Soil Health – what is it and what can you do about it

Bryan Griffiths, Paul Hargreaves,
Joanna Cloy, Bruce Ball

Bryan.Griffiths@sruc.ac.uk

Leading the way in Agriculture and Rural Research, Education and Consulting

Soils deliver many ecosystem services

SRUC

Soil ecosystem services

Food & biomass production

A. Richer de Forges (CA 45)

Infosol (INRA Orléans)

Habitat, gene pool

Infosol (INRA Orléans)

J. Moulin (CA 36)

Storing, filtering & transformation

A. Richer de Forges (CA 45)

Source of raw materials

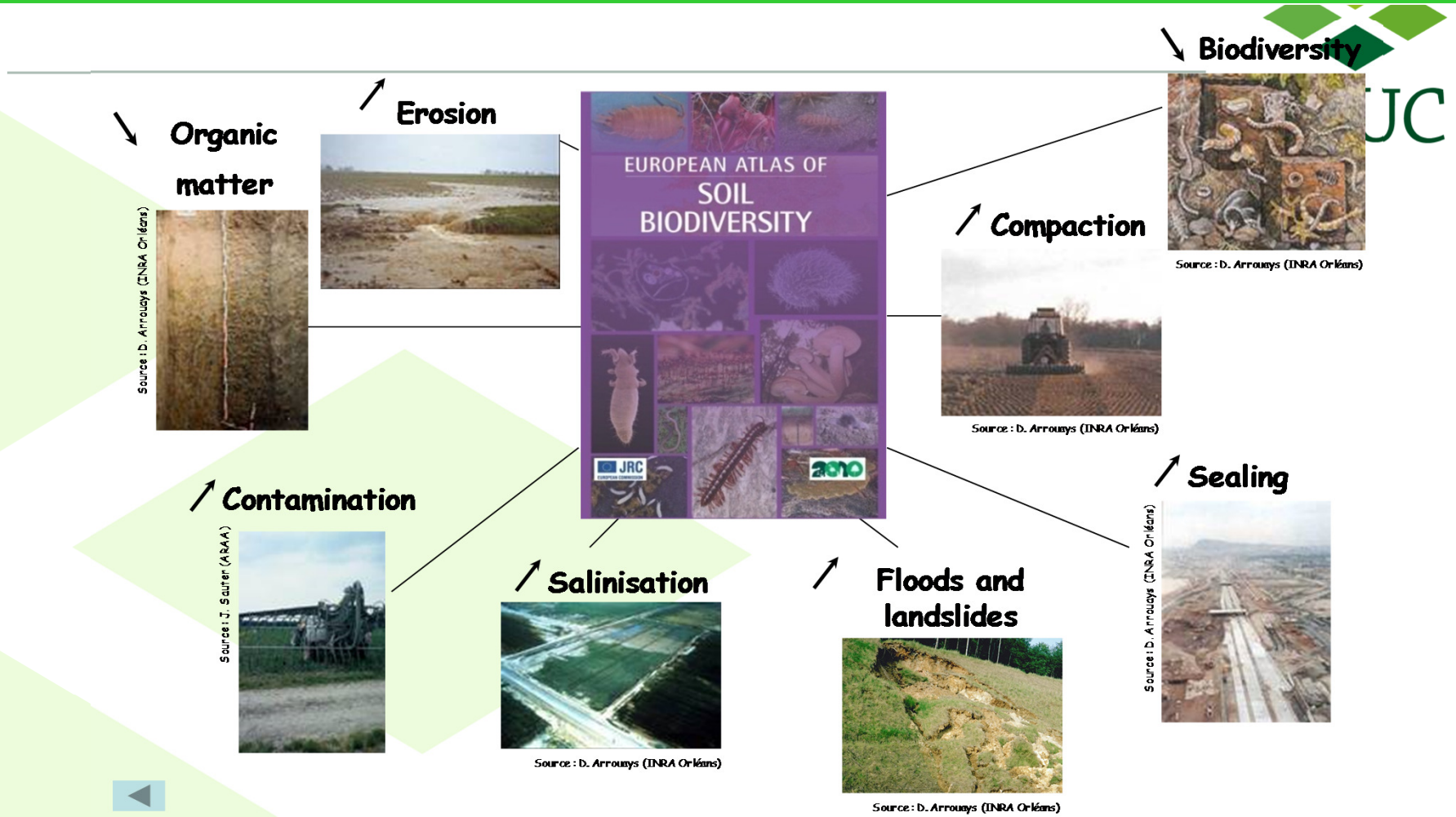
J. Moulin (CA 36)

