

Variations in the latitudinal diversity gradients of the ocean microbiome

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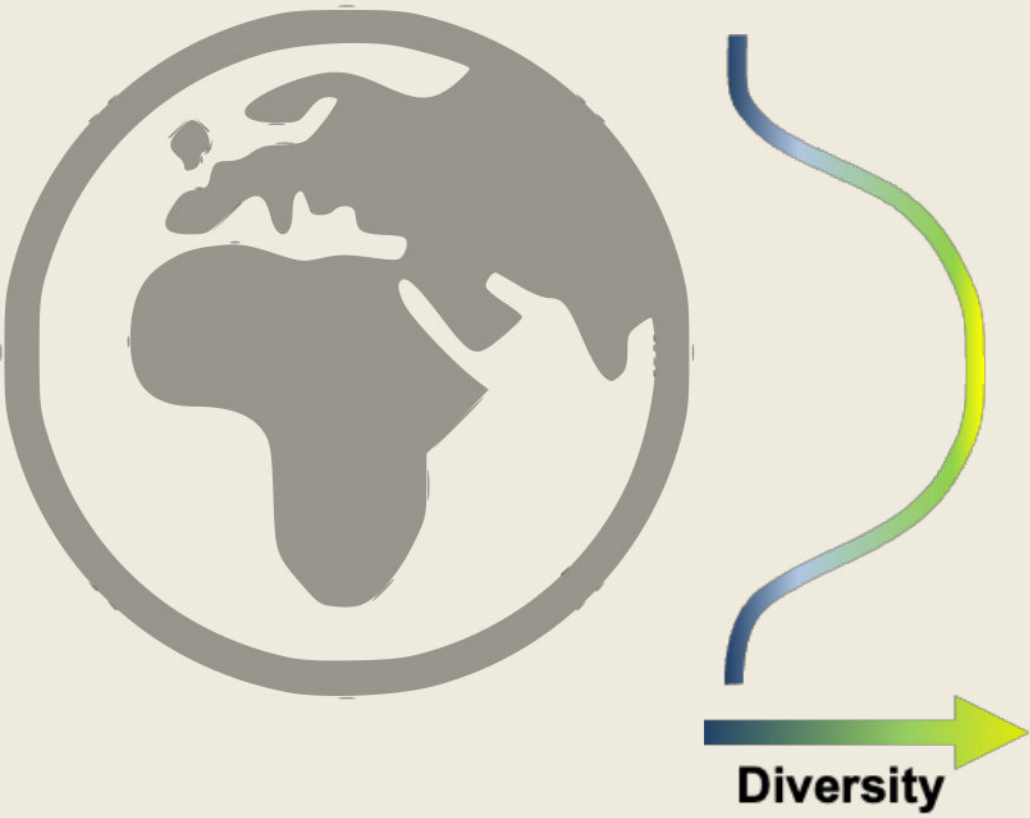
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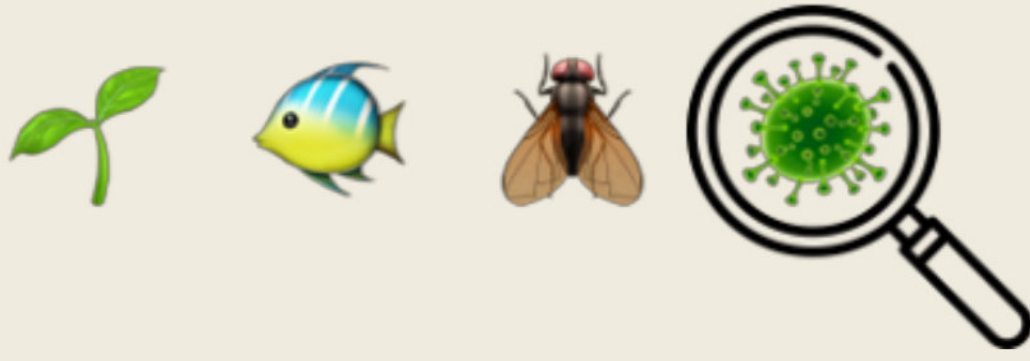
Latitudinal diversity gradients (LDGs)

Definition:

High species richness around the equator, decreases towards the poles



Applies on land and sea and across domains of life, **including prokaryotes**



Discovered >200 years ago, still lacks a generally agreed explanation!

