Soil microbial co-occurrence networks and functioning along an aridity gradient in Atlantic coastal dunes

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Raúl Ochoa-Hueso, Fernando T. Maestre, Jorge Durán

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CENTRE FOR FUNCTIONAL ECOLOGY
SCIENCE FOR PEOPLE & THE PLANET
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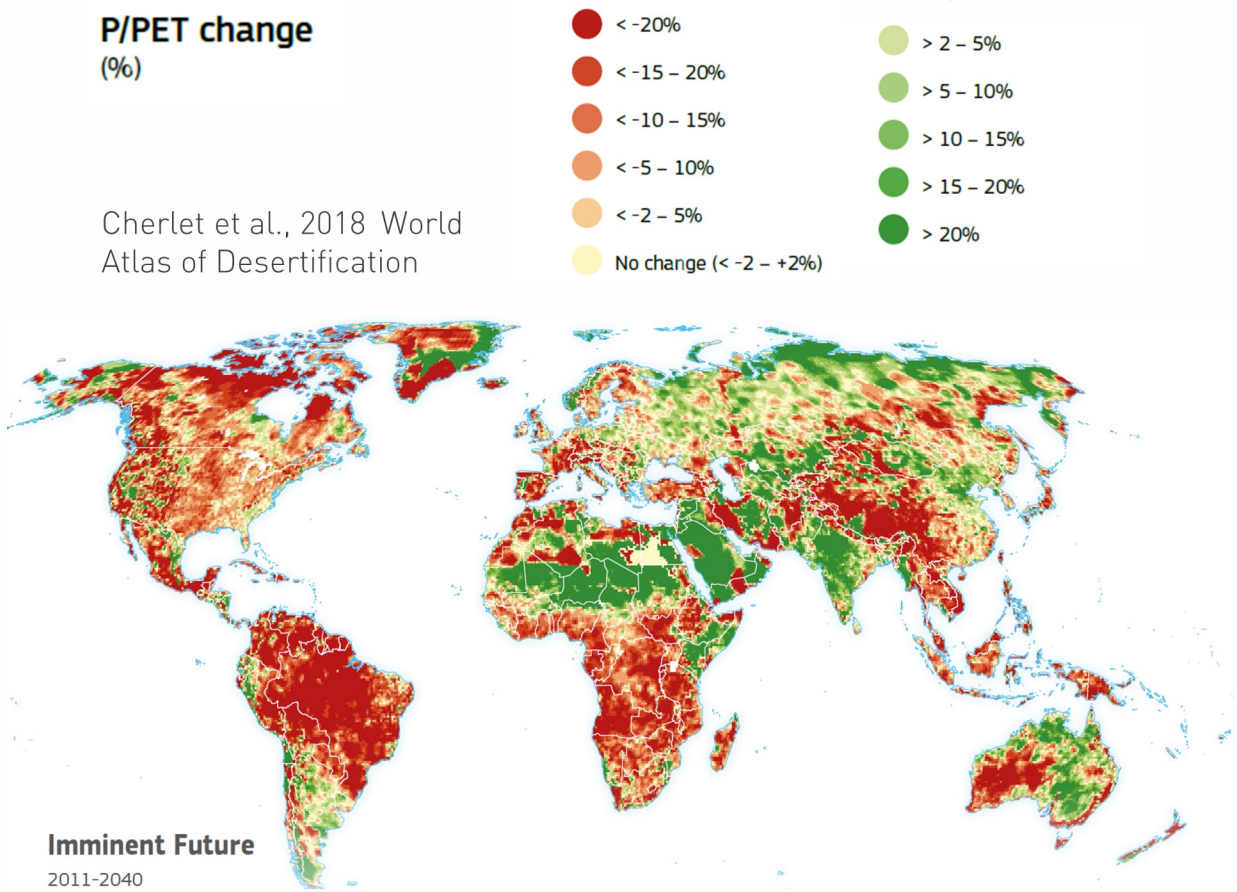
1 Introduction
Background

- Atlantic coastal dunes
  - dynamic and changing ecosystems
  - highly sensitive to climate change
  - will cross aridity thresholds

may endanger ecosystem services ???

