Soil pH modulates microbial nitrogen allocation in soil via compositional and metabolic shifts across forests in Japan

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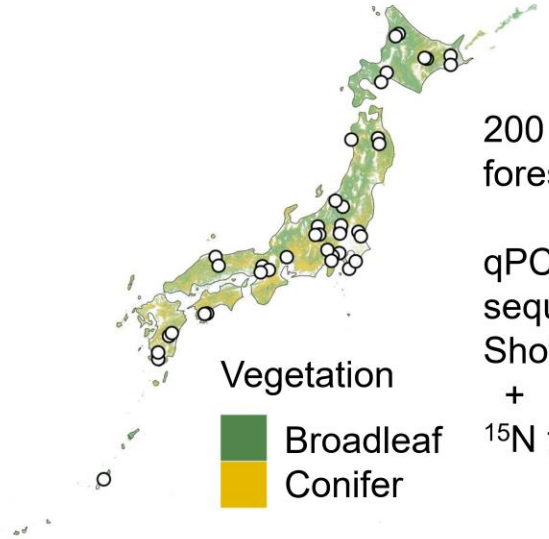
Abstract

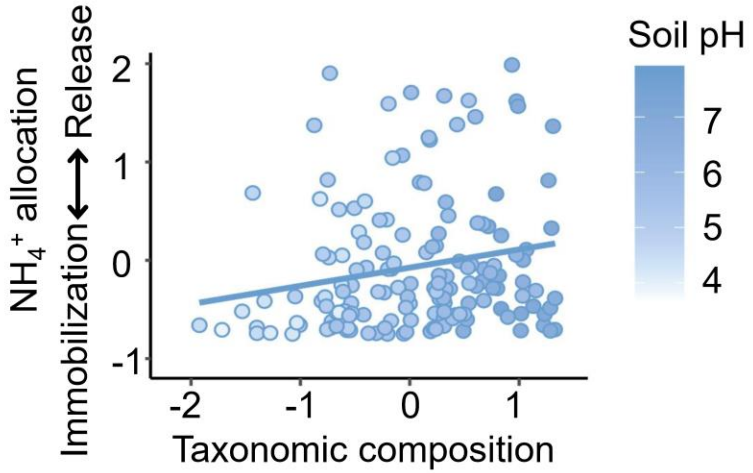
How is N allocation in forest soil—whether NH_4^+ is released or immobilized— regulated by the microbial community?



