

Soil organic matter recycling

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Soil quality

Soil quality is defined as the continued capacity of soil to function as a vital living system:

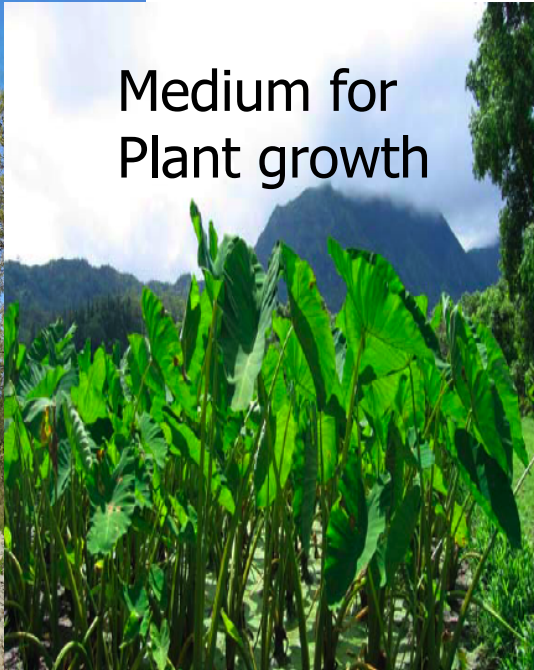
- sustain biological productivity
- promote the quality of air and water environments
- maintain plant, animal and human health

(Doran and Safley, 1997)



5 functions of soil

Medium for Plant growth



Recycling system

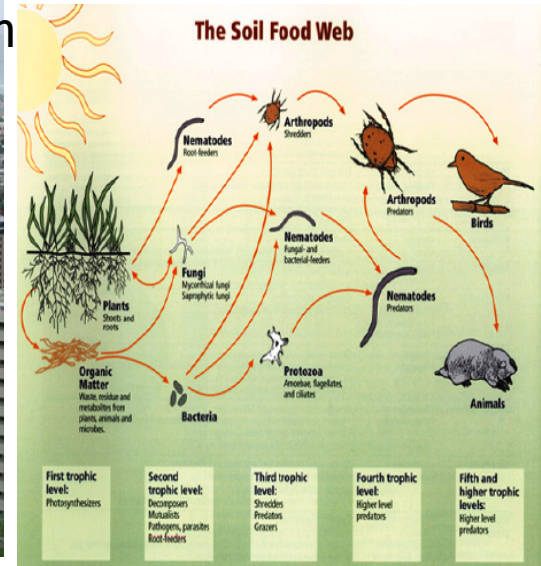
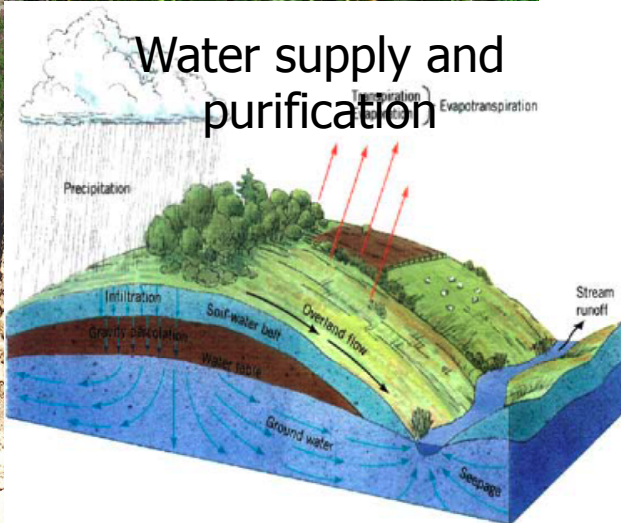