Methods

Biodiversity analysis of surface ocean prokaryotes globally distributed metagenomes

Species-level taxonomic profile (~2,000 metagenomes)

Sample	Species 1	Species 2	Species x
# 1	51	0	...
# 2	23	8	...
# x	...	...	...

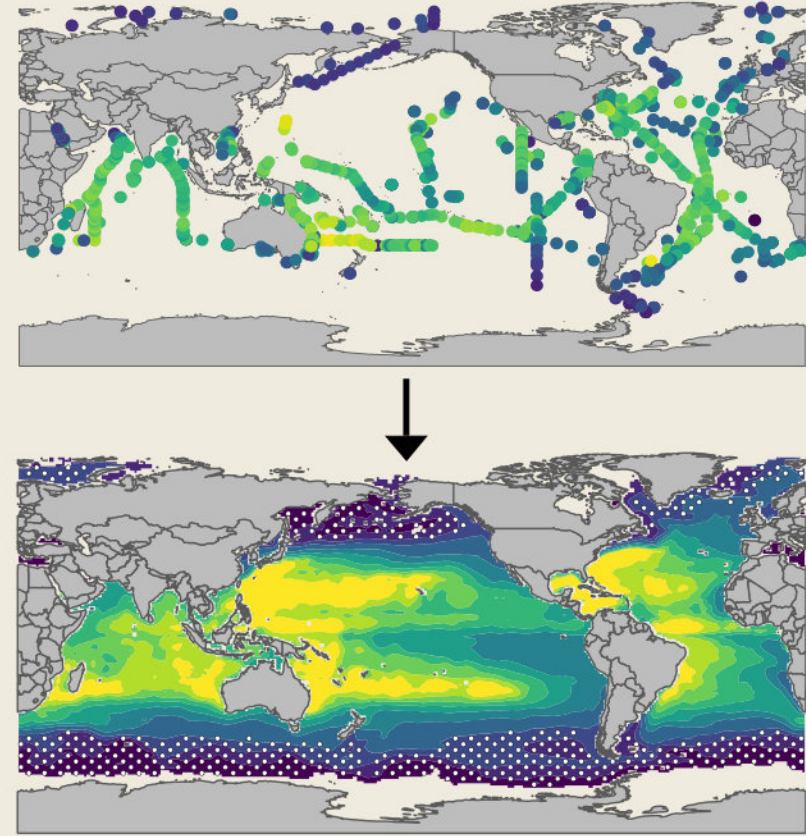
Within-sample observed richness

Spatiotemporal diversity modeling (surface mixed layer)

Sample-wise rarefaction: random subsampling (rarefy, R vegan) to 5,000 species counts

Richness Across: All prokaryotes Taxonomic ranks (Domain-Class)