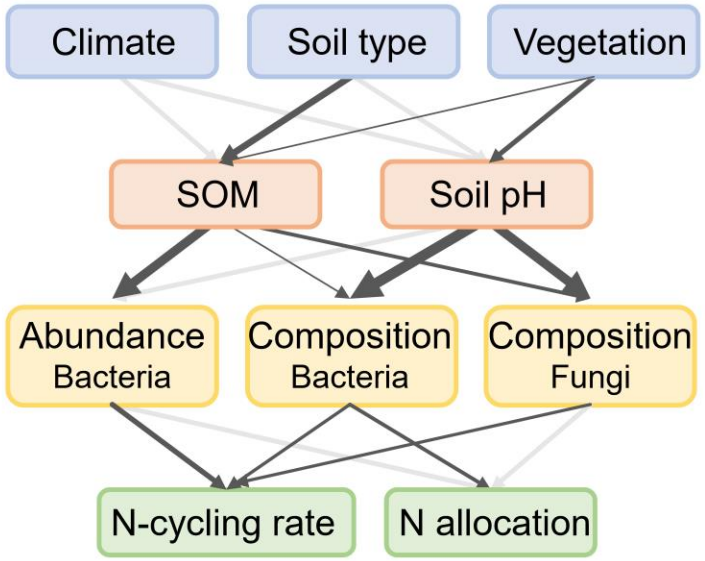
200 soil samples from 40 forest sites

qPCR and amplicon sequencing
Shotgun metagenomics
+
^{15}N tracer analysis

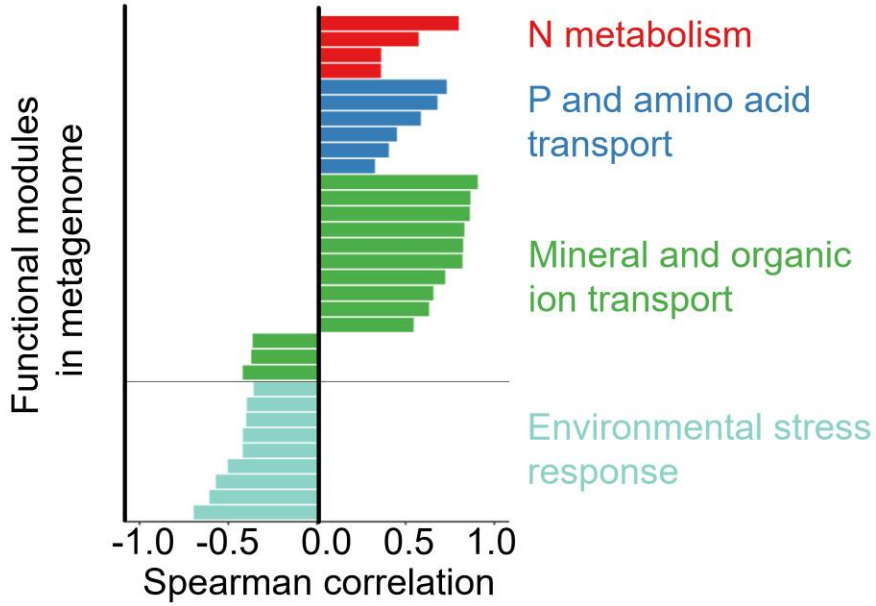
Soil pH regulates N allocation via taxonomic composition constraints



