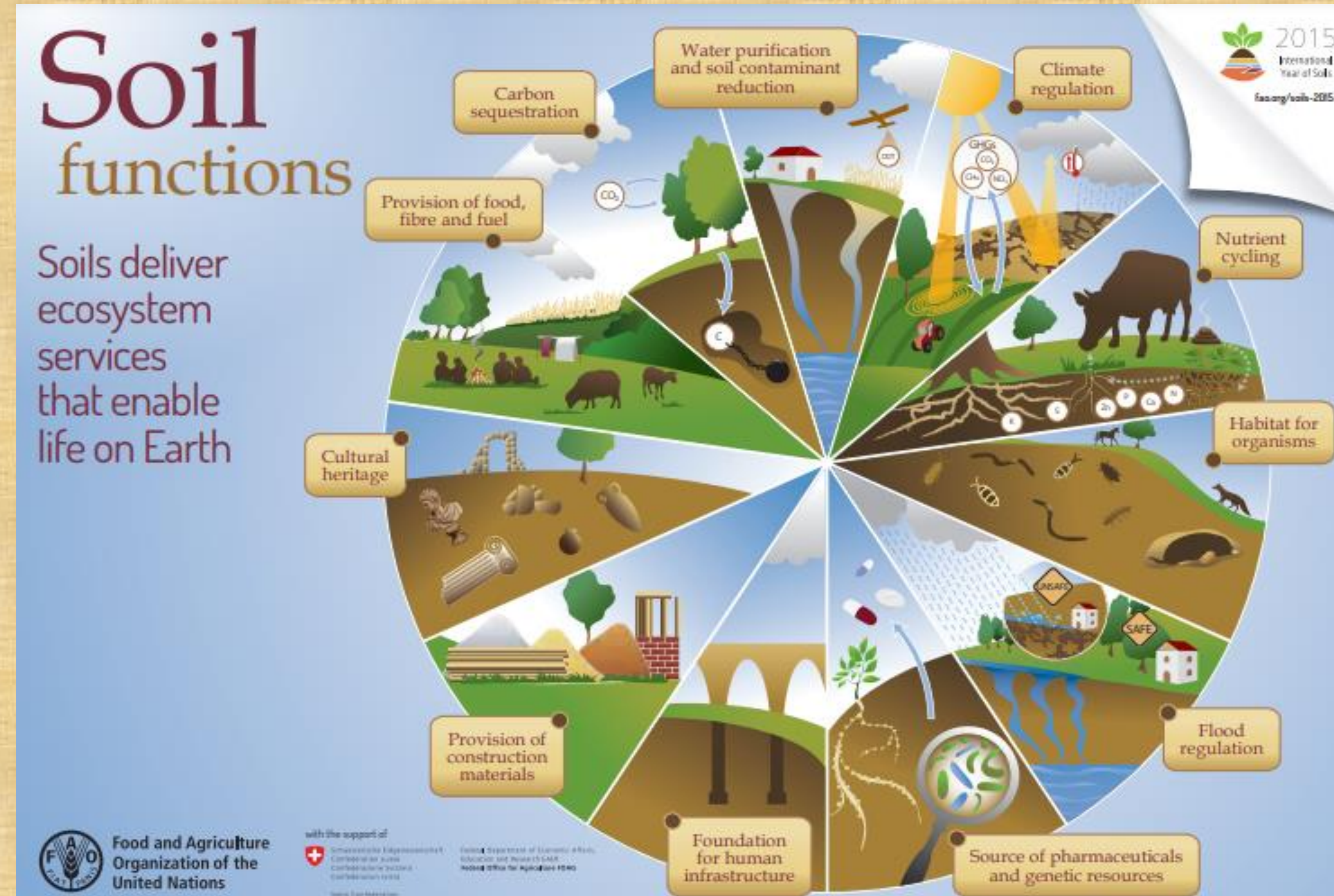
Is human being-soil relatioship limited only to agriculture?

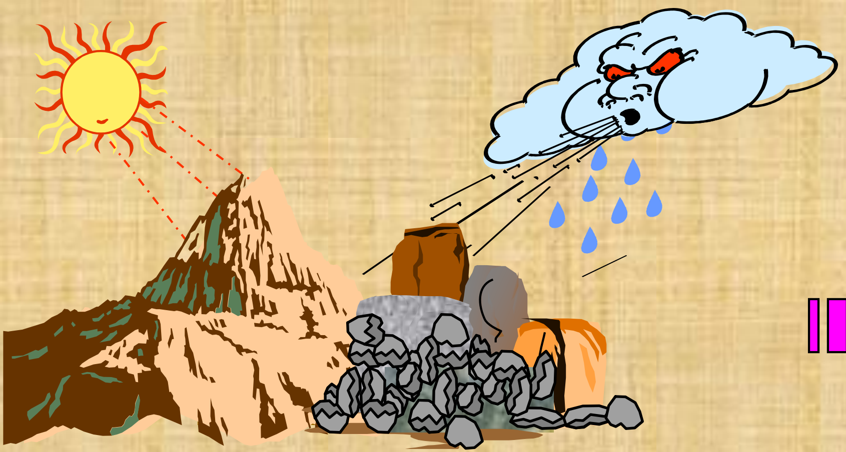
WHY IS SOIL IMPORTANT FOR US?



Functions of soil

1. Food and biomass production
   - agricultural, forest, pasture, and wetland
2. Storing/filtration/transformation
   - Soil is responsible for the chemical conversions between minerals, organic matter and water.
   - Soil diversifies chemical substances during biochemical processes in soil.
   - Soil is a natural filtering barrier forming clear underground water sources.
3. Habitate and gene pool:
   - Soil hosts very large amount and variety of organisms as a living environment.
4. Soil as a raw material:
   - clay, sand, gravel, mineral and peat,

Soil formation



Physical and chemical weathering

Plants, animals, human

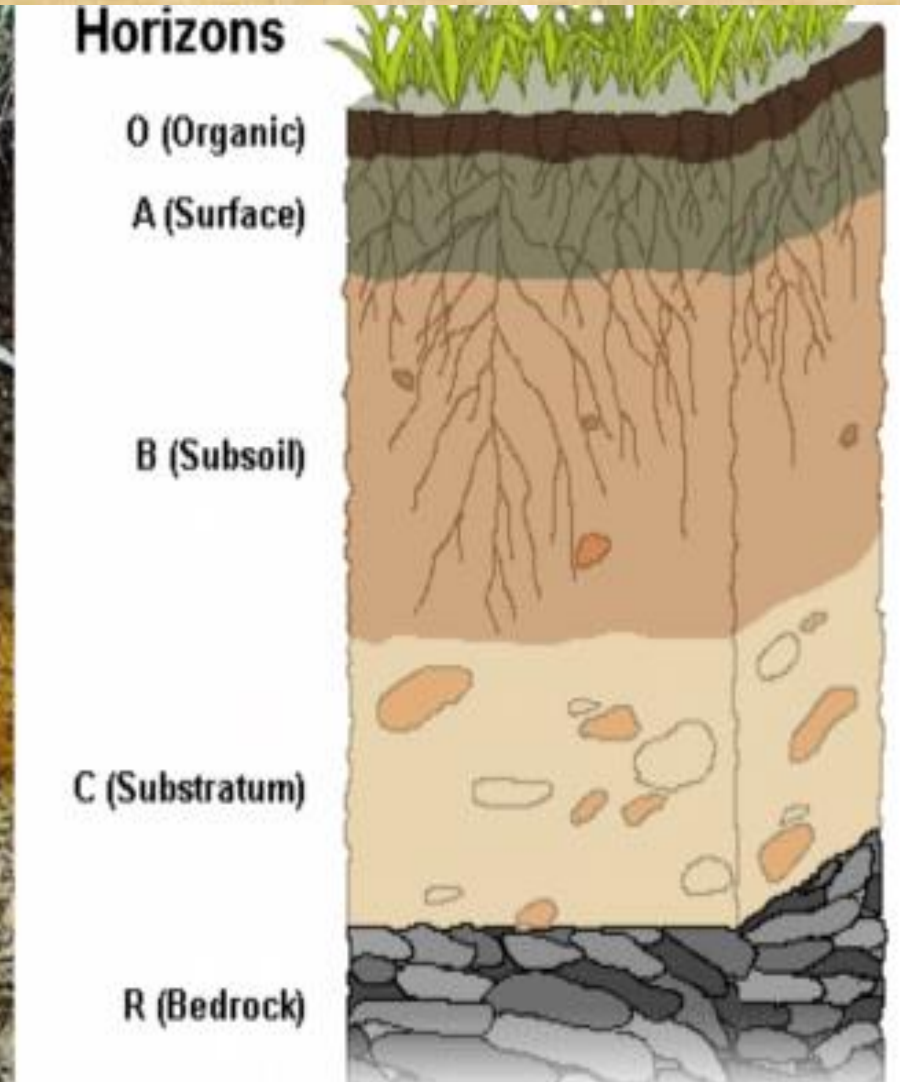
200-1000 year

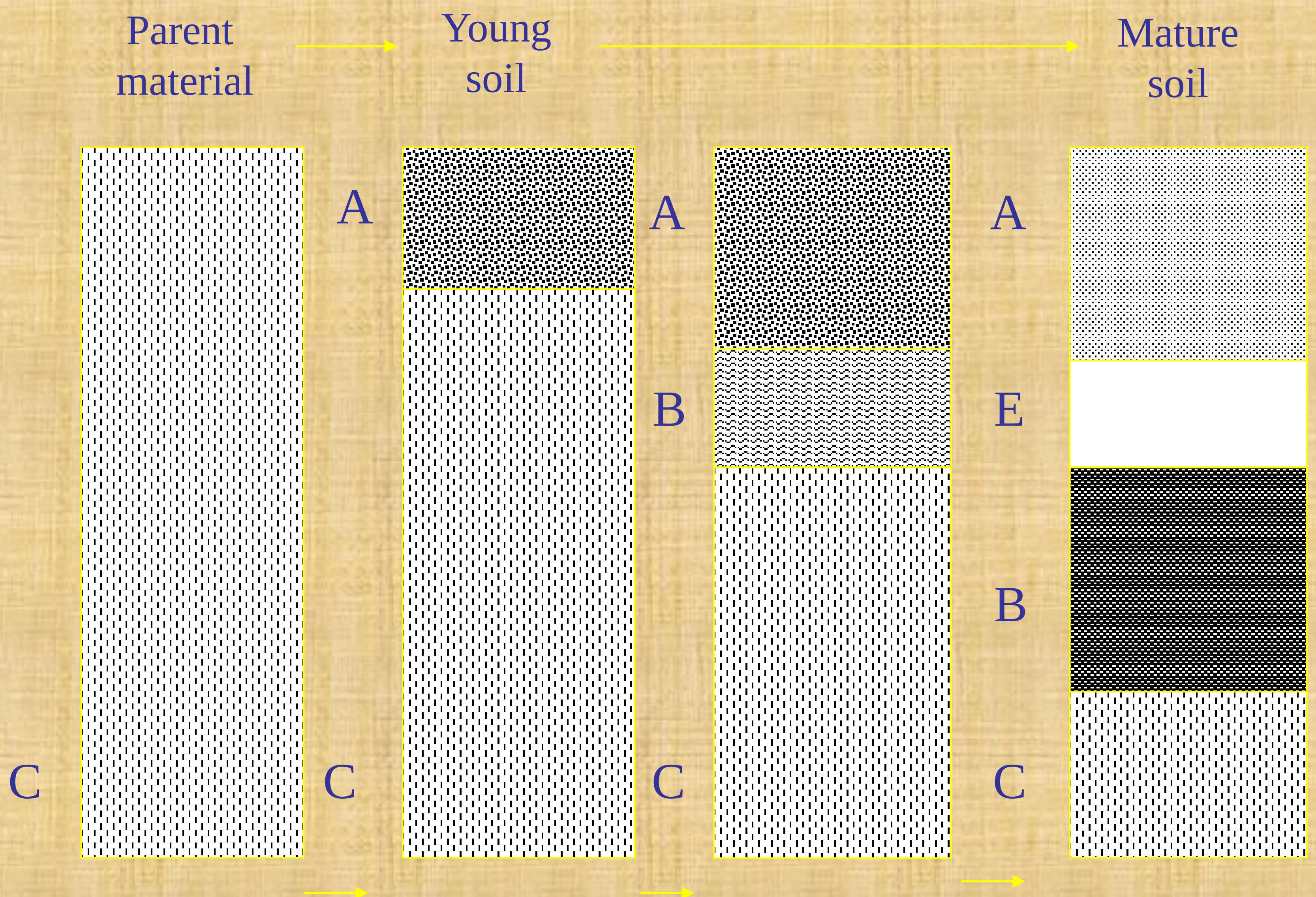
(average 500 yr)

Humus formation

Ideal agricultural soil


SUGARHERO!

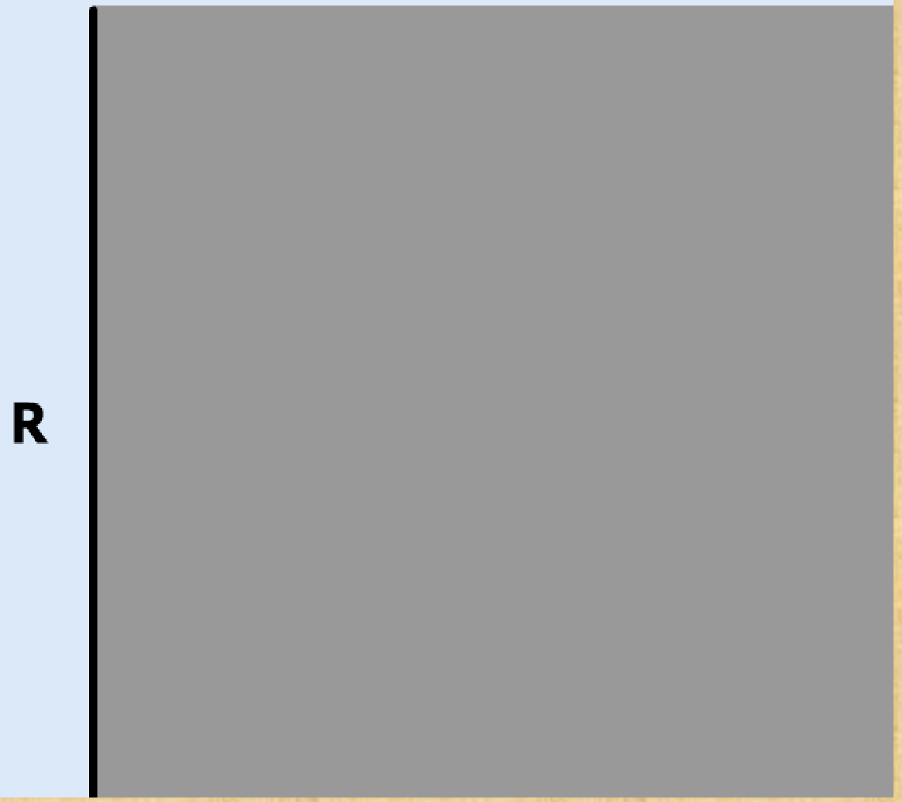

Horizons
O (Organic)
A (Surface)
B (Subsoil)
C (Substratum)
R (Bedrock)



Soil formation

ELAPSED YEARS : 0 YR

Parent Material existed in humid and hot region



ELAPSED YEARS : 10 YR

Weathering Rocks

WEATHERING describes the means by which soil, rocks and minerals are changed by physical and chemical processes into other soil components.

