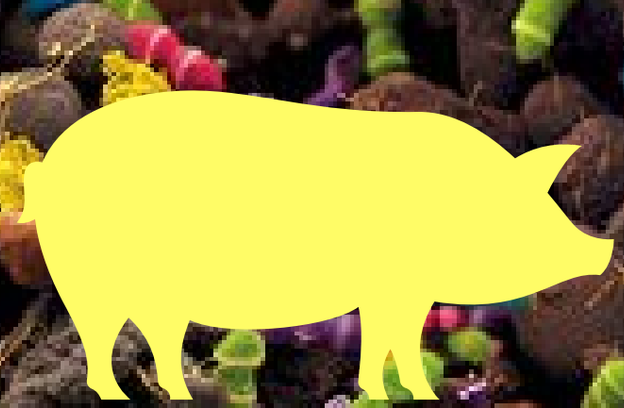
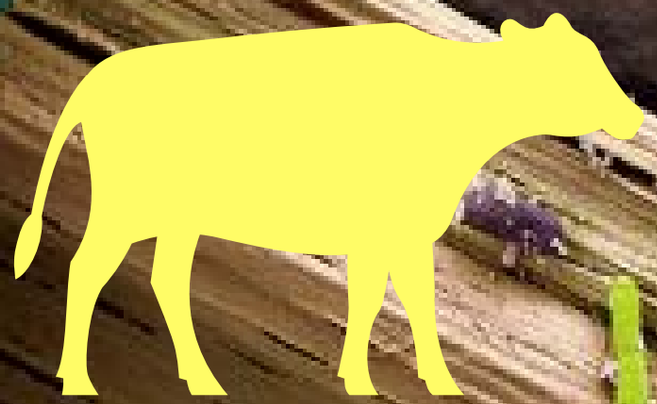
Microbial response to organic matter additions to soils:

What do we know & why do we care?

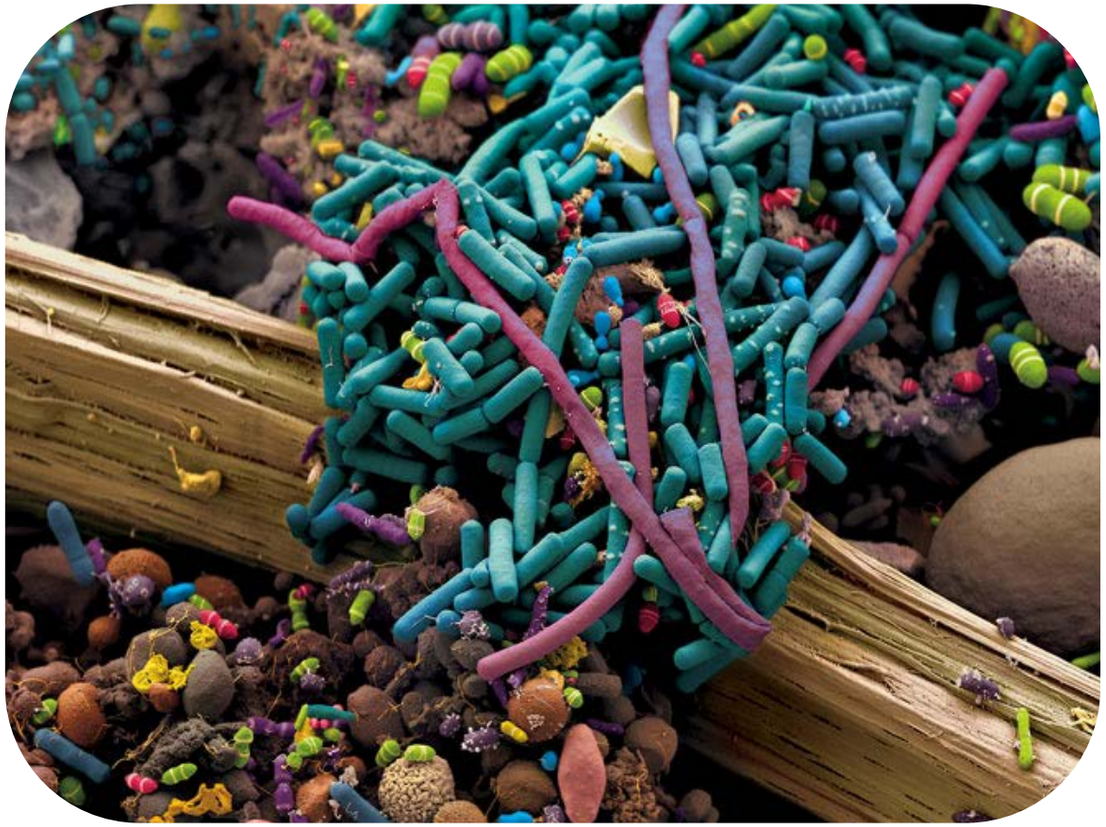
Thea Whitman - Department of Soil Science - UW-Madison
twhitman@wisc.edu; @theawhitman; whitmanlab.soils.wisc.edu

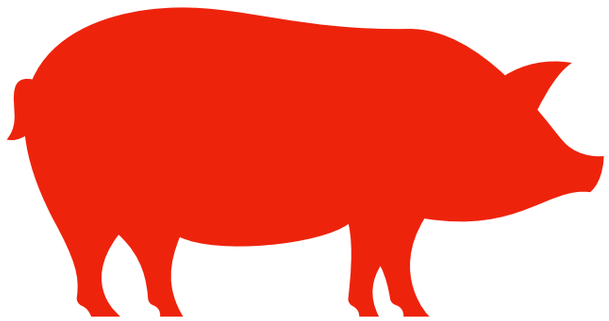


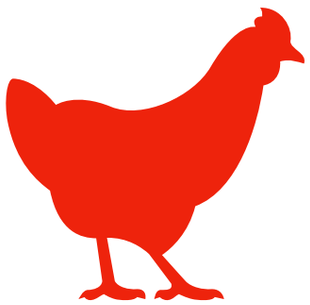


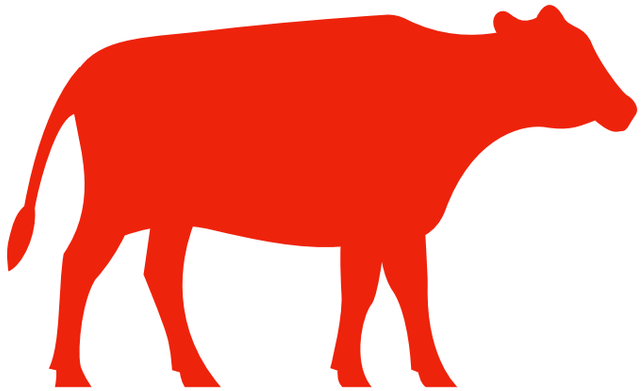
Microbial response to organic matter additions to soils

- Life in the soil - forms and functions
- Microbial diversity and soil functions
- Organic matter effects on soil microbes
- Managing microbes

