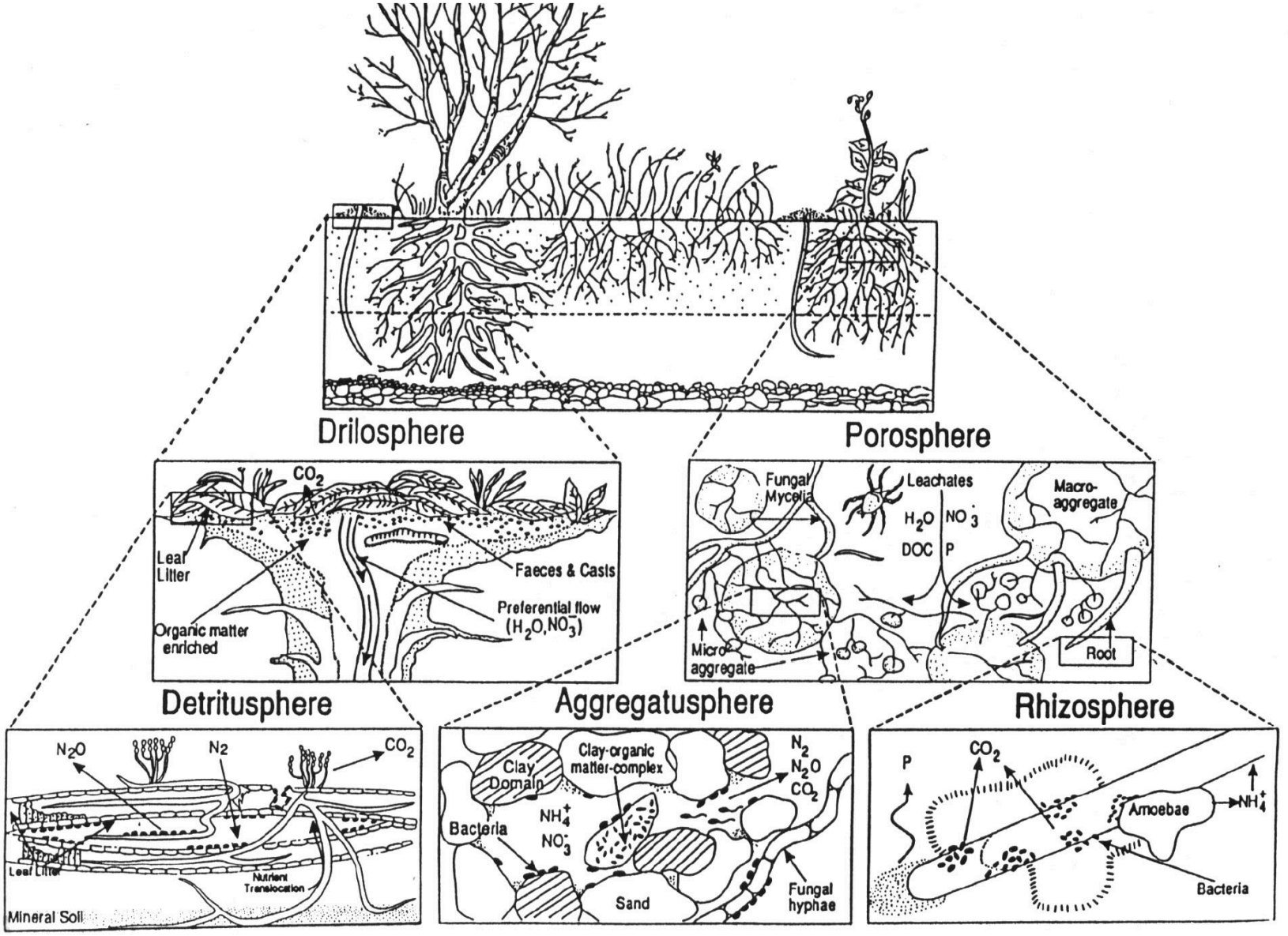
In one square meter of soil....

Organisms decrease in size and increase in number



Soil Microhabitats

Everything is everywhere and the milieu selects – Martinus Beijerinck



Rhizosphere

Rhizosphere

- Soil under root influence (<1 mm to >1 cm)

Rhizoplane

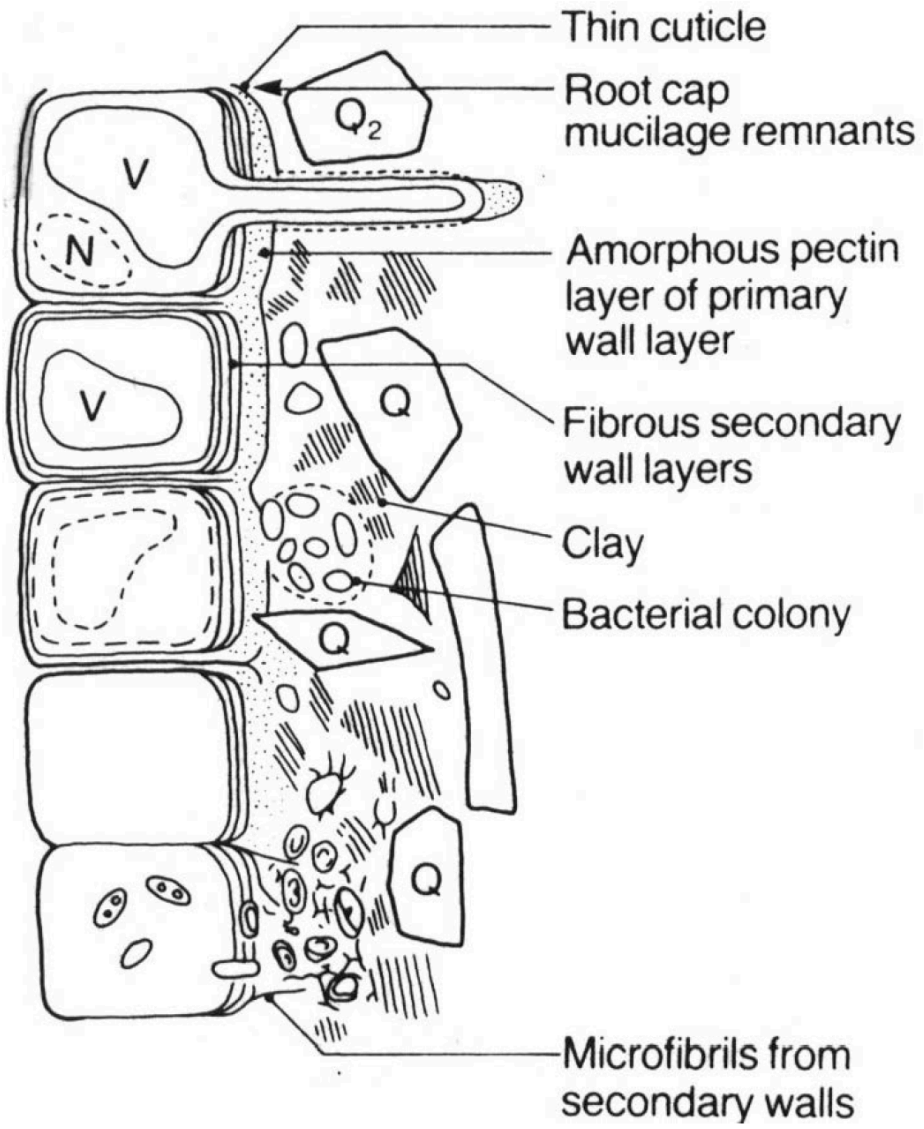
- Root surface (<100 µm)

