

From pattern to action:

Leveraging beta diversity for ecological
understanding and conservation

Caio Graco-Roza
University of Helsinki

Hi! I'm Caio!

A Postdoc trying to figure out what drives community variation in space and time



Ecologist



AI, R, Data analysis, Data visualisation



Statistics and modelling



Art lover / Musician / Talk a lot



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Art lover / Musician / Talk a lot

Not good at running uphill



Our Talk Today

Topics We'll Cover

Beta diversity

Functional traits

Theoretical applications

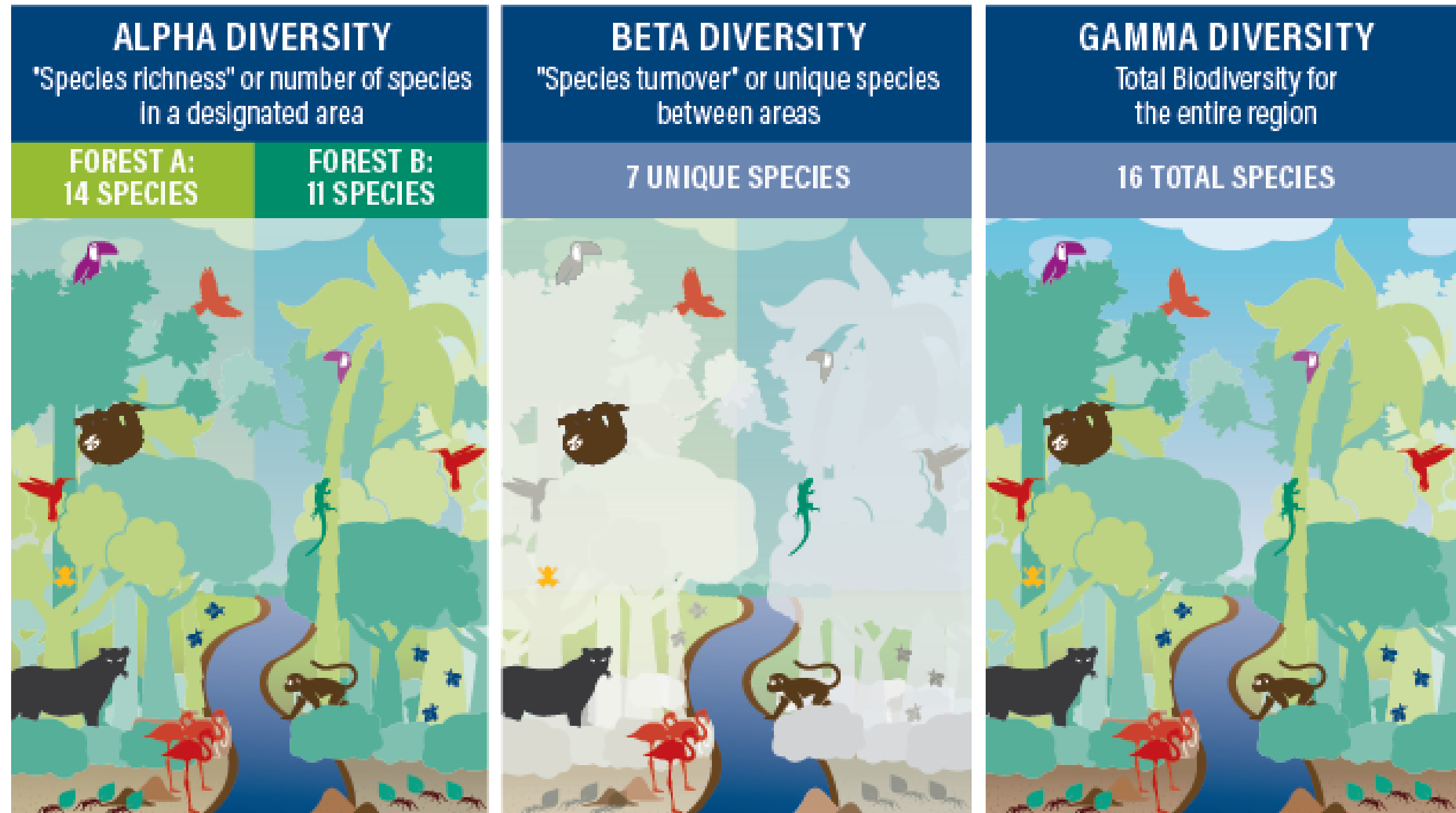
Practical applications



Measurements of Biodiversity within Ecosystems

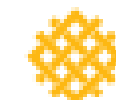
What is beta diversity?

Just another greek letter in front of a word to give it some scientific meaning?



Source: Global Forest Watch

20.04.20



WORLD RESOURCES INSTITUTE

What drives beta diversity?

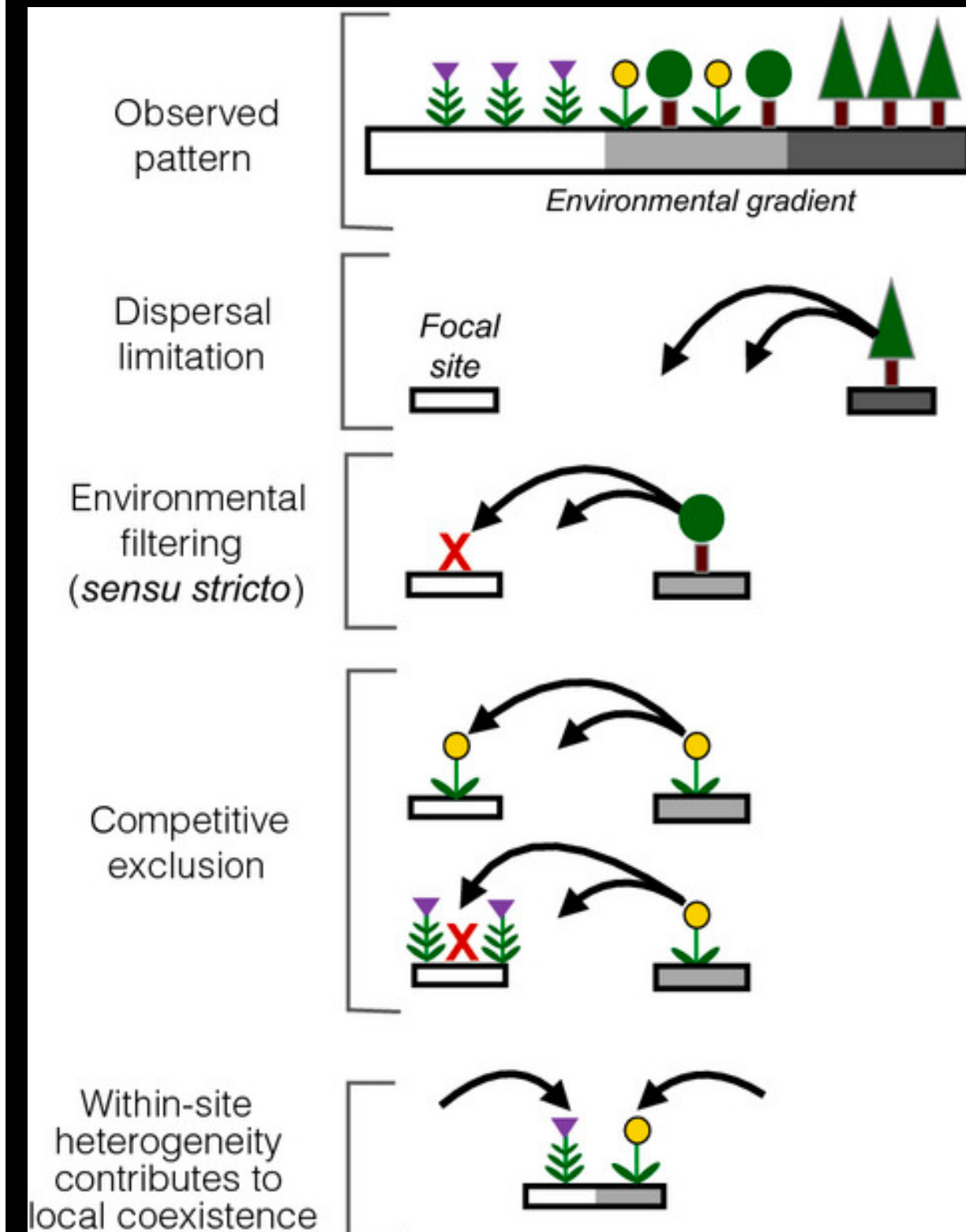
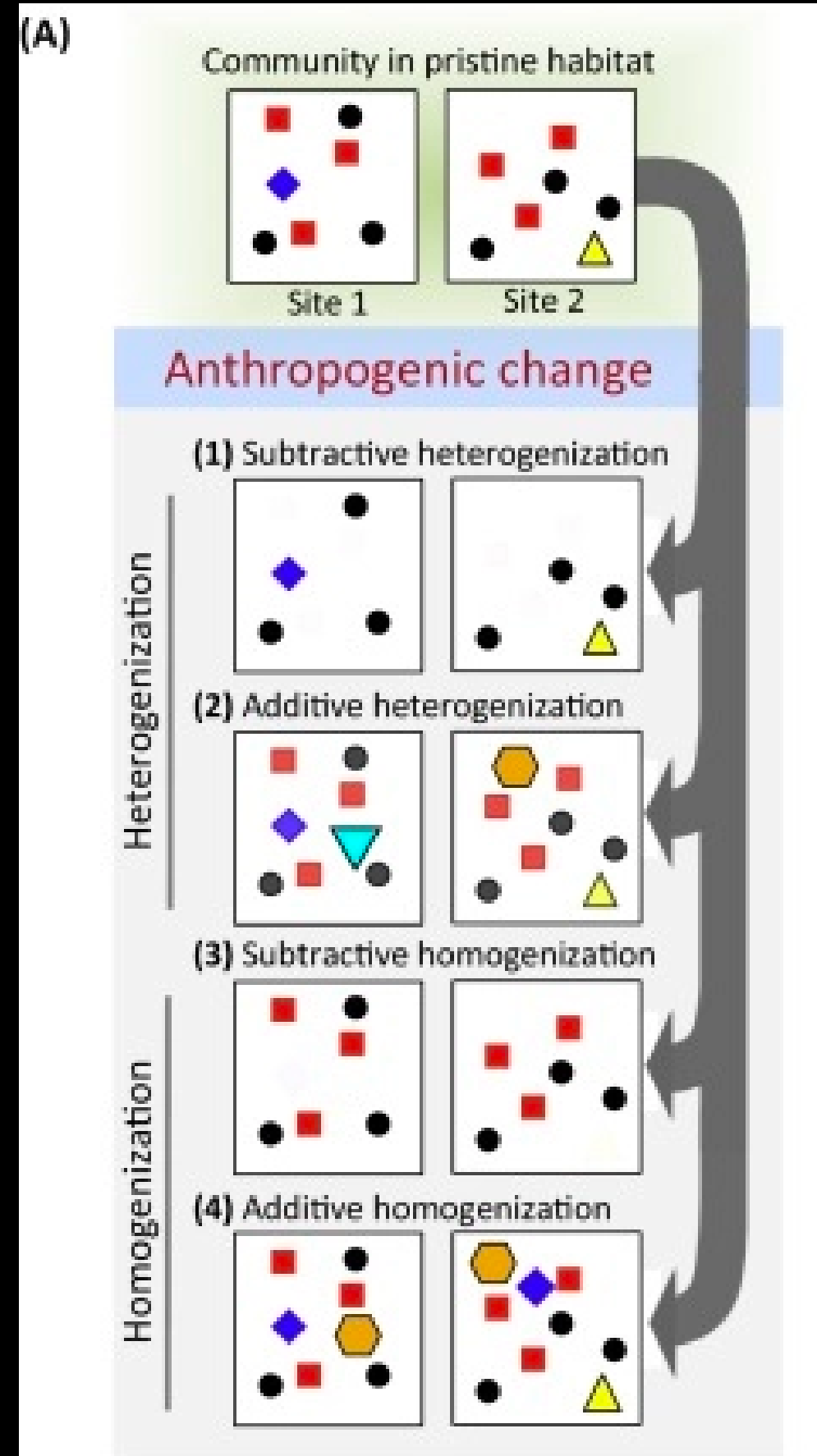
How can we connect our passive learning into active investigation?

How Should Beta-Diversity Inform Biodiversity Conservation?

Jacob B. Socolar • James J. Gilroy • William E. Kunin • David P. Edwards

Community assembly, coexistence and the environmental filtering metaphor

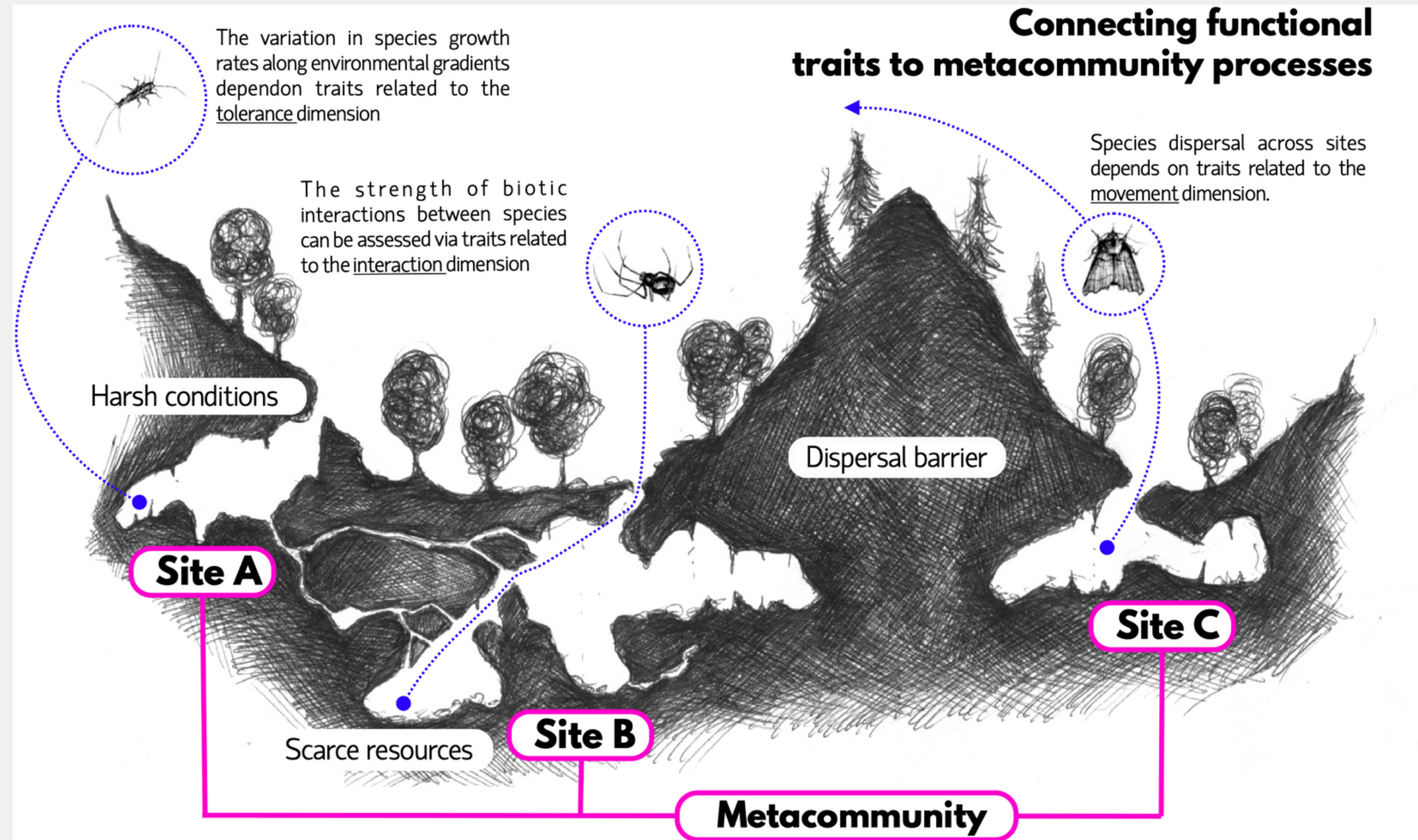
Nathan J. B. Kraft • Peter B. Adler • Oscar Godoy • Emily C. James • Steve Fuller • Jonathan M. Levine



Theoretical applications

"We must consider the distinctive characters and the general nature of plants from the point of view of their morphology, their behaviour under external conditions, their mode of generation, and the whole course of their life."