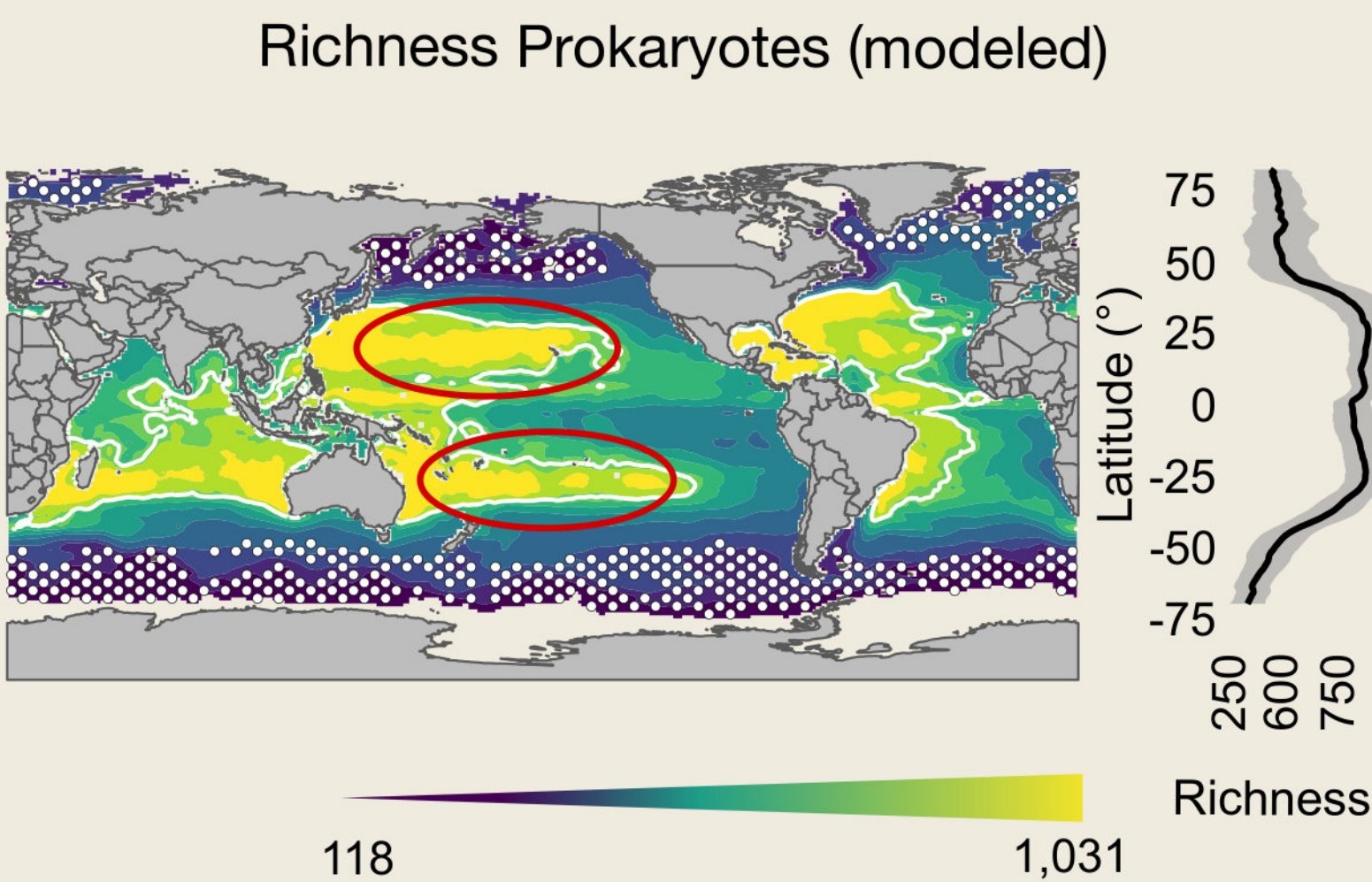
200x calculating diversity at each repetition final diversity is the mean



