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Fertilization weakens the fundamental soil biodiversity-function relationship

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Background

Bardgett and van der Putten, 2014 Nature

Plant production

SOM decomposition

Herbivore control

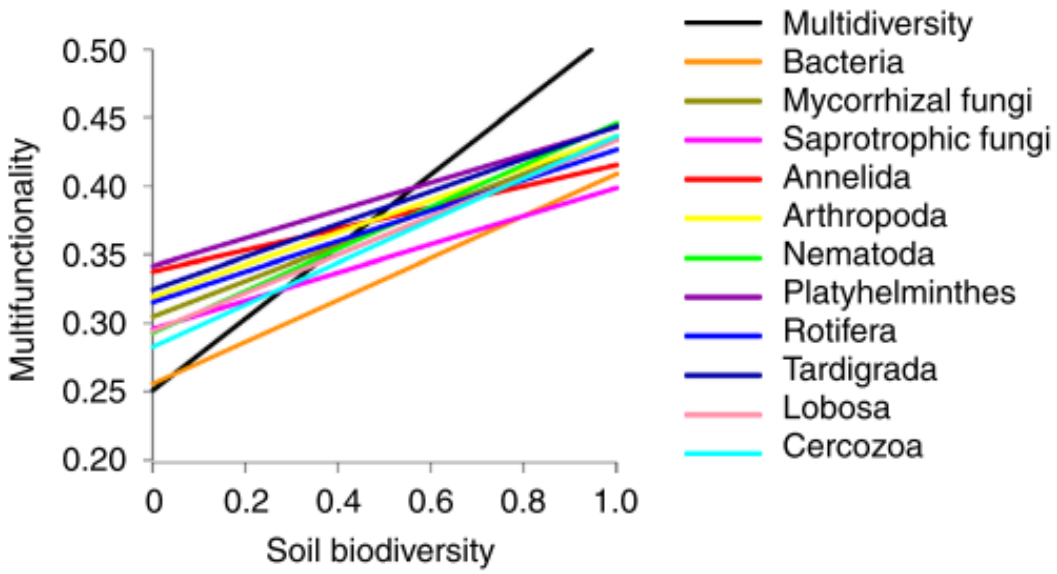
Climate manipulation

Carbon sequestration

Soil biodiversity supports multiple ecosystem functions such as decomposition and carbon cycling, which are critical for ecosystems sustainability.