Weathering is an integral part of soil development. Depending on the soil-forming factors in an area, weathering may proceed rapidly over a decade or slowly over millions of years.

C horizon develops on above Regolit.

https://passel.unl.edu/pages/informationmodule.php?idinformationmodule=1130447038

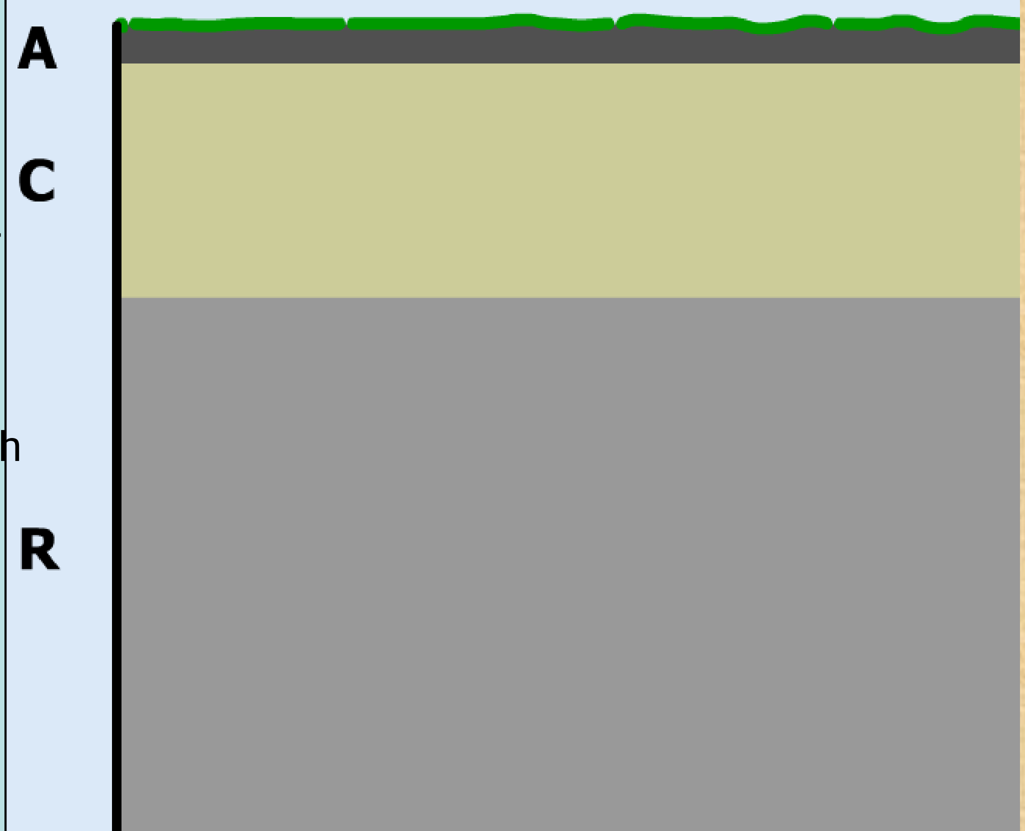
ELAPSED YEARS: 100 YR

Vegetation formation, accumulation of organic matter

Dying plants are accumulated on Surface and form soil organic matter and horizon-A

Weathering process continue through below profile

Parent material (R), changes into Horizon-C.



ELAPSED YEARS : 1000 YR

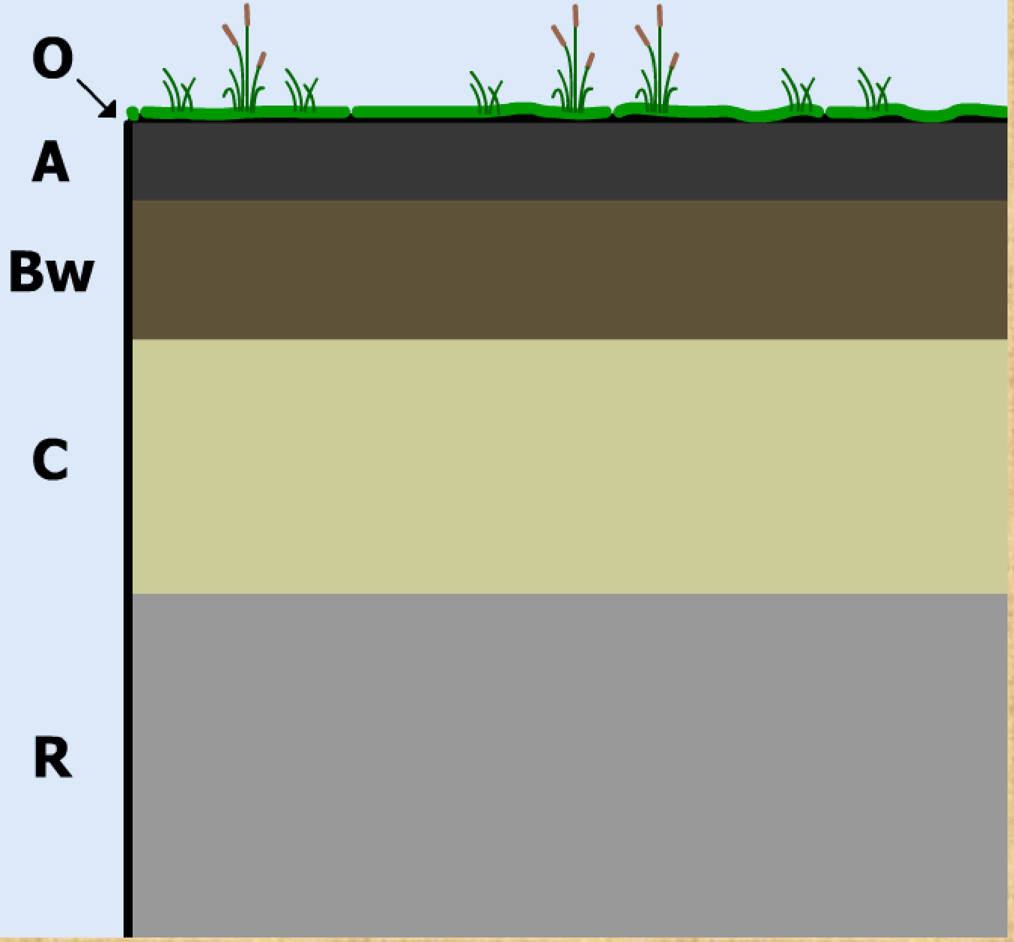
Color and structure development

Thickening horizon-A becomes dark color

Horizon-O can form by accumulating plant debris

Formation of Fe-oxides and clay minerals on the upper horizon and

Their transport to below layers causing formation of horizon-Bw



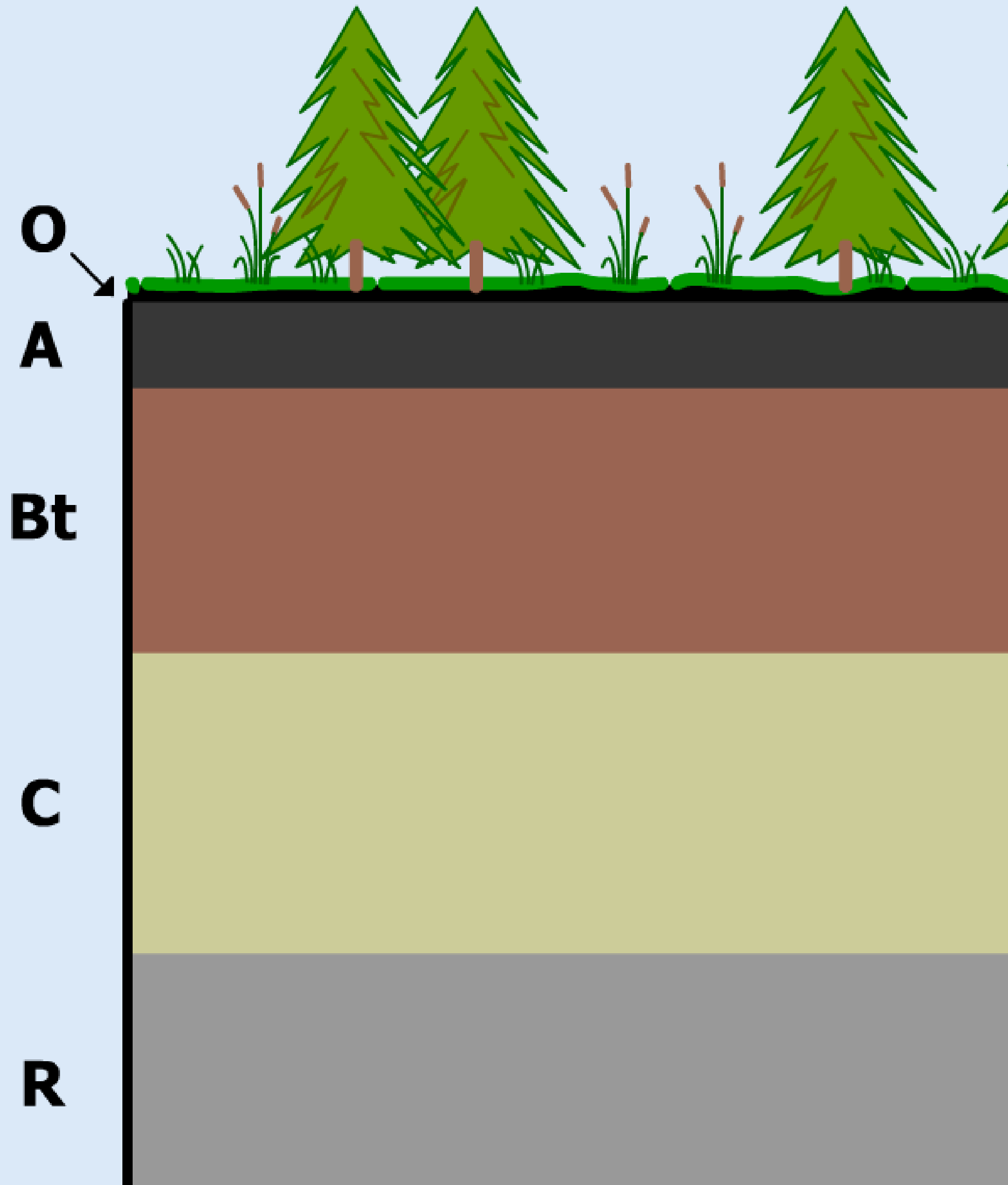
ELAPSED YEARS : 10,000 YR

Increasing clay transport
and accumulation in below layers

Fe-oxides and clays move down and,
Horizon-B becomes more redish
(formation of horizon-Bt