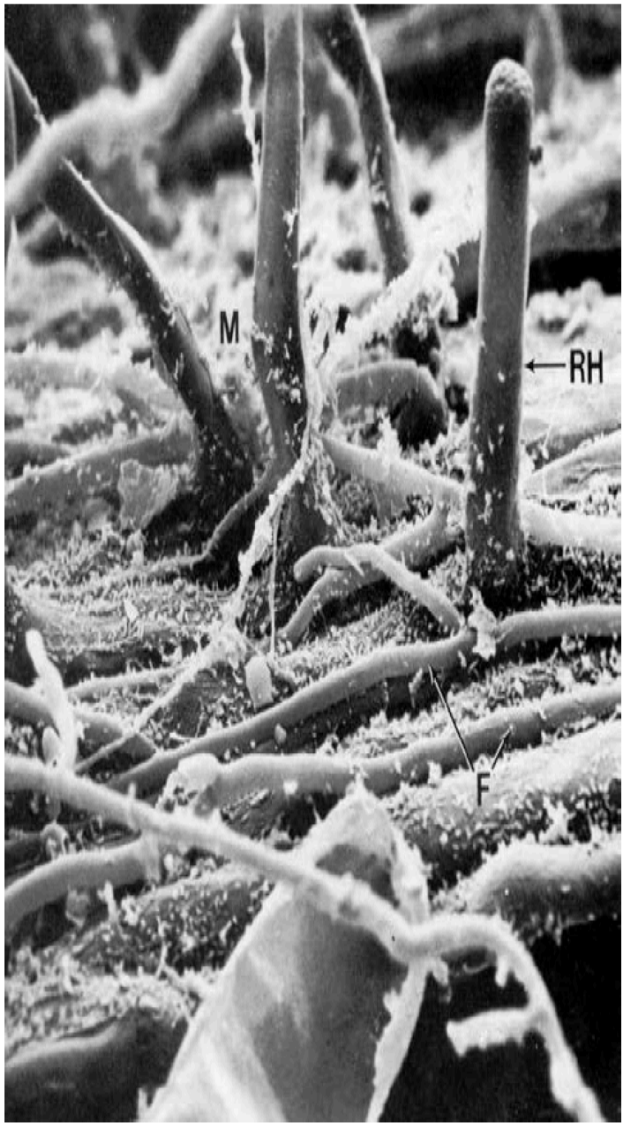
Mycorhizosphere

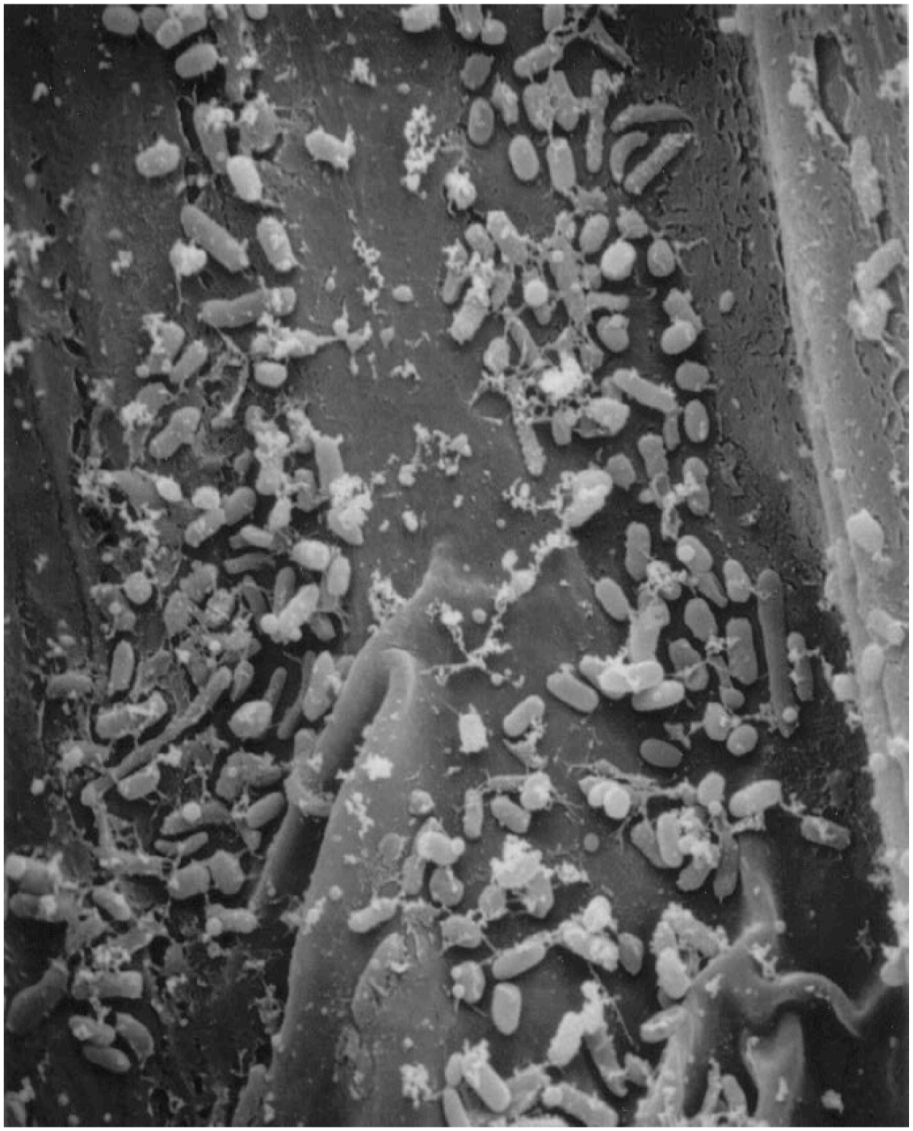
- Volume of soil influenced by mycorrhizae