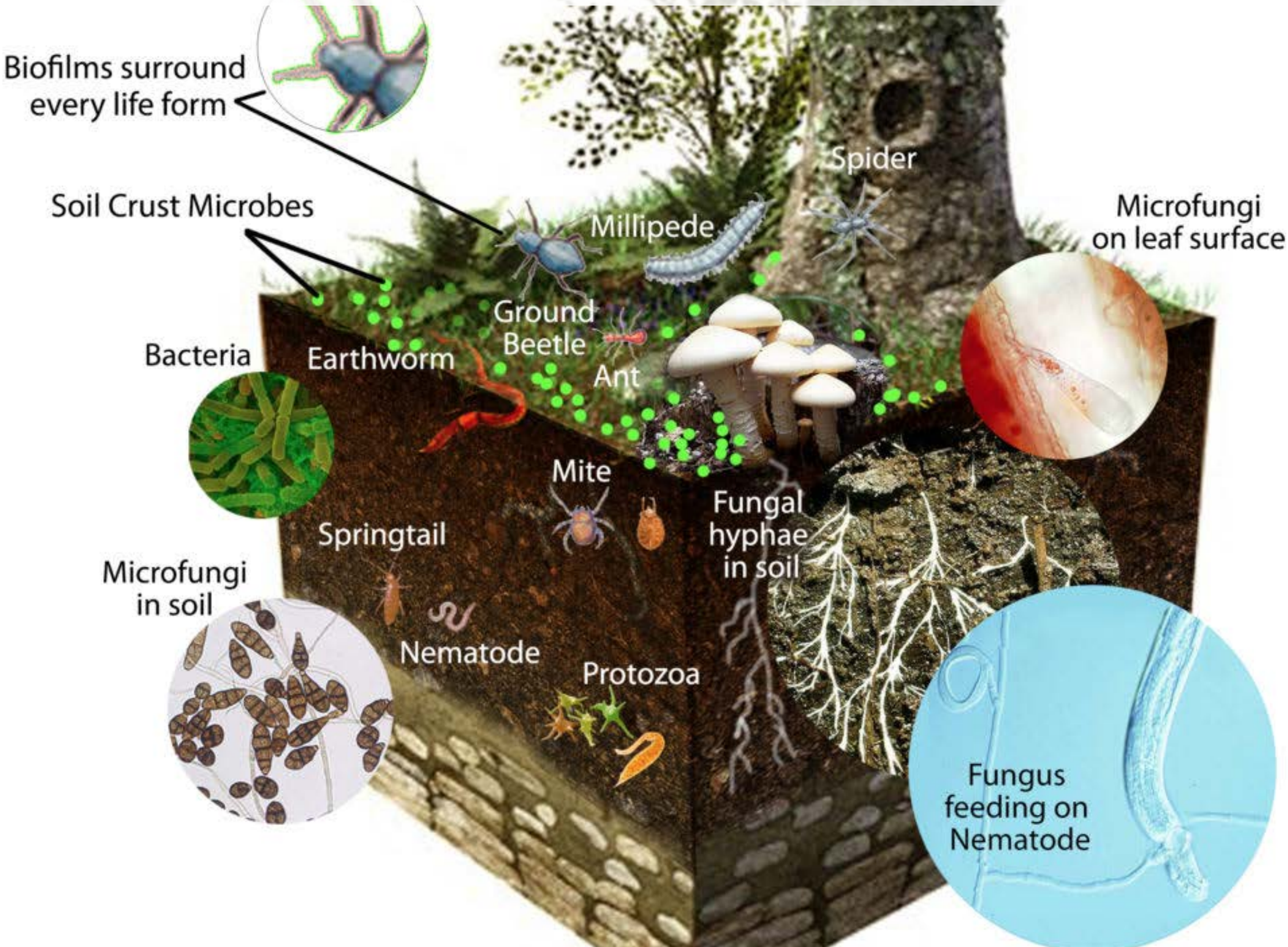






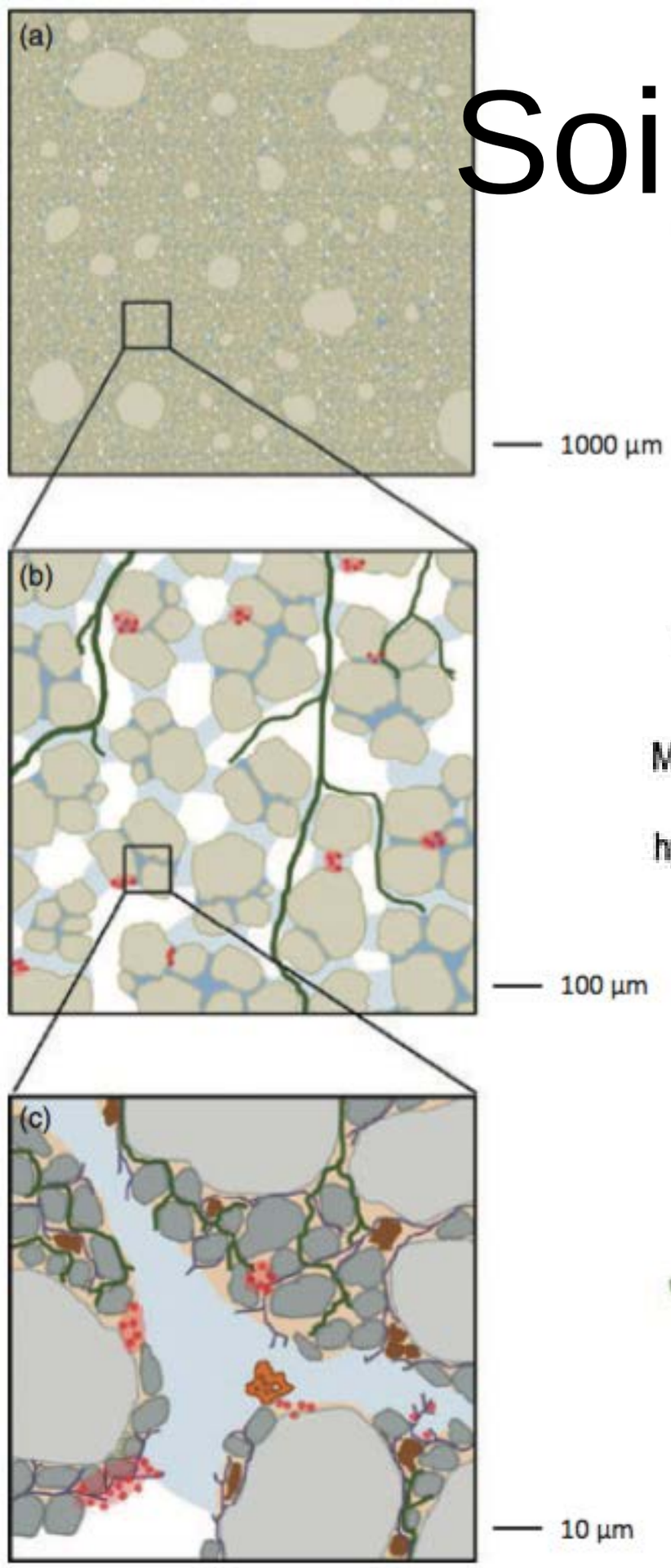


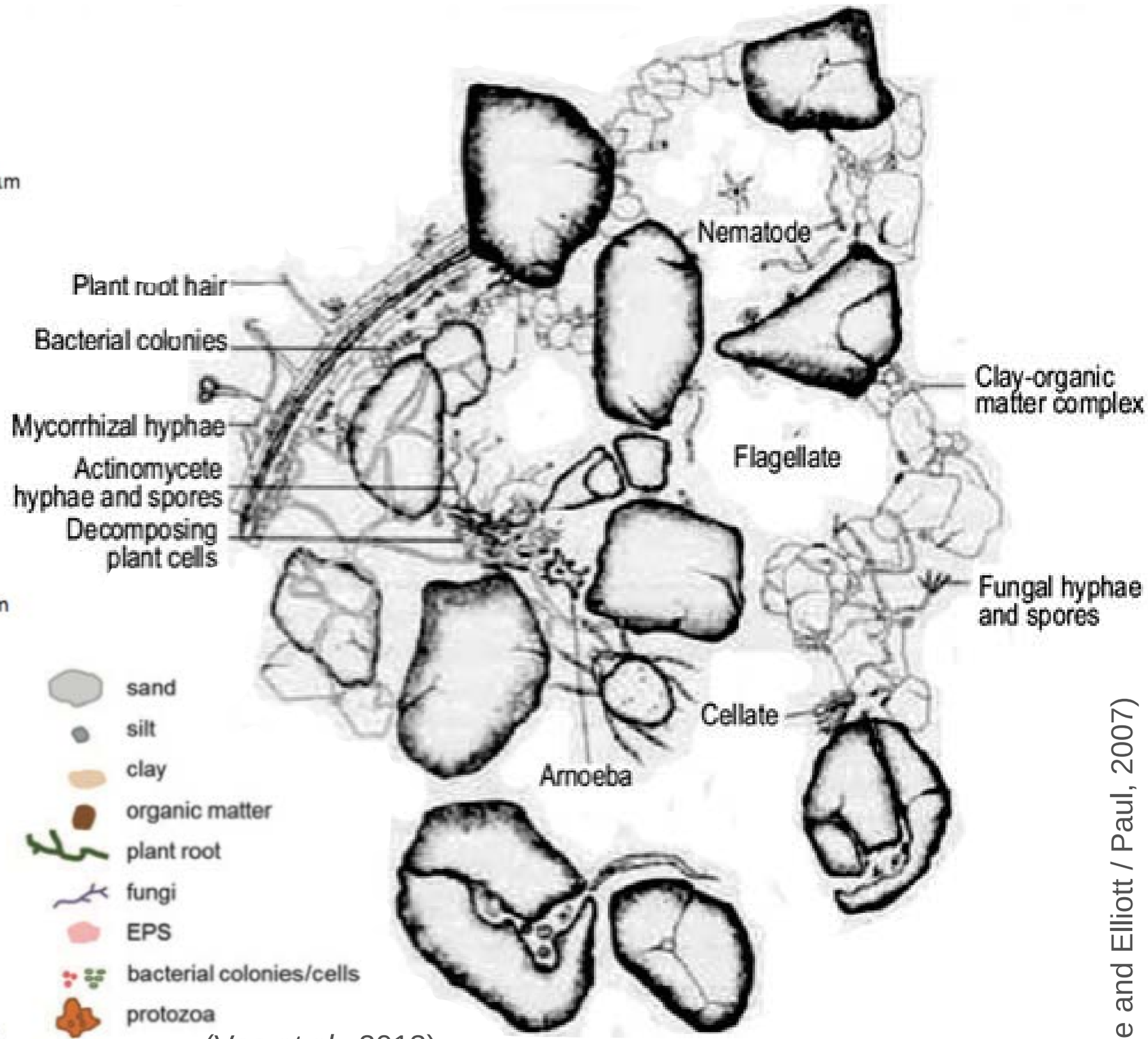
Soils are full of life



(endofite.com/soil-health)

Soils are full of life





(Vos *et al*., 2013)

(Rose and Elliott / Paul, 2007)

Soils are full of life

Soils are full of life

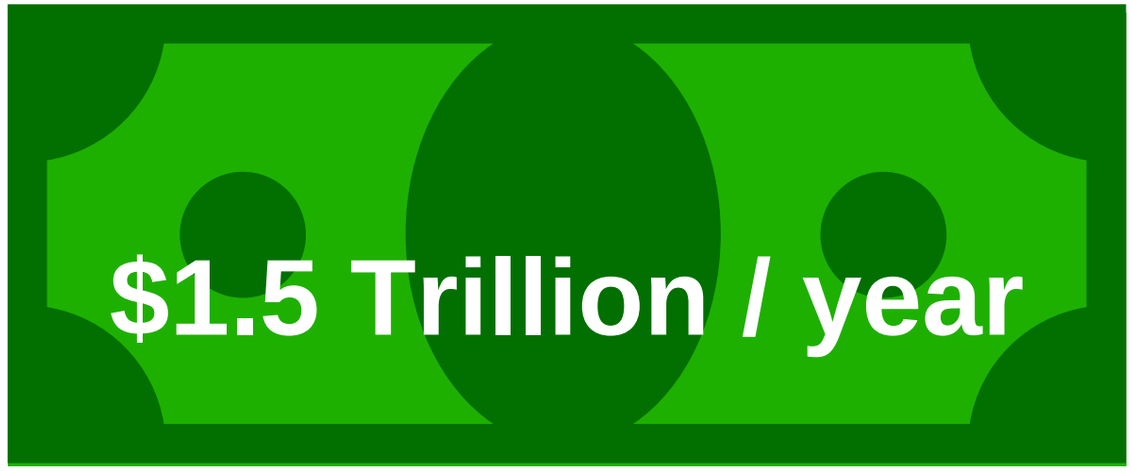
Soil organisms control key soil functions

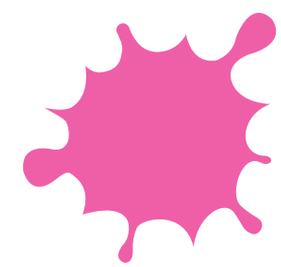
Nitrogen fixation

Pollination

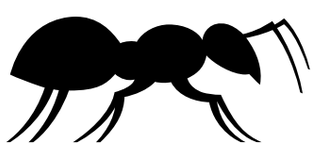
Soil formation

Wild products (food)





Bioremediation of chemical pollutants



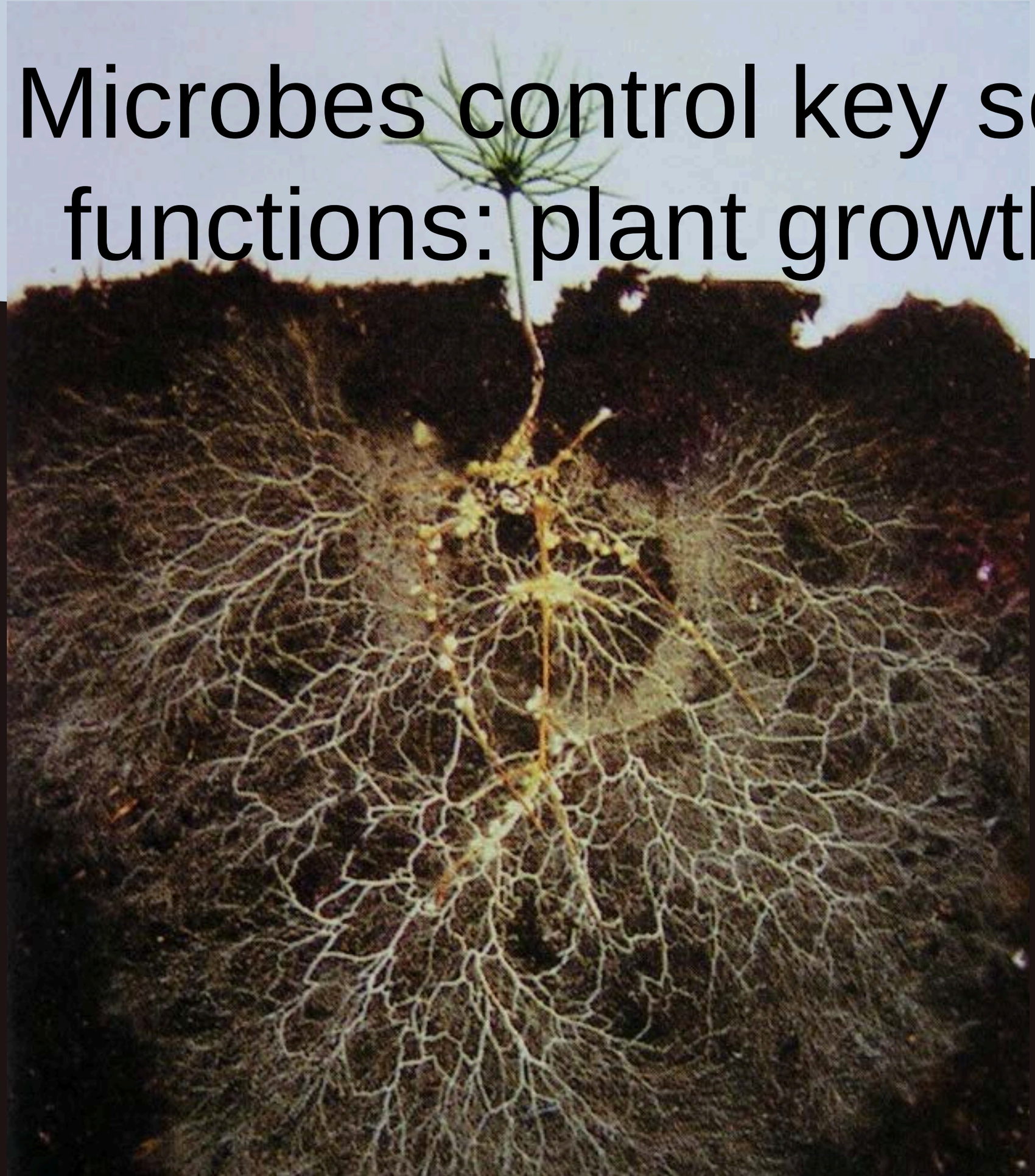
Biocontrol of pests

Industrial and pharmaceutical goods

Waste recycling

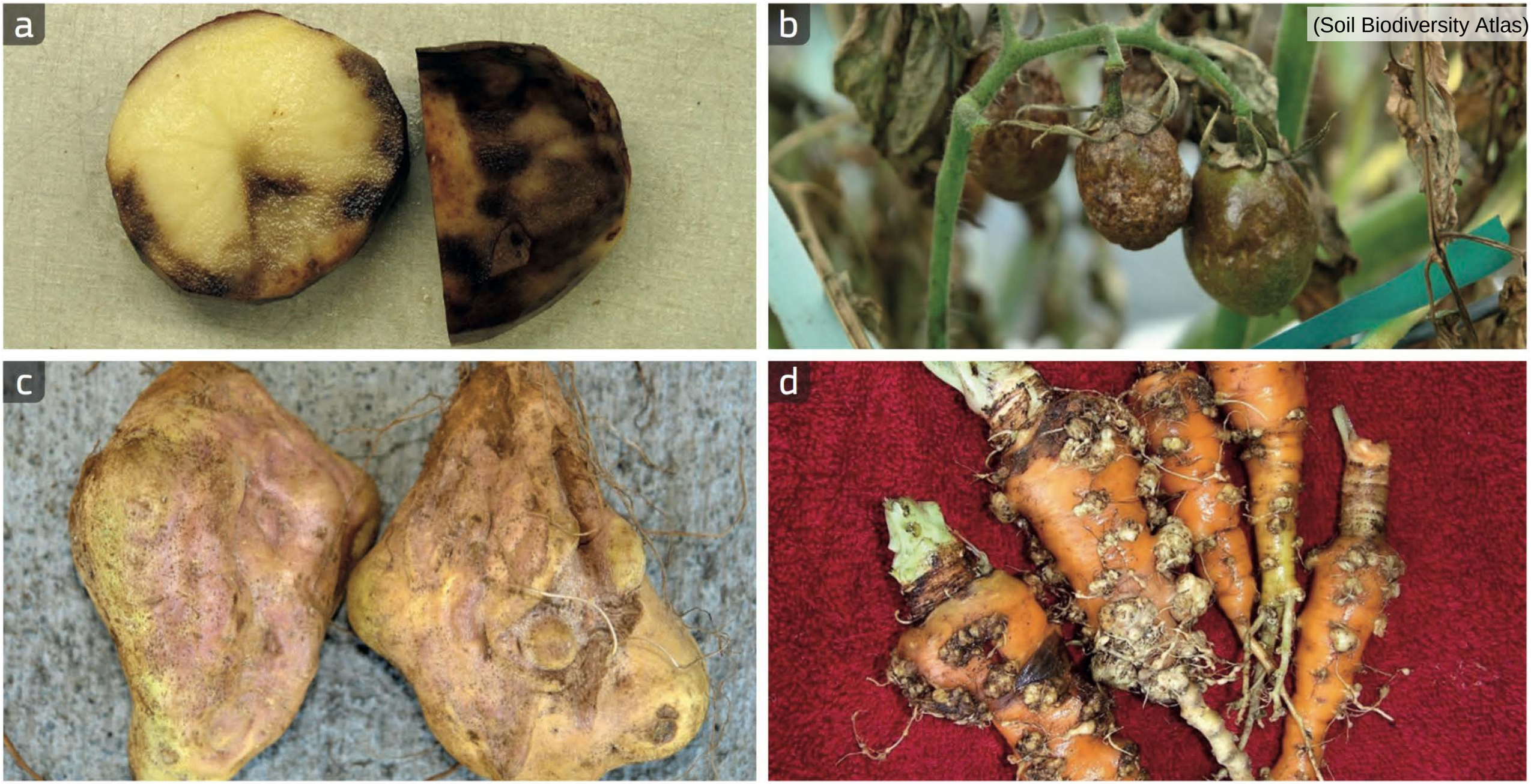
(Louise Jackson, UC Davis)