Thickening and darkening horizon-A
by increasing organic matter
accumulation

Weathering process continue through
below layers

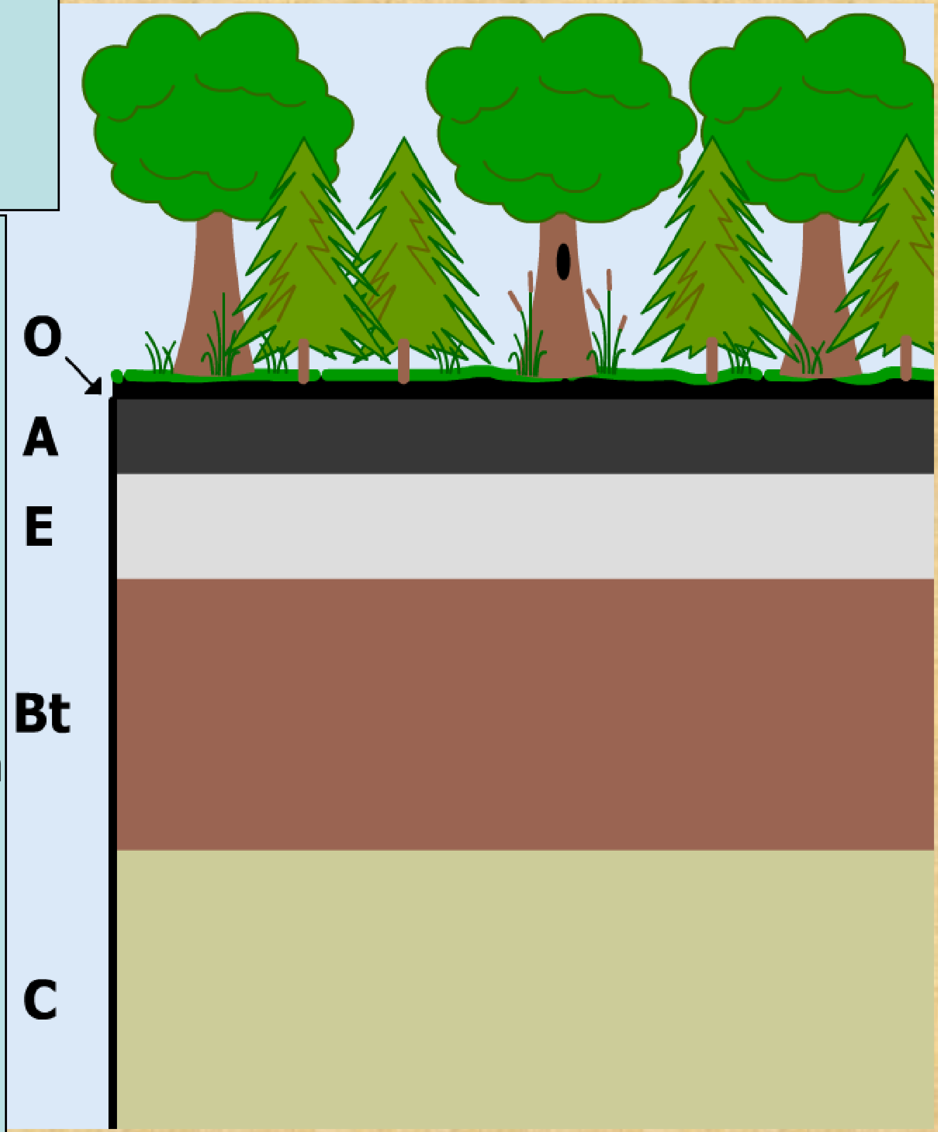


ELAPSED YEARS : 100,000 YR

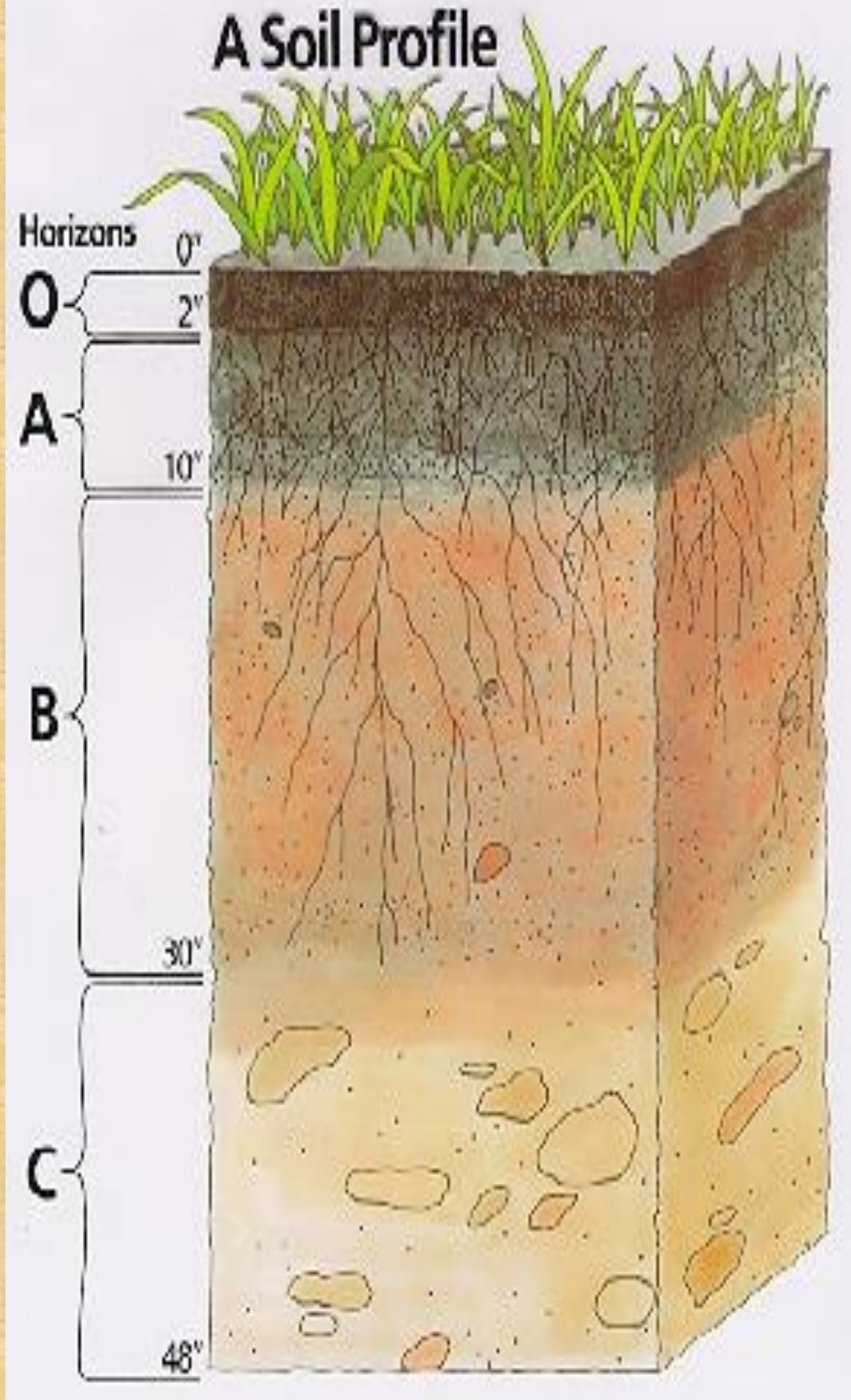
Continous leaching of Fe-oxides and silicate clays in upper layers resulted in the formation of Horizon-E.

Increasing clay transport forms a thick and deep horizon-Bt.

Weathering process continue through below layers



And 100,000 yr later…



Why soil is vital?

1 grams of soil (within 15cm depth)

600.000.000 Bacteria

400.000 Fungi

100.000 Algae

And many bugs and animals as well...

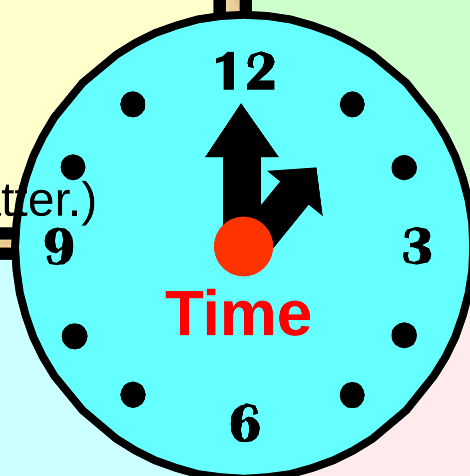
The UNESCO Courier / june1997

Soil forming factors...

Parent material

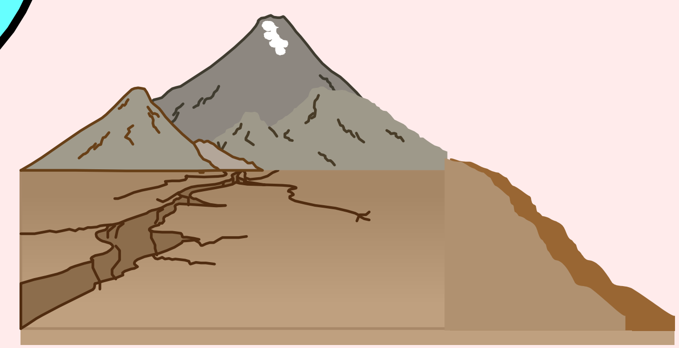
(Rocks, minerals, organic matter.)

Climate (Rainfall, temperature and wind)



Organizms

(Plants and animals)

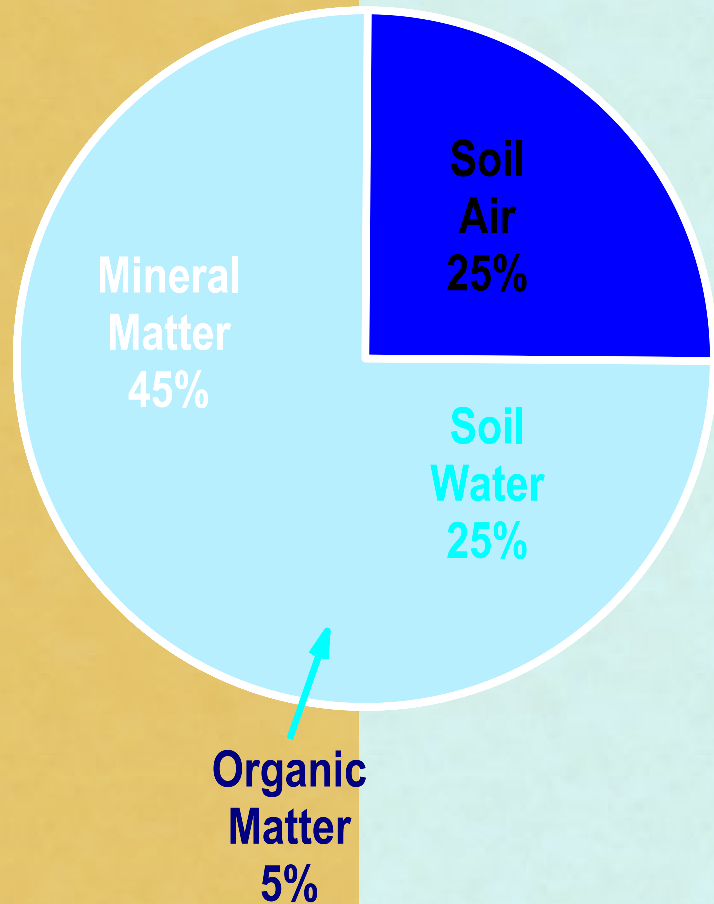


Topography

(Altitude, slope, vector)

SOIL COMPONENTS (4 divisions)

Minerals almost in half



Pores in other half

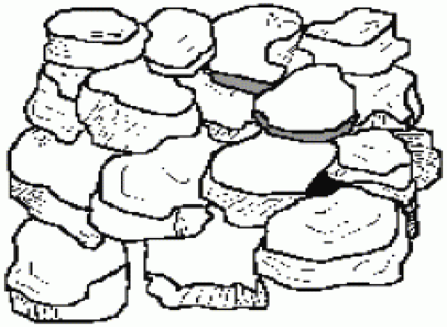
PHYSICAL CHARACTERISTICS OF SOIL

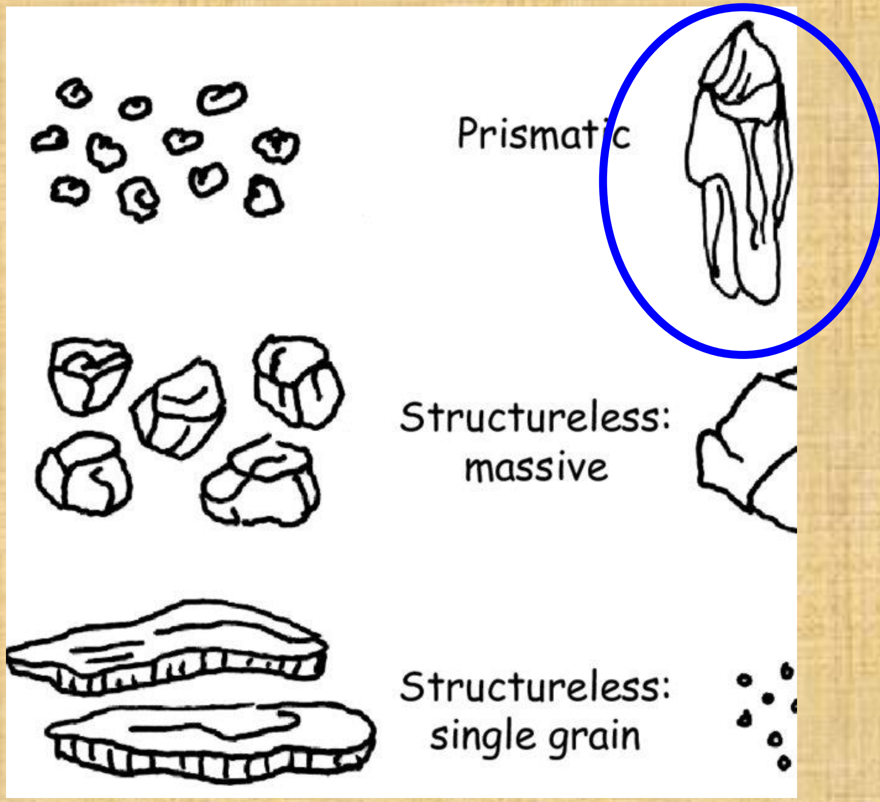
- Color
- Texture
- Structure
- Pores
- Soil water
- Soil air

https://www.qld.gov.au/environment/land/soil/soil-properties/colour/

Why different color?

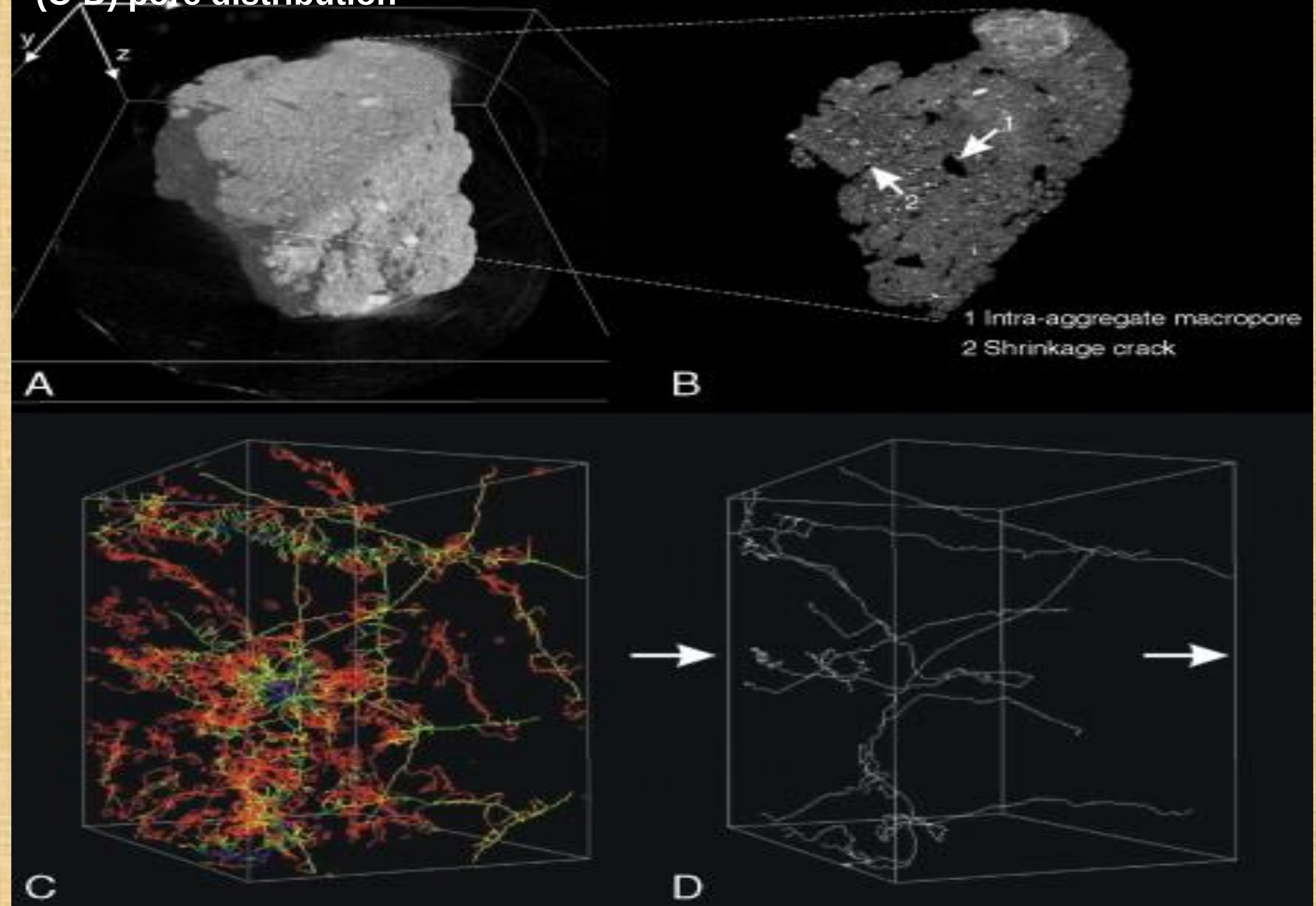
Why different pattern (structure)

		
Granular: Resembles cookie crumbs and is usually less than 0.5 cm in diameter. Commonly found in surface horizons where roots have been growing.	**Blocky**: Irregular blocks that are usually 1.5 - 5.0 cm in diameter.	**Prismatic**: Vertical columns of soil that might be a number of cm long. Usually found in lower horizons.
		
Columnar: Vertical columns of soil that have a salt "cap" at the top. Found in soils of arid climates.	**Platy**: Thin, flat plates of soil that lie horizontally. Usually found in compacted soil.	**Single Grained**: Soil is broken into individual particles that do not stick together. Always accompanies a loose consistence. Commonly found in sandy soils.


