Agriculture increases potential health risks of vertebrate viruses in soils

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Introduction

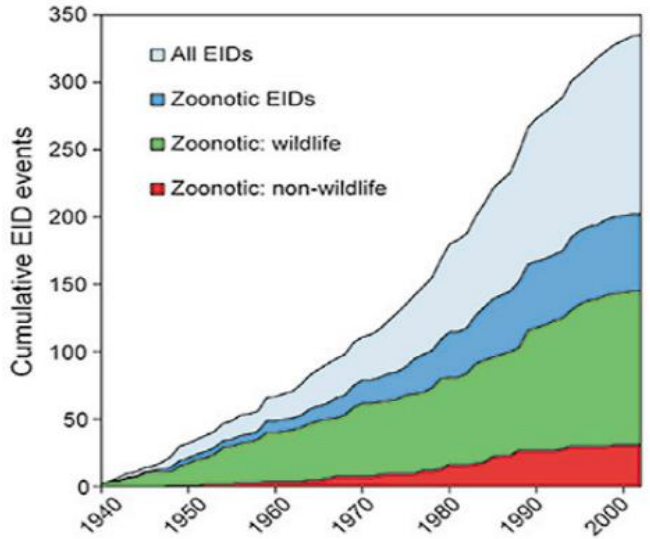
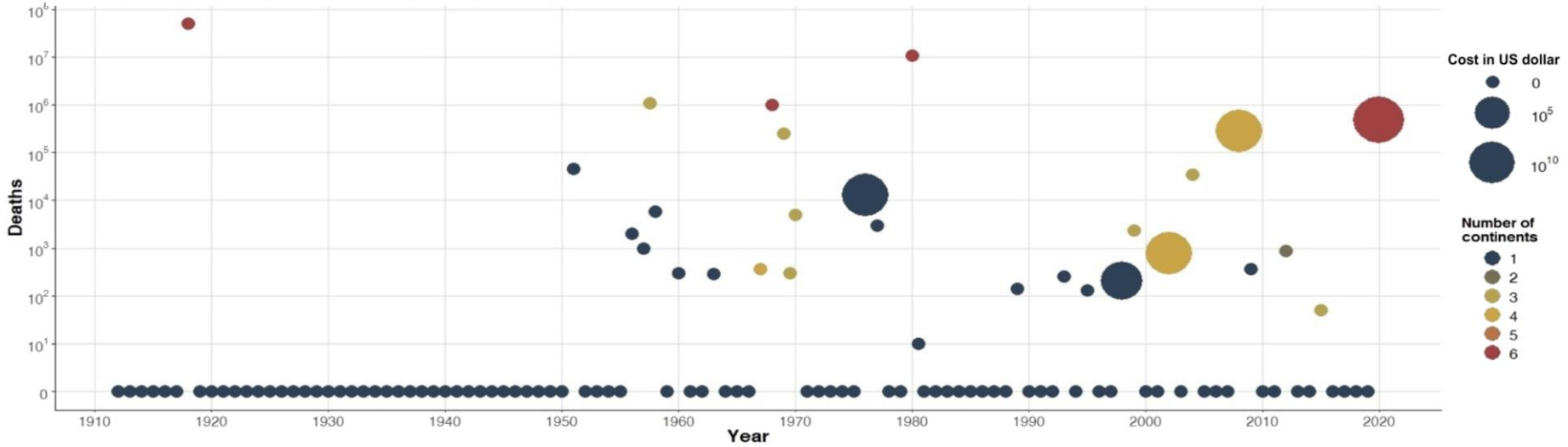


Table 2. Expected annual WTP to avoid mortality losses under three scenarios.

Willingness To Pay

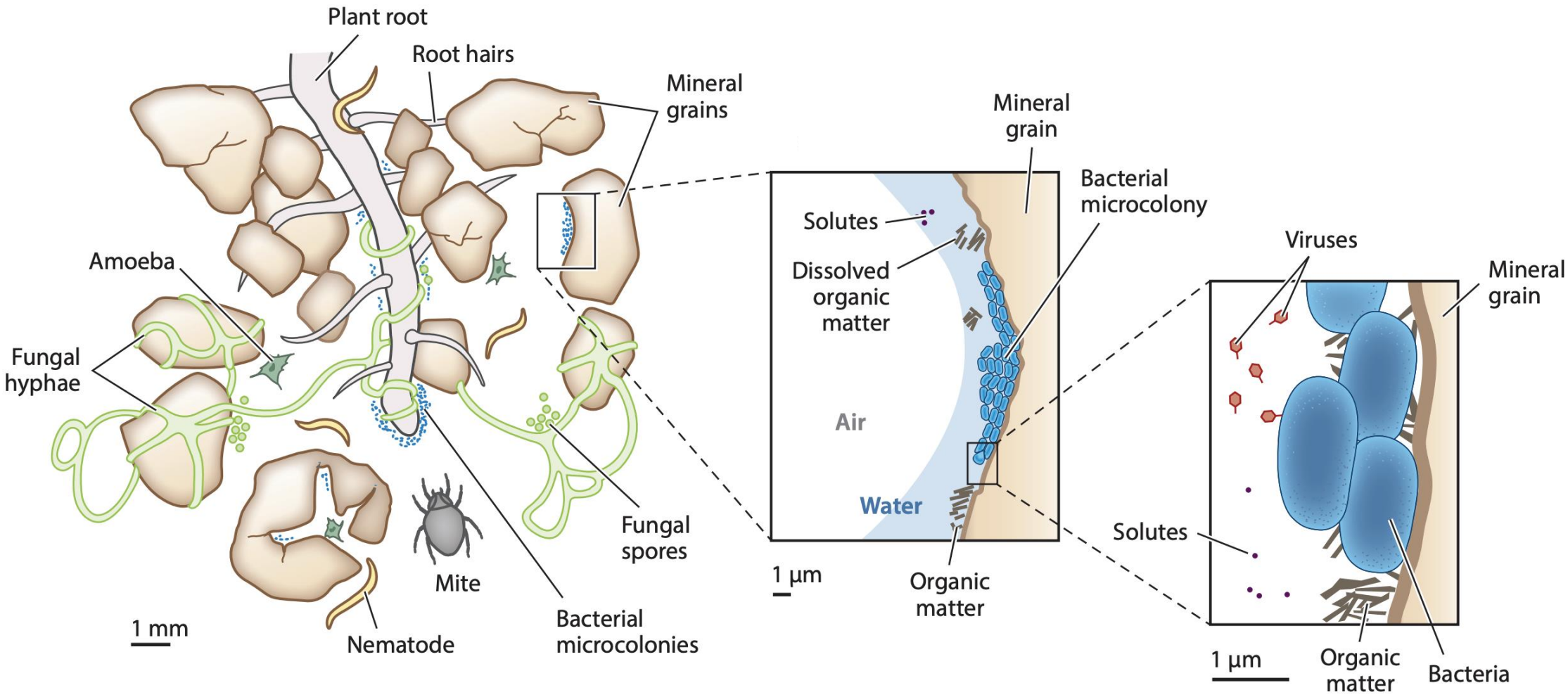
	Total lives lost (millions)	Total WTP to avoid lives lost (trillion dollars)
Baseline from observed events	3.3	0.35–21
Extreme outbreaks 10% less likely	3.0	0.32–19
Prevention cuts all frequencies ½	1.7	0.18–11



