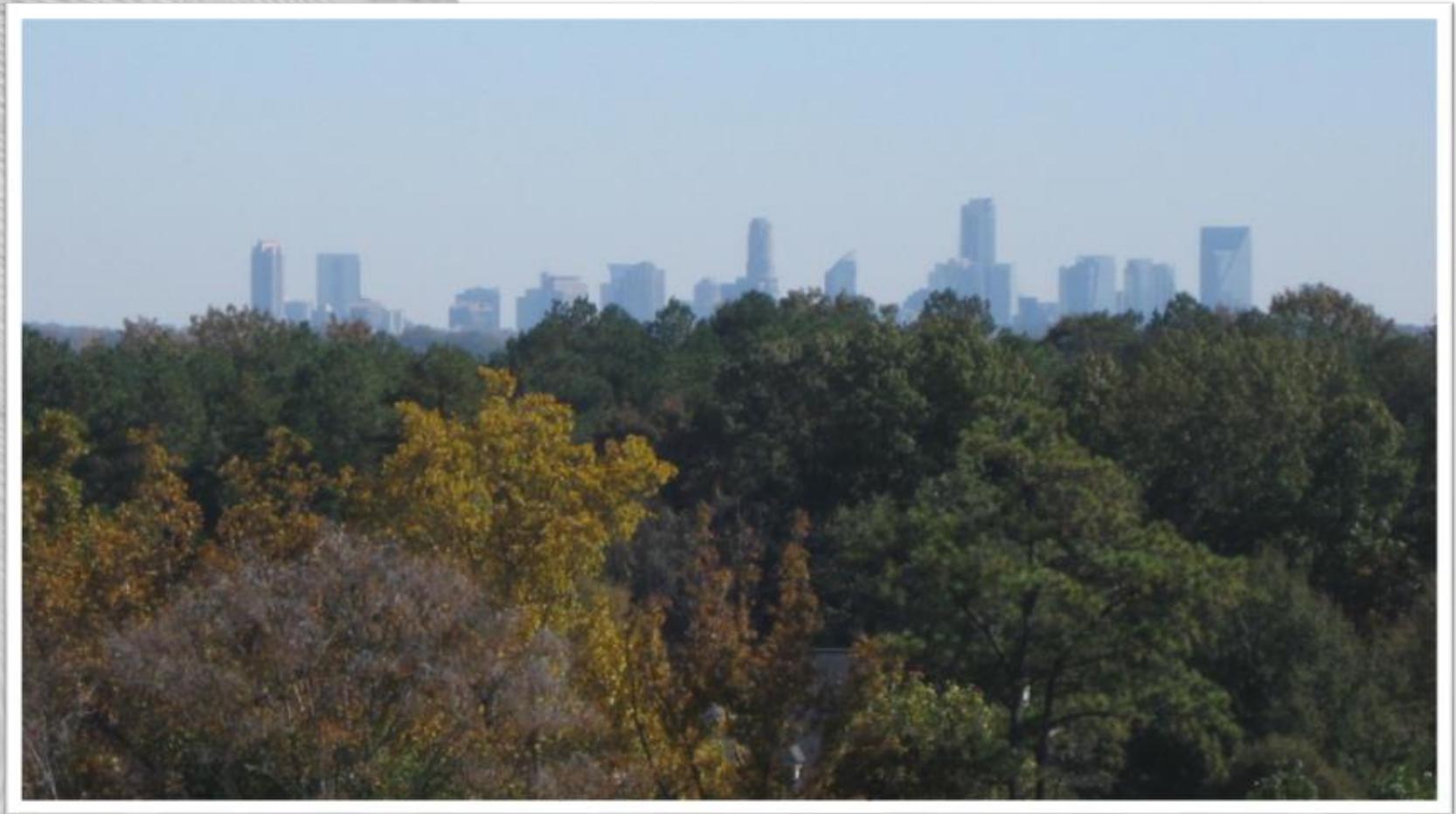
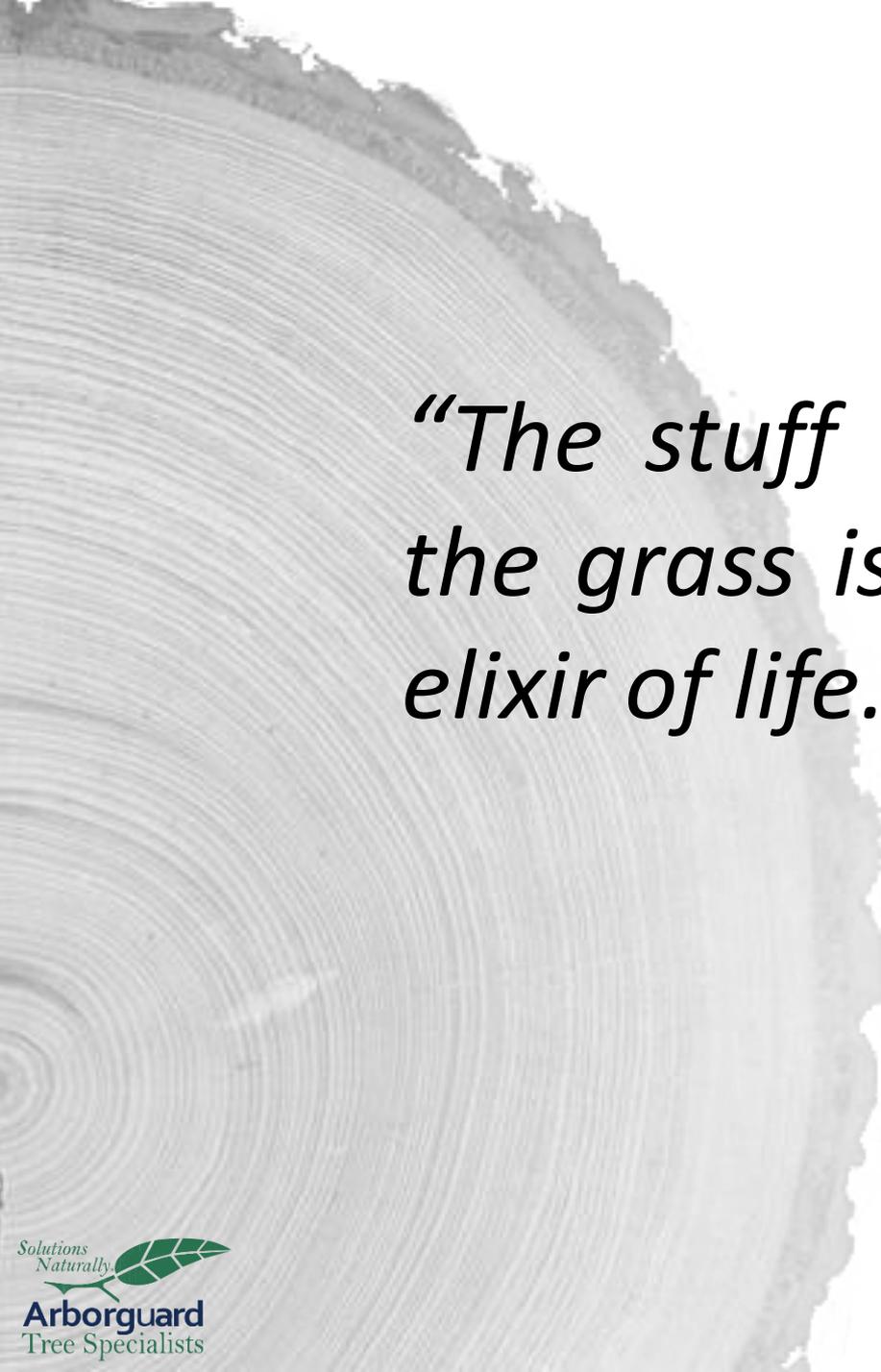


Urban Soils and Tree Health in the Built Environment



Is Healthy Soil Important?





*“The stuff that lies beneath
the grass isn’t dirt. It is the
elixir of life.”*

Phillip J. Craul

- Trees are living systems driven by chemical and biological processes
- Understanding how trees and soil are connected is important because soil is the foundation within which a tree grows
- Trees must obtain oxygen, water, and essential nutrients to meet daily energy requirements from the soil in which it is growing



WHAT LARGE TREES MEAN



More shade = more energy savings



Cleaner air = better health and fewer hospital visits

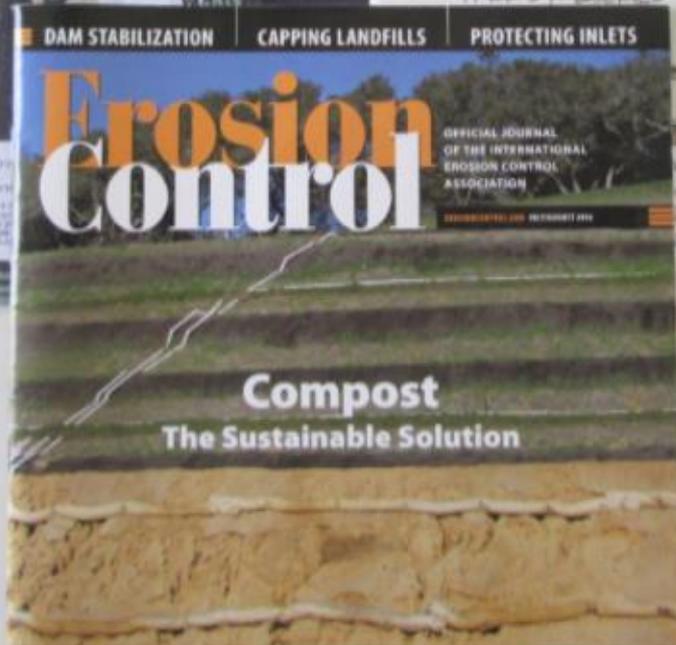


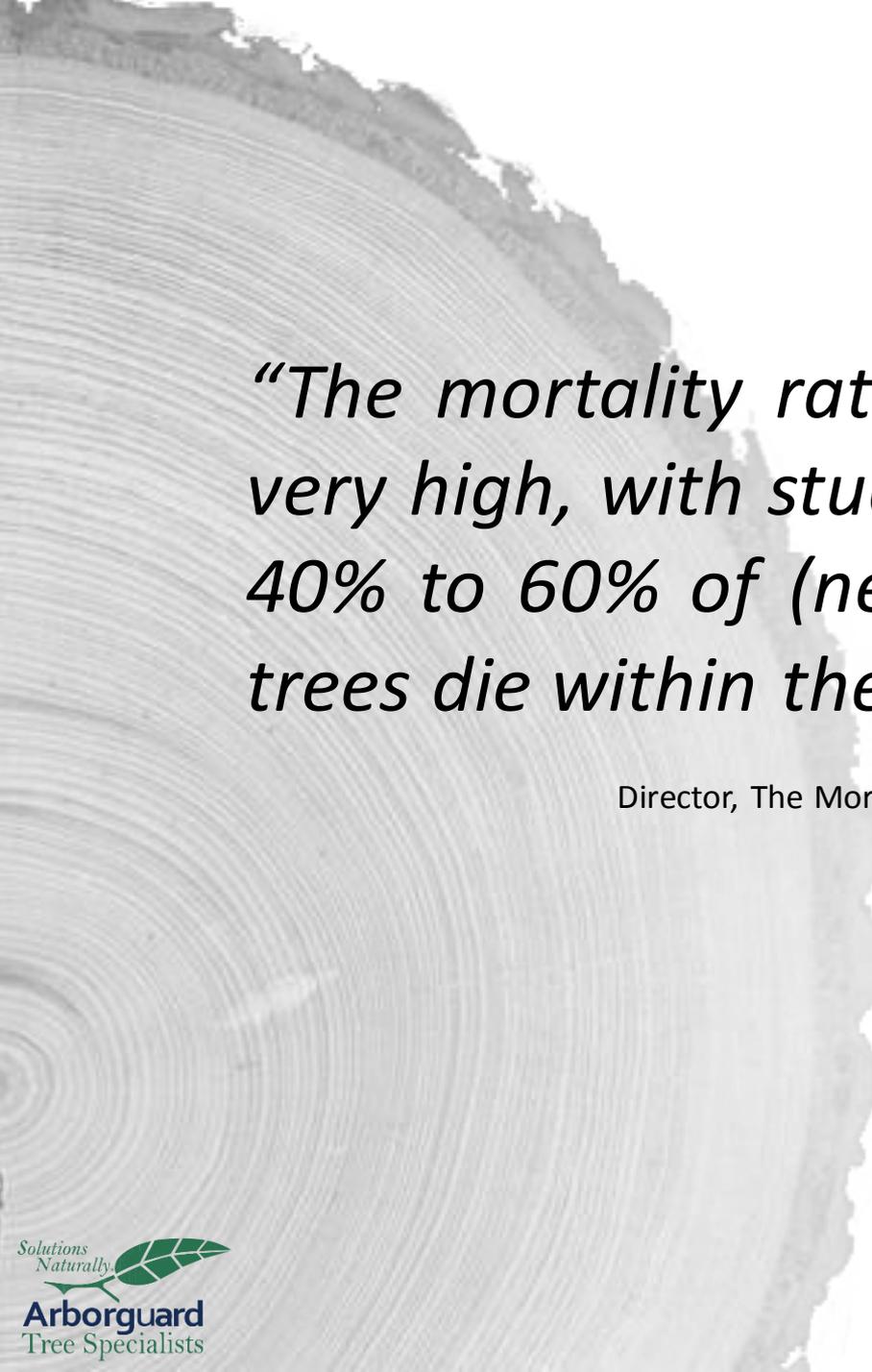
More stormwater management = lower costs for stormwater controls