(Theophrastus 300 BC)



Theoretical applications

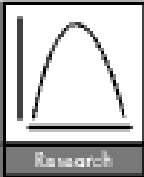
Journal of Biogeography, 26, 867–878



The distance decay of similarity in biogeography and ecology

Jeffrey C. Nekola* and Peter S. White *Curriculum in Ecology, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina 27599, U.S.A.*

1833 cit.



Ecography 30: 3–12, 2007
doi: 10.1111/j.2006.0906-7590.04817.x
Copyright © Ecography 2007, ISSN 0906-7590
Subject Editor: Andrew Liebhold. Accepted 20 September 2006

The distance decay of similarity in ecological communities

Janne Soininen, Robert McDonald and Helmut Hillebrand

1038 cit.

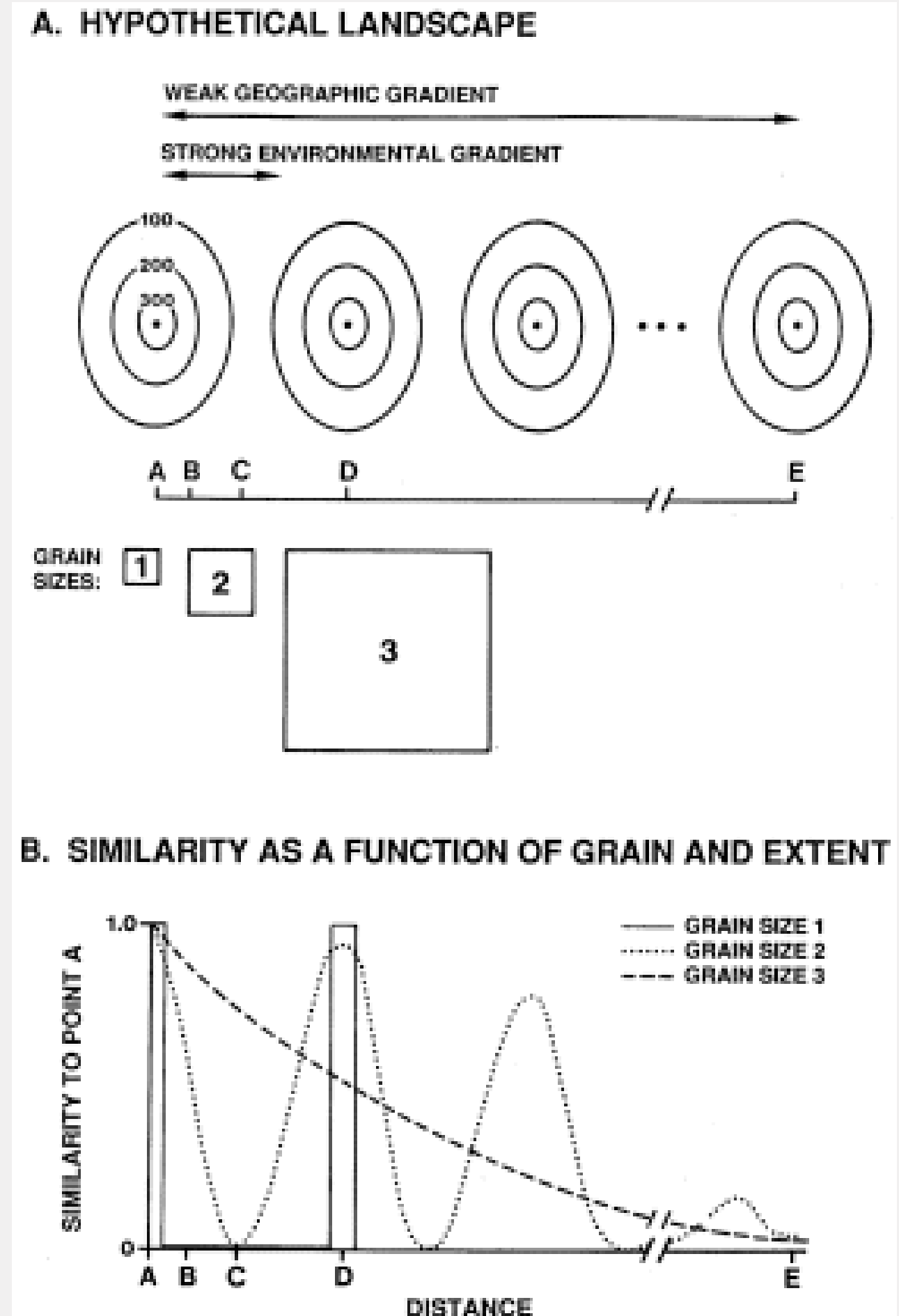
ECOLOGY LETTERS

Open Access

A general framework for the distance–decay of similarity in ecological communities

Hélène Morlon✉, George Chuyong, Richard Condit, Stephen Hubbell, David Kenfack, Duncan Thomas, Renato Valencia, Jessica L. Green

359 cit.



Filling in the gaps

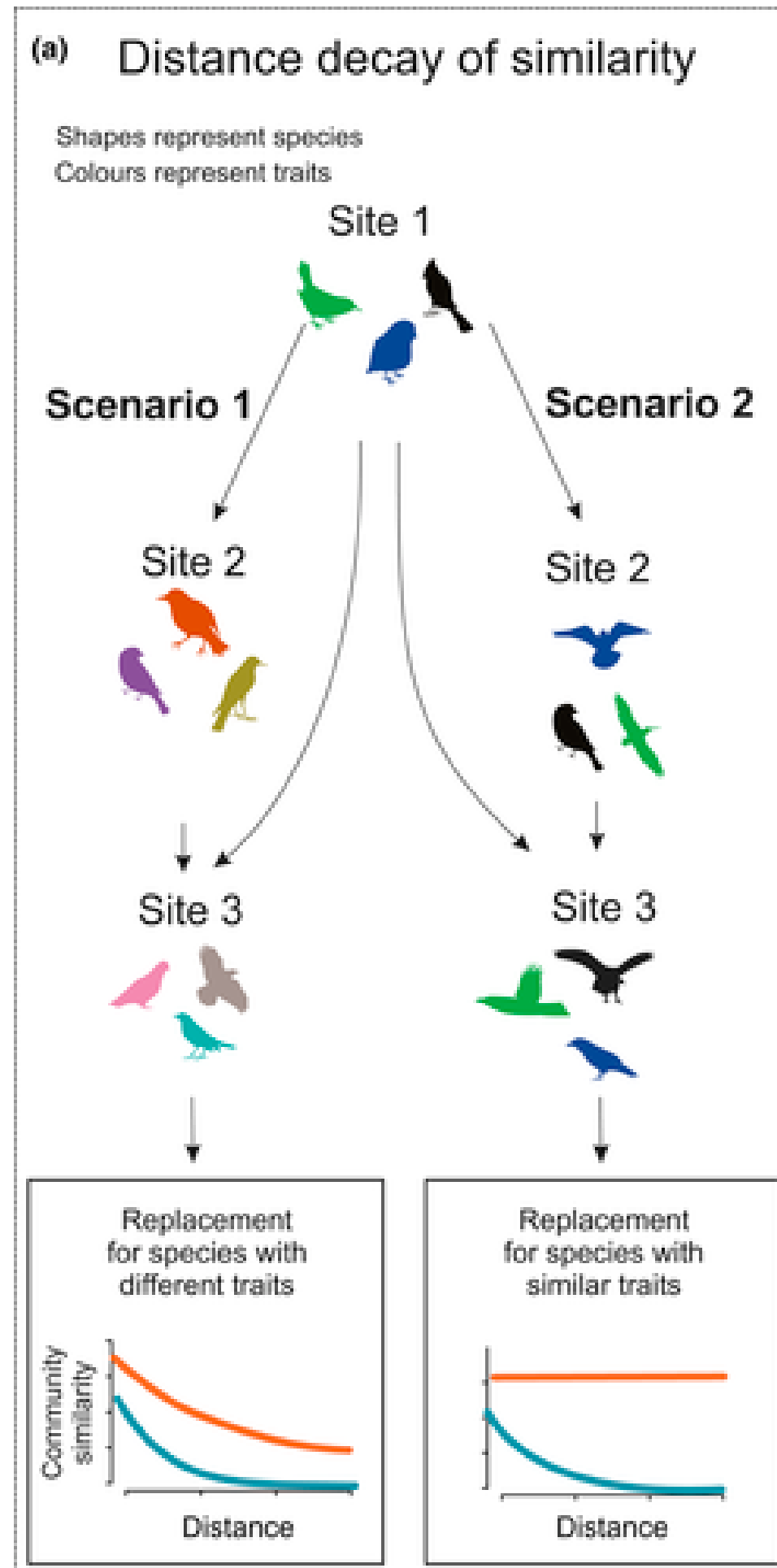
Using functional beta diversity to understand ecological processes.

Global Ecology
and Biogeography

A Journal of
Macroecology

RESEARCH ARTICLE | [Open Access](#) |

Distance decay 2.0 – A global synthesis of taxonomic and functional turnover in ecological communities



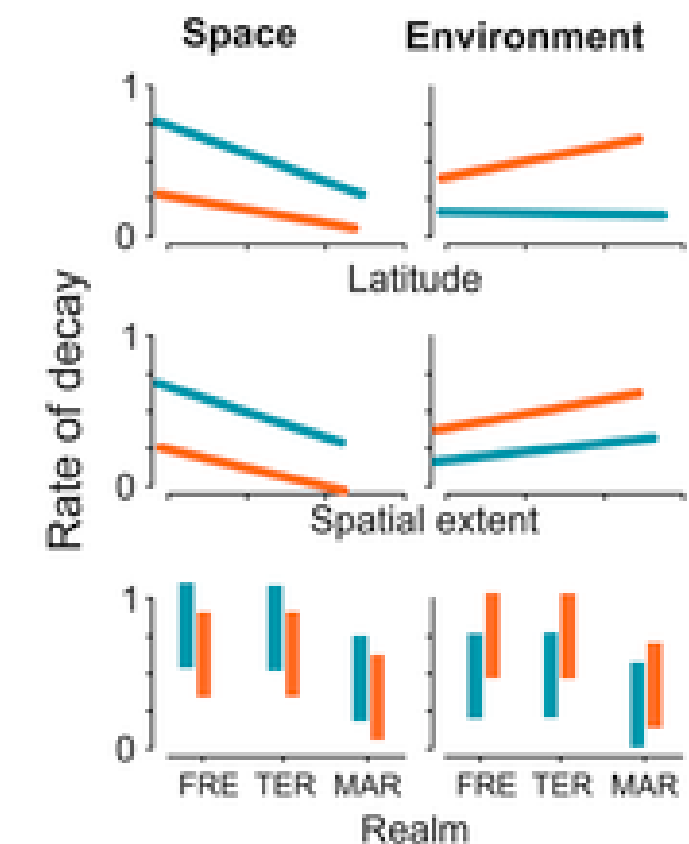
(b) Master hypothesis

Strength of the distance decay



(c) Specific hypotheses

Rate of decay



Taxonomic:

Functional:

Filling in the gaps

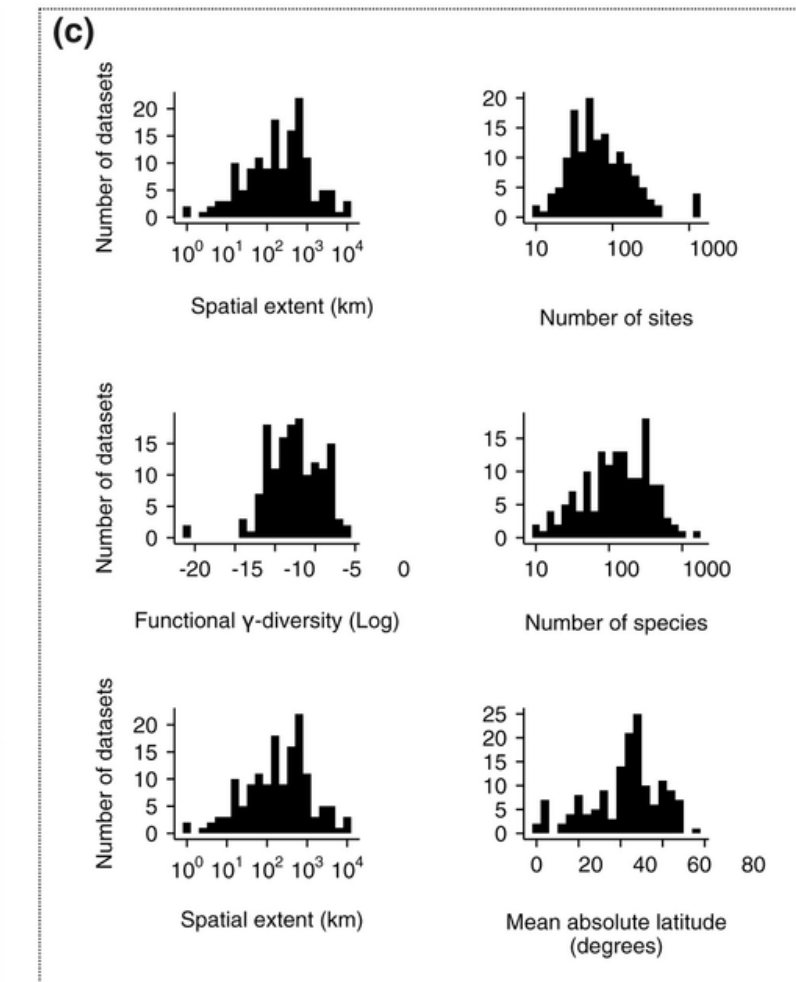
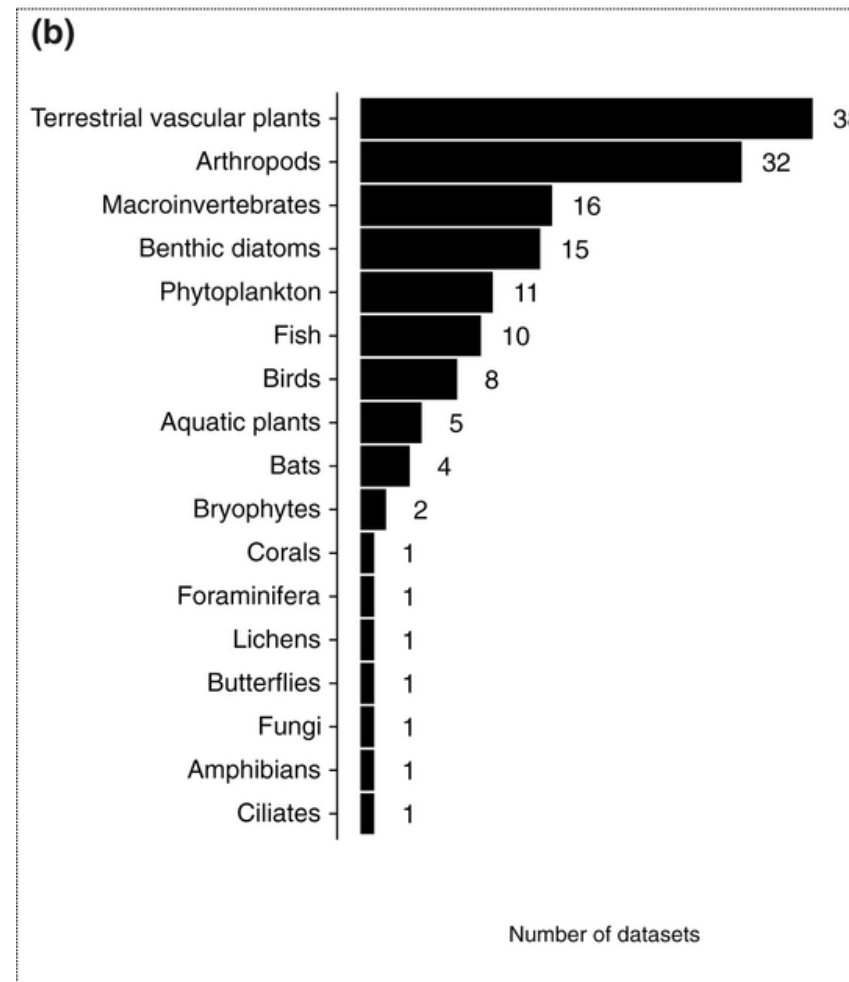
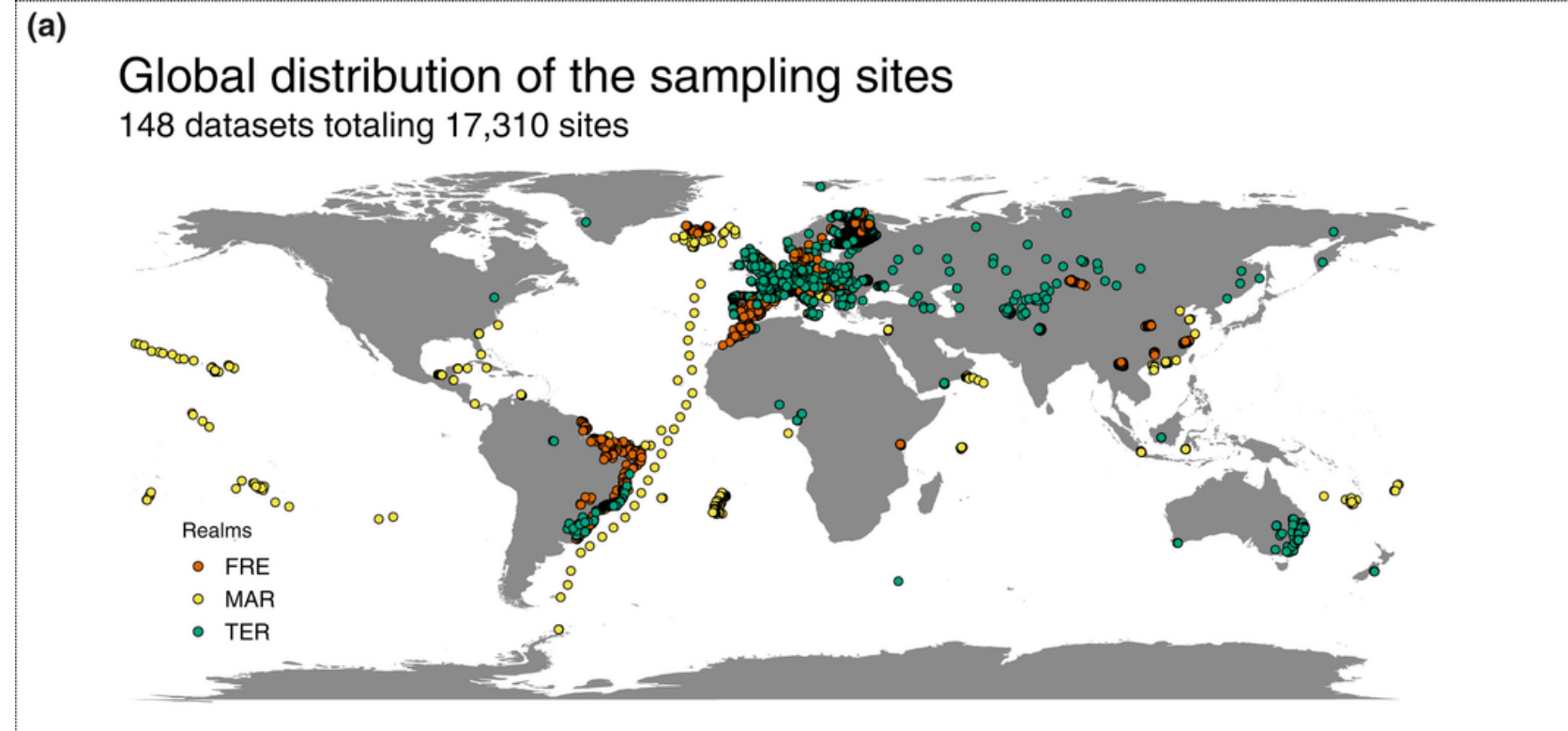
Using functional beta diversity to understand ecological processes.

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Distance decay 2.0 – A global synthesis of taxonomic and functional turnover in ecological communities



Filling in the gaps

Using functional beta diversity to understand ecological processes.

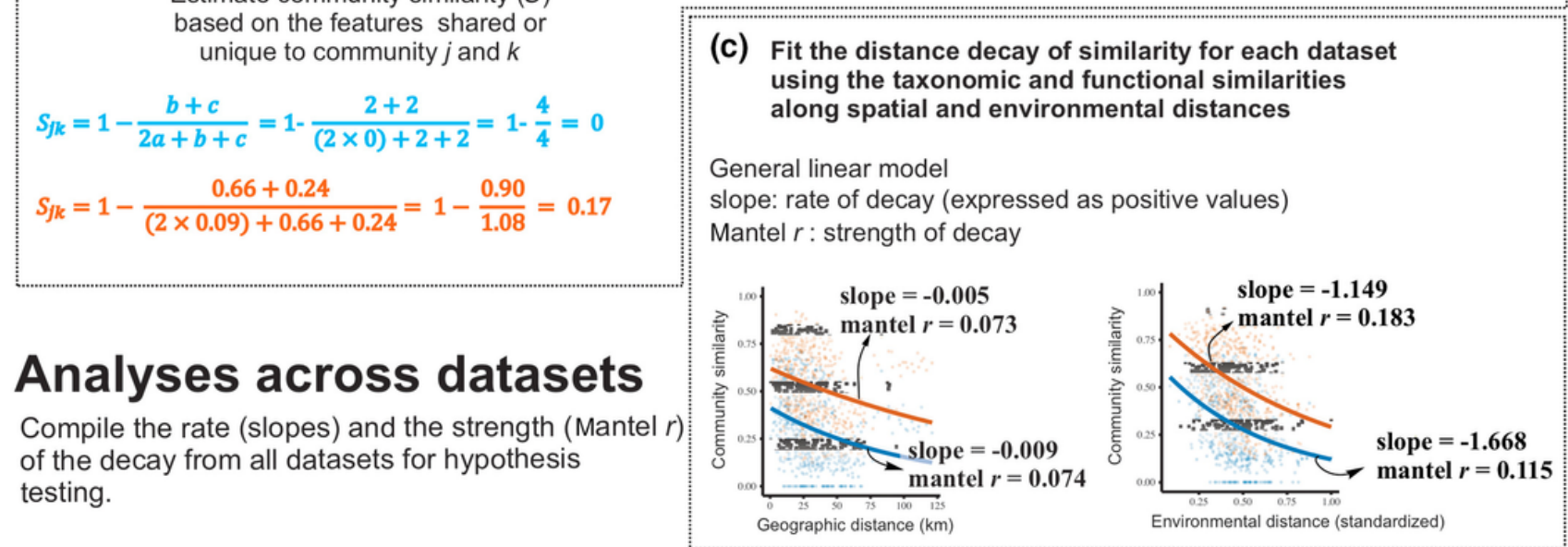
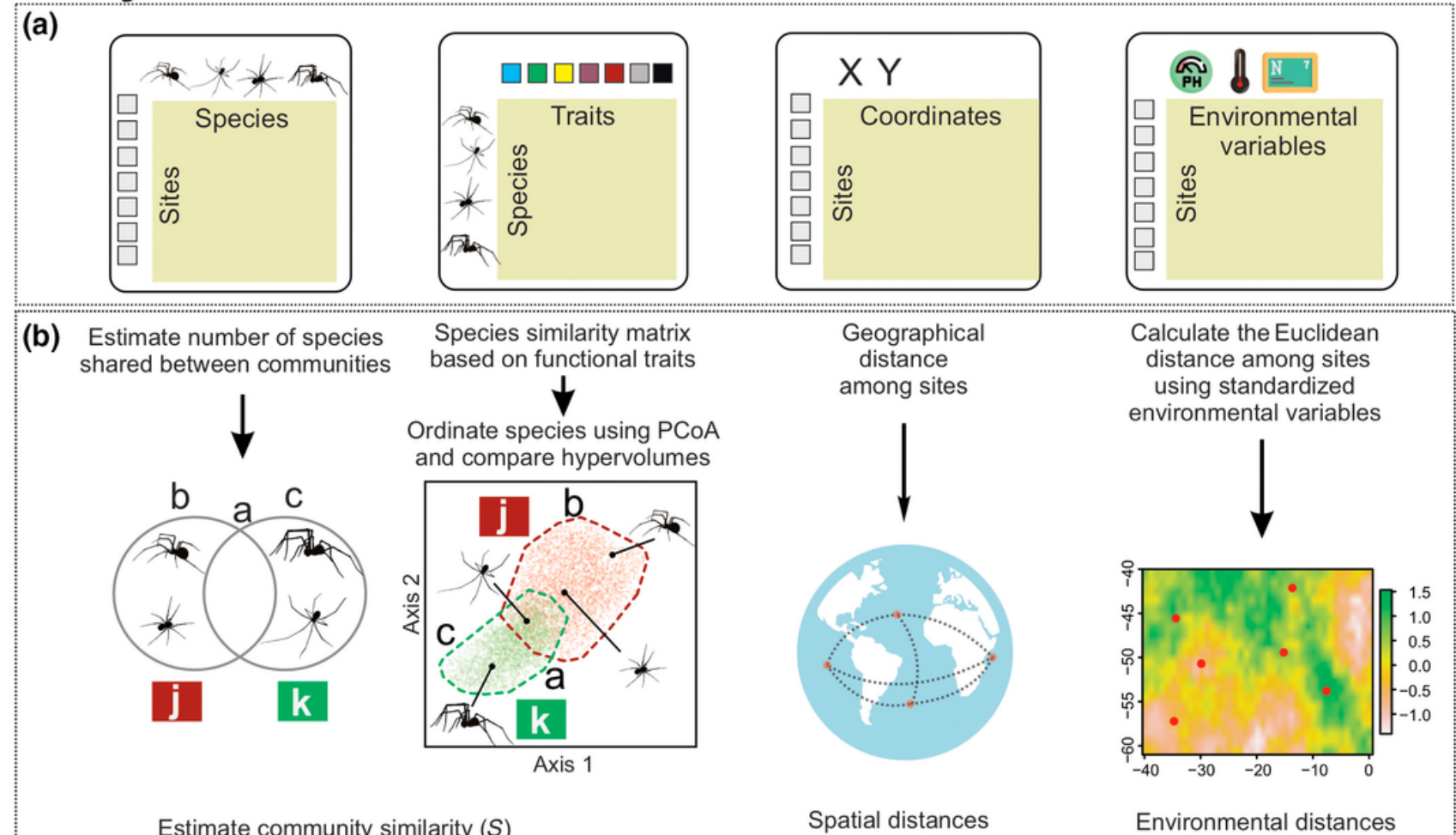
Global Ecology and Biogeography

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Distance decay 2.0 – A global synthesis of taxonomic and functional turnover in ecological communities

Analyses within datasets



Analyses across datasets

Compile the rate (slopes) and the strength (Mantel r) of the decay from all datasets for hypothesis testing.

(d) Testing hypothesis H_1

Analysis: Student's paired t -test
Response variable: strength of decay (Mantel r)
Comparison: taxonomic vs. functional
Number of tests: two (along spatial and environmental gradients)

Testing hypothesis $H_2 - H_4$

Analysis: boosted regression trees (BRT)
Response variable: rate of decay (slopes)
Predictor variables: geographical and ecological factors
Number of tests: four (taxonomic and functional decay rate along spatial and environmental gradients)

Geographic and ecological factors	Space	Environment
	Latitude	● ●
Spatial extent	● ●	● ●
Realm	● ●	● ●
Body size	● ●	● ●
Dispersal mode	●	●
Taxonomic γ -diversity	●	●
Functional γ -diversity	●	●
Number of sites	● ●	
Number of environmental variables		● ●

Filling in the gaps

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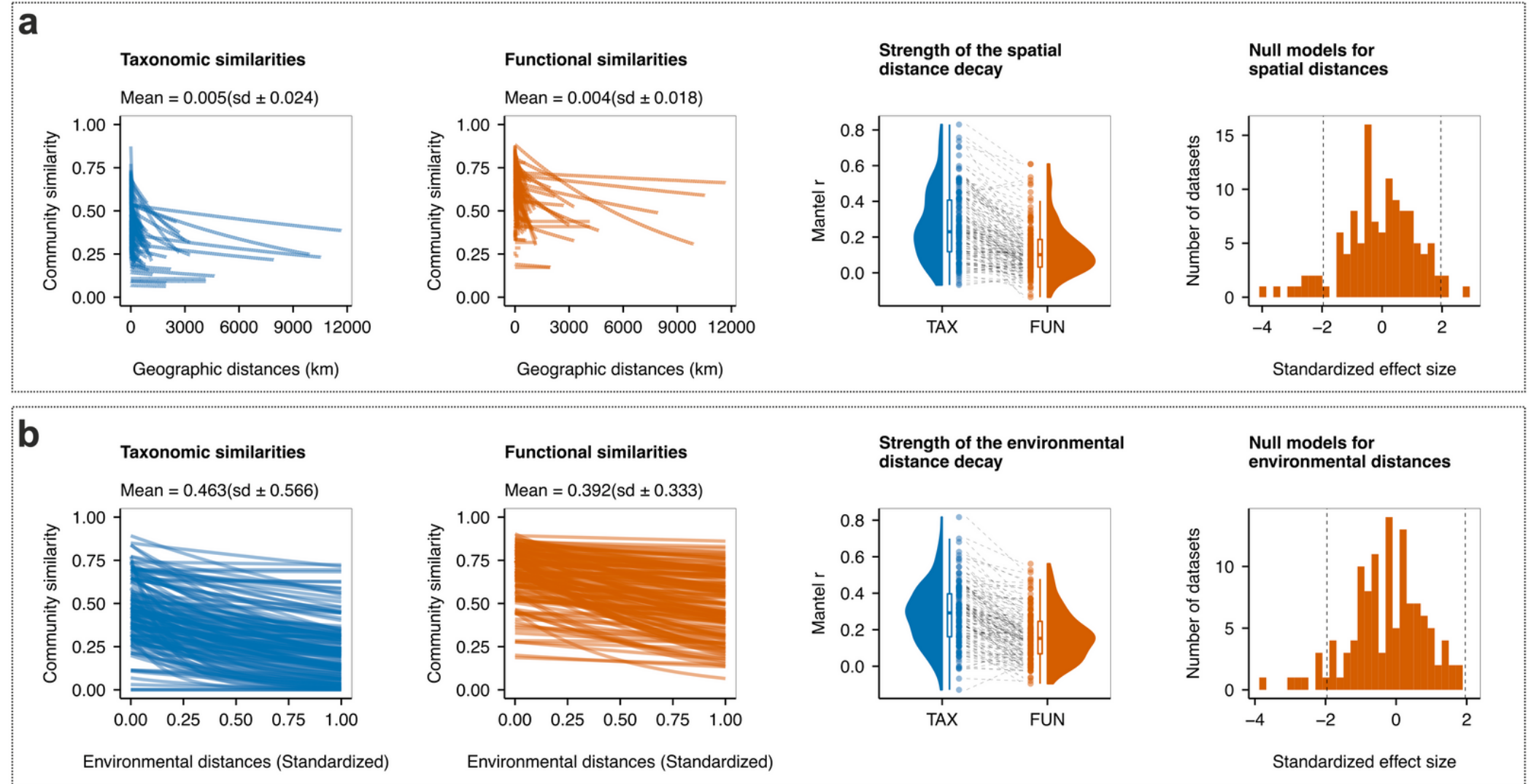
RESEARCH ARTICLE | [Open Access](#) |  

Distance decay 2.0 – A global synthesis of taxonomic and functional turnover in ecological communities

- Taxonomic beta diversity has stronger correlation with both spatial and environmental distances.
- Patterns of functional diversity are overall indistinguishable from those of taxonomic diversity.

