

# Soil - space under your feet

Ladislav Miko





A microscopic view of soil organisms, showing a dense population of small, dark, circular structures, likely bacteria or fungi, against a light blue background. The organisms are scattered throughout the frame, with some appearing in clusters and others in pairs.

Soil -  
space under  
your feet  
or...

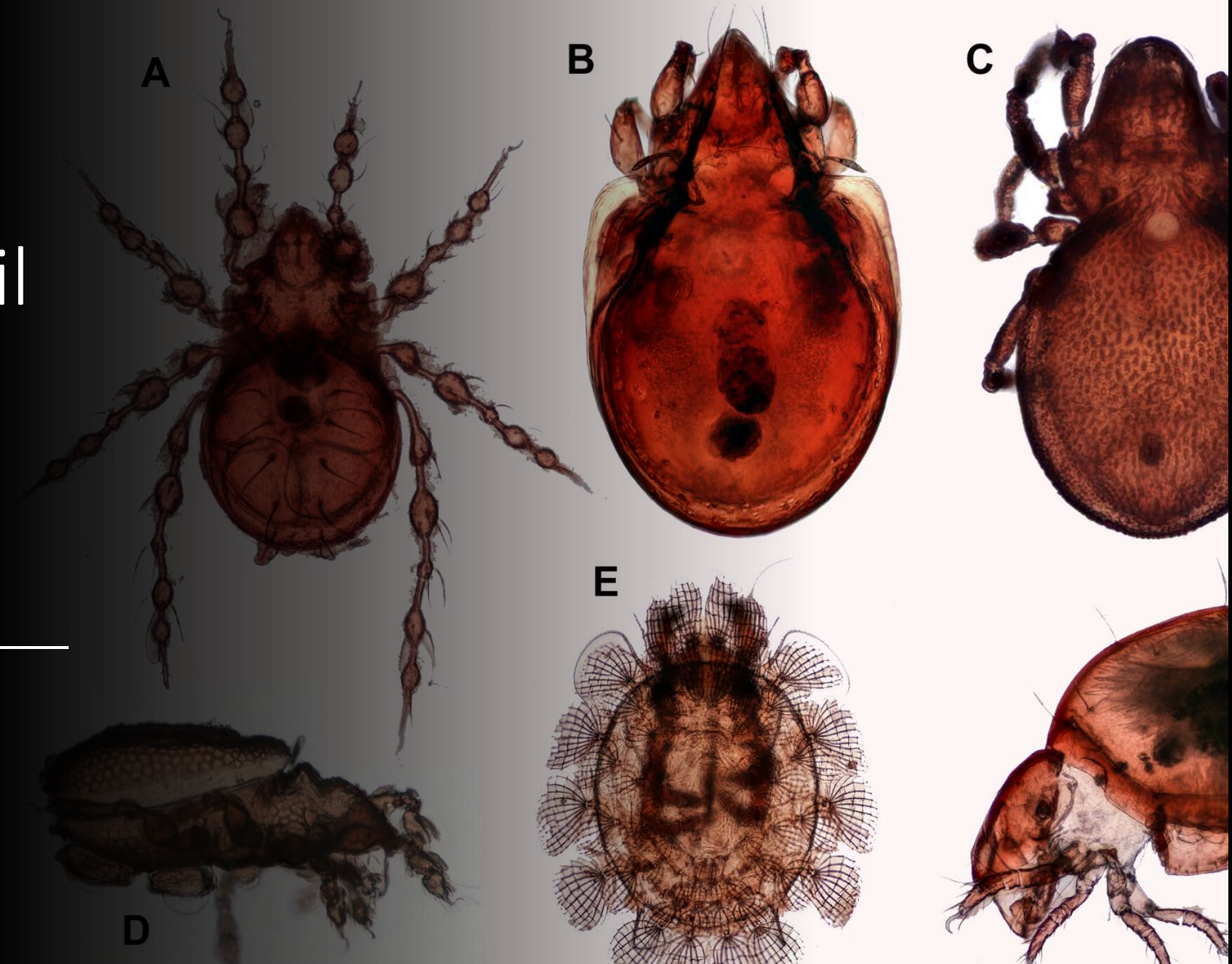
Ladislav Miko



About soil  
services and soil  
biodiversity  
and why we  
need them?

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Ladislav Miko







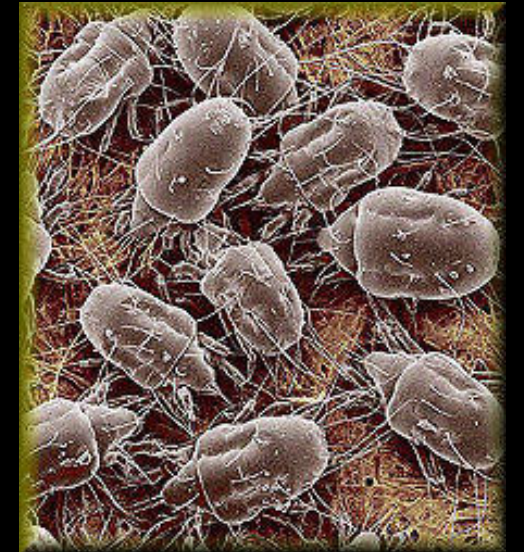
Soil is full of living creatures,  
each of them has a function

What they do in the soil??





...soil bugs ?  
itchy and  
scary staff.... !



But why?





...how we know them  
from movies



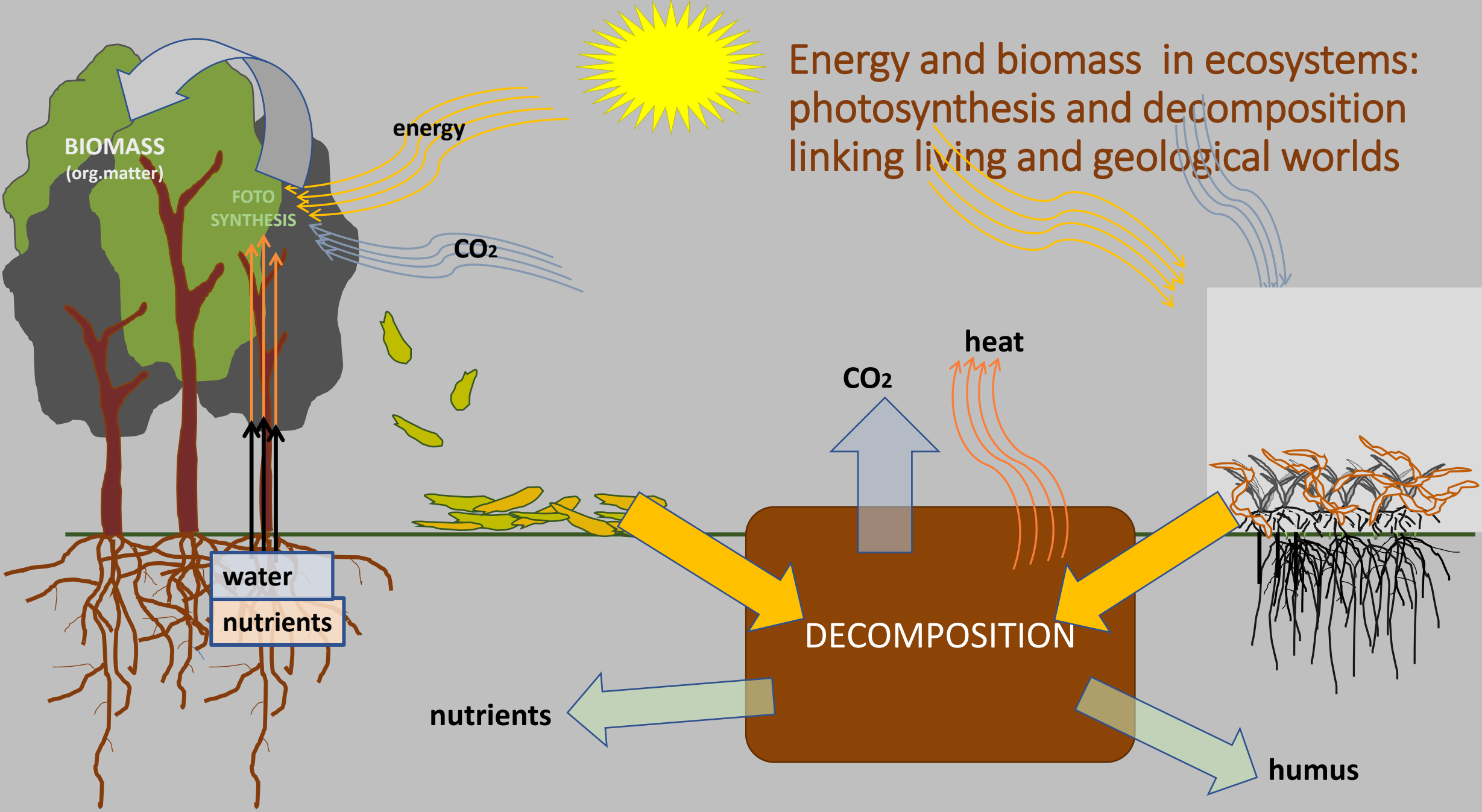
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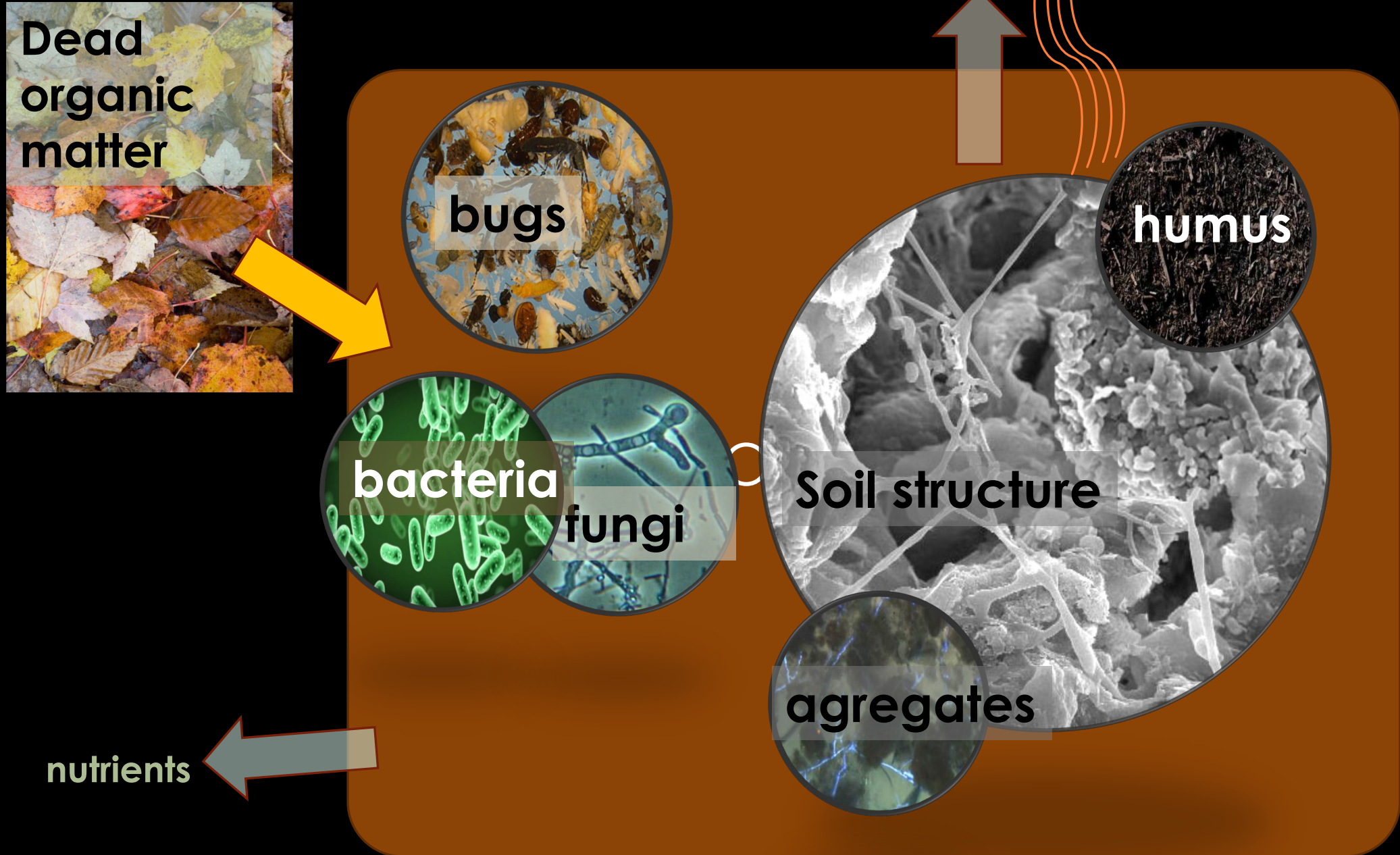