More shaded streets = longer time between resurfacing



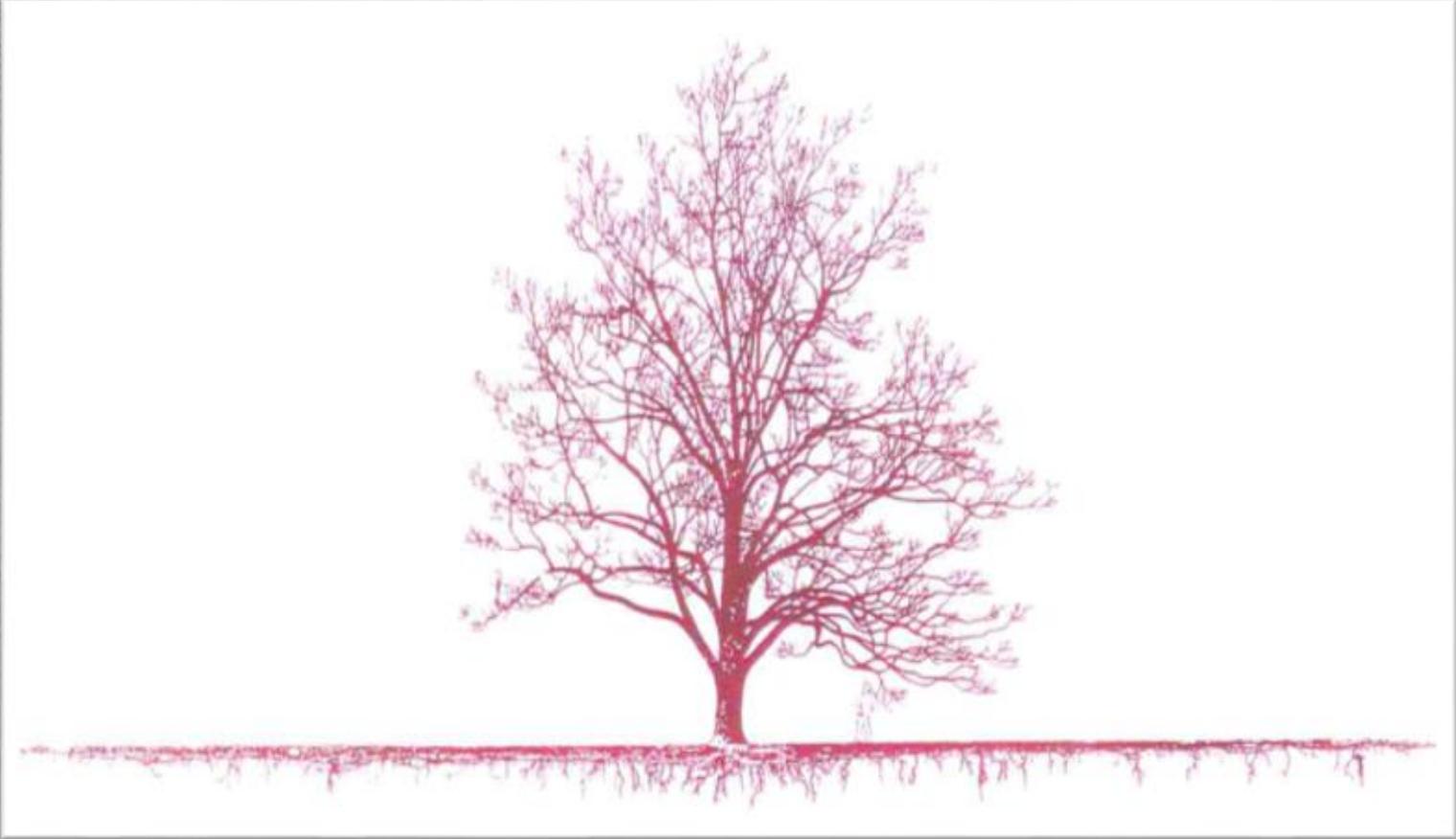




“The mortality rate for urban trees is very high, with studies suggesting that 40% to 60% of (newly planted) urban trees die within the first 10 years”

Bryant Scharenbroch

Director, The Morton Arboretum Soil Science Laboratory





A Brief History of the Appalachian Mountains

- Approximately 300mya the Appalachian Mountains and Stone Mountain were formed by a continental collision with Africa.
- Mountain peaks were estimated to be as high as 30,000 feet.
- From approximately 300mya to present these Appalachian mountains have been eroding to provide us with the soils we see today.



The Evolution of Trees

- First woody land plants appeared approximately 370mya.
- The earliest trees were conifers (monocots) appearing approximately 220-195mya.
- Tree types we would recognize today (dicots) appeared approximately 140-70mya.



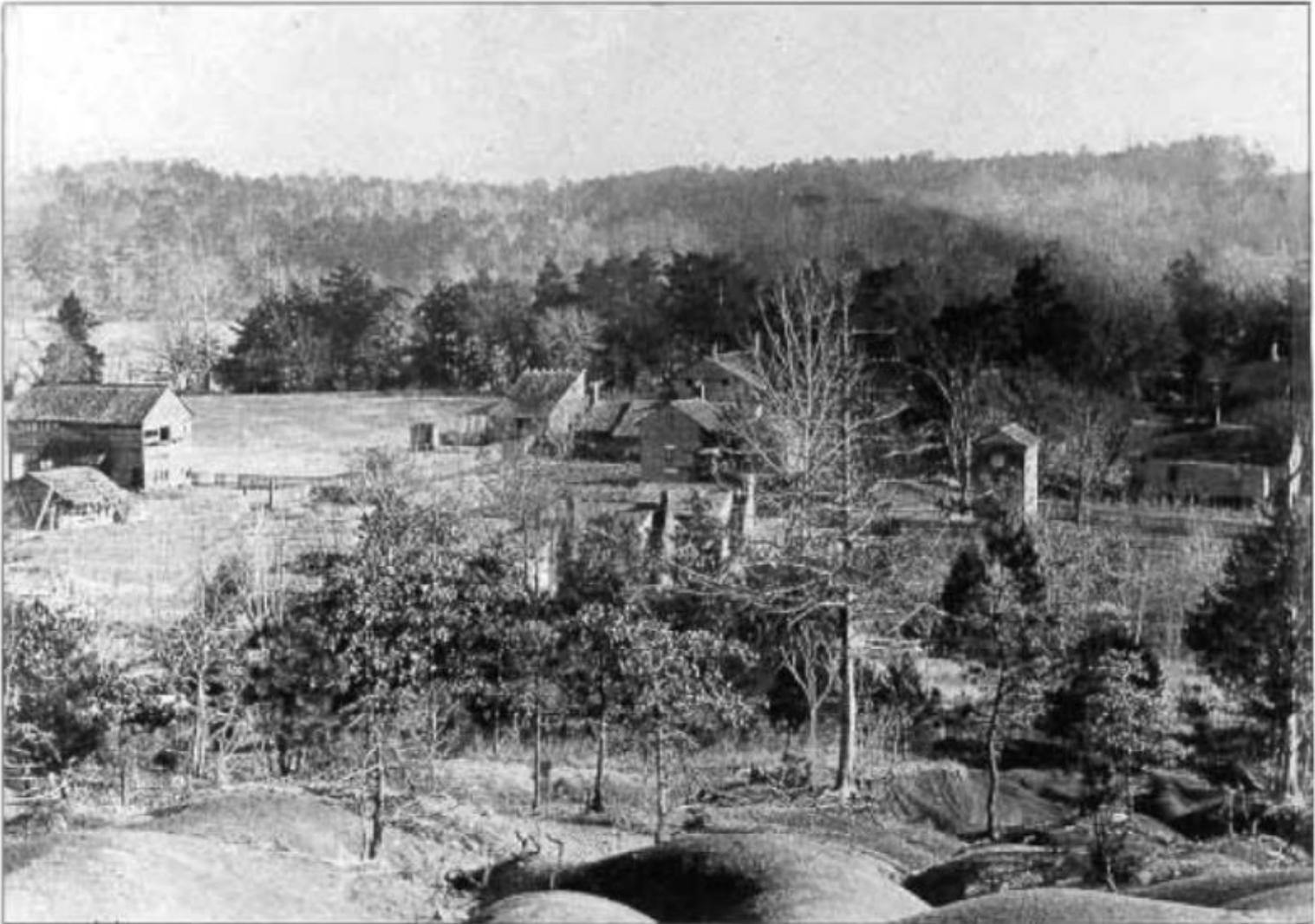


Figure 120: Millwood Plantation belonged to James Edward Calhoun, descendant of early South Carolina farmers. Erosion from poor farming practices common in the region is visible in the foreground.



PROPERTIES OF SOIL

PHYSICAL:

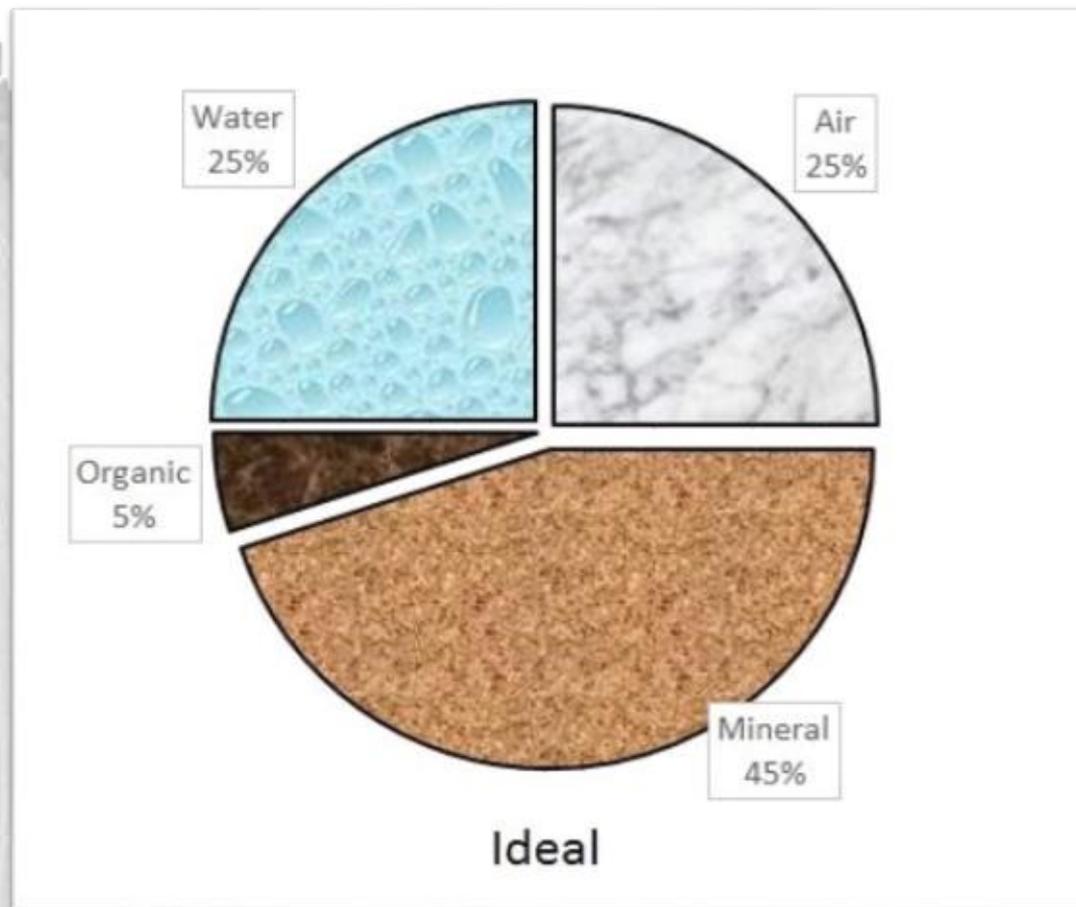
- Parent Material
- Texture
- Structure
- Soil Horizons

CHEMICAL:

- pH
- Buffering Capacity
- CEC

BIOLOGICAL:

- Rhizosphere
- Mycorrhizae
- Nutrient Cycling



A Soil Profile



— **O horizon** - Leaf litter and other organic debris

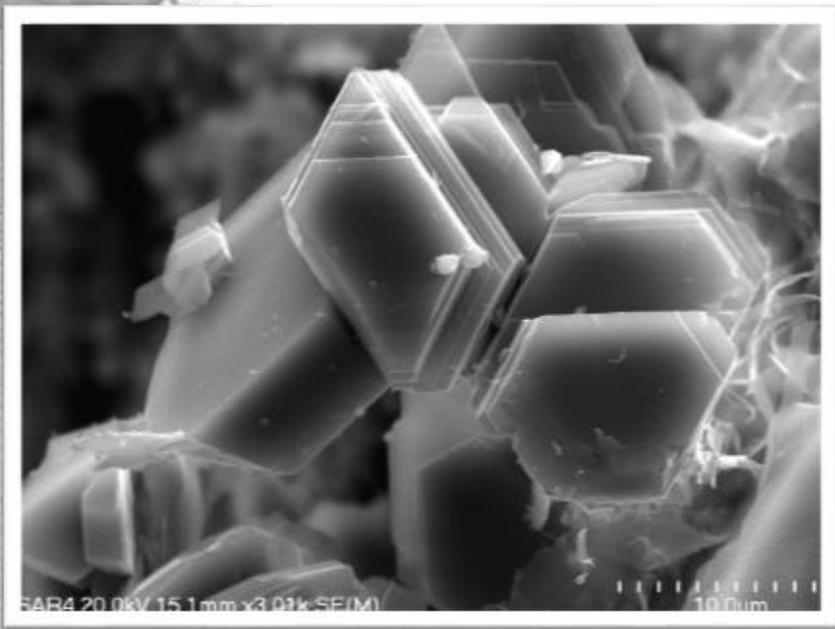
— **A horizon** – A surface mineral horizon showing coloration due to organic matter accumulation

— **B horizon** – A subsurface horizon showing depletion of organic matter and an accumulation of clay. Clay is typically iron and aluminum based compounds

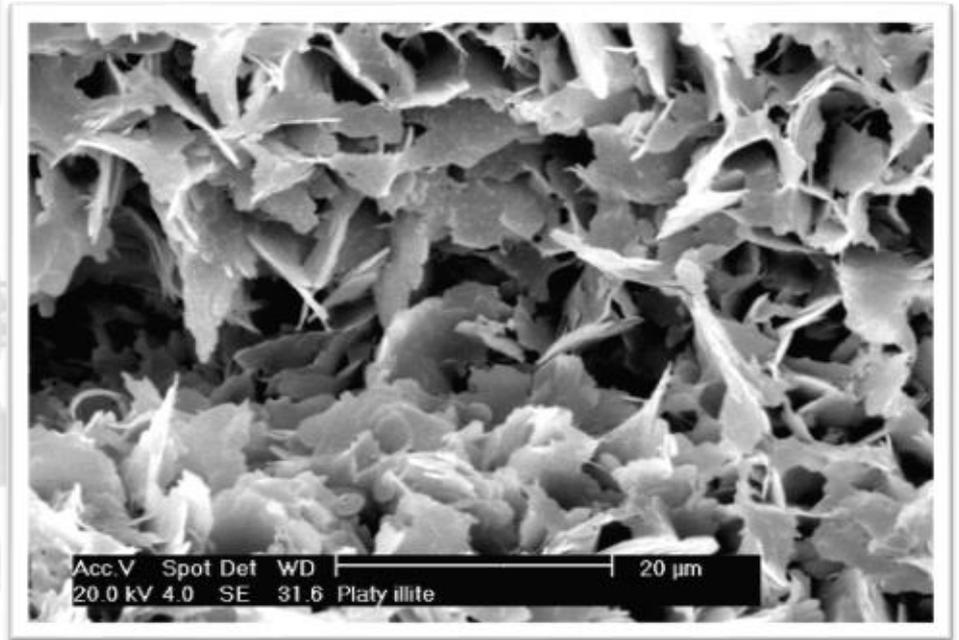
— **C horizon** – A subsurface layer of soil forming parent materials. Could be weathered rock, unconsolidated floodplain sediments or loose sands

— **R horizon** – Hard bedrock



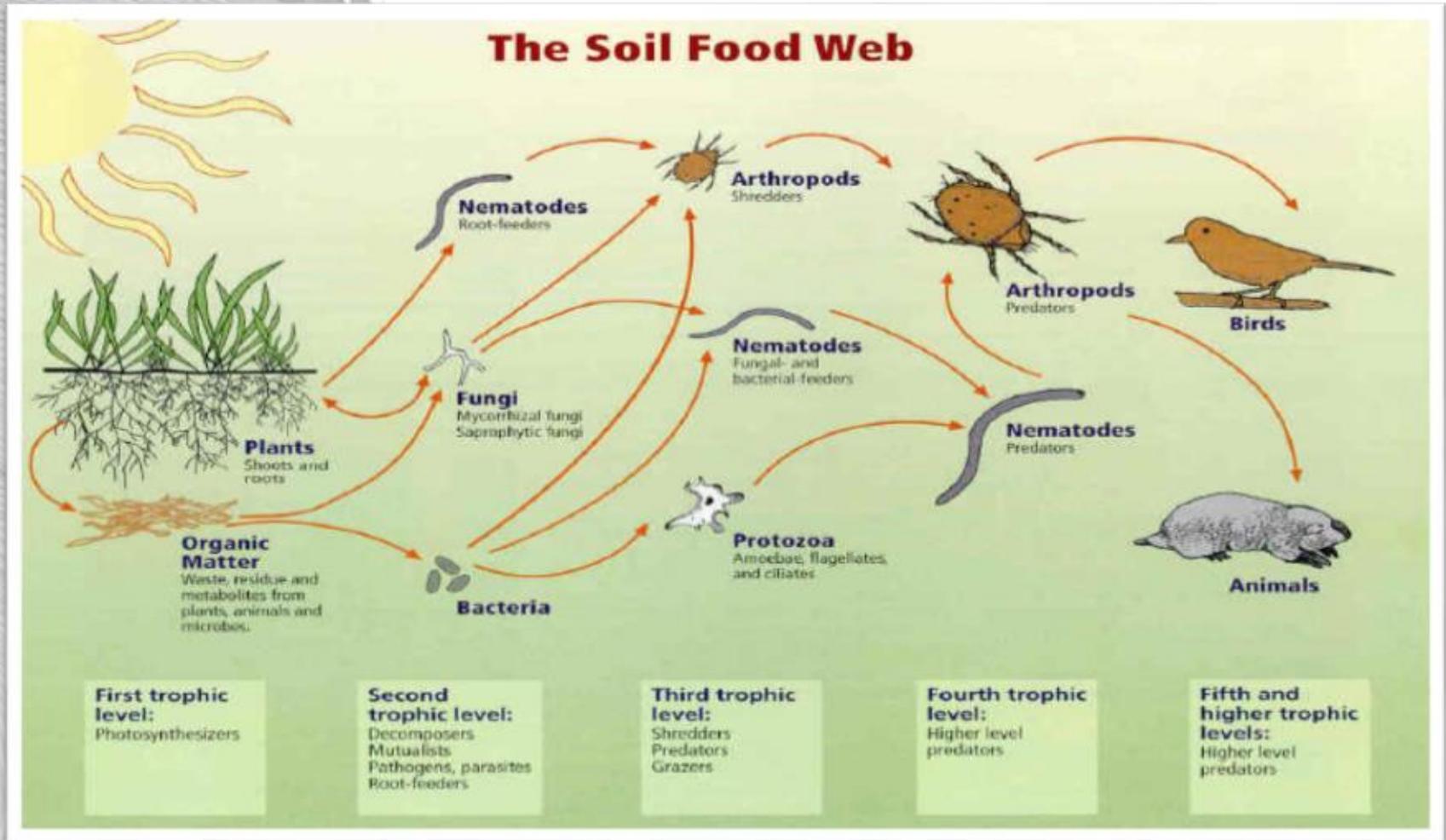


Kaolinite

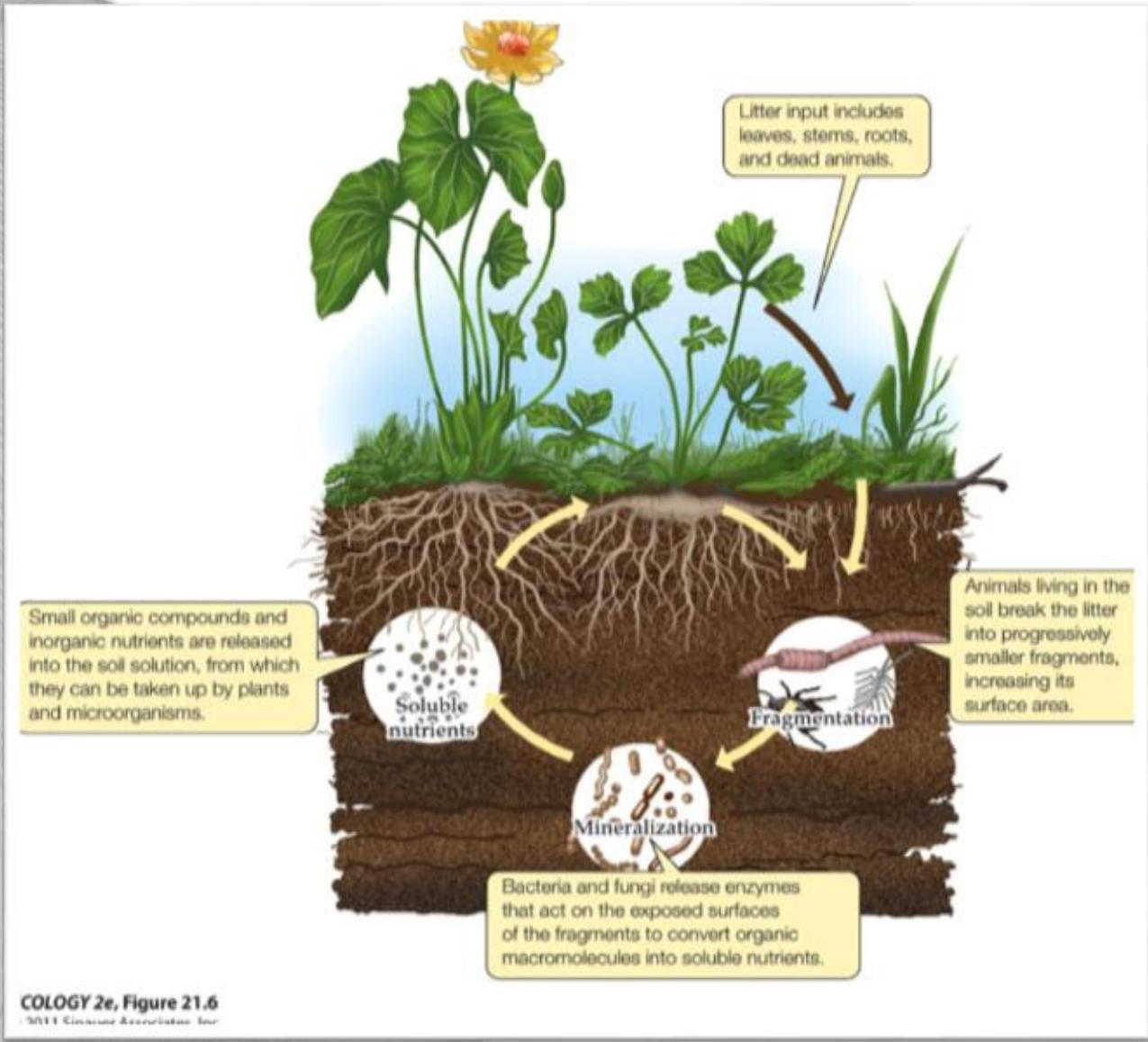


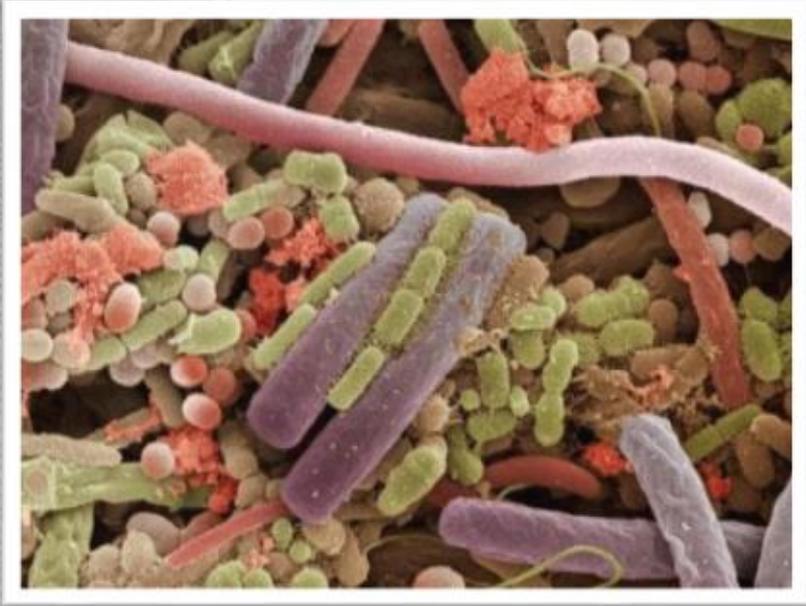
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BIOLOGICAL PROPERTIES OF SOIL