Habitat for soil organisms

Engineering Medium



Water supply and purification

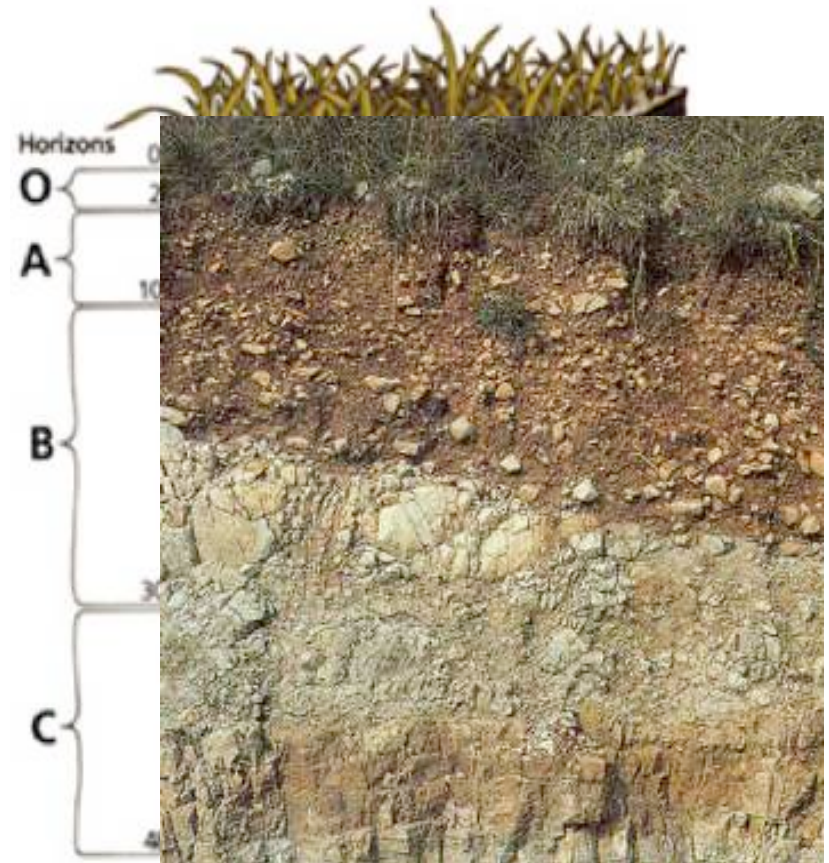


soil fractions

Organic horizons = Humus

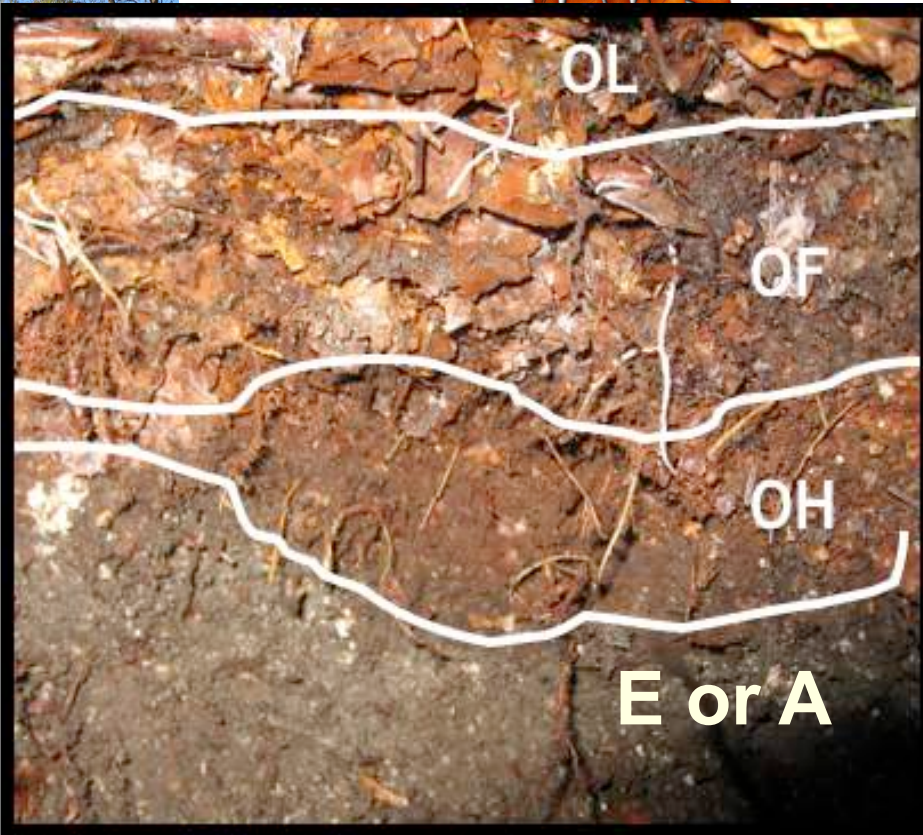
Poor in organic matter

Mineral horizon





Dead leaves (4 t/ha/year) constitute leaf litter

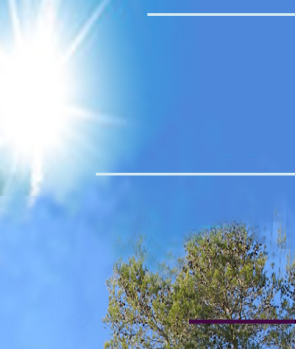


Non-fragmented leaves (horizon OL)

Fragmented leaves by faunal activity (horizon OF)

faunal faeces (horizon OH)

Organo-mineral or mineral soil



- Superficial organic horizons, especially litter, represent the most active compartment from a food web and flow of energy points of view
- From efficiency of leaf litter decomposition depends soil quality and fertility

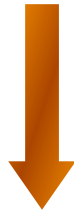


Leaf litter = the main resource of nutrients for many soil organisms in interaction

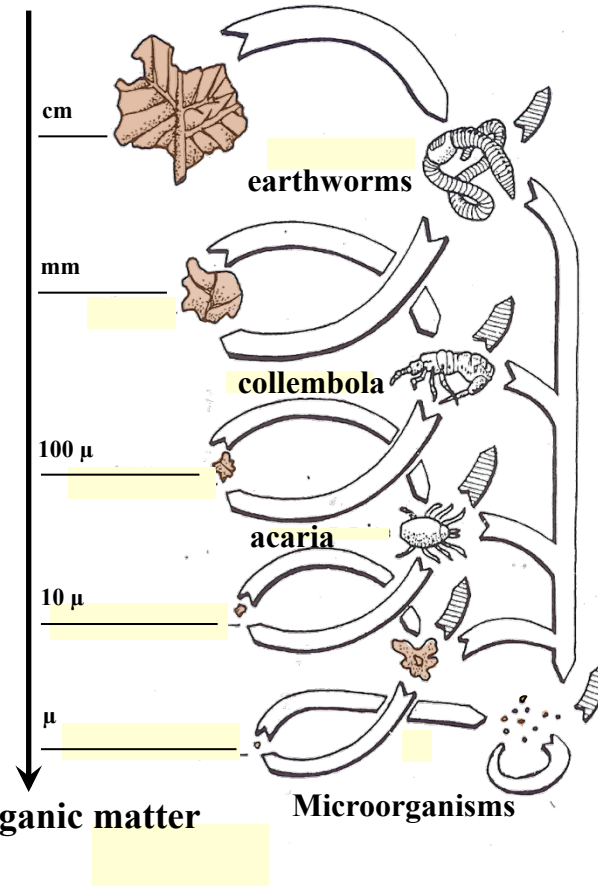
fragmentation and mixing of soil organic matter