Microbes control key soil functions: plant growth



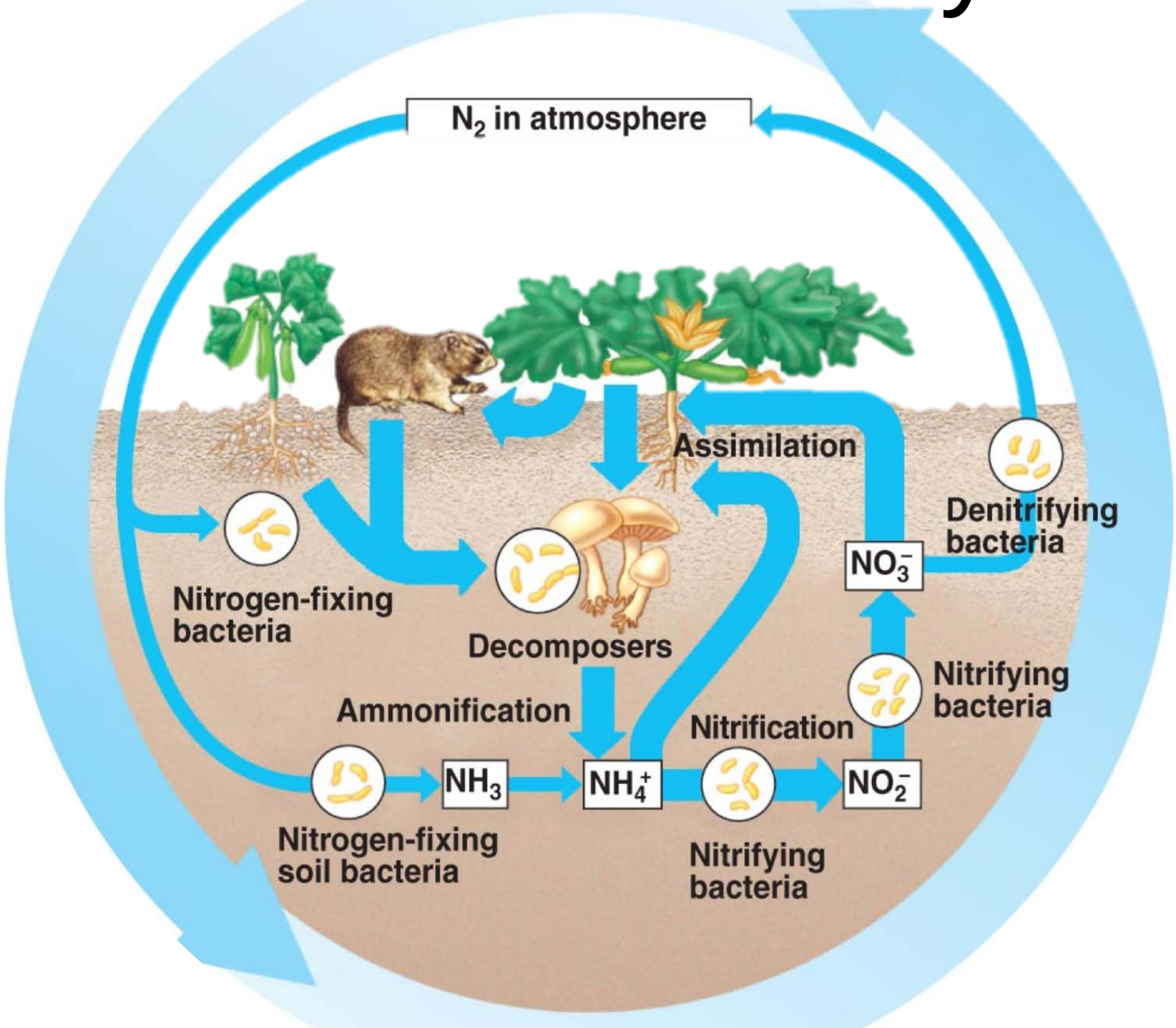
(David Read)

Microbes control key soil functions: plant growth

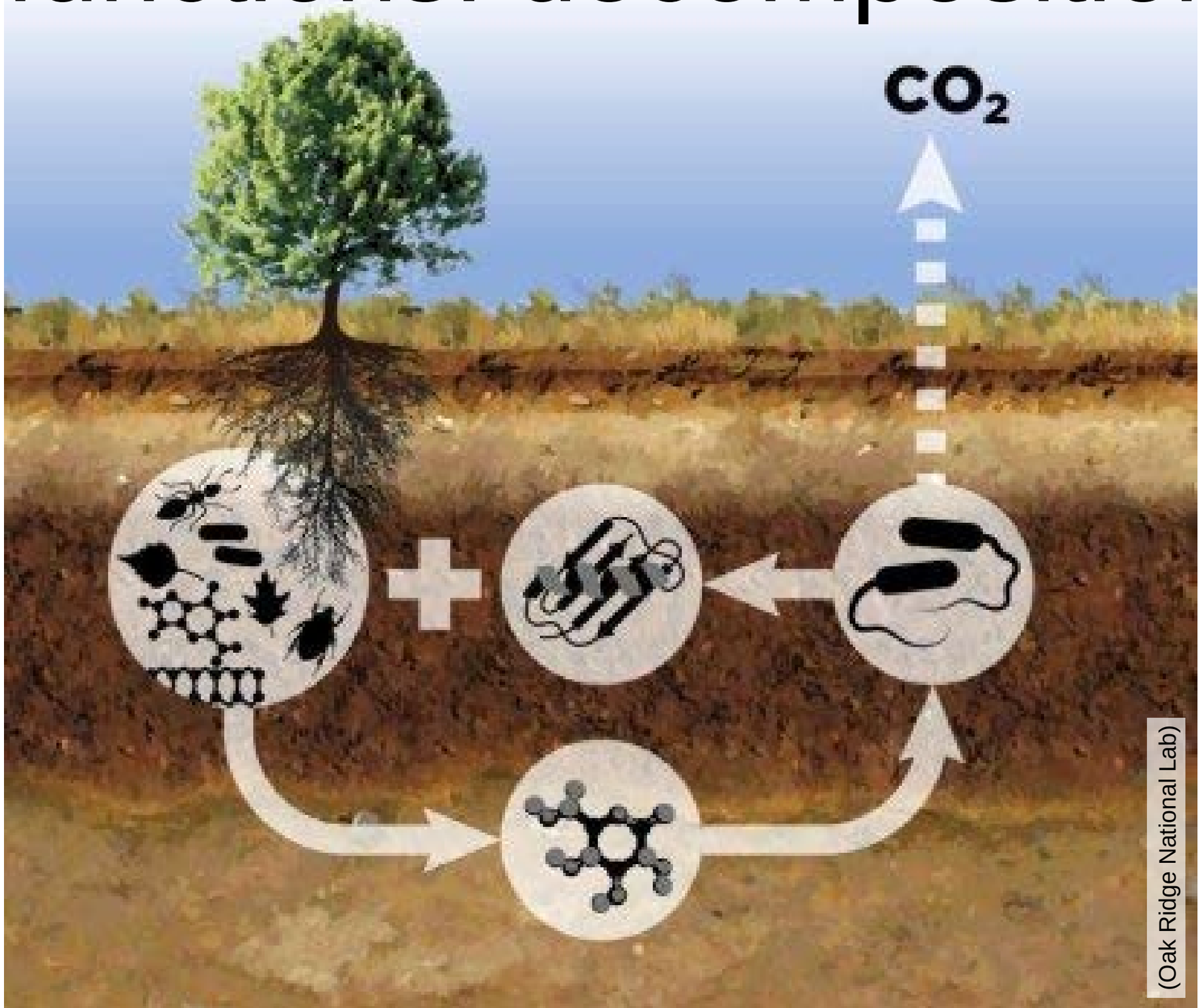


Some of the effects of plant pathogens that live in soil. (**a–b**) P*hyophthora infestans* responsible for the late blight on potatoes and tomatoes. (**c–d**) Sweet potatoes and carrots affected by nematodes of the genus *Meloidogyne* show deformations and outgrowths called root-knots. (BMI, SCN, AKK)

Microbes control key soil functions: nutrient cycling



Microbes control key soil functions: decomposition



(Oak Ridge National Lab)

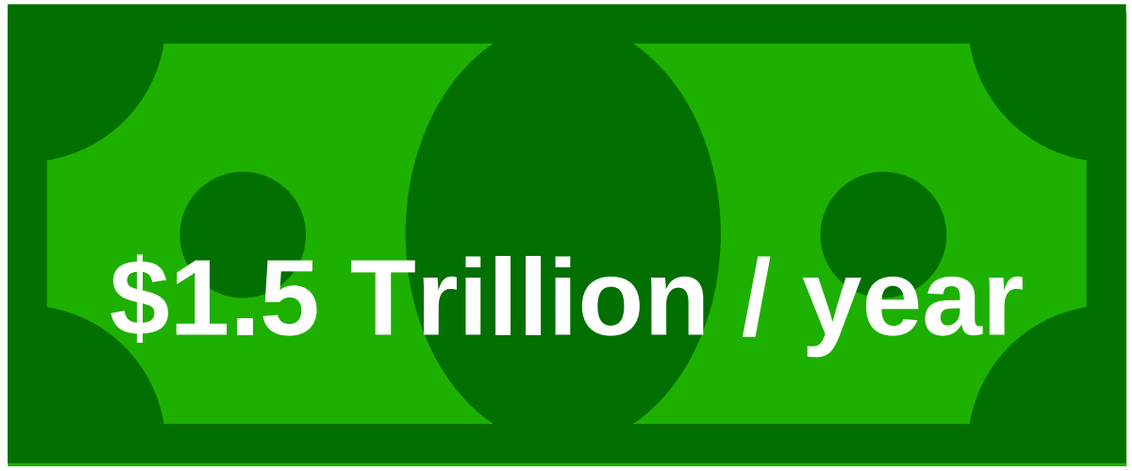
Soil organisms control key soil functions

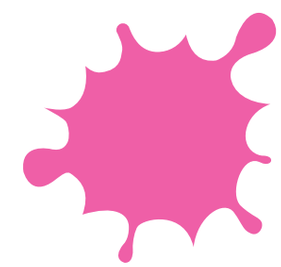
Nitrogen fixation

Pollination

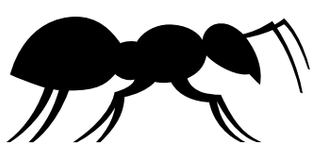
Soil formation

Wild products (food)





Bioremediation of chemical pollutants



Biocontrol of pests

Industrial and pharmaceutical goods

Waste recycling

(Louise Jackson, UC Davis)

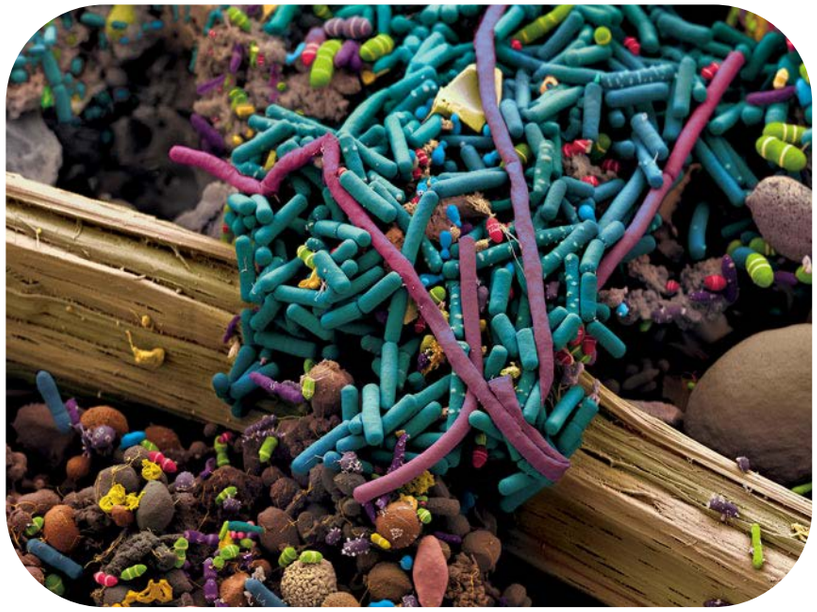
Does microbial diversity affect soil functions?

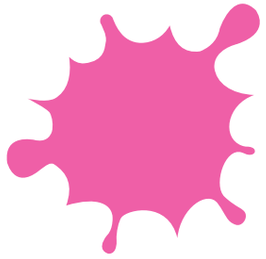
Nitrogen fixation

Pollination

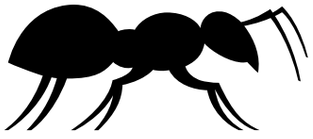
Soil formation

Wild products (food)