# Energy and biomass in ecosystems: photosynthesis and decomposition linking living and geological worlds





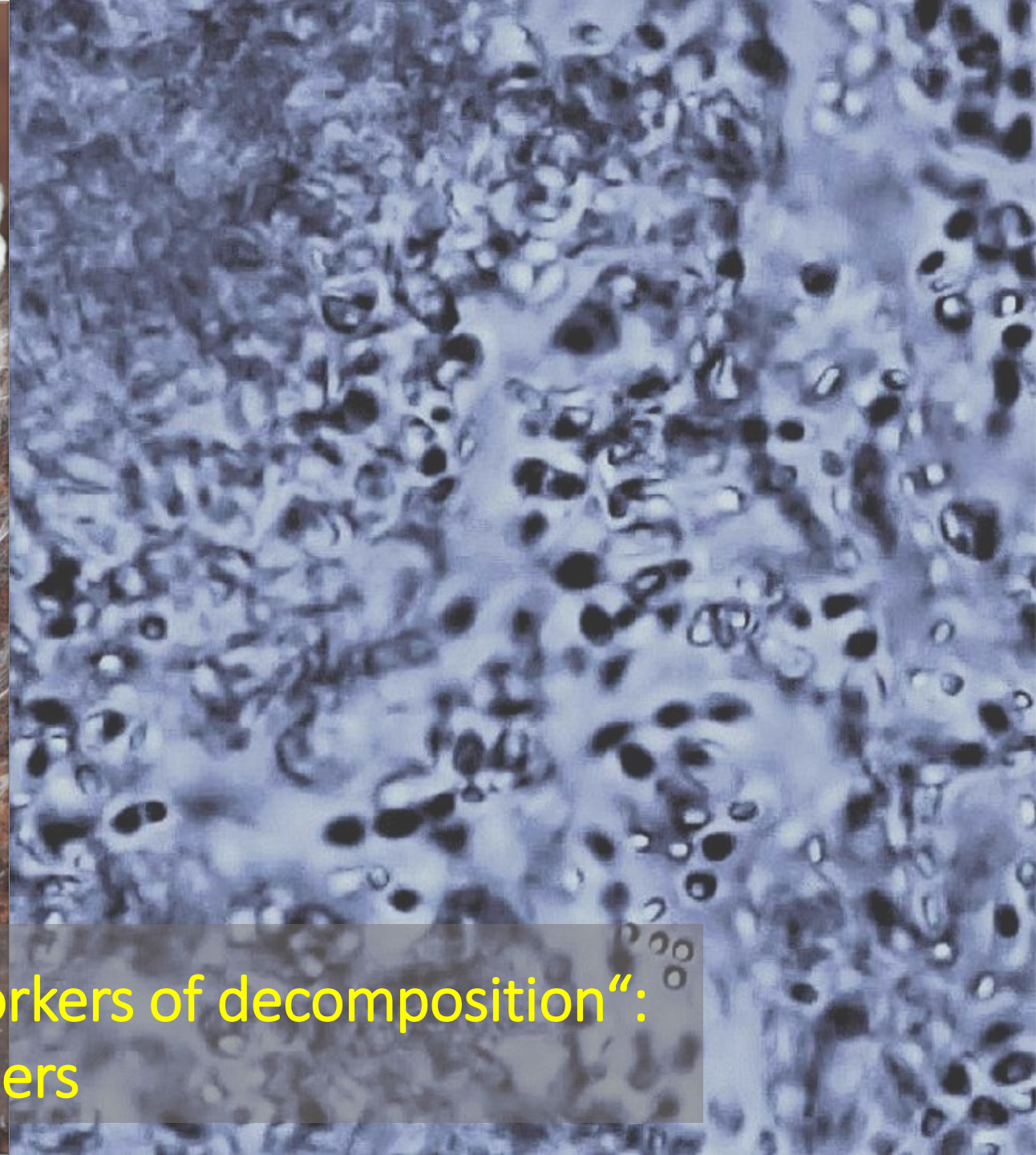
# Soil: actors and ...structure



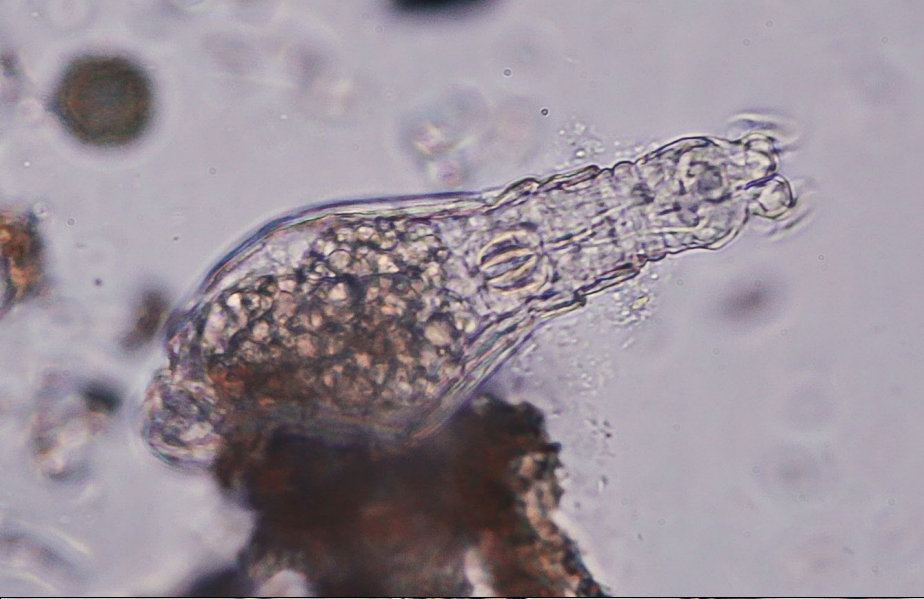




Microflora: bacteria and fungi – „workers of decomposition“:  
Primary decomposers and mineralisers



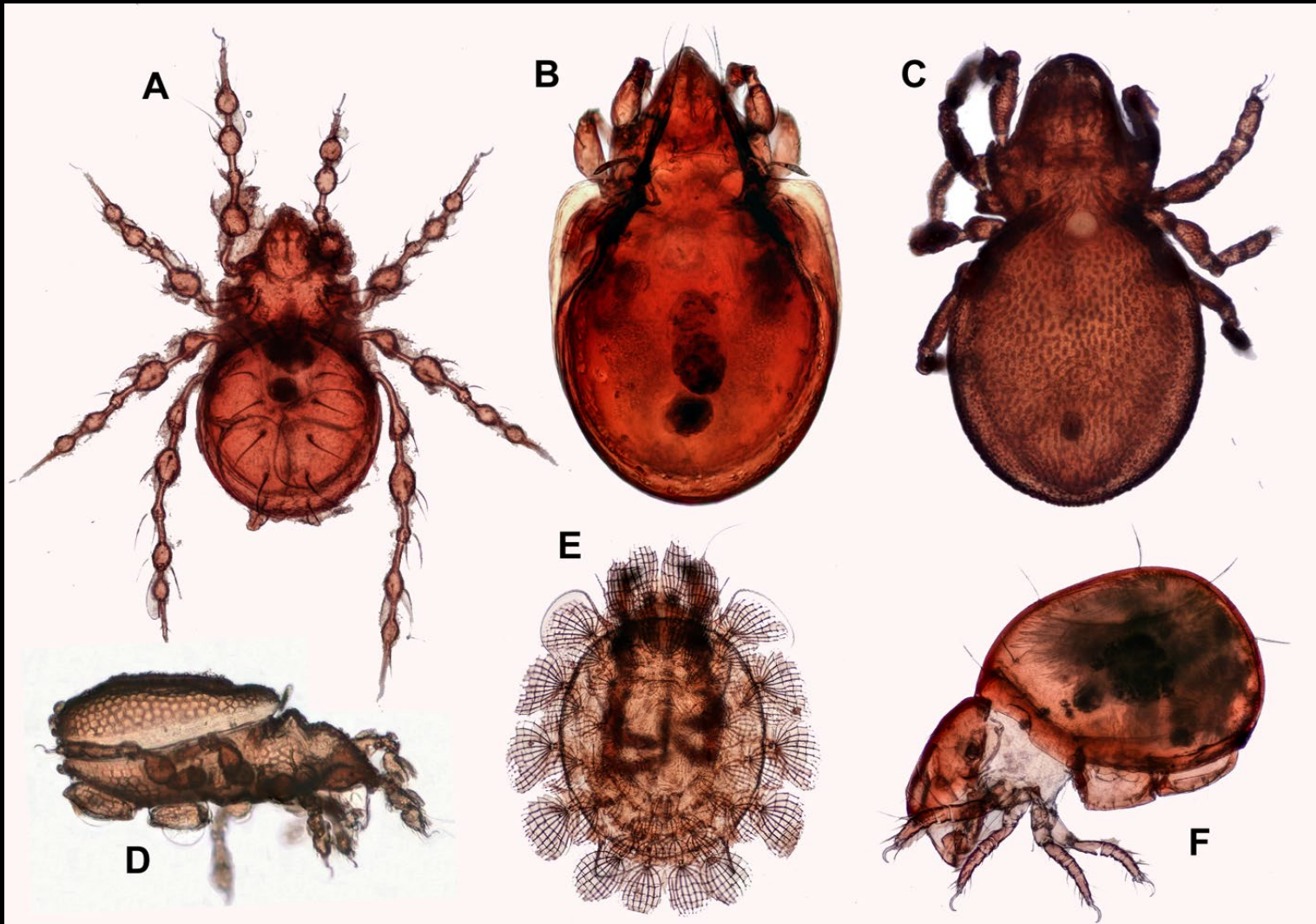




**Microfauna: „soil water fauna“:  
Osmotrophs and fagotrophs  
Complex communities**



**Mesofauna: oribatid mites (Oribatida)**  
macro- and microphytophagues, generalists,  
feeders, fragmenters, mixers, coprogenous humus





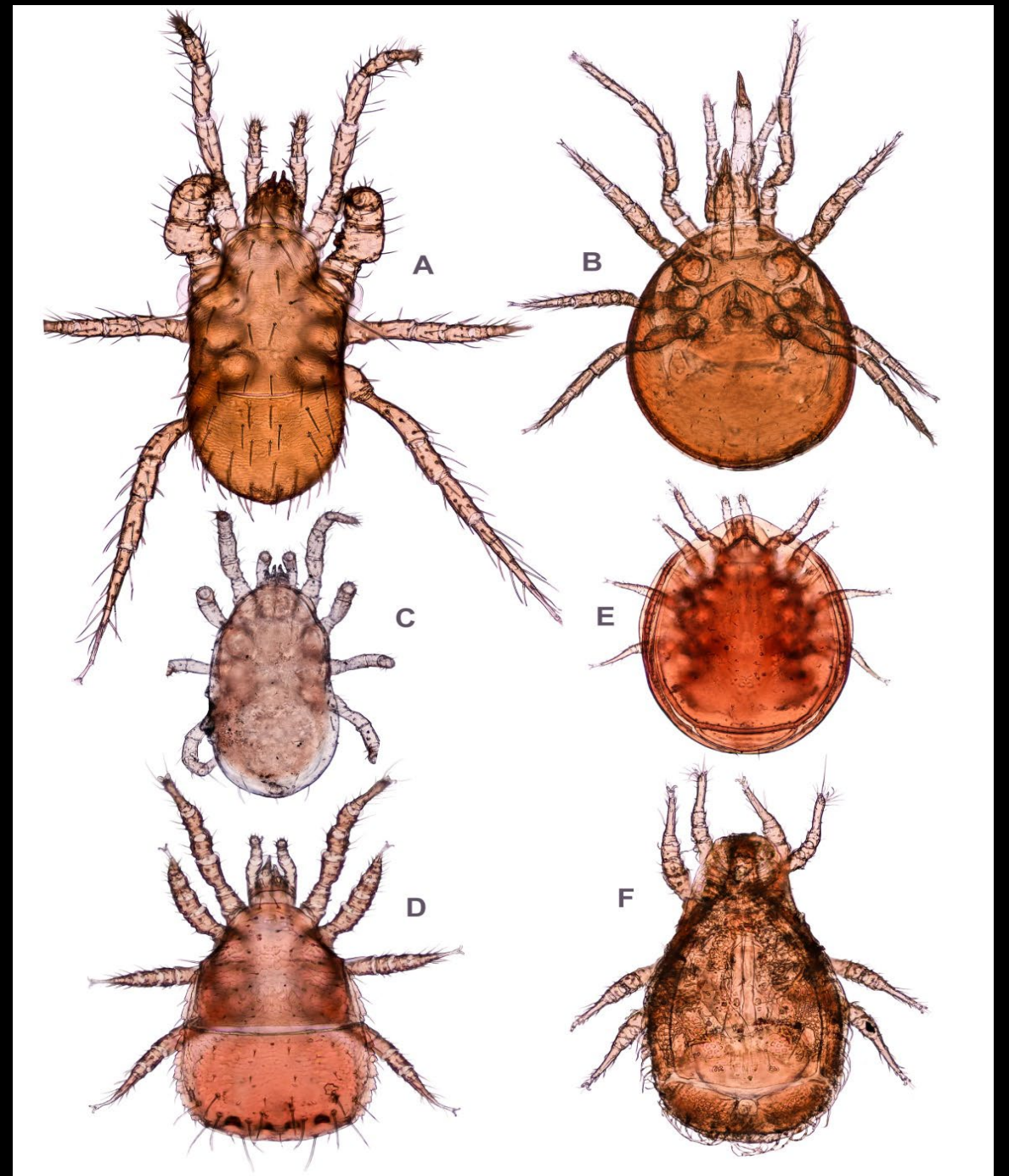
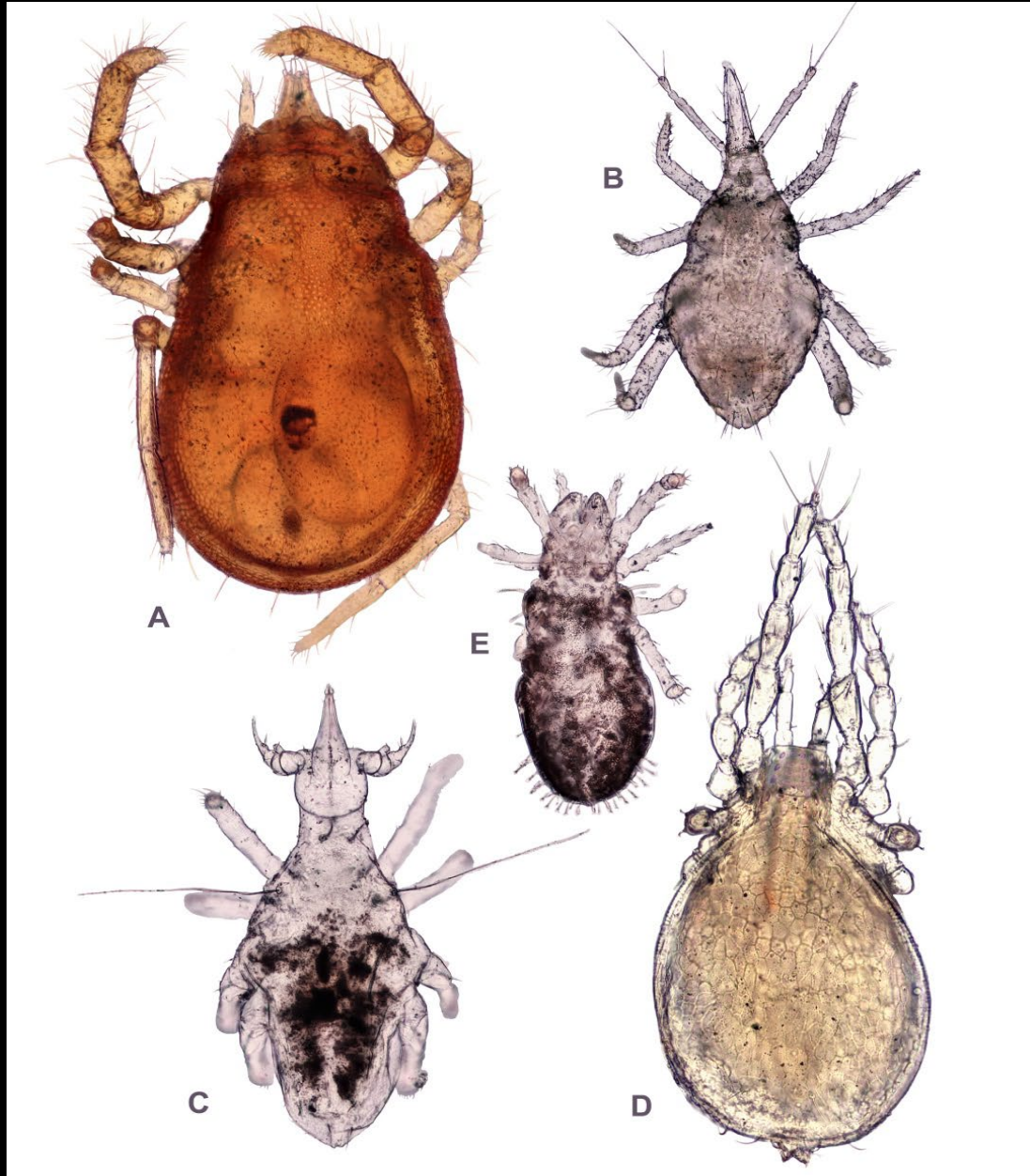


Mesofauna: springtails, symphylans,  
pauropods,...