Prismatic
Structureless: massive
Structureless: single grain

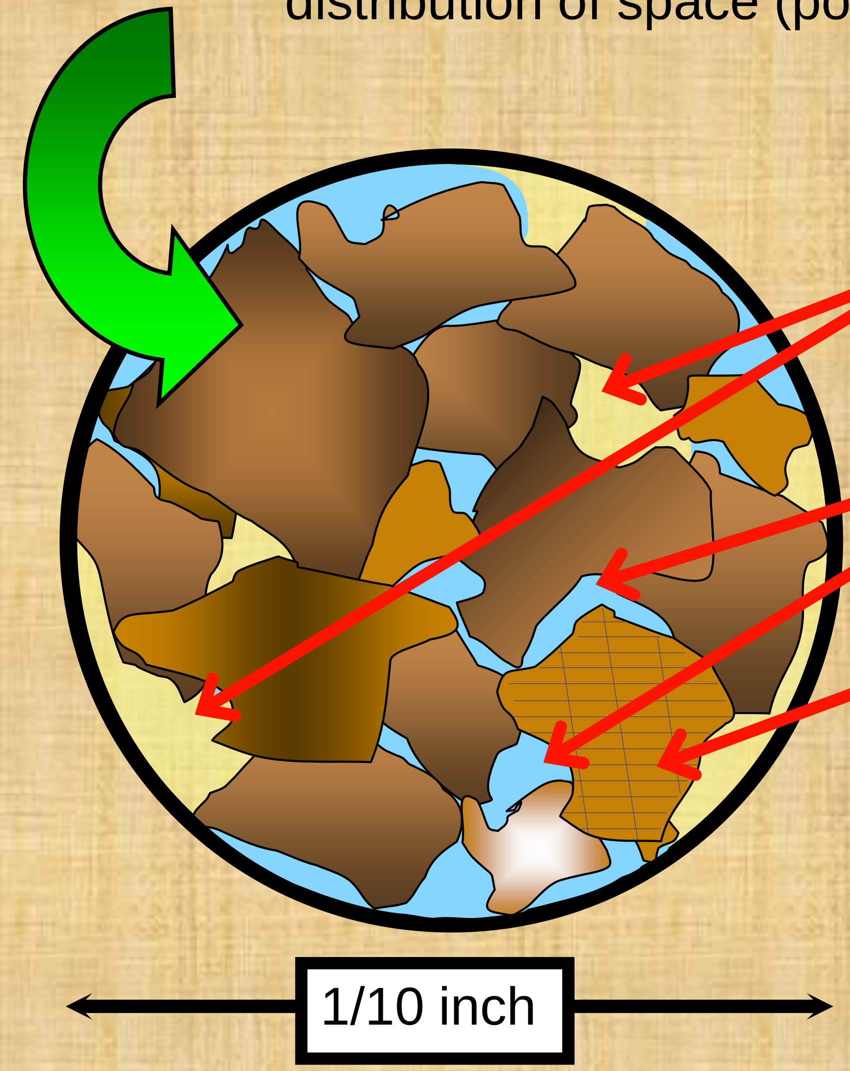
Space in soil (porosity)

(A) A soil particle with 5mm dimension in 3D, (B) cross section view, (C-D) pore distribution



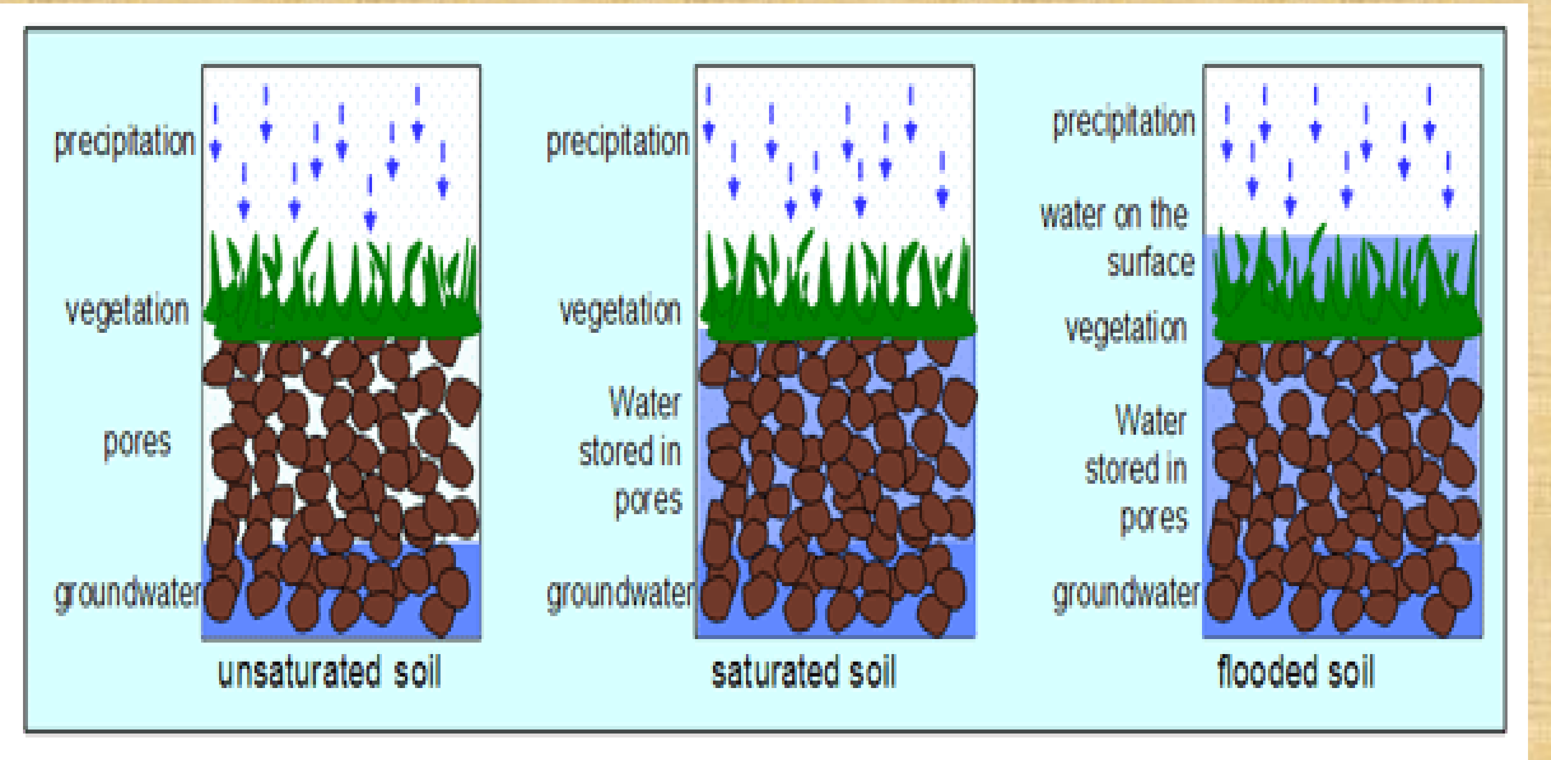
Soil porosity

distribution of space (por) and natural soil particles in soil



- **<u>Macropore</u> (big pores)**
  (>0.003 inch)
- **<u>Mezopores</u> (intermediate pores)**
  (0.001 – 0.003 inch)
- **<u>Micropores</u> (small pores)**
  (<0.001 inch)

Changing water in soil



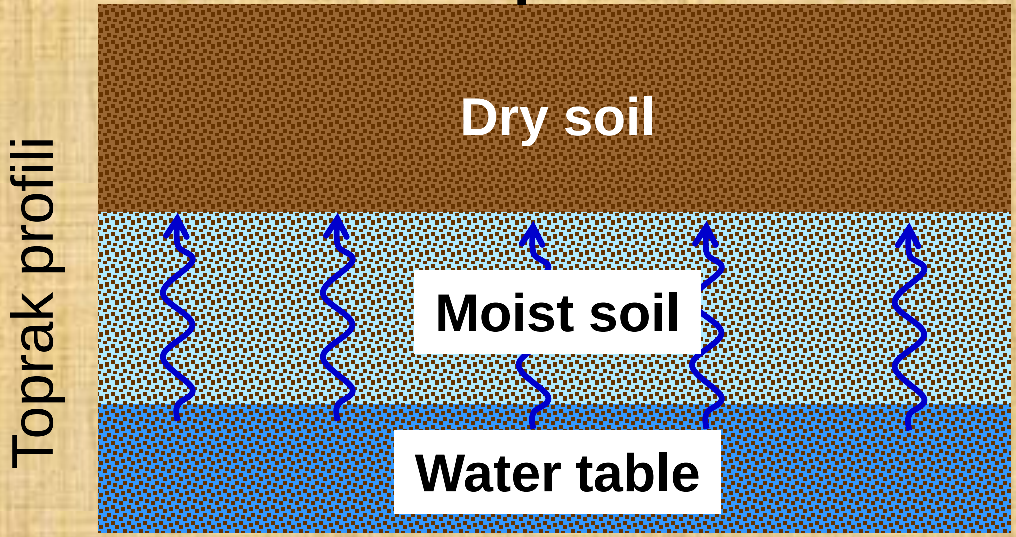
http://www.floodsite.net/juniorfloodsite/html/en/student/thingstoknow/hydrology/waterstorage2.html

Water in soil

Two main forces moving water in soil

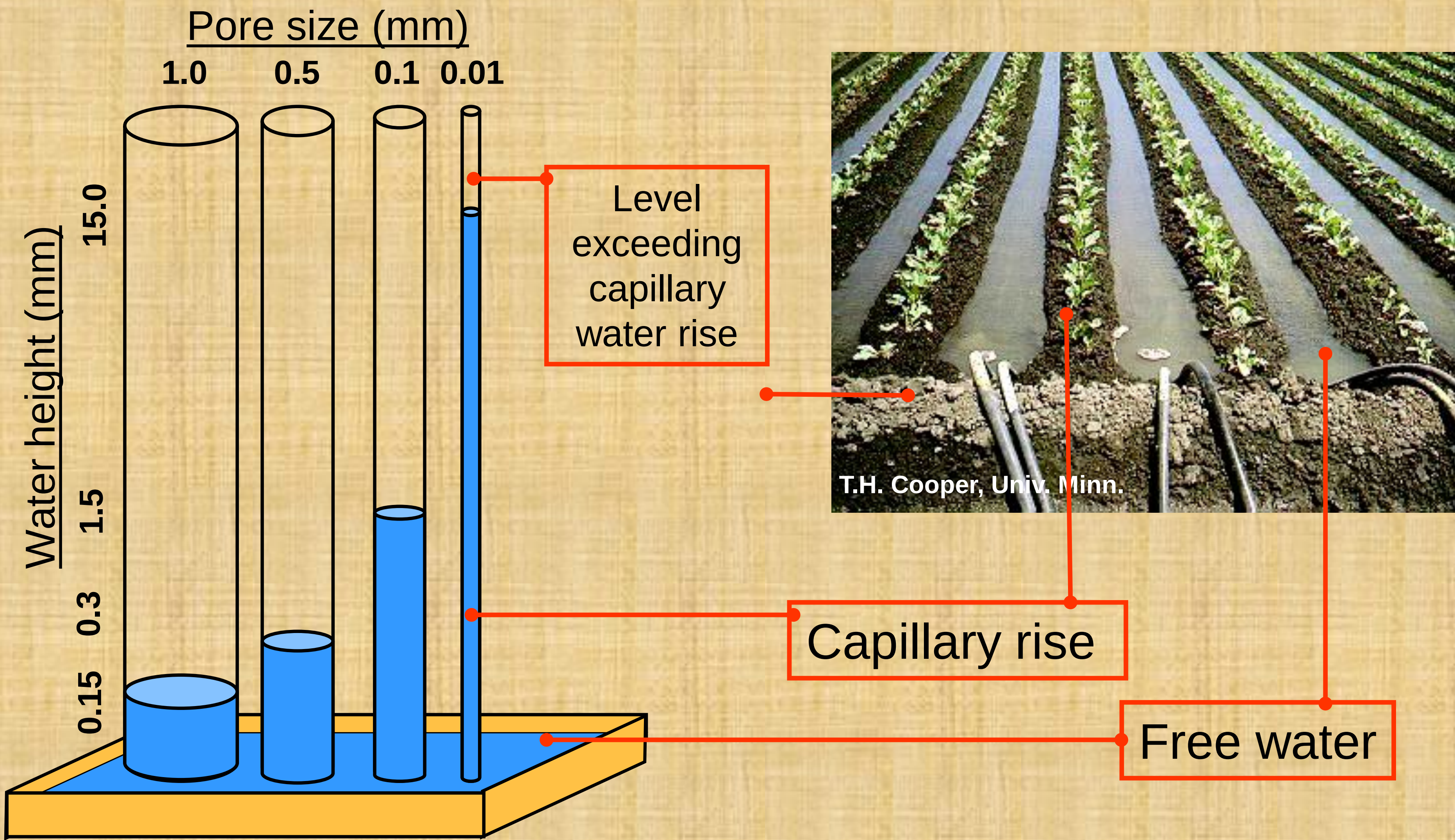
gravity

Matric potential

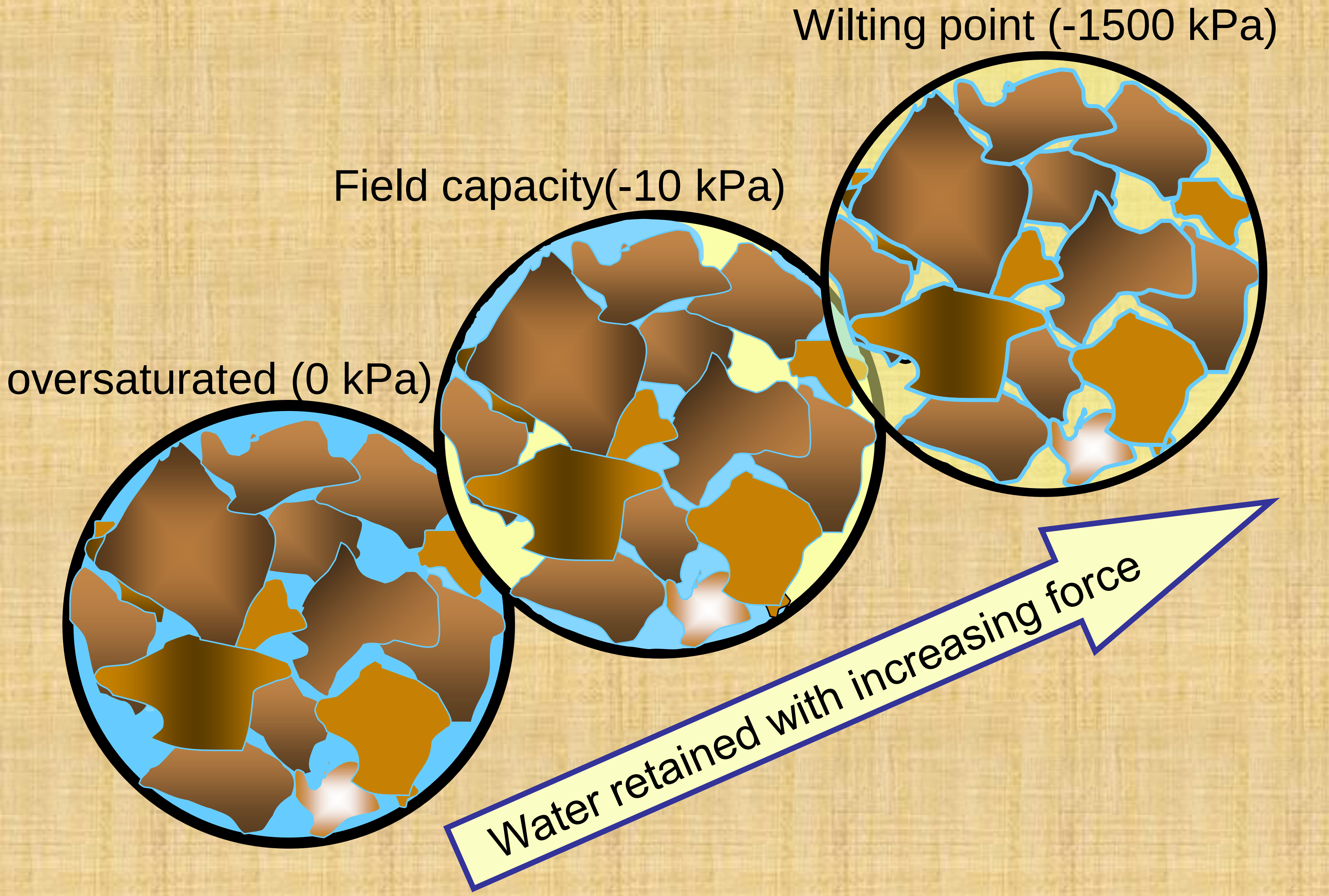


In conditions with less water in the micropores, physical attraction force between soil-water surface is driven by slow water movement called "capillarity"