Coastal dune site in Santo André
AI = 0,43



Cherlet et al., 2018 World Atlas of Desertification

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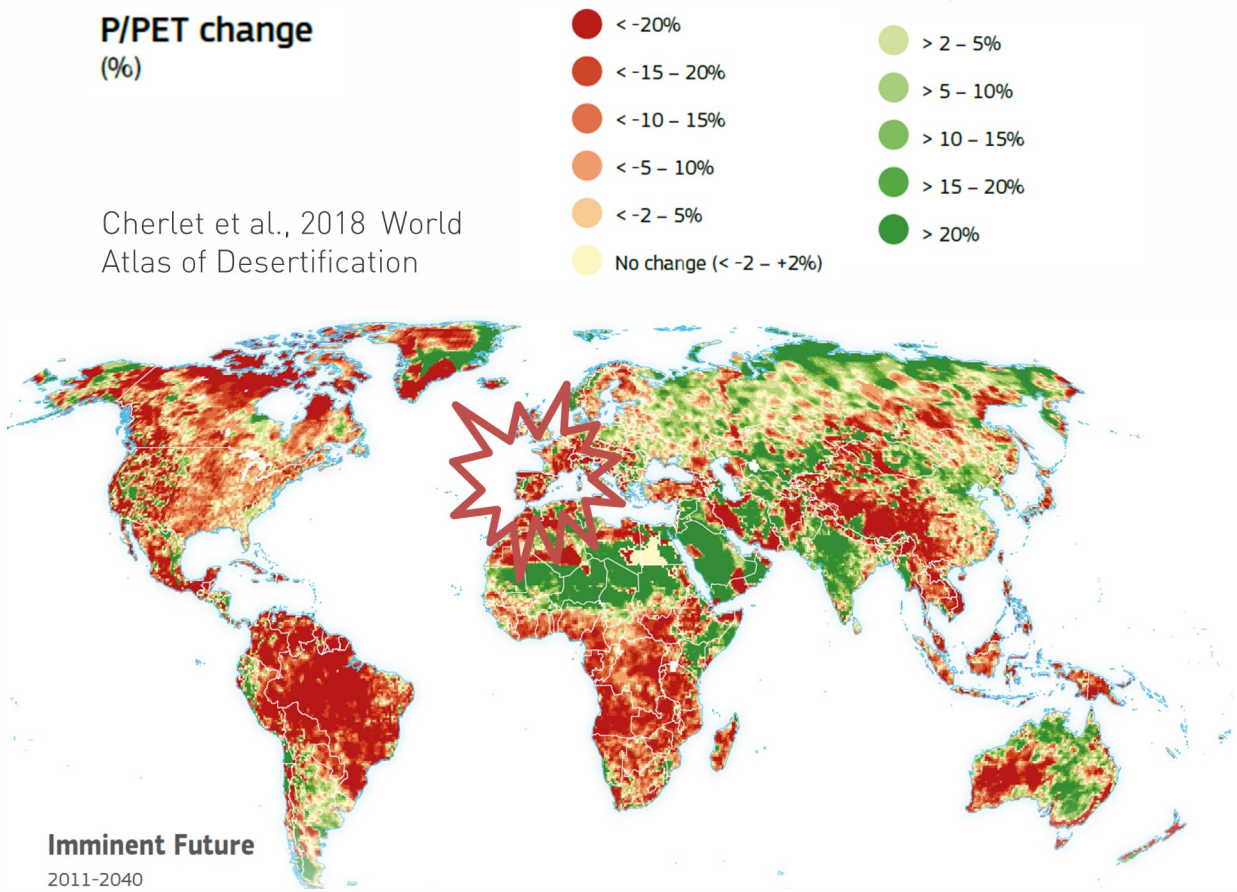

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- Biotic cover loss
- Reduced nutrient availability
- Drastic changes in the composition and structural organization of soil microbes

1 Introduction
Aims

- To understand the integrative effects of:

  (i) increasing aridity (regional scale) & (ii) biotic cover (local scale)

  on soil biotic and abiotic attributes and processes in coastal dune ecosystems.

- Microbial abundance and diversity indexes
- Coupling of soil microbial networks

- High-throughput sequencing (16S, ITS) & qPCR

- Water holding capacity
- pH
- Soil organic
- Total nitrogen
- Total phosphorus

- Soil physicochemical properties

- Nitrogen mineralization
- Potential fluxes of greenhouse gases

- Potential soil functions

San Xurxo
AI = 0,92

La Antilla
AI = 0,29

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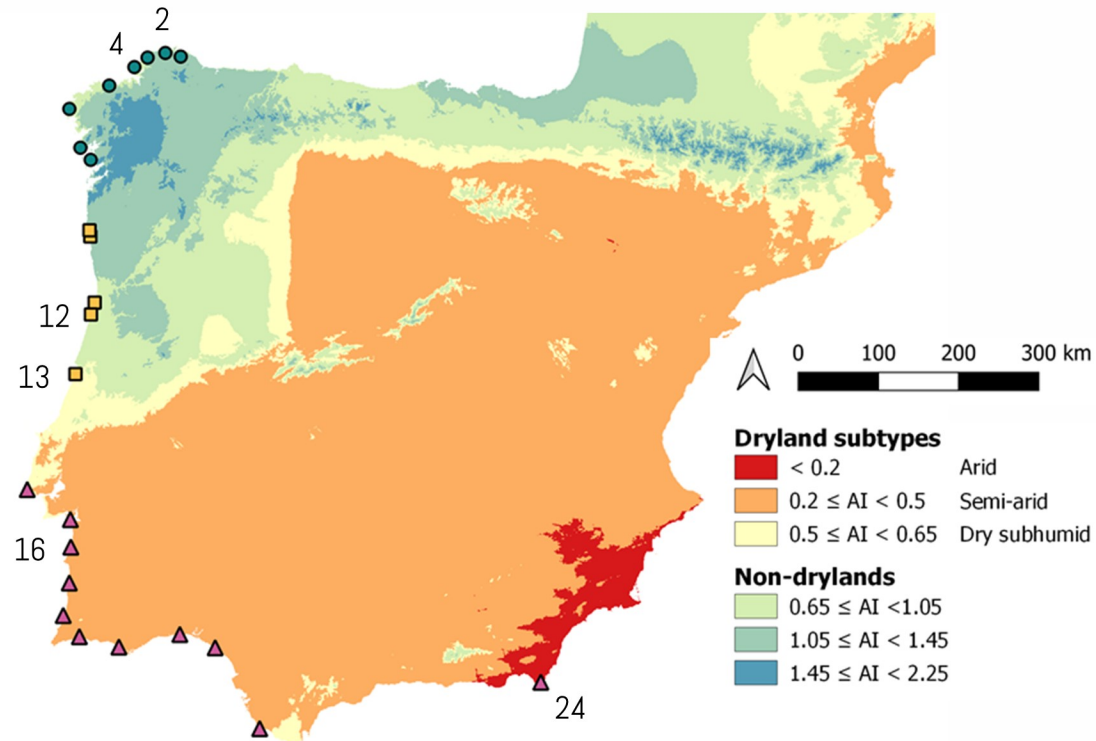
2 Materials and Methods
Experimental design

- 24 dune systems distributed along a **natural aridity gradient** (~1500 km) in the Iberian Peninsula (AI, Aridity Index).