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# Mesofauna: predatory mites





Macrofauna: soil engineers and technicians  
Fragmenting, mixing,  
distributing of organic matter  
Active burrowing of corridors  
Excrements - coprogenic humus



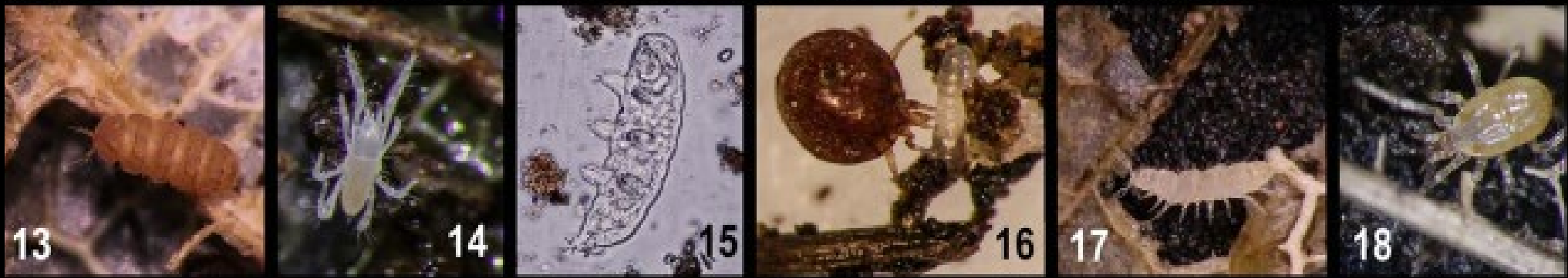




Macrofauna: soil predators  
Hunting – regulating of populations

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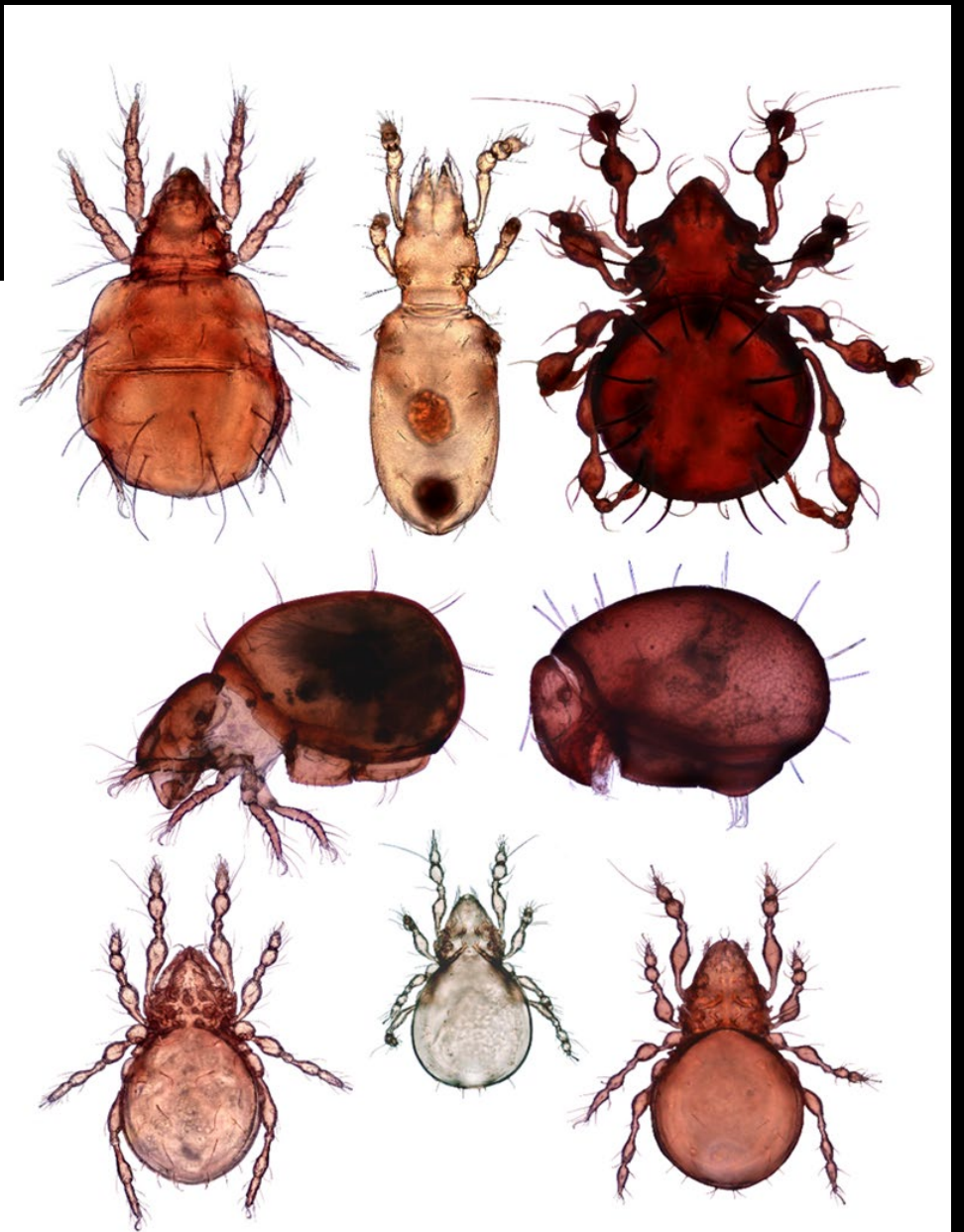
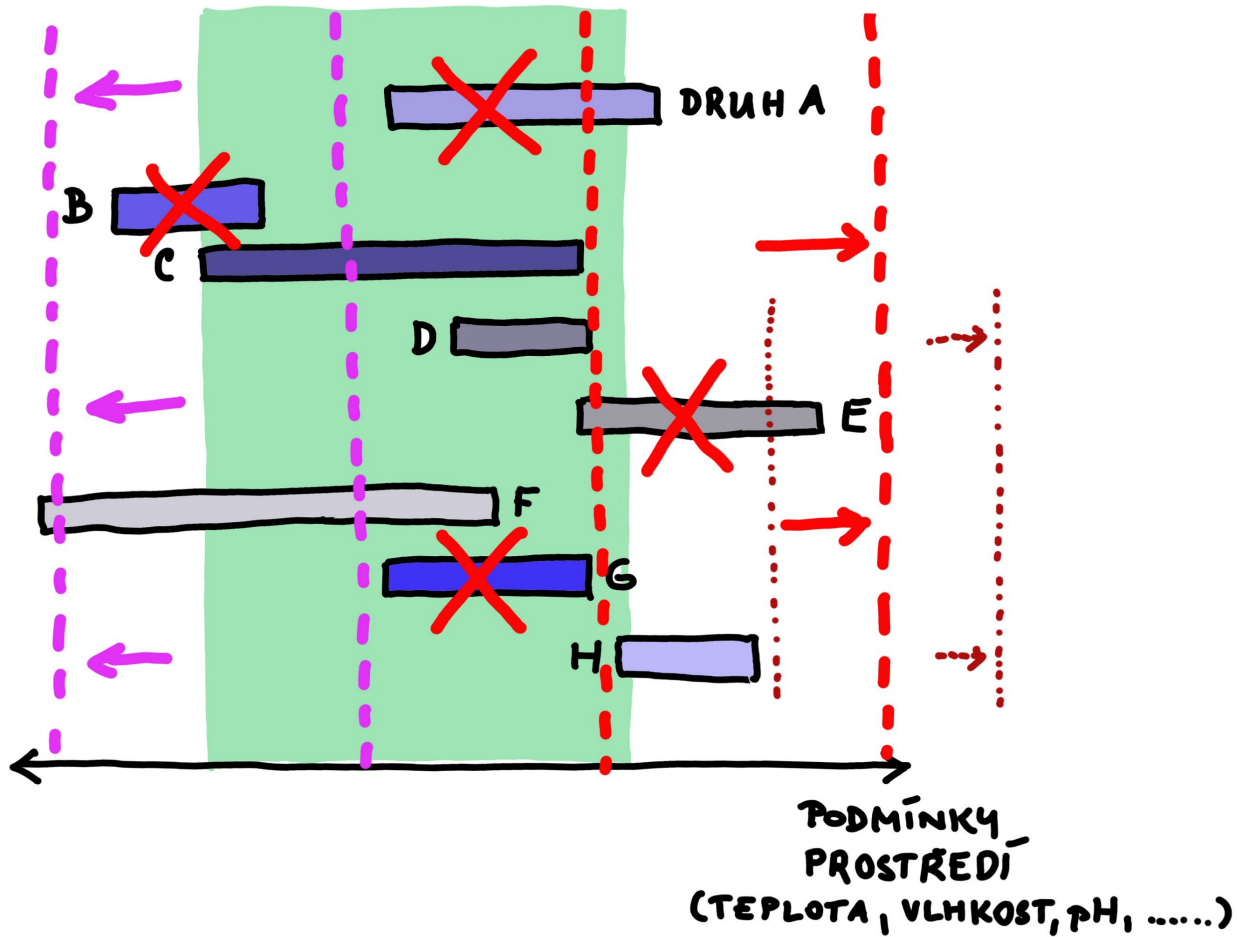