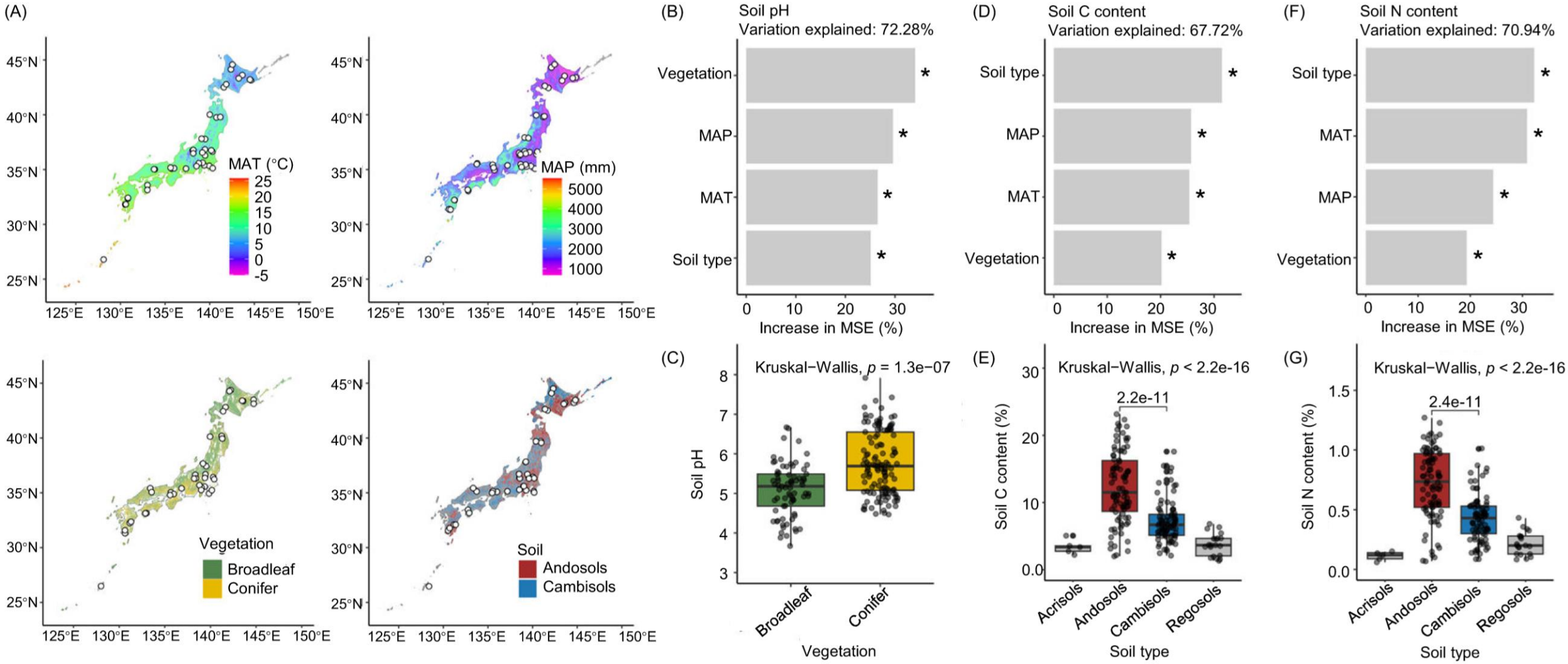
Hierarchical effects on N-cycling



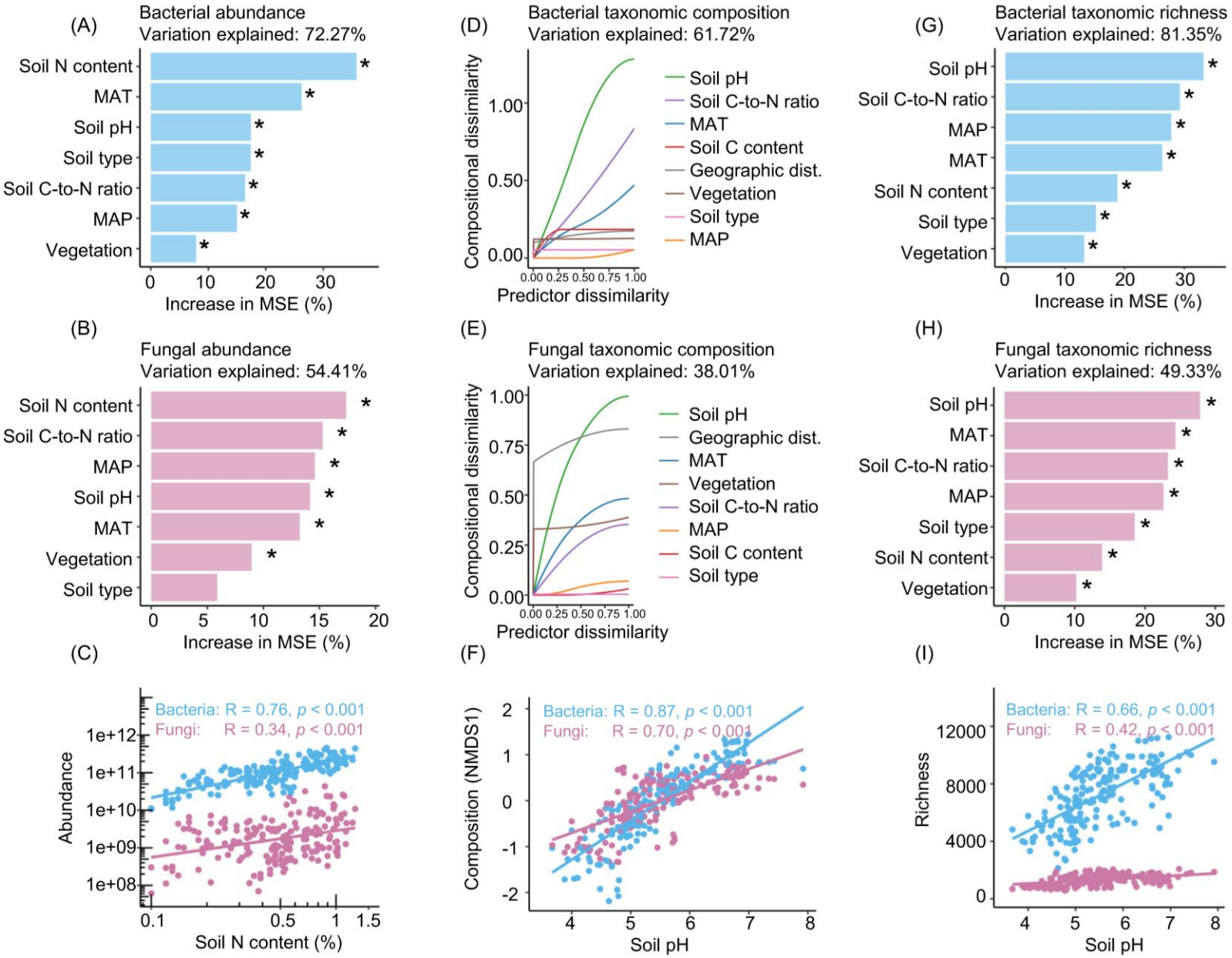
Soil pH regulates N allocation via metabolic constraints