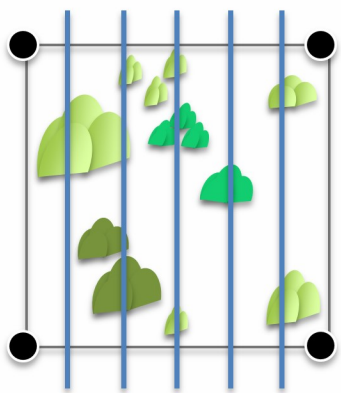
$$AI = \frac{\sum_{i-1}^{30} \left(\frac{P_i}{PET_i} \right)}{30}$$

- We carry out a **stratified sampling design** under *microsites:*

Vascular plants Cryptogams Bare soil



30 × 30 m



→ Data on vegetation

→ Soil samples (0-10 cm Depth) → Lab analyses

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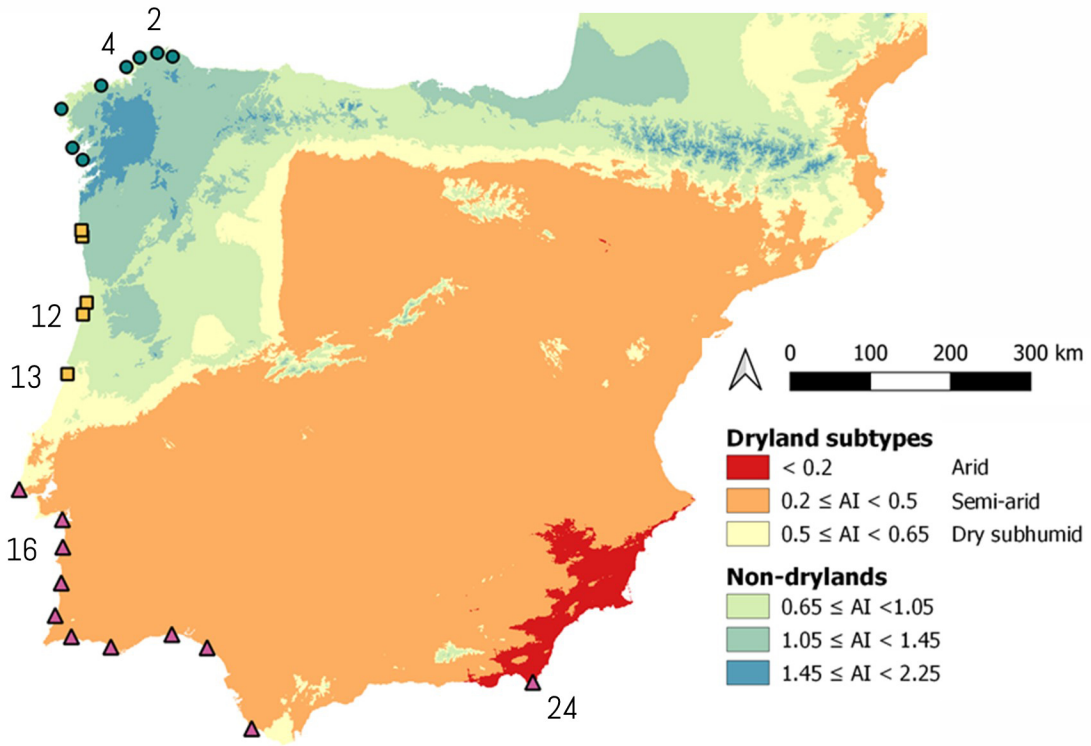
- We classified dune systems into **3 bioclimatic areas:**