Pandemics have become more frequent and more costly.

Zhu YG, Gillings M, Penuelas J. One Earth, 2020.
Bernstein AS, et al. Science Advances, 2022.

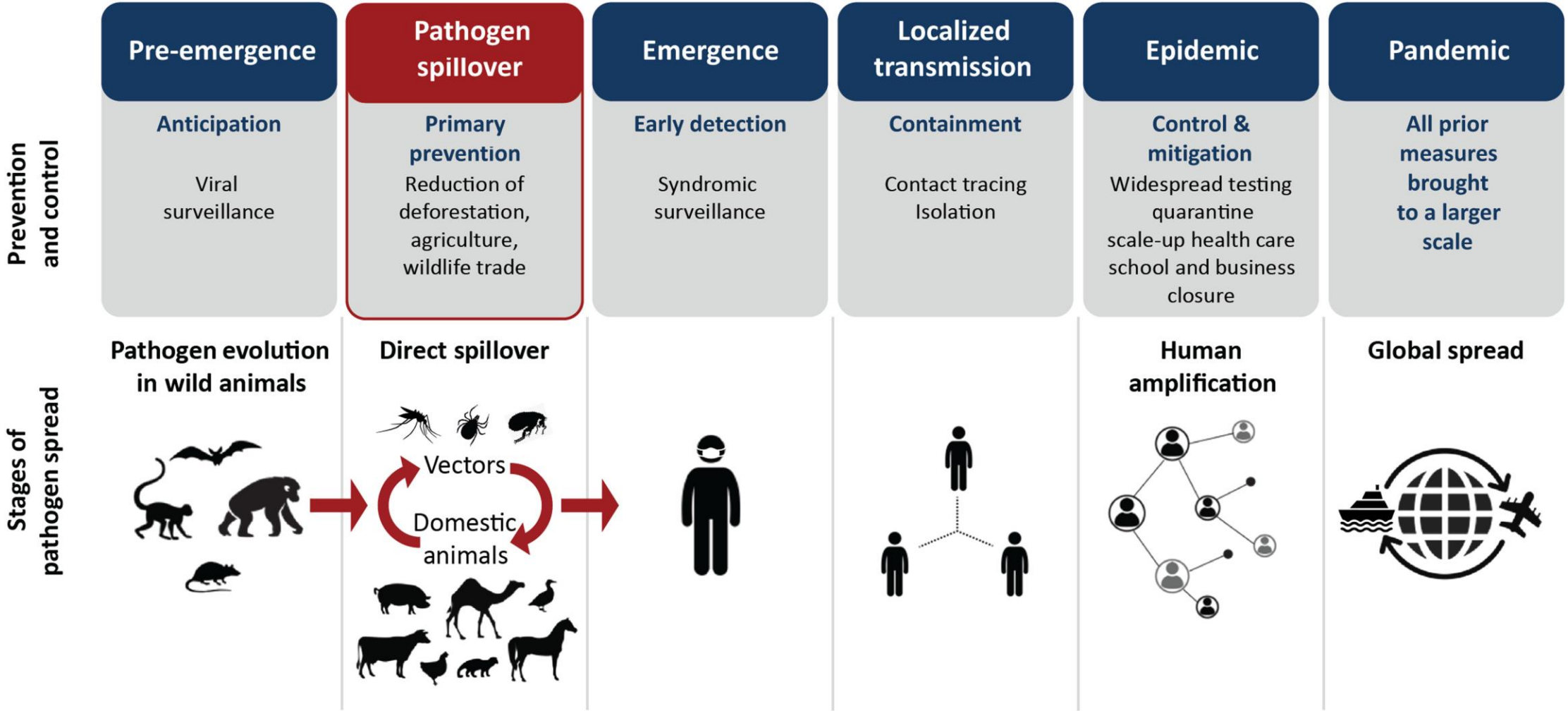
Introduction



The occurrence of vertebrate viruses in soils is still unknown, which is a key priority for One Health research.