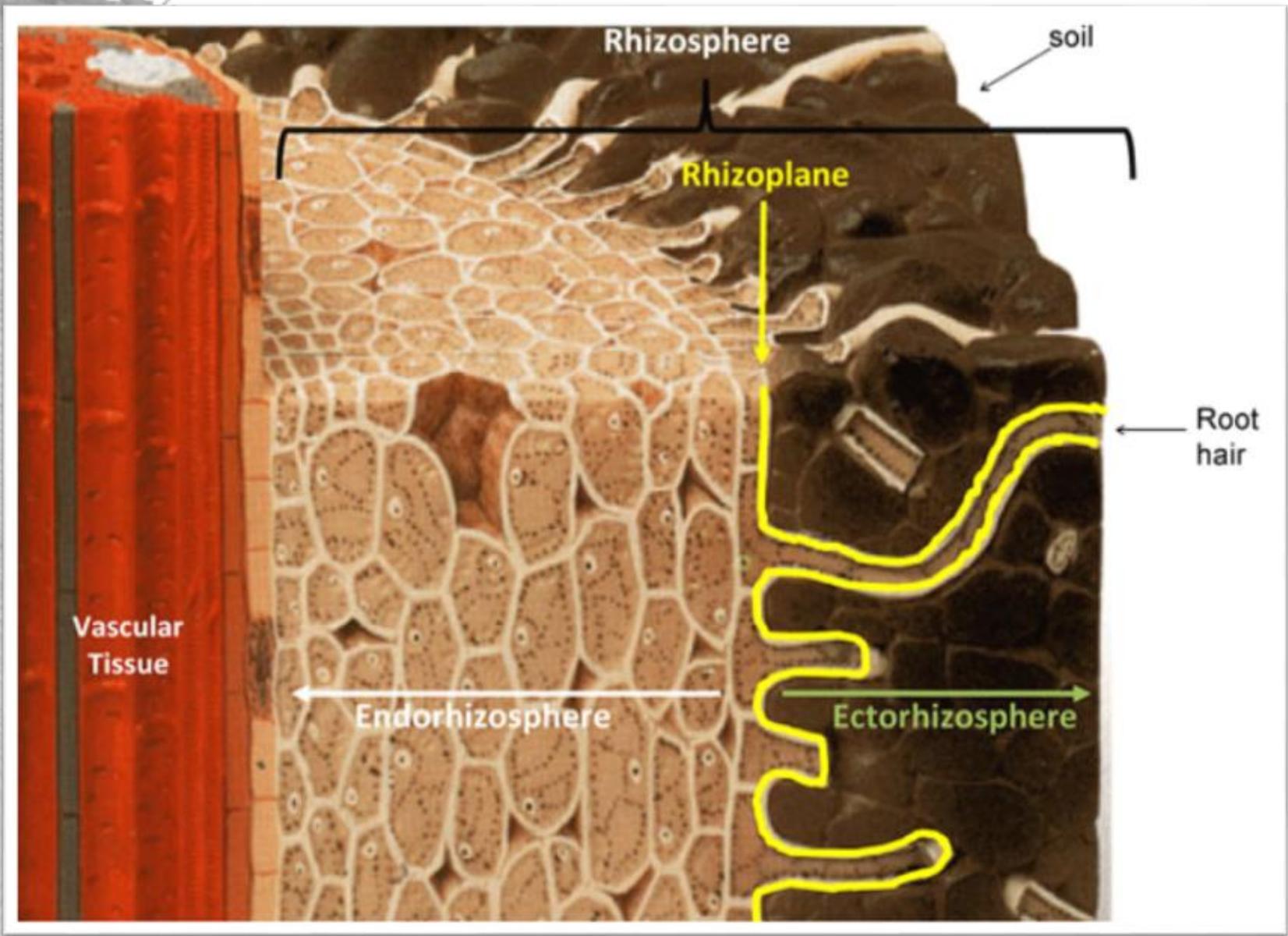


A healthy food web is critical for nutrient cycling within the rhizosphere





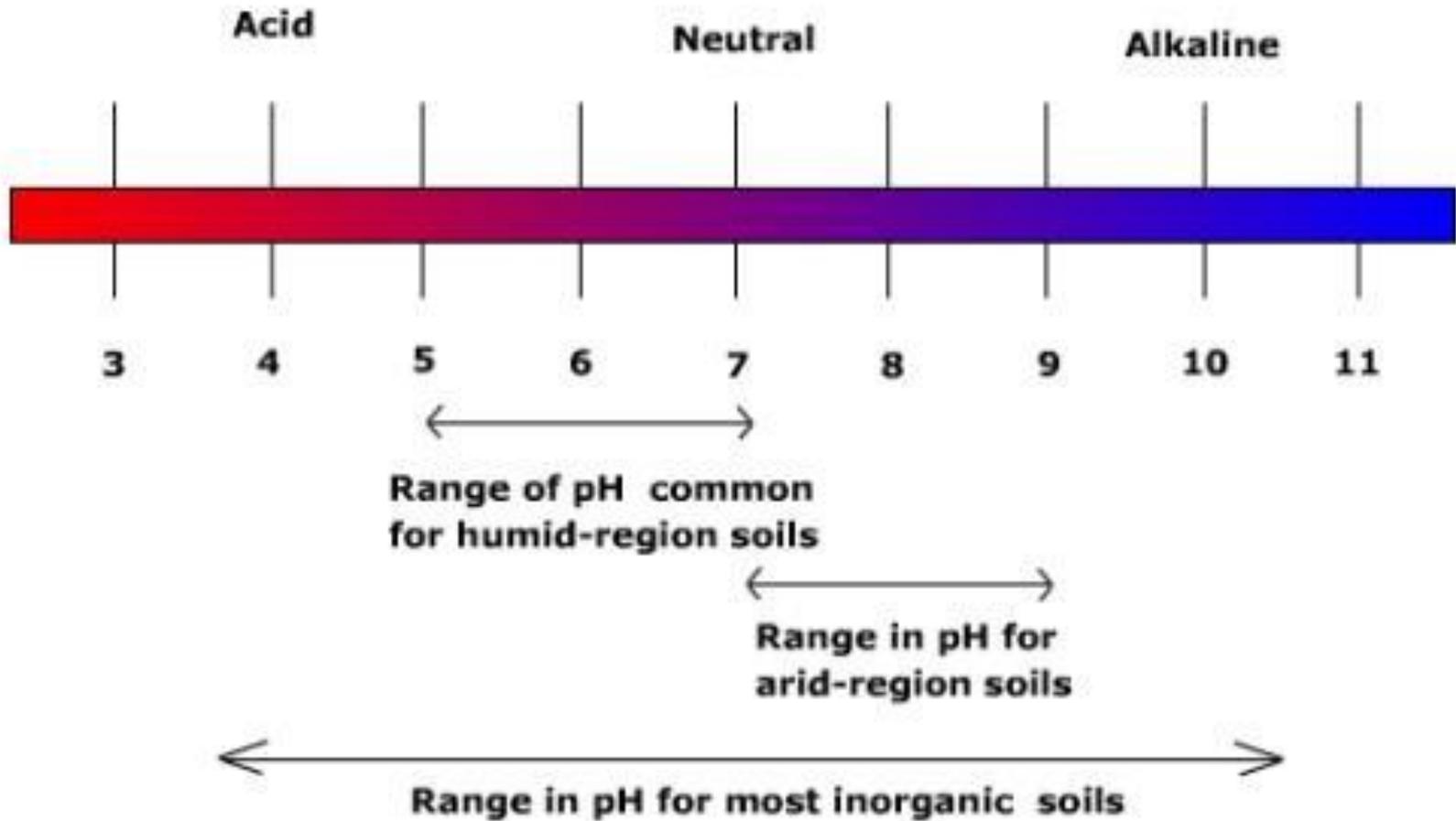
© 2012 by Harp



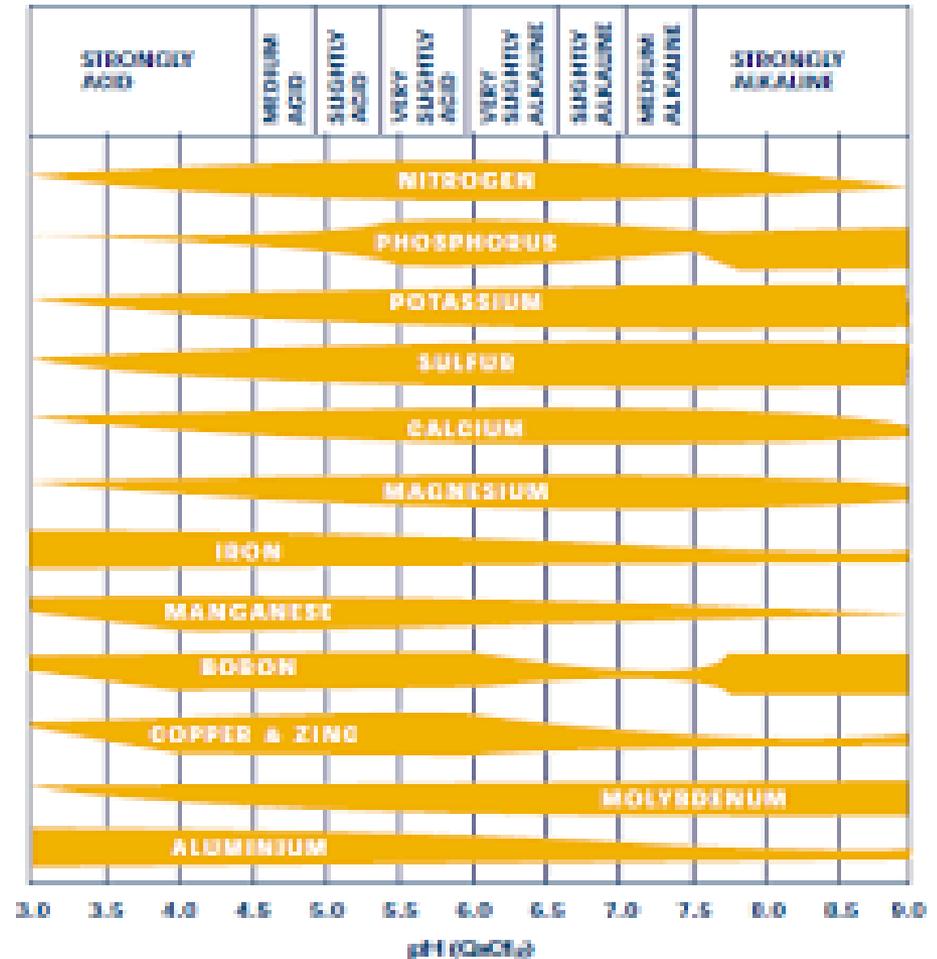


*Healthy, biologically active soils
are the single most important
factor for tree growth*

CHEMICAL PROPERTIES OF SOIL



- pH of 6.0 to 7.0 is favorable for most plant growth
- An important effect of pH on tree growth is the availability of essential nutrients
- At certain pH levels, nutrients may be made insoluble
- In acidic soils aluminum will become soluble
- In alkaline soils iron and manganese may be unavailable





In the Piedmont, the parent material is acidic.
We set the plants up for failure before they are even planted.

- The igneous and metamorphic parent material of the Piedmont is predominantly an Aluminosilicate rock.
- In an acidic environment, aluminum is released into the soil solution forming Al^{3+} . This is toxic to the apical meristem of plants, restricting root growth, or even killing the plant.





This is what we should
be planting in.

- Low pH
- Aluminum Toxicity
- No Organic Matter
- No Biological Activity
- No Nutrient Cycling

This is the soil that the
tree actually gets
planted in.