=

Chemical and physical modifications

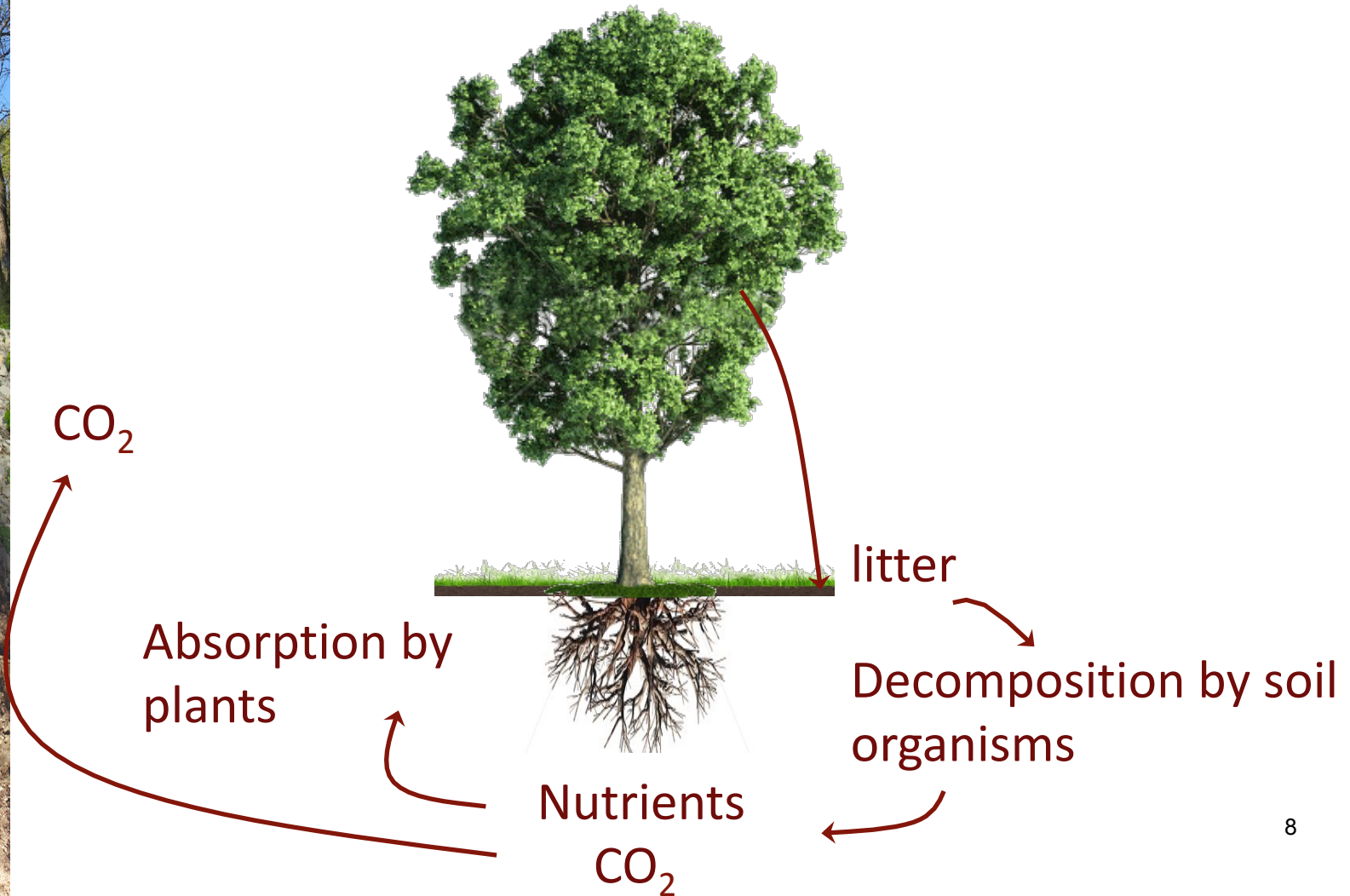


Humification and mineralization



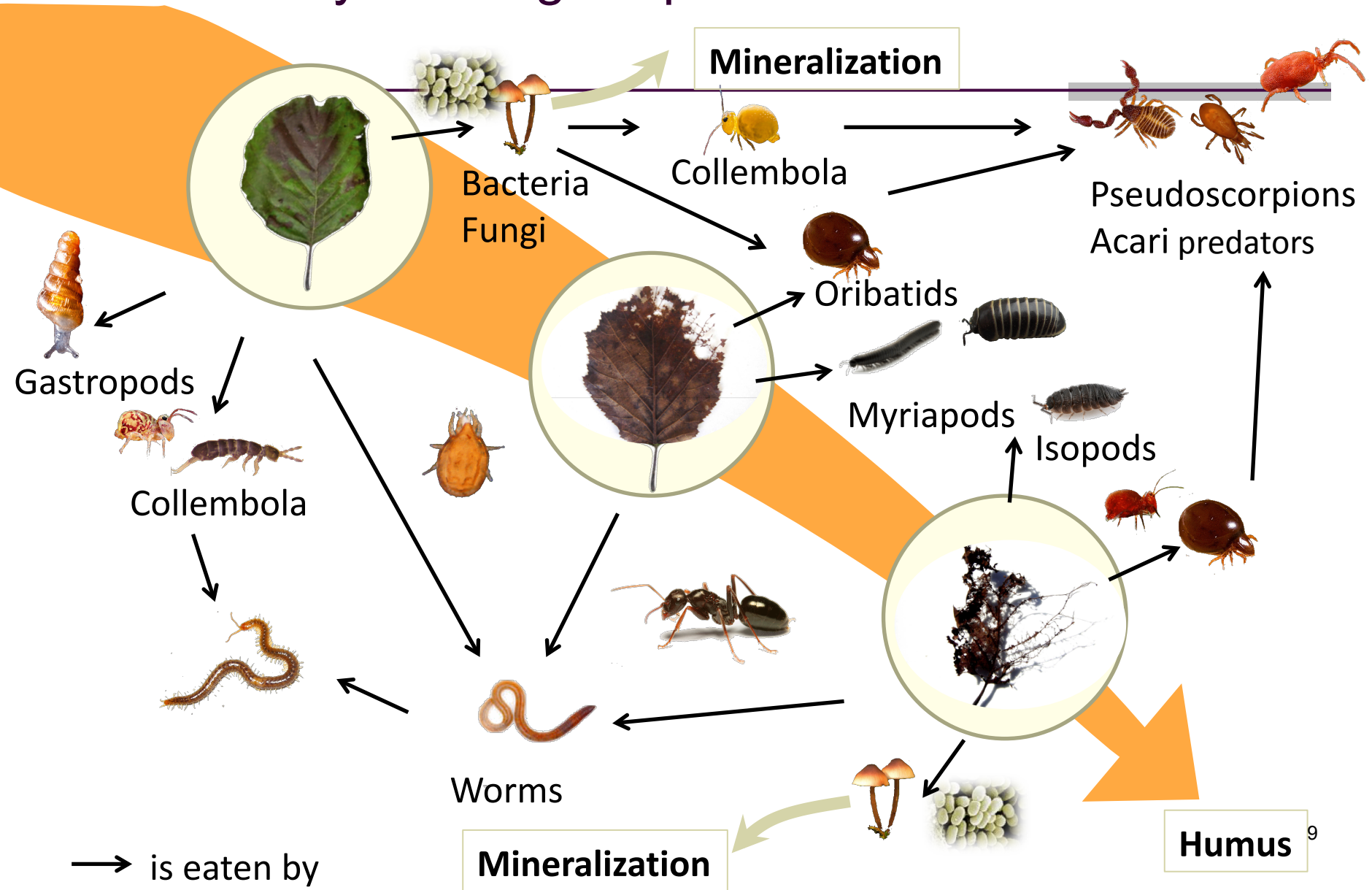
Leaf litter decomposition

The principal pathway of the nutrients return to the soil in an available form to plants