Williamson KE, et al. Annual Review of Virology, 2017.

Introduction

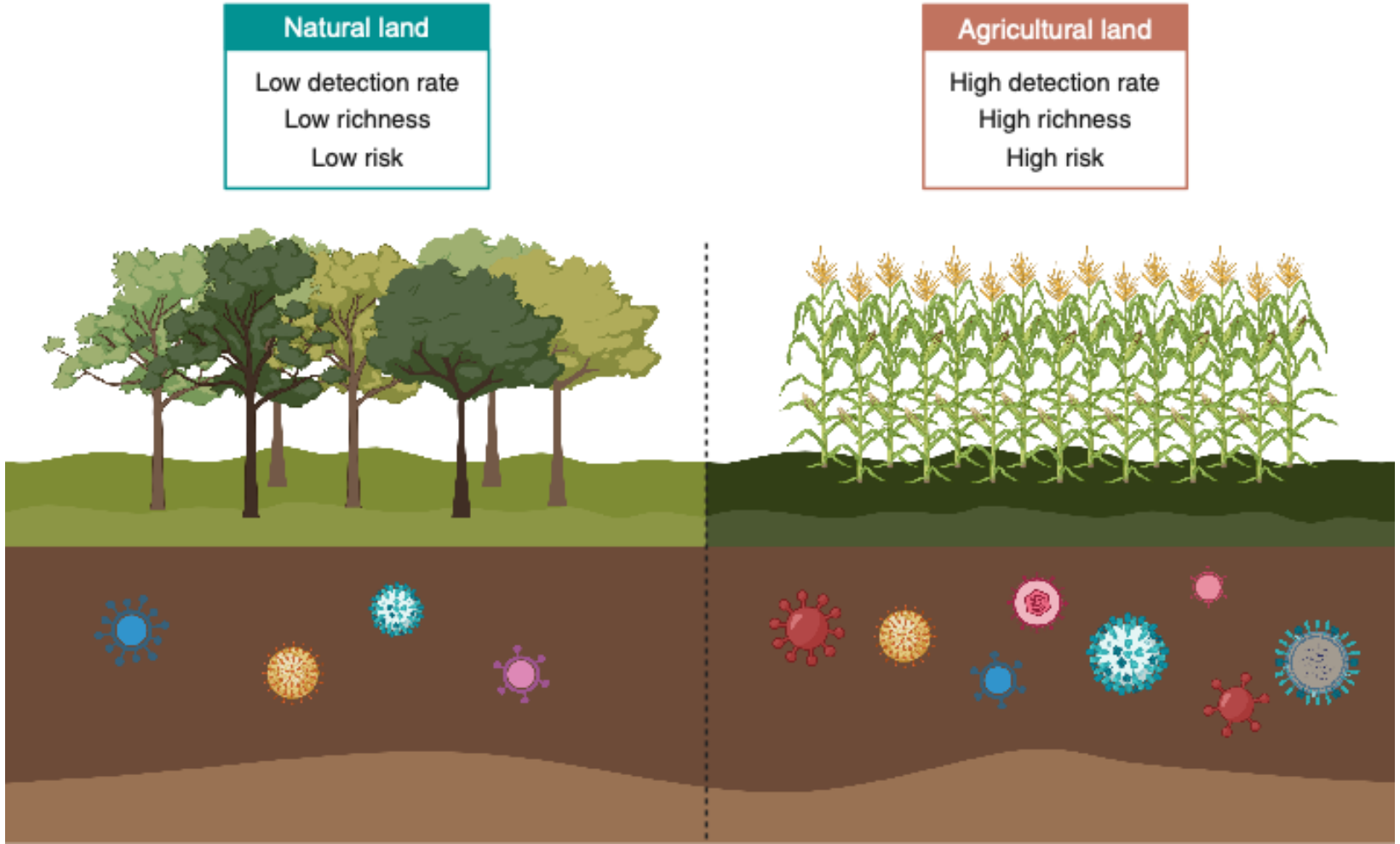


It is critical to assess the effects of agriculture in distribution and health risks of vertebrate viruses in soils.