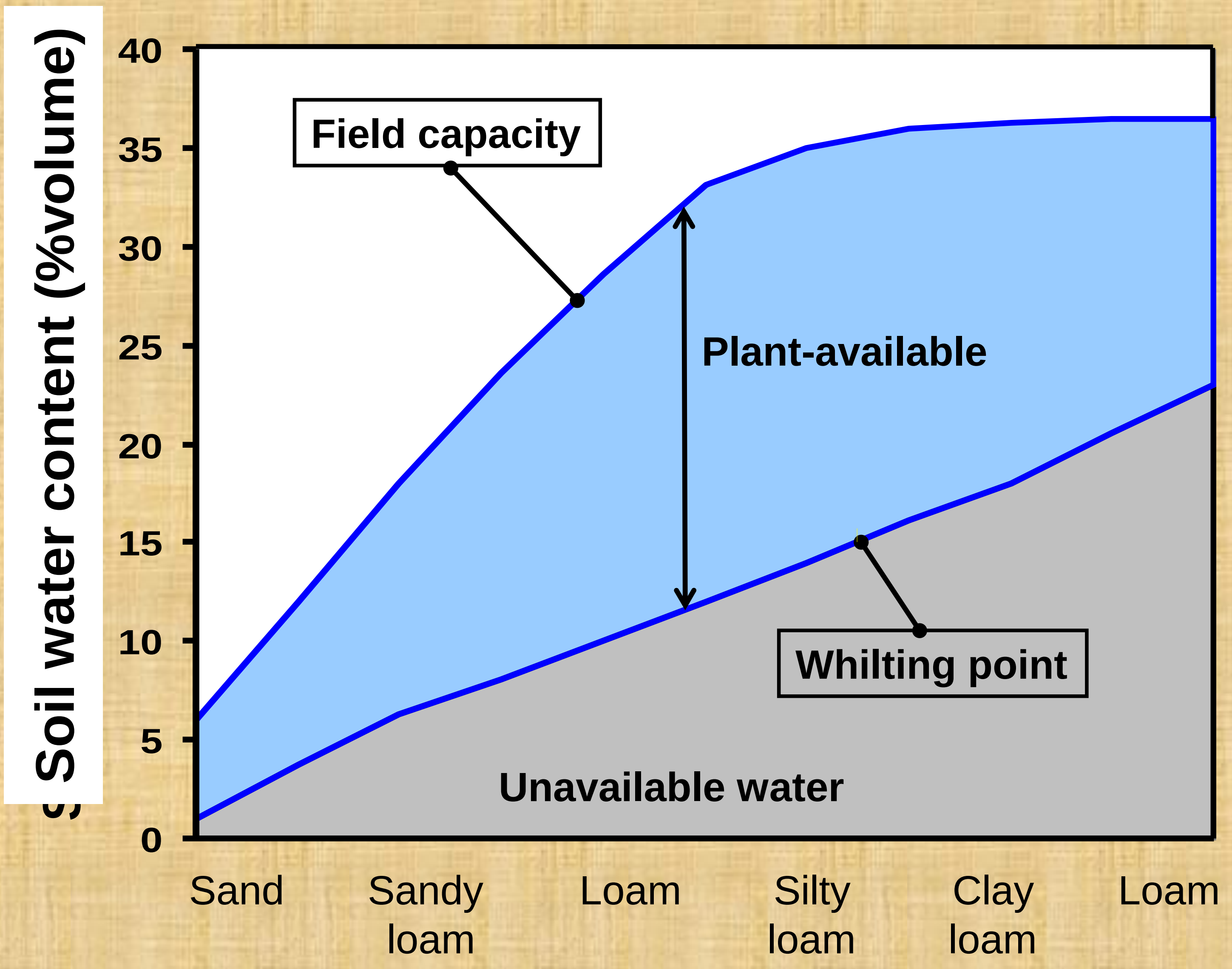
Capillary water movement in soil



Water retention in soil

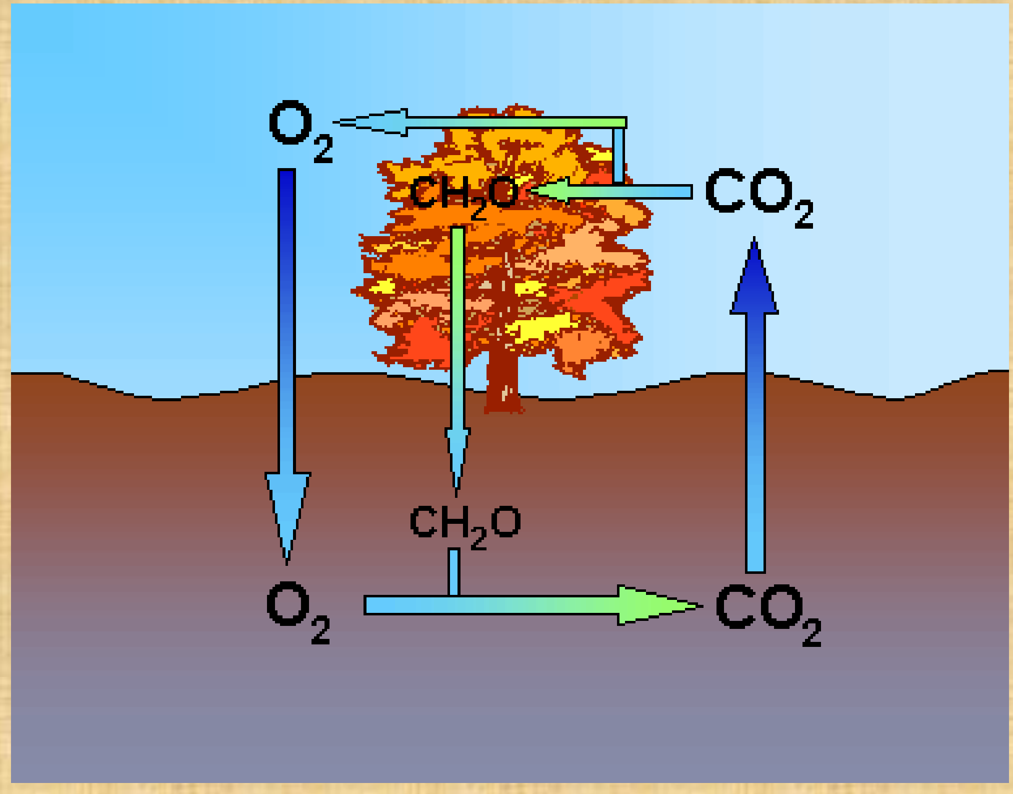


Plant available water



Brady and Weil. 1999. *The Nature and Properties of Soil*. Prentice Hall

Air cycle in soil



Soil texture

- **Soil mineral portion consists of 'clay', 'sand' and 'silt'**

- **A ratio between these particles (in %) determines soil texture**
  - Coarse texture (more sand-less clay)
  - Heavy texture (more clay –less sand)
  - Loamy(same amount of sand-clay-silt)

Chemical characteristics of soil

- Soil pH
- Mineral nutrients in soil
- Colloids (clay and organic matter)
- CEC (cation exchange capacity)
- Electrical conductivity
- Soil buffering capacity

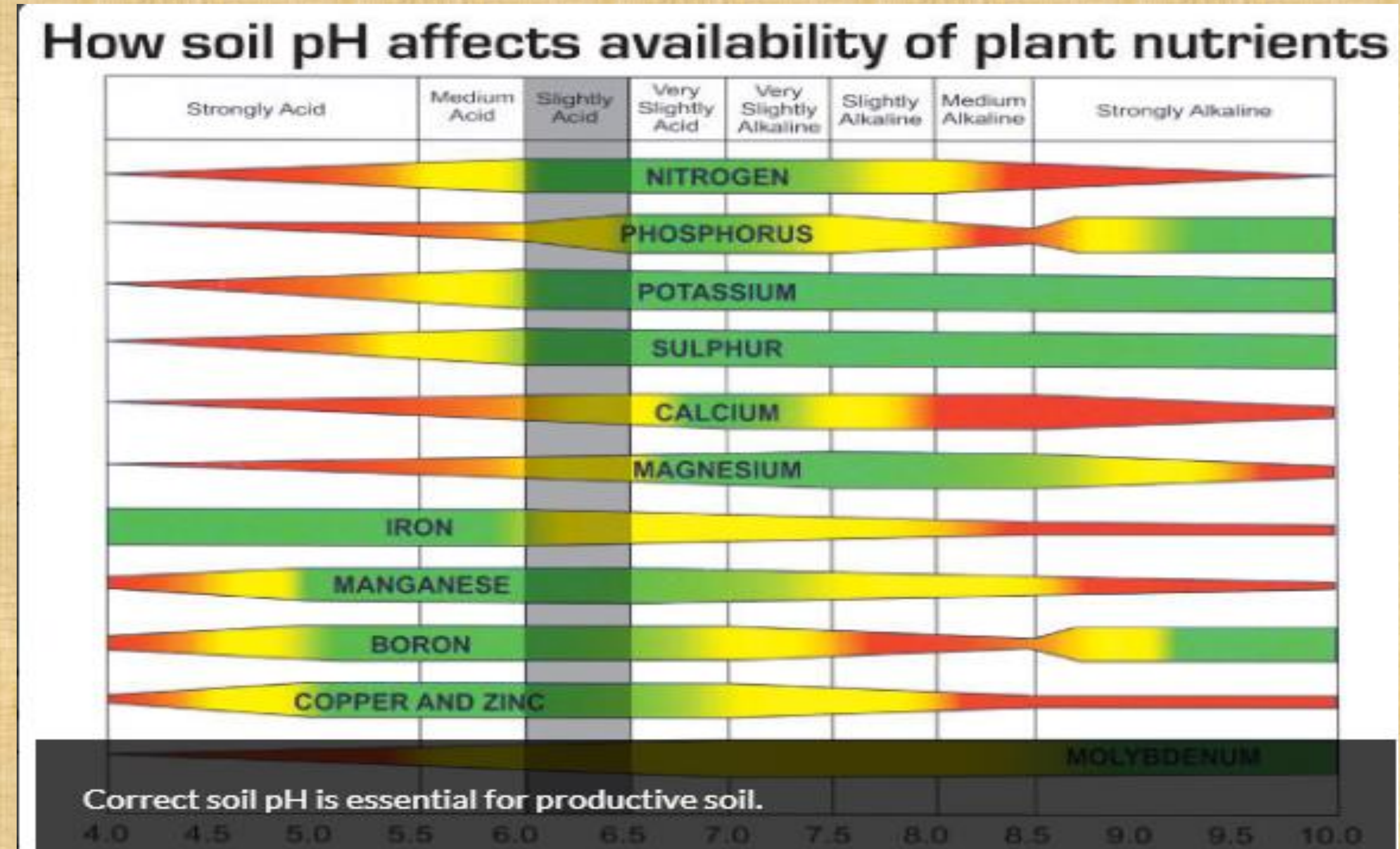
Soil pH

- Soil pH or soil reaction is an indication of the acidity or alkalinity of soil and is measured in pH units.
- Soil pH is defined as the negative logarithm of the hydrogen ion concentration.
- The pH scale goes from 0 to 14 with pH 7 as the neutral point.
- As the amount of hydrogen ions in the soil increases the soil pH decreases thus becoming more acidic.
- From pH 7 to 0 the soil is increasingly more acidic and from pH 7 to 14 the soil is increasingly more alkaline or basic.

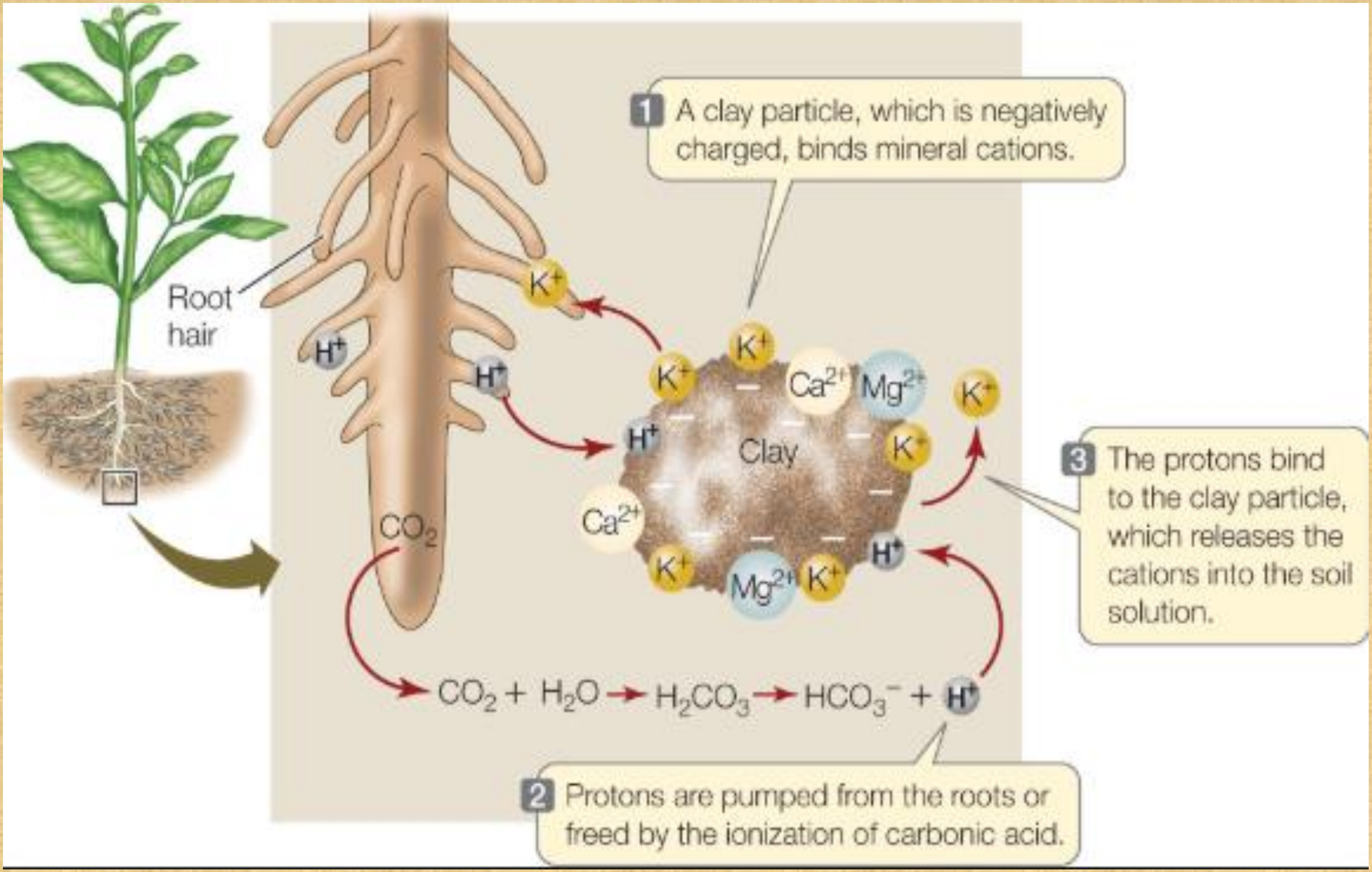
https://www.esf.edu/pubprog/brochure/soilph/soilph.htm

What can be the potential reasons for the situation below?