**BIODIVERSITY!**

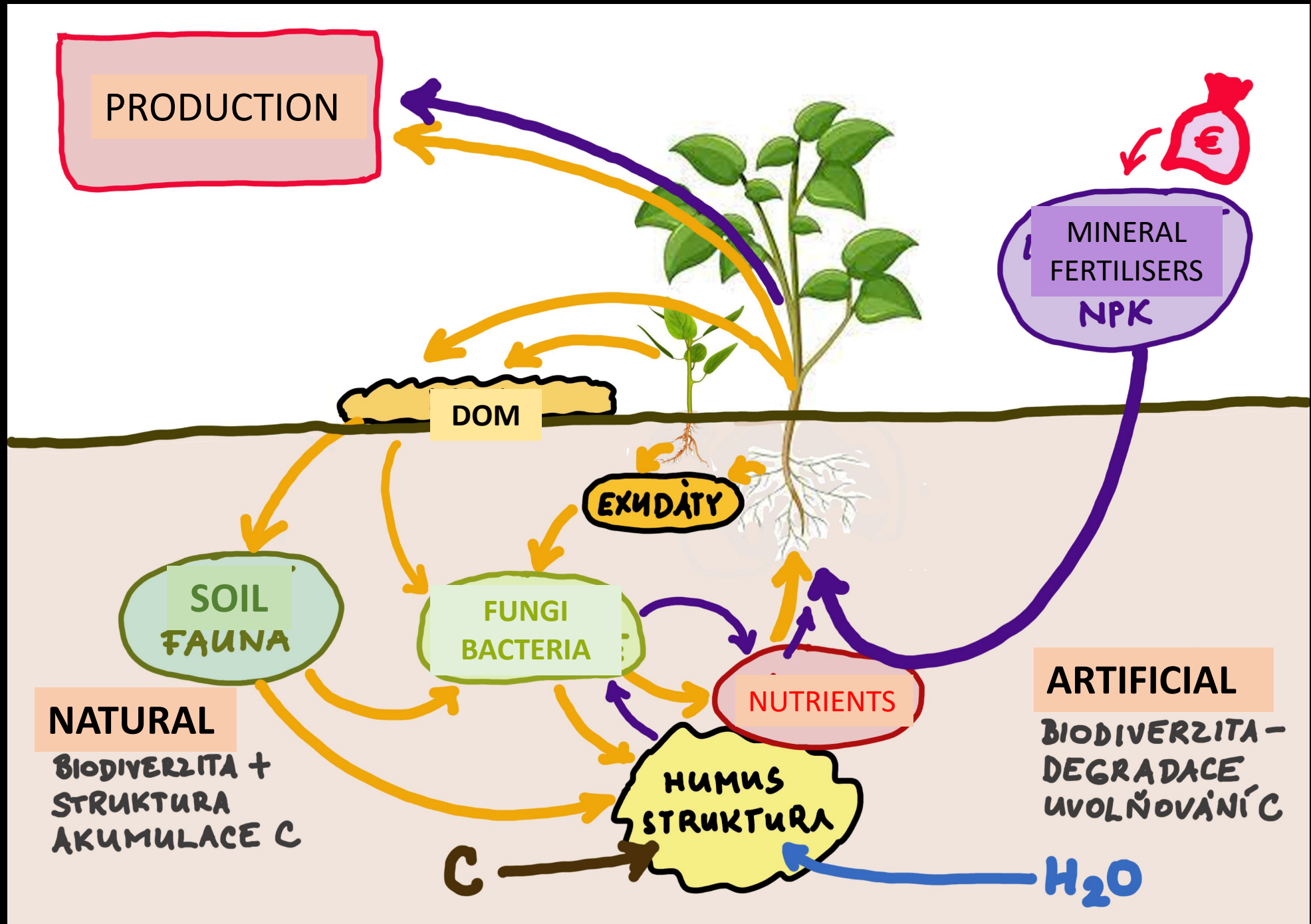


# Best insurance: functional redundancy

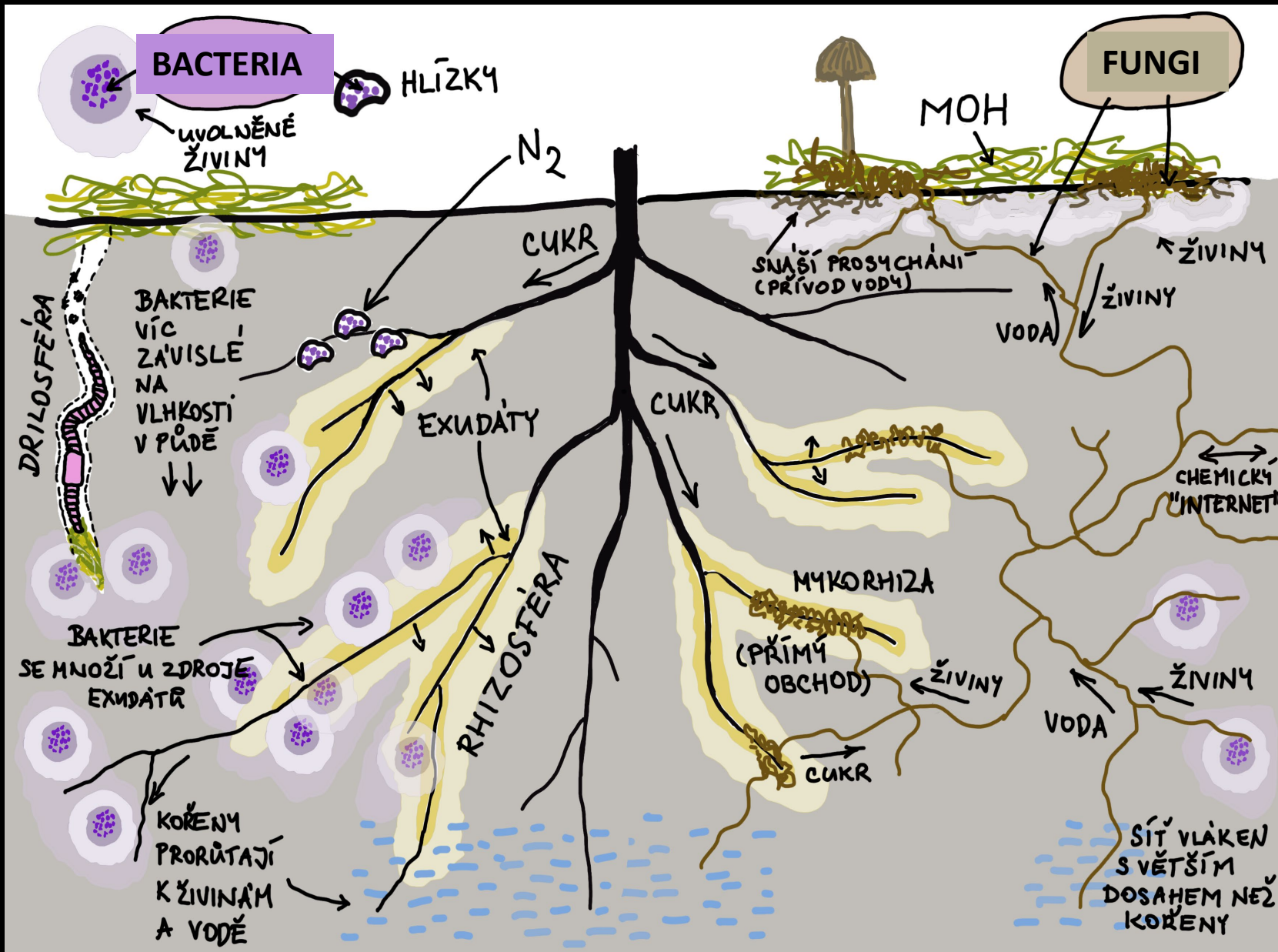




Organic matter and ecosystem services of healthy / functioning soil







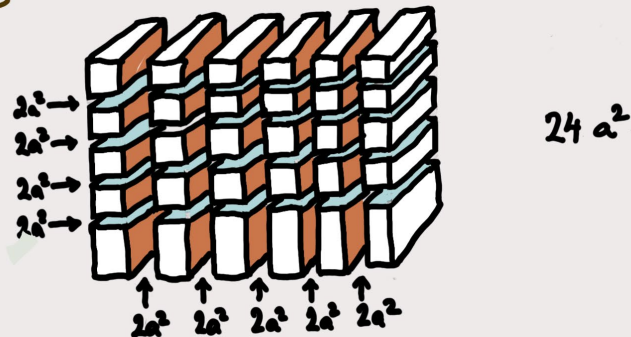
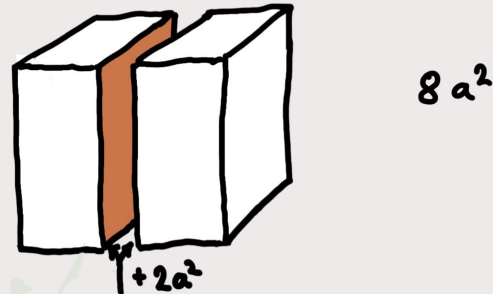
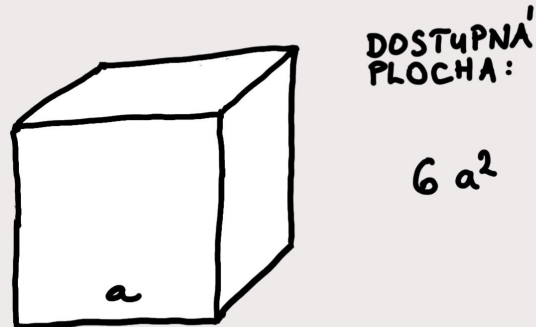
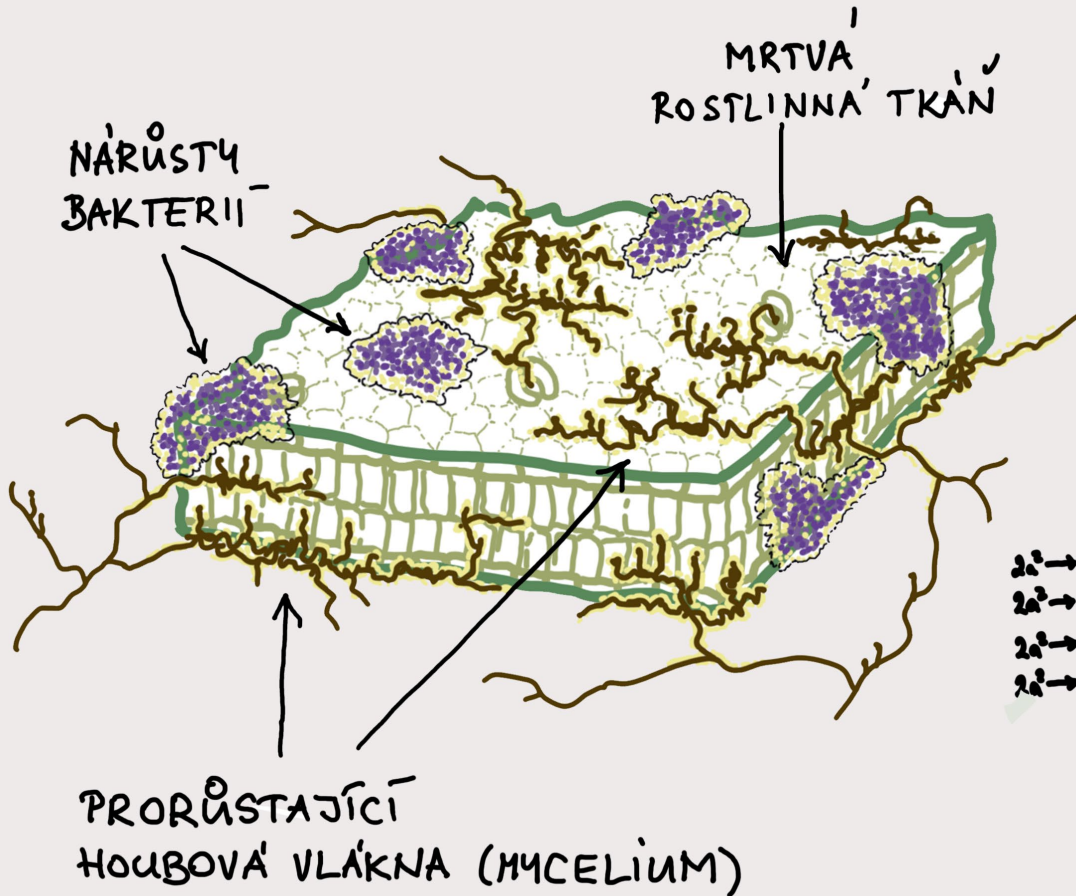
## Interconnected world: decomposition channels and relations with plant roots

- Plant in soil environment interacts: selling metabolites for nutrients and water
- Two main energy channels of decomposition:
  - Bacterial – more sensitive to conditions, but more universal, dependent on ecosystem engineers, within soil profile
  - Fungal – better in extremes (drying, pH,...) closer to surface, longer distance connection („pipelines“, transport)
- Symbiotic relations (rhizobia, mycorrhises)



# MIKROBIÁLNÍ GAMBIT

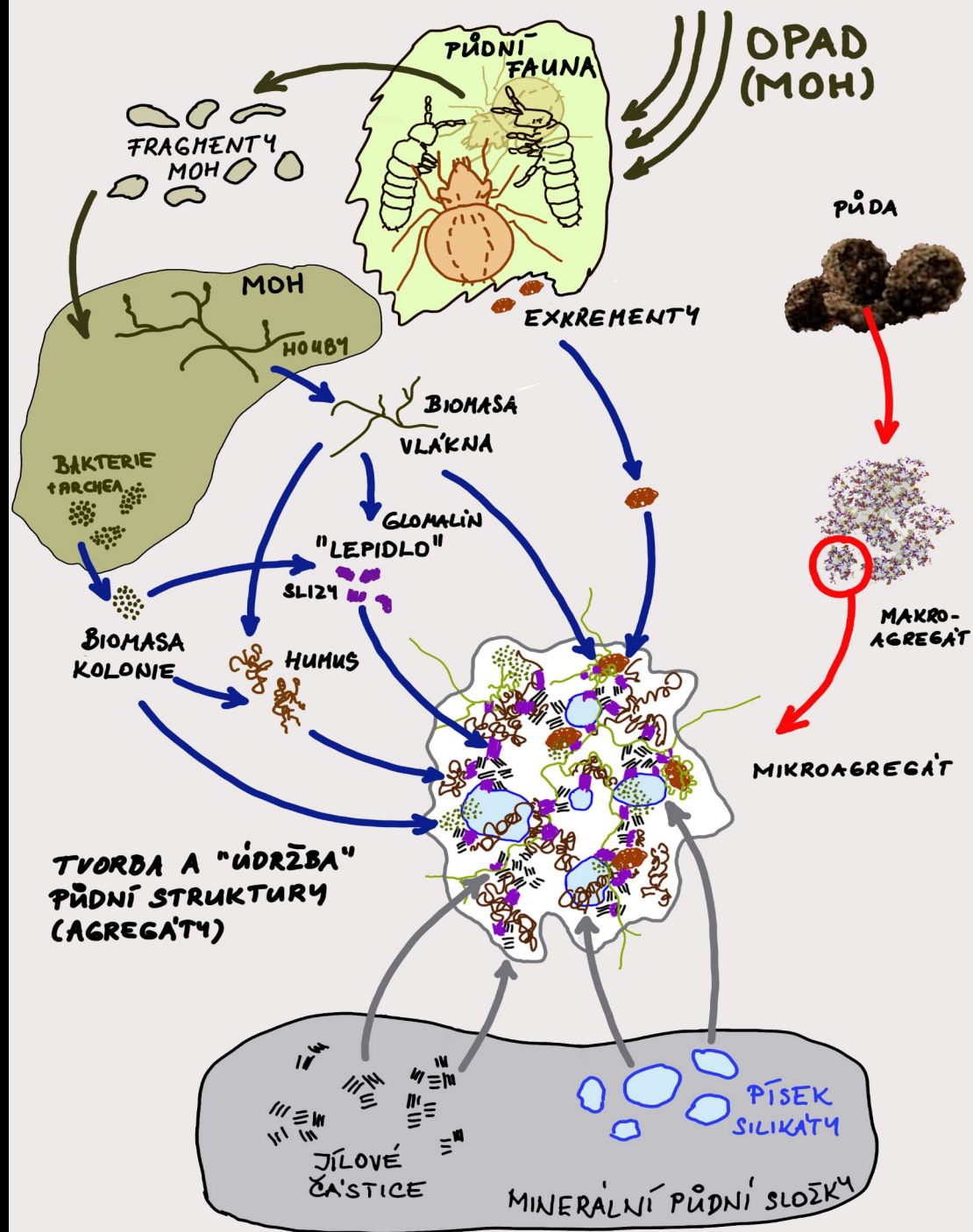
→ SEŽER MĚ A VYHRAJU!



Microbial gambit: role of soil organisms in decomposition of dead organic matter (DOM)

- Primary decomposers – mineralisation, humification
- Soil fauna:
  - Consuming detritus and microflora – fragmenting, increase of surface available, mixing (perturbation)
  - Soil „ecosystem engineers“ – distribution of DOM in soil (earthworms, ants, beetles)
  - Secondary decomposition a coprogenic humification, nitrogen
  - Predators - regulation



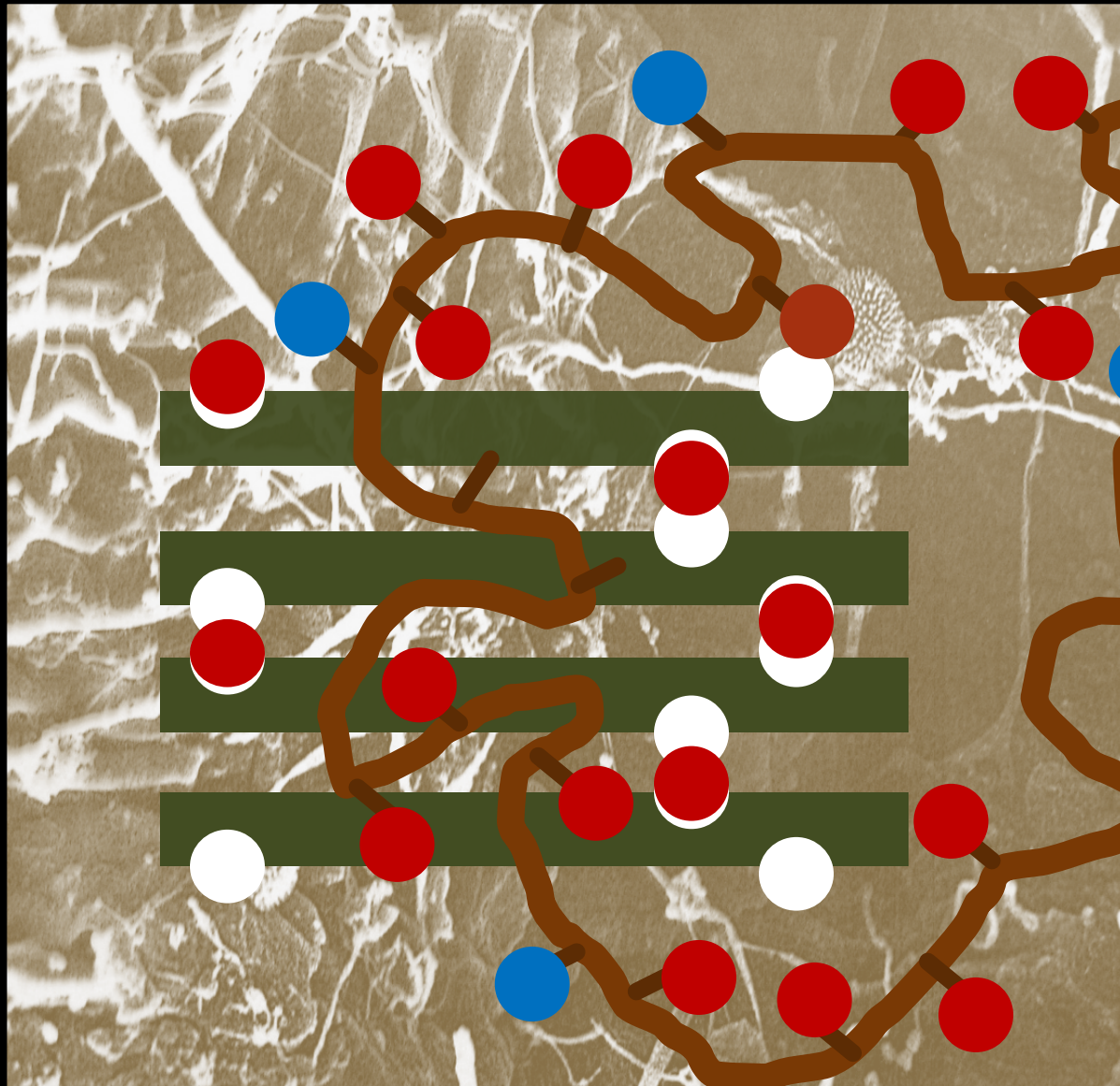


## Soil structure: complex origin and maintenance, KEY FUNCTION!

- Result of decomposition and synthesis at the same time
- Food (energy) source and living environment (mikrohabitat)
- Functional connection of living and non-living component of soil
- Principal stabilisation element of the soil (physical, chemical, biological, immobilisation, nutrient and energy source)
- DOM (and exudates) are the key
- Product of soil organism action, impossible to produce artificially



# Why is soil structure so crucial: nutrients



## **cations**

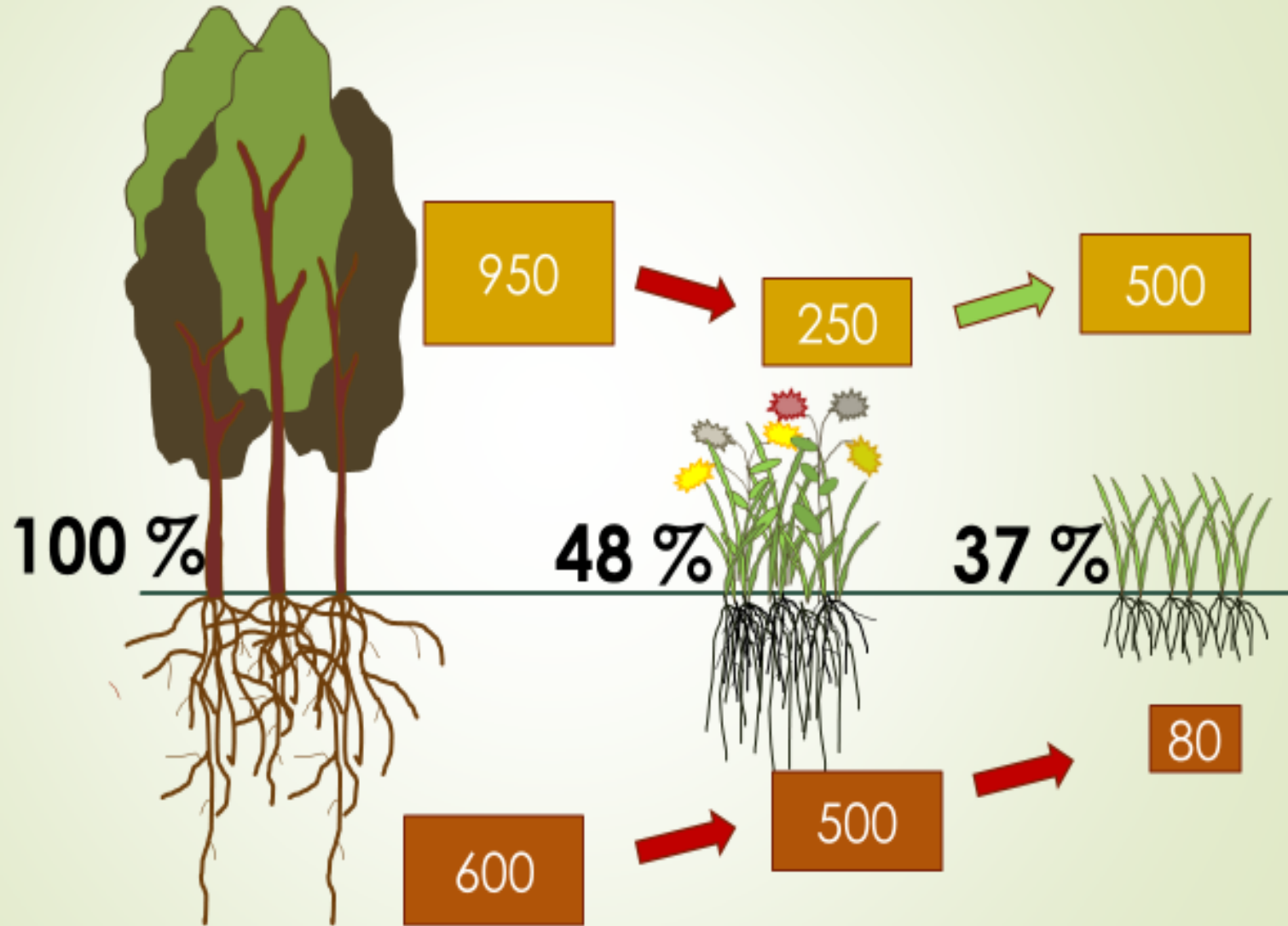
- $K^+$
- $Ca^{2+}$
- $Na^+$ , ...