Leaf litter decomposition

Mainly a biological process



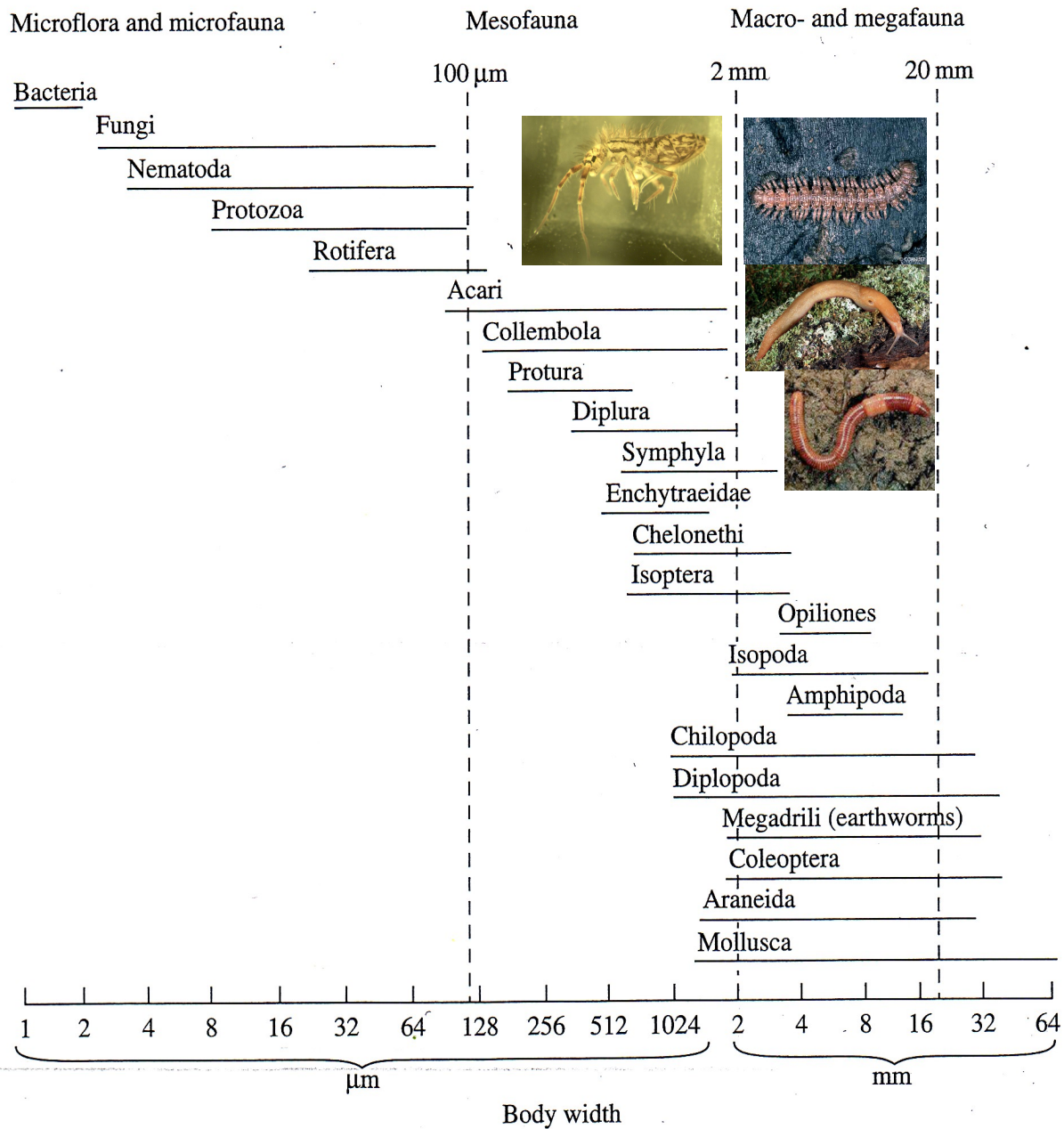


Fig. 2.1

Classification of soil biota on the basis of their body size. (Adapted from Swift et al. 1979).