The shape and strength of the distance decay

Using occurrence-based total similarities



Filling in the gaps

Global Ecology
and Biogeography

A Journal of
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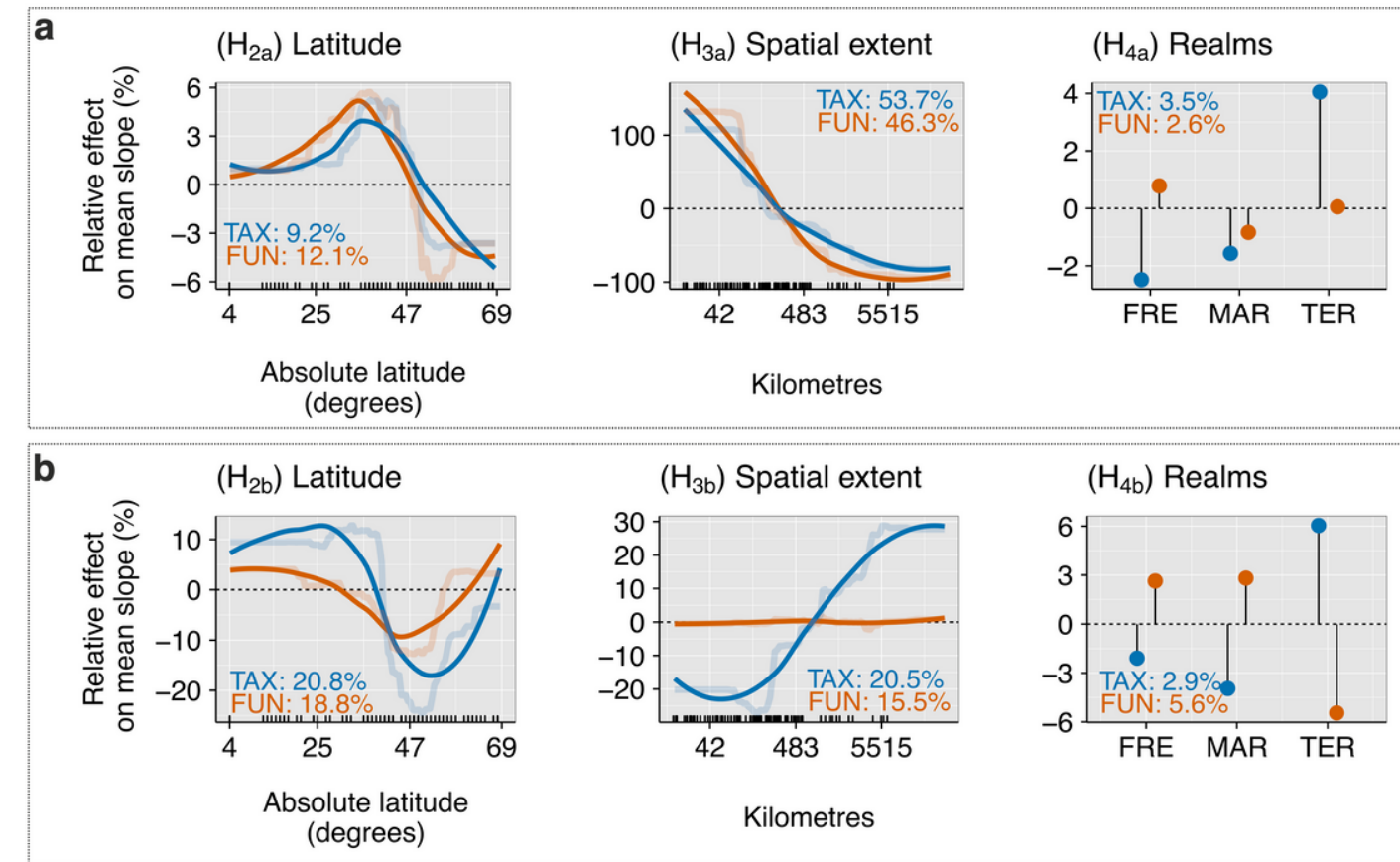
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Distance decay 2.0 – A global synthesis of taxonomic and functional turnover in ecological communities

- Congruence between functional and taxonomic diversity patterns.
- Functional beta diversity may be a cost-effective option for investigating how human activities modify ecosystems.

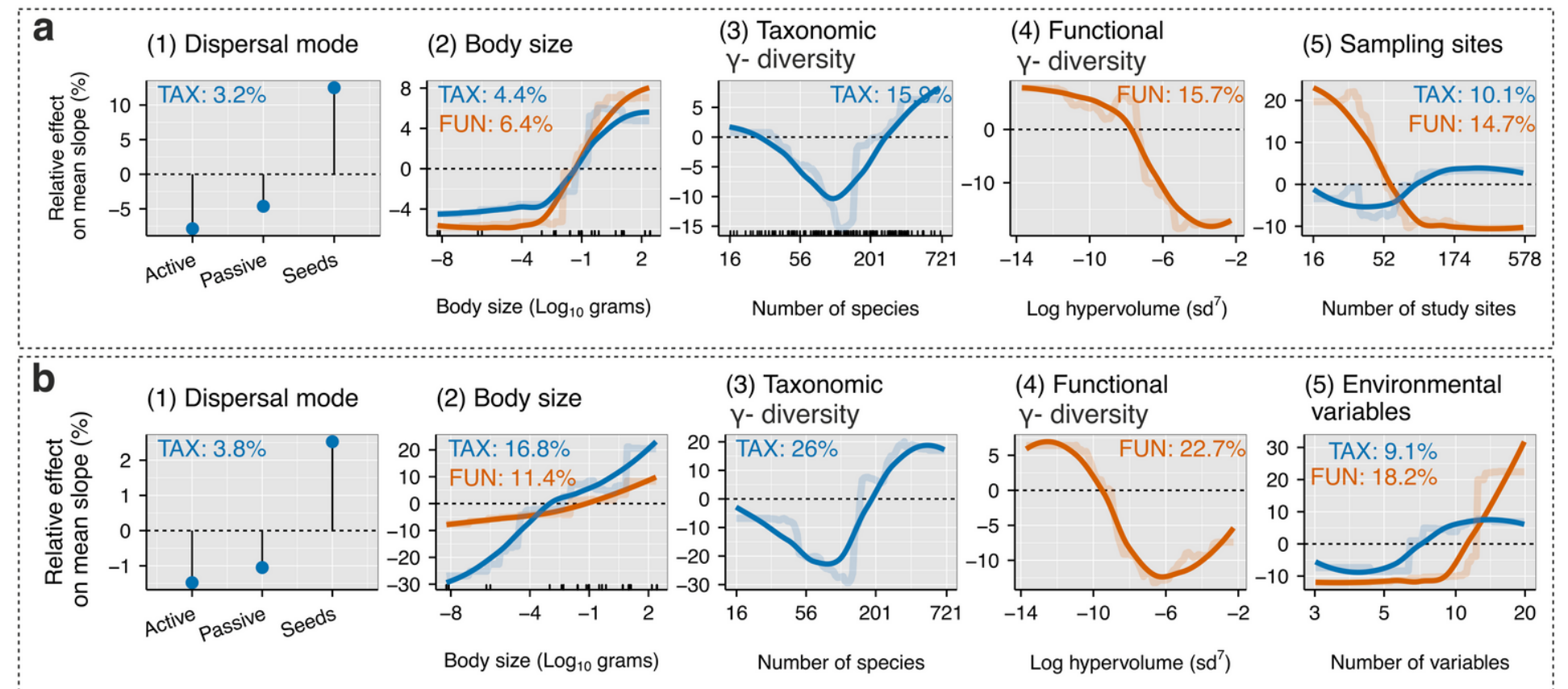
Effects of geographic factors on the rate of decay

Using occurrence-based total similarities



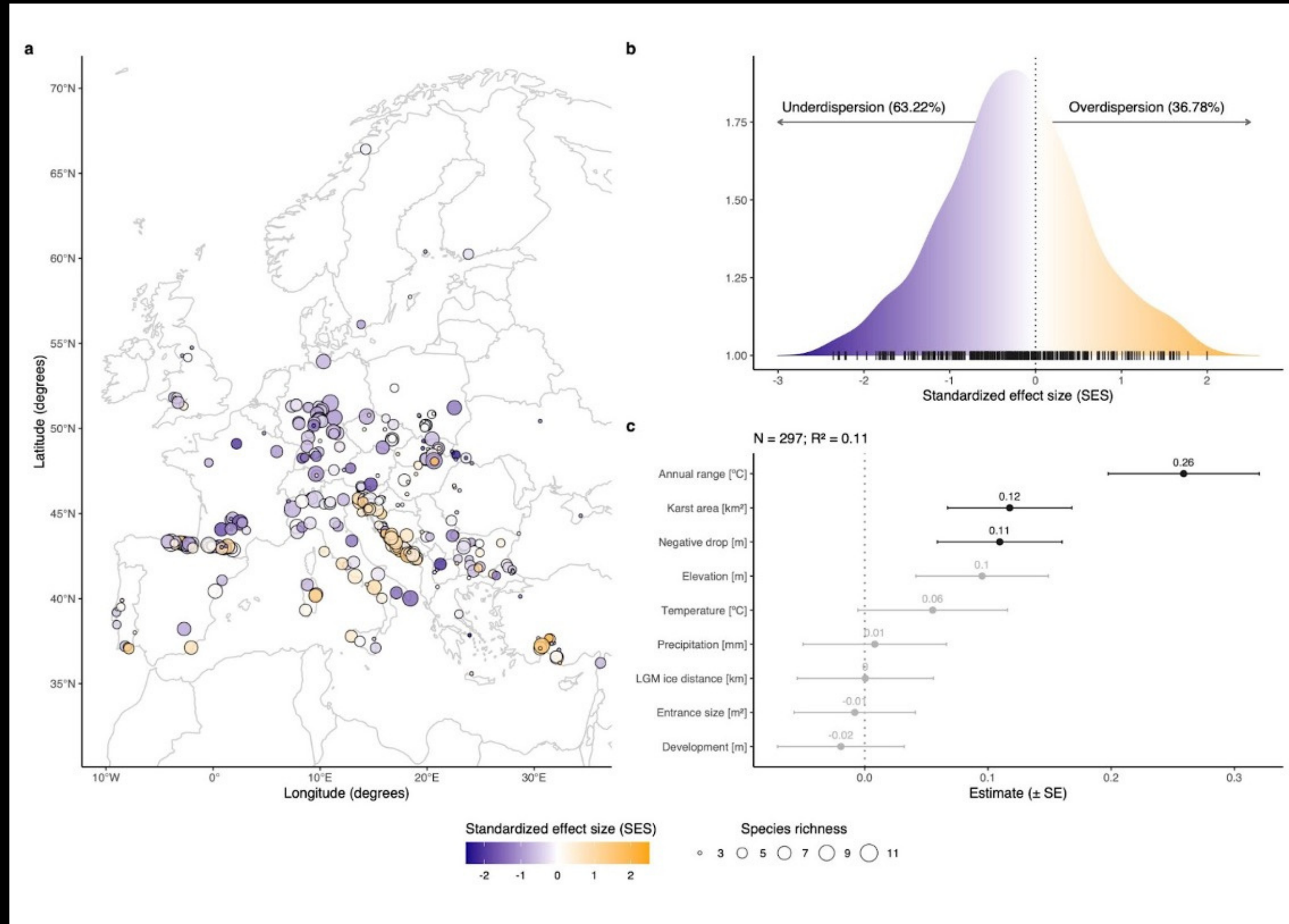
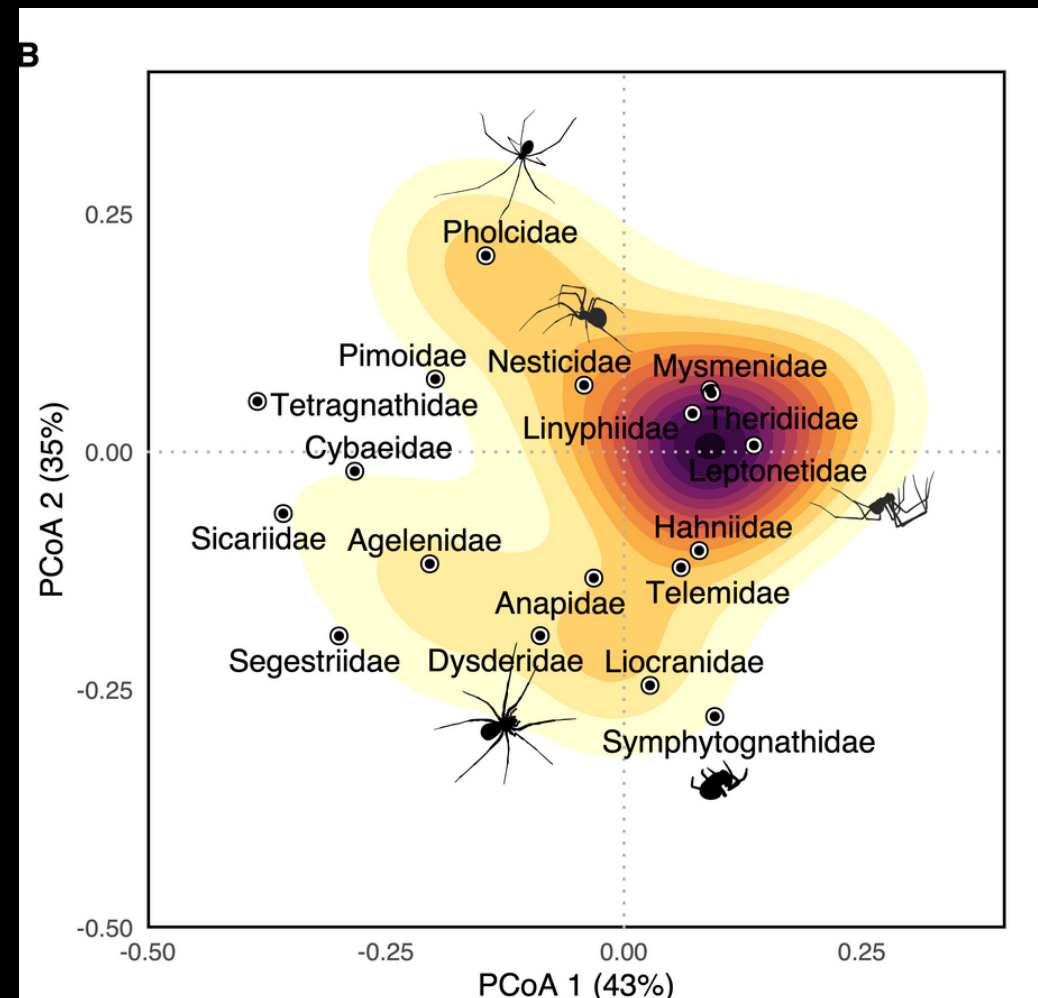
Effects of organismal variables and dataset features on the rate of decay

Using occurrence-based total similarities



Is it true that functional patterns are not independent from taxonomic ones?