● Humid ▫ Transition sites ▲ Drylands


2. Ortigueira


4. San Xurso


12. Dunas São Jacinto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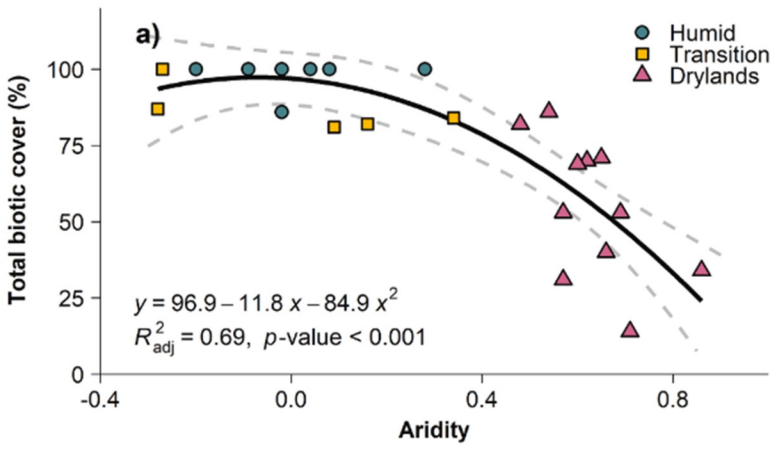
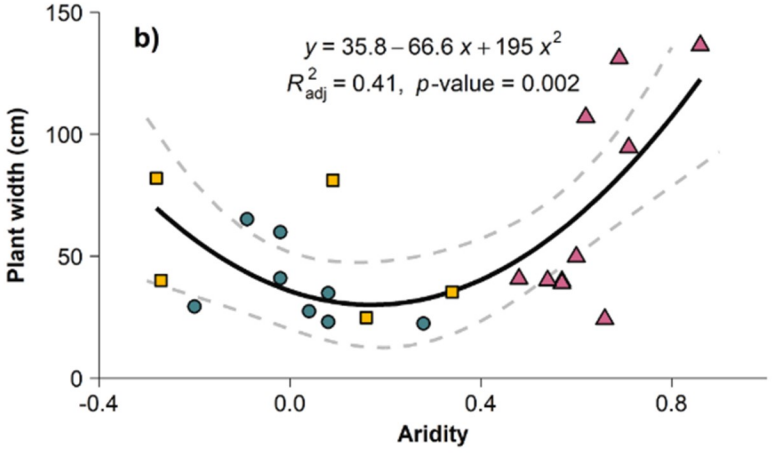
3 Results and discussion
Climate effects on the biotic cover



(1-AI)



(1-AI)

Aridity decreased total vegetation cover and favoured the formation of shrub-dominated patches.

Humid | Transition sites | Drylands

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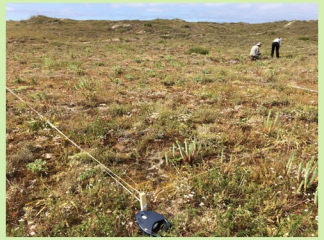

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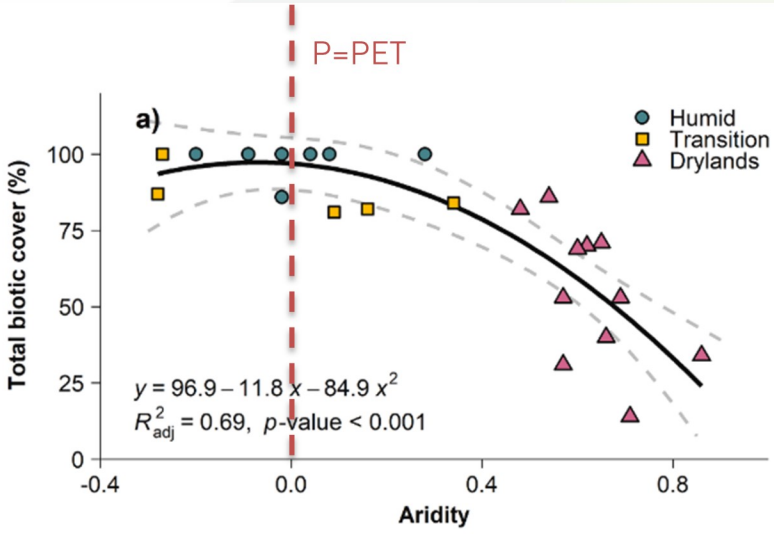

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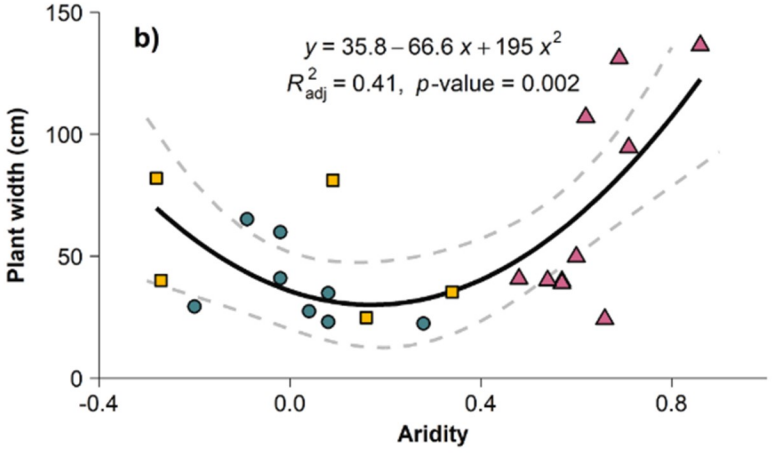

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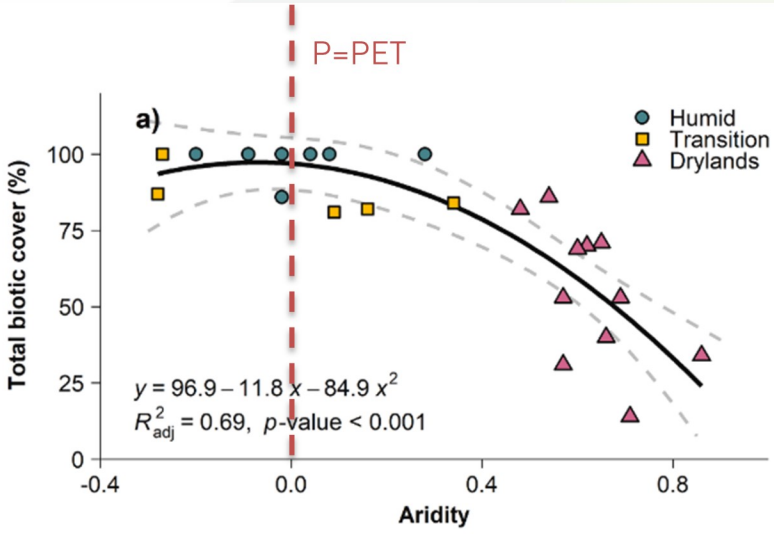