Bioremediation of chemical pollutants

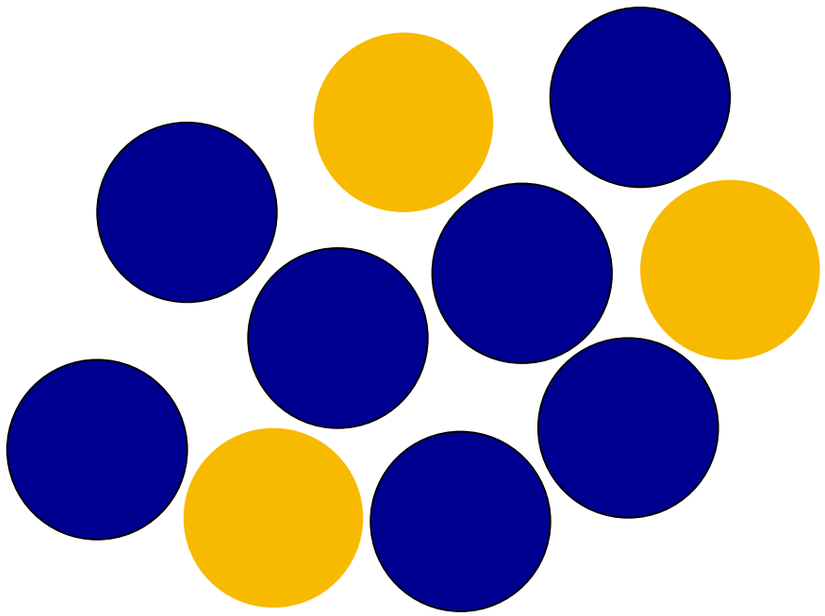


Biocontrol of pests

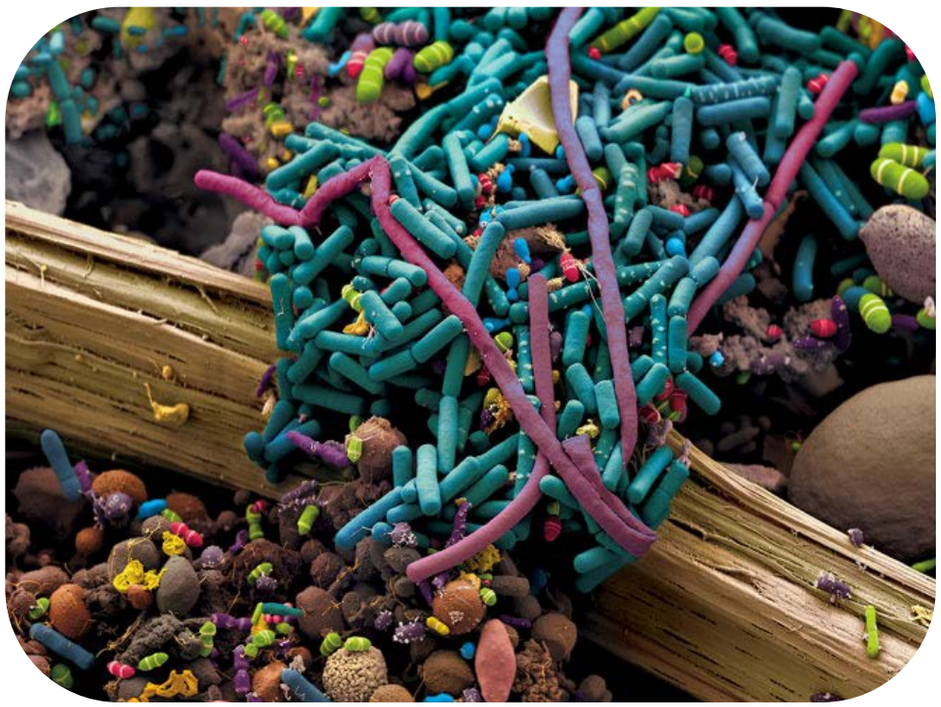
Industrial and pharmaceutical goods

Waste recycling

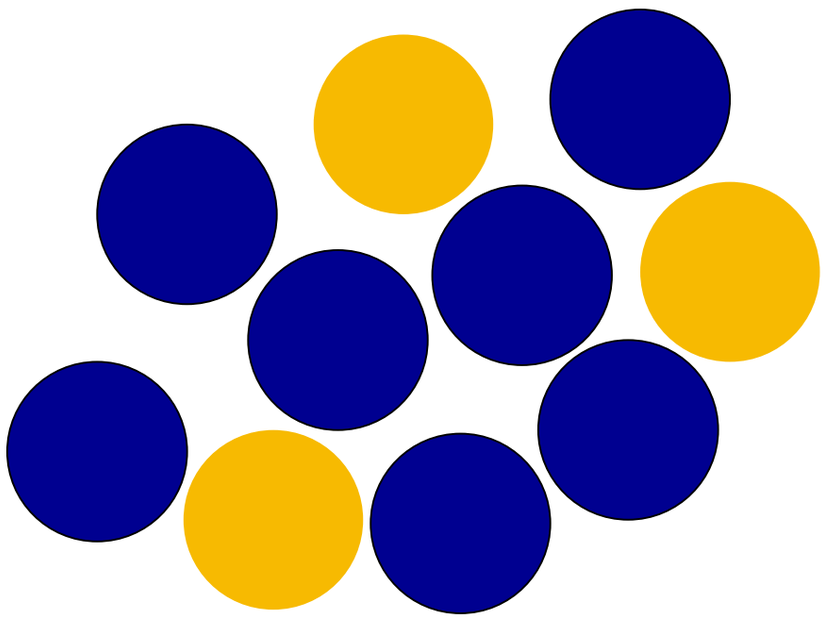
Quantifying diversity



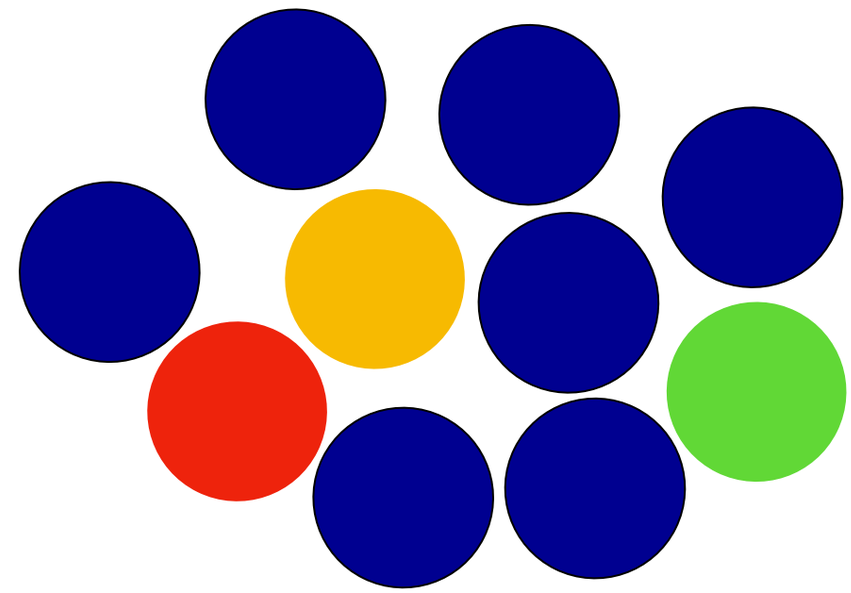
Baseline



Quantifying diversity

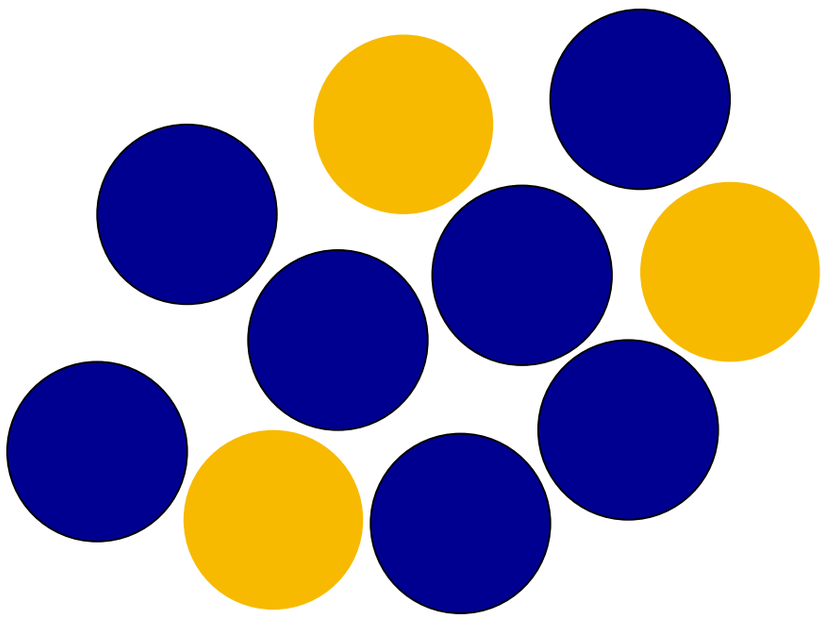


Baseline

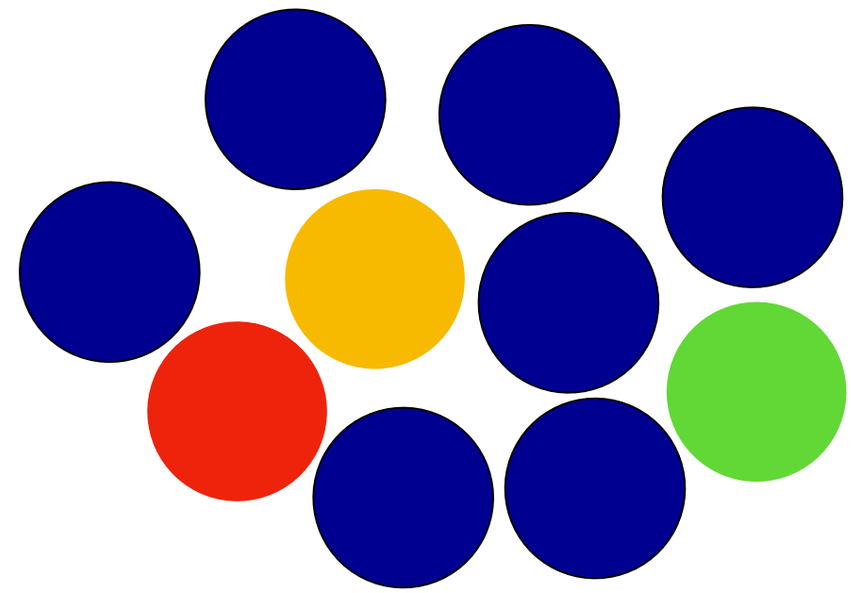


More rich (more species)

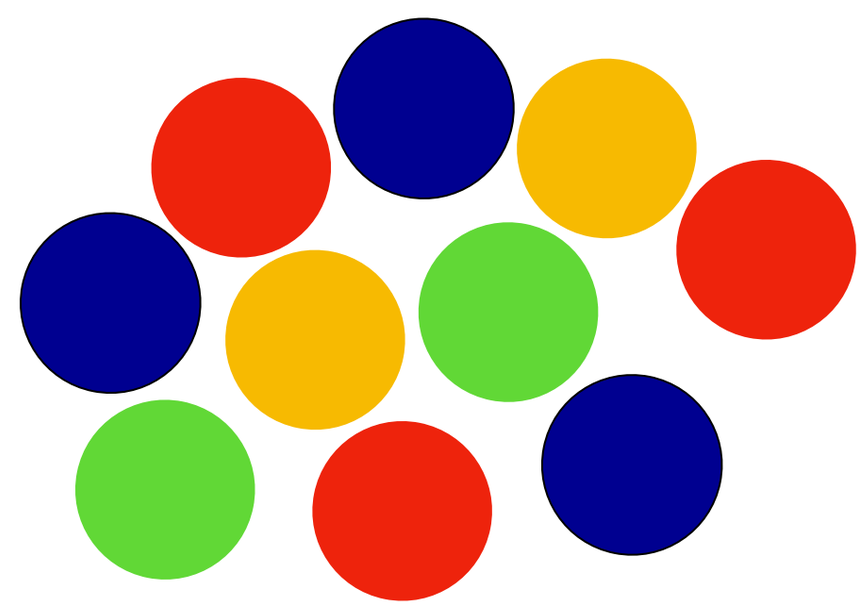
Quantifying diversity



Baseline



More rich (more species)



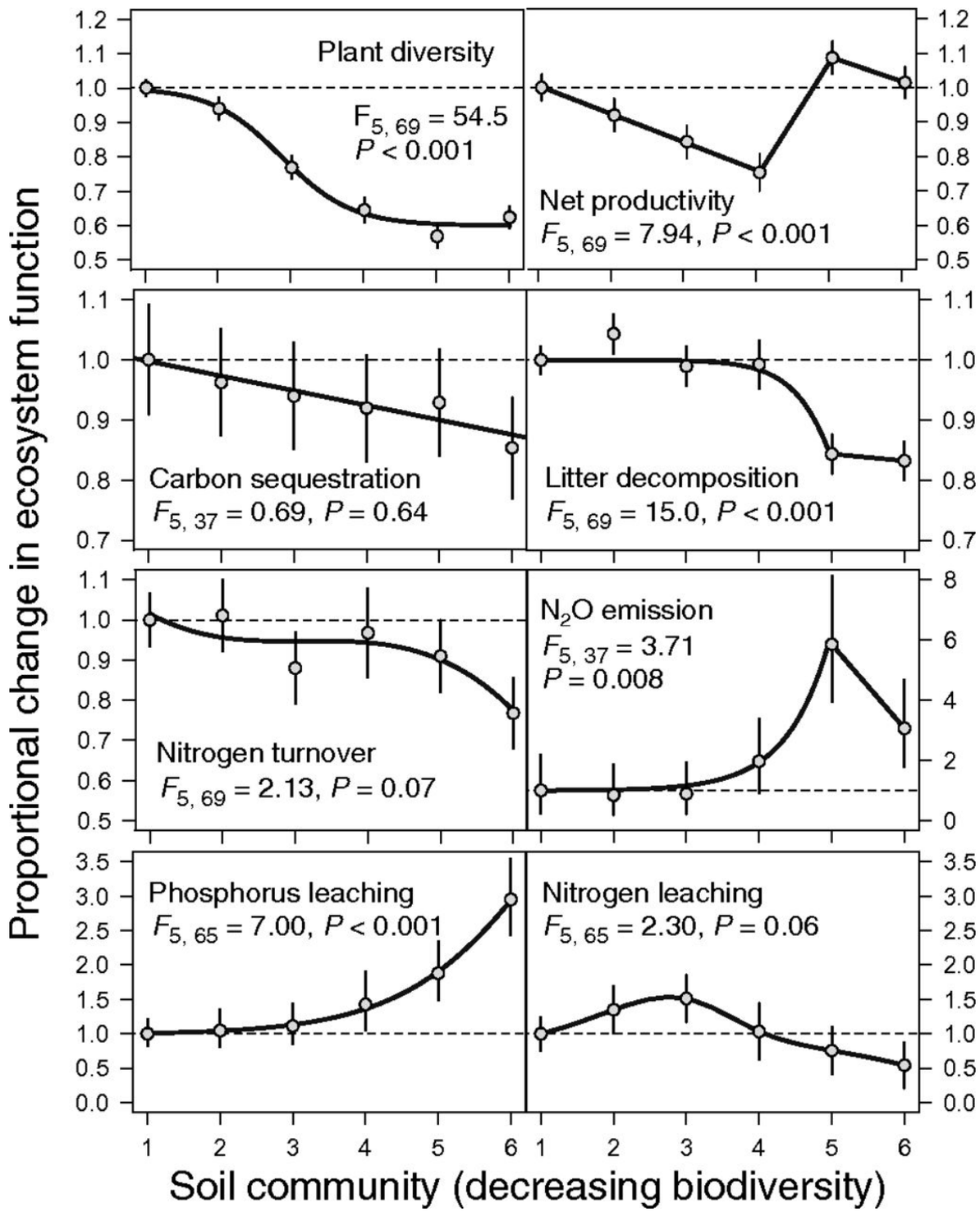
More even

Does microbial diversity affect soil functions?