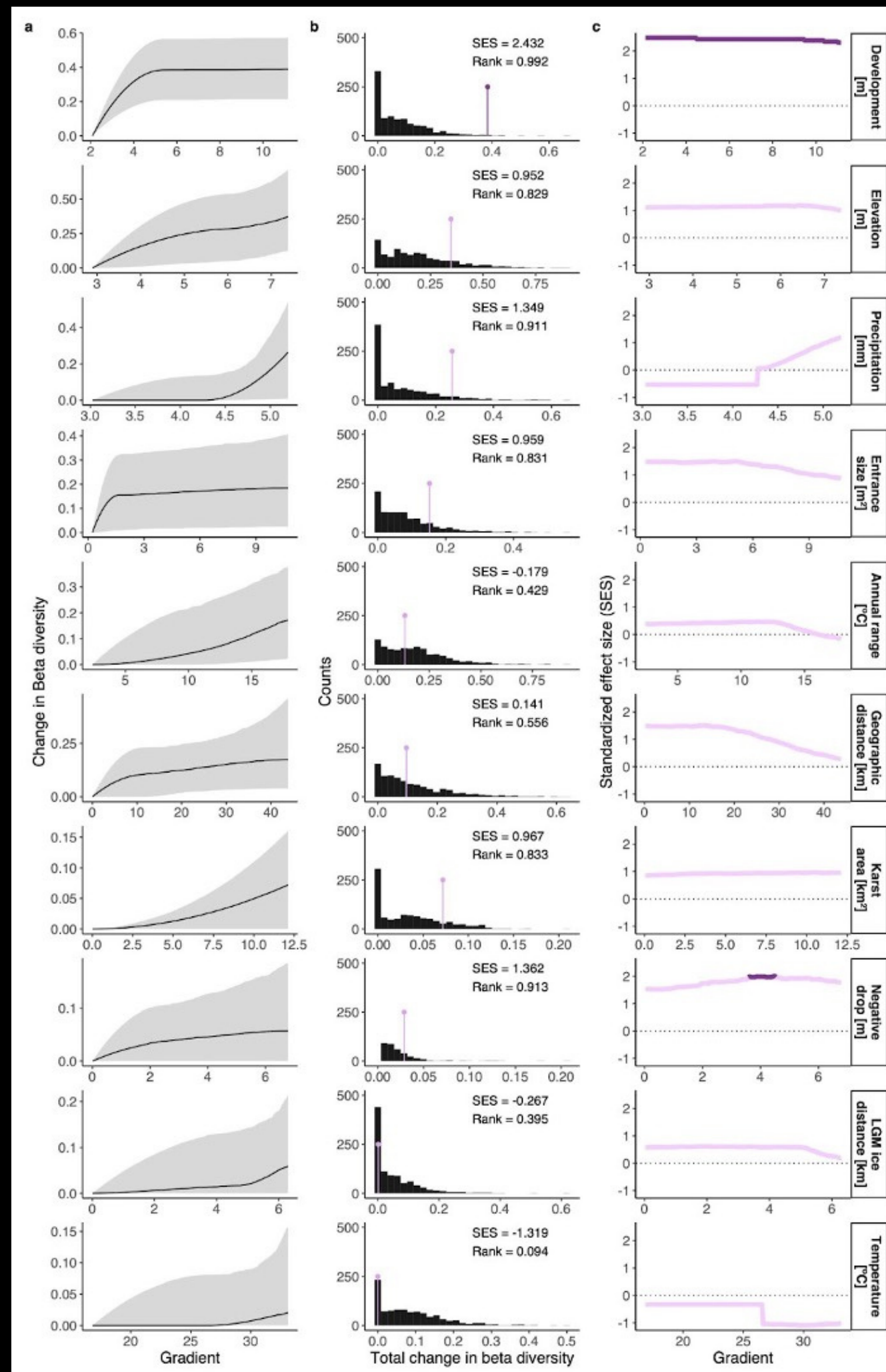
We don't think so...



Is it true that functional beta is not independent from taxonomic beta?

We don't think so...

- Variables that capture local niche conditions have a stronger effect in functional beta diversity
- The effect of geographic distance on functional beta diversity varies along the gradient, making it difficult to synthesise a single value per study.



How to move from theory to practice?

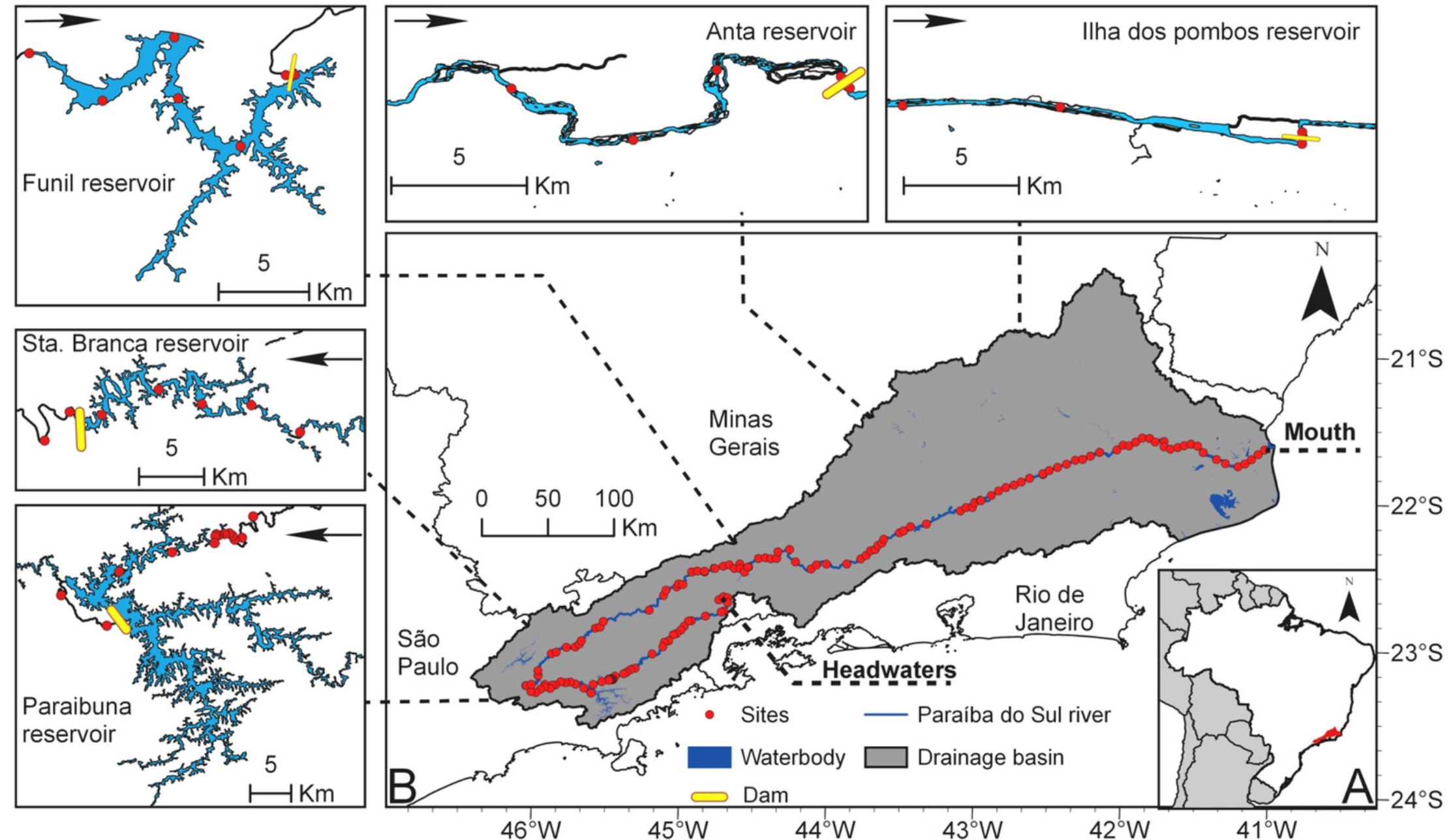
Building the bridge between academy and society

An overview across multiple scales



How river damming affects beta diversity?

Through the lens of the lovely phytoplankton community



Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind



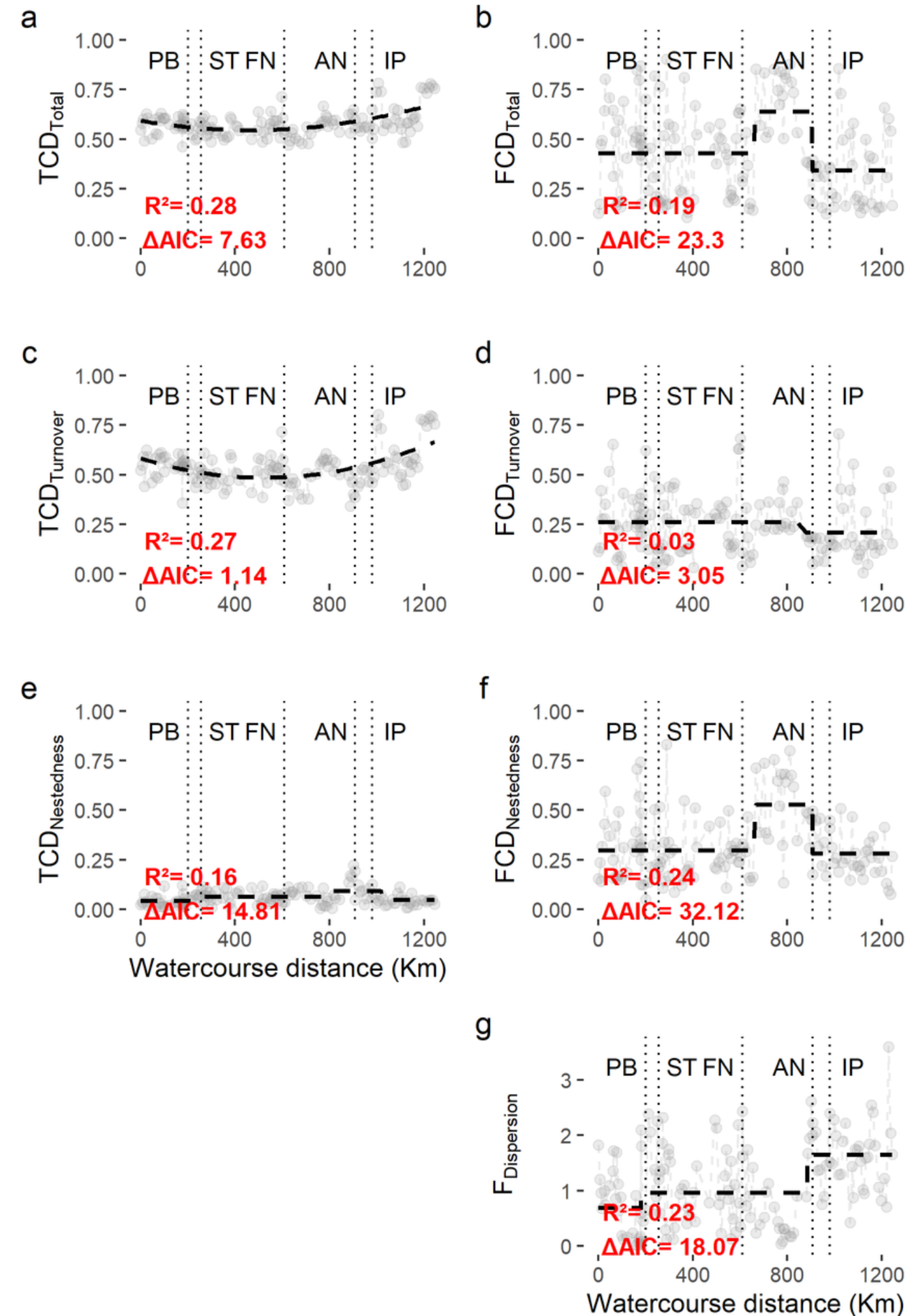
Functional rather than taxonomic diversity reveals changes in the phytoplankton community of a large dammed river

Caio Graco-Roza^{a,b,*}, Janne Soininen^b, Gilsineia Corrêa^a, Felipe S. Pacheco^c,
 Marcela Miranda^c, Patricia Domingos^a, Marcelo M. Marinho^a

How river damming affects beta diversity?