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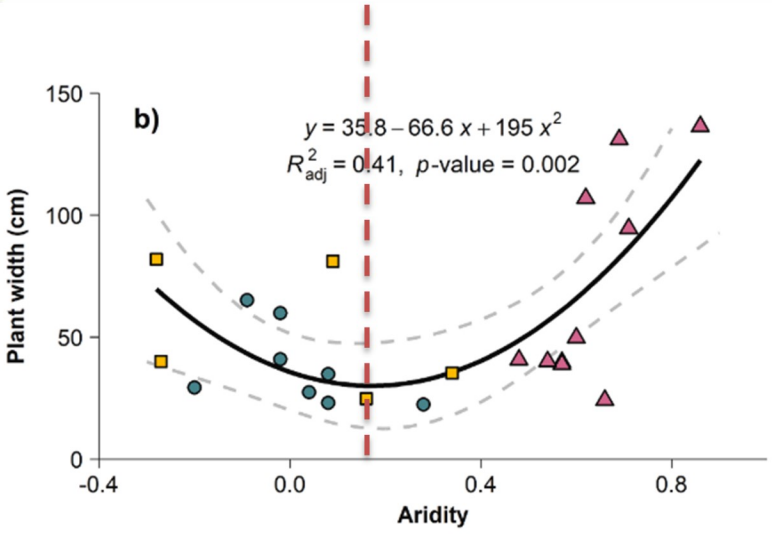

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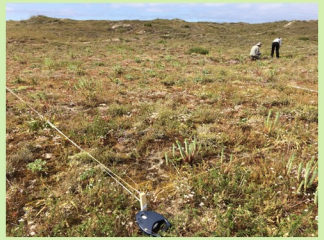

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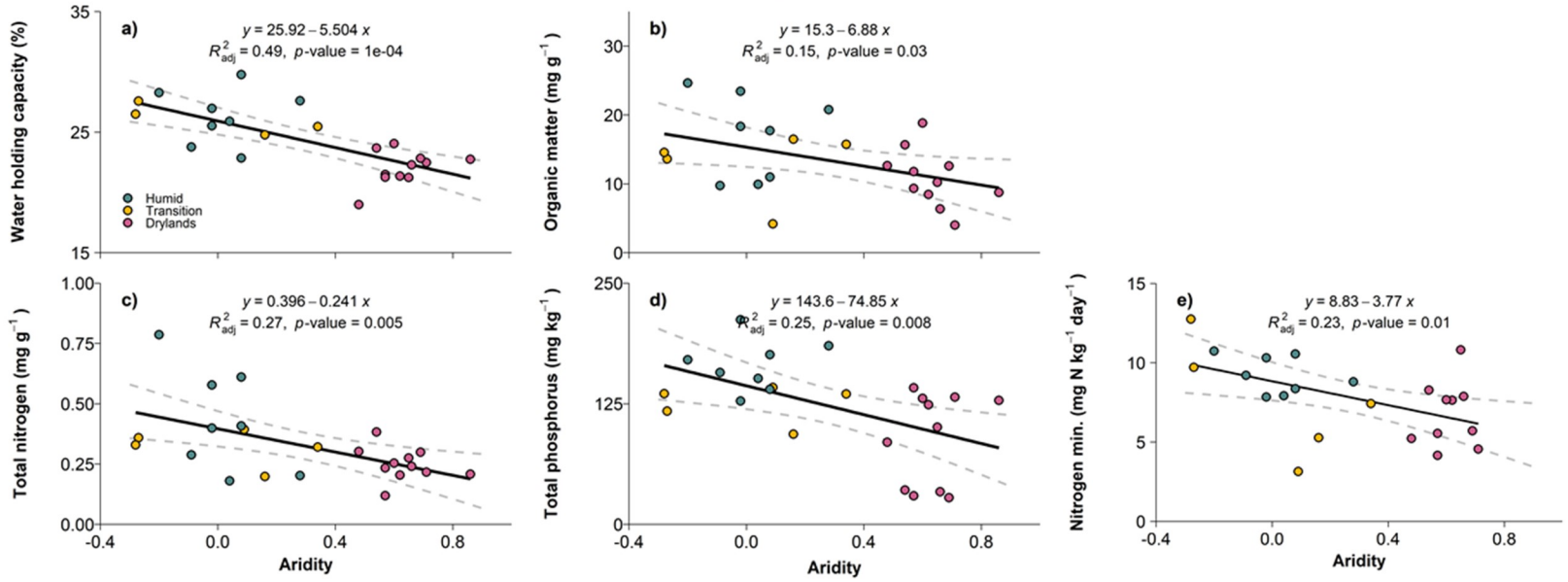

Vegetation shifts were accompanied by declines in water holding capacity, organic matter, nutrient contents and N mineralization.