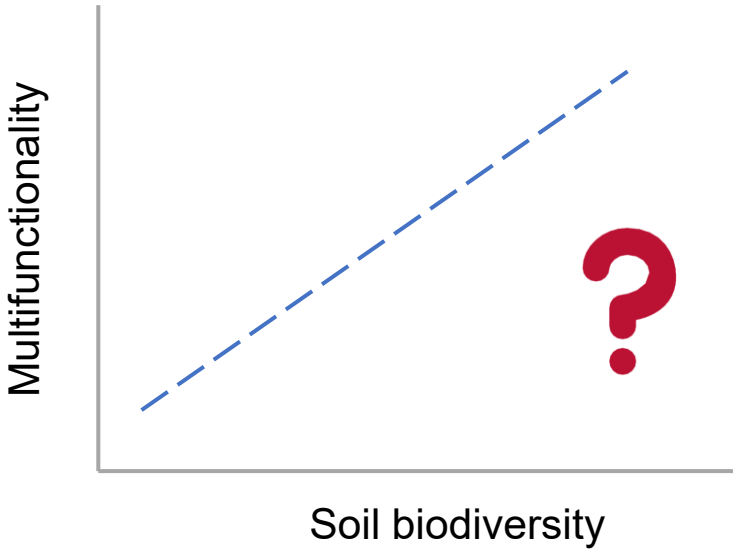
Background

Natural ecosystems



Delgado-Baquerizo et al., Nature Ecology and Evolution

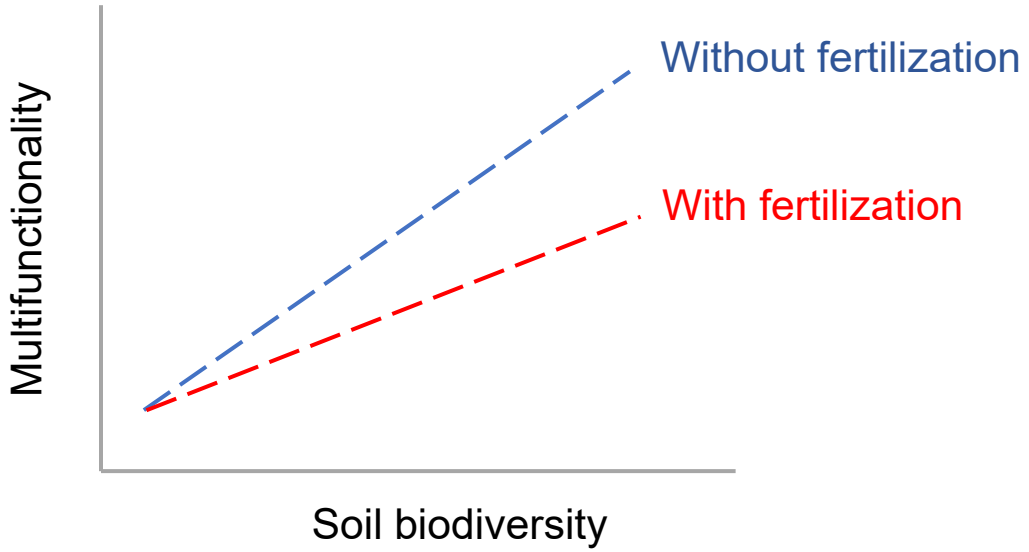
Over-fertilized ecosystems



This fundamental biodiversity-function relationship may, however, be challenged in agricultural, and other fertilized environments, wherein nutrient additions might substitute the natural role of biodiversity in supporting essential soil functions such as nutrient cycling.

Hypotheses

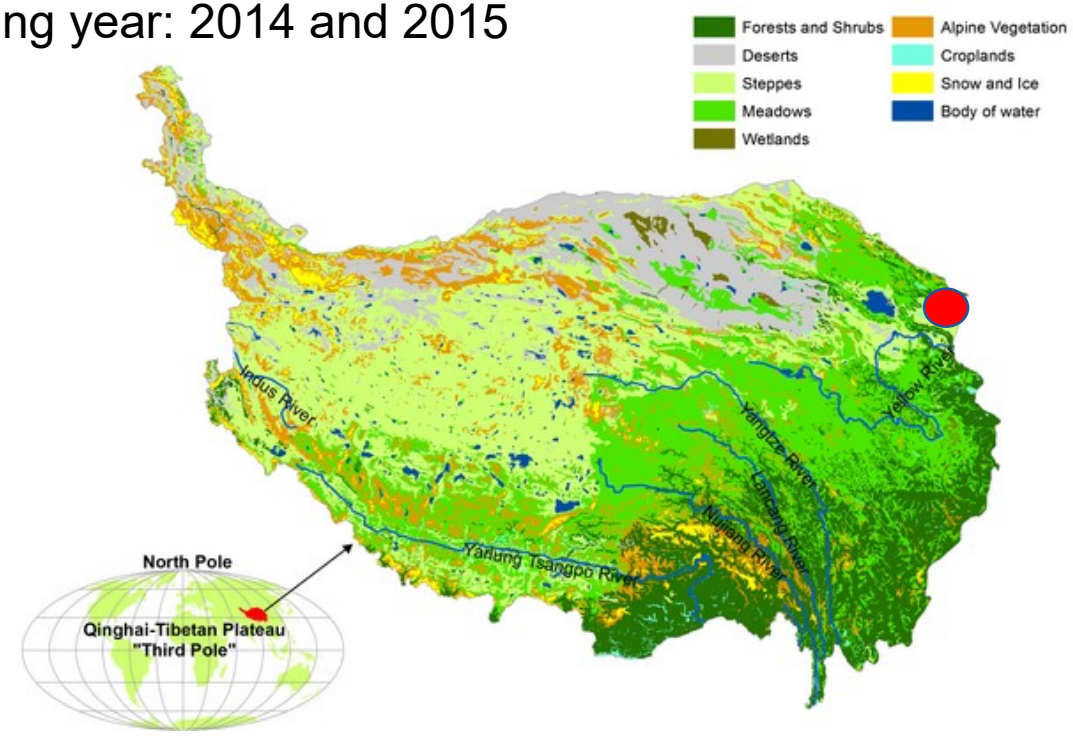
We posit that soil biodiversity is essential to maintain ecosystem multifunctionality (EMF) in highly fertilized environments, but its effect size could be modulated by fertilization.