Physical & cultural environment for mankind

C. Schvartz (ISAL)

Courtesy of Antonio Bispo, ADEME

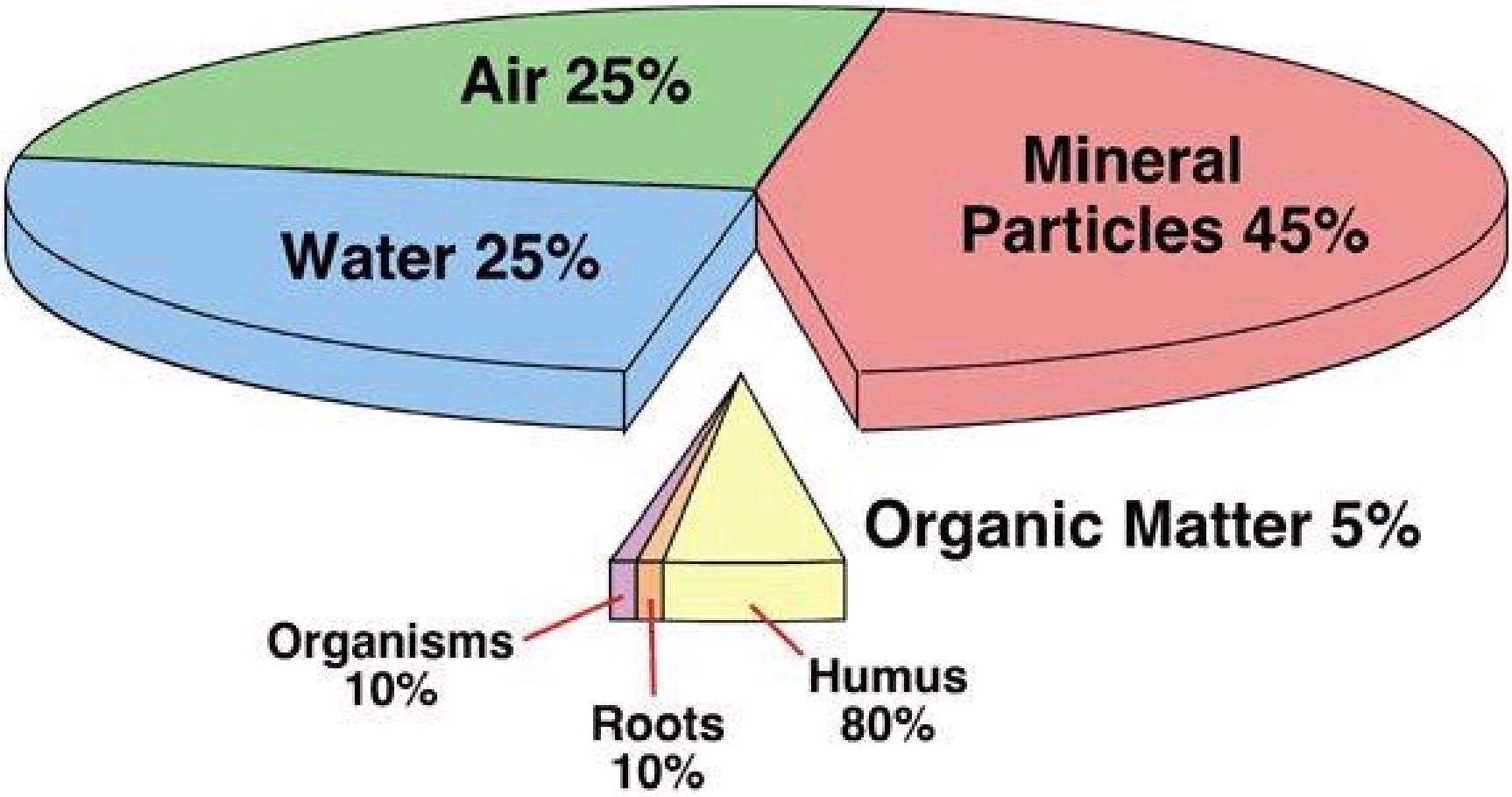
Soils and biodiversity are submitted to major threats



- **Erosion:** 115 million hectares subject to water erosion, 42 million hectares to wind erosion.
- **Contamination**: 3.5 million sites could be contaminated
- **Decrease of organic matter:** About 45% of European soils have low organic matter content
- **Soil sealing:** 1990-2000: 1,000 km² of soil/year , 2000-2006, the average loss increased by 3%

http://ec.europa.eu/environment/soil/

Soil– air, water, minerals, biology



Living soils

- Huge quantity of organisms
  - Fauna: 1-5 T/ha
  - Fungi: 3.5 T/ha
  - Bacteria: 1.5 T/ha