## **anions**

- phosphorus
- nitrogen, ...



## Produkce nadzemní a podzemní biomasy (g/m<sup>2</sup>/rok)

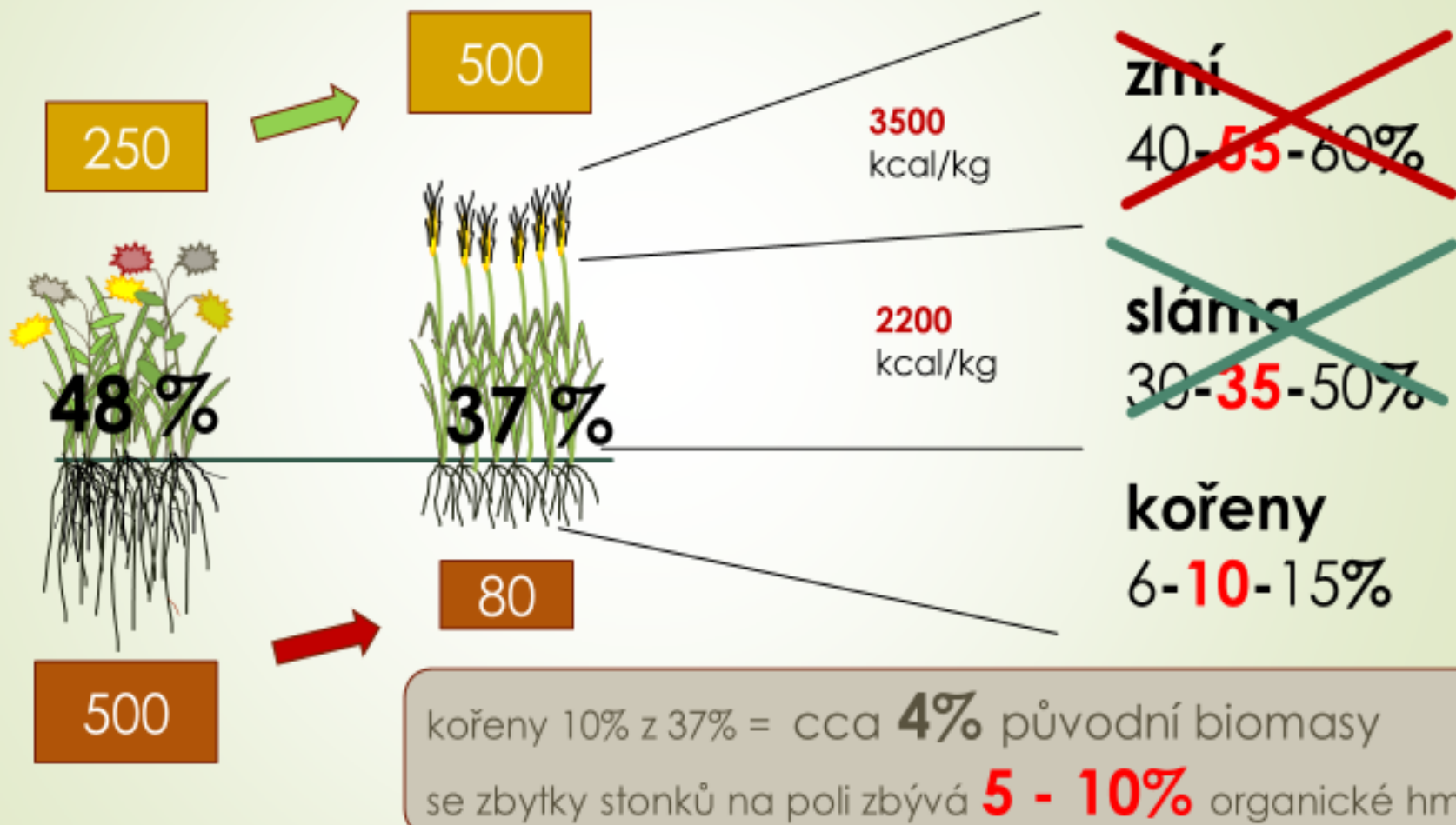


## Losses in biomass production

- Changing cultures changes productivity aboveground and belowground
- Changes differ in different habitats / landuses
- Significant impact in intensive, short-term cultures (farming)



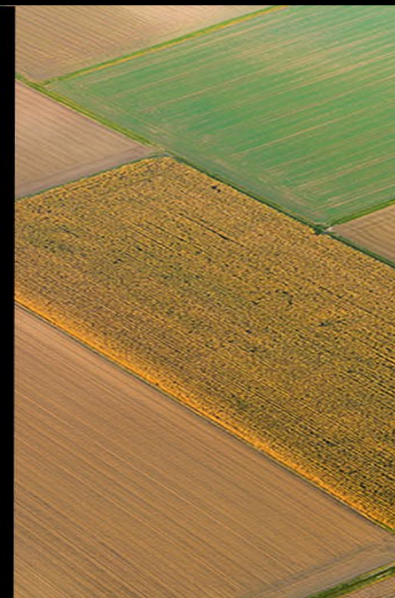
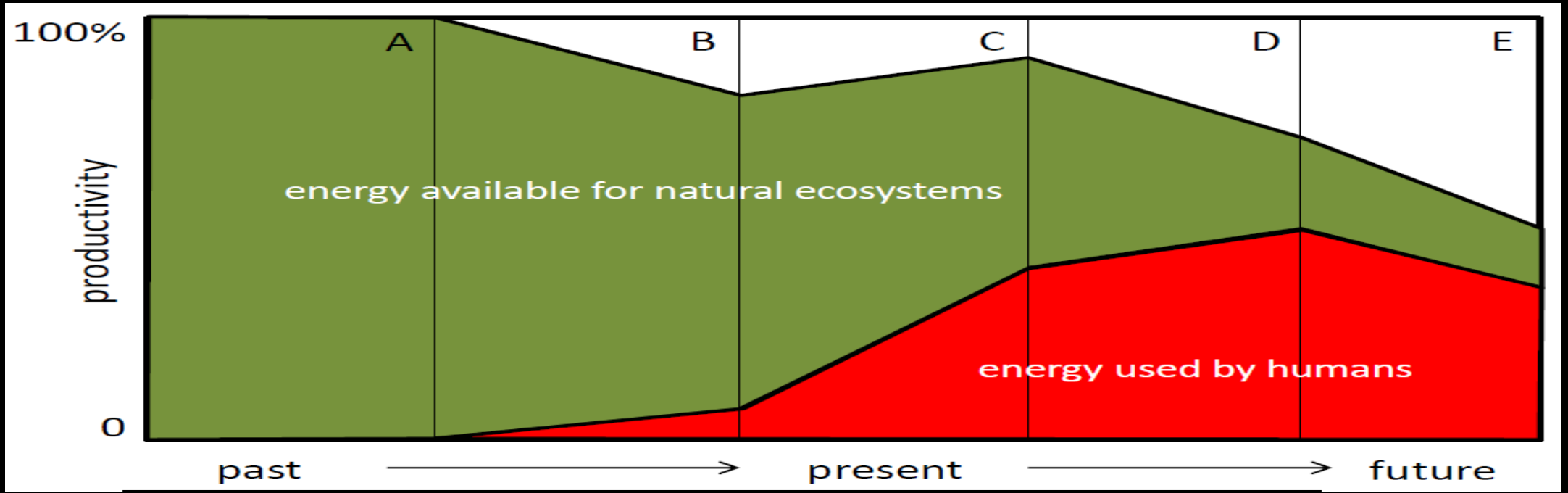
# Využití biomasy vyprodukované na poli (g/m<sup>2</sup>/rok)