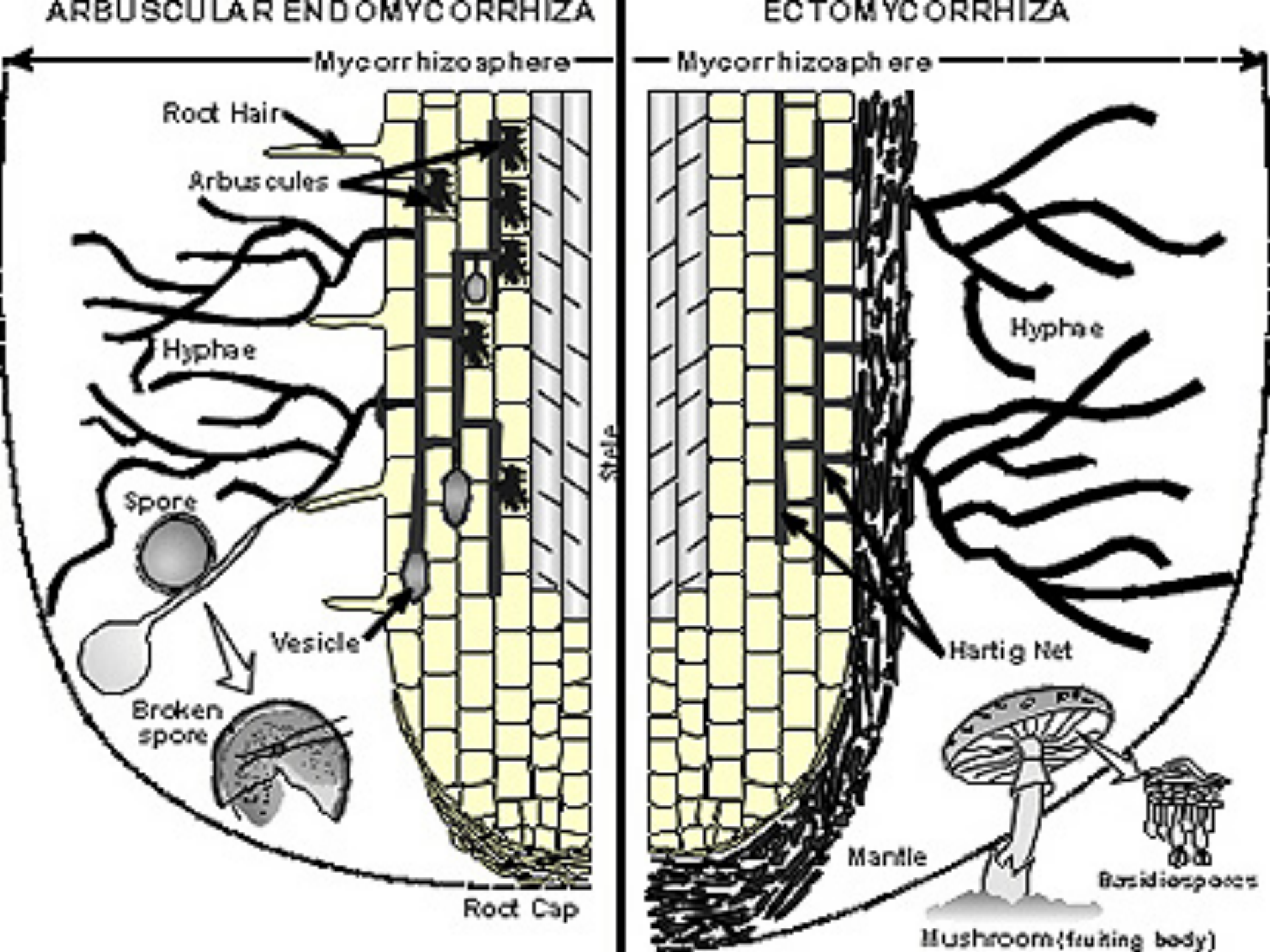
Spermosphere

- Volume of soil influenced by germinating seed

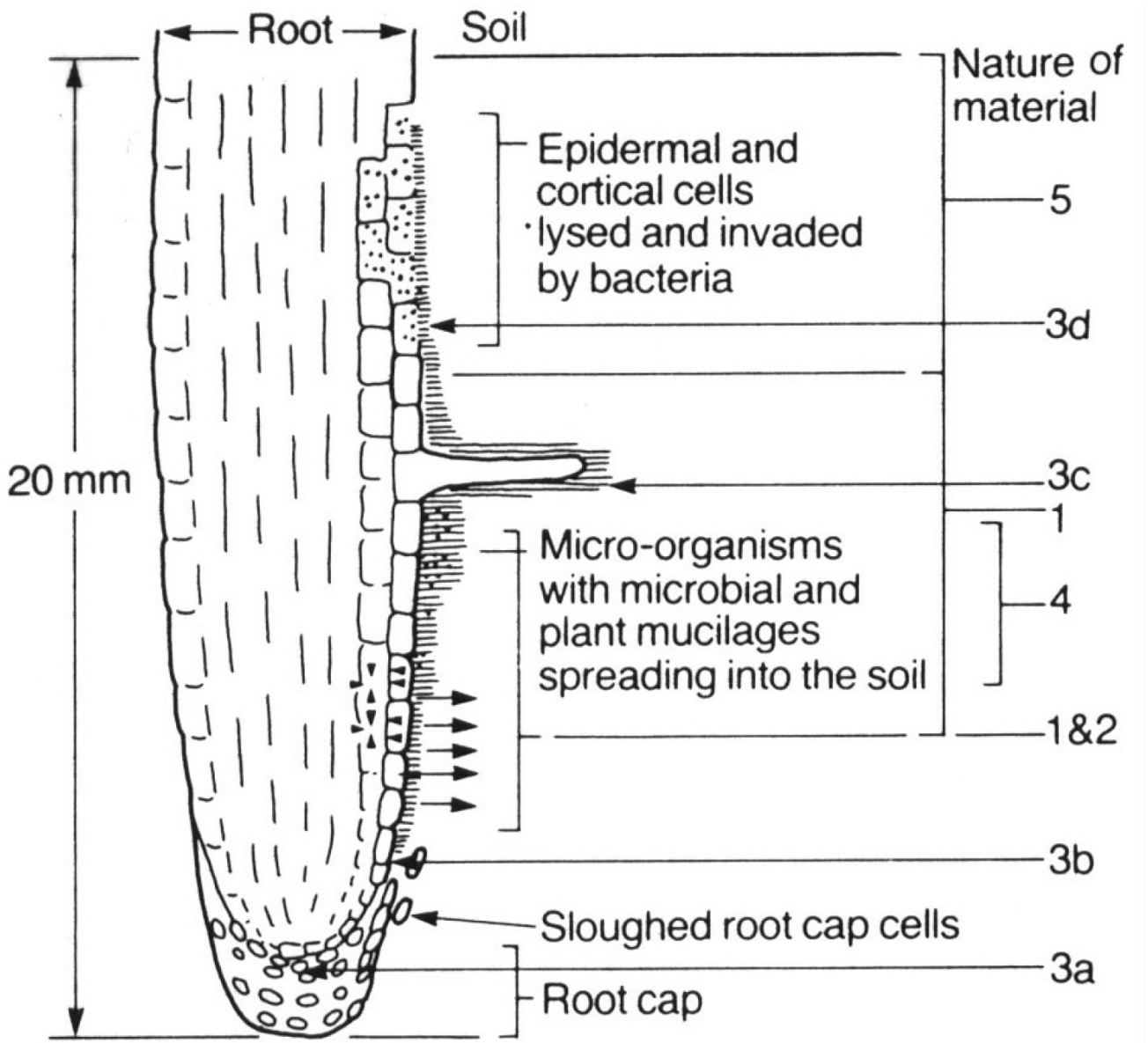



M
RH
F




ARBUSCULAR ENDOMYCORRHIZA
ECTOMYCORRHIZA
Mycorrhizosphere
Mycorrhizosphere
Root Hair
Arbuscules
Hyphae
Spore
Vesicle
Broken spore
Stele
Root Cap
Hyphae
Hartig Net
Mantle
Basidiospores
Mushroom (fruiting body)

Organic Inputs to Rhizosphere



1. Exudates
2. Secretions
3. Mucilages
4. Mucigel