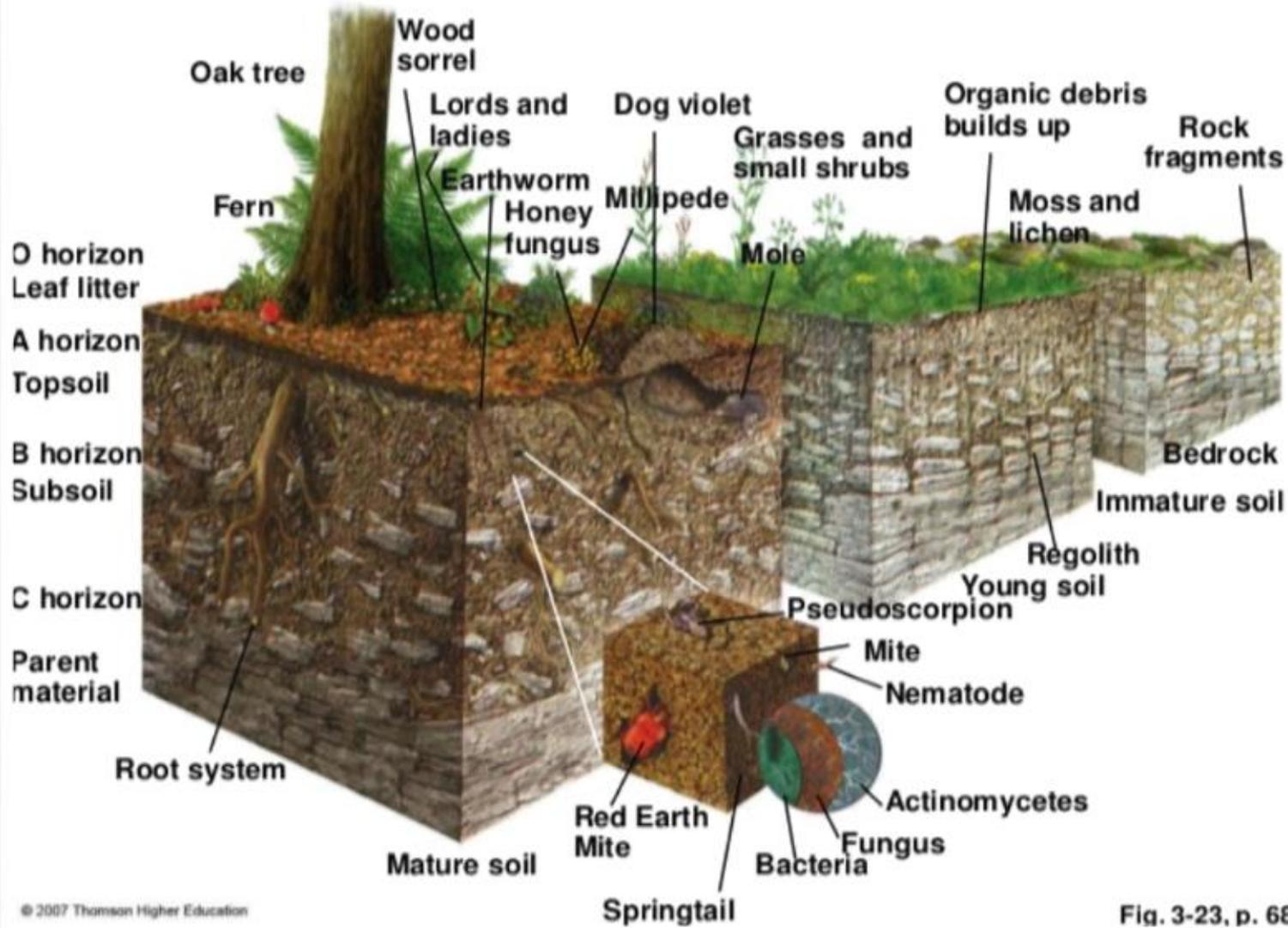
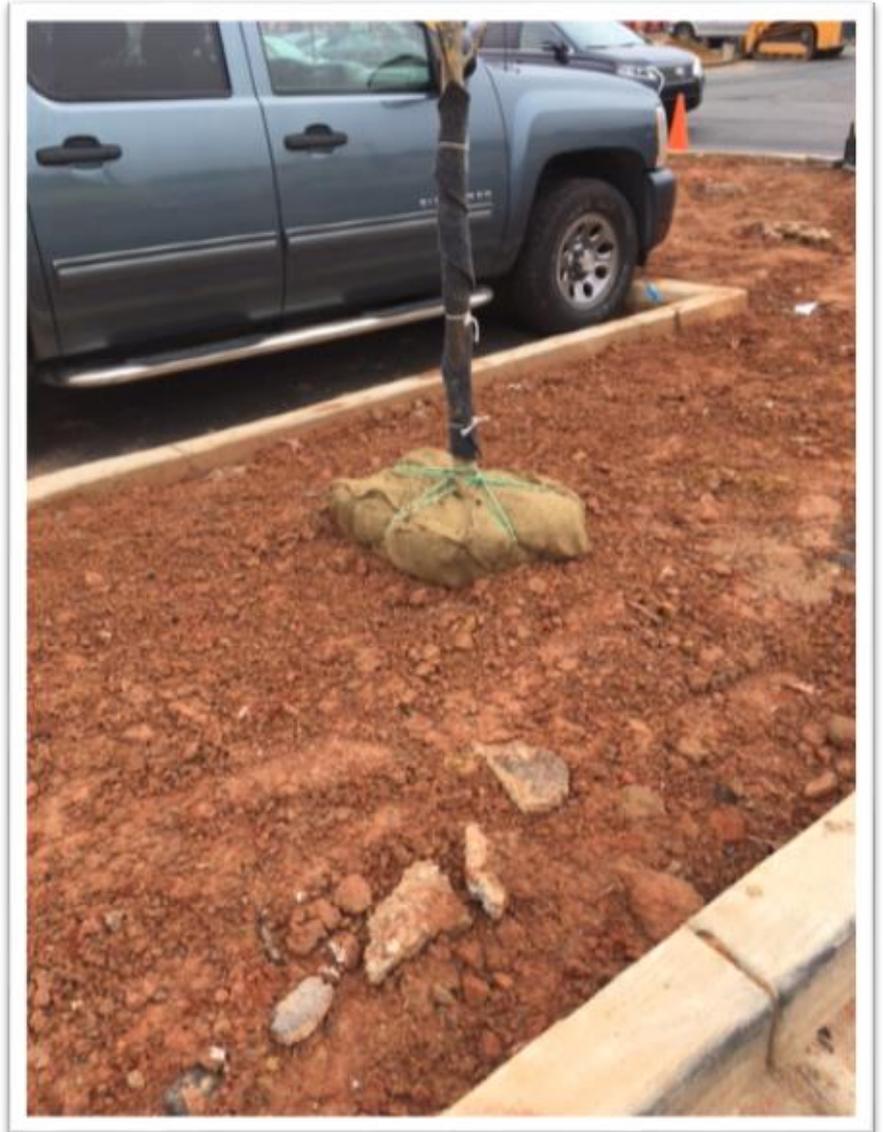


Fig. 3-23, p. 68







Roots unable to penetrate severely compacted soils will redirect to the surface with very little drought tolerance.



When water replaces air in pore space, it slows the diffusion of oxygen to 1/10,000 of that in air. Literally suffocating the root system.

An estimated 80% of urban tree problems can be attributed to a poor soil environment



SO WHAT DO WE DO?

Invigorating Sterile Soil to Improve: Soil Properties and Soil Microbiology

Soil fracturing to relieve soil compaction

Add Gypsum to remediate soil properties

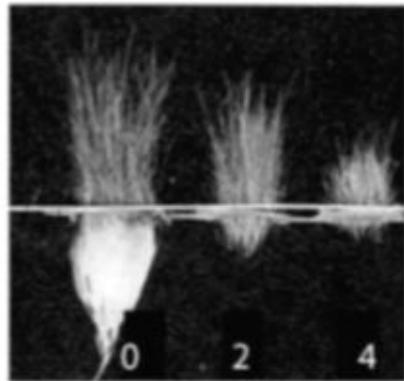
Mix 5% to 10% COMPOSTED wood mulch into the
planting bed

Incorporate organic soil amendments

Pneumatic Soil Fracturing



Gypsum as a Soil Amendment



Al³⁺ is highly toxic to most plant roots.

← Fescue grown in nutrient solution containing soluble Al³⁺

Al³⁺ Concentration (ppm)

Figure 2-7. Effects of aluminum (Al³⁺) on growth of fescue. (Illustration adopted from Buckman and Brady (1969) and kindly provided by Dr. Jerry Bigham, The Ohio State University.)

Gypsum forms soluble complexes with Al³⁺

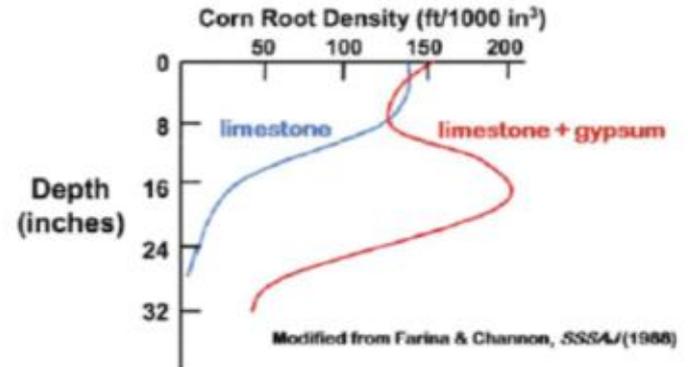


Figure 2-10. Soluble aluminum (Al³⁺) is toxic to plants. Gypsum can react with Al³⁺, thus removing it from the soil solution and greatly reducing its toxic effects on plant roots. (Illustration kindly provided by Dr. Jerry Bigham, The Ohio State University.)

- Gypsum is one of the earliest forms of fertilizers, in use for more than 250 years in the United States
- Gypsum can improve physical and chemical properties of soil
- Currently a large amount of flue gas desulfurization (FGD) gypsum is produced from coal fired electric generating plants that is suitable as a soil amendment

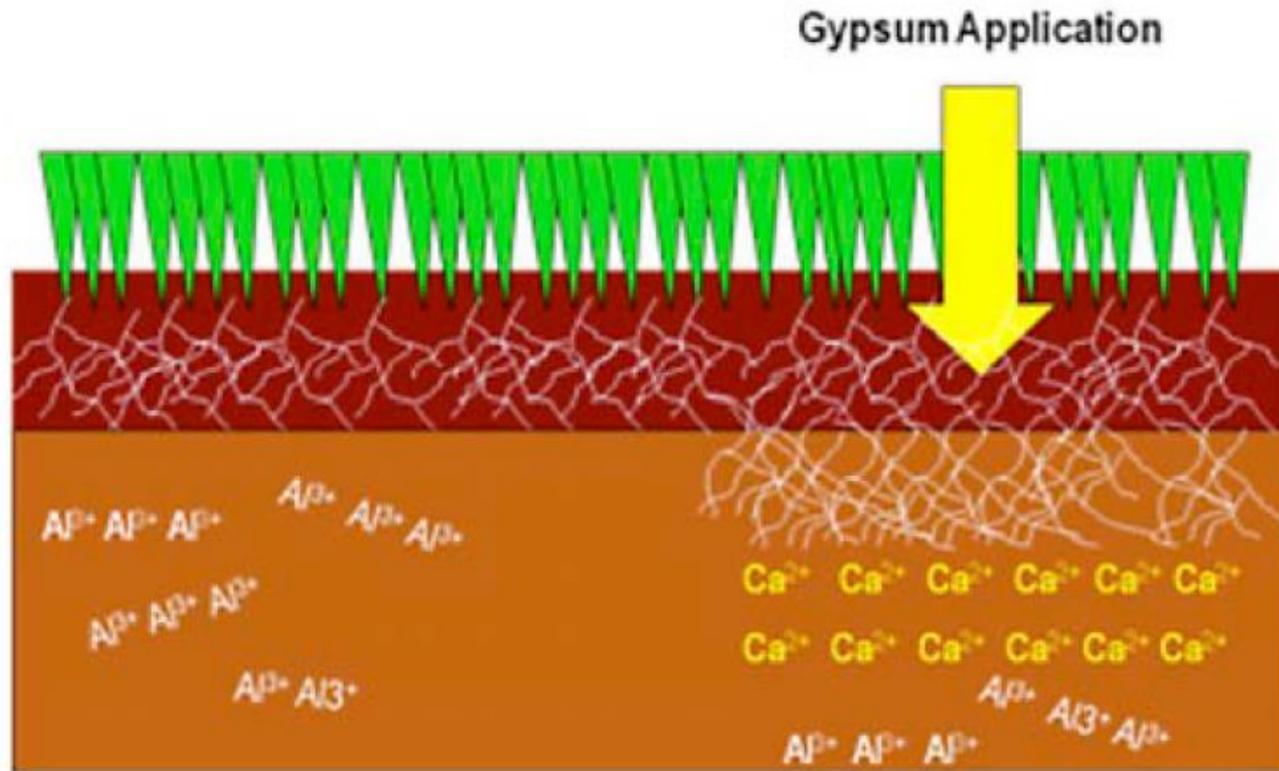
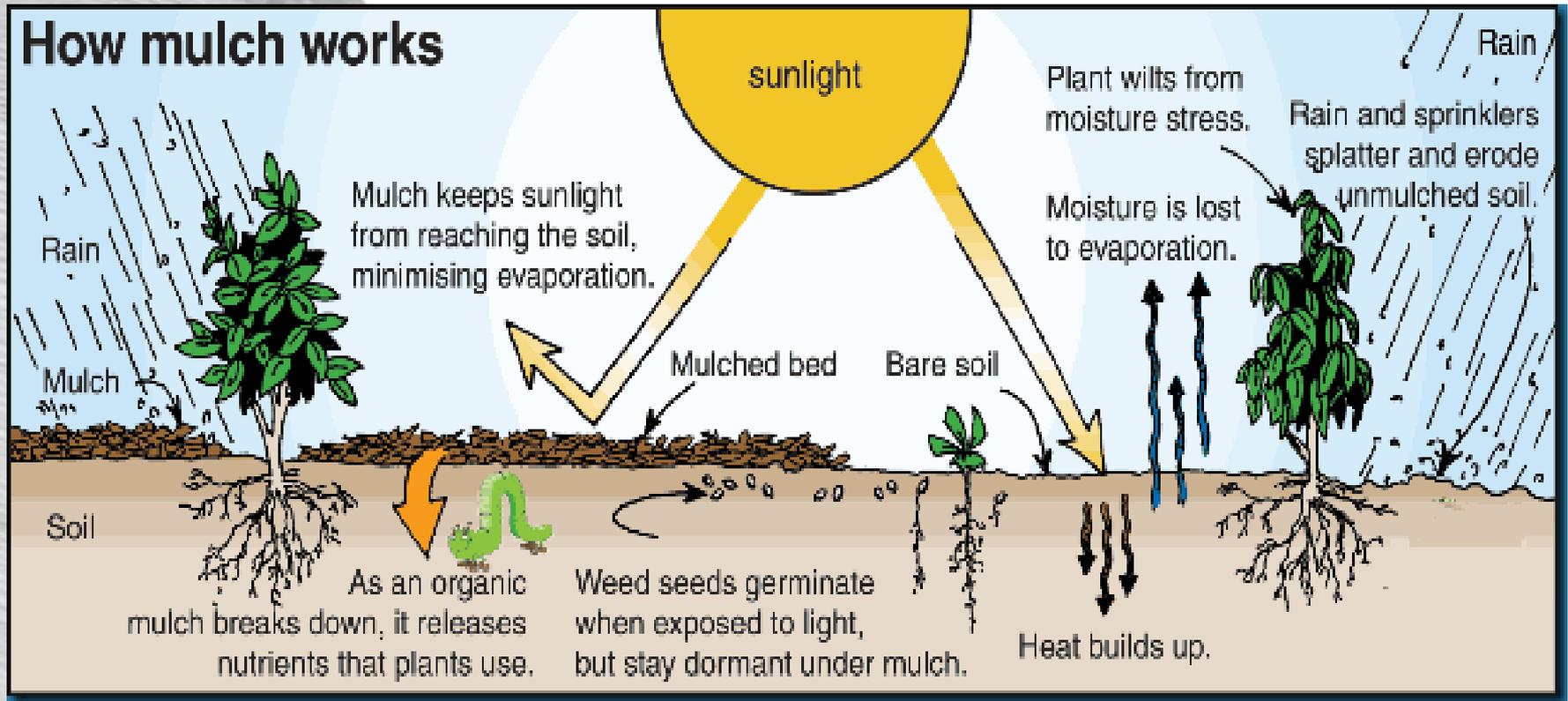