F. Ippolito

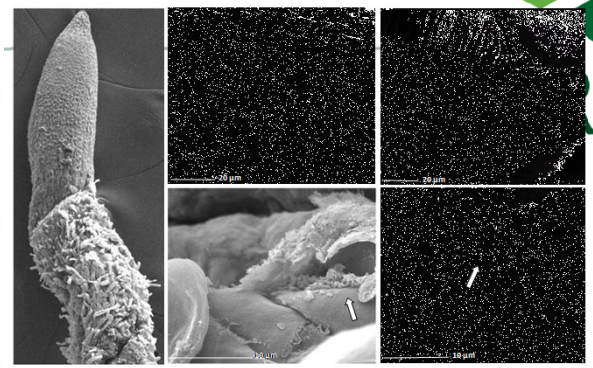
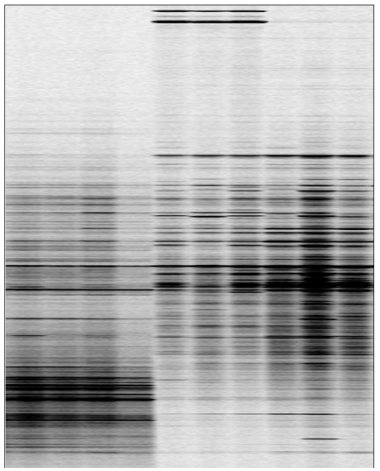
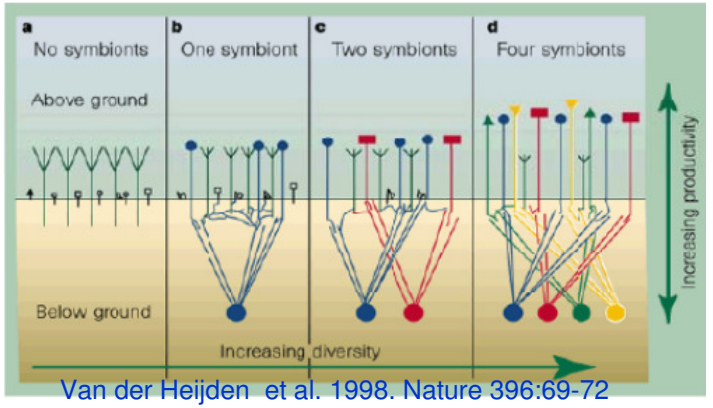


Photo : L. Avoscan & A. Violleau



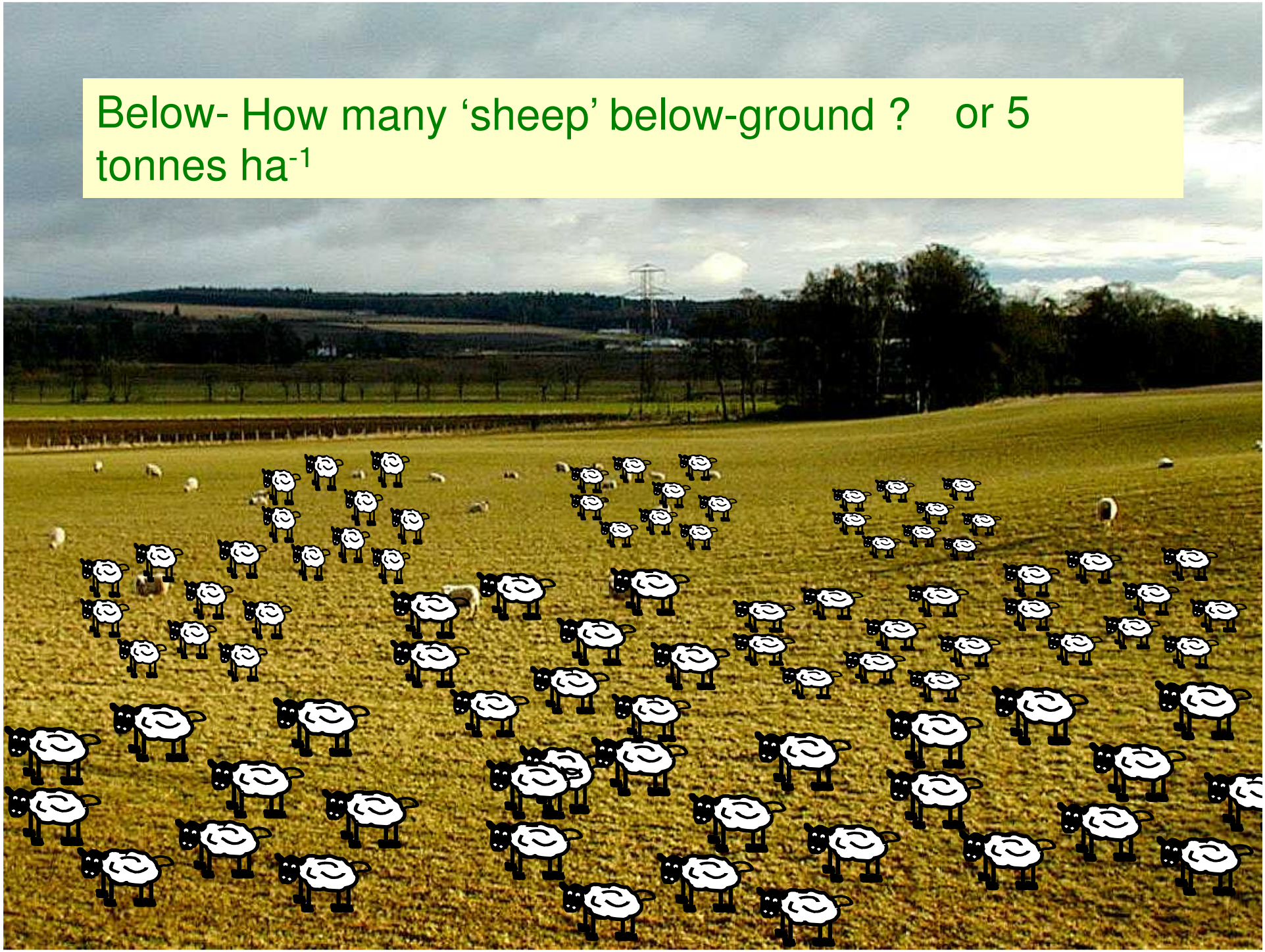
- Fantastic diversity
  - Until recently: only access to culturable microorganisms
  - Methodological progresses
    - ⇨ possibility to extract DNA from soils
      - ⇩ 10^4 – 10^6 bacterial genotypes / g sol