Soil is by far the most biologically diverse part of the Earth. Soil biodiversity reflects the mix of living organisms in the soil. These organisms interact with one another and with plants and small animals, forming a web of biological activity. The soil food web includes earthworms, spiders, arts, beetles, collembolans, mites, nematodes, fungi, bacteria and other organisms. (VG, SA, EDM, CHB, MH, MKKH, MBE, CA/KC, LT)

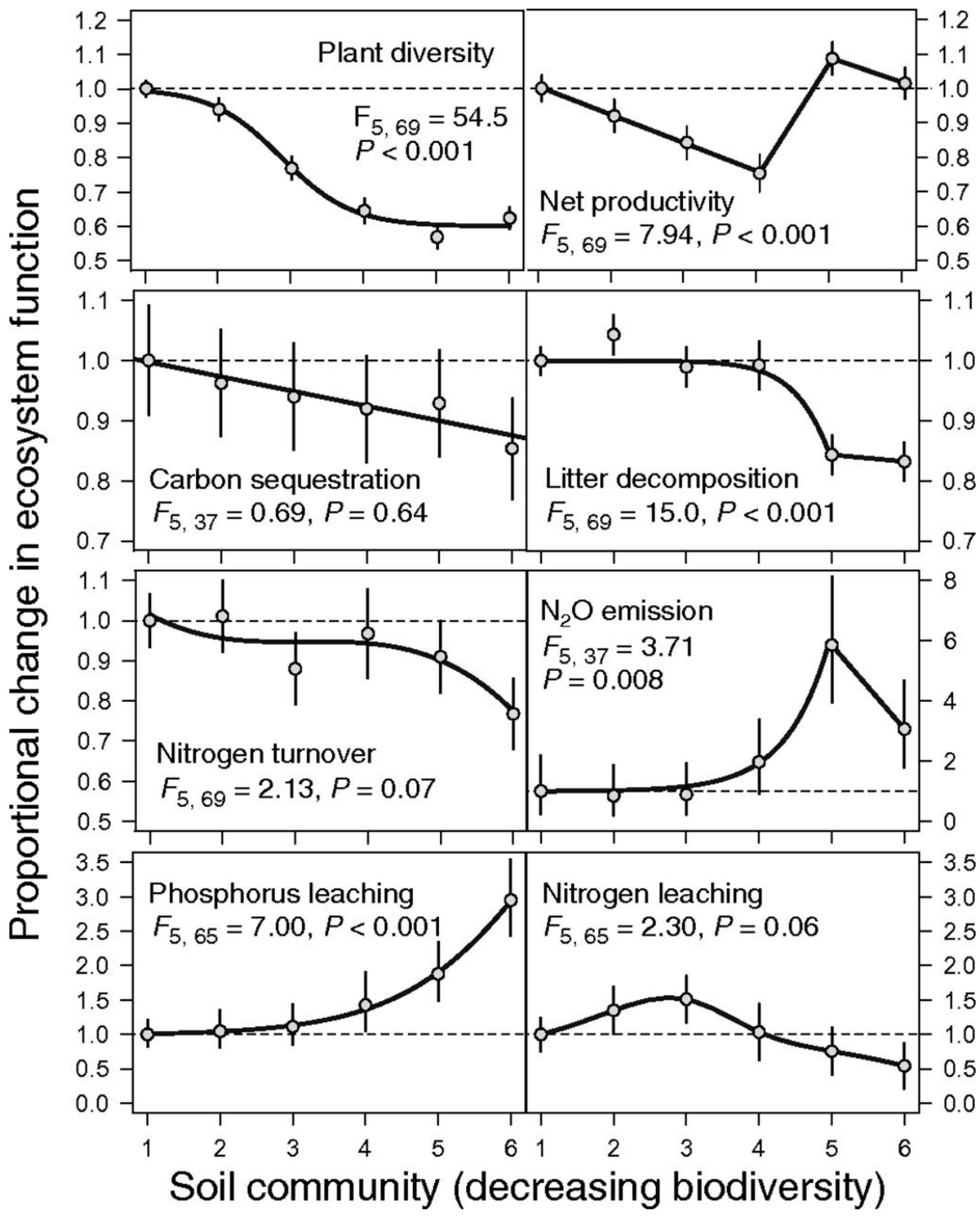
(Wagg et al., 2013)

Does microbial diversity affect soil functions?



(Wagg et al., 2013)

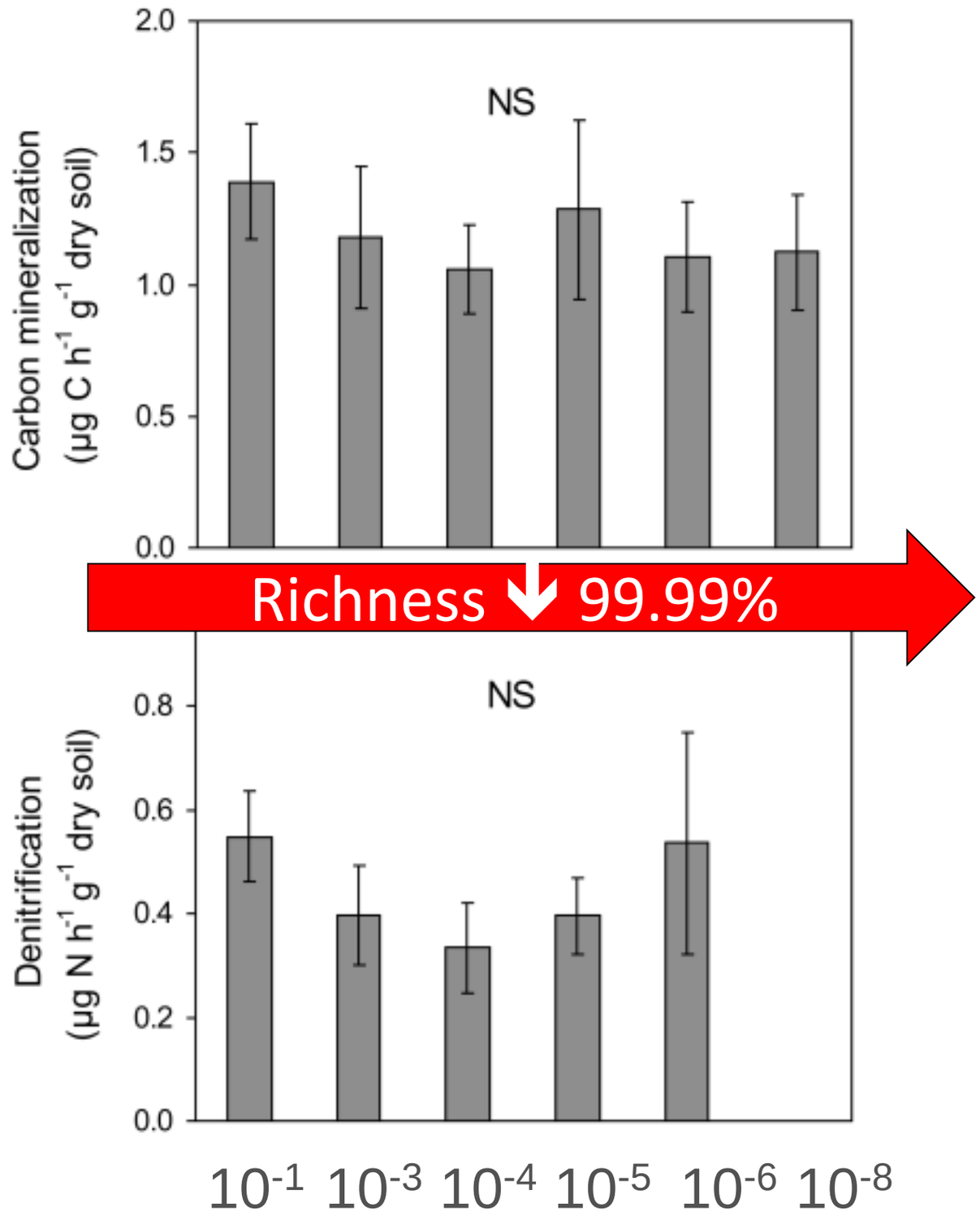
Does microbial diversity affect soil functions?



Elimination of entire groups of microfauna affects numerous functions

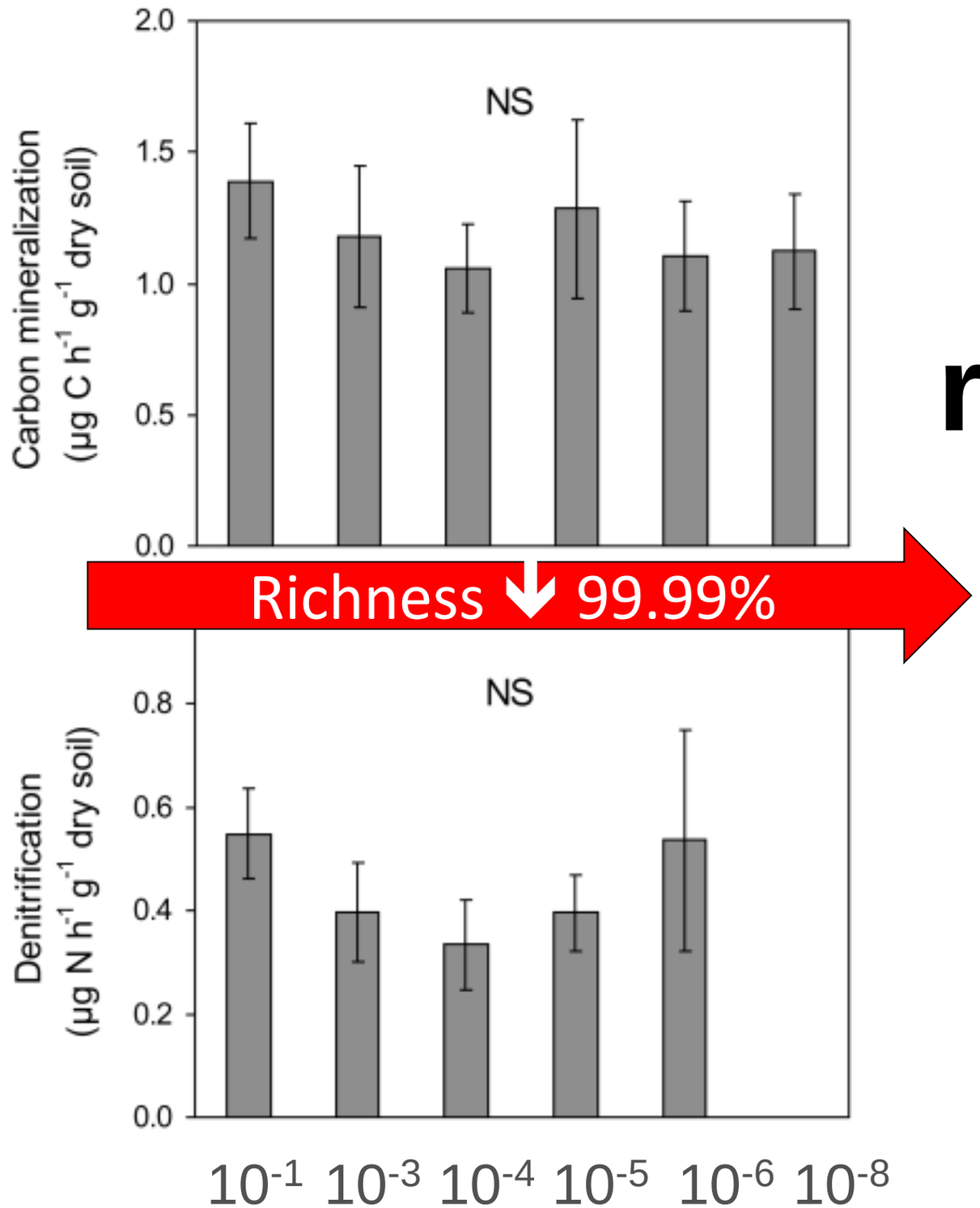
(Wagg et al., 2013)

Does microbial diversity affect soil functions?



(Wertz et al., 2006)

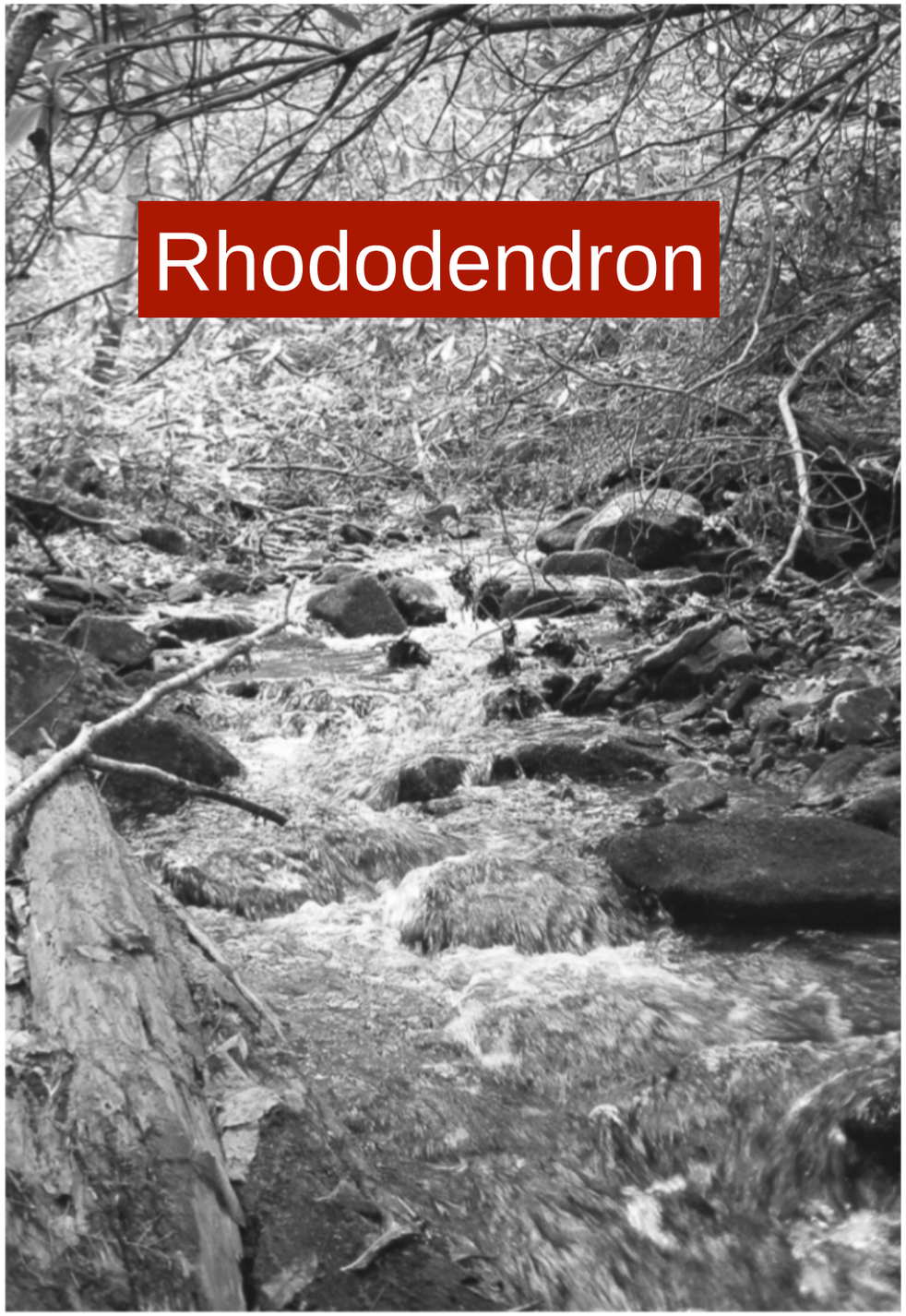
Does microbial diversity affect soil functions?