5. Lysates

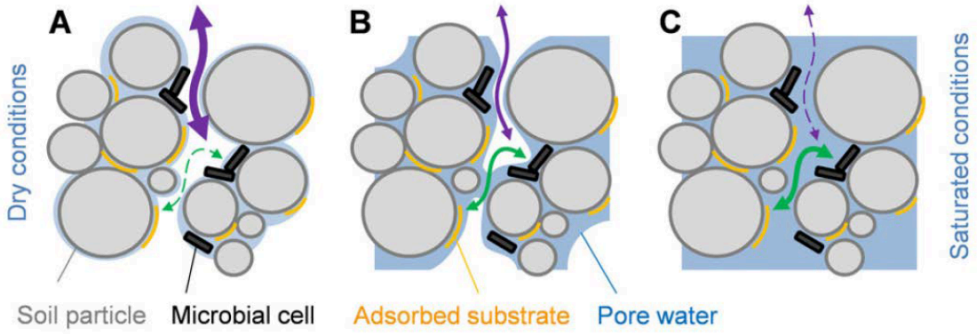
Water Effects

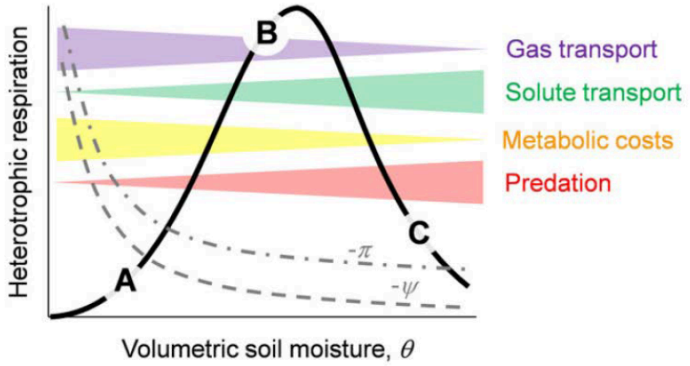
Oxygen Limited

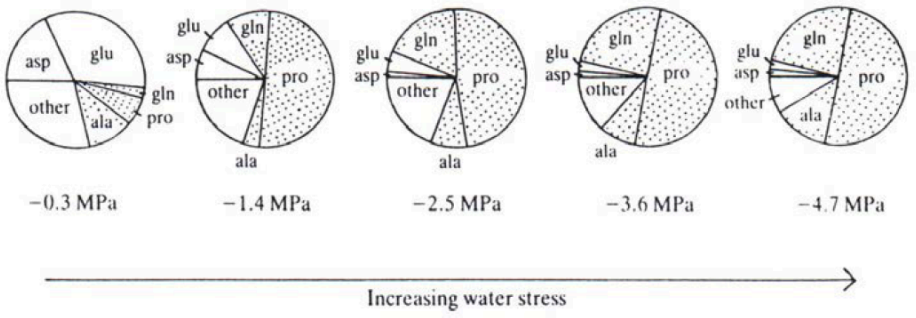
- O_2 diffusion limited
  - $D_{O2,air}$ 10,000 times $D_{O2,water}$

Water Limited

- Substrate diffusion limited
  - Diffusion function of path-length (tortuosity) and diffusion coefficient
- Physiological stress
  - Osmoregulation with inorganic salts or compatible solutes