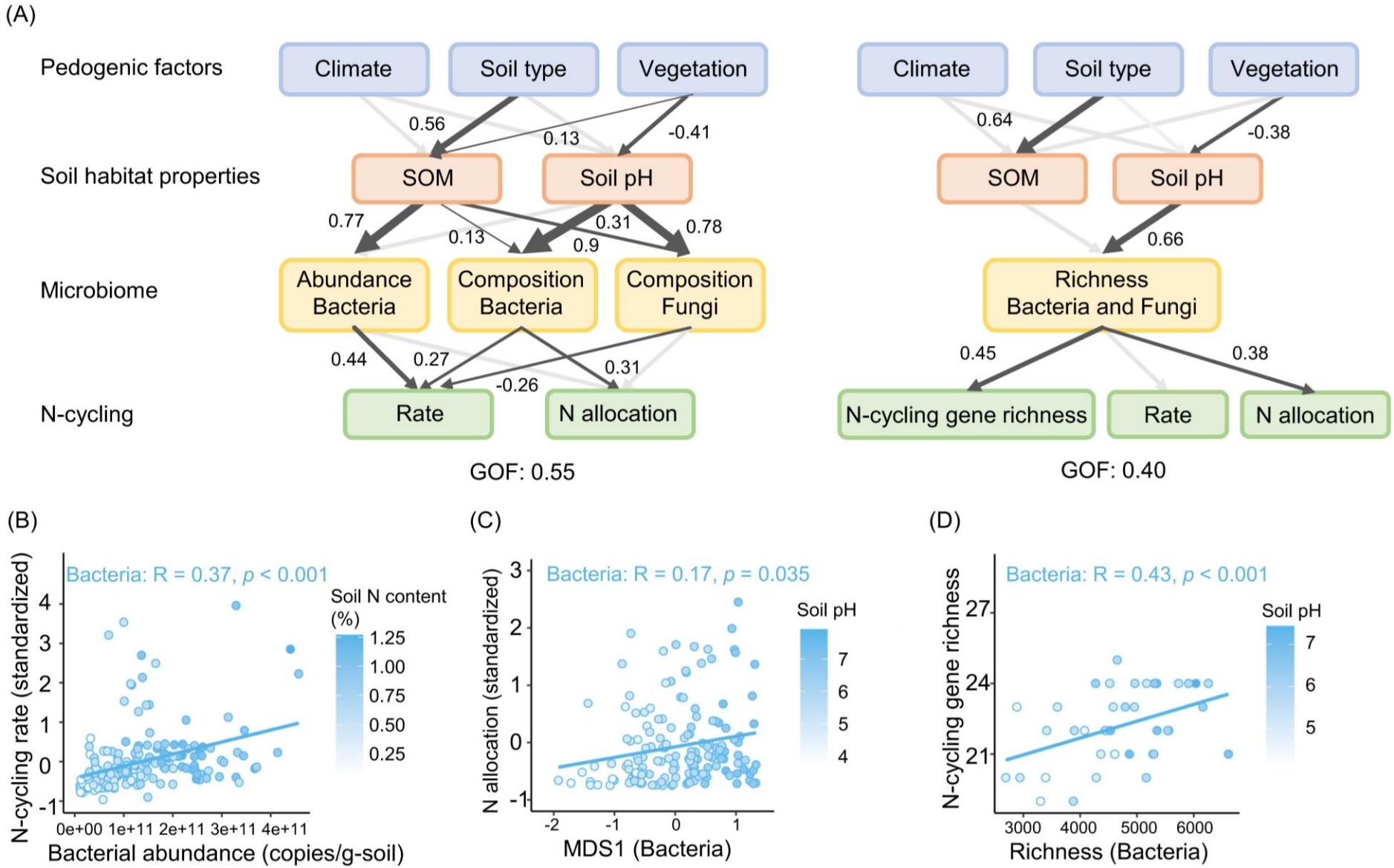
Result1：Pedogenic factors shaping soil habitat properties