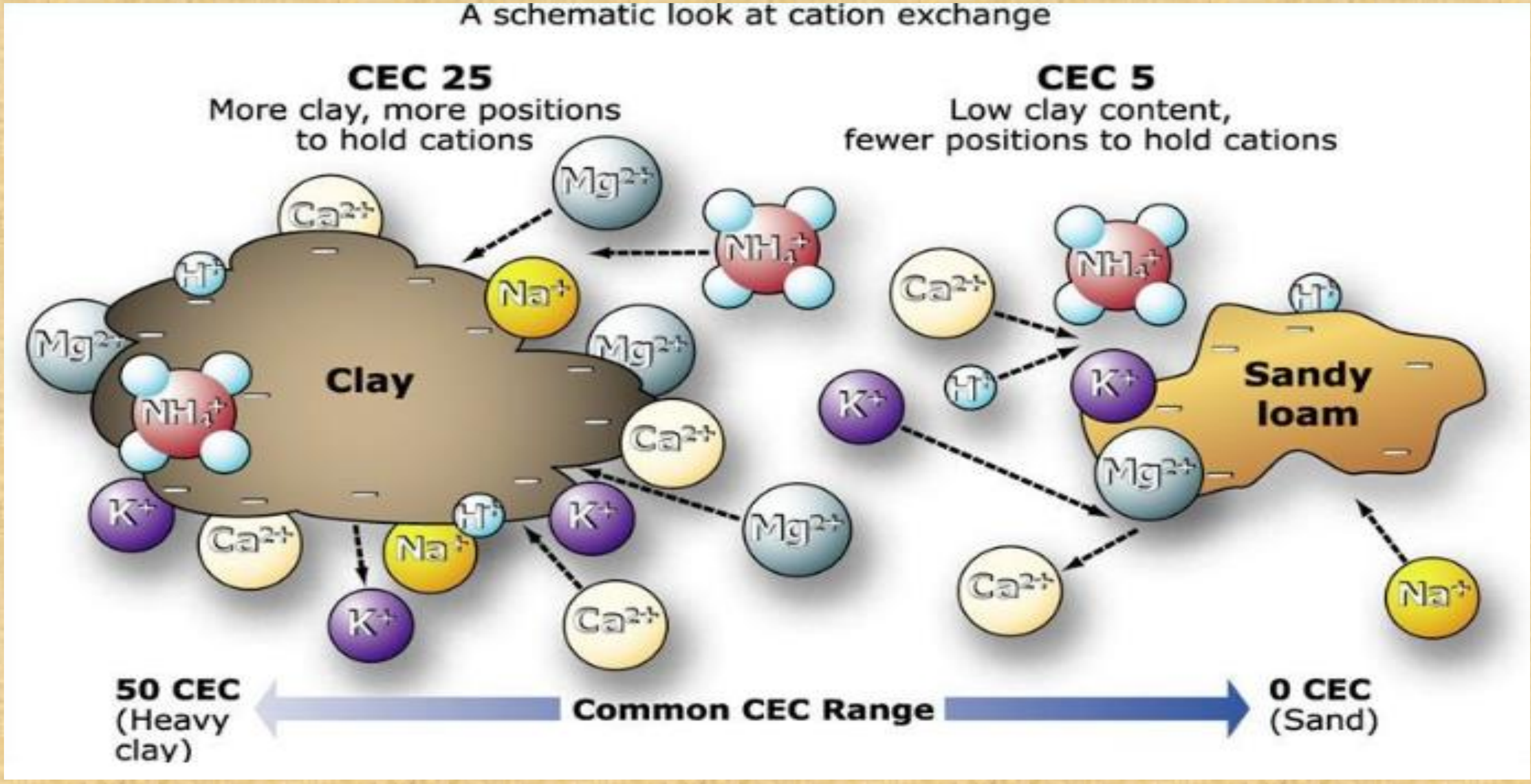
Why soil pH matters??



Ion Exchange in Soil



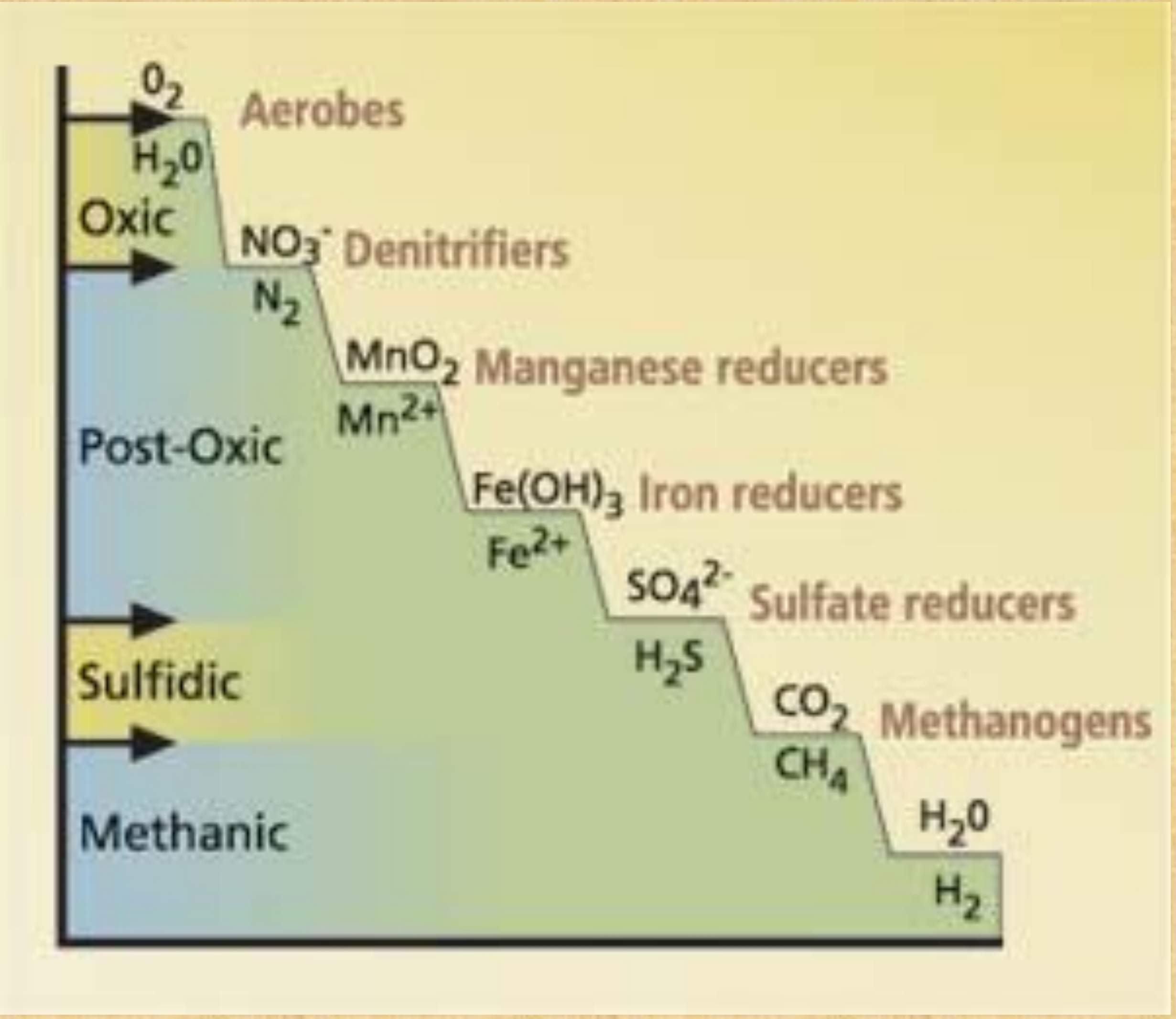
Cation Exchange Capacity (CEC)



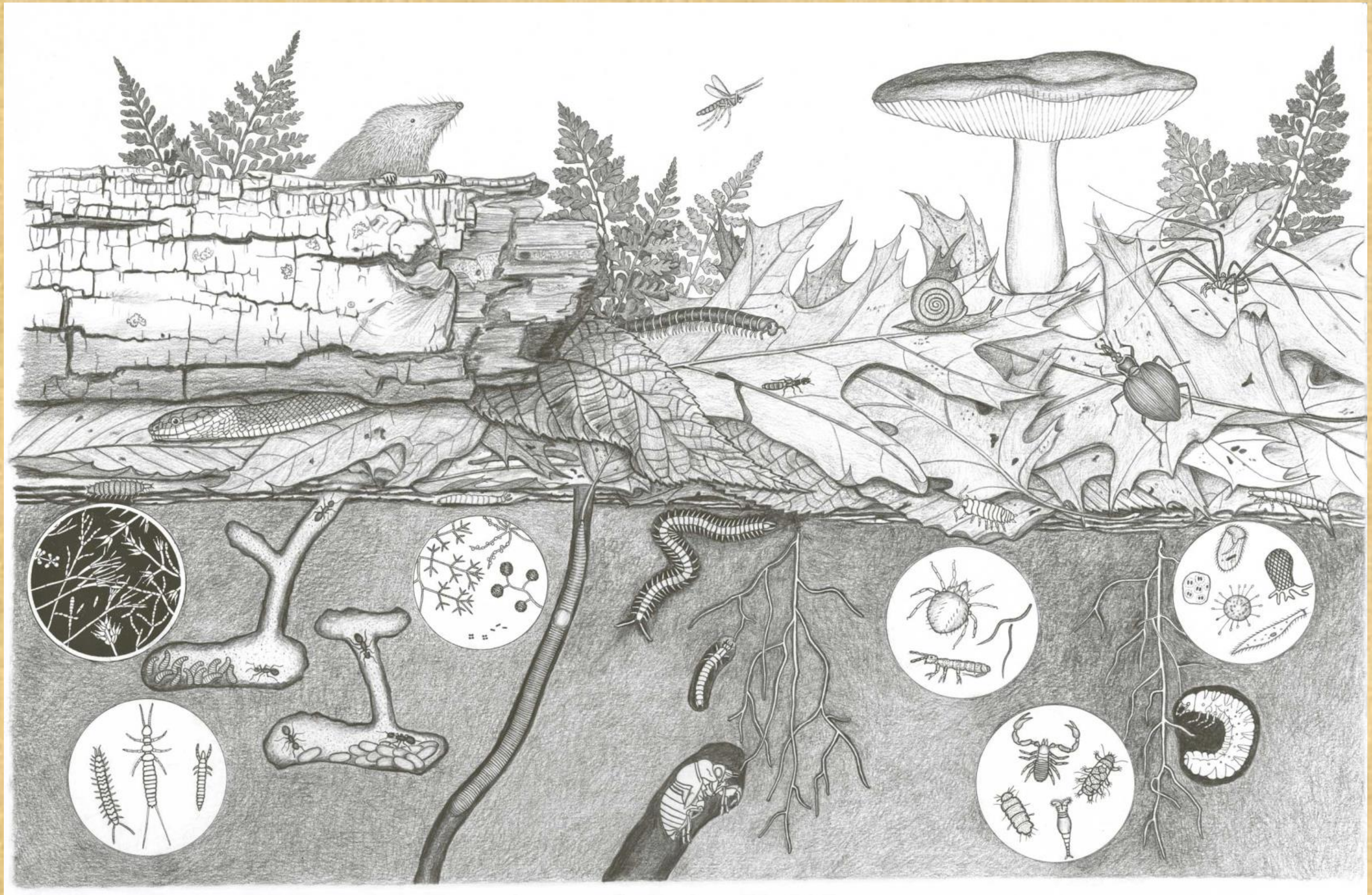
Not only nutrients but also pollutants can be sorbed (adsorption+adsorption) by clays

CEC is important in the sense of soil pollution

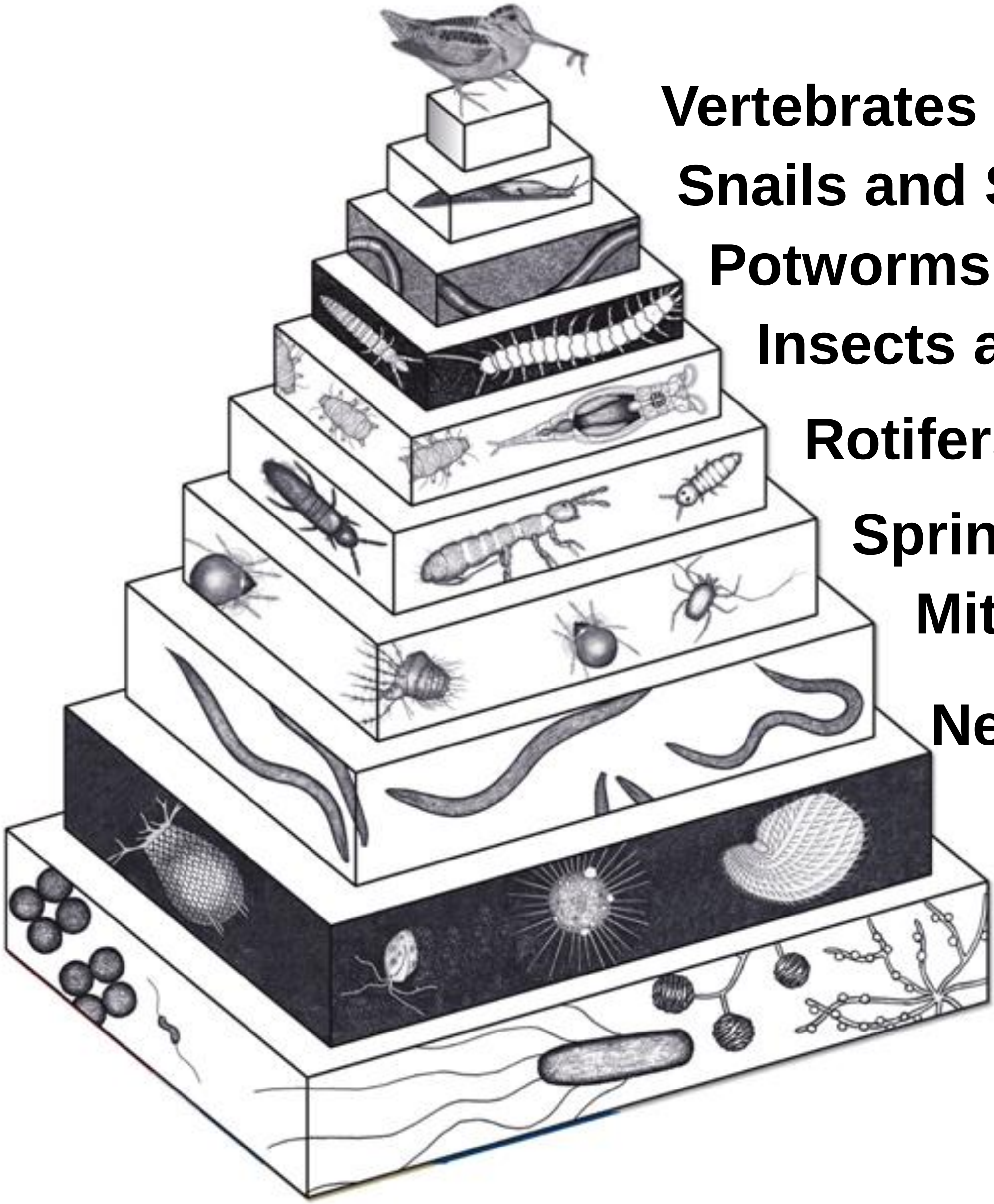
Soil redox potential (ooxidation and reduction processes)