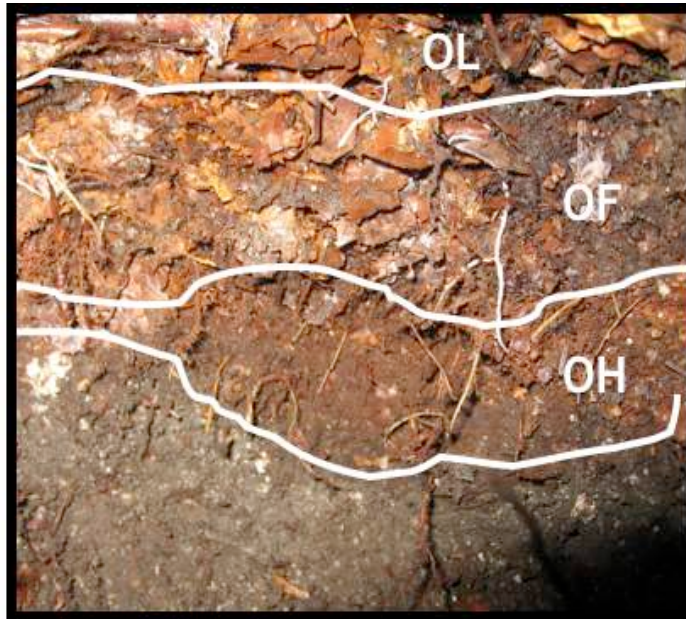
I. Concerning fauna....

divided in 3 groups depending on the size of the organisms:

Microfauna (nematods and protozoa, size<0.2mm)

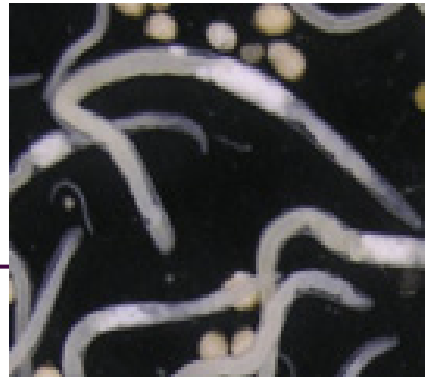
Mesofauna (enchytreids, microarthropods, size=0.2-4mm)

Macrofauna (earthworms and diplopods, size> 4mm)

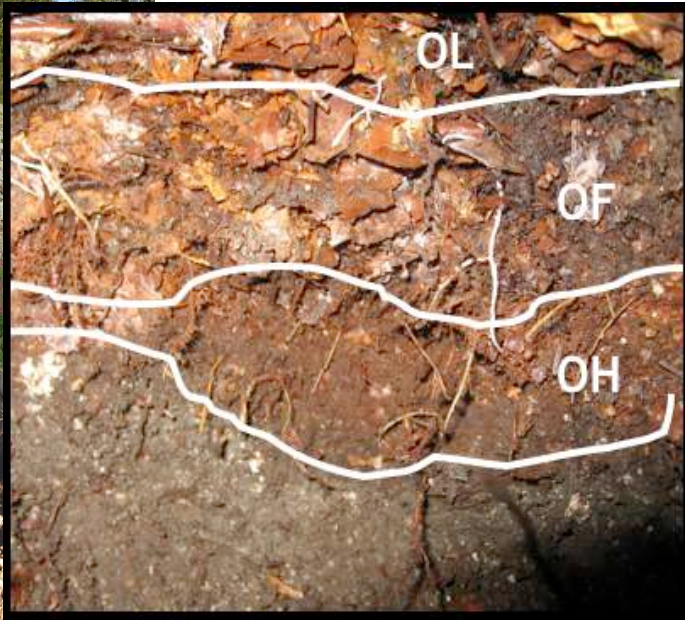


They colonize all organic horizons and play a key role in the organic matter transformation

1. Enchytreids (small and white worms 1-5 mm)



Feed on soft parts of dead leaves



They live in OL, OF and their fecal pellets constitute OH



2. Earthworms

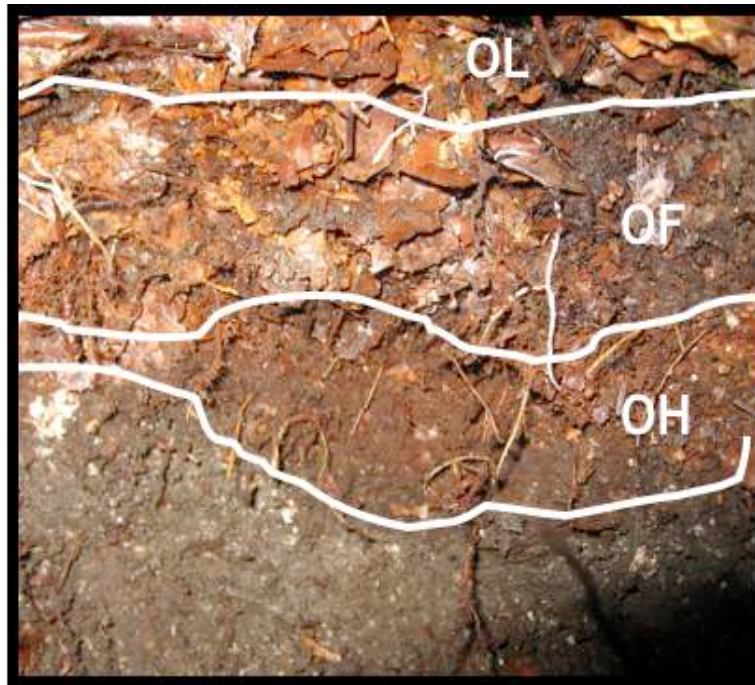
Big ones (>5cm) (Lumbricidae)



One ha of soil = 2 tons of earthworms!