“Functional redundancy”

(Wertz et al., 2006)

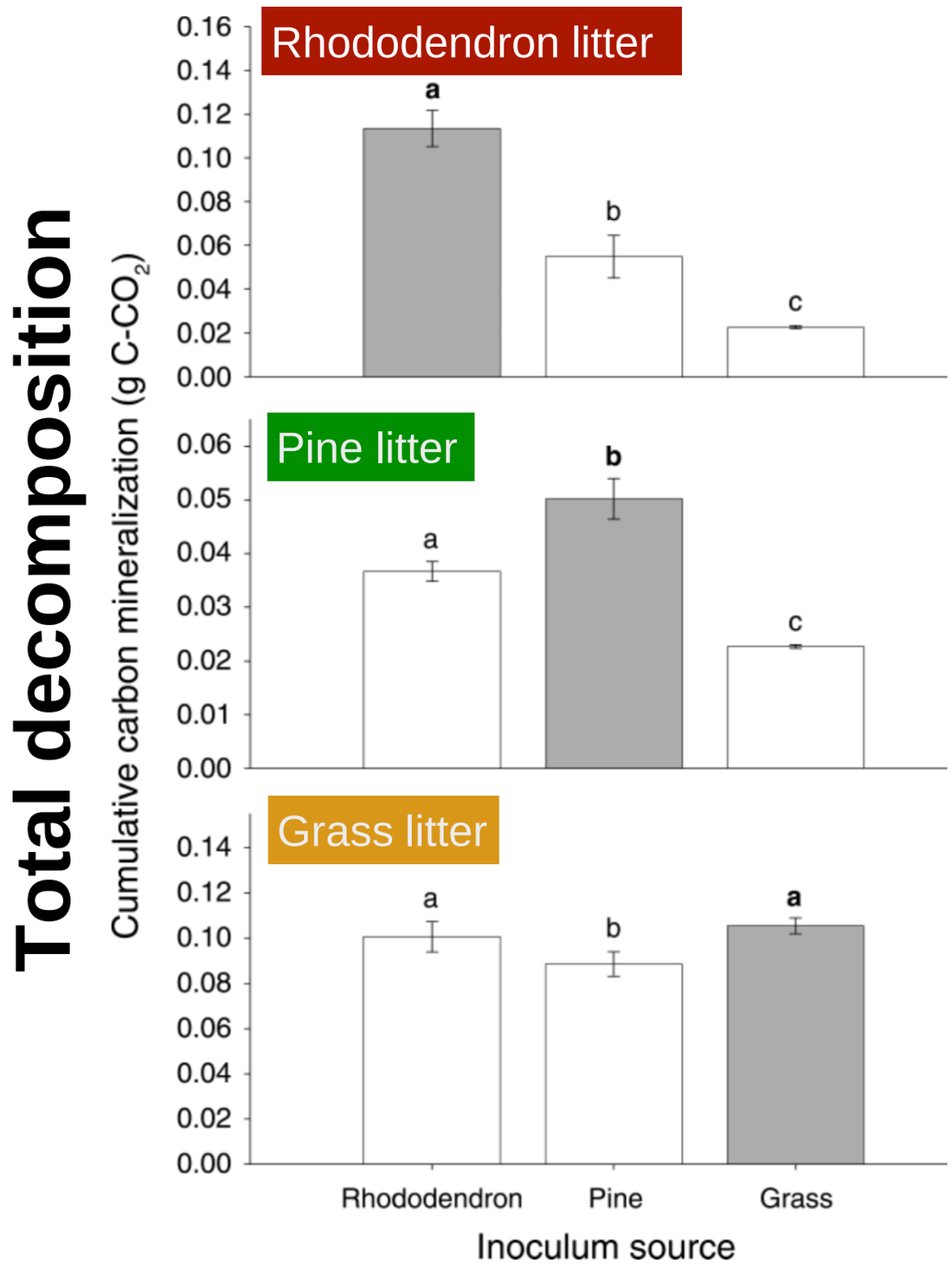
Community composition matters for decomposition



Exchanged microbes and plant materials from each environment

(Strickland et al., 2009)

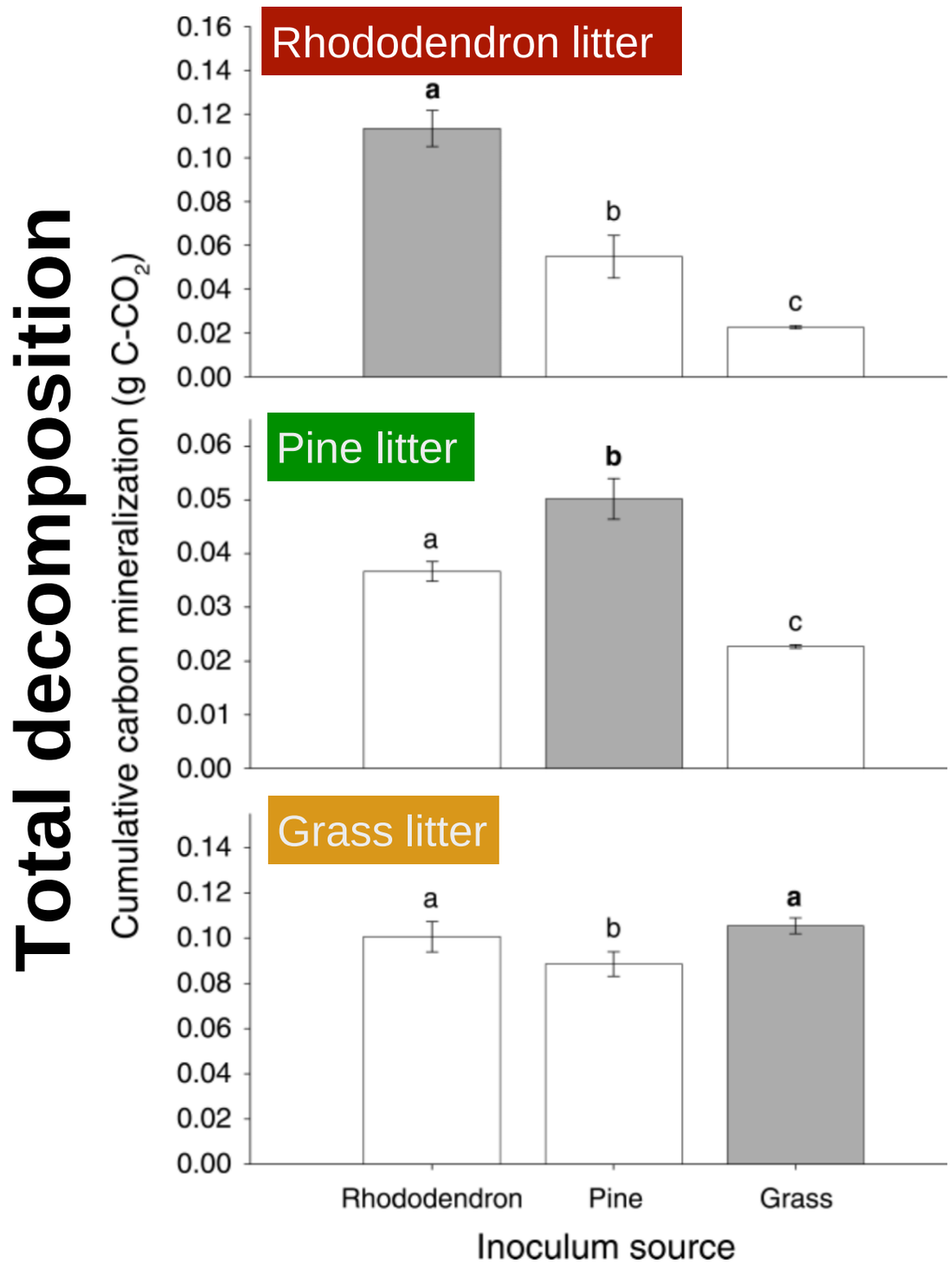
Community composition matters for decomposition



Does community composition affect organic matter decomposition?

(Strickland et al., 2009)

Community composition matters for decomposition

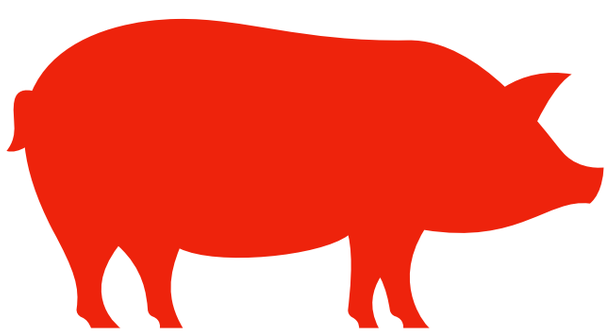


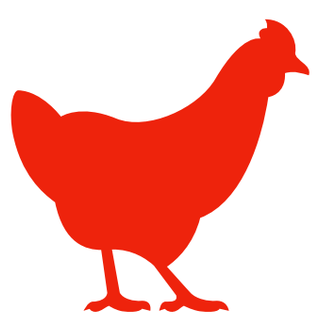
“Home field advantage”: Microbes are best at decomposing organic matter from their own environment

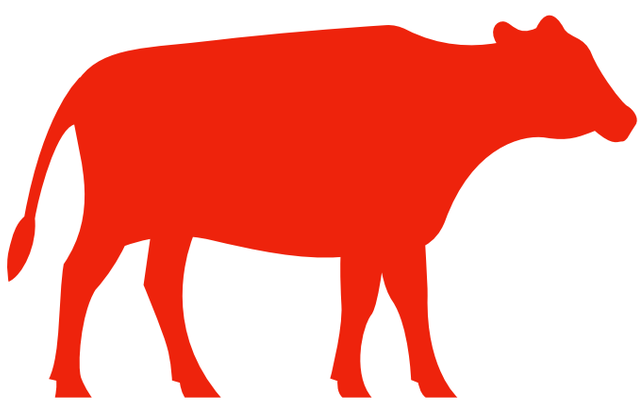
(Strickland et al., 2009)

