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Canada

Soil biodiversity and sustainable agricultural systems

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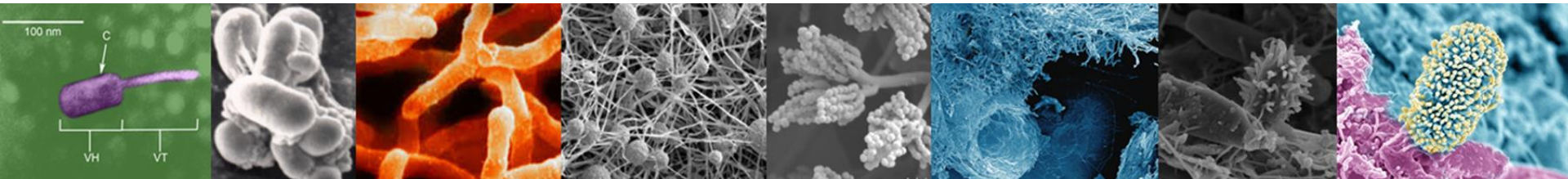
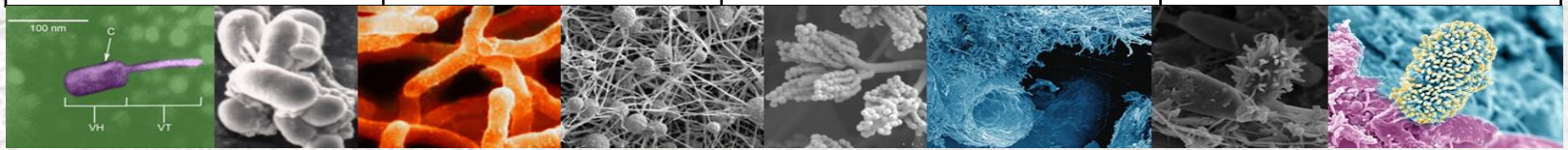


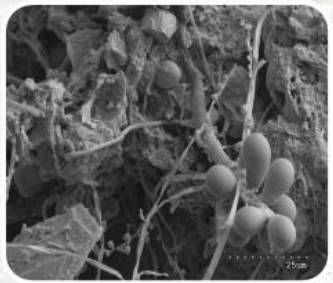
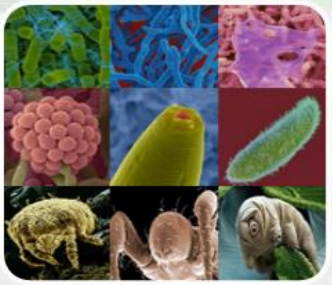
Soils contain 25% of our planet's biodiversity

- Millions of different microbial 'species' and billions of individual organisms critical for healthy soils
- These microbes are mainly invisible and still mostly unidentified

Microbial group	*Size*	*Estimated # individuals*	*Global Species estimates*
Archaea	0.5-3 µm	> 10^9	>10,000
Bacteria	1-5 µm	> 10^9	>4,000,000
Fungi	>4 µm	> 10^6	>1,500,000
Protozoa	5-200µm	> 10^6	> 150,000
Nematodes	10µm-2mm	>10^6 (m^2)	>20,000
Other Fauna	250µm-2mm-2m	>10^6 (m^2)	>100,000

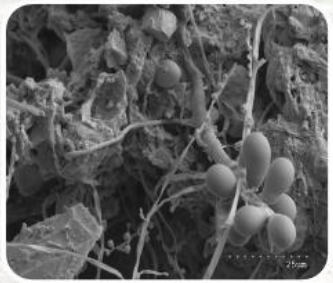


What does this biodiversity do for us?

Soil Structure	Carbon transformation	Nutrient Cycling	Biocontrol
			
Macro-fauna Meso-fauna Fungi Bacteria	Macro-fauna Meso-fauna Micro-fauna Fungi Bacteria	Micro-fauna Fungi Bacteria Archaea	Increased biodiversity at all levels Predators Parasites

What does this biodiversity do for us?