Biological characteristics of soil



Biology Pyramid in Soil



Vertebrates (1)

Snails and Slugs (100)

Potworms and Earthworms (3,000)

Insects and Spiders (5,000)

Rotifers (10,000)

Springtails (50,000)

Mites (100,000)

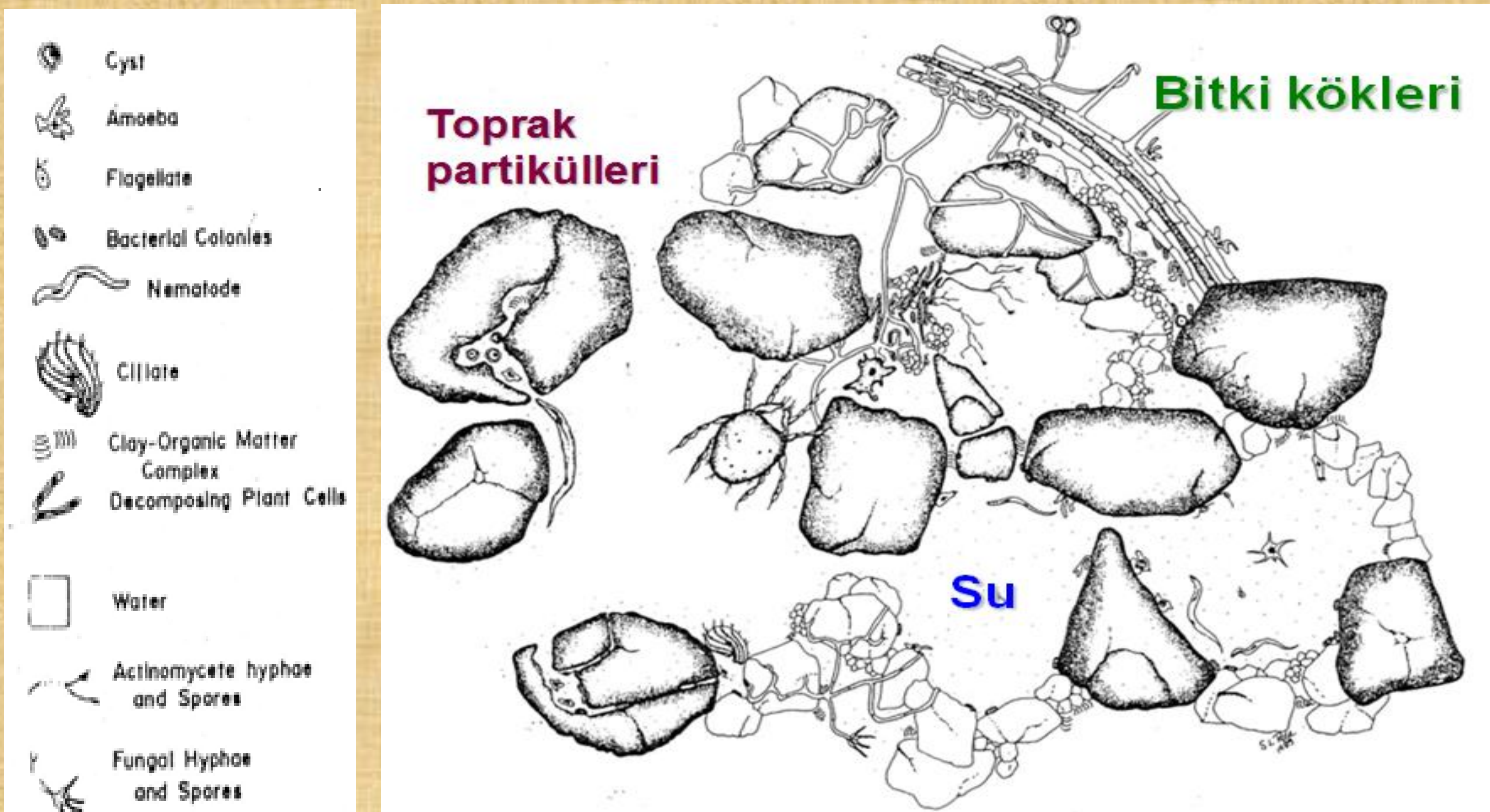
Nematodes (5,000,000)

Protozoa (10,000,000,000)

Fungi (100,000,000,000)

Bacteria (10,000,000,000,000)

Soil as a habitate



1cm^2 of soil microzone indicating relationships between living organisms and their access to life resources

Classification of Microorganisms (according to their size)

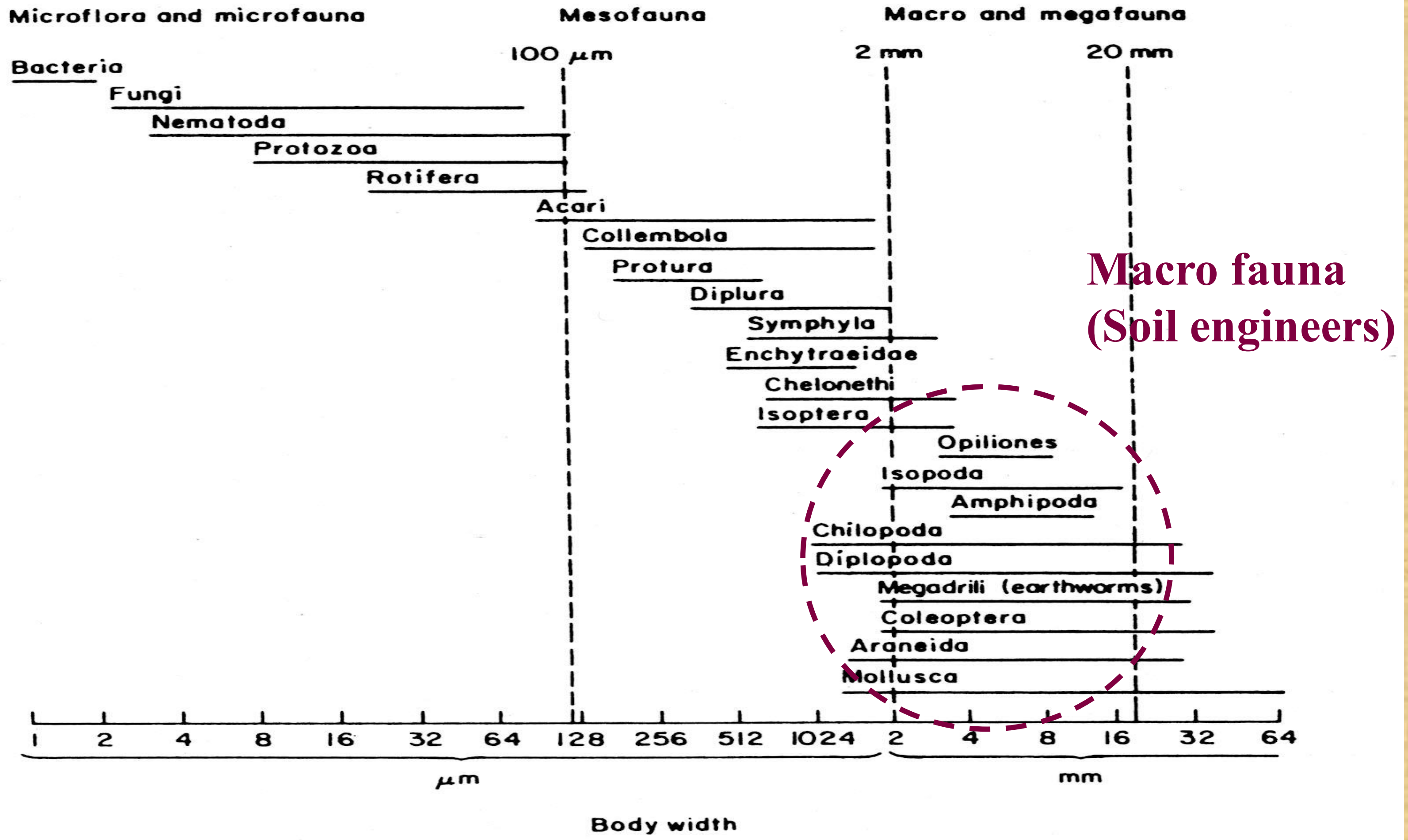


FIGURE 4.3 Size classification of organisms in decomposer food webs by body width (Swift *et al.*, 1979).

Soil Macrofauna

Macrofauna is important because they're responible for organic matter decomposition, predation and bioturbation (mixing of mineral soil by living microorganisms)

Mesofauna: predators pathogenes

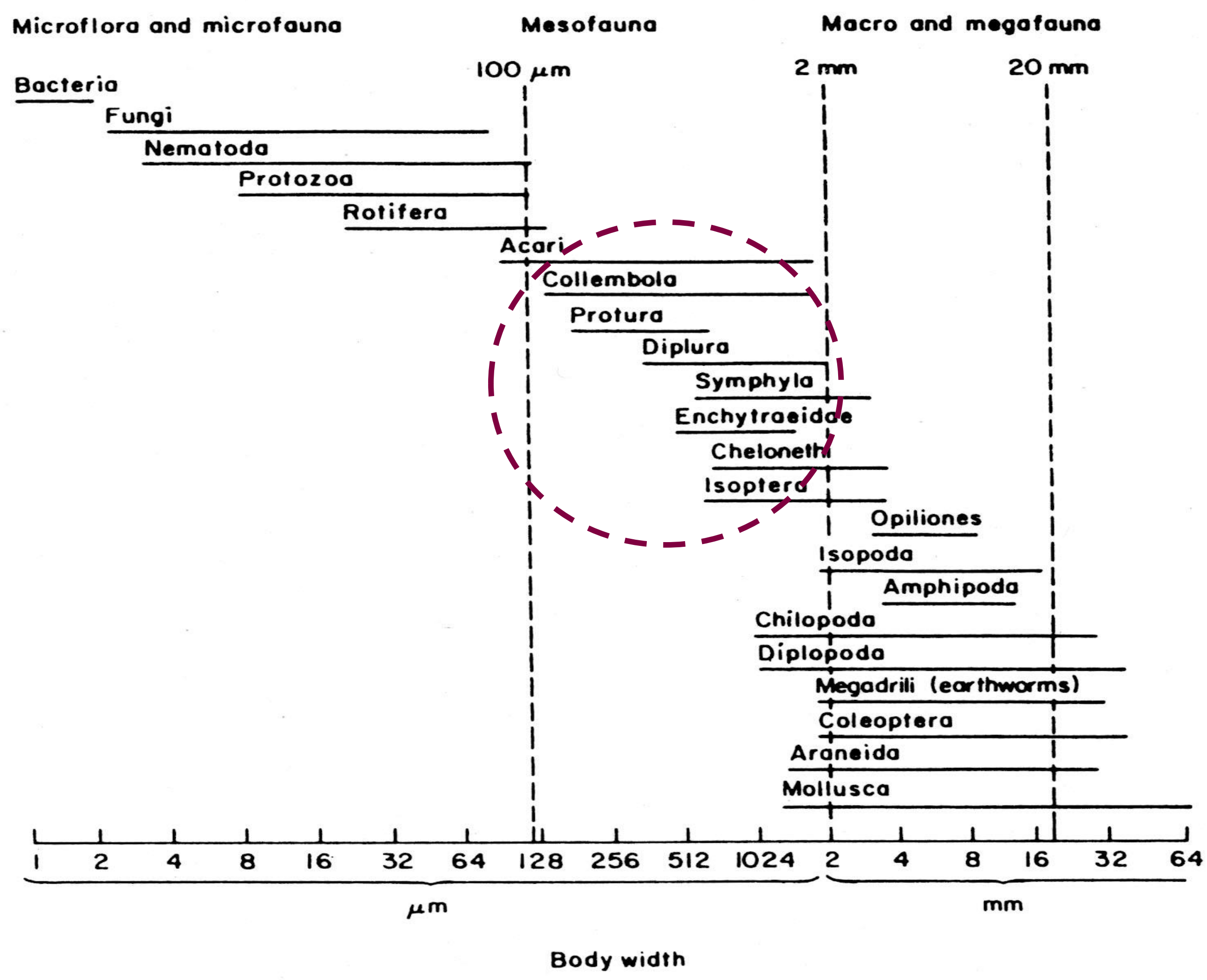
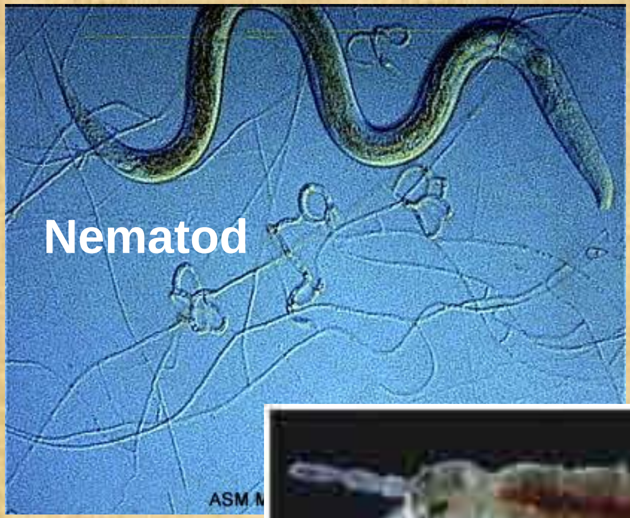
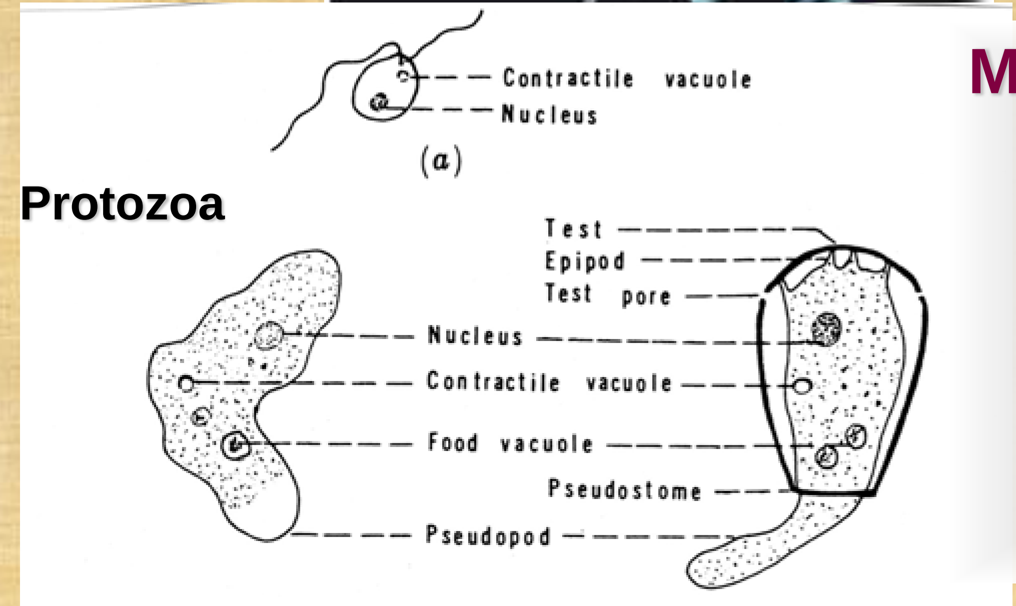


FIGURE 4.3 Size classification of organisms in decomposer food webs by body width (Swift *et al.*, 1979).