Microbial response to organic matter additions: manure

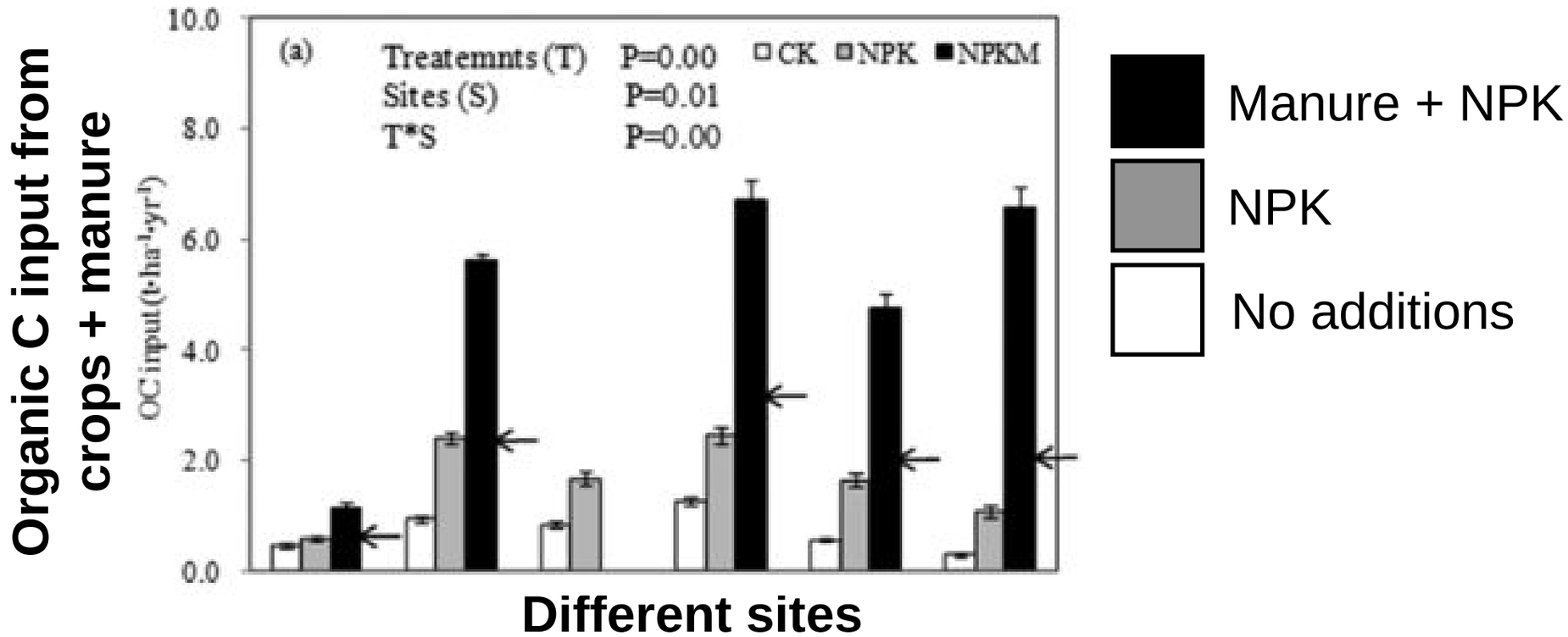
Manure increases soil organic matter

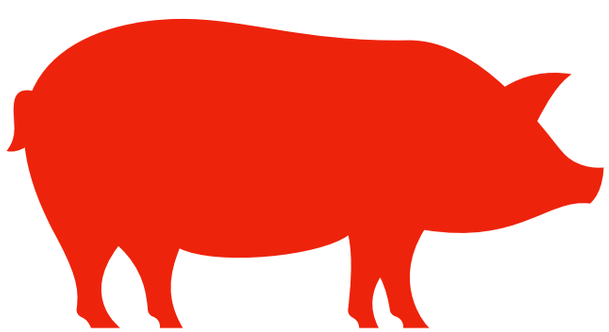


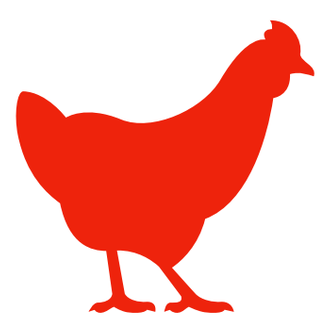


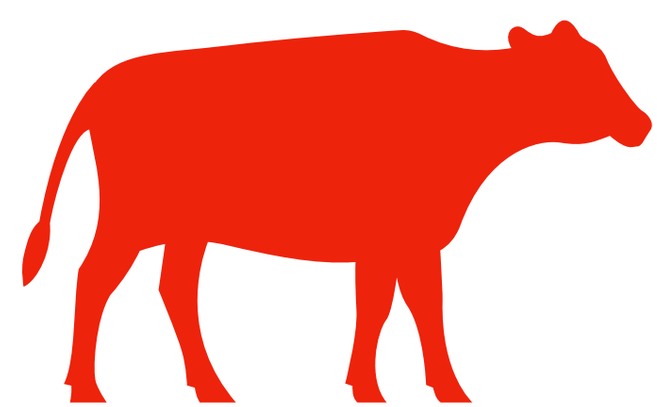


Microbial response to organic matter additions: manure



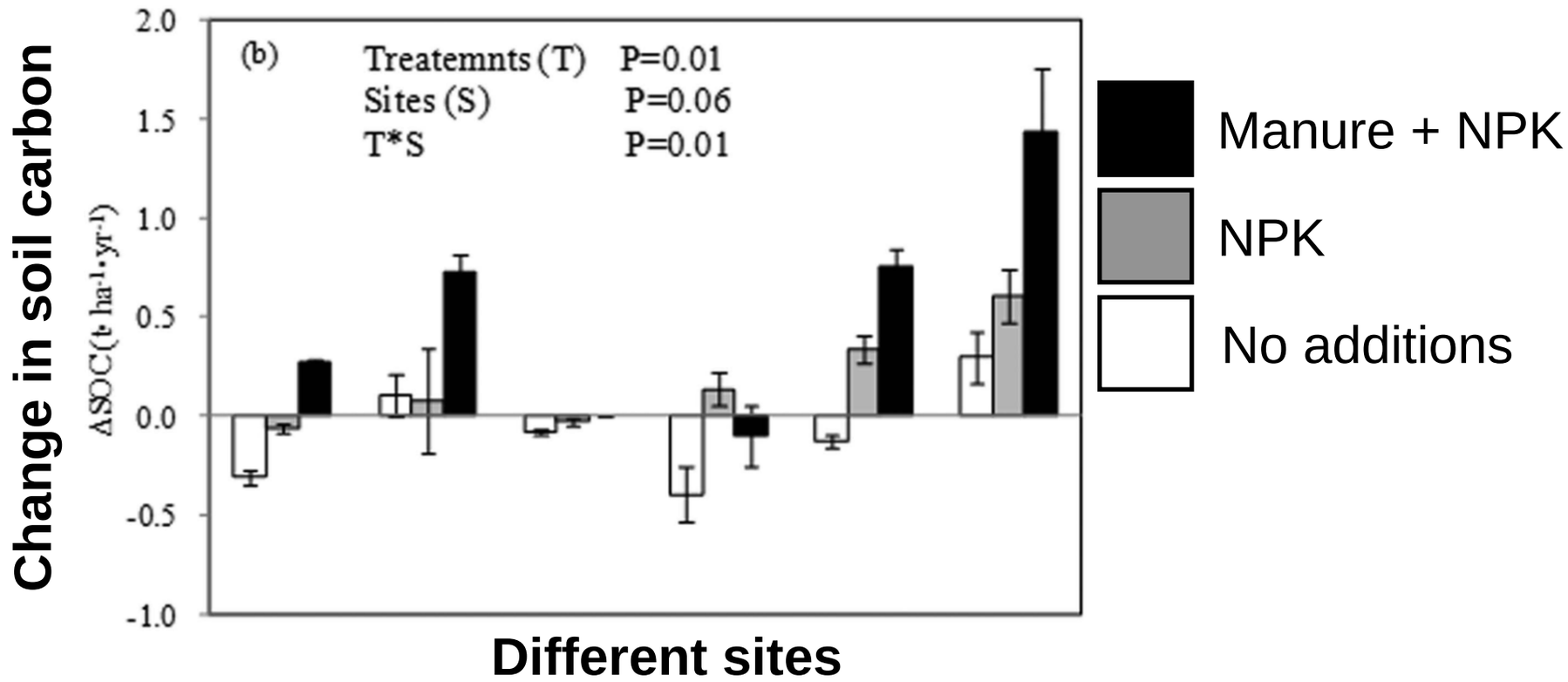


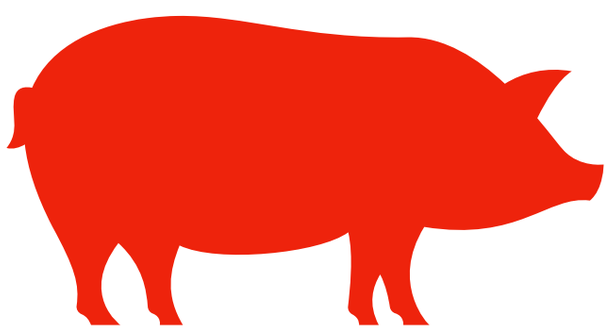


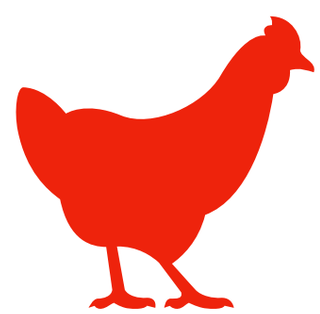


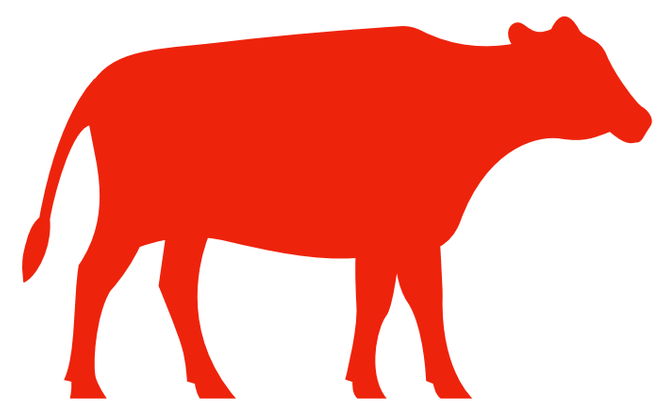
(Liang et al., 2016)

Microbial response to organic matter additions: manure









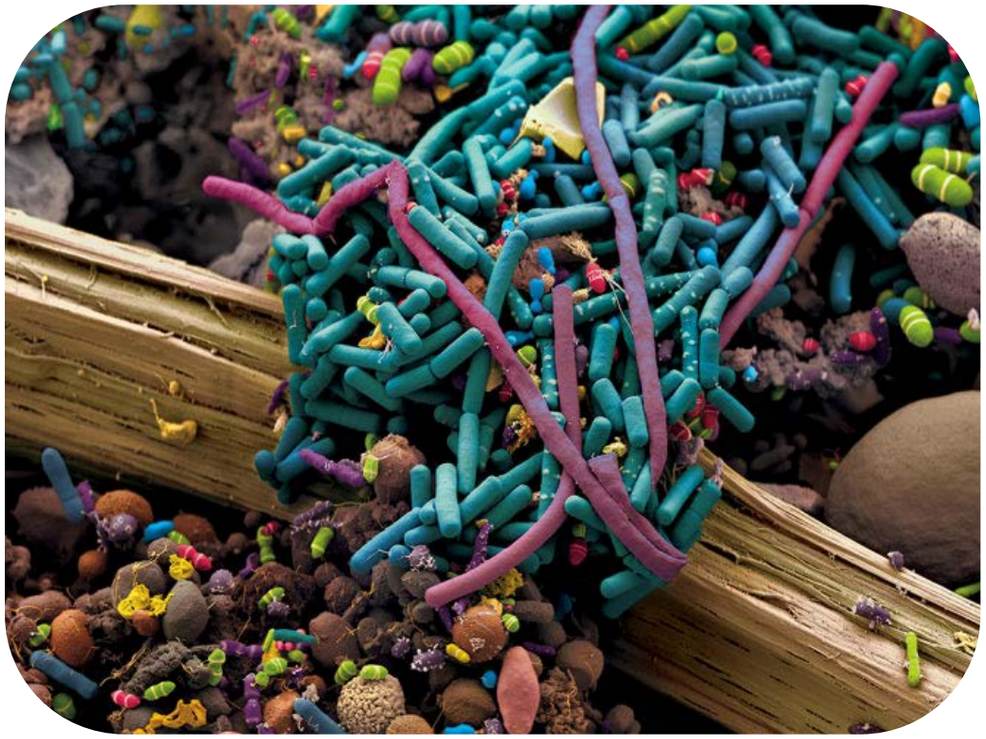
(Liang et al., 2016)

Microbial response to organic matter additions: manure

- **Organic matter…**
  - Is a key source of **nutrients** (esp. N, P, and S)
  - **Adsorbs** pesticides and other toxic substances
  - Affects **greenhouse gases**
  - Helps create soil **structure**

Microbial response to organic matter additions: manure

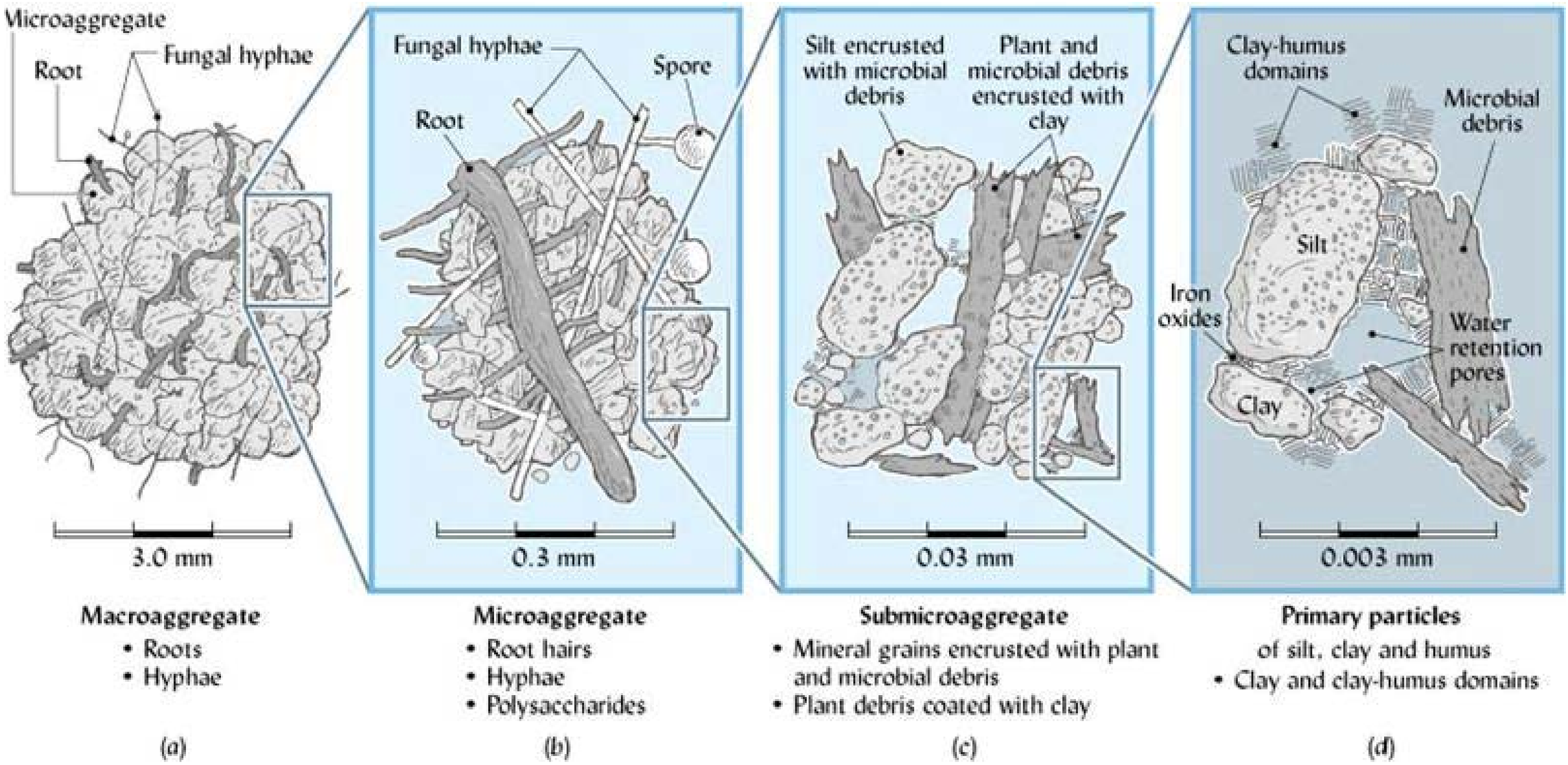
- **Organic matter…**
  - Is a key source of **nutrients** (esp. N, P, and S)
  - **Adsorbs** pesticides and other toxic substances
  - Affects **greenhouse gases**
  - Helps create soil **structure**