Result2:Pedogenic factors and soil habitat properties shaping the soil microbiome

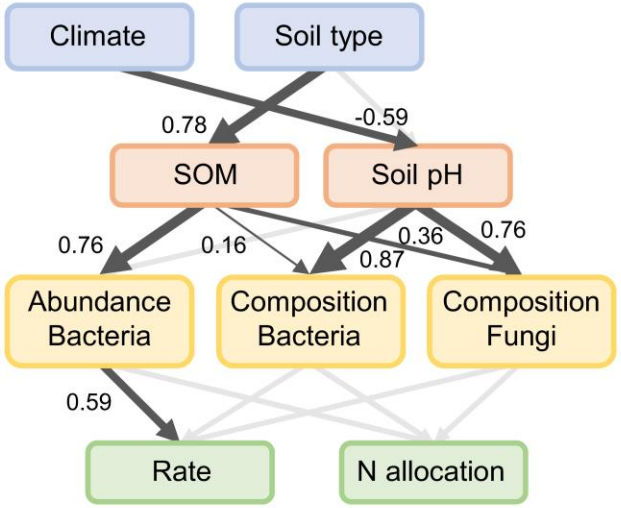


Result3: Hierarchical effects of pedogenic factors, soil habitat properties, and microbial community components on N cycling



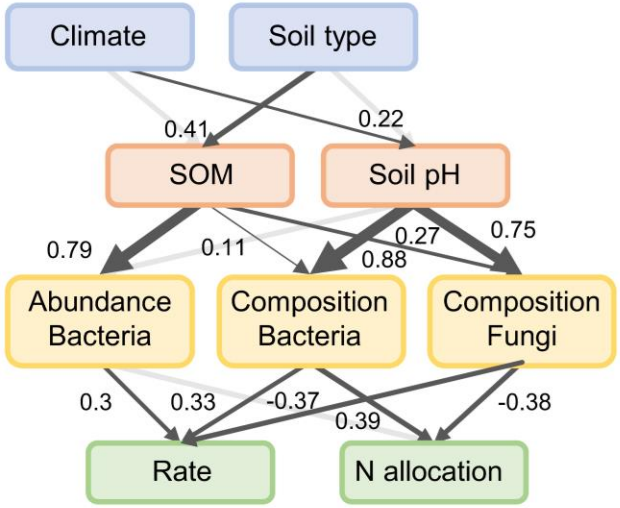
Result4: Context dependency of microbial community responses and their N cycling outcomes