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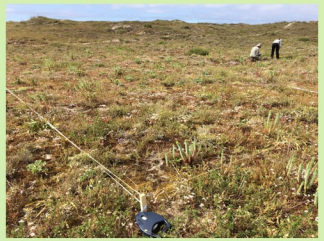
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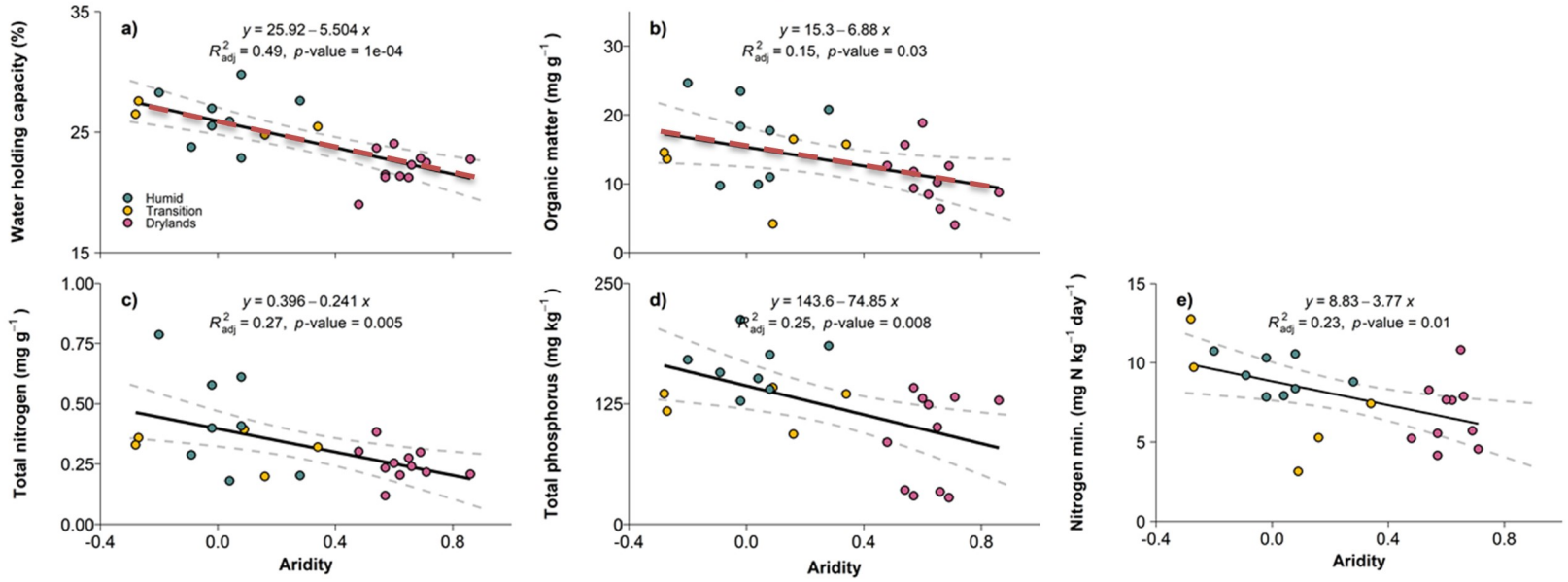

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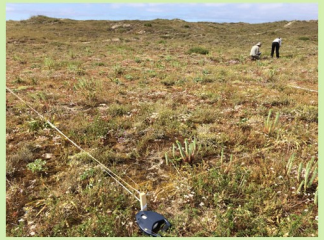
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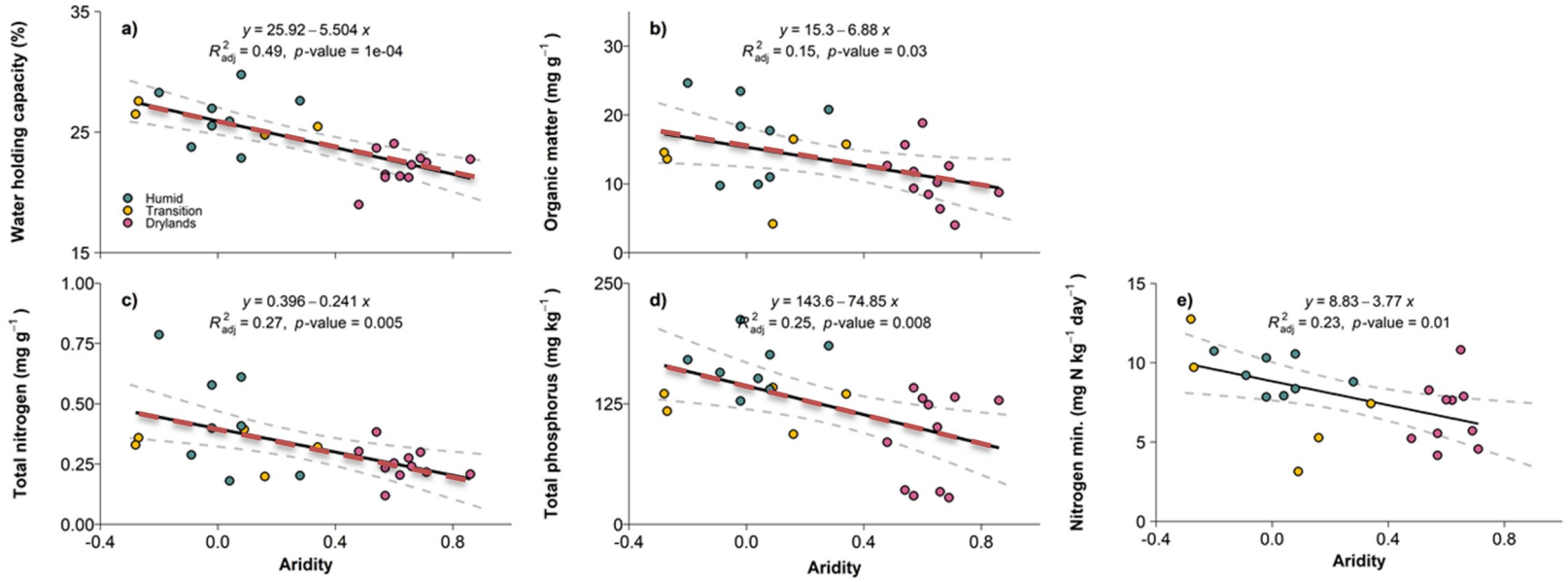