Methods and materials

- Long-term fertilization experiment

Altitude: > 3500 m
MAP: 620 mm
MAT: 1.2 ℃
Start year: 2001
Sampling year: 2014 and 2015



Fertilizer: $(NH_4)_2HPO_4$

Treatment

Control: 0 g m^{-2}
(0 g N m^2 and 0 g P m^2)

NP30: 30 g m^{-2}
(6.3 g N m^2 and 7.0 g P m^2)

NP90: 90 g m^{-2}
(18.9 g N m^2 and 21 g P m^2)

NP120: 120 g m^{-2}
(25.2 g N m^2 and 28.0 g P m^2)

5 replicates

Methods and materials

Ecosystem functions

C-cycling	Soil respiration
	Microbial Biomass C
Nutrient cycling	N availability
	P availability
	Microbial Biomass N
	Microbial Biomass P
SOM decomposition	Sugar decomposition
	Chitin decomposition
	Lignin decomposition
	Polymer decomposition
	P mineralization
	alkyl:O-alkyl
Soil structure	Aggregate stability
Pest control	Nematode parasite

Soil biodiversity

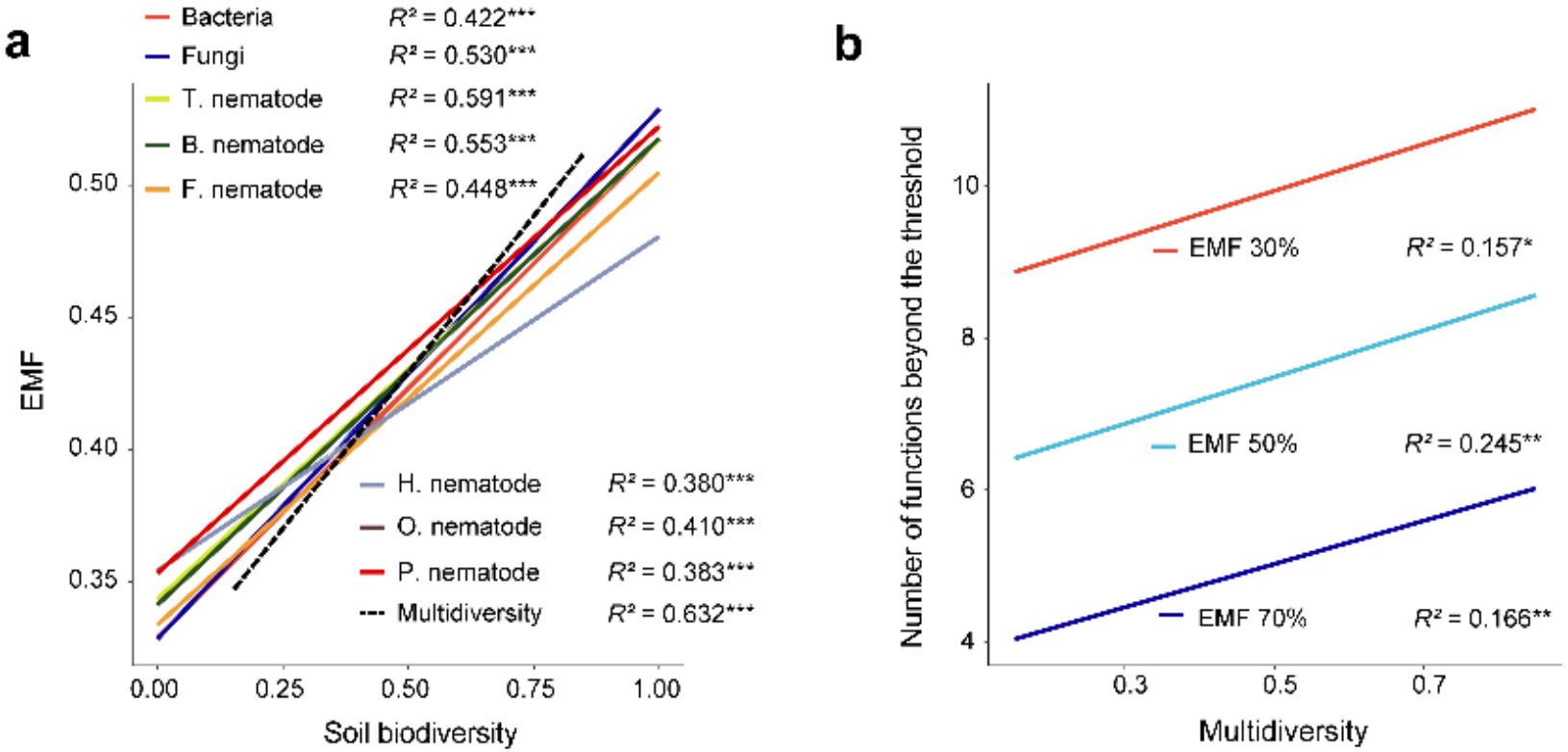
Microbial diversity	Bacteria
	Fungi
Faunal diversity	Total nematode
	Bacterivores
	Fungivores
	Plant-parasites
	Omnivores
	Predators