Produced biomass is taken away, does not saty at the place – in the soil system

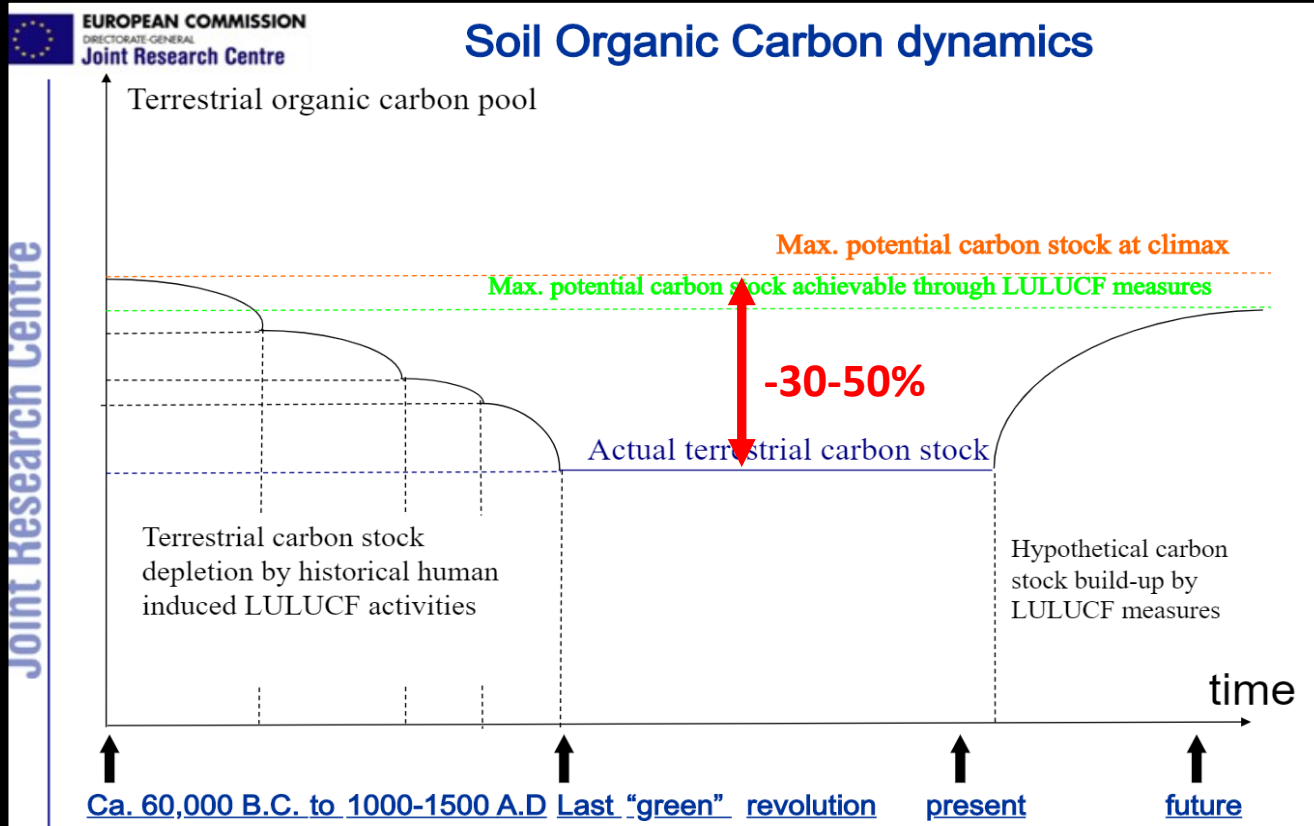


# ... Energy not just for humans ???

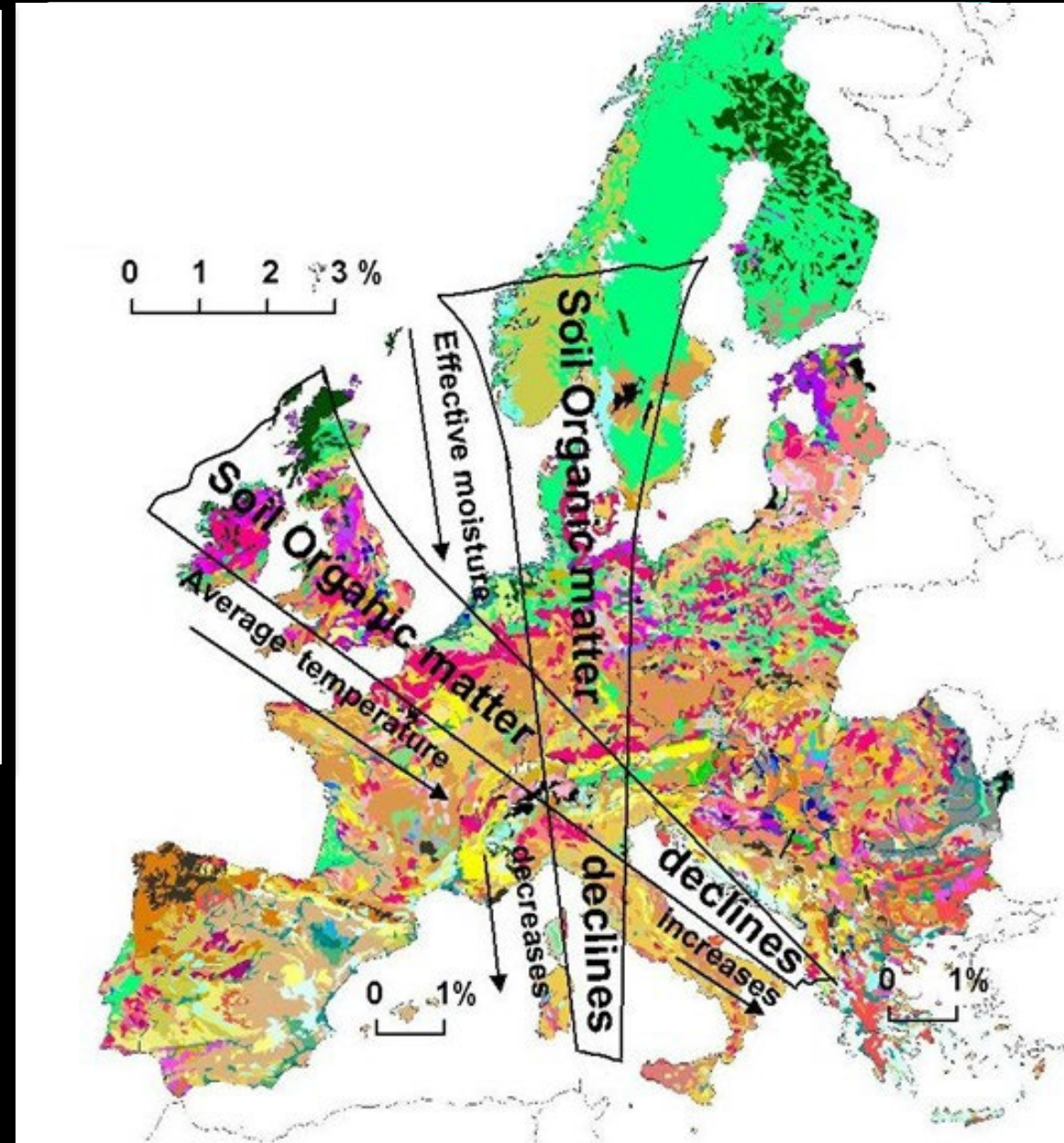




# Intensive farming and organic matter in soils

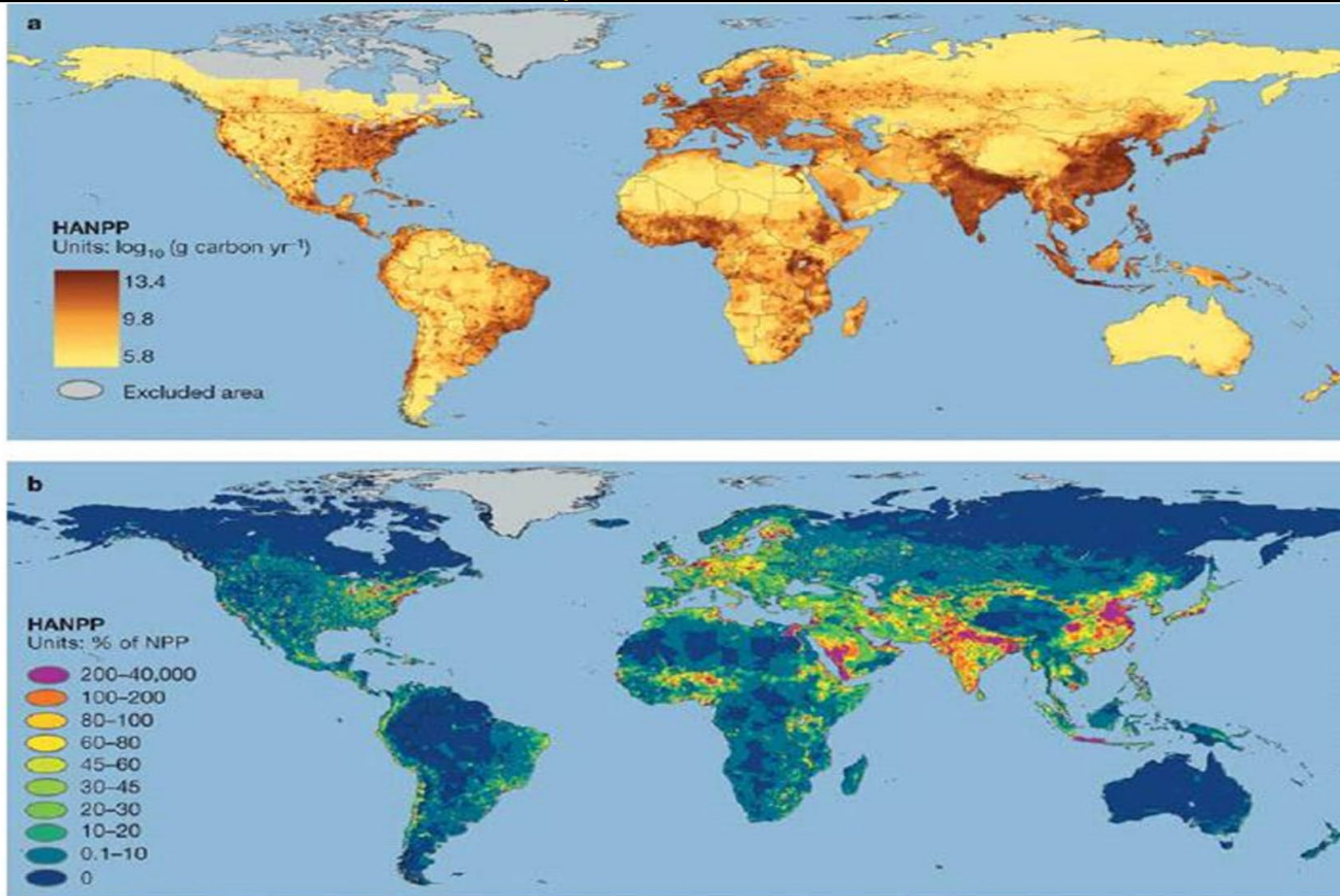


- With increased intensity of farming  $C_{org}$  declines
- Decrease is more intensive in higher temperatures and lower humidity
- Therefore, this trend is even strengthened by change of climate
- Adaptation measures necessary to address the decline





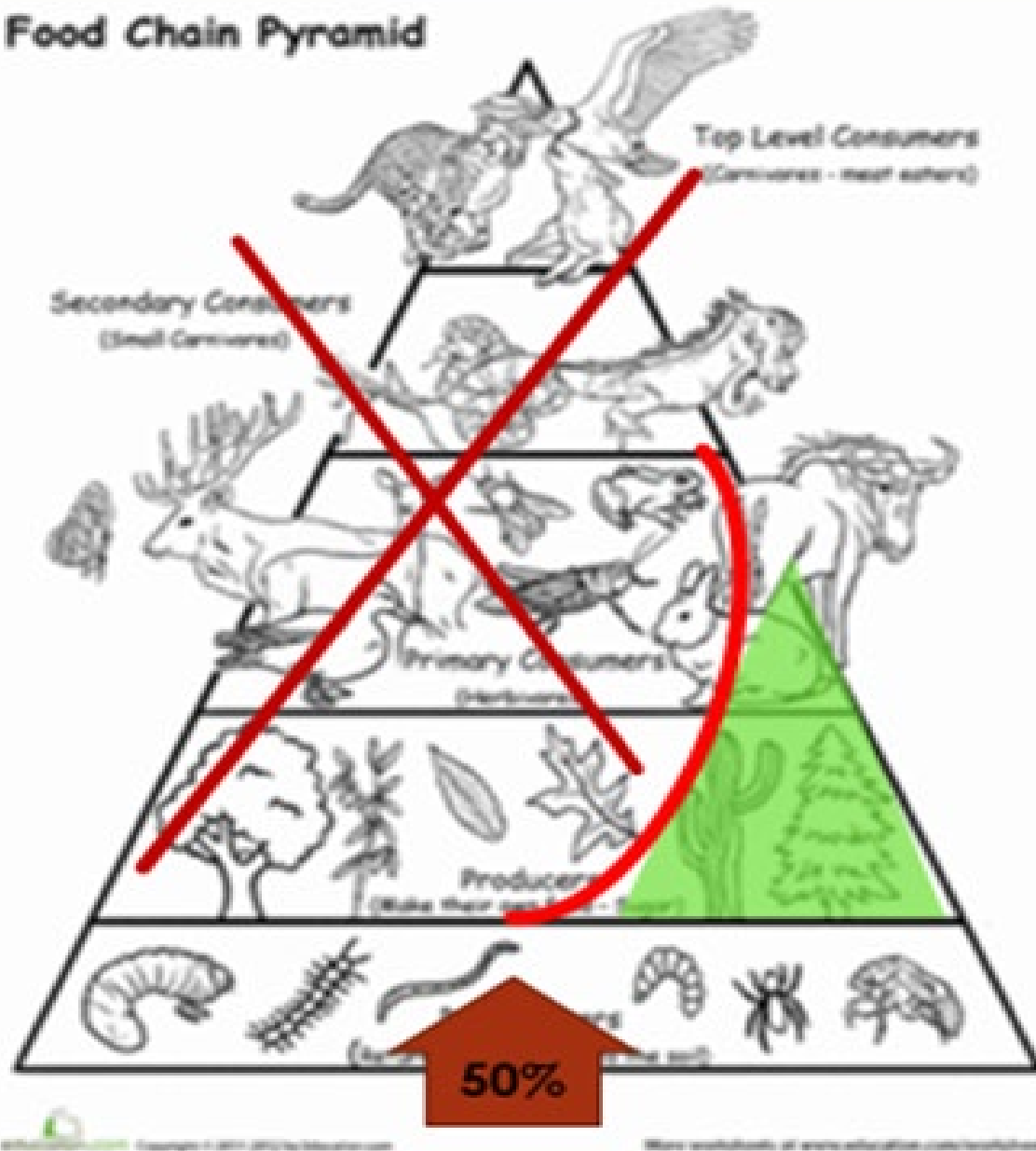
# How much human acquires?? - HANPP



**Figure 1** Spatial distribution of the annual NPP resources required by the human population. As measured by **a**, HANPP and **b**, HANPP as a percentage of local NPP. Both maps use the intermediate estimate for HANPP and are in units of carbon.



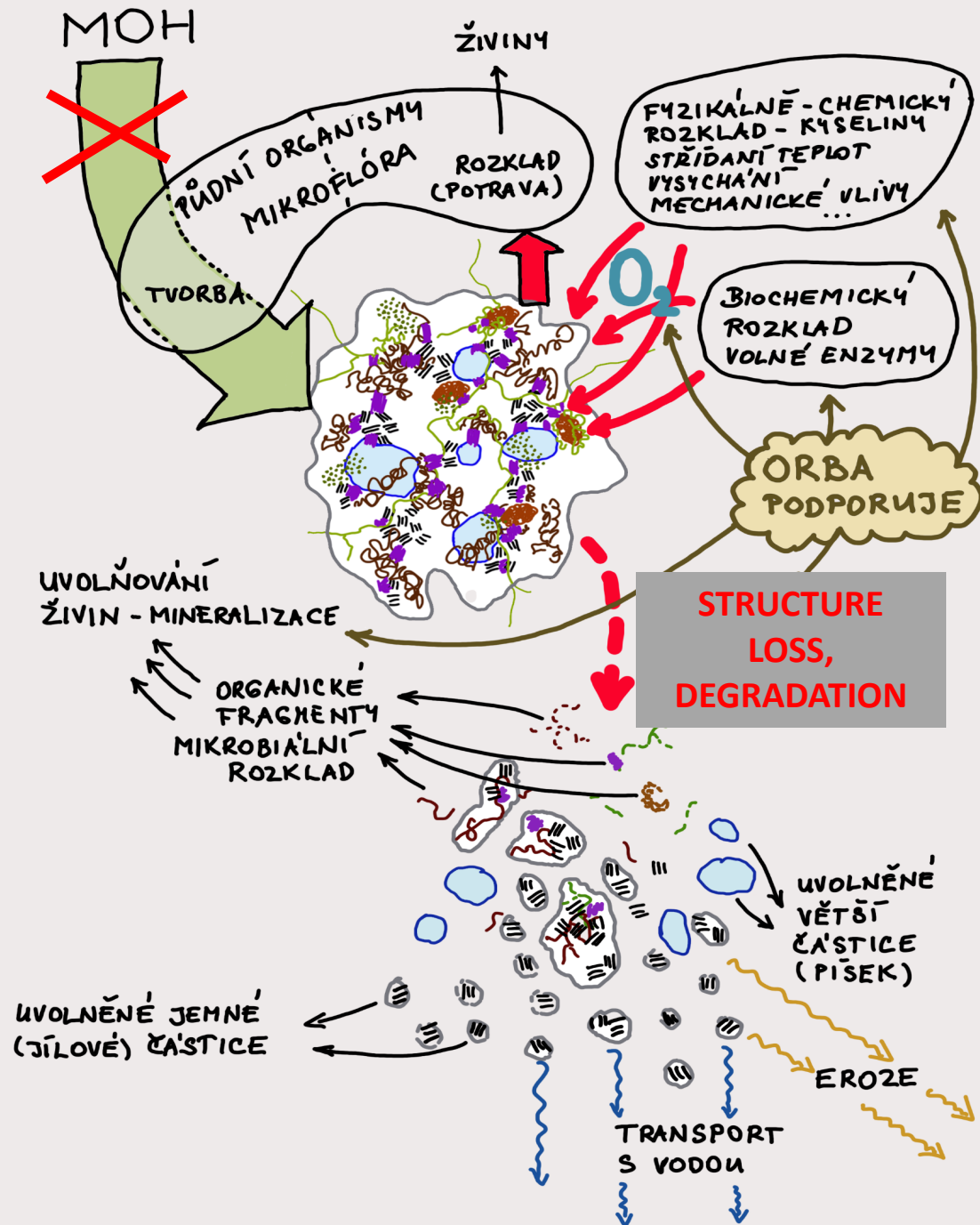
## Food Chain Pyramid



## Energy availability and biodiversity

- Food pyramid— trophic levels
- Energy transfer roughly 10%
- Decrease of not only number of species and complexity, but also abundance (numbers of individuals) – visible in intensive farming lands

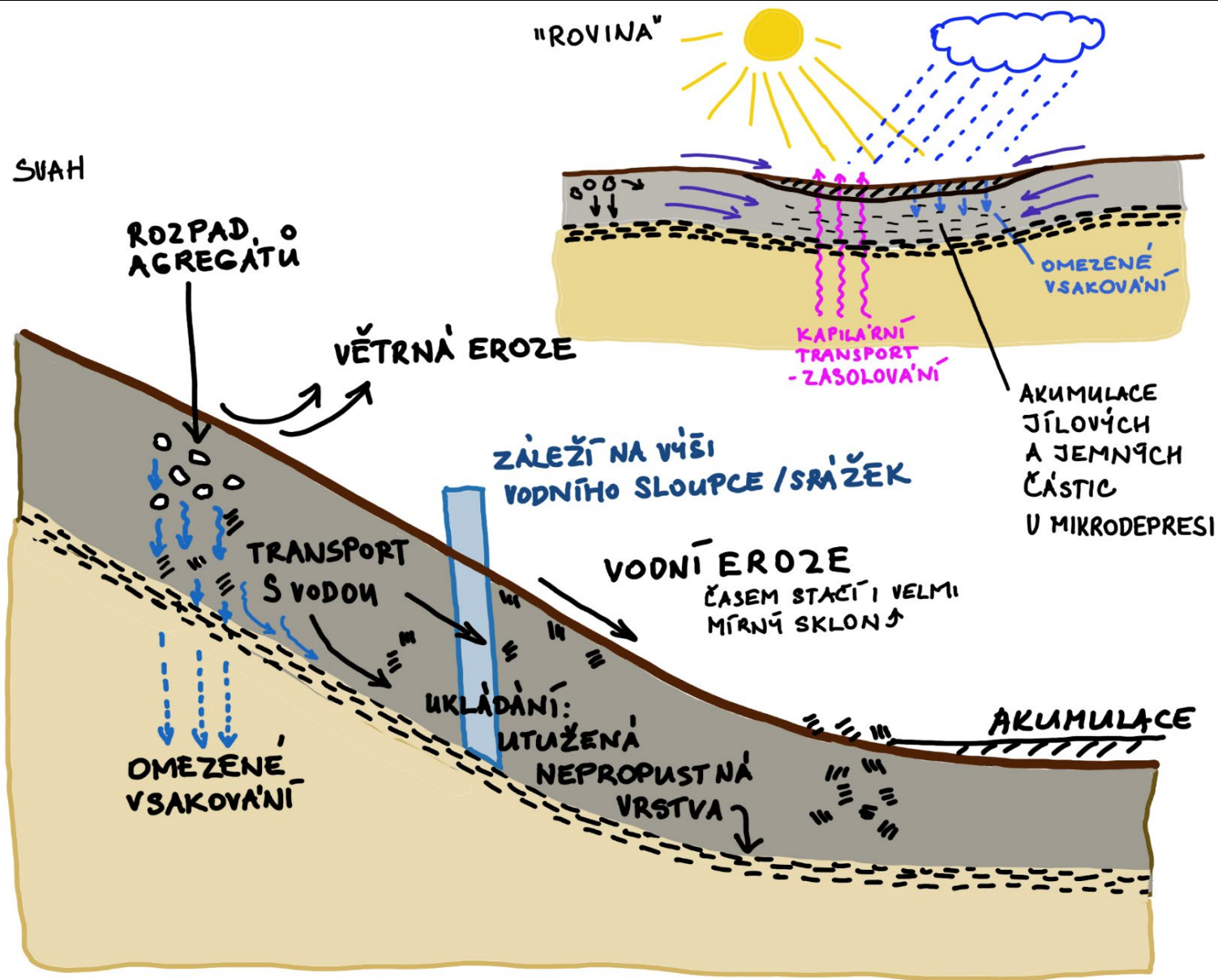




## Destruction (degradation) of structure – major problem

- Decomposition/destruction of soil structure is a permanent process, as well as creation of the structure. Both are largely dependent on the action of soil organisms, and input of „raw material“ and energy (all in dead organic matter and soil exudates)
- Degradation of structure occurs, when DOM input is low and organisms switch to use „reserves“ in long term stabilised organic matter in the soil (important component of soil aggregates)
- Results in release of small particles, easier migrating/transported by water, air,....