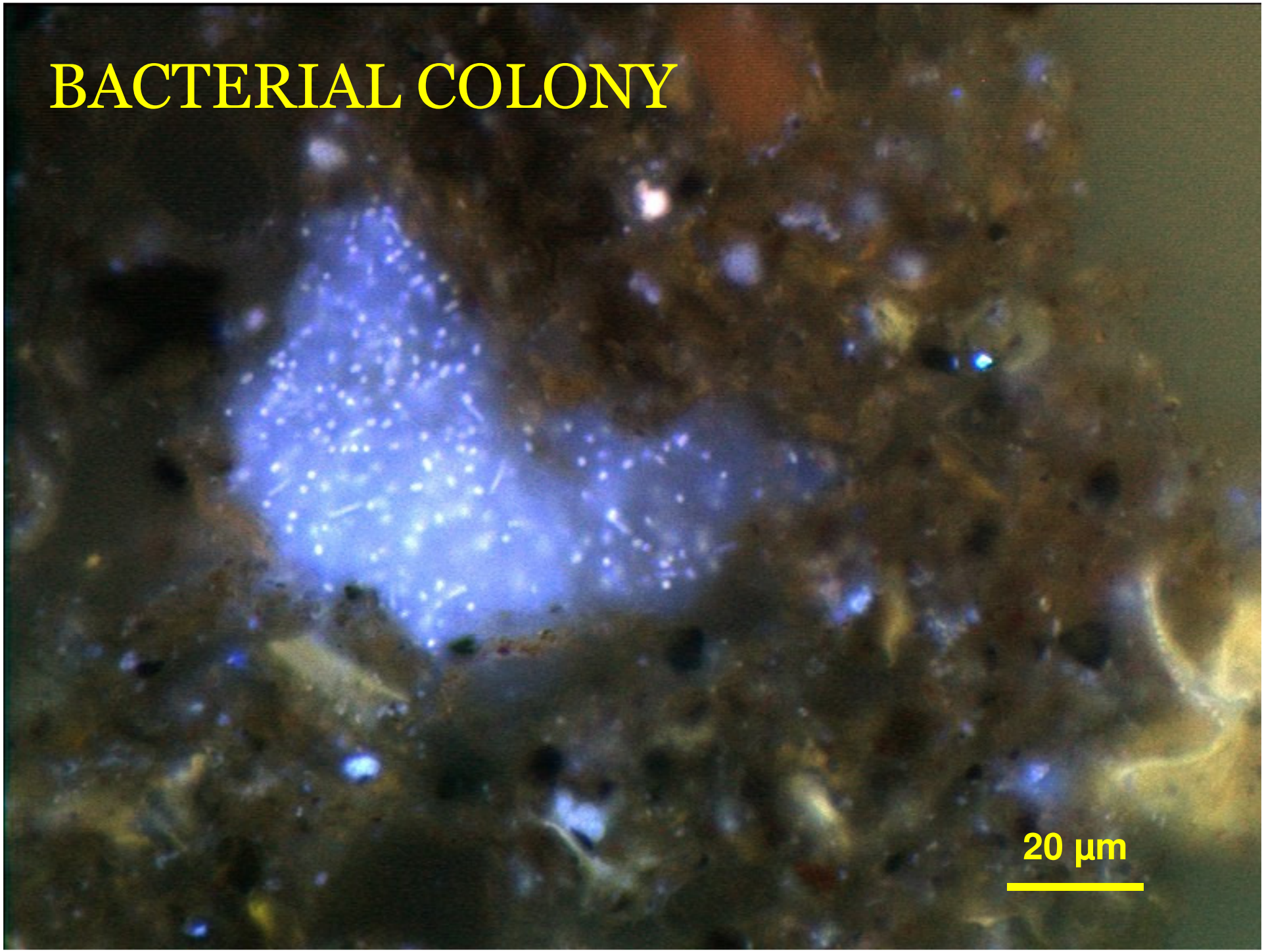
- A lot to be explored on the relations between below & aboveground diversity