(A) Vegetation: Broadleaved forests



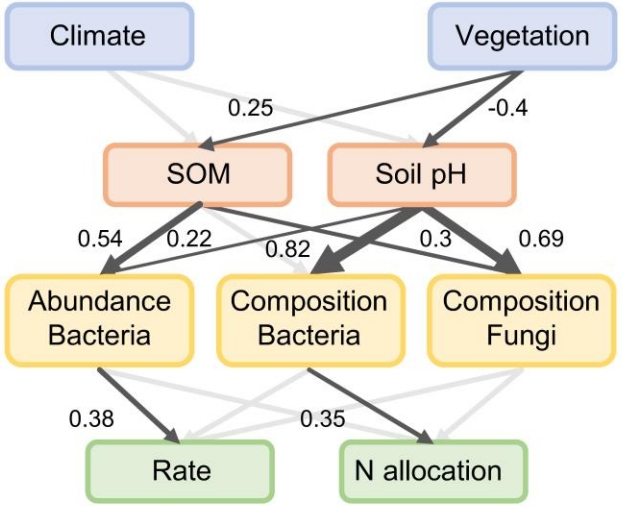
GOF: 0.60

(B) Vegetation: Coniferous forests



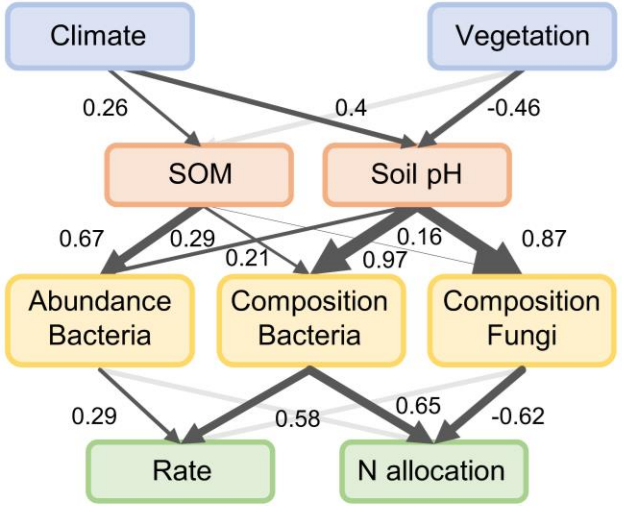
GOF: 0.50

(C) Soil type: Andosol forests



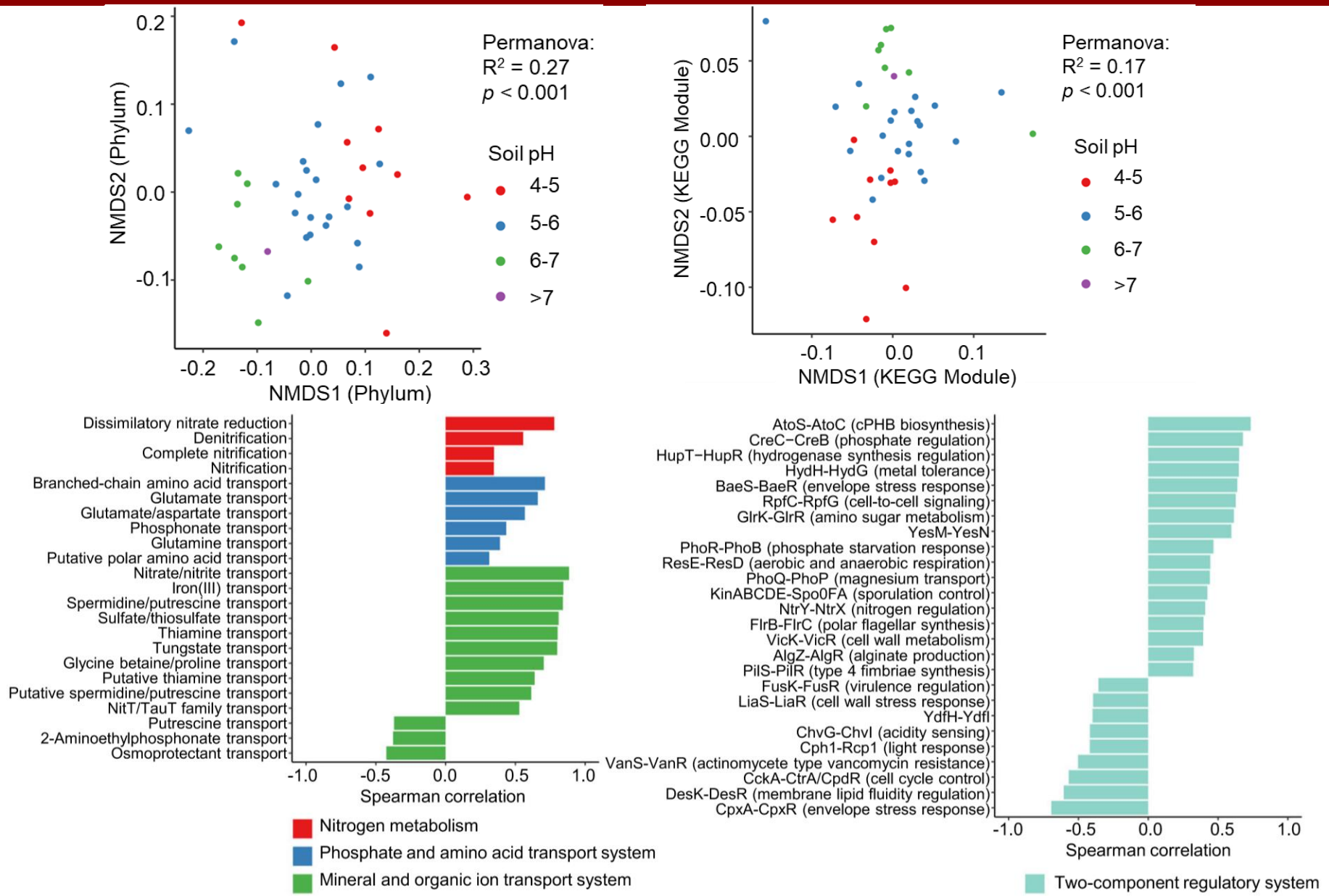
GOF: 0.49

(D) Soil type: Cambisol forests



GOF: 0.54

Result5：Changes in the metabolic capabilities of the microbial community in response to changes in the soil pH



Summary

- Pedogenic factors influence soil properties, shaping microbial communities and regulating nitrogen cycling and allocation.
- Microbial abundance drives nitrogen cycling rates, while composition and diversity determine ammonium release or retention through metabolic constraints.