Results

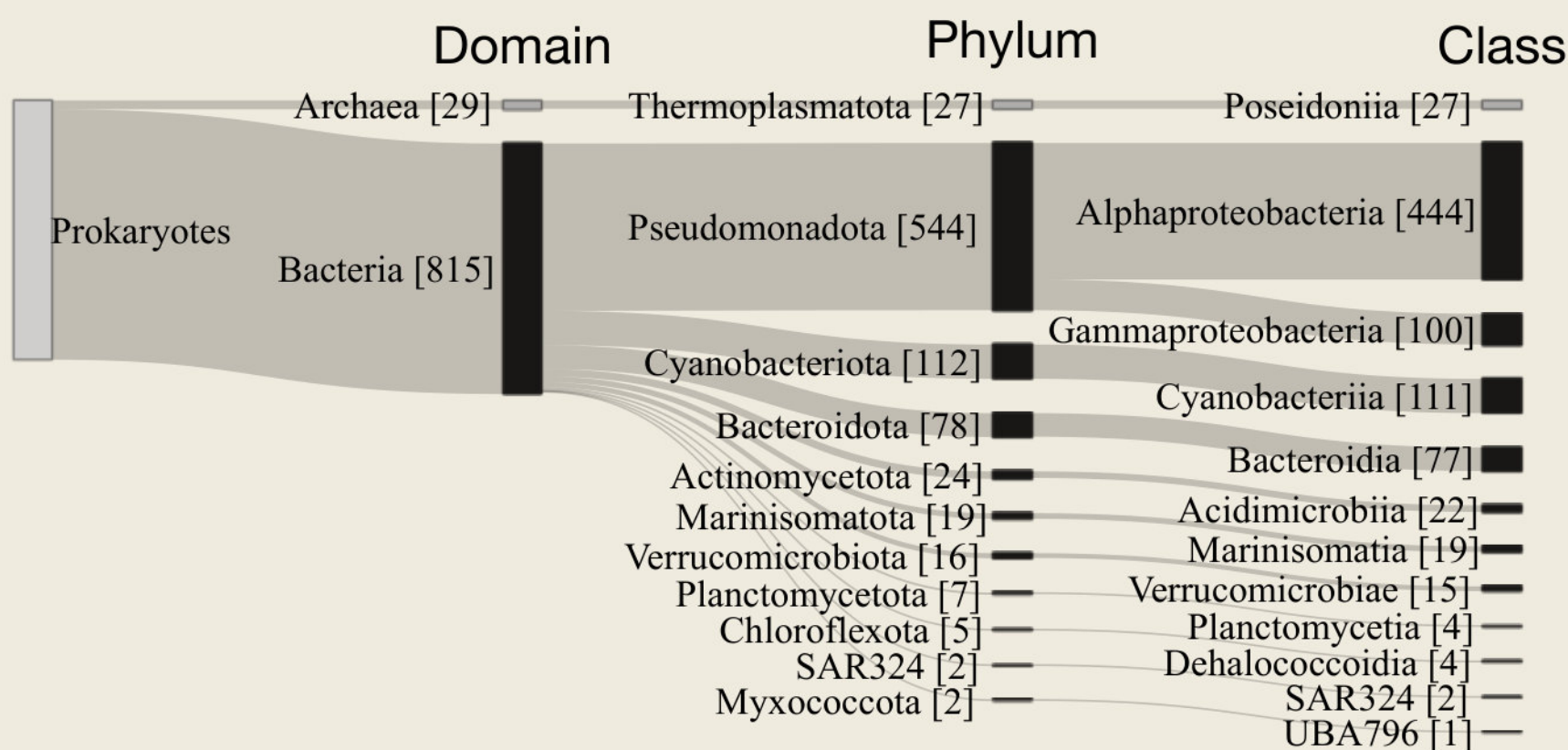
1 The surface ocean LDG is shaped by a few species-rich lineages

Prokaryotic richness peaks at low latitudes, particularly in **nutrient-scarce gyre regions**



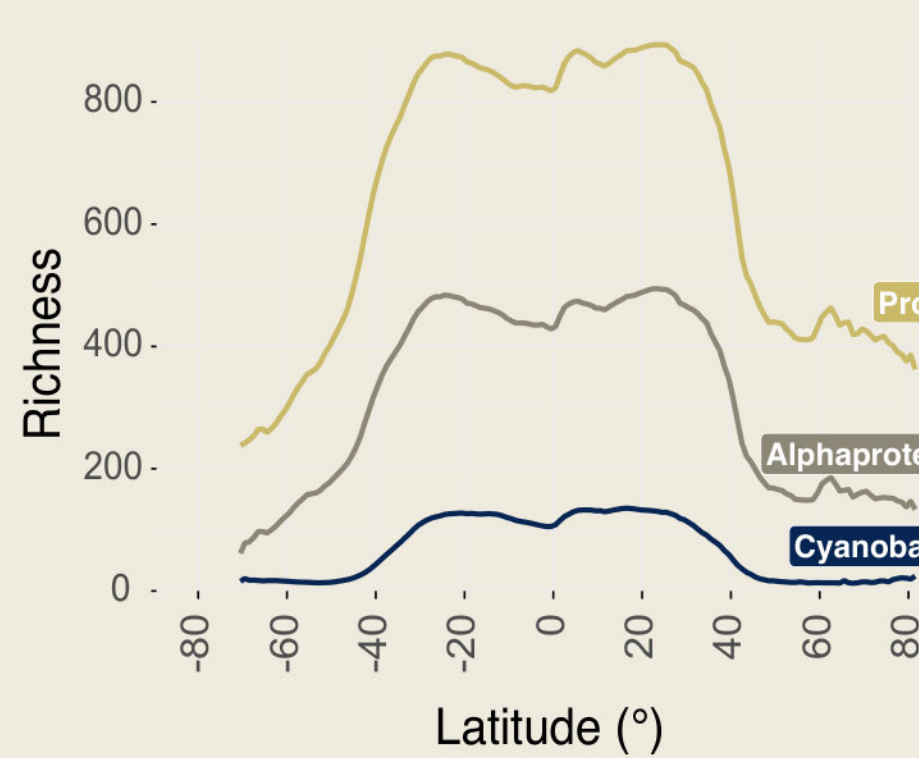
Prokaryotic species richness is dominated by **Pseudomonadota (especially Alphaproteobacteria) & Cyanobacteria**