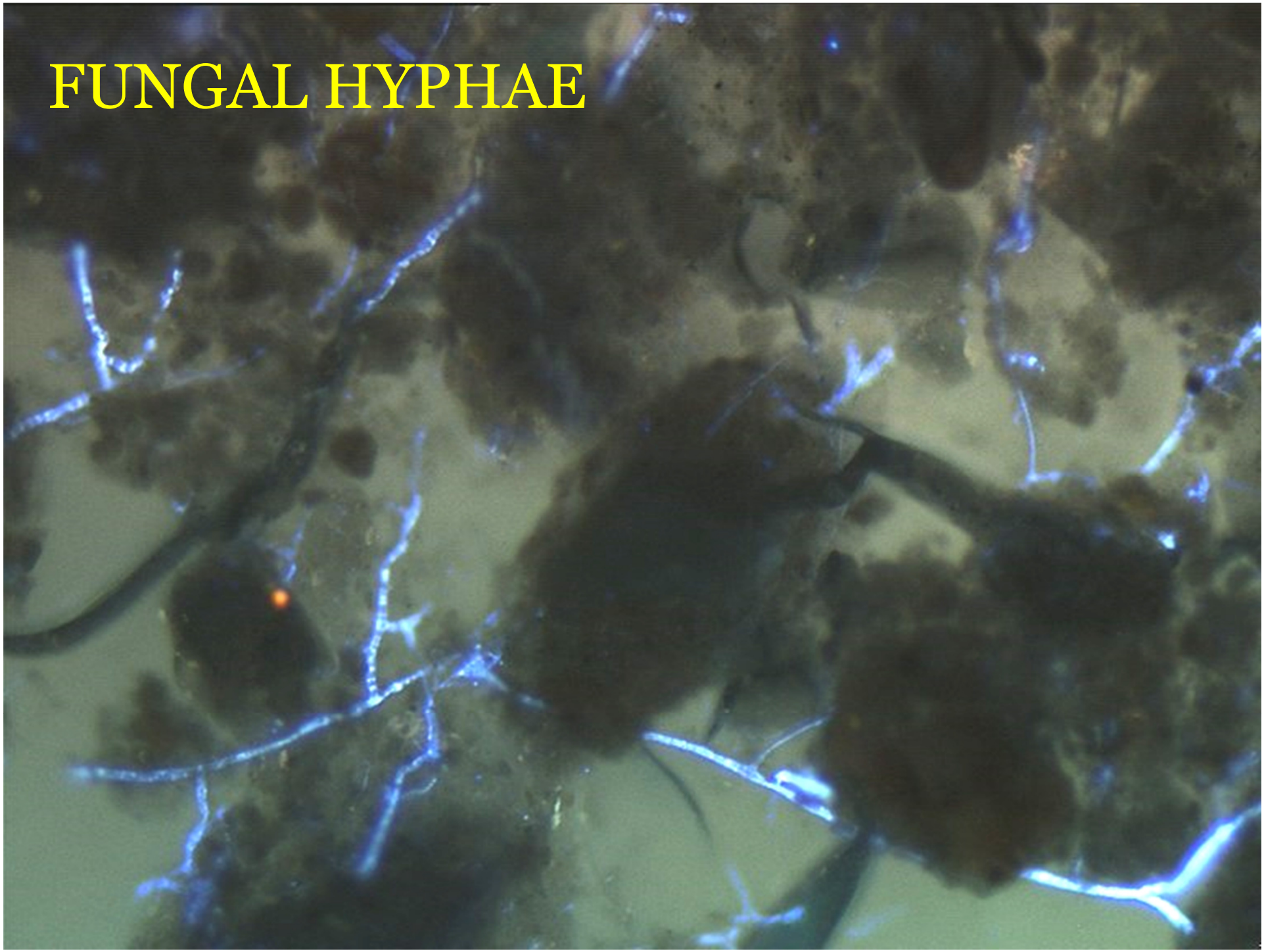


Van der Heijden et al. 1998. Nature 396:69-72

Below- How many ‘sheep’ below-ground ? or 5 tonnes ha^{-1}

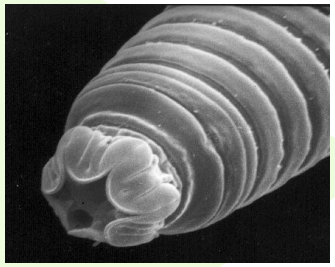