Multifunctionality (averaging and threshold approach)

Multidiversity (averaging approach)

Results---field investigation

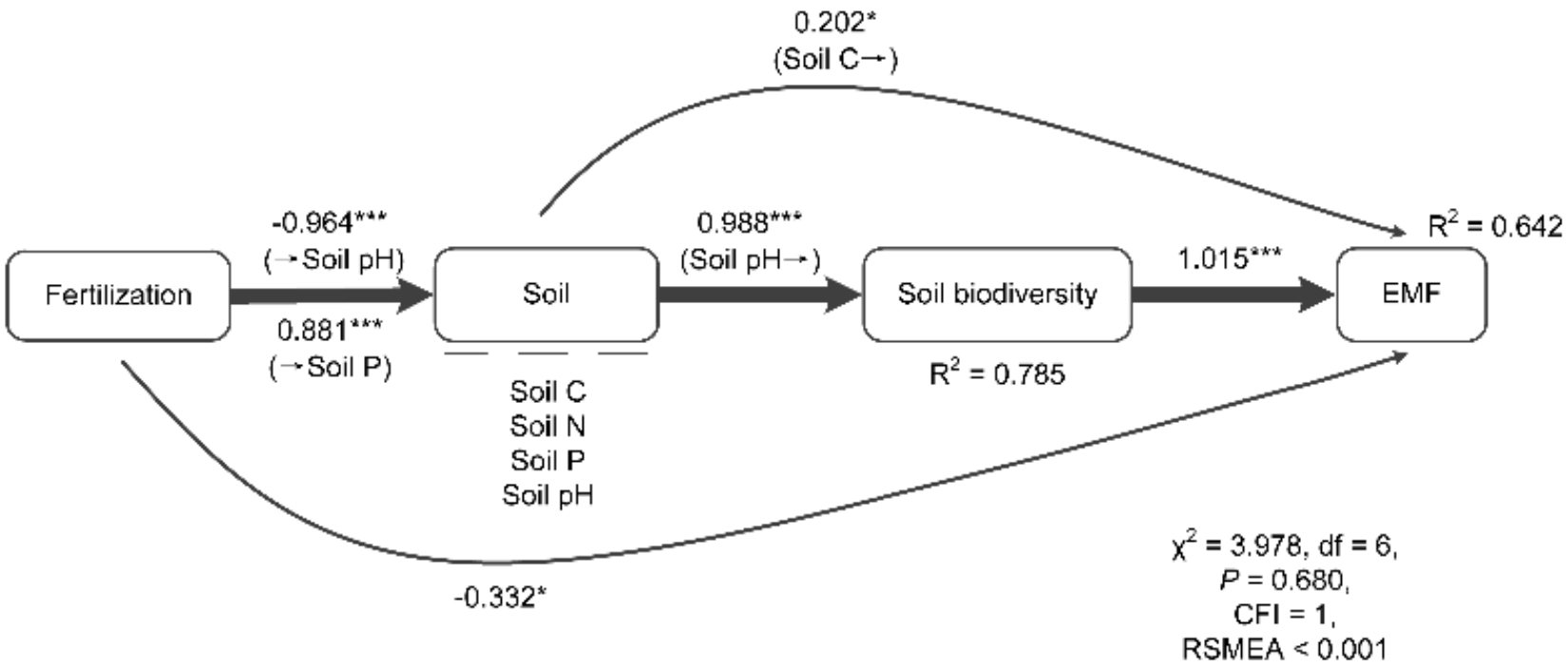
- Links between soil biodiversity and ecosystem multifunctionality



Significant positive relationships between the diversity of all individual groups of soil biota or the index of multidiversity and averaging EMF.