Soil Mesofauna





Mesofauna is important because responible for organic matter decomposition, predation and controlling pathogenes in soils

Microorganisms (responsible for many nutrient processes in the soil)

C, N, S, P

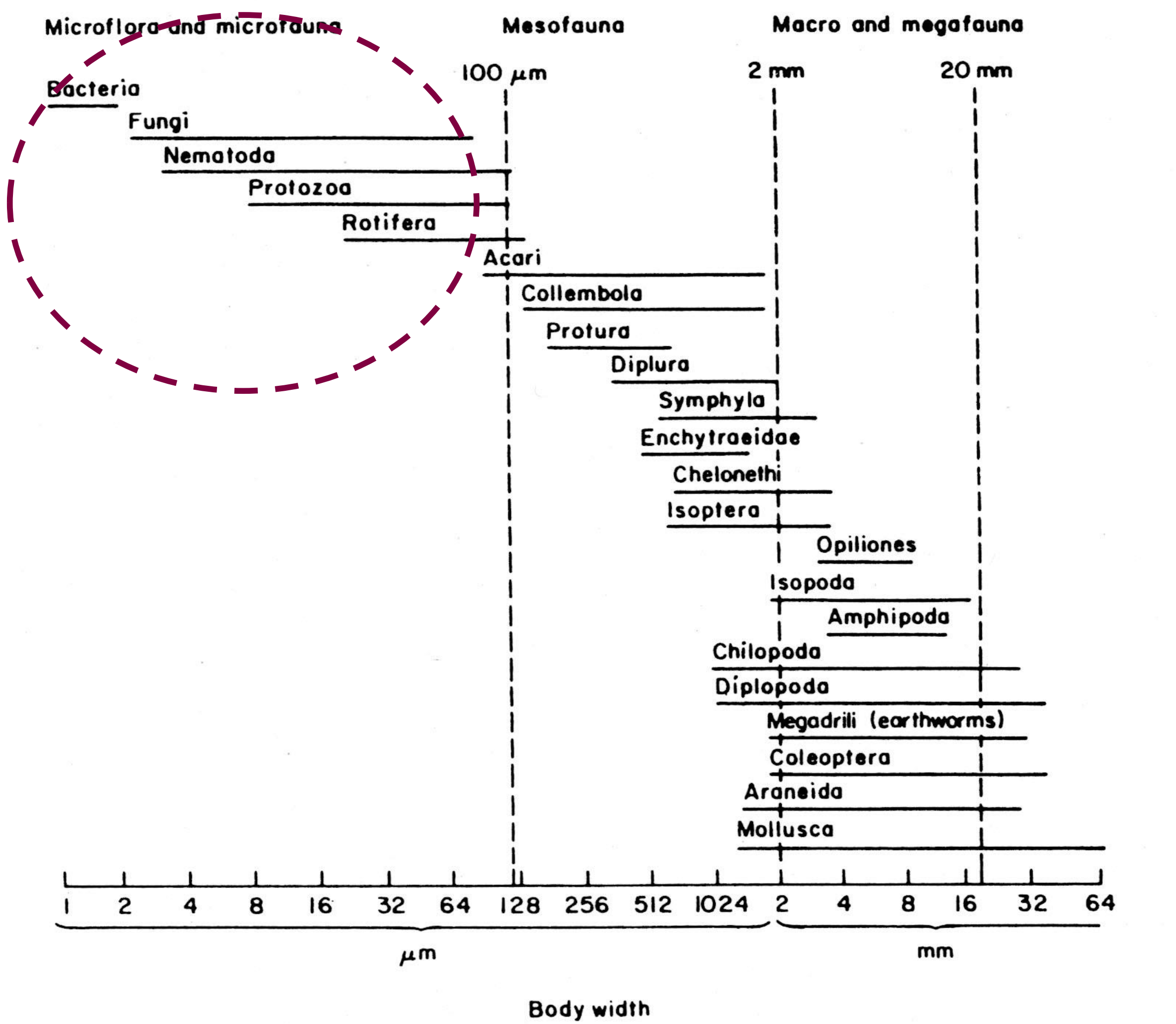
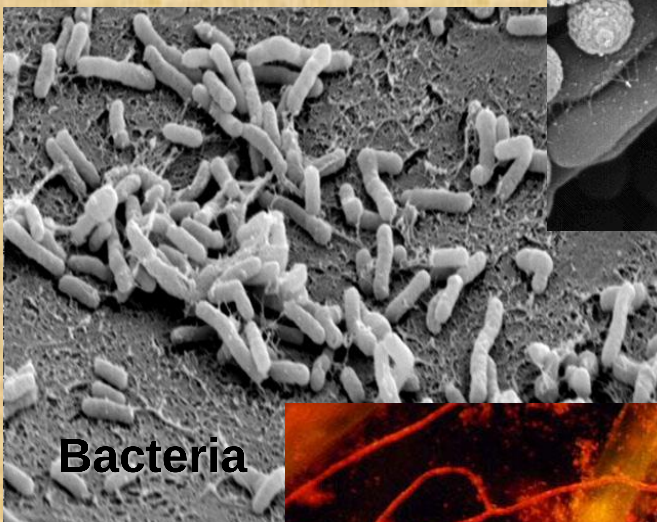
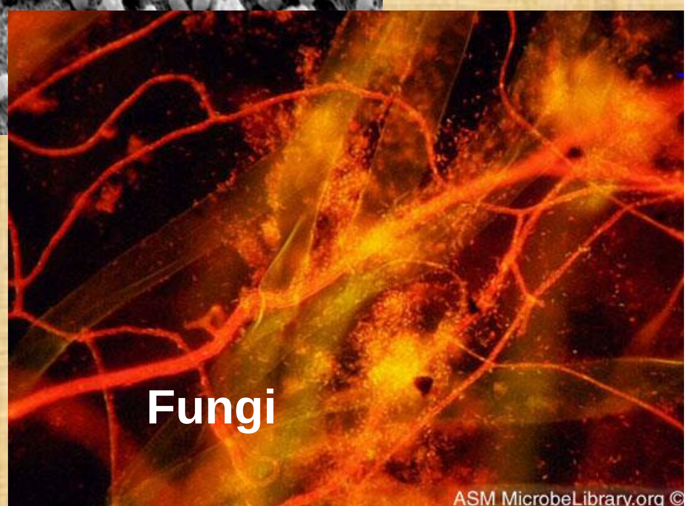


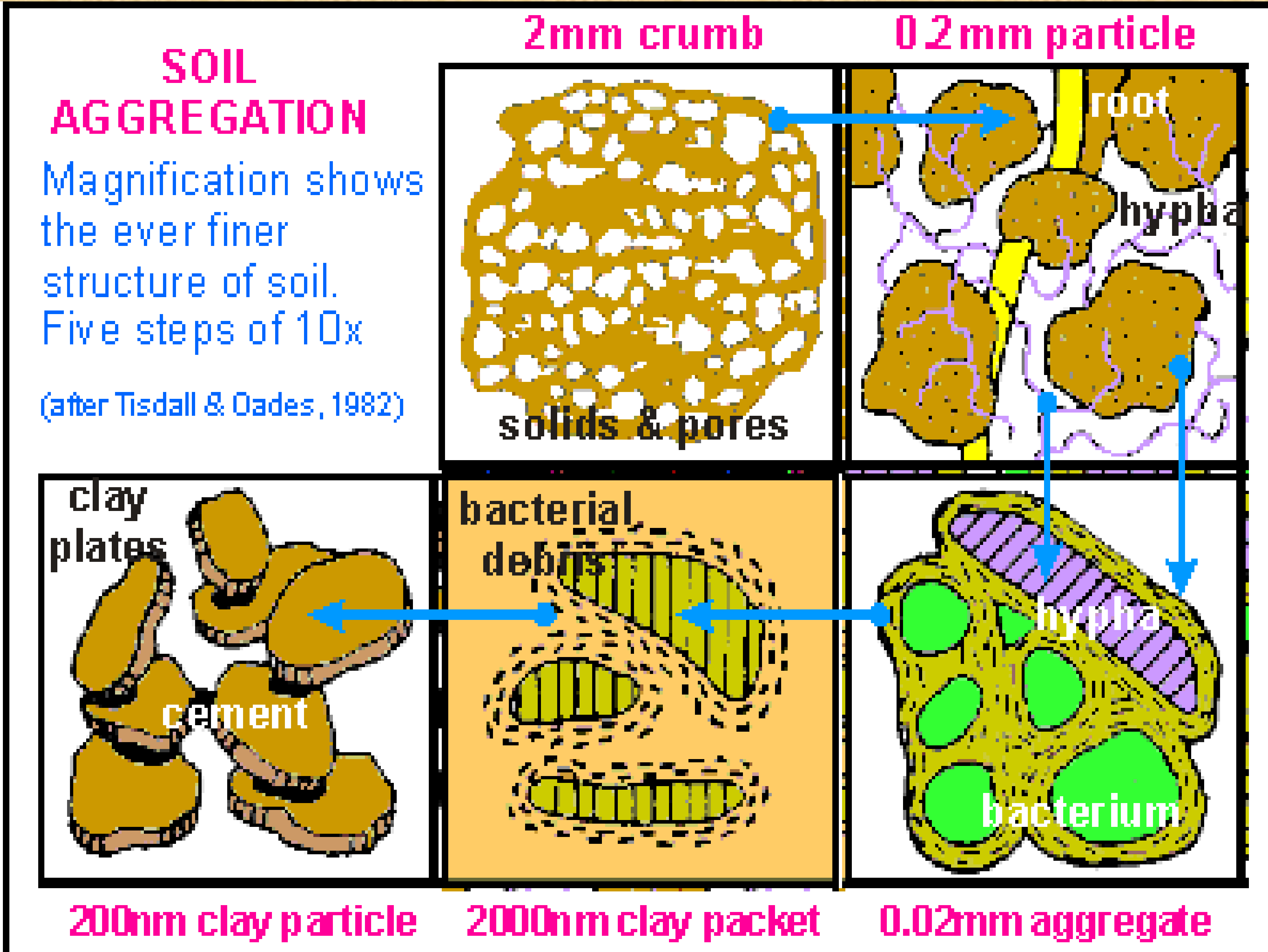
FIGURE 4.3 Size classification of organisms in decomposer food webs by body width (Swift *et al*., 1979).

Soil microfauna

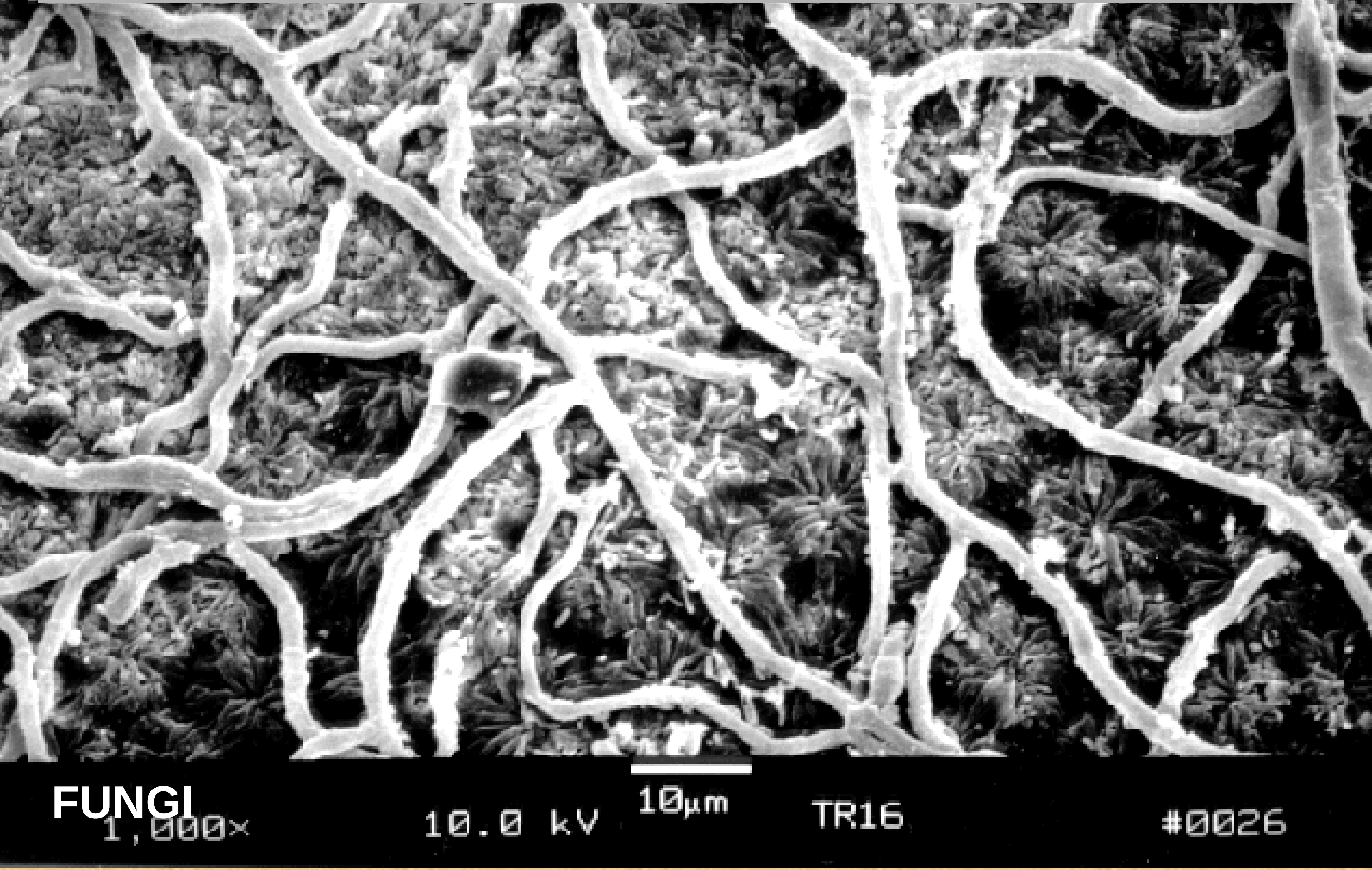




Microfauna is the most abundant in the soil and mainly responsible for the decay of organic matter, nutrient transformations and cycles, ‘’carbon sequestration’’ and disease suppression as well . Therefore it is regarded as living part of soil organic matter.


SOIL
AGGREGATION
Magnification shows
the ever finer
structure of soil.
Five steps of 10x
(after Tisdall & Oades, 1982)
2mm crumb
0.2mm particle
solids & pores
root
hypha
clay
plates
cement
bacterial
debris
hypha
bacterium
200nm clay particle
2000nm clay packet
0.02mm aggregate

Microbial fungal decomposition (nutrient cycle, humus formation, carbon sequestration etc)



Soil classification