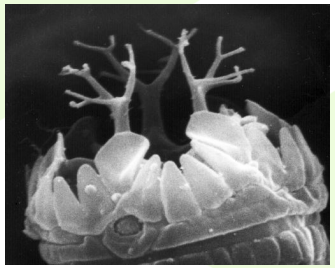
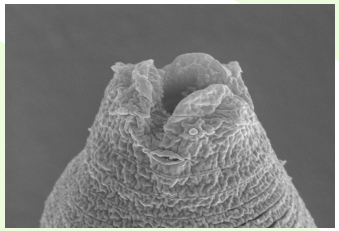
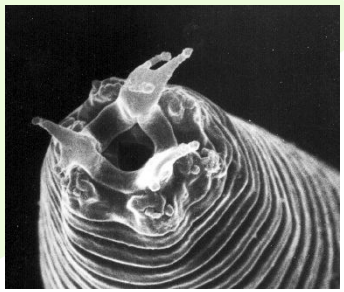
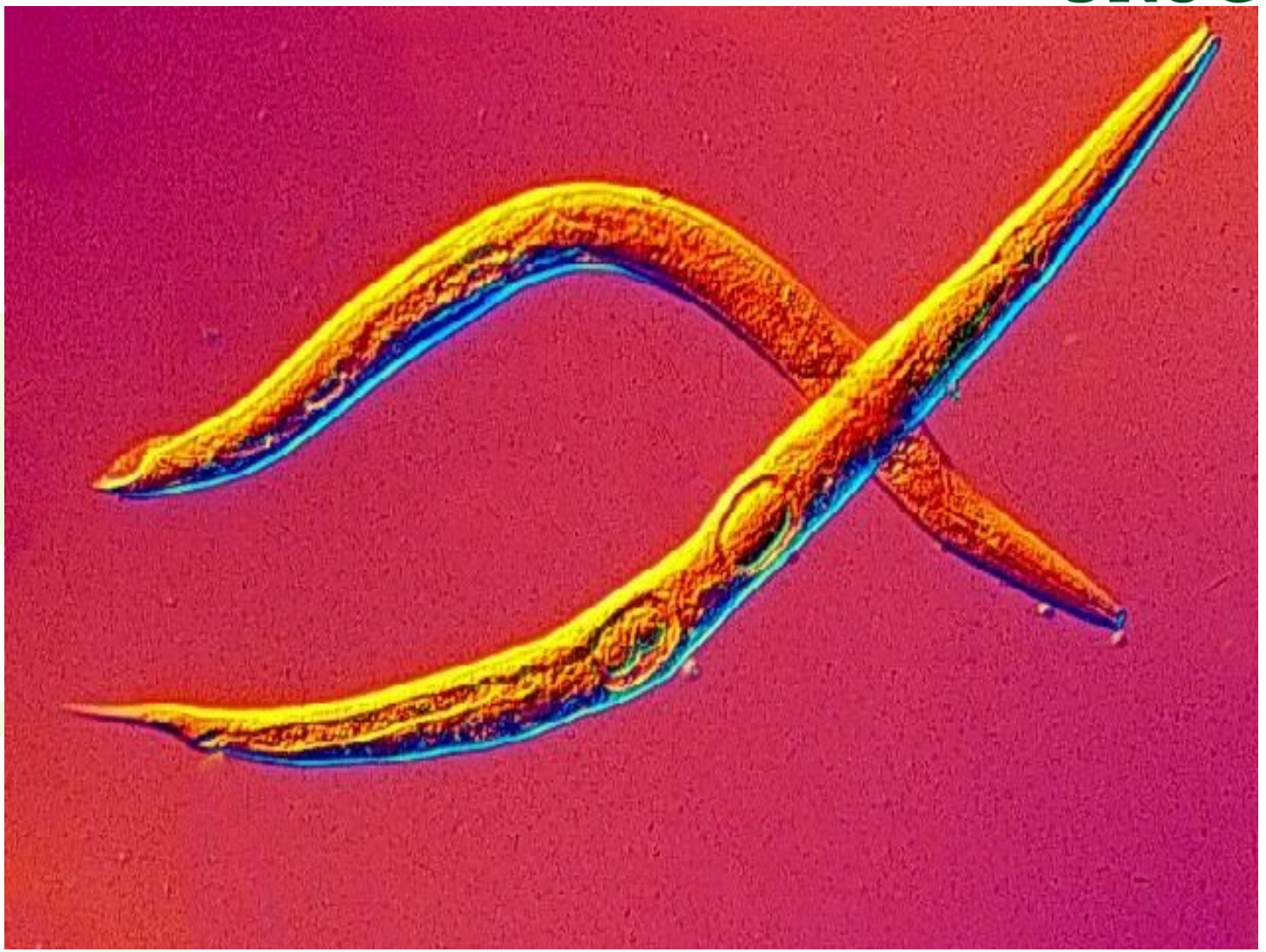