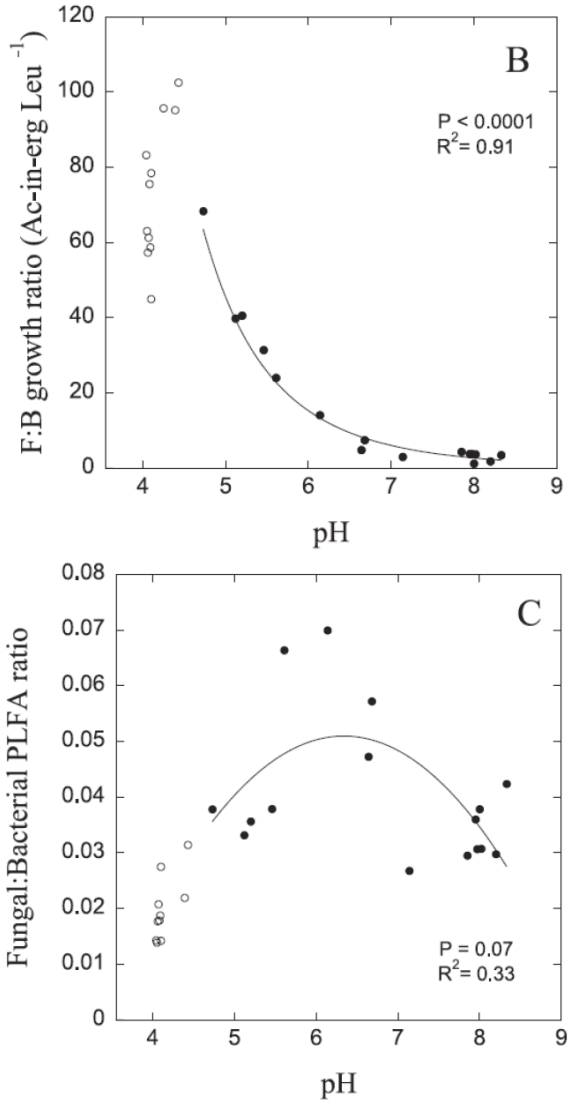


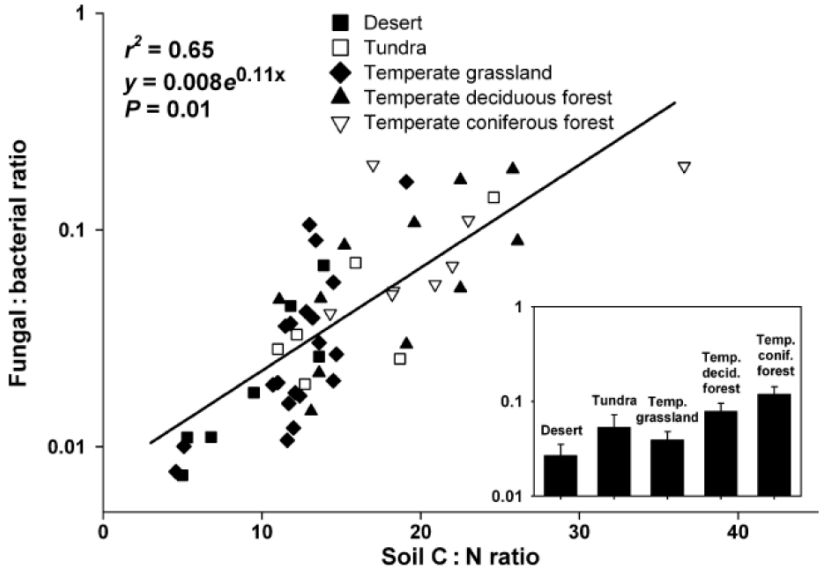




Moyano et al. (2013) *Soil Biol Biochem* 59:75

pH: Fungal:Bacterial Ratios



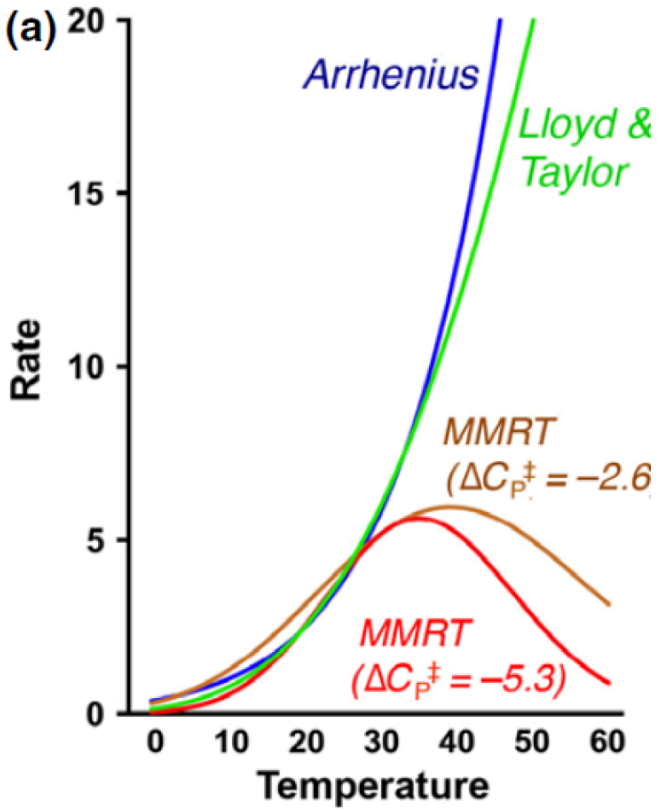


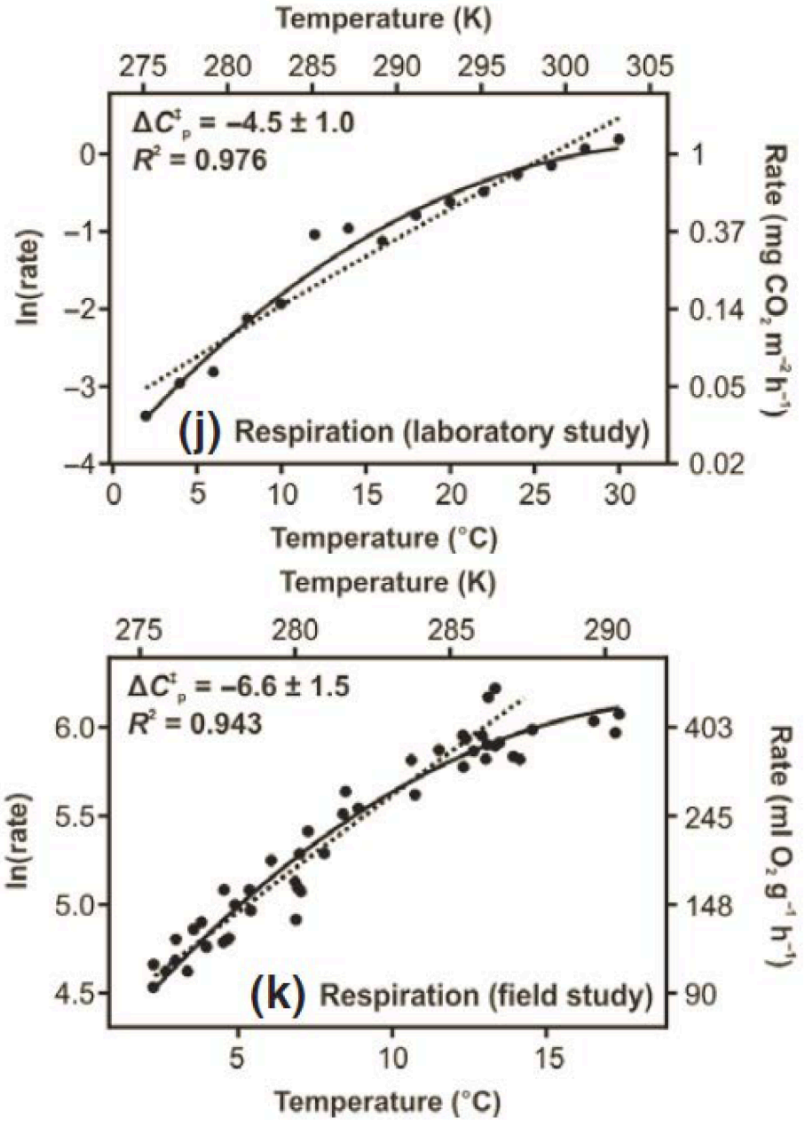
Rousk et al. (2009) *Appl Environ Microbiol* 75:1589
Fierer et al. (2009) *Ecol Lett* 12:1238