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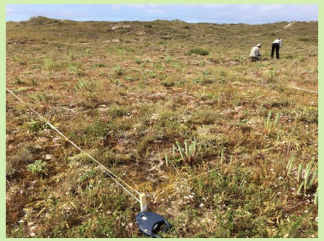
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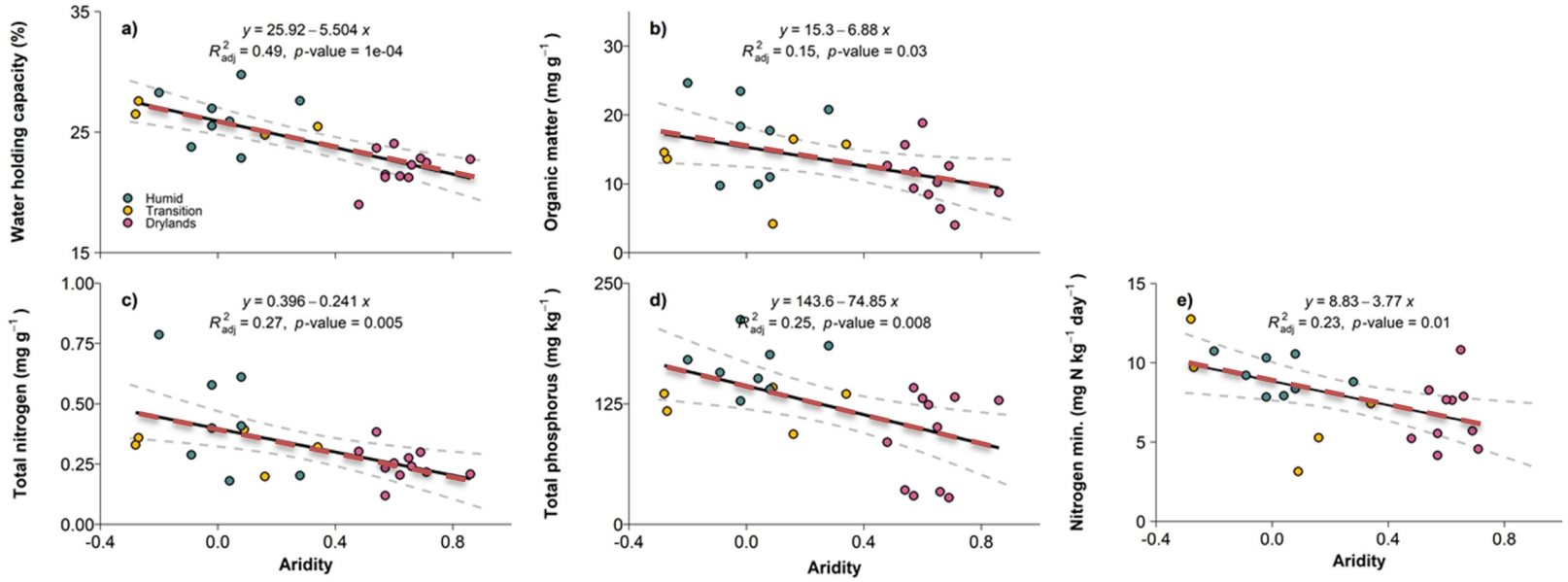

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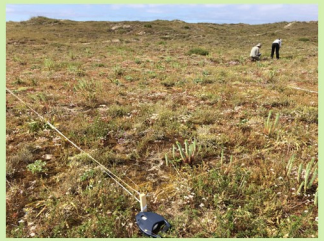
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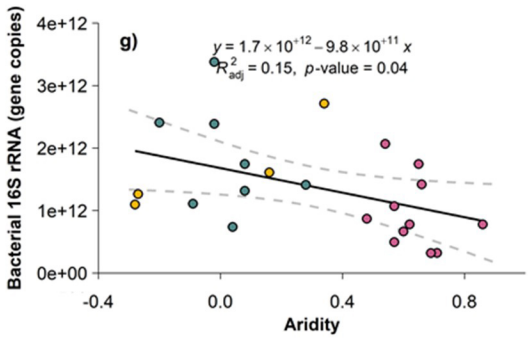