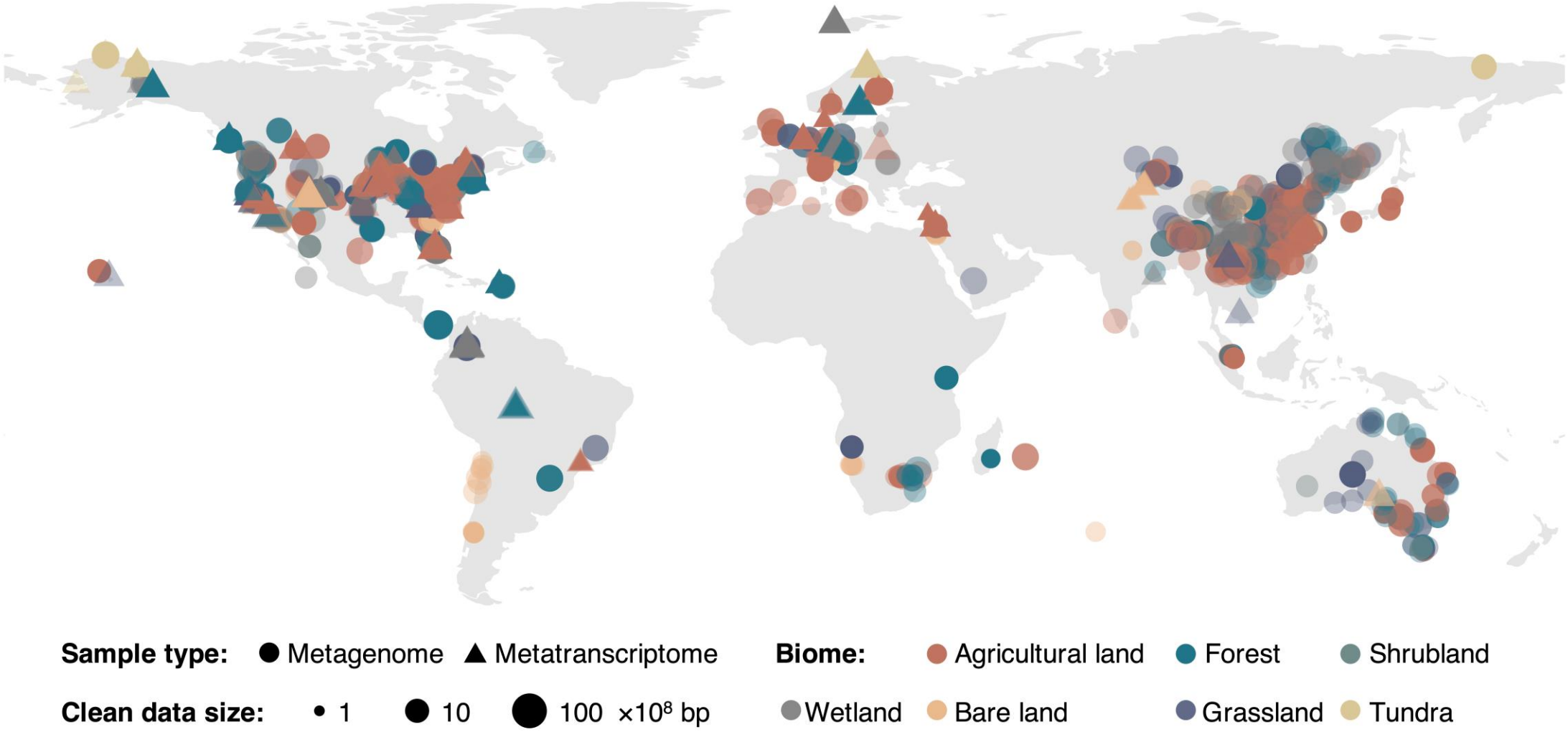
Bernstein AS, et al. Science Advances, 2022.

Highlights

- Agricultural soils have higher detection rates of vertebrate viruses than natural soils
- Human-related viruses dominate abundance but not diversity in agricultural soils
- Most soil vertebrate viruses are conditionally rare with stochastic distributions
- Agriculture increases potential health risks of vertebrate viruses in soils