Results---field investigation

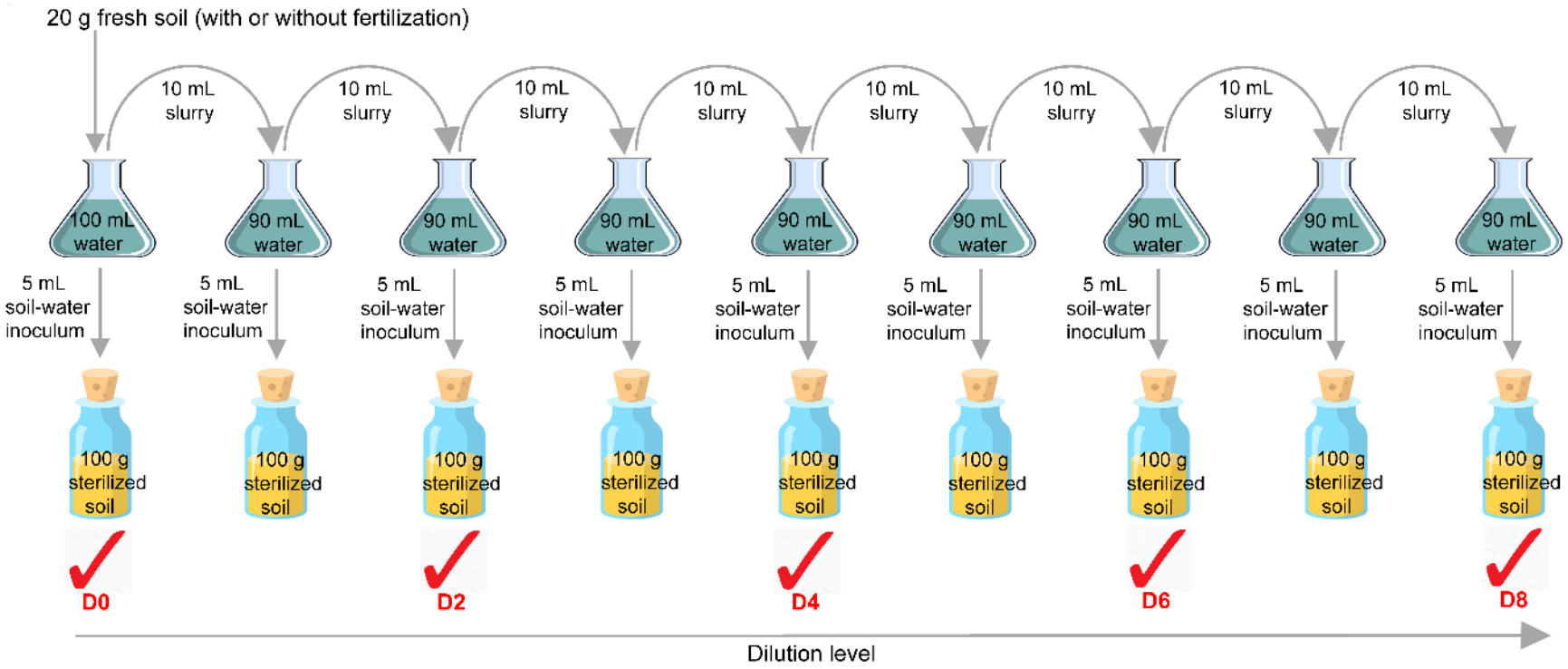
- Structural equation modelling



The positive effects of soil biodiversity on EMF was maintained after accounting for soil attributes (pH, total C, N, and P) as influenced by fertilization.