- Acidic soils favor stress-tolerant microbes that retain N, while near-neutral soils support energy-efficient taxa that enhance ammonium release and nitrification.
- These findings underscore the role of microbial taxonomic composition and metabolic capabilities in regulating N allocation and highlight soil pH as a key environmental filter linking soil conditions to ecosystem- level N cycling.

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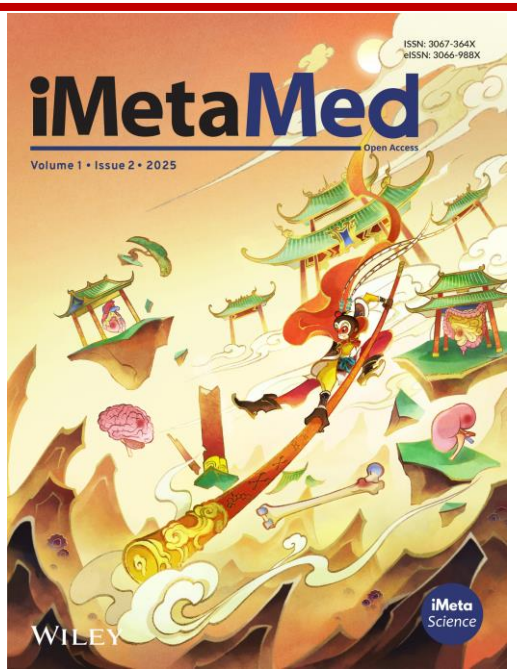

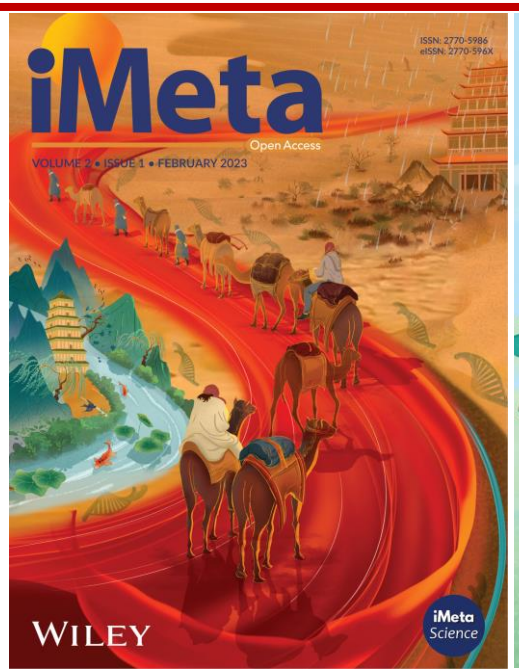

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