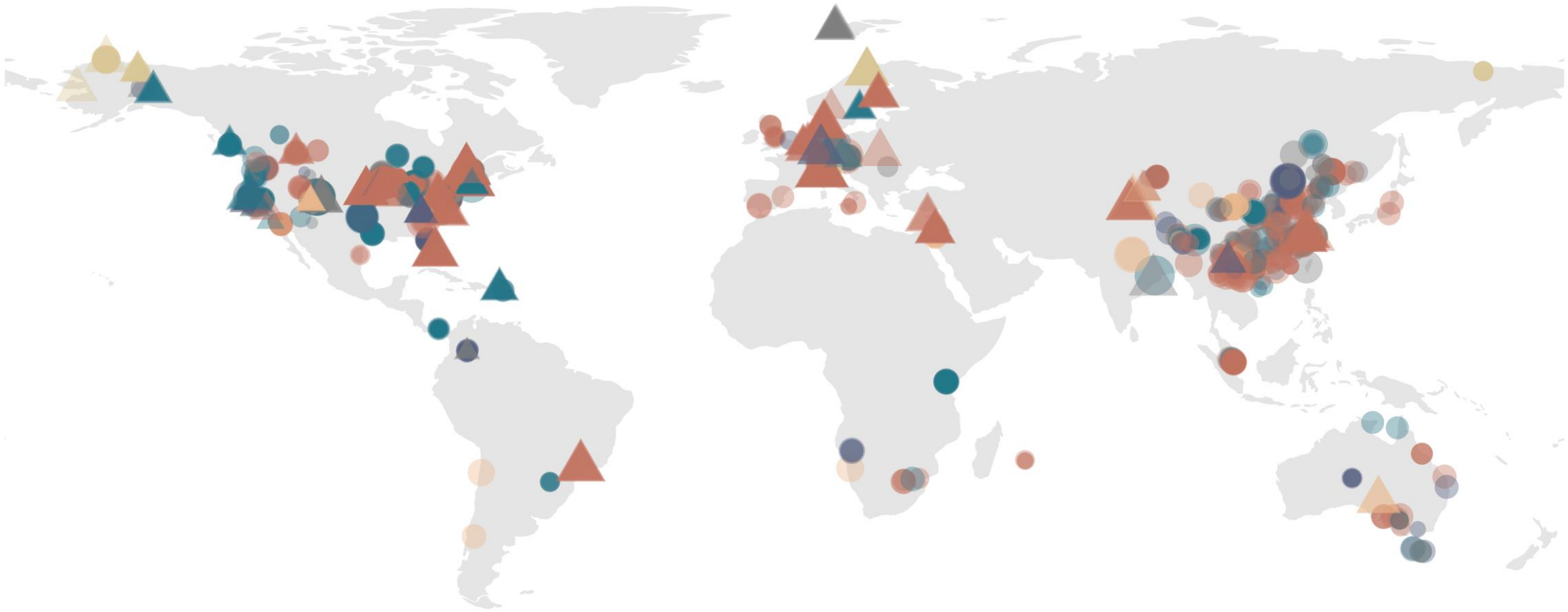


Geographic distribution of soil samples



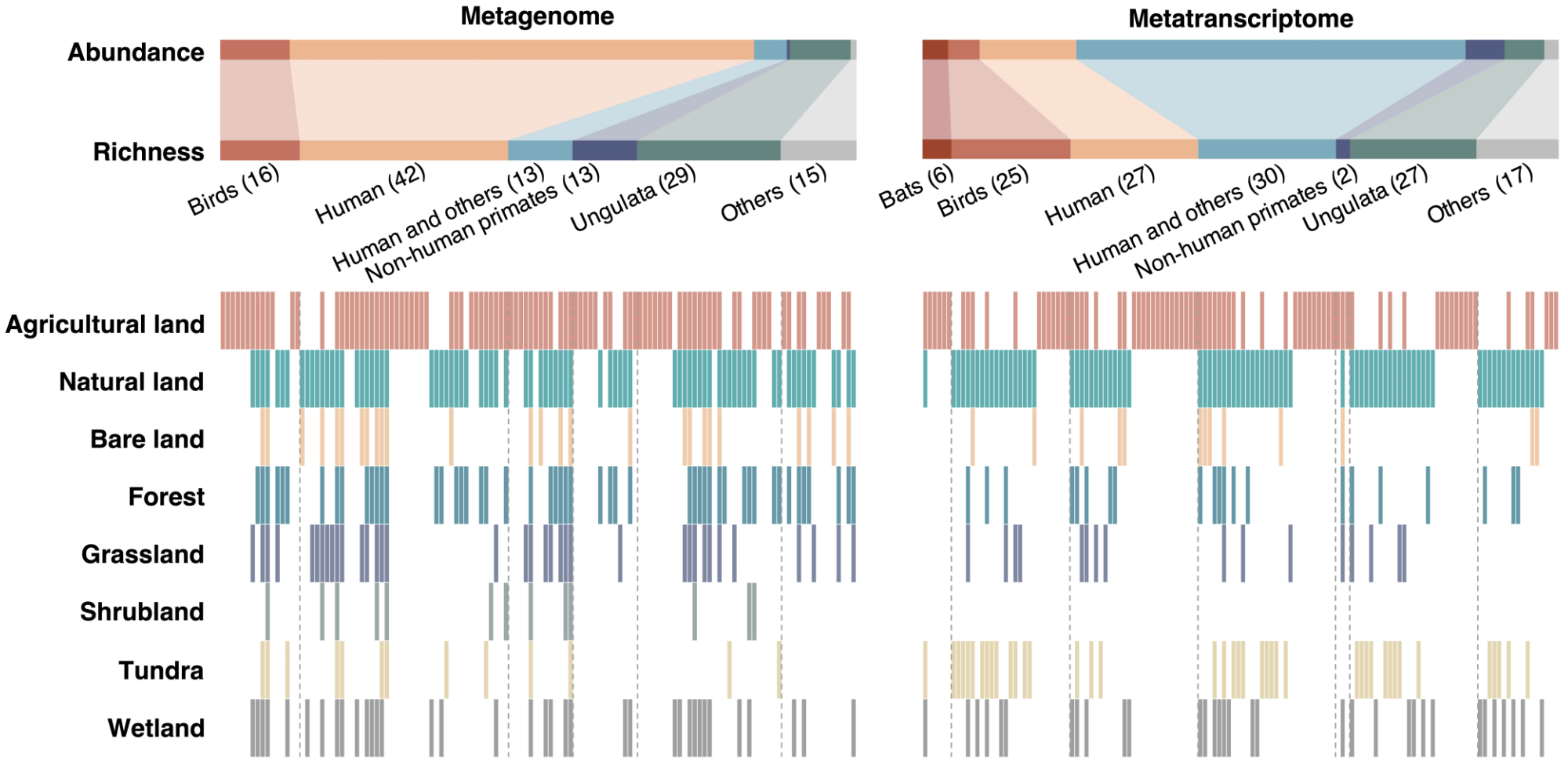
3053 metagenome (~50 Tb) + 1424 metatranscriptome (~15 Tb) samples

Soil serve as a reservoir for vertebrate viruses



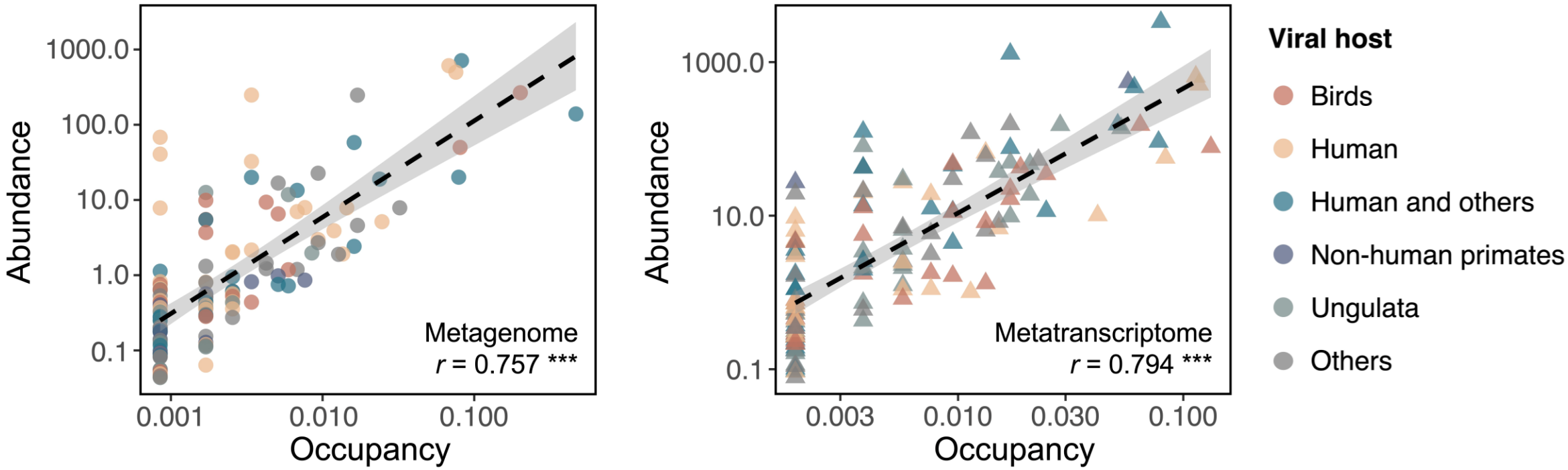
Vertebrate viruses were detected in 38.6% MG samples (128 viruses) and 37.1% MT samples (134 viruses)