Figure 2-8. Gypsum as a soil amendment to remediate subsoil acidity. Gypsum is 200 times more soluble than lime and calcium and sulfur movement into soil profiles is enhanced by the addition of gypsum. (Sumner and Larri-more, 2006.)

Establishment of Soil Microbiology

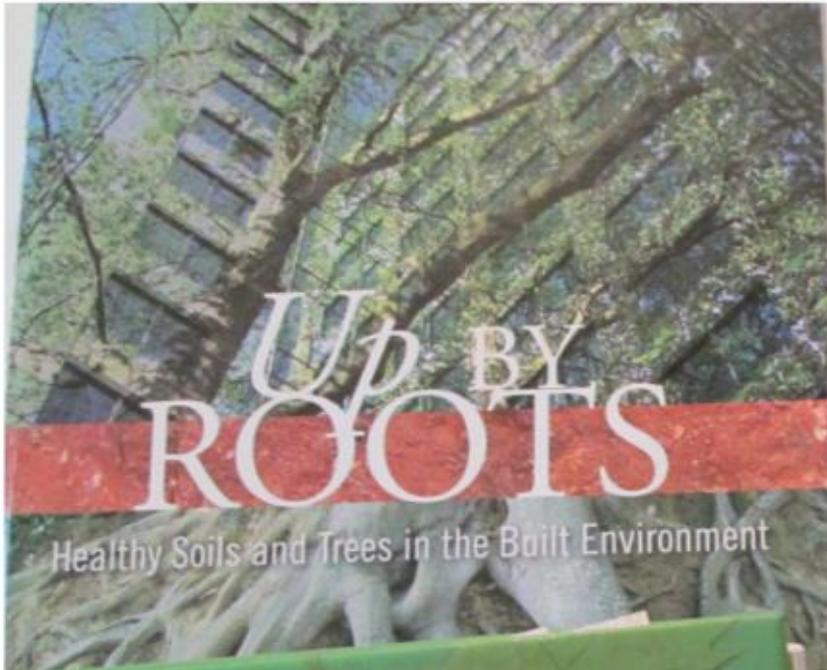


Benefits of Composted Wood Mulch

- Reduce evapotranspiration
- Insulates soil from temperature extremes
- Adds soil microorganisms and macroinvertebrates
- Improves soil physical properties

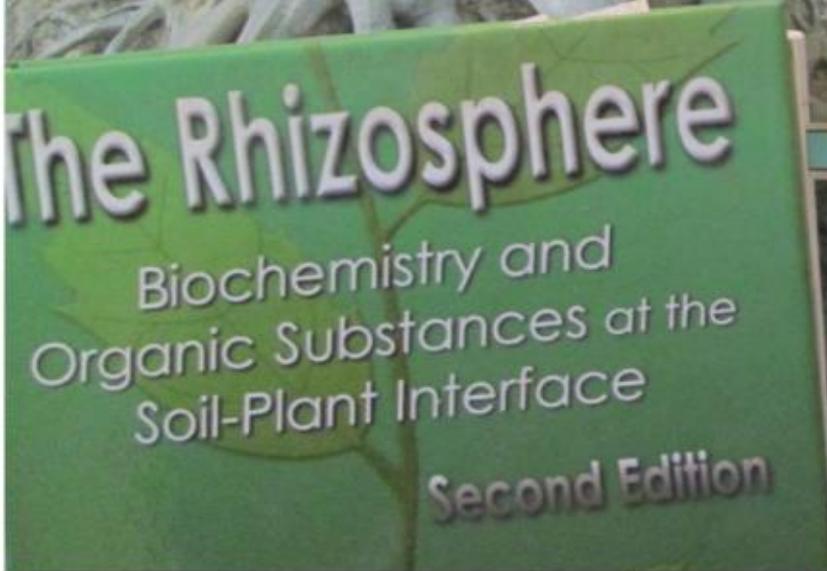






Up BY ROOTS

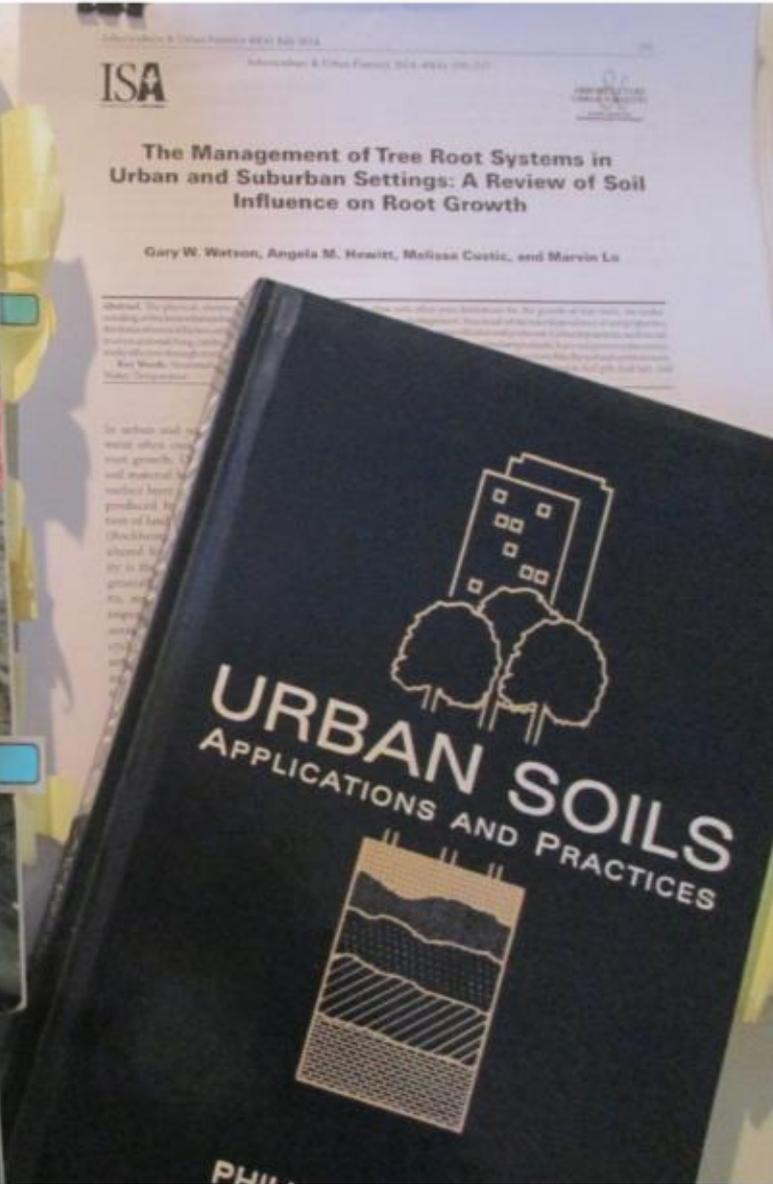
Healthy Soils and Trees in the Built Environment



The Rhizosphere

Biochemistry and Organic Substances at the Soil-Plant Interface

Second Edition



Urbanization & Urban Forestry 48(2) July 2014

Urbanization & Urban Forestry 2014, 48(2), 176-177



The Management of Tree Root Systems in Urban and Suburban Settings: A Review of Soil Influence on Root Growth

Gary W. Watson, Angela M. Hewitt, Melissa Costic, and Marvin Lu

Abstract. The general perception is that tree root systems in urban and suburban settings are constrained by the presence of soil compaction, the resulting reduction in soil porosity, and the associated reduction in soil water and nutrient availability. However, recent research has shown that root growth is not necessarily inhibited by soil compaction and that roots can grow in compacted soils. This review examines the current understanding of soil influence on root growth in urban and suburban settings, with a focus on the role of soil compaction and soil water and nutrient availability. Key words: tree roots, soil compaction, soil water, soil nutrients.

In urban and suburban settings, tree root growth is often constrained by soil compaction, which reduces soil porosity and soil water and nutrient availability. This review examines the current understanding of soil influence on root growth in urban and suburban settings, with a focus on the role of soil compaction and soil water and nutrient availability.