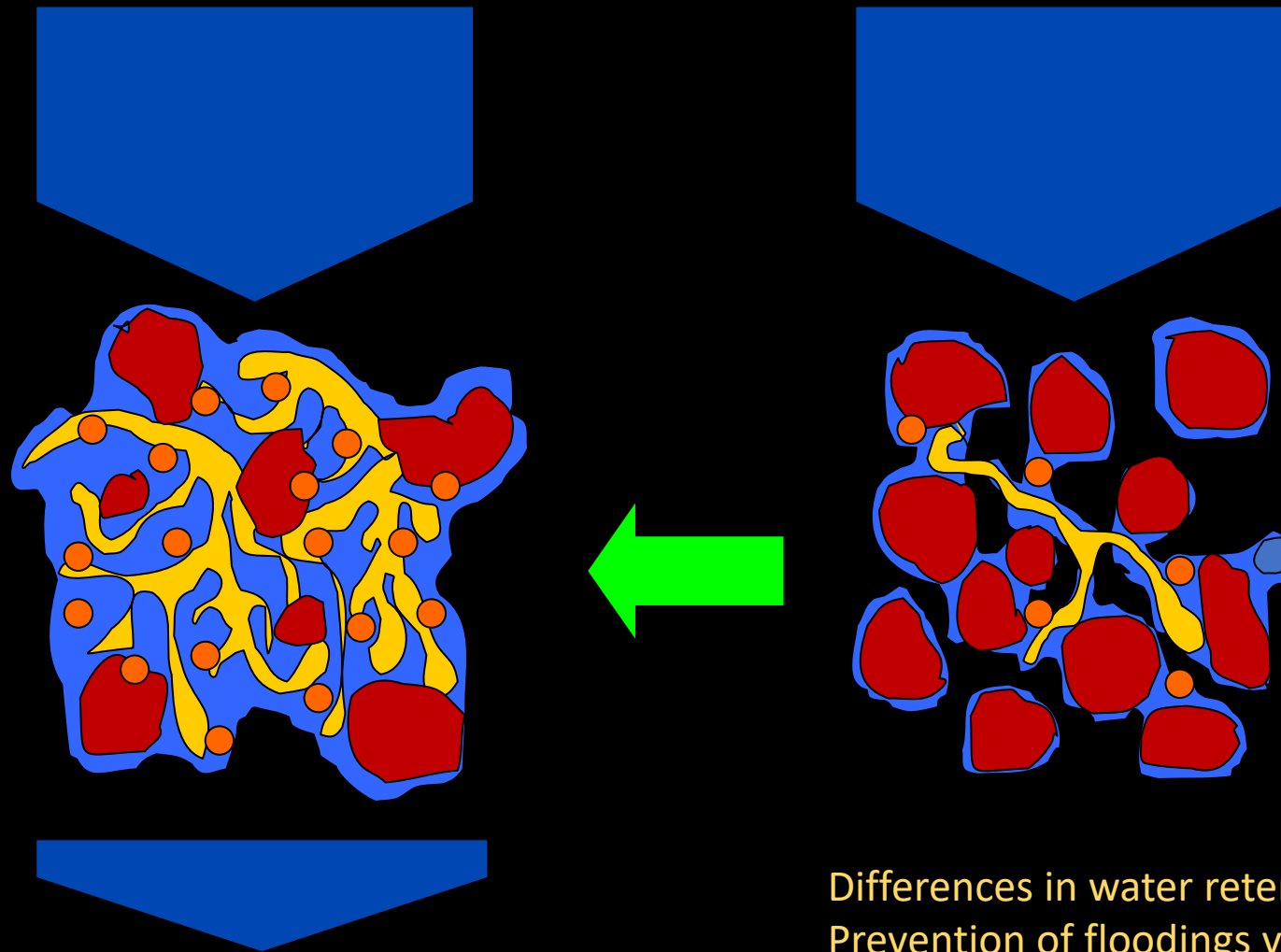


## Erosion and compaction as a result of soil structure degradation

- Structure degradation – free movement of small fragments)
- Accumulation in subsoil – compaction
- Easier surface erosion, easier wind erosion
- Much smaller soil slope angles are sufficient to start erosion events
- In microdepressions – accumulation, capilarity - salinisation



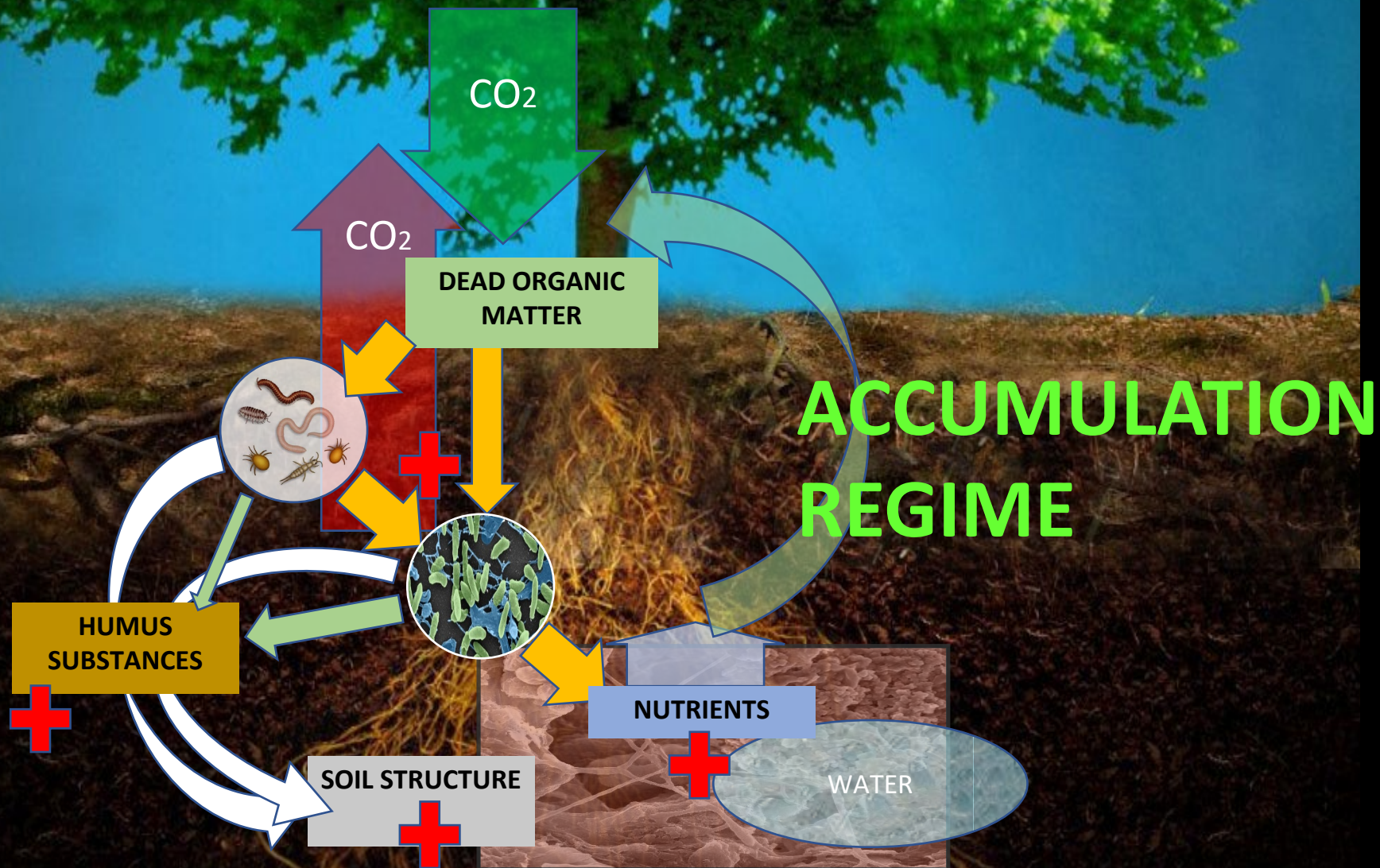
# Soil structure and water



Differences in water retention and accessibility  
Prevention of floodings versus increased risk  
Temperature buffering, etc.



# How healthy soil works?

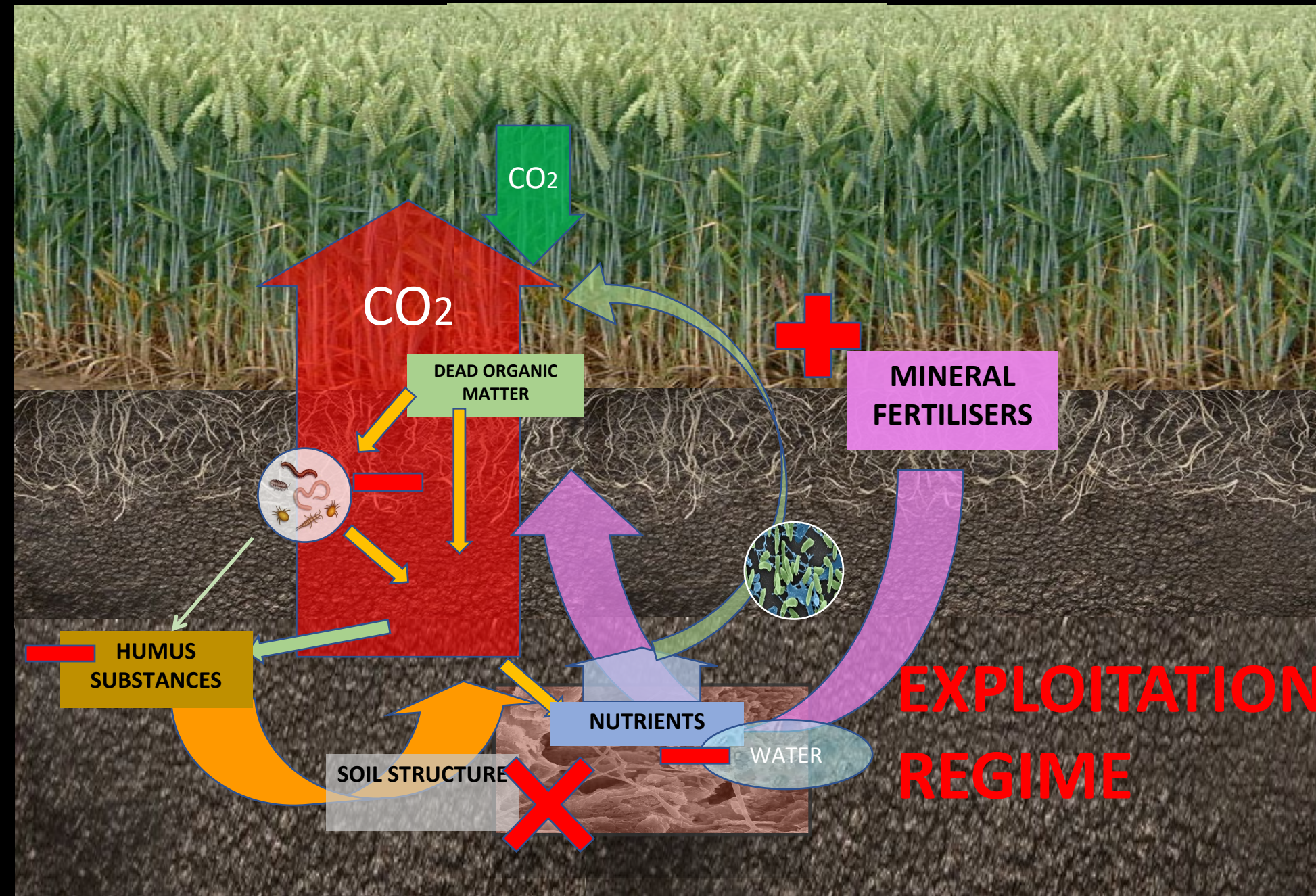


- Important processes:
- Decomposition
- Nutrients
- Structure
- Water
- Biodiversity
- Carbon



# Where is a problem?

- In almost all functions
- All works thanks system geniality
- „best insurance“:
- functional redundance
- „Switching“ of food preferences
- BUT: structure degraded with subsequent effects





SOIL ECOSYSTEM SERVICES

SUSTAINABLE

ACCUMULATION

NATURAL CONDITIONS,  
NO INTERVENTIONS/SPONTANEOUS  
OR SIMULATED

KEEPING

COMBINATION OF NATURAL  
AND HUMAN IMPACTS

EXPLOITATION

ARTIFICIAL CONDITIONS, MOSTLY  
HUMAN INPUTS , „HYDROPONICS“

DEFICIT  
TO BE  
COMPLE-  
MENTED  
BY HUMAN

AGROTECHNICS  
FERTILISING  
IRRIGATION  
ANTI-EROSION  
MEASURES  
ARTIFICIAL SUBSTRATE  
ENERGIE  
(PRECISION AGRICULTURE)

- MOER OF DEAD ORGANIC MATTER (DOM) (INPUT>USAGE)
- BETTER SOIL STRUCTURE
- HIGHER WATER CAPACITY
- MORE NUTRIENTS KEPT
- C ACCUMULATION - CAPTURE
- SOIL ORGANISMS MORE DIVERSE AND ABUNDANT

- LITTLE DOM INPUT (INPUT=USAGE)
- WORSENEO SOIL STRUCTURE
- LOWER WATER CAPACITY SOME EROSION
- NUTRIENT, C LOSSES
- SIMPLIFIED SOIL ORGANISM COMMUNITIES, RESILIENT SPECIES

- DOM MISSING (INPUT<< NEED)
- DEGRADED SOIL (STRUCTURE LOSS)
- LOW WATER CAPACITY, HIGH EROSION
- BIG NUTRIENT LOSSES
- C RELEASED - EMISSIONS
- SOIL FAUNA MISSING, MICROFLORA SIMPLIFIED