Soil serve as a reservoir for vertebrate viruses



Although human-related viruses were detected in less than half of richness, their abundance were >75% in both MG and MT samples.

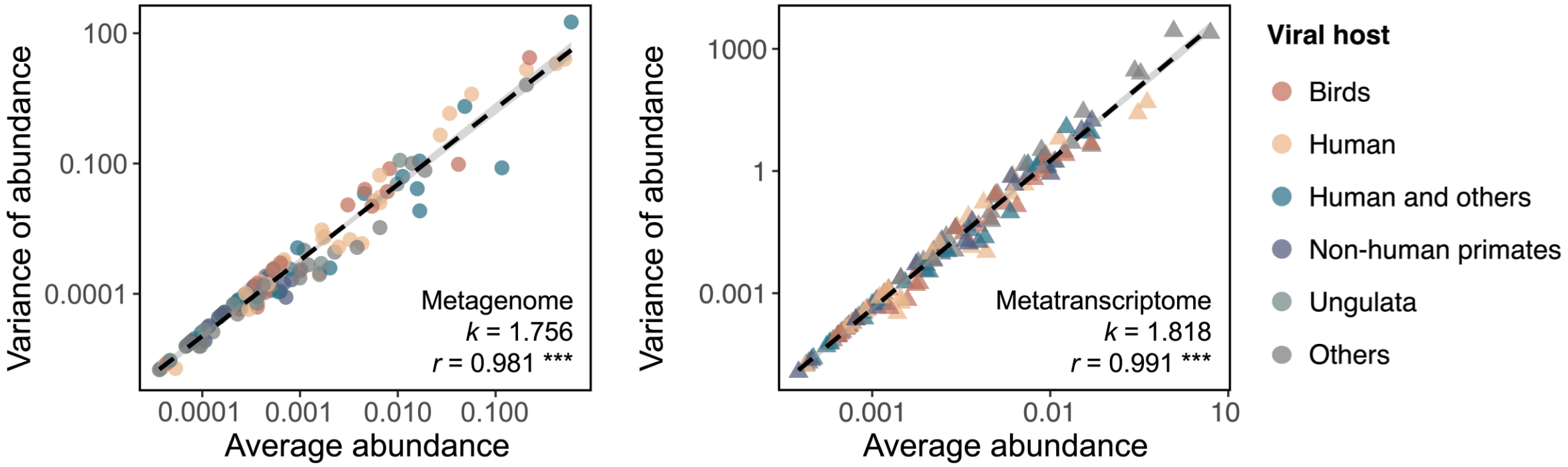
Most vertebrate viruses are conditionally rare



The linear relationship between occupancy and abundance indicated that vertebrate viruses in soils were conditionally rare taxa.

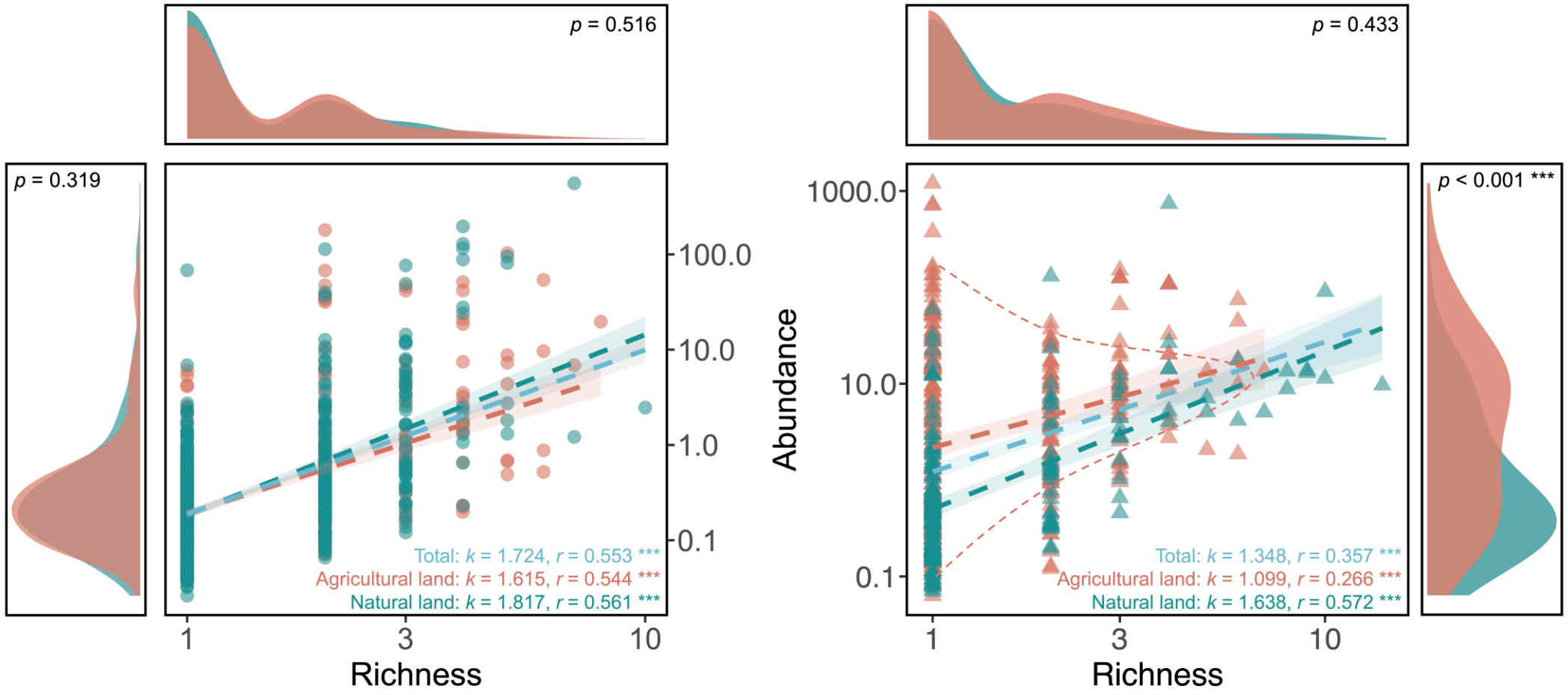
Most vertebrate viruses are conditionally rare