Modeling Temperature Effects

MMRT—macromolecular rate theory

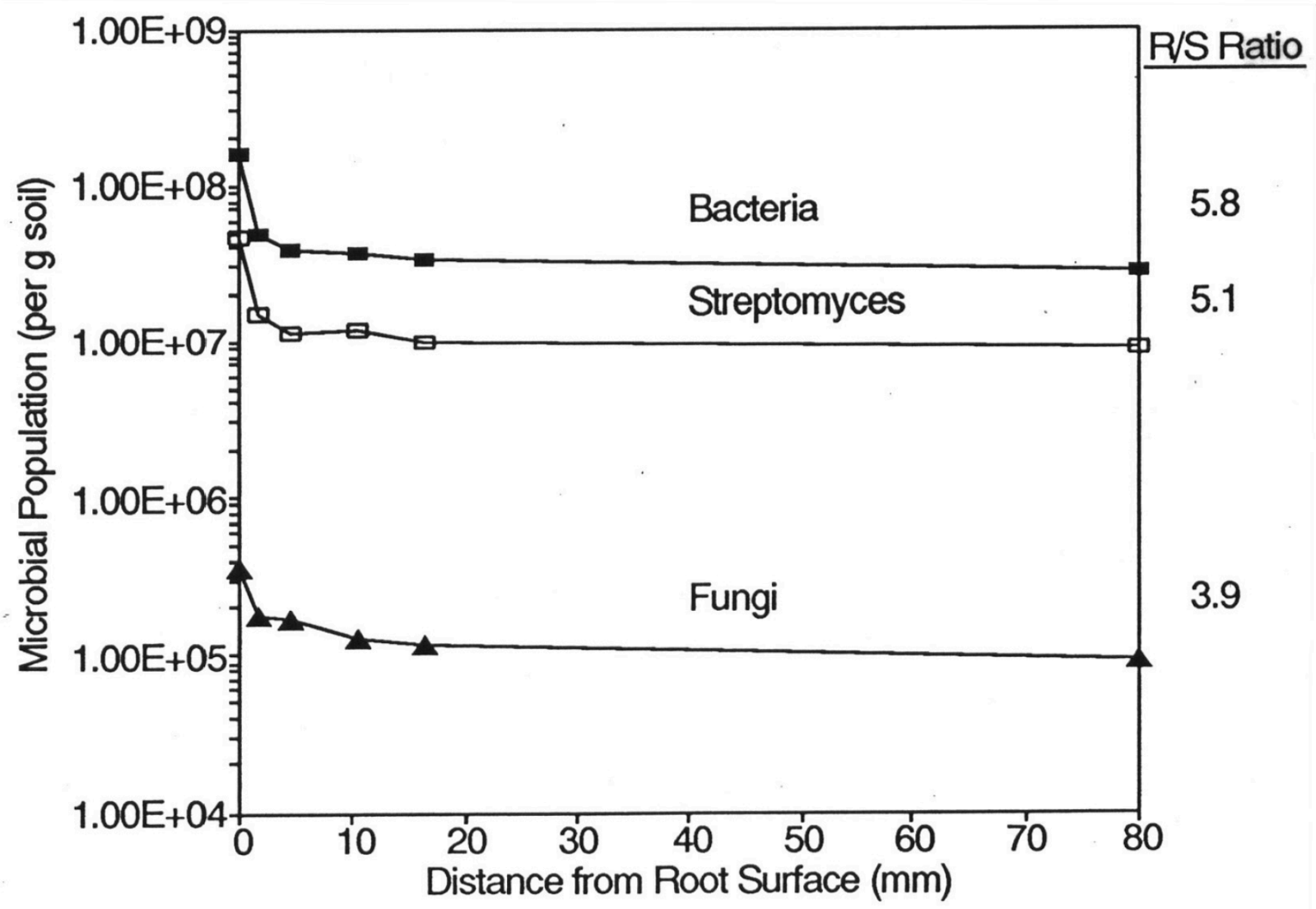
$$\ln(k) = \ln\left(\frac{k_B T}{h}\right) - \frac{\Delta H^{\ddagger}_{T_0} + \Delta C^{\ddagger}_P (T - T_0)}{RT} + \frac{\Delta S^{\ddagger}_{T_0} + \Delta C^{\ddagger}_P (\ln T - \ln T_0)}{R}$$