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Large-scale analysis



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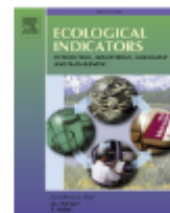
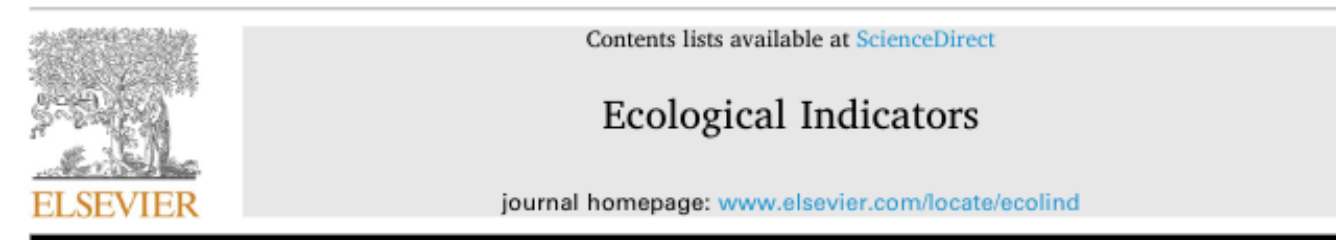
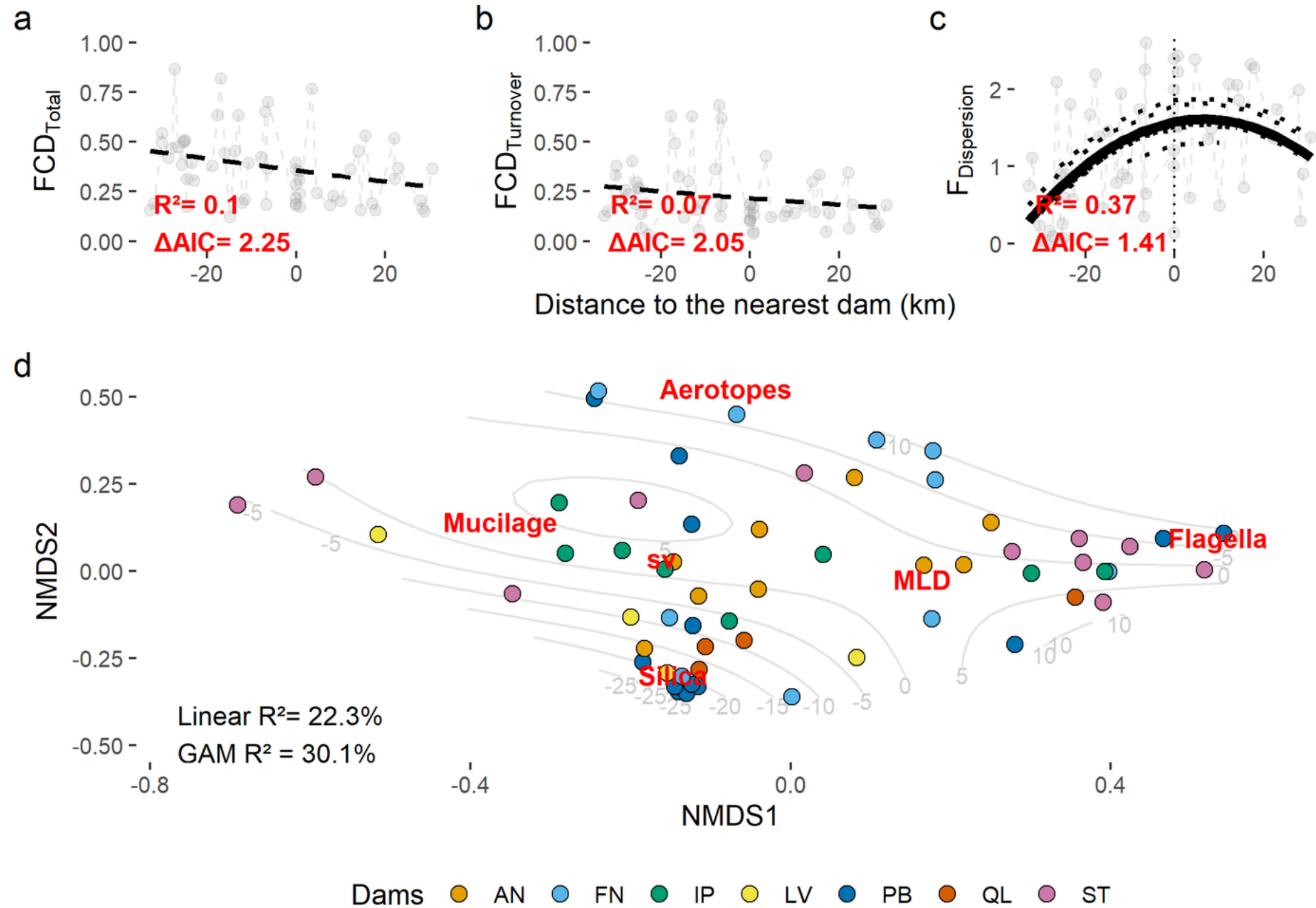
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Marcela Miranda^c, Patricia Domingos^a, Marcelo M. Marinho^a

How river damming affects beta diversity?

Through the lens of the lovely phytoplankton community

Small-scale analysis



Functional rather than taxonomic diversity reveals changes in the phytoplankton community of a large dammed river

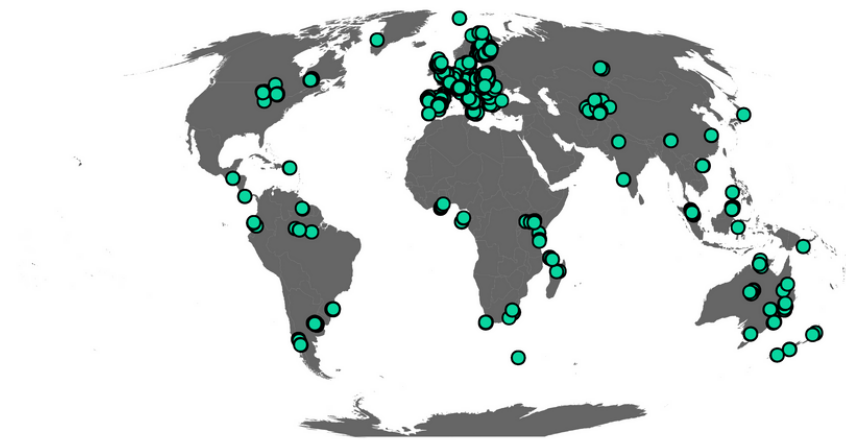
Caio Graco-Roza^{a,b,*}, Janne Soininen^b, Gilsineia Corrêa^a, Felipe S. Pacheco^c,
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Another test of generalities that are not so general...

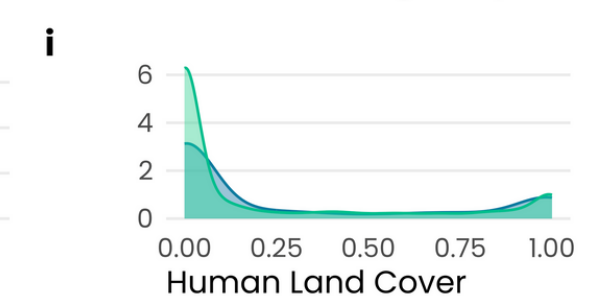
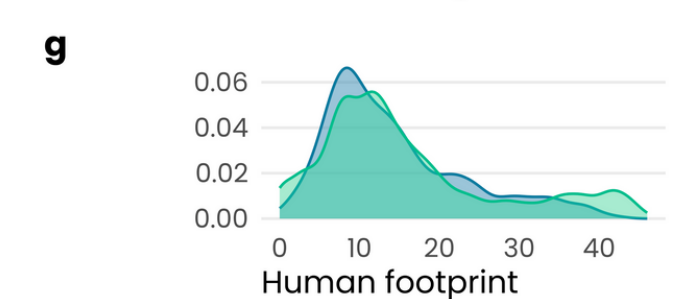
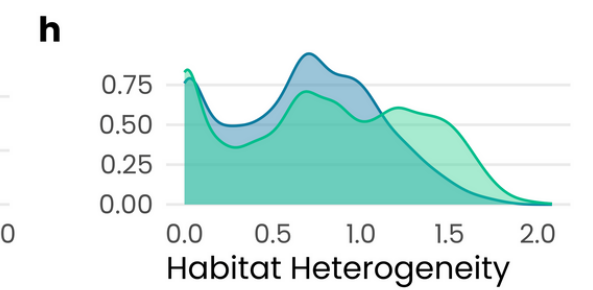
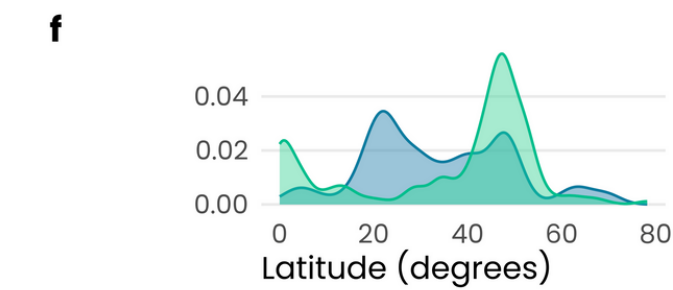
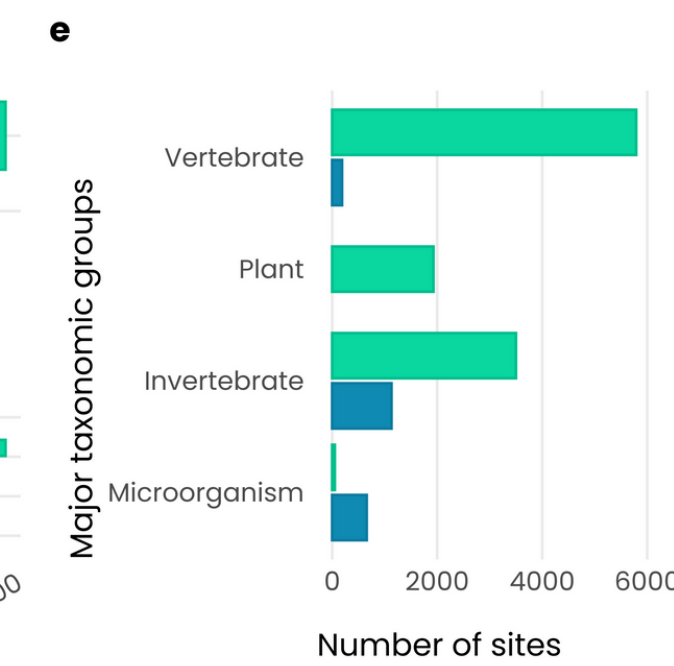
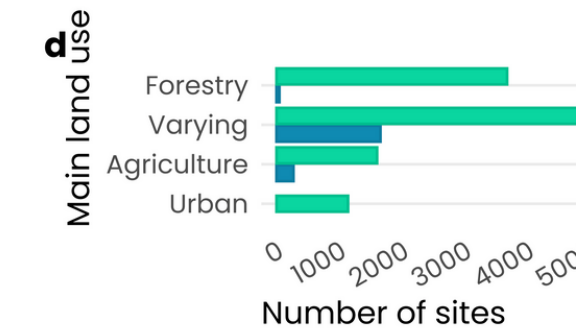
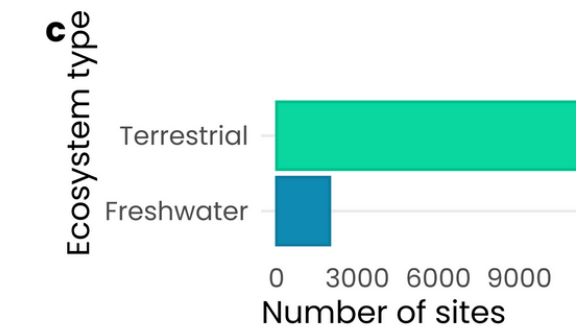
What are the effects of human pressures on beta diversity?



a Terrestrial sites



b Freshwater sites



HIATE: Testing the generality of biotic homogenization by human impact in aquatic and terrestrial ecosystems

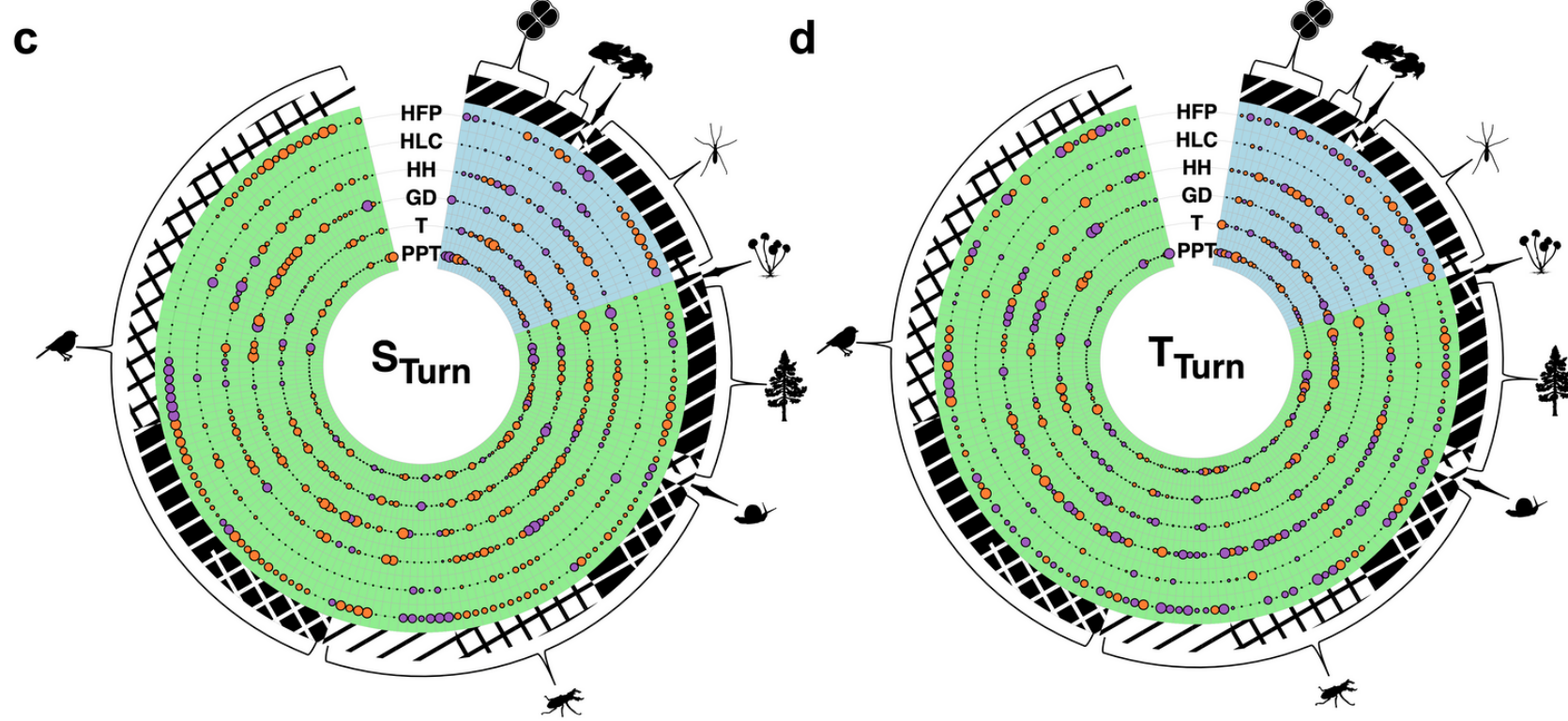
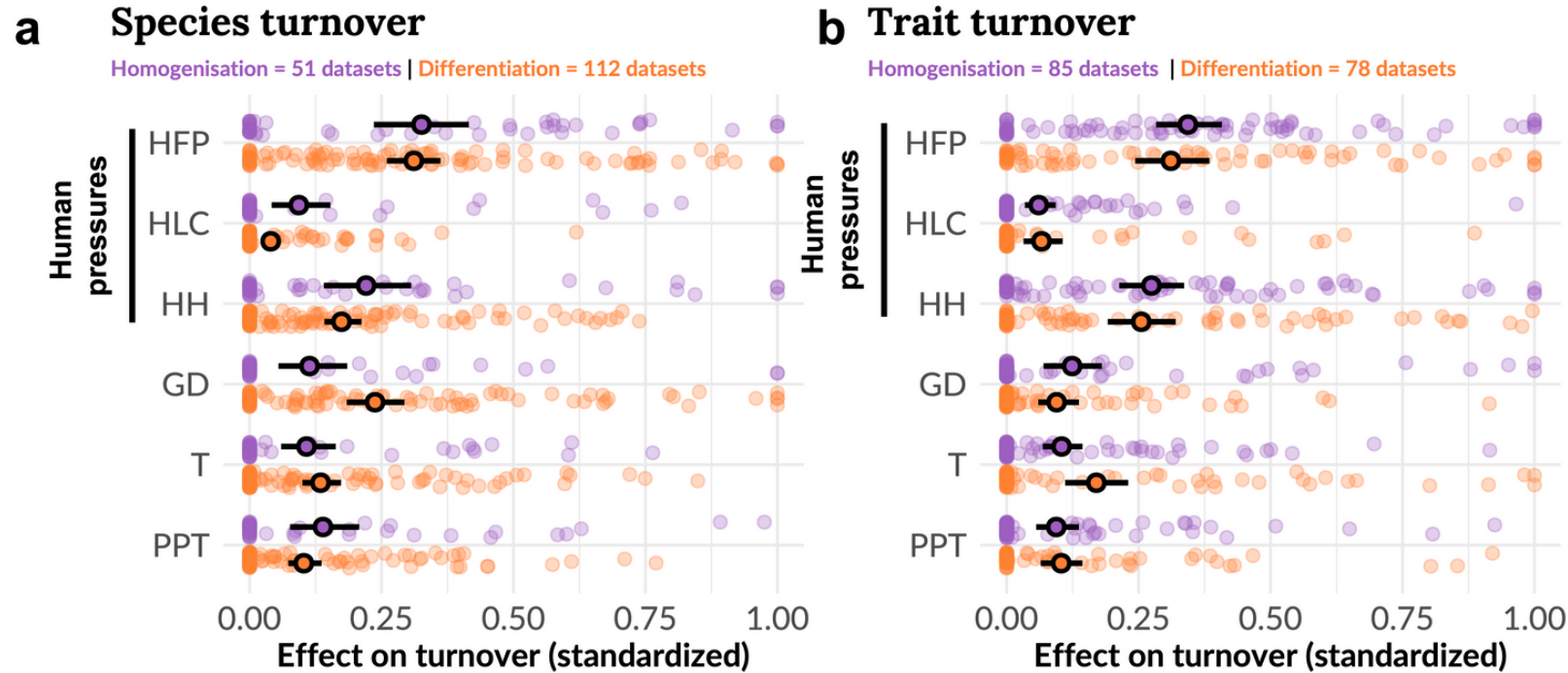
This project contributes to the **Blue-Green Biodiversity Research Initiative** – an Eawag-WSL collaboration focusing on biodiversity at the interface of aquatic and terrestrial ecosystems.