Taylor's Law: $V = aM^k$, a is a constant, k is the exponent of M



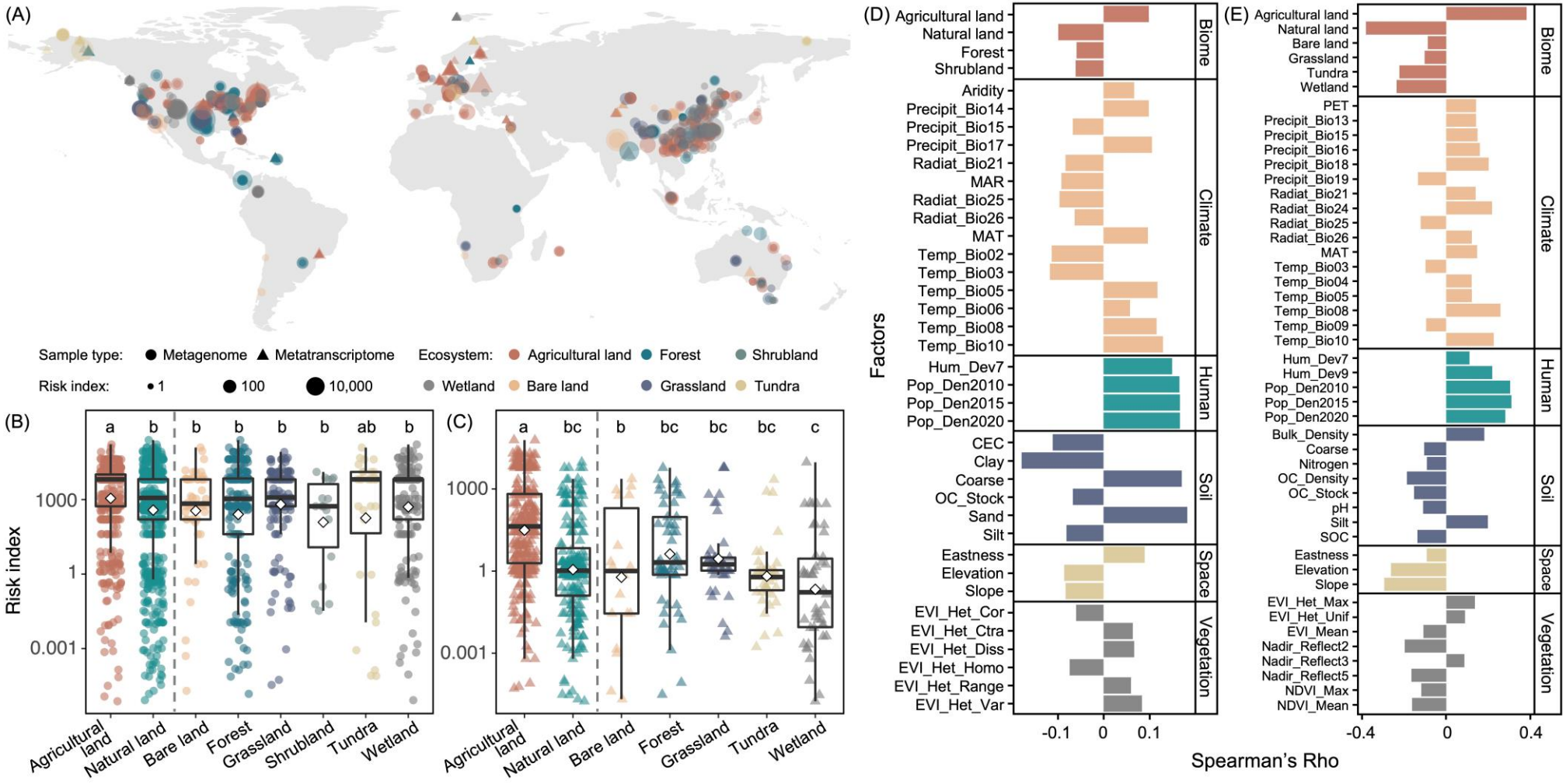
Taylor's law were verified in vertebrate viruses, implying a dependency between average and variance of abundance across soil samples.