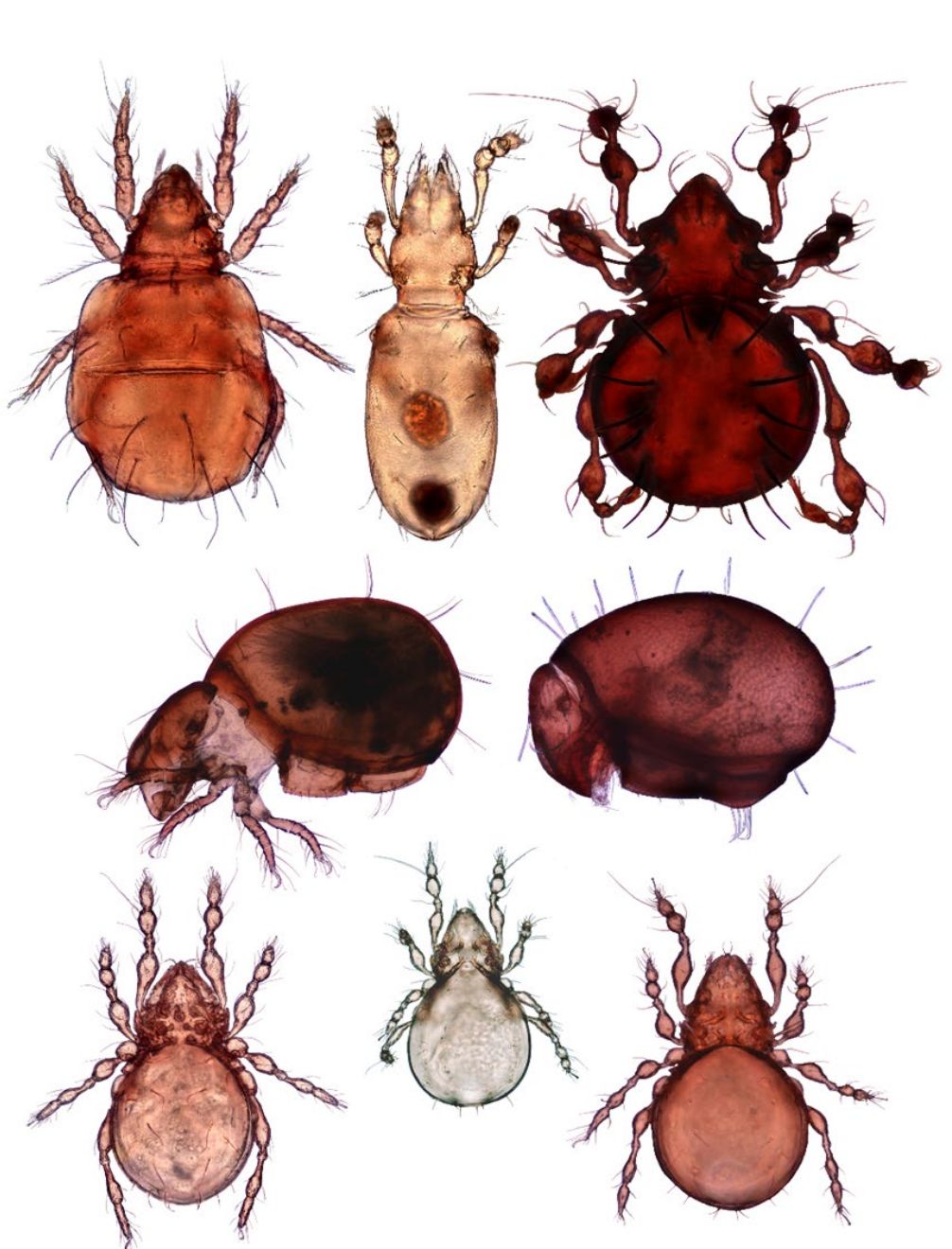
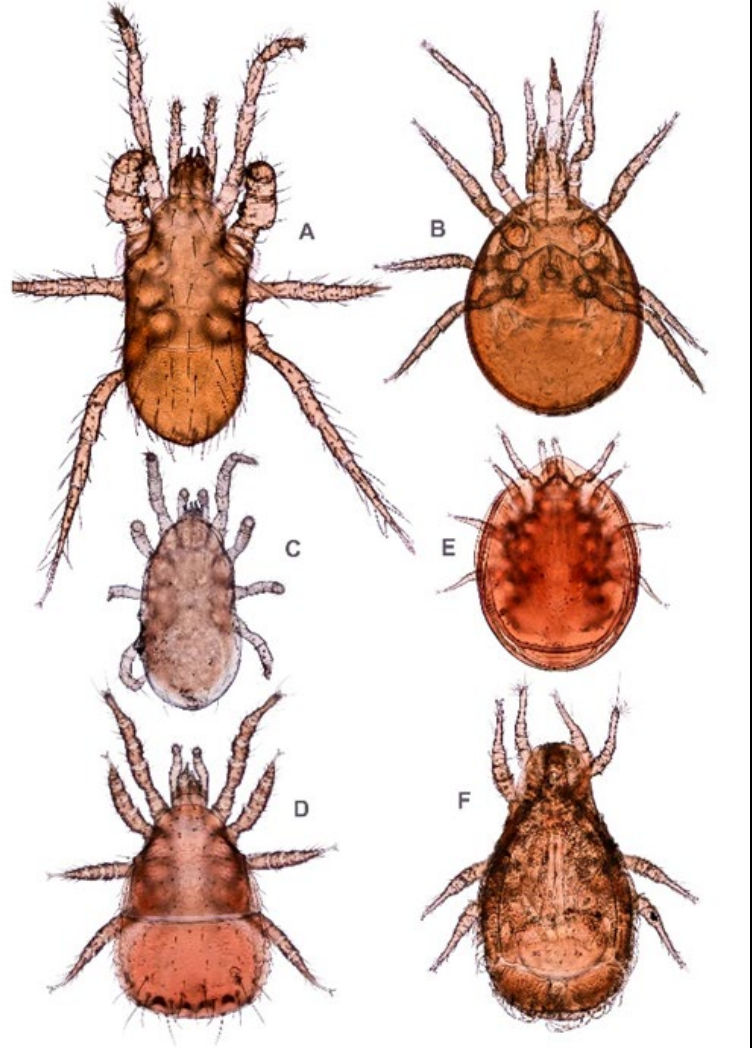
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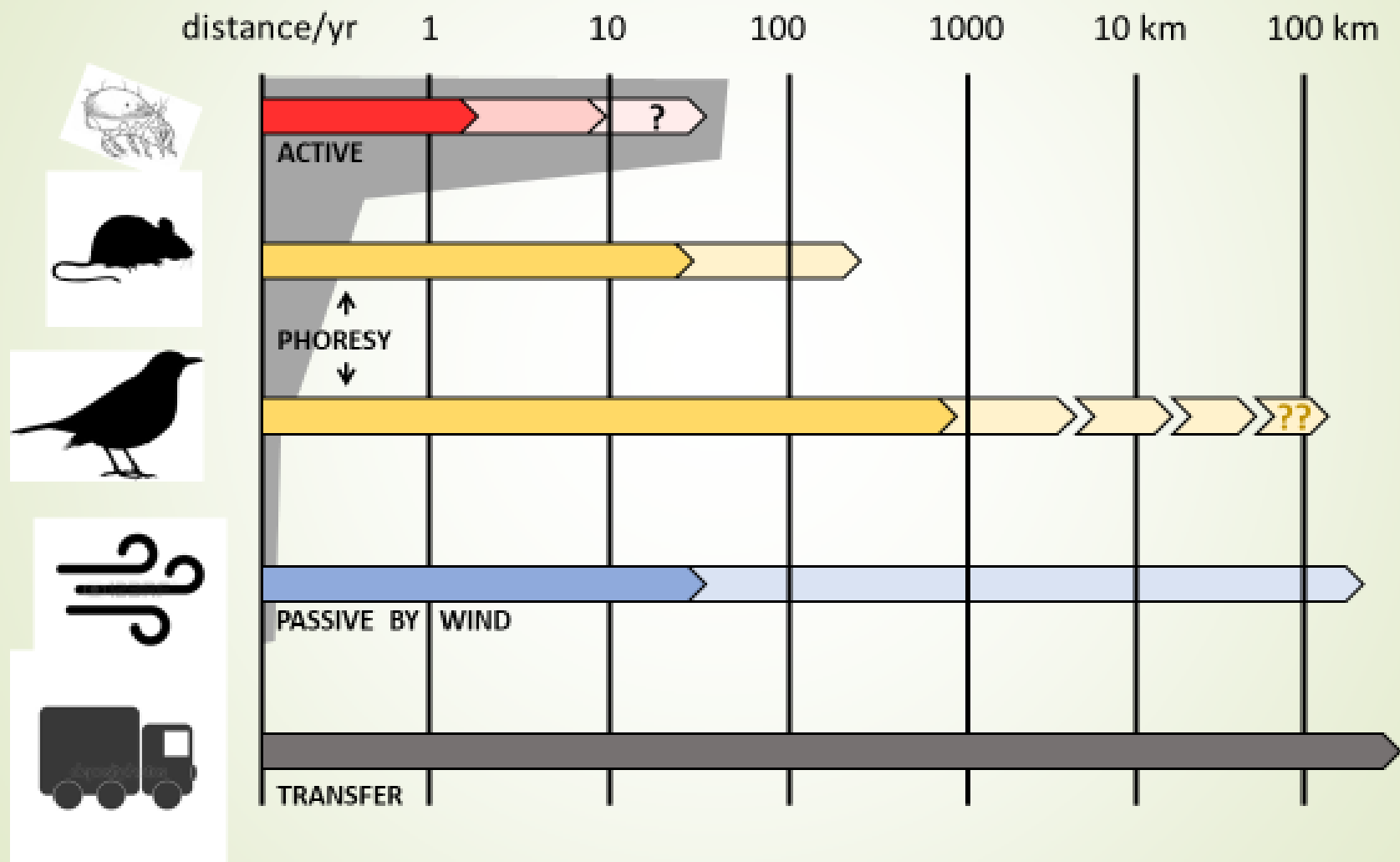




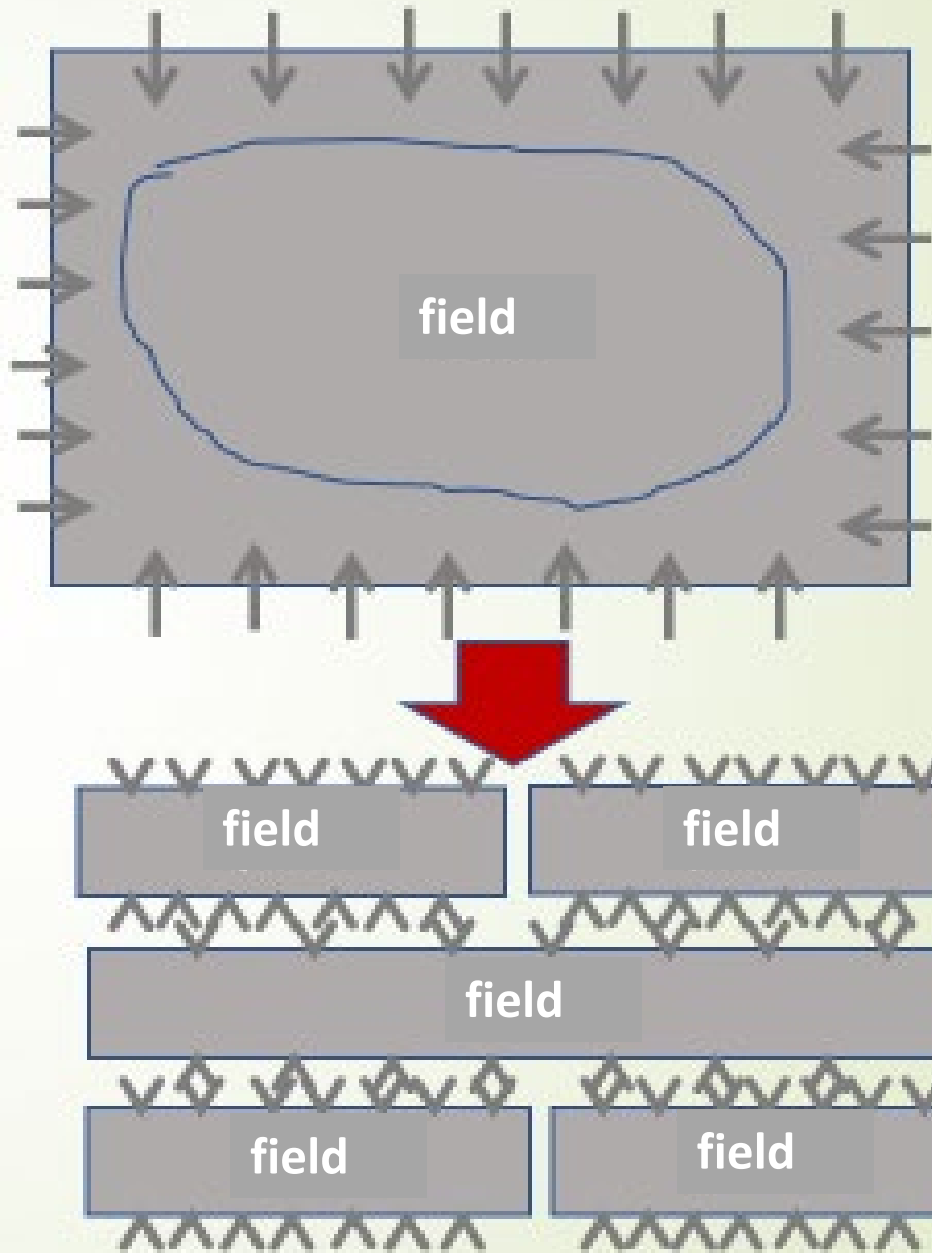
How to get them back?



# Reintroduction options – reimmigration: distances?





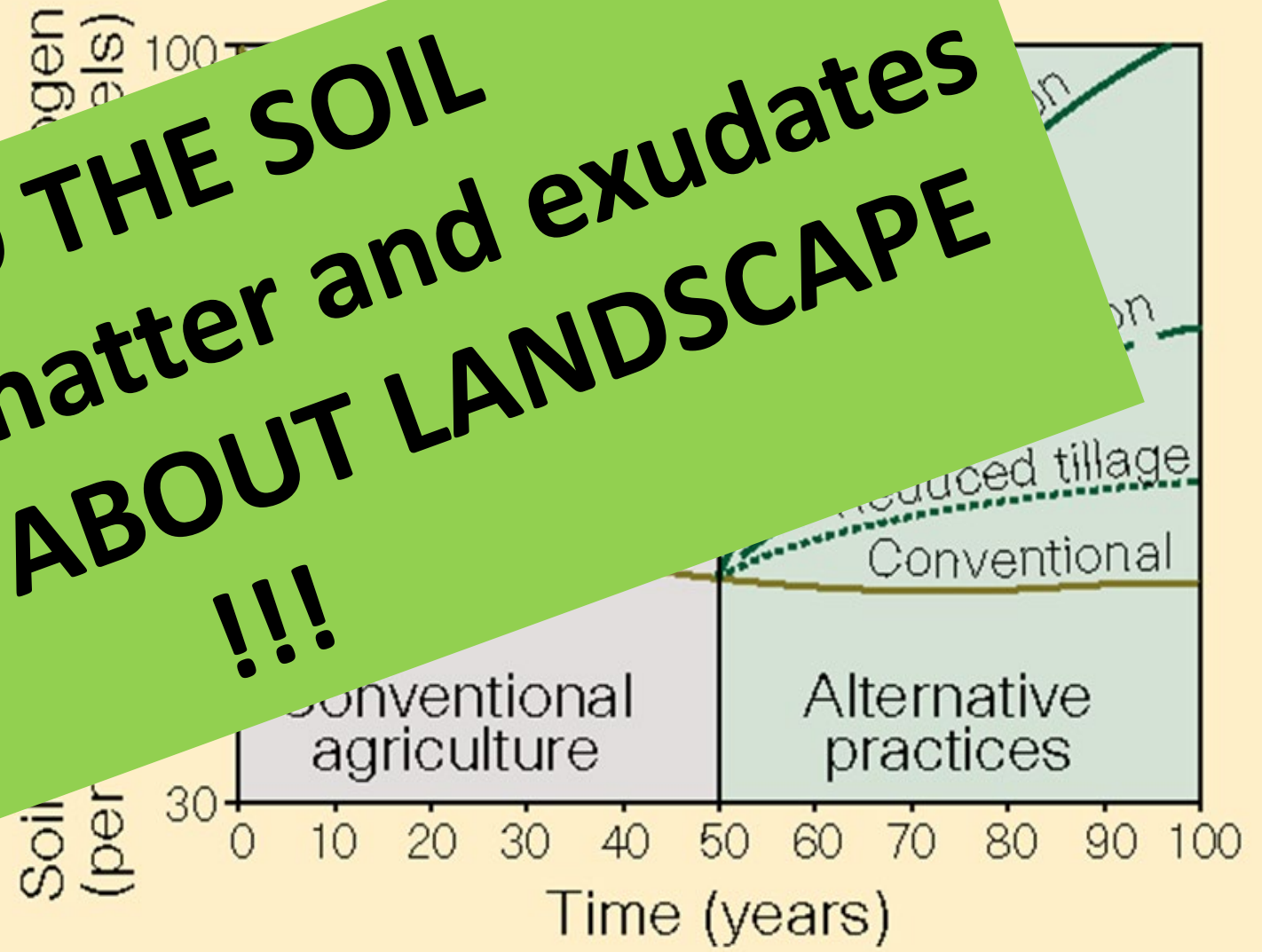


Adding organic matter may not be sufficient!

- Fauna destroyed by intensity
- Recolonisation from surrounding habitats important
- Landscape structure essential
- Secondary effects: aboveground biodiversity, ecosystem functions

What we can do ??

**FEED THE SOIL**  
**(by organic matter and exudates**  
**AND CARE ABOUT LANDSCAPE**  
**!!!**





Thank you for awareness!