They are anecic (move from a horizon to another)



Worms castings



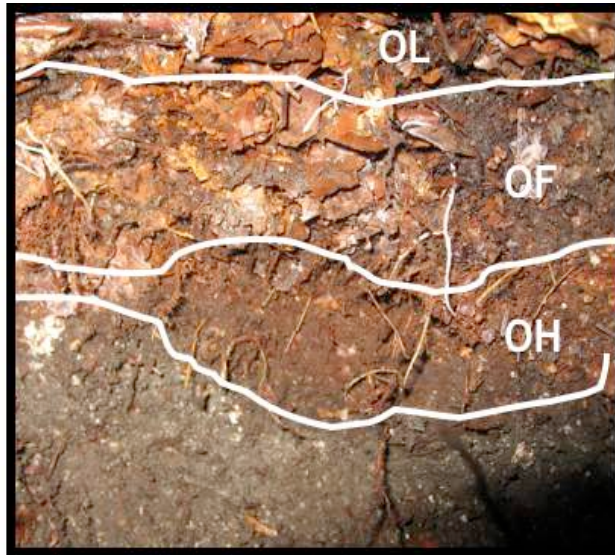
Phosphorus x 16

Nitrogen+ 30

Compared to soil

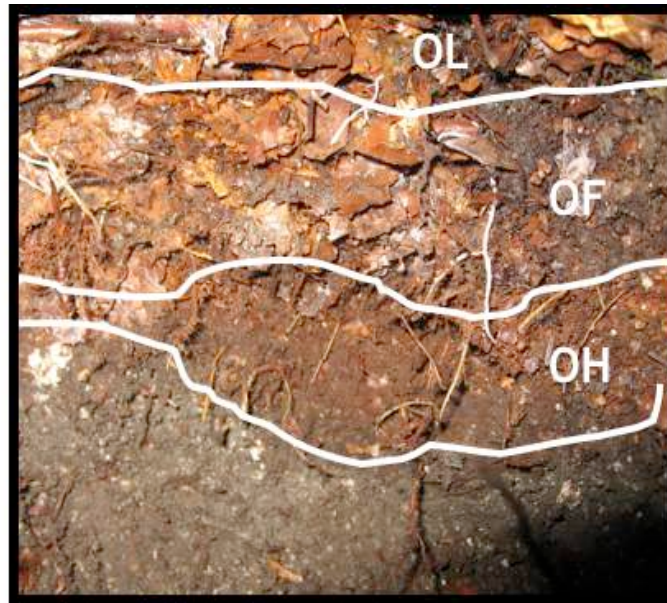


Smaller earthworms (0.5-5 cm) « epigeous »
(they live in horizons OF and OH)

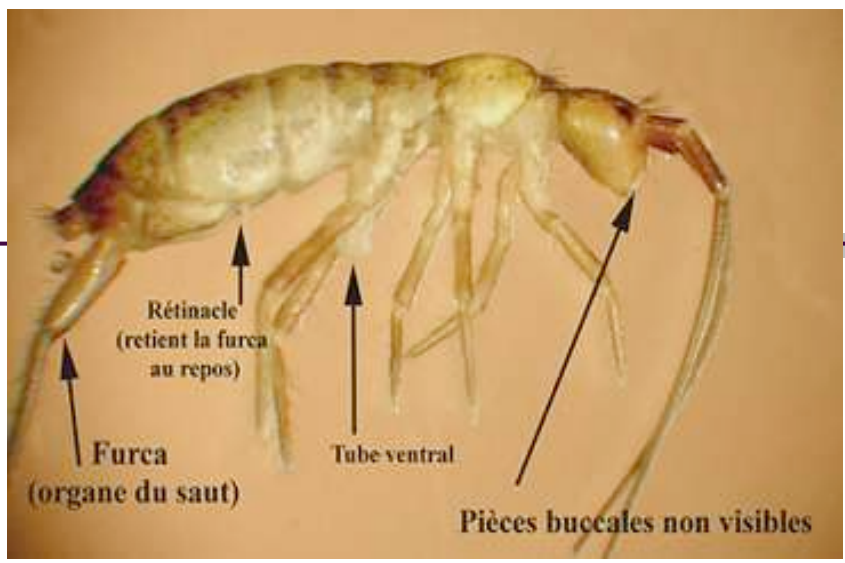


Mean size earthworms endogenous

Stay in the 10 first cm of mineral soil where they feed



3. Collembola (microarthropods without wing)



Collembola
can be eat by
a predator:
pseudoscorpion

1 m² of forest soil: more than 200000 collembola



4. Acaria (microarthropods without wing)



Acariens Oribates

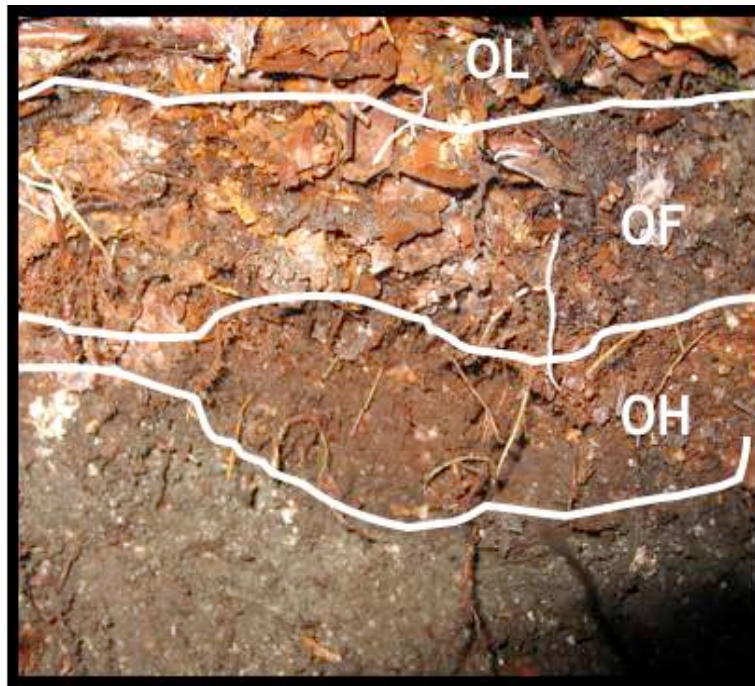


Acariens gamasides



1 m² of forest soil: more than 250000 acaria

Collembola and acaria decompose leaf litter in horizons OL and OF and accumulate fecal pellets in OH