Schipper et al. (2014) *Global Change Biol* 20:3578

The Rhizosphere Effect

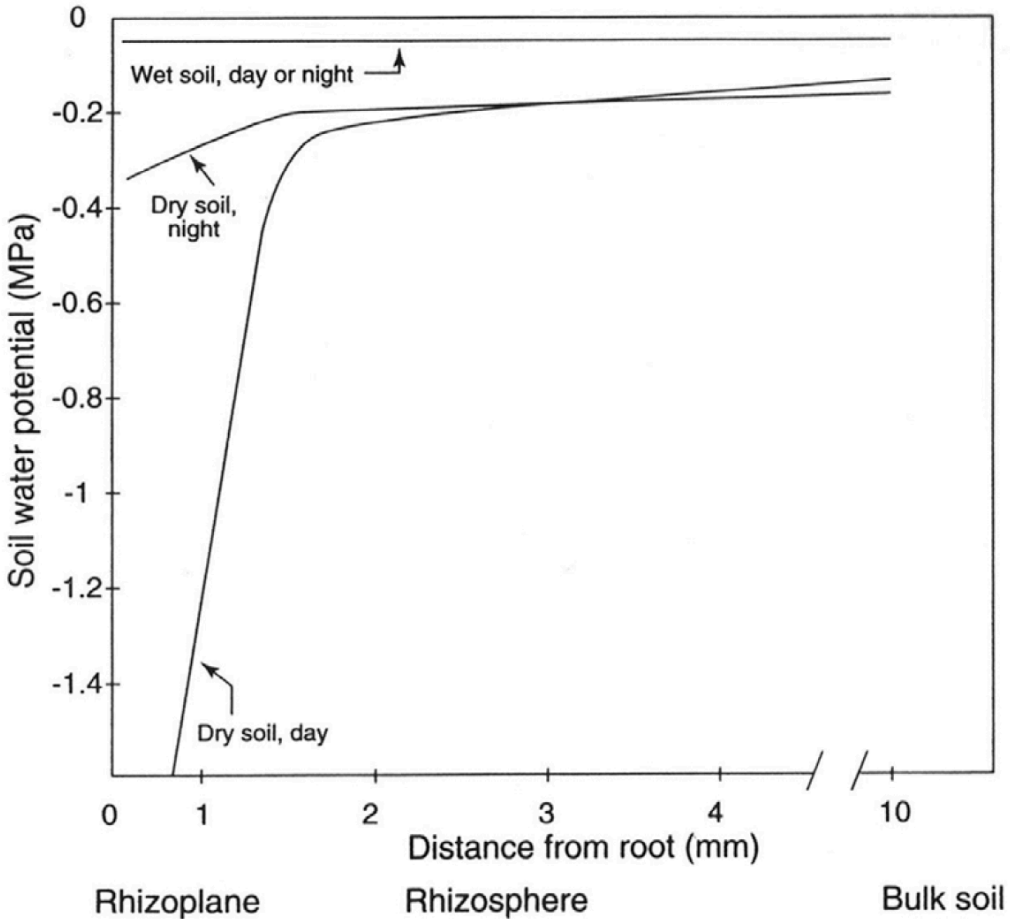


Other Rhizosphere Characteristics

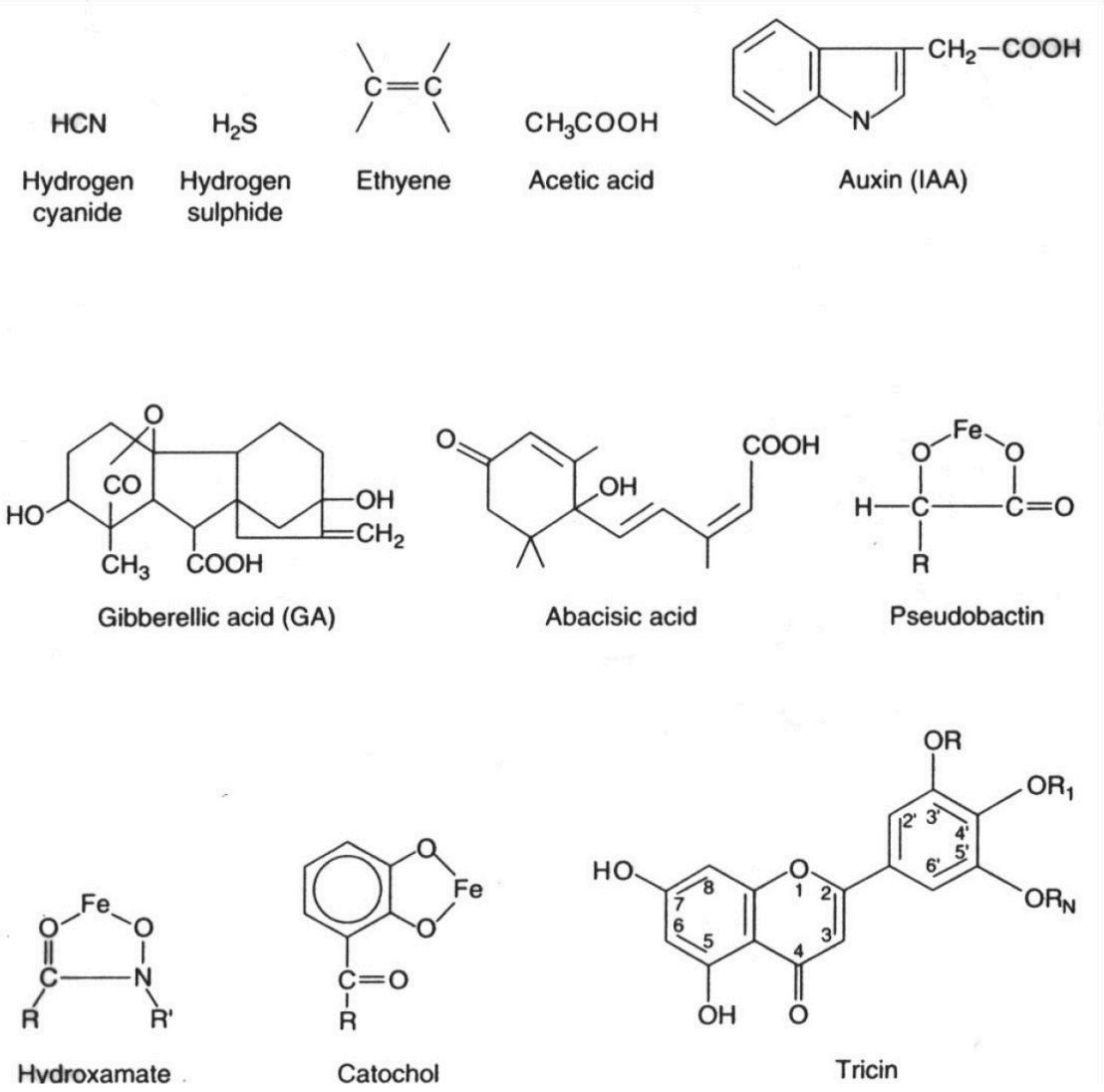
Water Uptake

Nutrient Uptake

- Nutrient depletion vs. constant flux
- pH shifts (NH_4^+ vs. NO_3^-)
- Extracellular enzymes