Ecosystem mediates distribution patterns of vertebrate viruses in soils



Richness in agricultural soils possessed weaker linear correlations with abundance than in natural soils, which might be caused by anthropogenic disturbance.

Agriculture increases potential health risks of vertebrate viruses



$$\mu_i = \overline{\alpha_i} \times \lambda_i \times \gamma_i$$ μ_i: risk index $\overline{\alpha_i}$: average abundance λ_i: occupancy γ_i: hazard classification

$$\mu = \beta \times \sum_{i=1}^{n} (\alpha_i \times \mu_i)$$ μ: sample risk index β: richness α_i: abundance μ_i: viral risk index

Summary

- Soils are an important mediator of vertebrate viruses.
- Most of vertebrate viruses were conditionally rare and gain/loss in soil samples stochastically, bringing challenges to vertebrate virus surveillance.
- Health risks of vertebrate viruses are aggravated by agriculture related activities, offering a new perspective on comprehension of risks in agricultural expansion.

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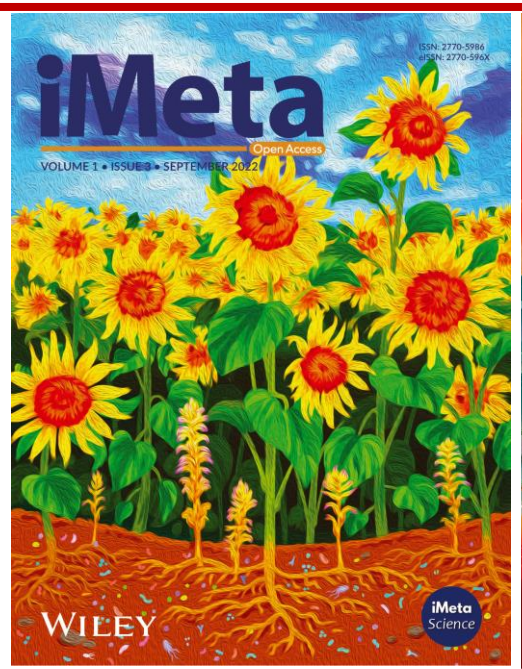

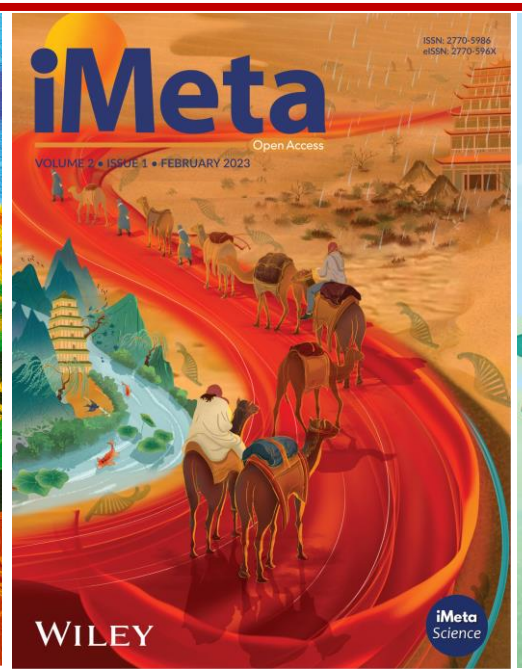

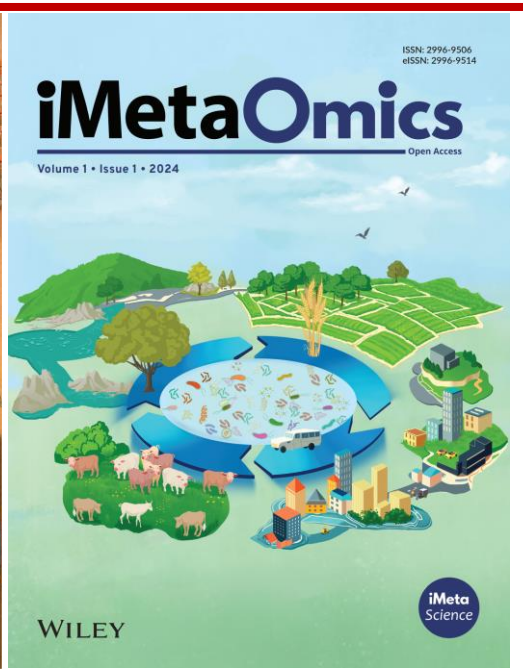

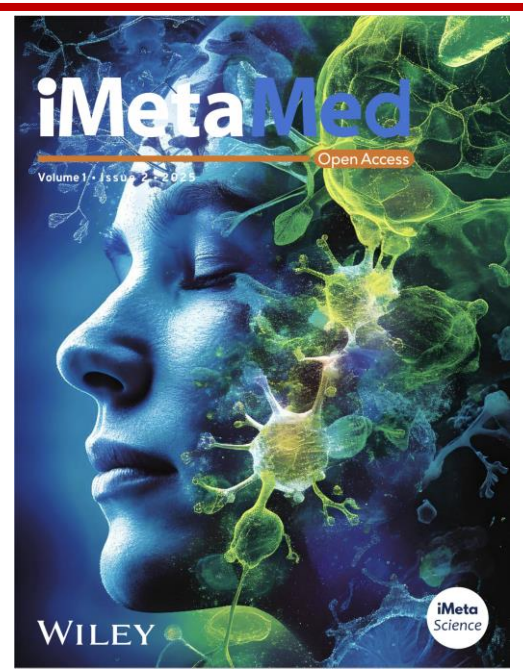

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