Are communities more homogenized or differentiated?

HIATE: Testing the generality of biotic homogenization by human impact in aquatic and terrestrial ecosystems

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Direction

- Homogenisation (purple)
- Differentiation (orange)

Ecosystem type

- Freshwater (blue)
- Terrestrial (green)

Disturbance type

- ▨ Urban
- ▨ Agriculture
- ▨ Forestry
- ▨ Varying

Effect size

- 0.00
- 0.25
- 0.50
- 1.00

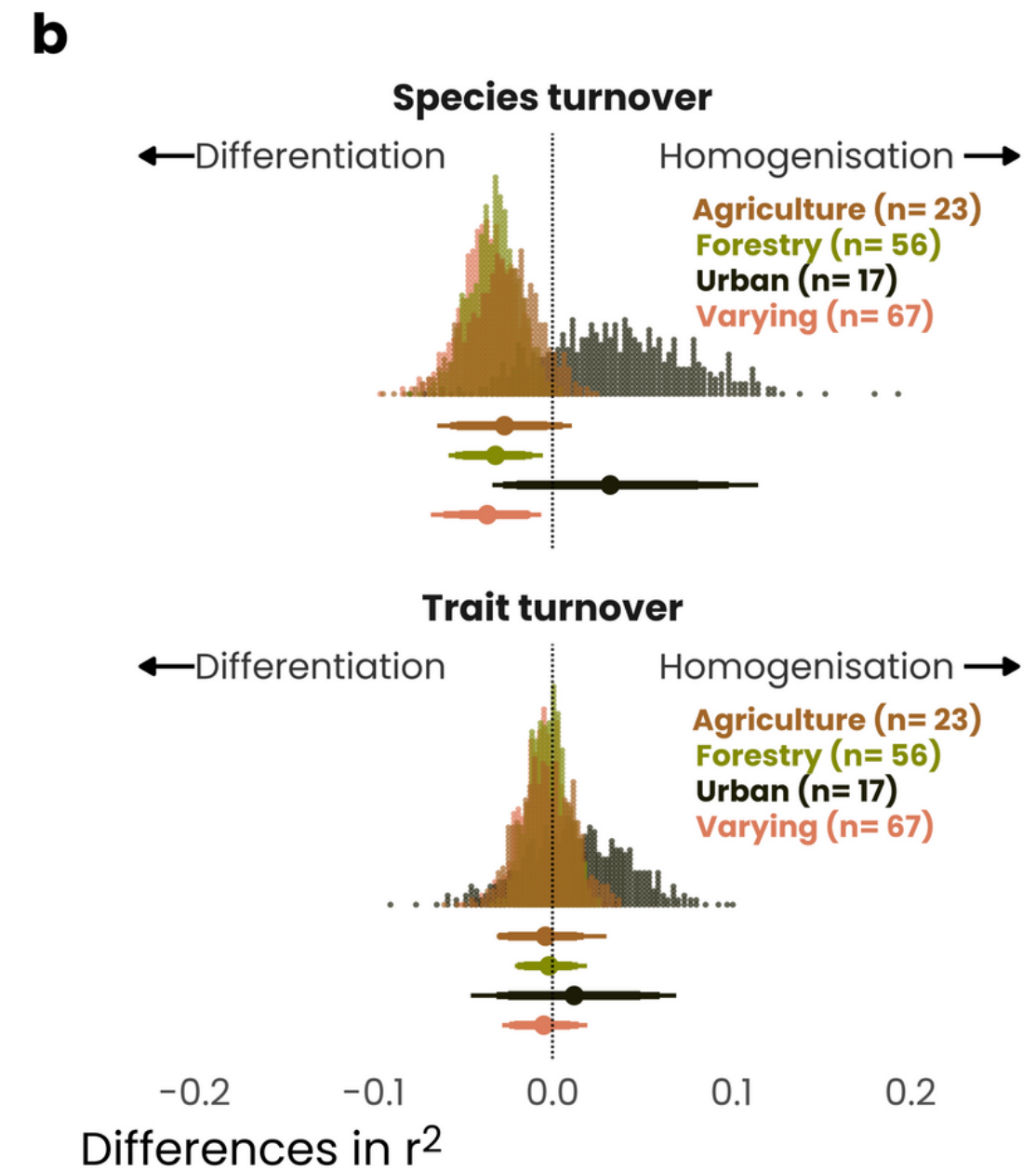
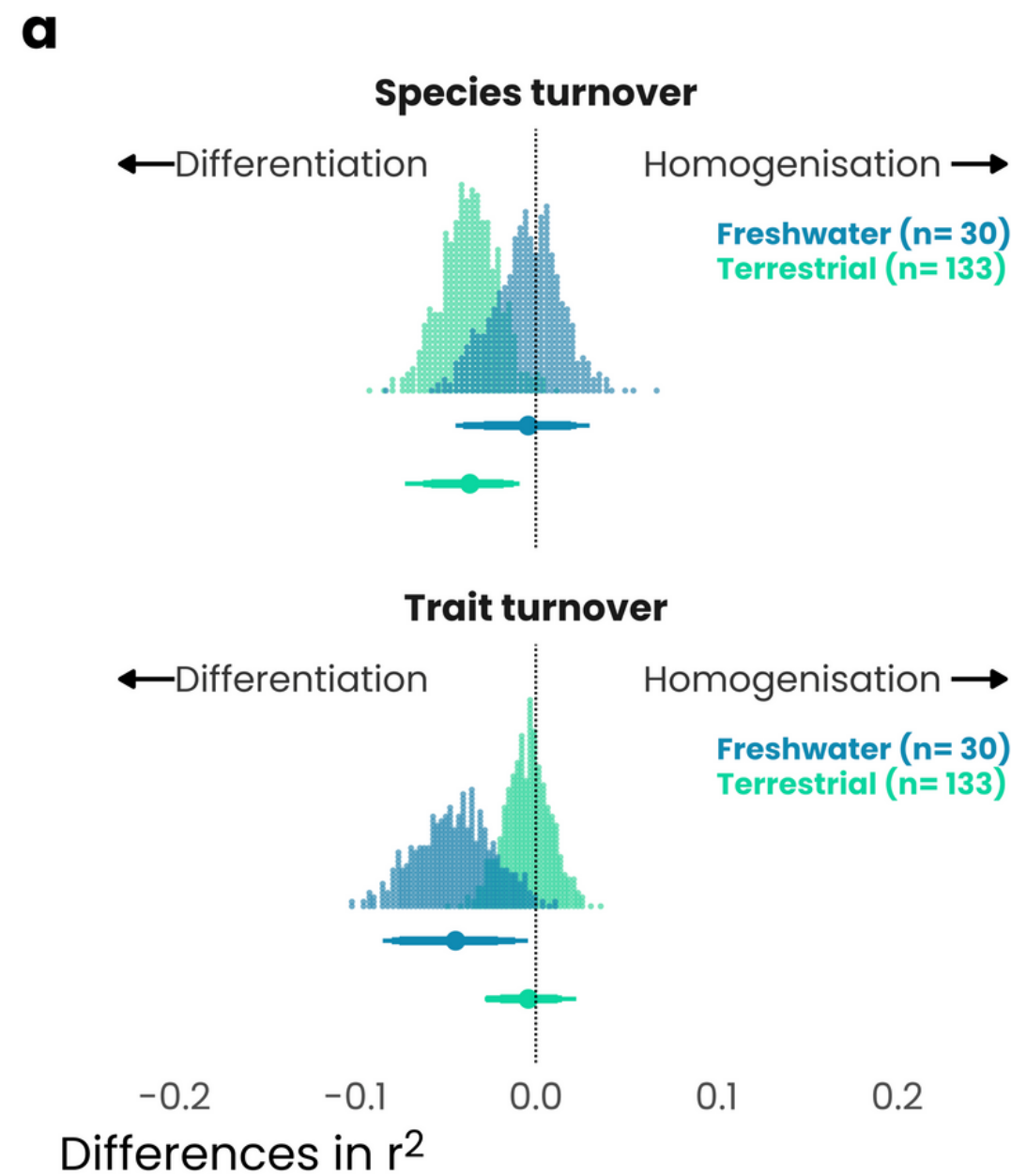
Biotic group

- Microorganism
- Fish
- Amphibian
- Waterinsect
- Fungi
- Plant
- Gastropod
- Insect
- Bird

How ecosystem type and main pressure affect beta diversity?

HIATE: Testing the generality of biotic homogenization by human impact in aquatic and terrestrial ecosystems

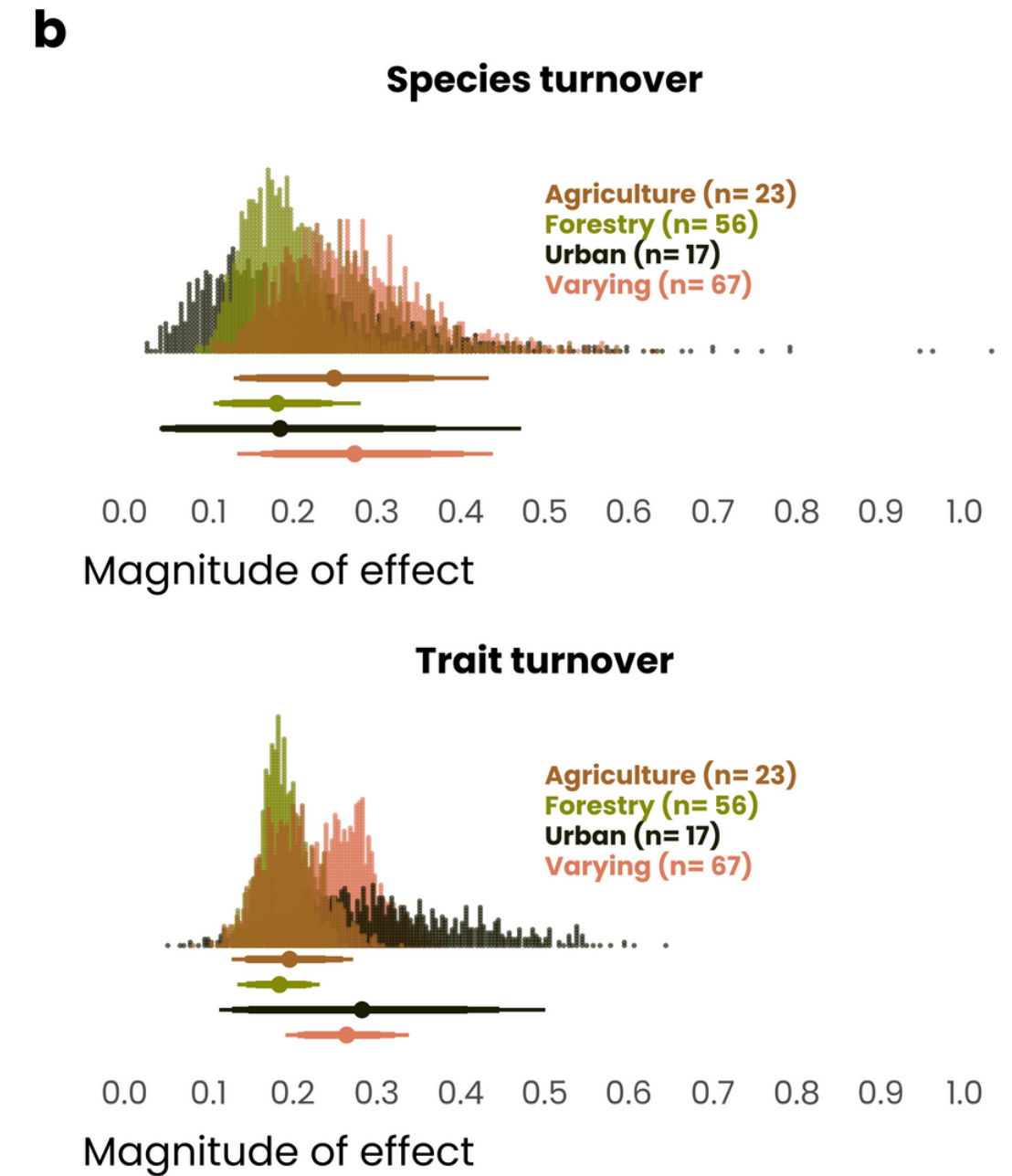
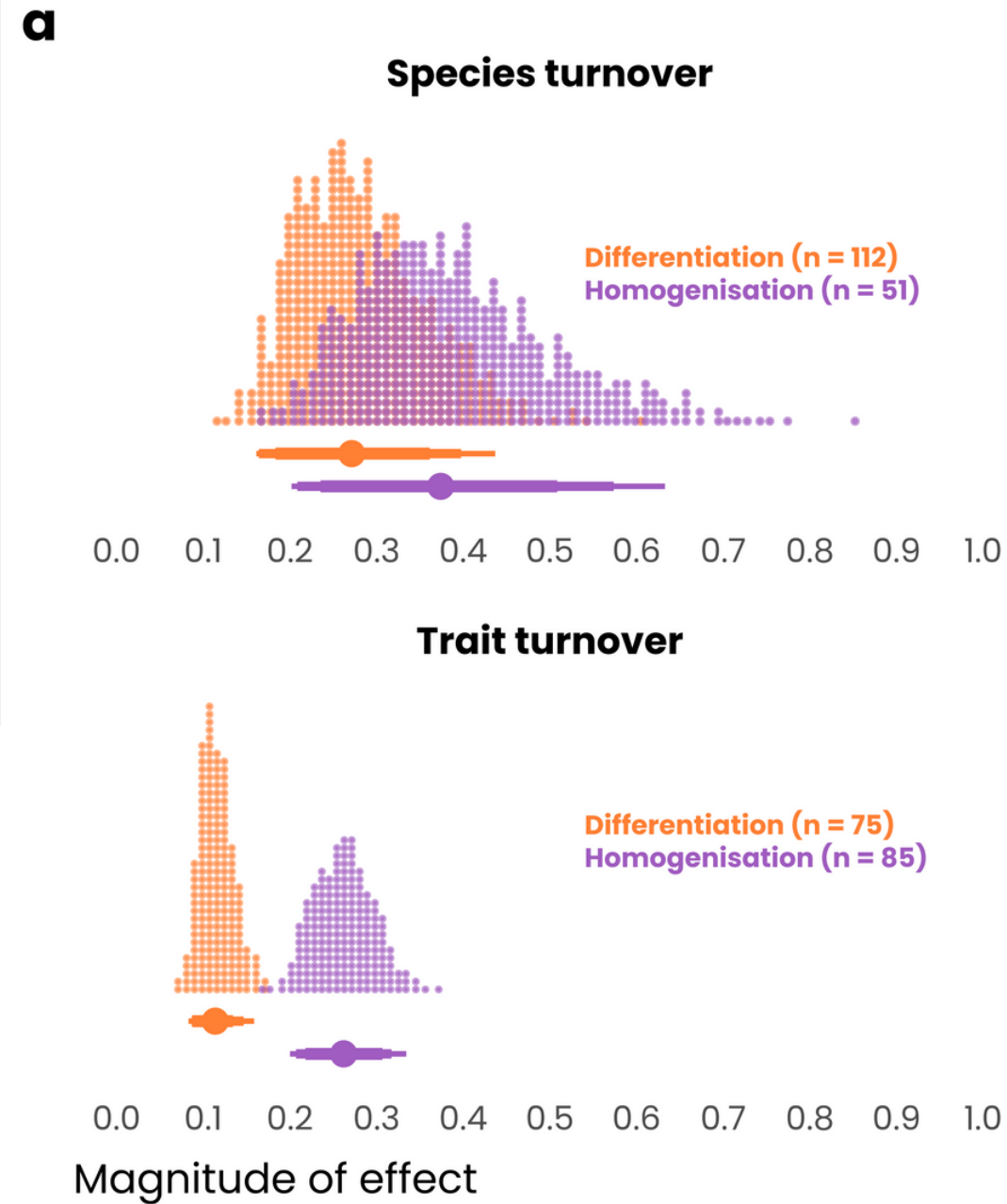
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What communities have the strongest effect of human pressures?