Incubation experiment

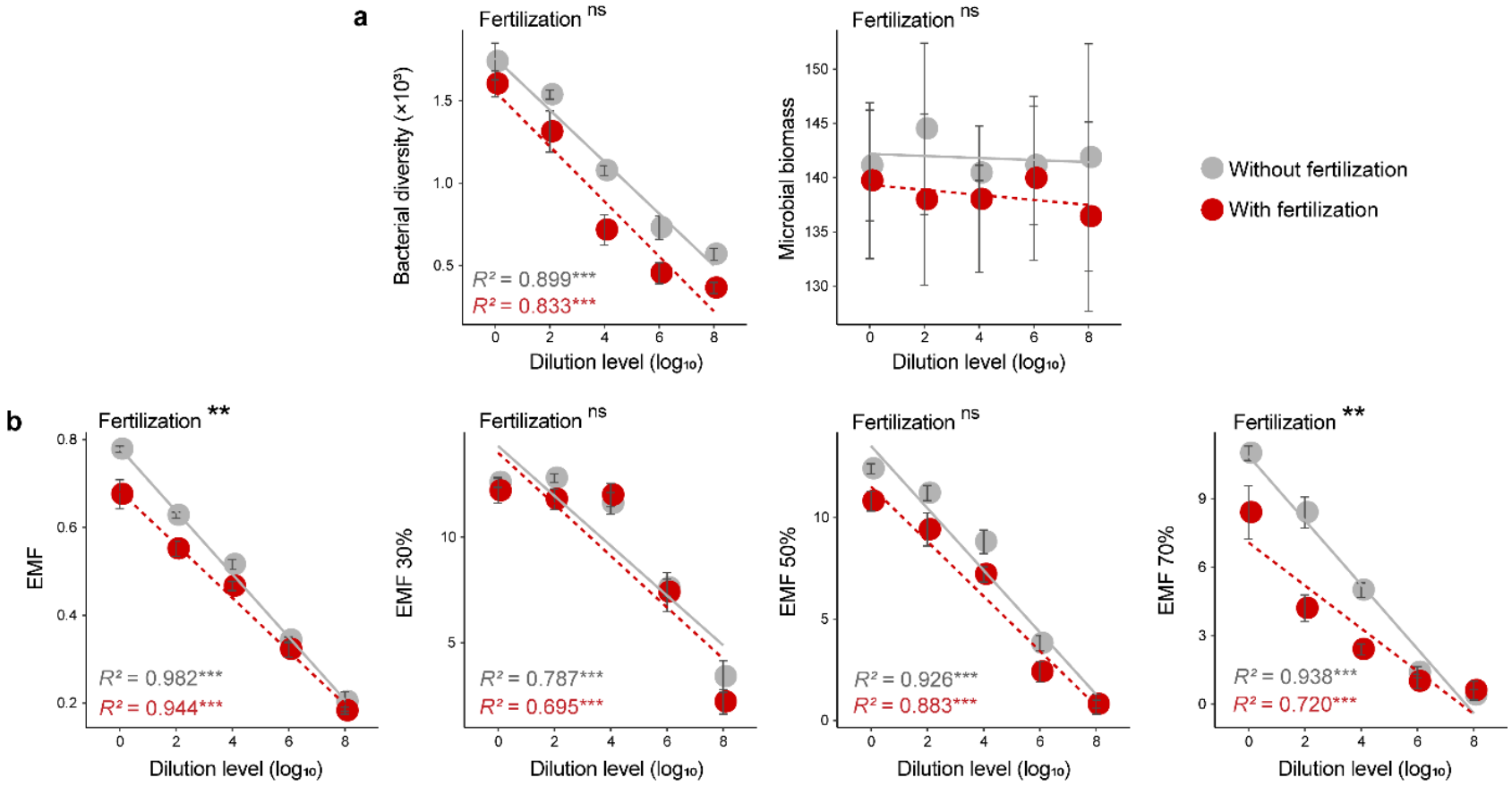
- Set up of biodiversity levels (dilution to extinction)



- Measurement of ecosystem functions (nutrient cycling, SOM decomposition, plant growth)

Results---Microcosm experiment

- Linkages between soil biodiversity and ecosystem



Fertilization can weaken the relationship between soil biodiversity and function compared with unfertilized controls. Even so, soil biodiversity is still critical for function under fertilization.

Conclusion

- Our findings provide experimental evidence that soil biodiversity is of paramount importance for maintaining ecosystem multifunctionality under high fertilization scenarios.

- Although our results demonstrate that fertilization weakened biodiversity effects, they also highlight that soil biodiversity is still essential for supporting many ecosystems functions at high levels.

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Thanks for your attention!

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