Microbial response to organic matter additions: manure

Organic matter inputs often stimulate soil microbial activity

Microbial response to organic matter additions: manure

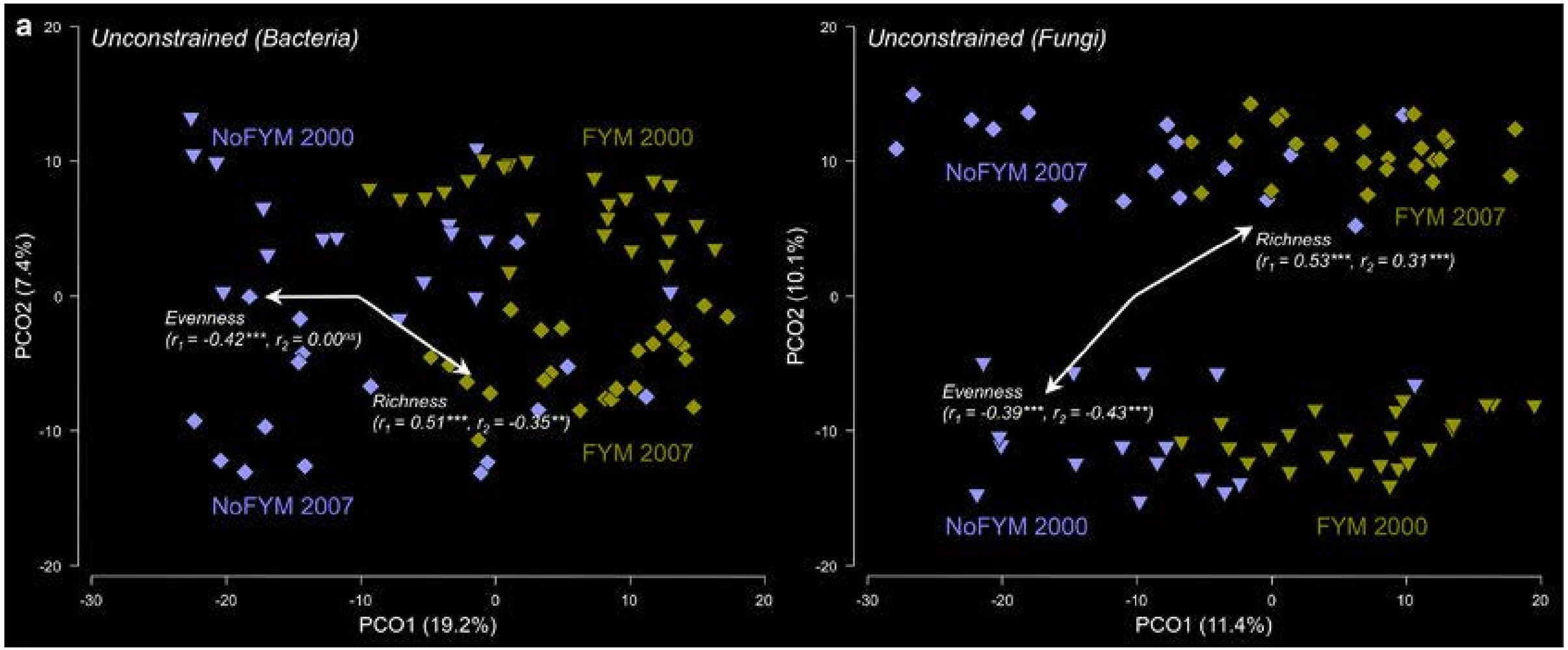


(Brady and Weil)

Microbial response to organic matter additions: manure

Manure or organic matter inputs often shift soil microbial communities

Microbial response to organic matter additions: manure

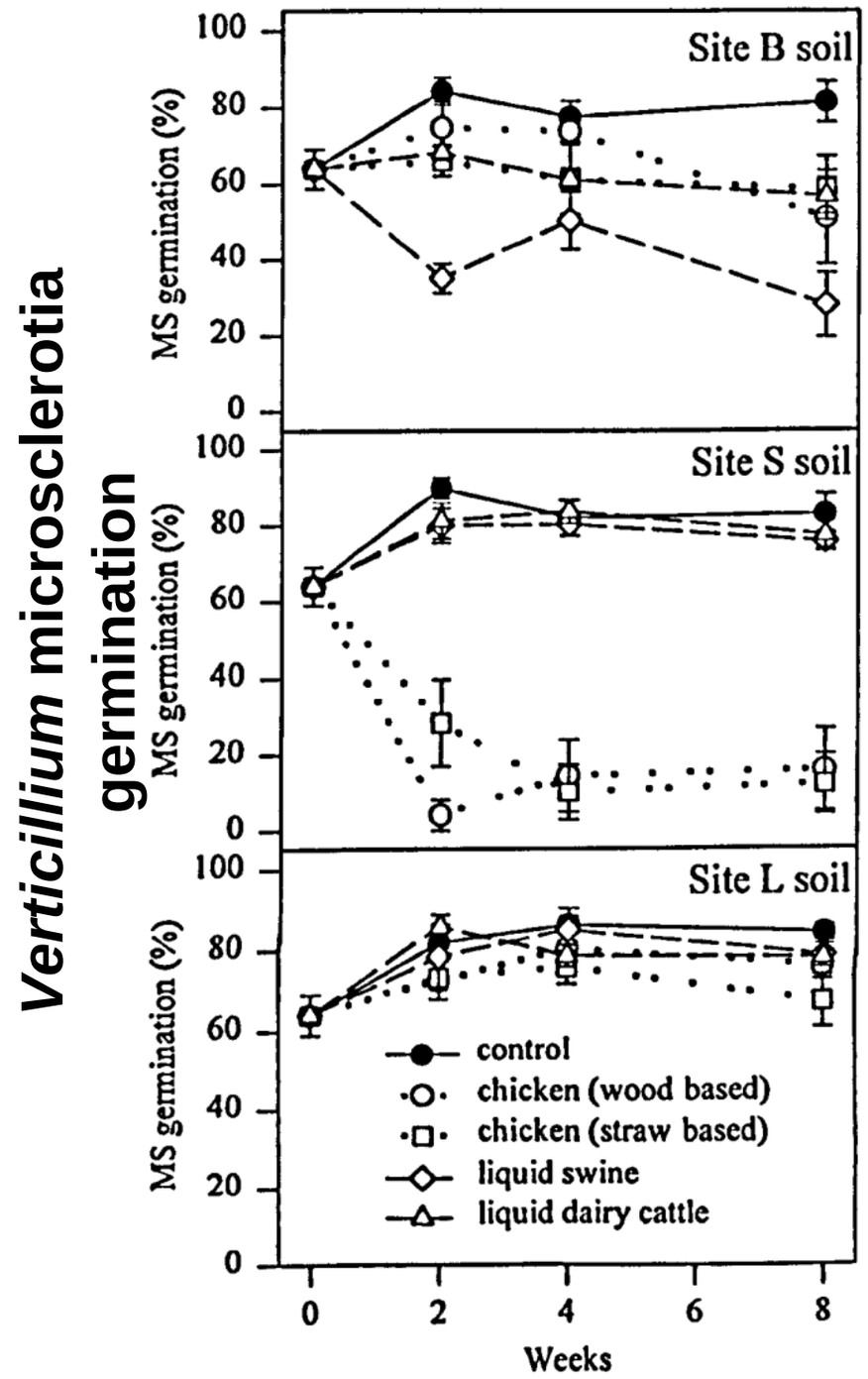


(Hartmann, 2015)

Bacterial and fungal communities changed with manure additions

Microbial response to organic matter additions: manure

Implications for pathogens



(Conn and Lazarovits, 1999)

Managing soil microbes

Nitrogen fixation

Pollination

Soil formation

Wild products (food)

Bioremediation of chemical pollutants

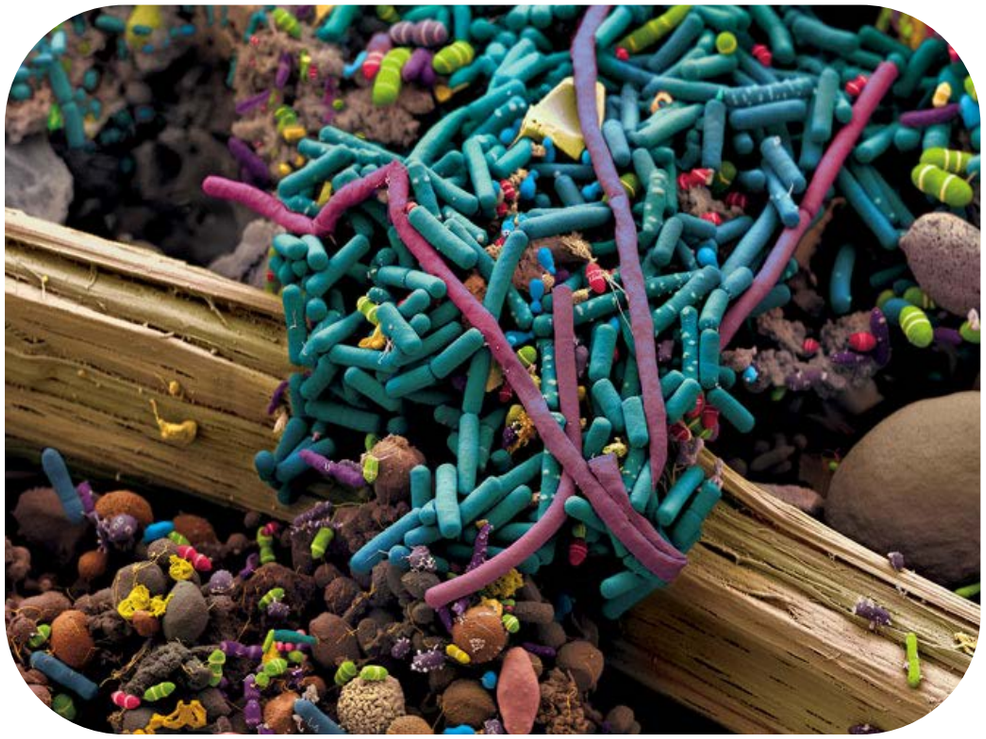
Biocontrol of pests

Industrial and pharmaceutical goods

Waste recycling

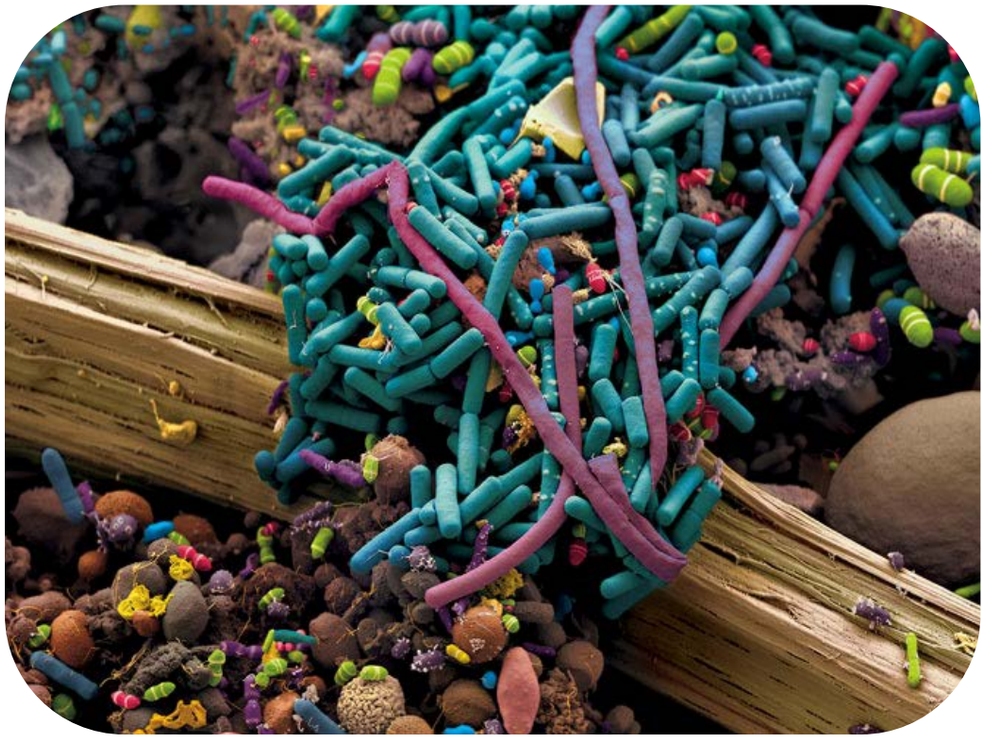
Managing soil microbes

- **Key questions:**
- What do you feed them?
- What is their habitat?
- Targeted groups?
- Inoculation with specific microbes?



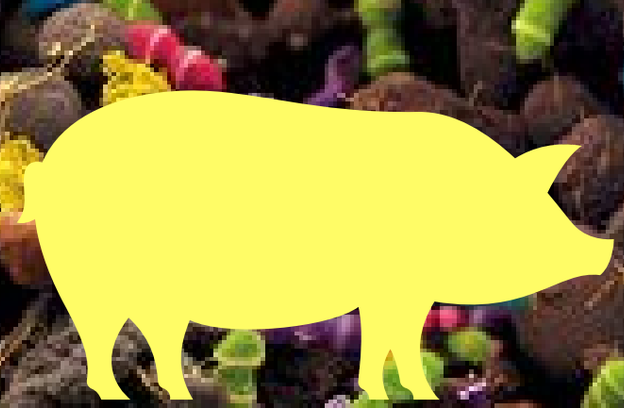
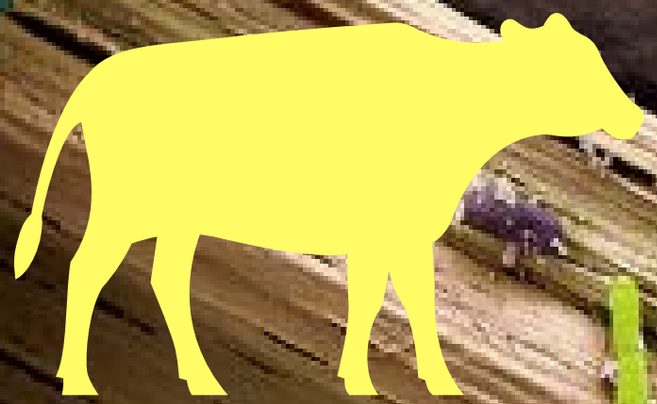
Managing soil microbes

- **Key questions:**
- What do you feed them?
- What is their habitat?
- Targeted groups?
- Inoculation with specific microbes?



“Functional redundancy?”

Microbial response to organic matter additions to soils:

What do we know & why do we care?

Thea Whitman - Department of Soil Science - UW-Madison
twhitman@wisc.edu; @theawhitman; whitmanlab.soils.wisc.edu