Action of fauna on leaves



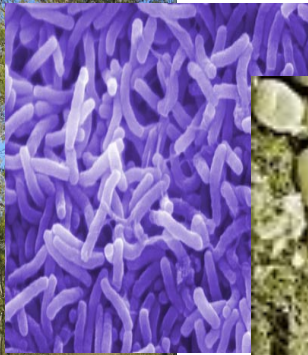
Action of fauna on leaves



II. Concerning microorganisms....

Bacteria

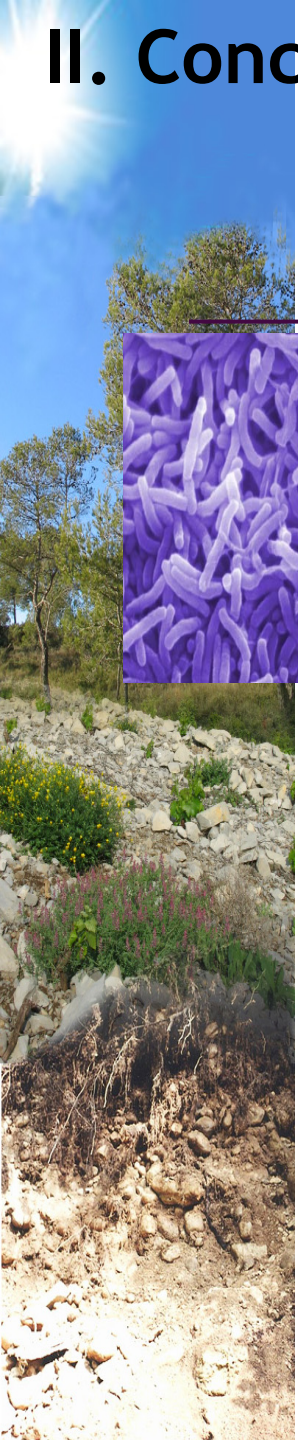
Fungi



High species and function diversity

Key role in leaf litter decomposition

Able to mineralize all organic matter
(C, N, P, cations,...)



Different leaf litter decomposition stages by fungi



Leaf litter decomposition is controlled by two types of factors

Leaf litter chemistry

(structure and defence compounds, nutrients)

Environmental conditions

Macrodetritivorous



Microarthropods



Microorganisms



Decomposition rate



Leaf litter decomposition

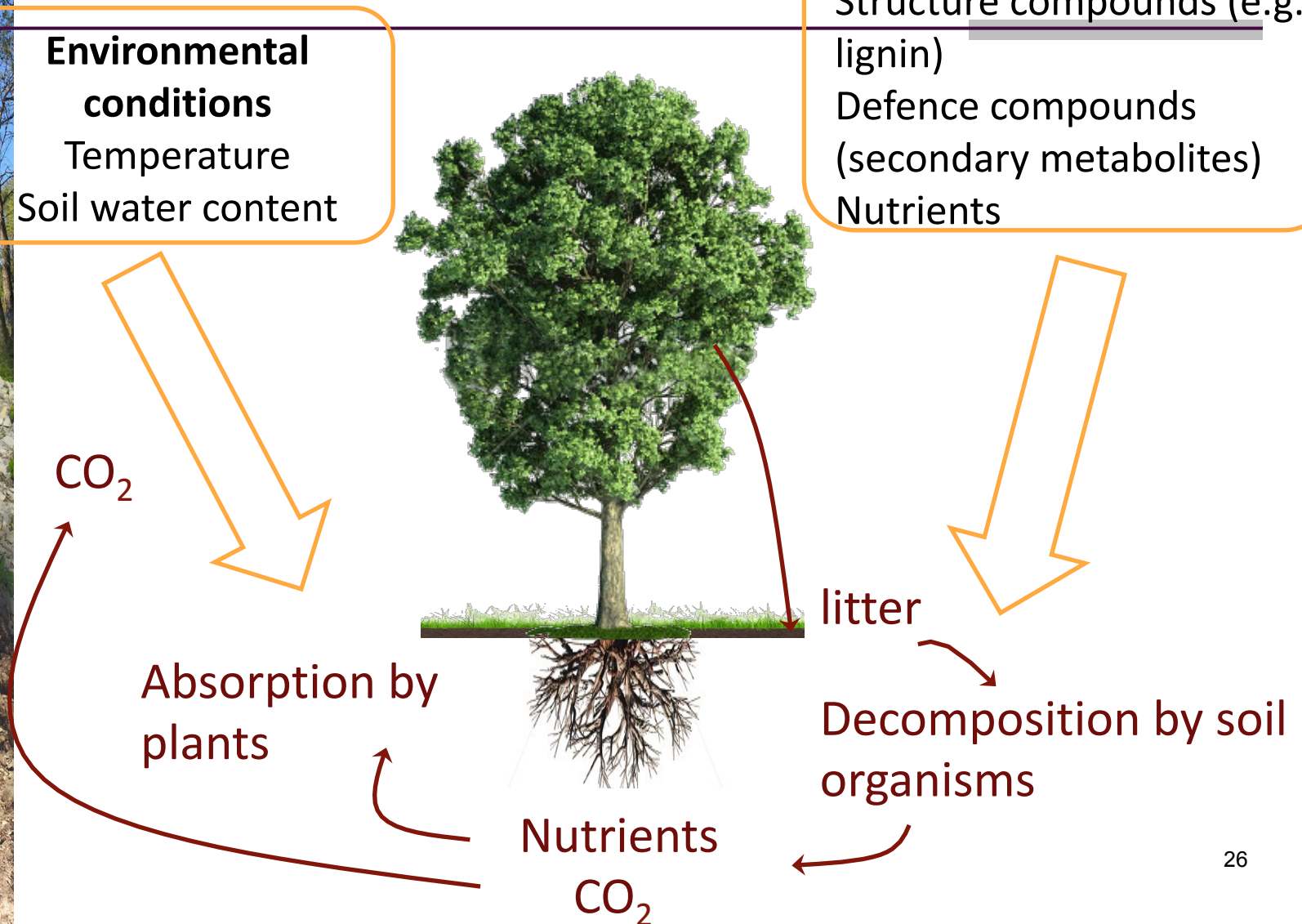
Leaf litter decomposition is controlled by two types of factors