Mean species richness across surface ocean samples

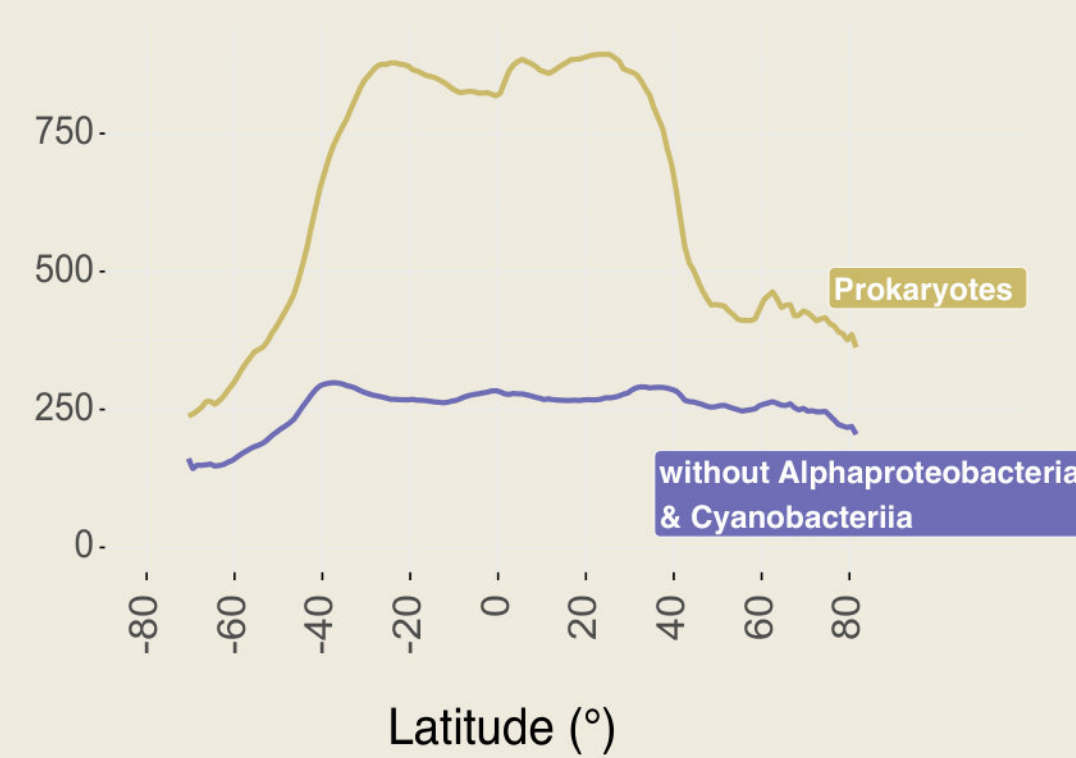


Without Alphaproteobacteria & Cyanobacteriia, the typical LDG shape would not exist for surface ocean prokaryotes

LDGs of most species-rich classes (modeled)