BACTERIAL COLONY
20 µm


FUNGAL HYPHAE


NAKED AMOEBA
20 µm

NEMATODES

Collembola





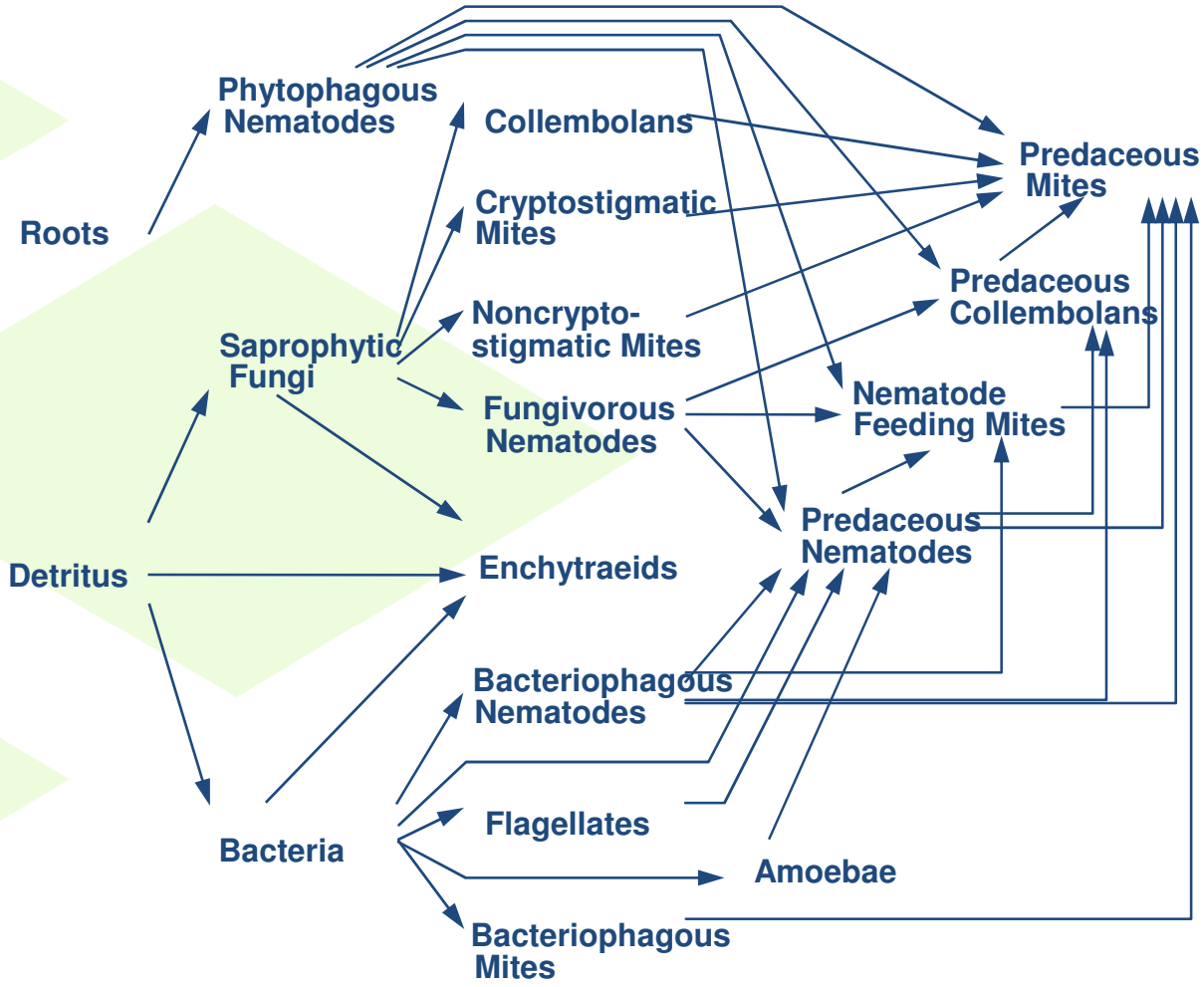



Enchytraeid worms

Earthworms

The soil food web

(de Ruiter et al. 1993, J Appl Ecol 30, 95-106)