Environmental conditions

Temperature
Soil water content

Leaf litter chemistry

Structure compounds (e.g. lignin)
Defence compounds (secondary metabolites)
Nutrients



Leaf litter decomposition

Relative importance of factors

Environmental conditions

Leaf litter chemistry

Habitat effect

Resource effect



↓
Decomposers



↓
Litter decomposition

Experimental approach

« Litter bags » in situ experiment



Leaf litter mass loss and chemical transformations



Biomass, functional and specific diversity, activity of decomposers

Methods

Mesofauna and fungal biomass associated to decomposed leaves

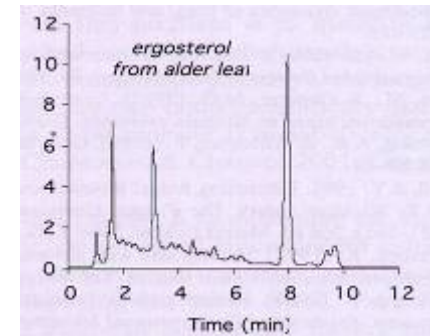
- ✓ Berlese funnel: mesofauna extraction

Identification and counting of organisms belonging to mesofauna



- ✓ Ergosterol: fungal biomass indicator

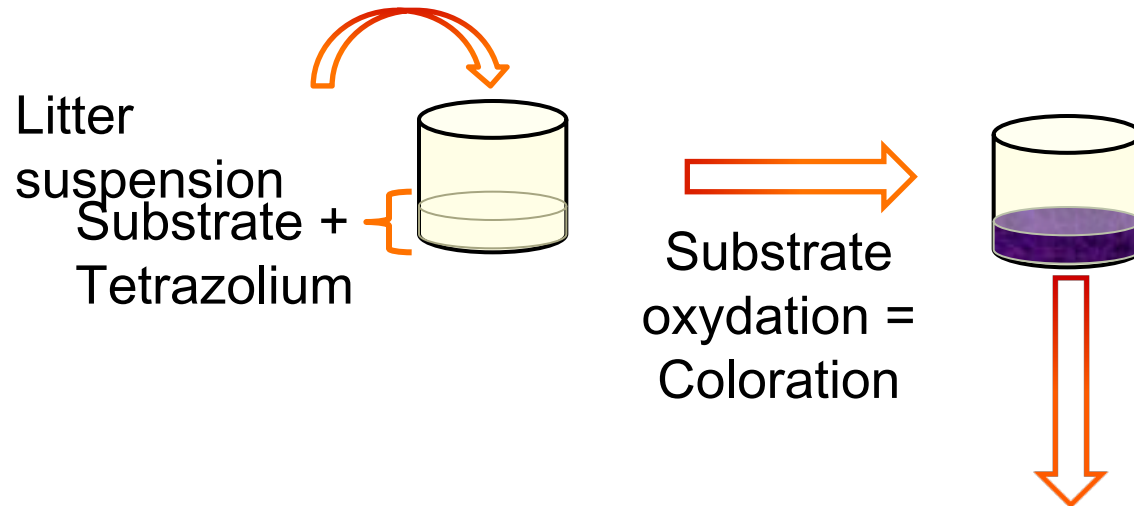
Extraction, purification and quantification by HPLC



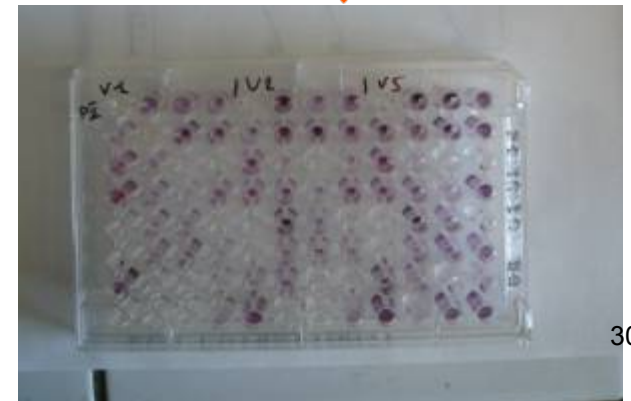
Methods

Microbial catabolic profiles associated to decomposed leaves

- ✓ Biolog ecoplate® : microbial catabolic diversity (indicator of microbial functional diversity)



Optical density is proportional to the capacity of microorganisms to degrade each substrate

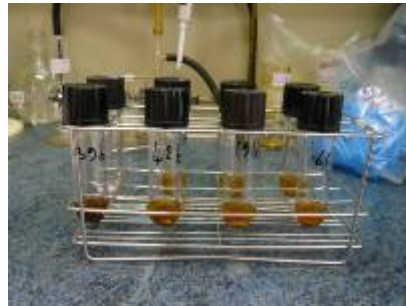


Methods

Secondary metabolites litter content

✓ Terpenoids extraction:

Measurement by Gaz Chromatography coupled Mass Spectrometry



✓ Phenolics extraction:

Measurement by Gaz Chromatography coupled Mass Spectrometry

✓ Phenolic Index: total amount of phenolics in equivalent of gallic acid

Colorimetric measurement in spectrometry