Composition of Exudates



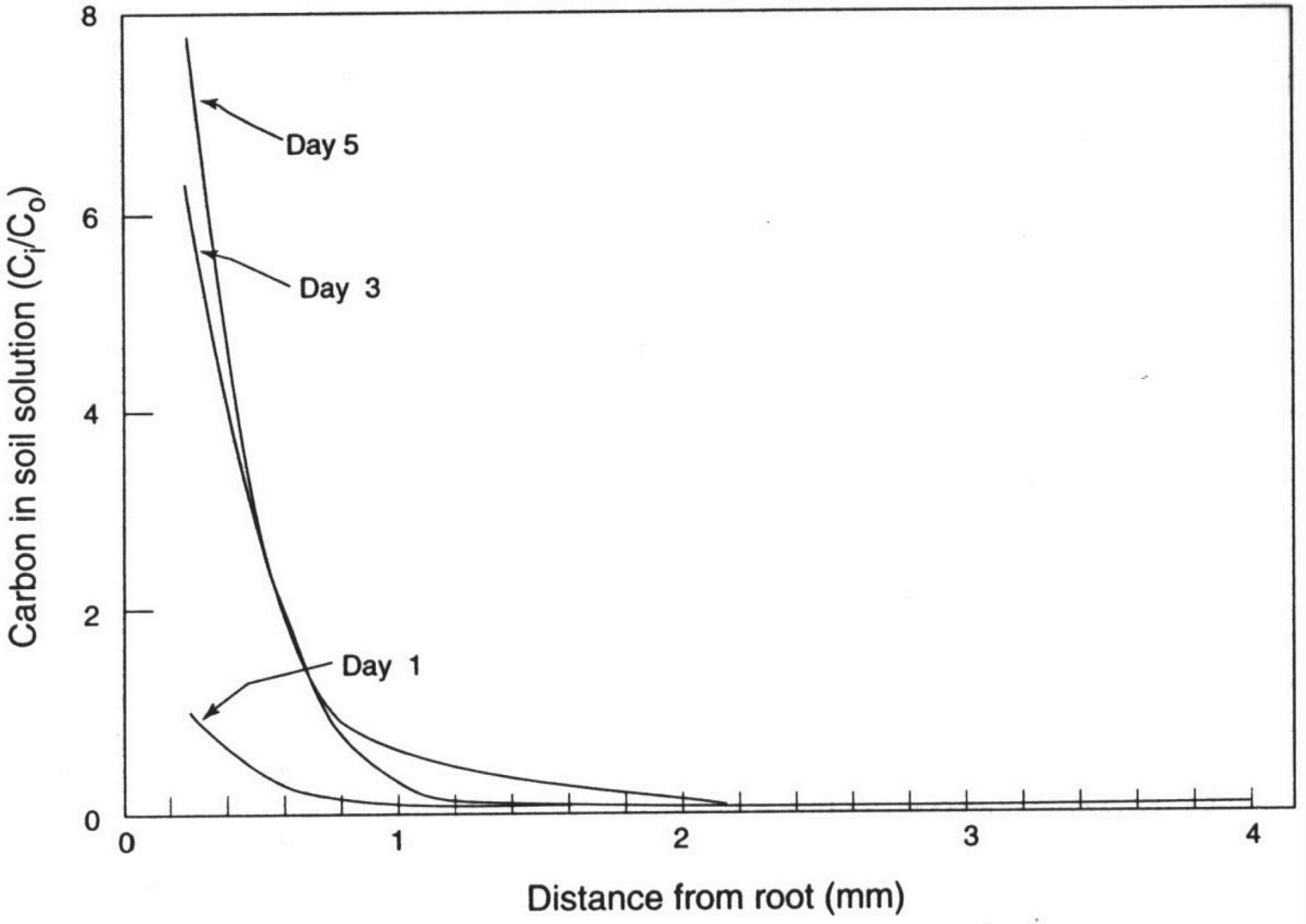
General compounds

- Sugars, amino acids, organic acids, etc.

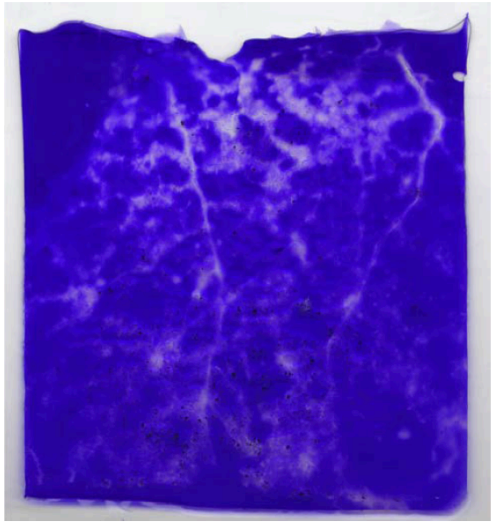
Specific compounds

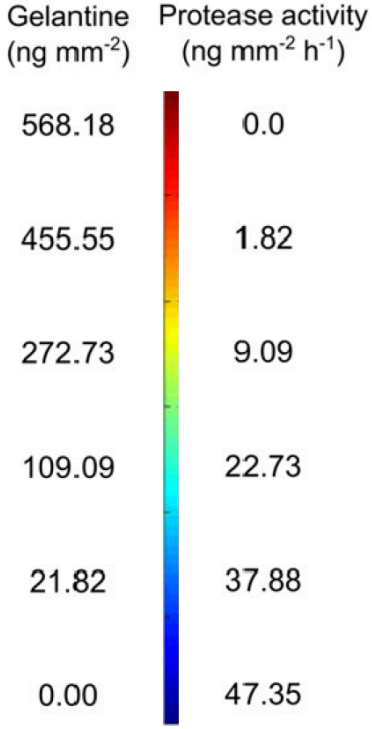
- Plant hormones
- Siderophores
- Allelopathic compounds
- Symbiosis signals

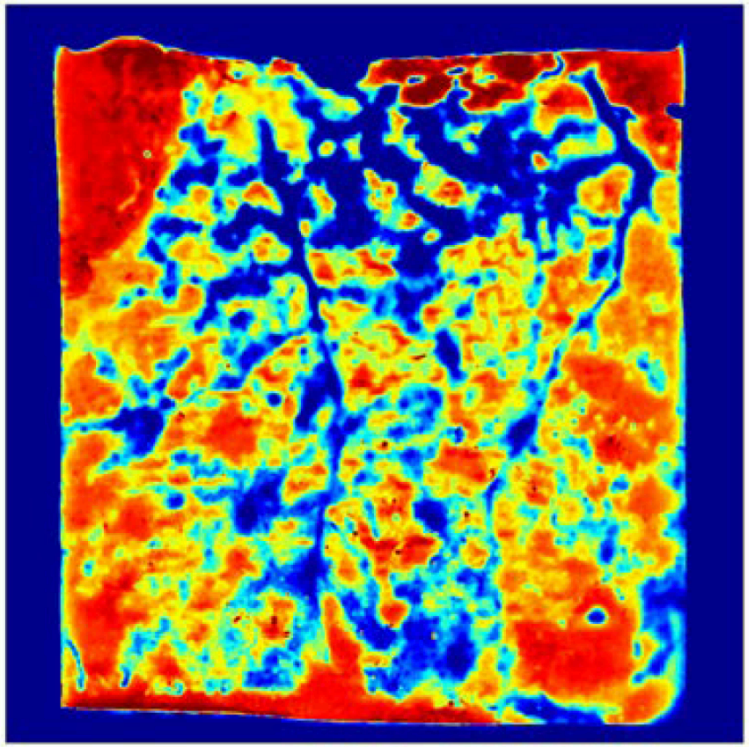
Spatial Extent of Exudates



Other Rhizosphere Characteristics







Spohn et al. (2013) *Soil Biol Biochem* 58:275

Rhizosphere Dynamics