HIATE: Testing the generality of biotic homogenization by human impact in aquatic and terrestrial ecosystems

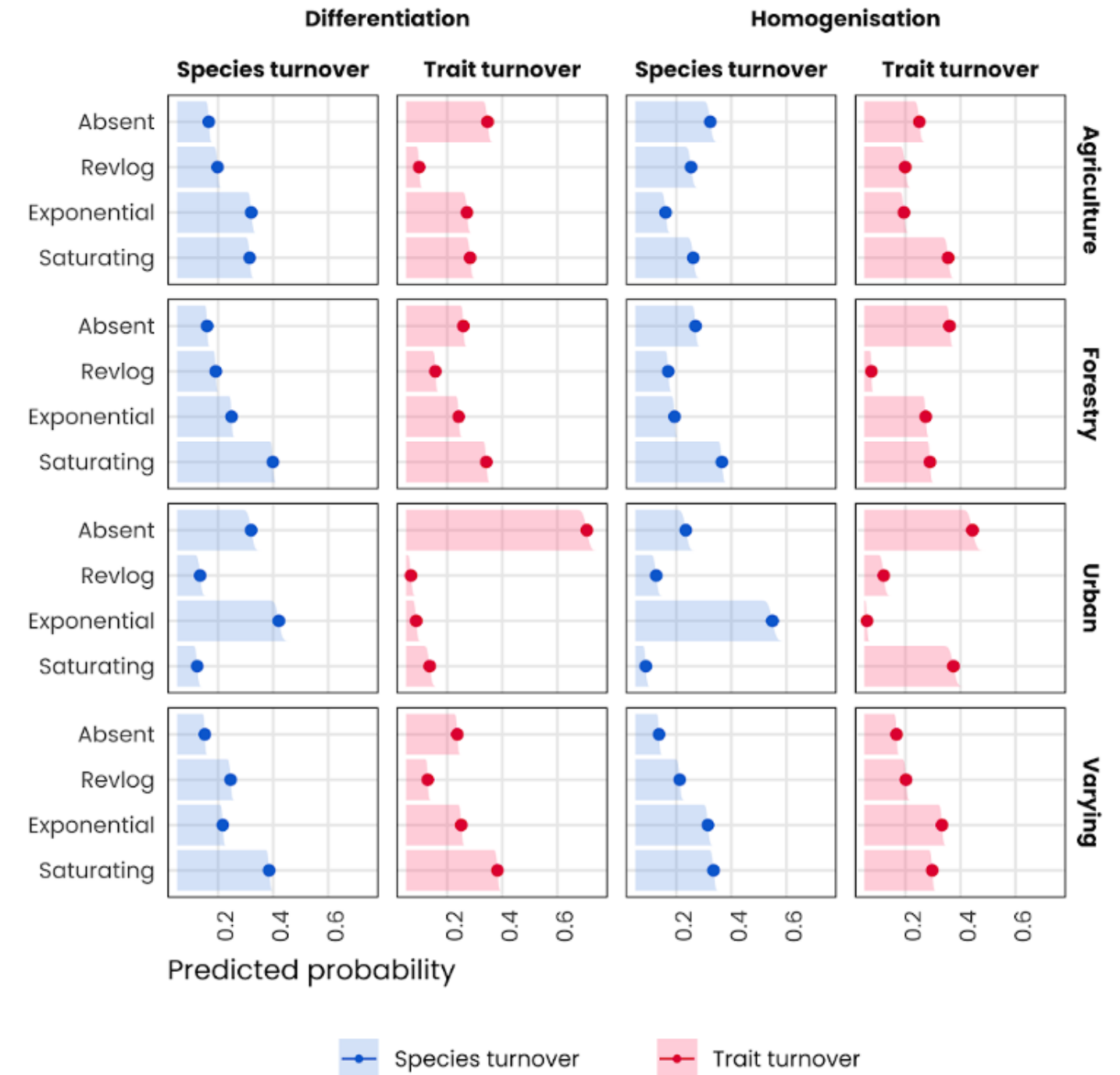
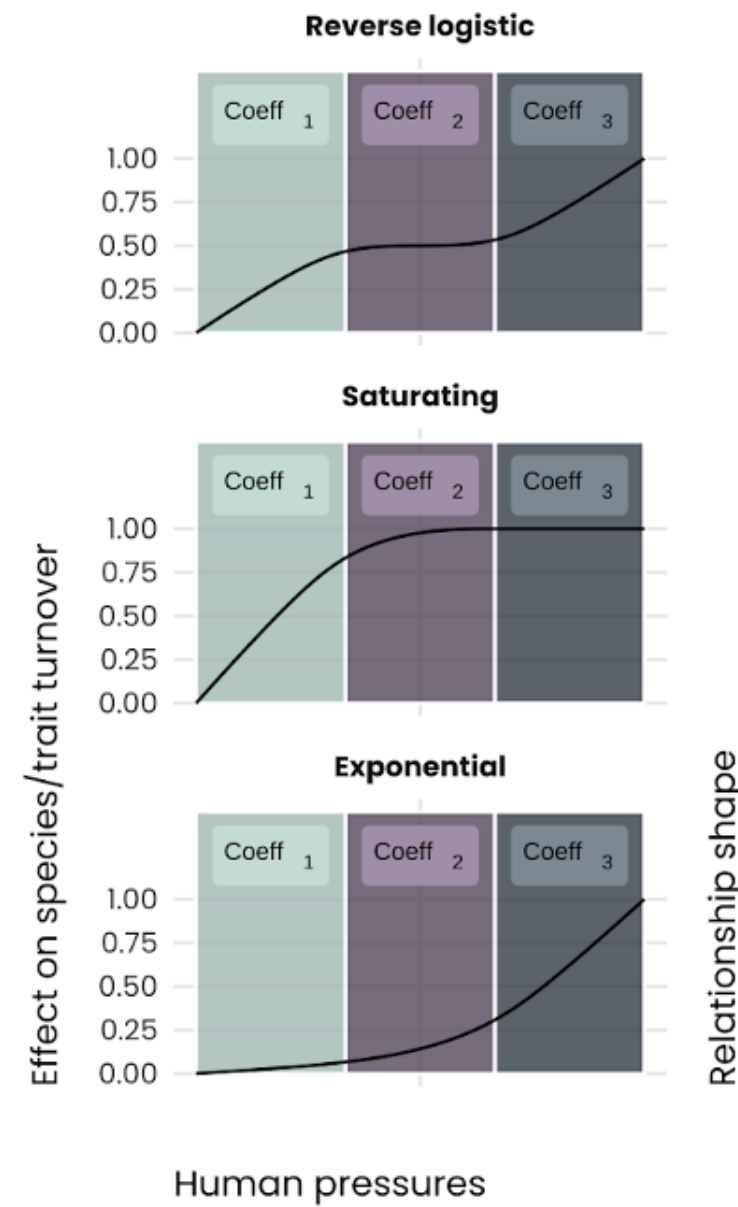
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Where in the gradient we find the strongest effects

HIATE: Testing the generality of biotic homogenization by human impact in aquatic and terrestrial ecosystems

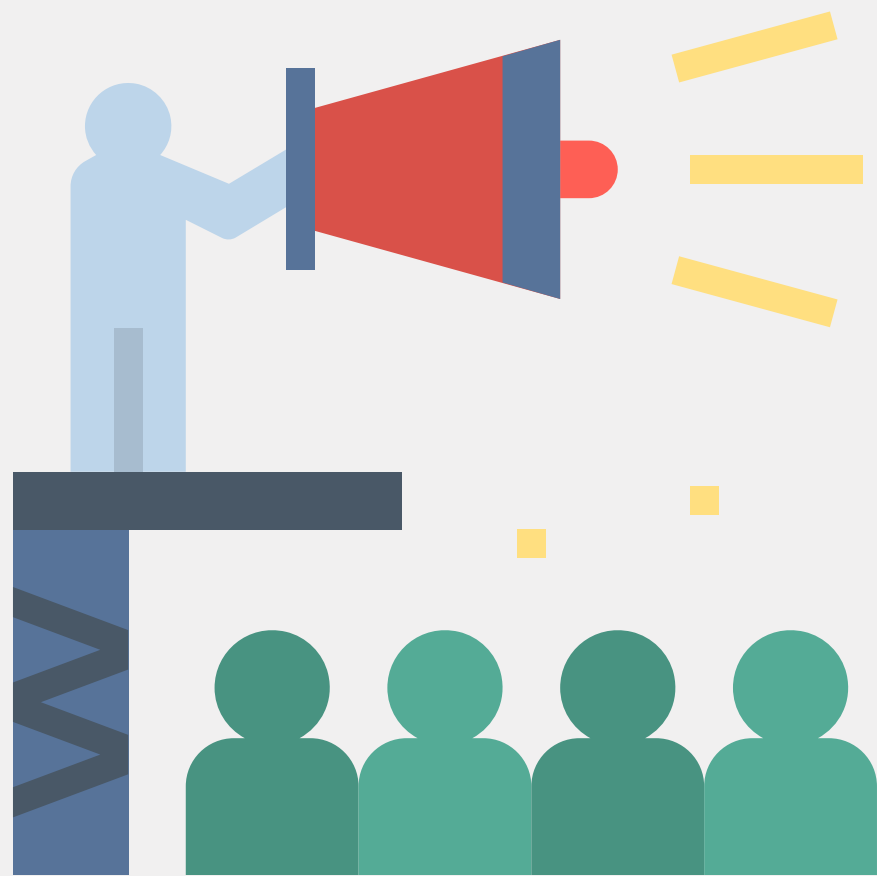
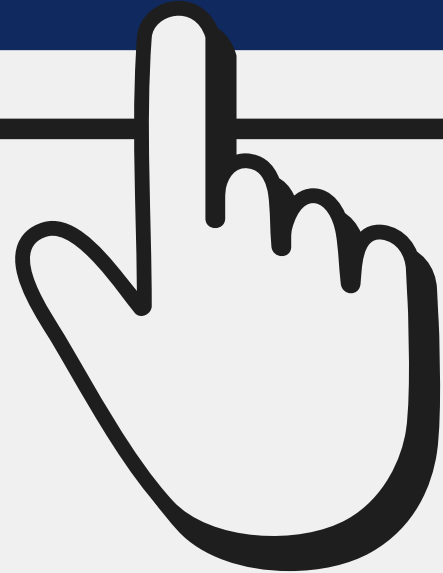
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Concluding remarks

- The theoretical knowledge of ecological processes can be used to inform practical research and conservation strategies. For example, interplay between environmental filtering and limiting similarity helps predicting how communities will respond to changes in the environment.
- Applying beta diversity analysis to real-world scenarios can help us identify areas that are particularly vulnerable to biotic homogenization and prioritize conservation efforts accordingly.
- River damming and other human actions can significantly alter community composition patterns, but understanding the underlying ecological processes can help us mitigate their impacts on biodiversity and ecosystem functioning.

PROPAGANDA

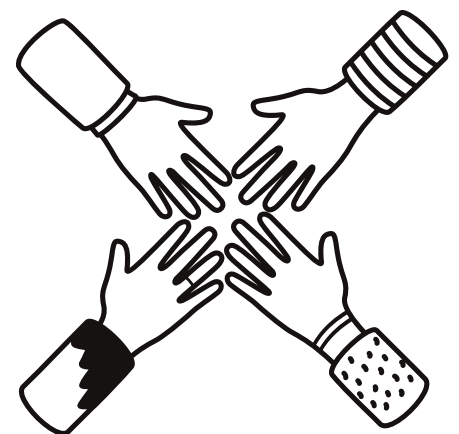


Our current developments involve:

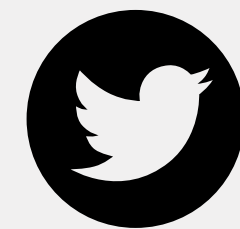
- Studying beta diversity for long time-series;
- Investigating the contribution of species to the functional beta diversity;
- Using text-analysis tools to generate scientific synthesis;

If you are interested in one of these topics and want to collaborate. Contact us!

Together we are stronger!!



*Thank
You*



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Caiogracor@gmail.com