URBAN SOILS

APPLICATIONS AND PRACTICES



PHU



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Southern Organics & Supply

Ron Danise

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Monroe, NC 28110

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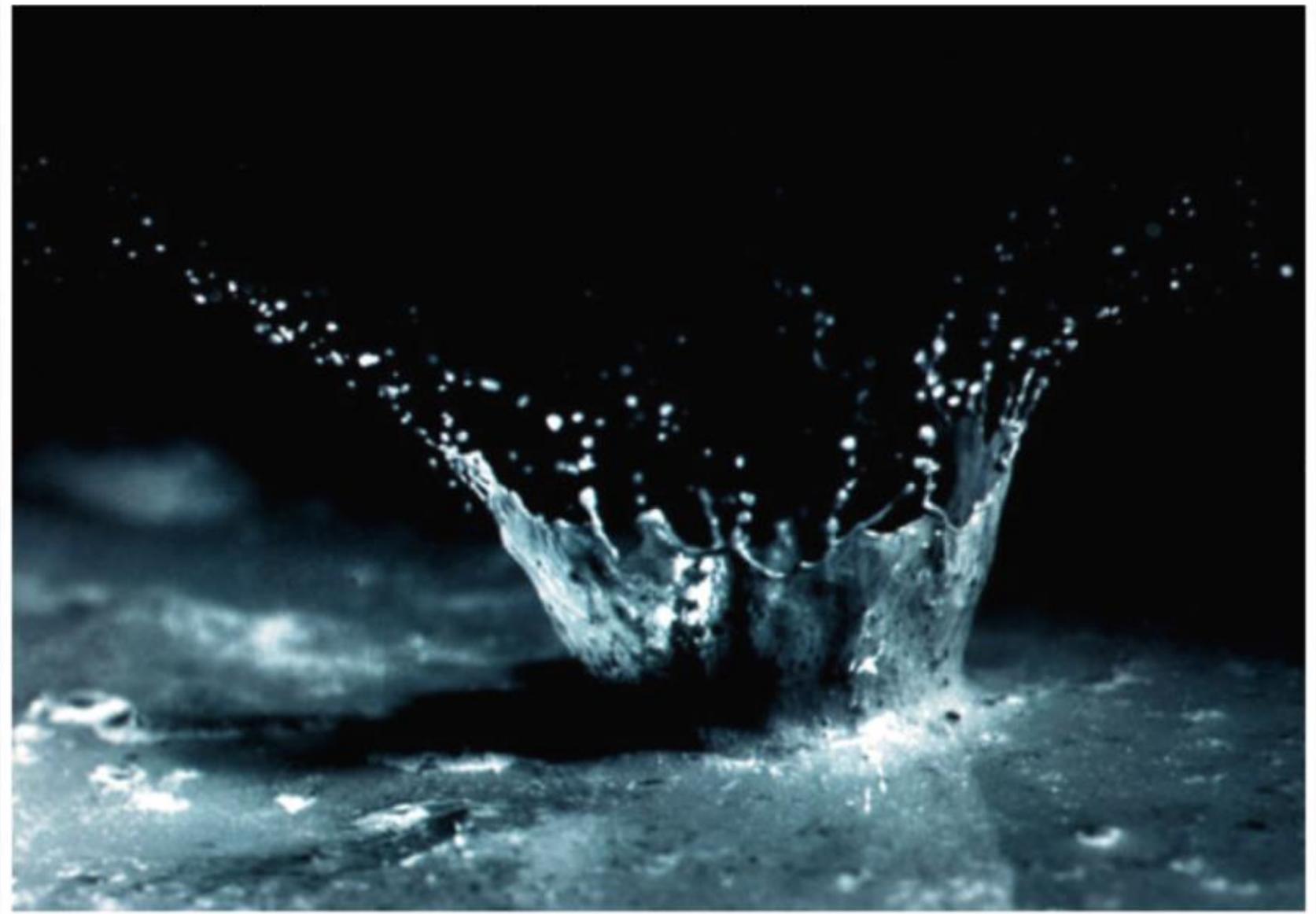
YOU DEVELOP THE PERFECT PROPERTY.
WE'LL HELP YOU WITH THE TREES.

David Dechant LEED® AP

*ISA Board Certified Master Arborist
ISA Certified Municipal Specialist
ISA Qualified Tree Risk Assessor*

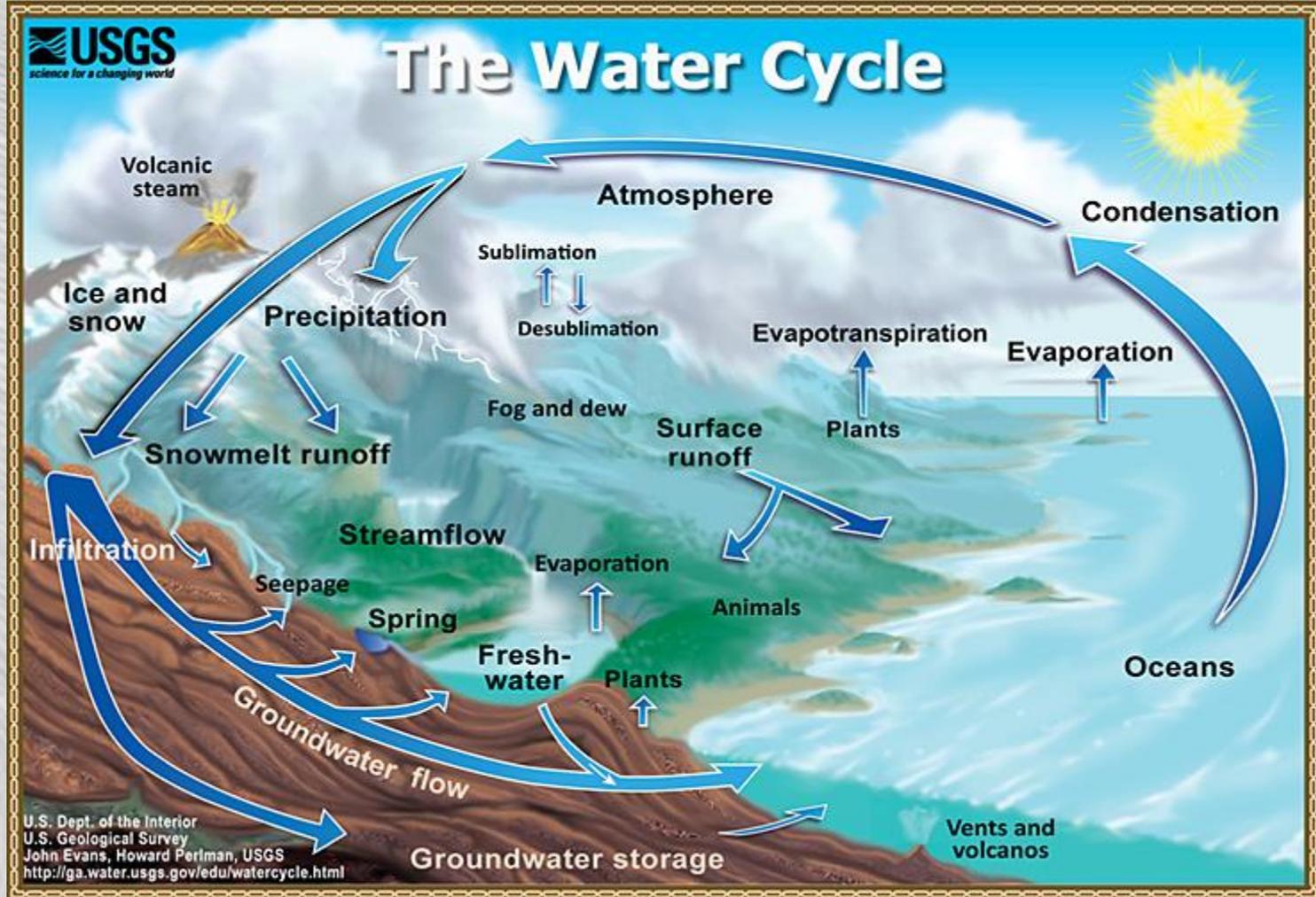
Arboguard Tree Specialists
ddechant@arboguard.com
404-354-2638



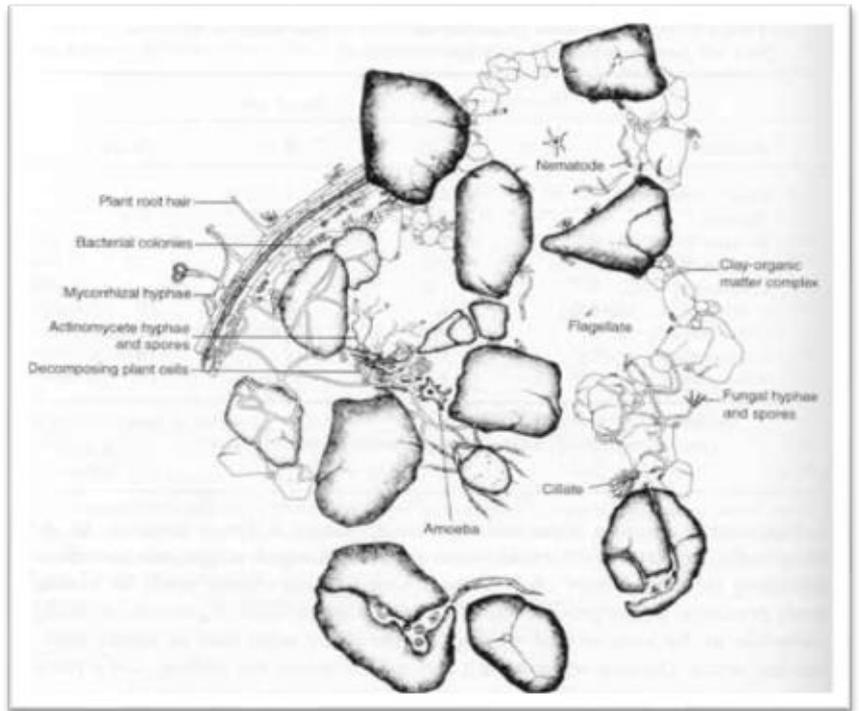




The Water Cycle



U.S. Dept. of the Interior
U.S. Geological Survey
John Evans, Howard Perlman, USGS
<http://ga.water.usgs.gov/edu/watercycle.html>

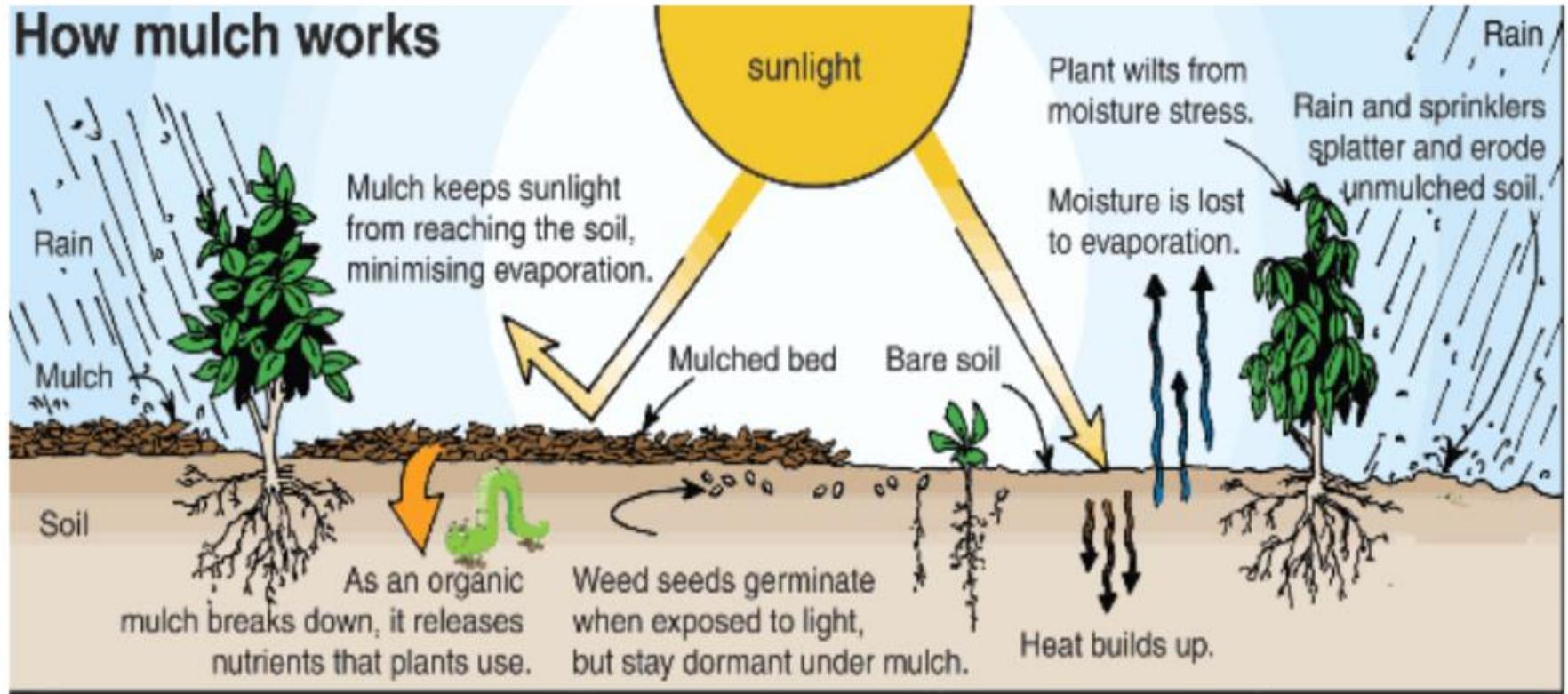








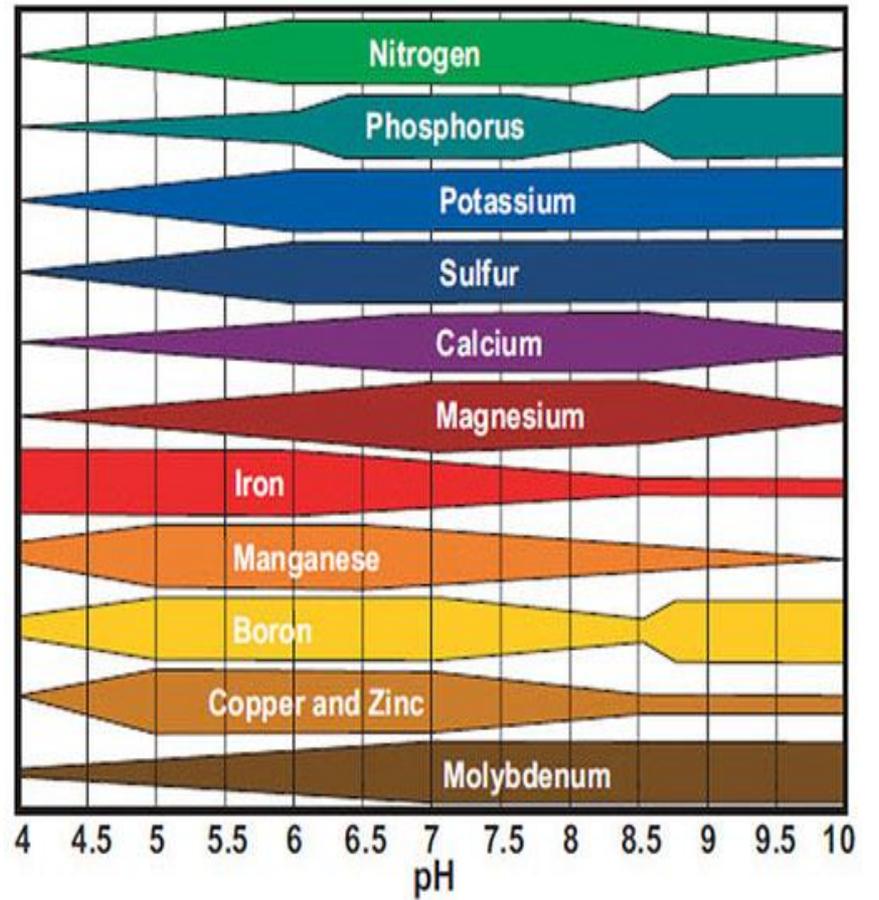
How mulch works





The problem of connecting soil and trees in an urban setting:

- We only see the above ground portions of the tree
- Soil is given little value in urban environments
- Soil is poorly protected in urban environments
- Newly planted trees often have limited soil volume
- Soil compaction results from foot traffic and mechanical vibration
- There is often poor drainage in the urban soil profile
- Turf is often planted over tree root systems
- Typical urban soils are completely devoid of essential nutrients
- The urban soils we often plant in are likely to be sterile or even toxic to plant roots

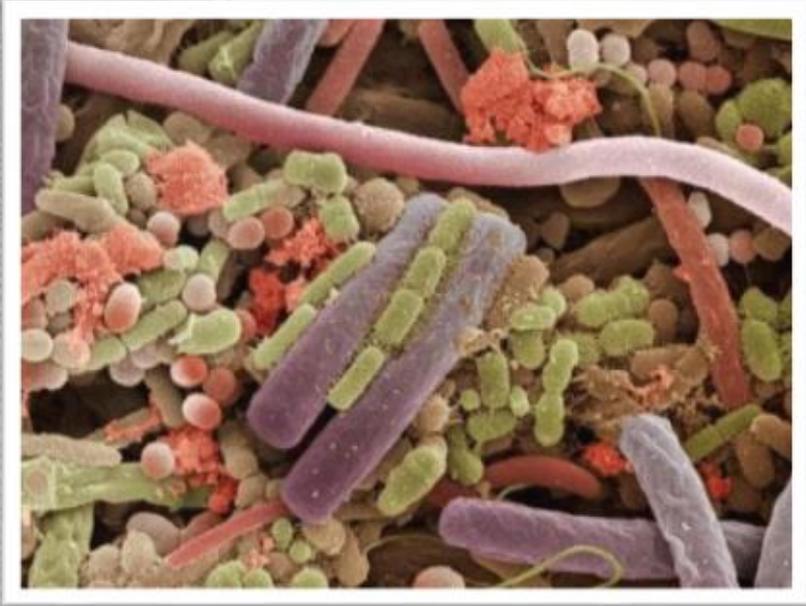


Trees as Green Infrastructure

- Trees provide natural stormwater management
- Trees remove pollutants from the air
- Trees cool the surrounding environment

BUT

The trees have to be **BIG**







SO WHAT DO WE DO?



— **O horizon** - Leaf litter and other organic debris

— **A horizon** – A surface mineral horizon showing coloration due to organic matter accumulation

— **B horizon** – A subsurface horizon showing depletion of organic matter and an accumulation of clay. Clay is typically iron and aluminum based compounds

— **C horizon** – A subsurface layer of soil forming parent materials. Could be weathered rock, unconsolidated floodplain sediments or loose sands

— **R horizon** – Hard bedrock

The Large versus Small Stature Tree Argument

	CHOICE A			CHOICE B		
	Avg. Ann. Benefit Avg. Ann. Cost	# Trees	Total Benefit Total Cost	# Trees	Total Benefit Total Cost	
Large Trees	\$65.18 \$13.72	259	\$16,882.00 \$3,553.00	1,693	\$110,350.00 \$23,228.00	
Medium Trees	\$36.04 \$6.87	753	\$27,138.00 \$5,173.00	753	\$27,138.00 \$5,173.00	
Small Trees	\$17.96 \$6.23	1,693	\$30,406.00 \$10,547.00	259	\$4,652.00 \$1,614.00	
Total Trees		2,705		2,705		
Total Benefits			\$74,426.00		\$142,140.00	
Total Costs			\$19,273		\$30,015.00	
Annual Net Value to Community			\$55,153.00		\$112,125.00	

Note: Each "tree" represents 259 trees planted.

plant food produced by earthworms

Black Castings™

(1-0.5-0.2)

ALL NATURAL ORGANIC PLANT FOOD



Lawns, Turf,
Trees & Shrubs



Fruits



Gardening &
Houseplants



Vegetables

ALL NATURAL ORGANIC PLANT FOOD

ALL PURPOSE **INDOOR/OUTDOOR**

Environmentally friendly - Does NOT burn
Promotes vigorous root growth - Increases root growth
Reduces watering requirements - Promotes greater root systems

Net Wt. 40 lb.

ODOR FREE

SGN

NutriSmart™

Active Eco-Fertilizer
0-5-0



GUARANTEED ANALYSIS:
Available Phosphoric Acid (P₂O₅)
derived from Phosphate Rock.

SEE BACKSIDE FOR
Optimal conditions for NutriSmart™ to perform.

CAUTION
Dust from this product may cause irritation to the eyes, skin and nose. Avoid contact with eyes and skin. Avoid inhaling dust.

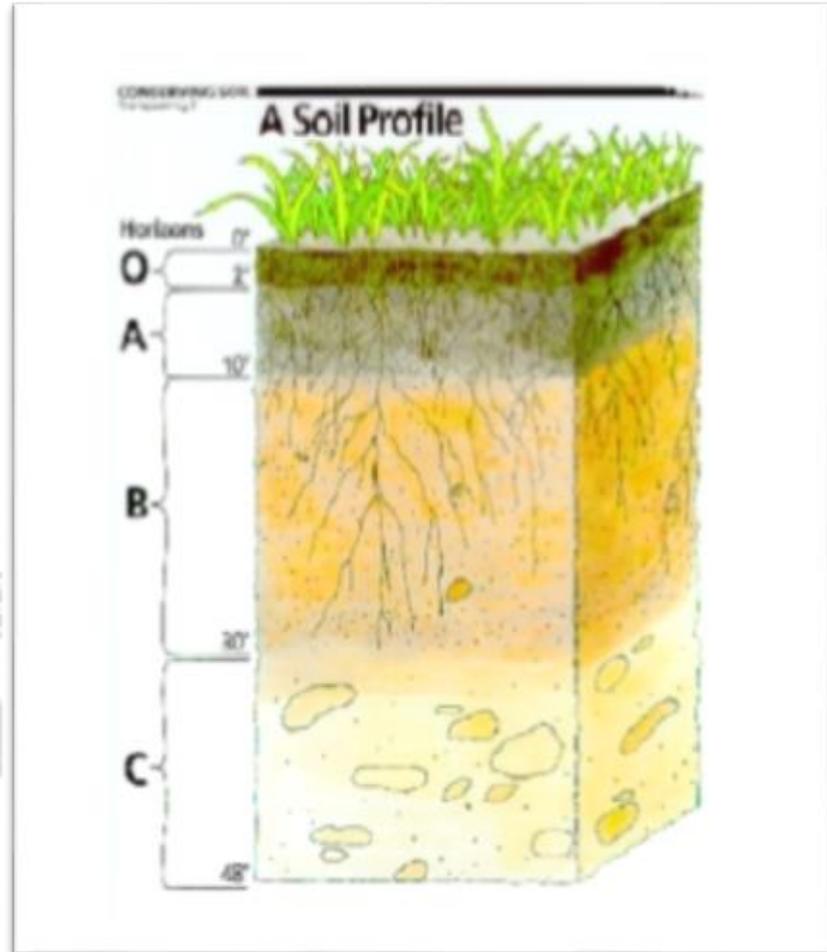
HANDLING AND STORAGE

- Always keep granules dry and intact before application.
- Always wear protective gloves.
- Store bags and product in cool and shady areas away from humidity, high temperatures, fungicides, and strong magnetic and electric fields.

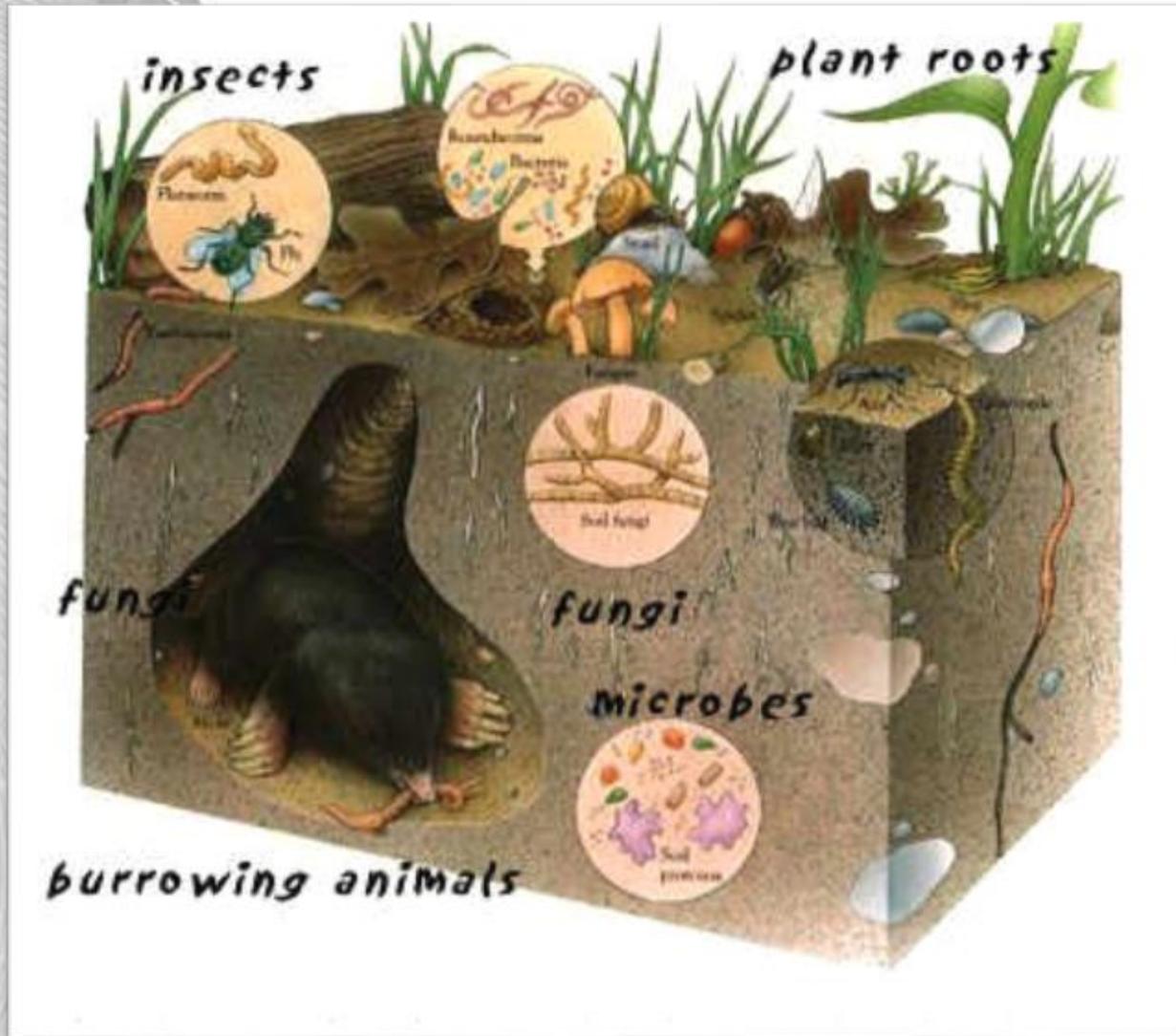
Net Weight: 50 pounds (22.7 kg)
Expiration Date:
Batch Number: On the inside of bag

Soil Profile

- A soil profile is a vertical cross section of a soil, showing the soil horizons
- The soil profile may be altered by land disturbing activities such as grading, cutting and filling, and agricultural practices



BIOLOGICAL PROPERTIES OF SOIL



Soil is an ecosystem containing billions of organisms

Physical Properties of Soil