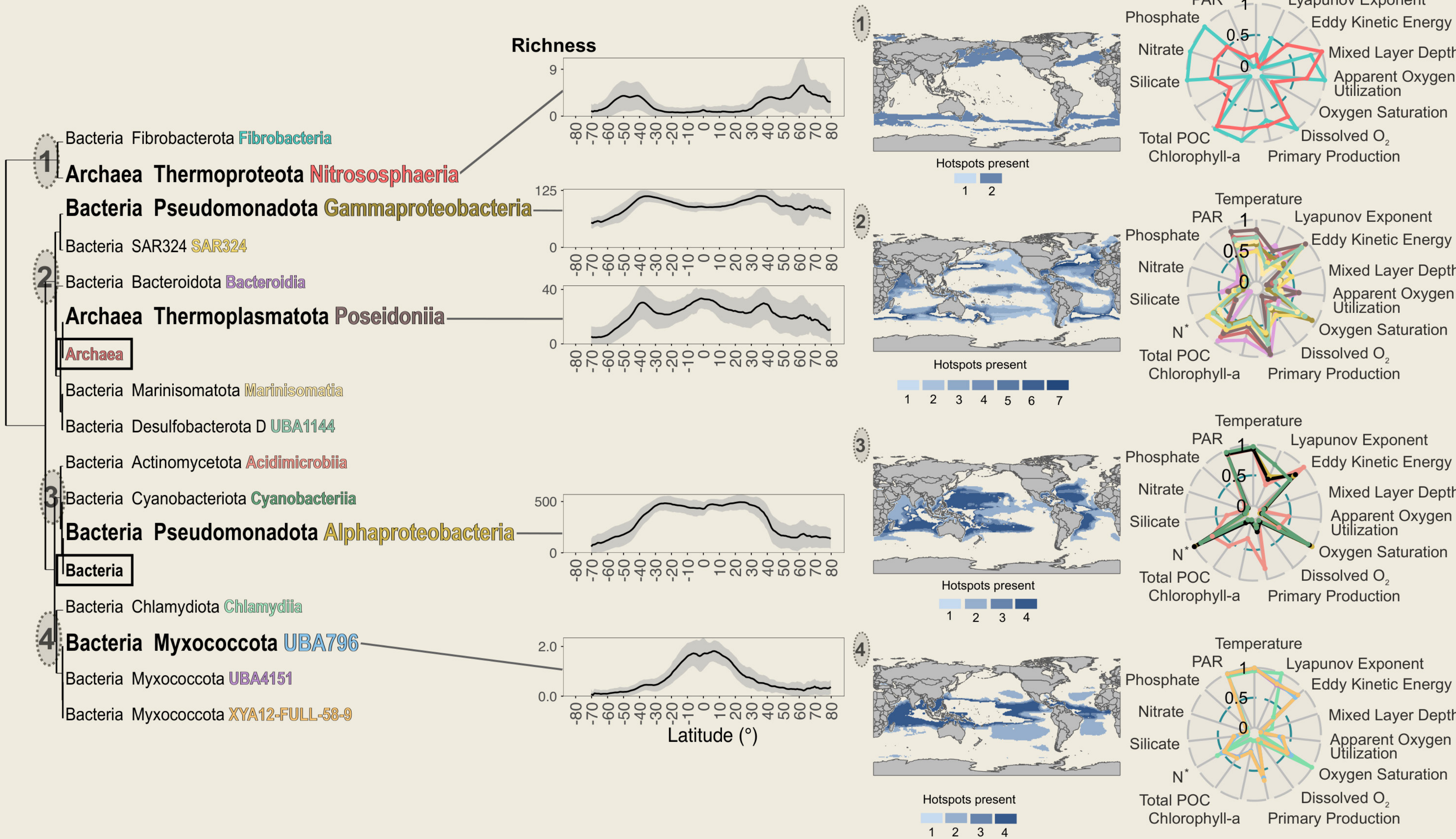
Prokaryotic LDG without most species-rich classes (modeled)



2 Masked by a few species-rich lineages, a variation of LDG shapes exist

Differences in LDG shapes

Richness hotspots & their environmental conditions



Nitrososphaeria (Archaea) peak in polar regions

Abilities to yield energy from ammonia oxidation and urea degradation (1) and to withstand freeze-thaw cycles (2)

Gammaproteobacteria peak outside of nutrient-scarce gyres

Associated with copiotrophic (nutrient-available) conditions (3–4)

Poseidoniiia (Archaea) & Bacteroidia peak in productive regions

Respond to organic matter in upwelling systems (5–7)

Alphaproteobacteria & Cyanobacteriia peak in nutrient-scarce gyres

Many species adapted to low-nutrient conditions (3, 8–9)

“Prokaryotic LDGs are not uniform, but reflect lineage-specific lifestrategies and environmental preferences!”

Outlook

Climate change could affect the biodiversity of different prokaryotic lineages in distinct ways

The lineage-resolved perspective could improve forecasts of prokaryotic biodiversity under climate change

References

- (1) Alonso-Sáez et al., 2012
- (2) Doytchinov & Dimov, 2022
- (3) Ebihara et al., 2024
- (4) Ma et al., 2023
- (5) Qu et al., 2022
- (6) Santoro et al., 2019
- (7) Piontek et al., 2024
- (8) Caille et al., 2024
- (9) Rajaneesh et al., 2020

Acknowledgements



Contact

I'll soon be looking for new research opportunities in computational molecular biology!

JONAS SCHILLER