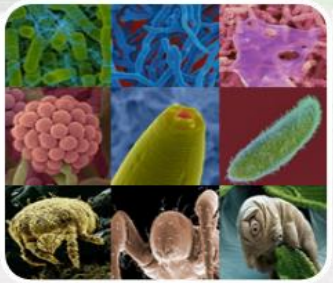
Soil Structure



Carbon transformation

Nutrient Cycling

Biocontrol



Sustainable agricultural systems

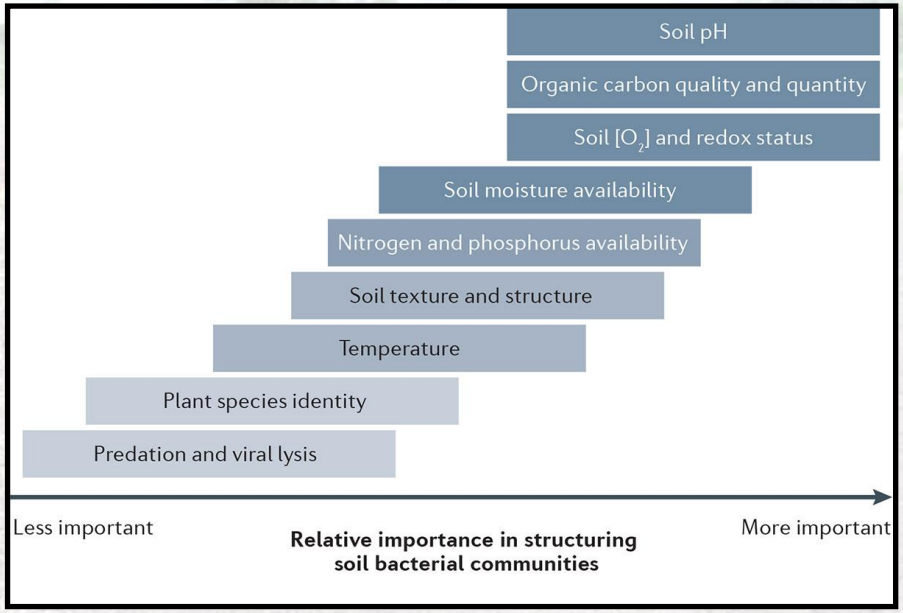
Increased: climate resilience, C storage, nutrient cycling, pathogen suppression

Productive agricultural systems

Decreased: fertilizer/herbicide/ pesticide costs, nutrient losses, GHG

How do agricultural practices affect soil biodiversity?

- **Residue management and fertilizer inputs**
  - ➢ quantity & quality of microbial nutrient sources
- **Tillage practices**
  - ➢ habitat properties & biopore networks
- **Crop rotations**
  - ➢ microbial diversity & function
- **Soil amendments**
  - ➢ microbial population dynamics

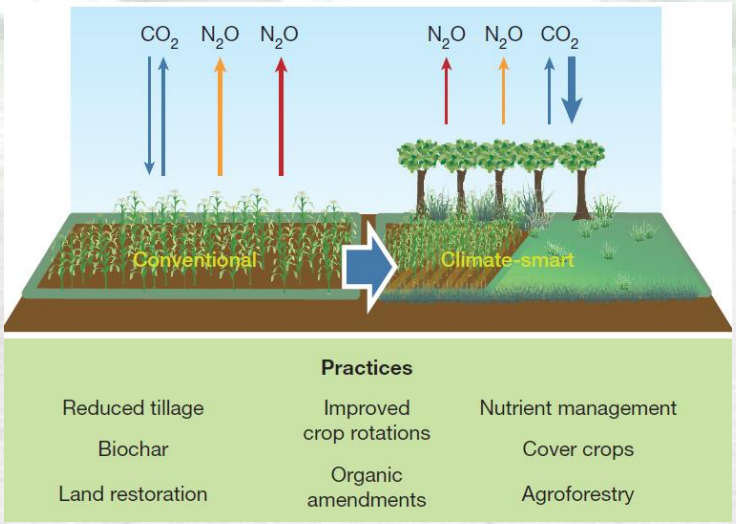


N. Fierer *et al*. 2017, Nature Reviews Microbiology: doi:10.1038/nrmicro.2017.87

Soil biological communities respond to management

- **Functionally relevant responses begin as soon as a new BMP is imposed**
  - Days: fertilizers, nitrification inhibitors
  - Months: amendments, residue addition/removal, controlled drainage
- **Consistently imposed BMPs result in altered yet resilient/resistant microbial communities**
  - Years: altered tillage practices
  - Decades: crop rotation, cover crops

The inherent biological capital of a system can be fundamentally changed within a decade



Cumulative changes to soil biological capital lead to ecosystem relevant outcomes

K. Paustian *et al*. 2016, Nature: doi:10.1038/nature17174