What is a healthy soil?

Looks good
Feels good
Smells good

Supports lot of life
Easy to work

Can we define it?

Soil health is the ability of a soil to sustain, in the long term, its most important functions within the limits imposed by its local environmental conditions (including its current use) to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health. (Soil Security Programme)

How do we measure soil health?

- To date it has been mainly from the analysis of soil
  - Chemistry (pH; nutrients; heavy metals)
  - Physics (water flow, pore size, bulk density)

- But more recently there has been a much greater awareness of Biology

Current projects to measure soil health 'on farm'

- Supported by several sources

The Scottish Government

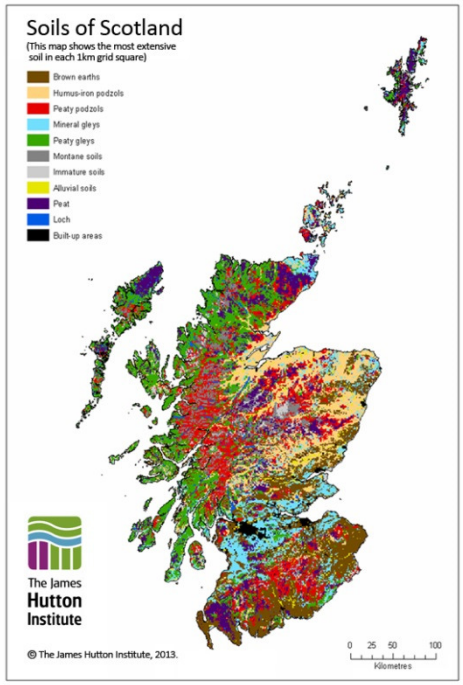
Innovate UK
Technology Strategy Board

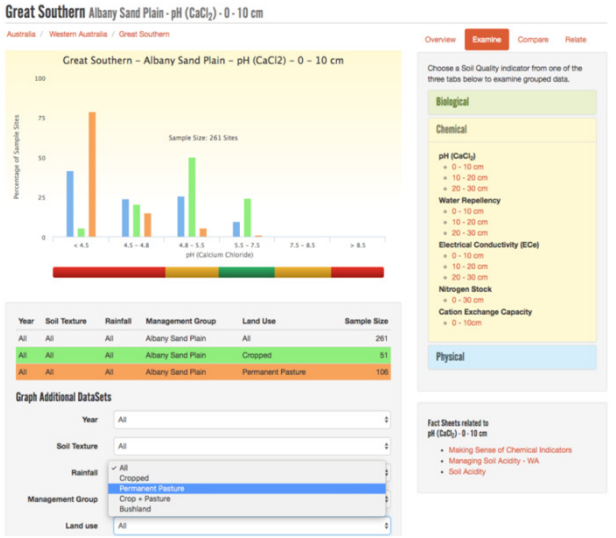
SRDP Farm Advisory Service
National Advice Hub
T: 0300 323 0161
E: advice@fas.scot
W: www.fas.scot

AHDB

- Two pronged approach
  - Actual field measurements and advice
  - Practical information and increased knowledge

Actual field measurements and advice





SAMPLE

DATABASE

BENCHMARKED SCORE

Practical information and increased knowledge

There is a lot out there, such as the 'Valuing your Soils' booklet....

Practical information and increased knowledge

- Collate information how the most common management options affect soil conditions:

- Biology +ve: worms, other organisms, biomass, activity, mycorrhiza, natural enemies
- Biology –ve: slugs, weeds, disease, soil pathgens
- Chemistry +ve: N, P, K, pH, CEC, SOM
- Chemistry –ve: leaching, denitrification, nutrient immobilisation, herbide use
- Physics – infiltration, structure, trafficability
- Yield

Practical information and increased knowledge

- Reduce this to a list relevant to farm operations

- Positive biology
- Slugs, weeds, disease, soil pathogens
- N, P, K, pH, CEC, SOM
- Nutrient loss, herbicide use
- Soil physics, trafficability

- Yield ??? (or margin)