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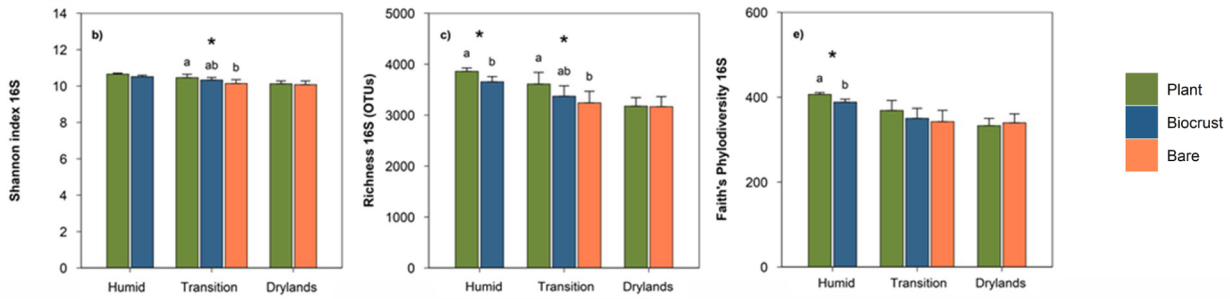

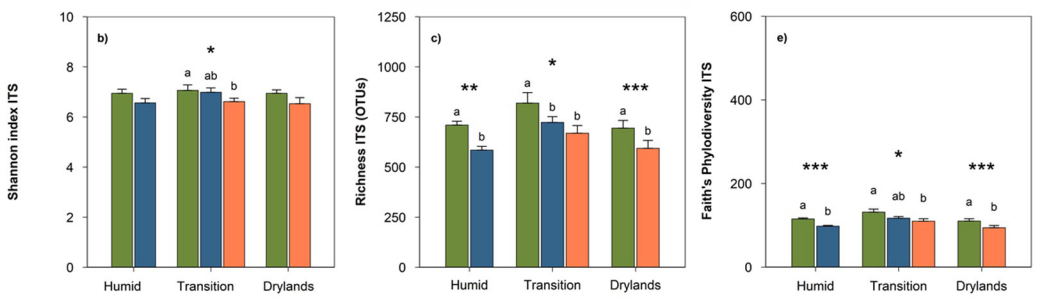

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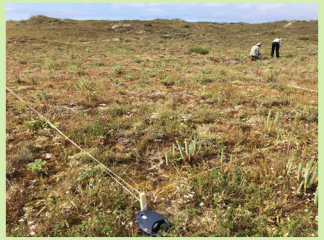

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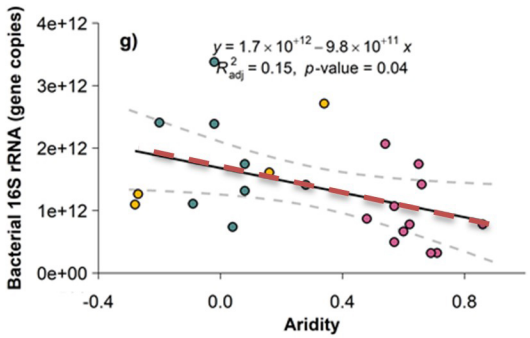

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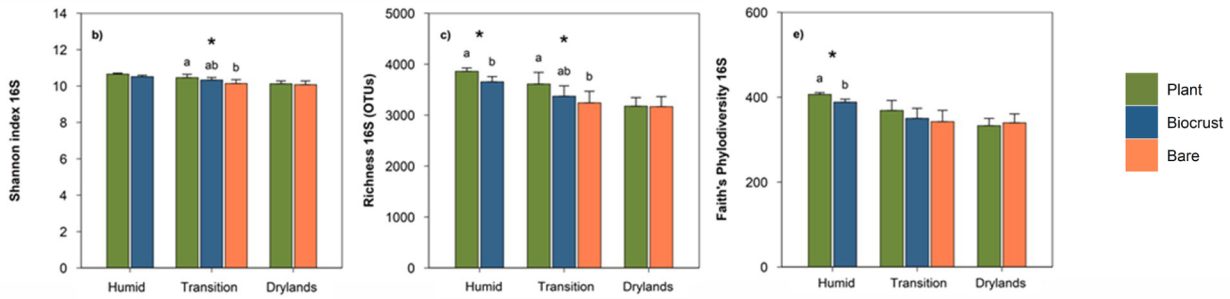

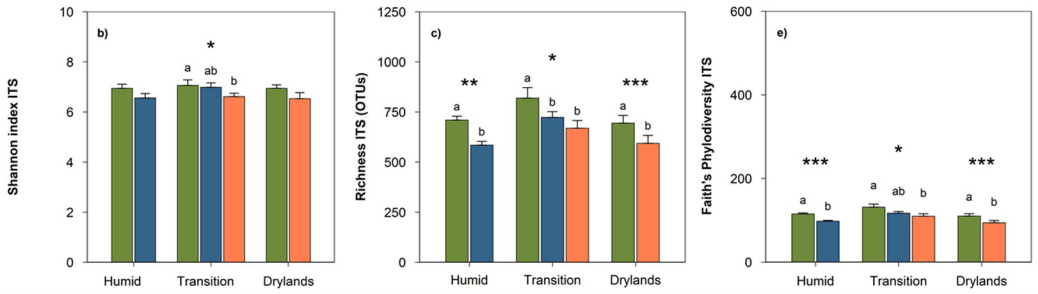

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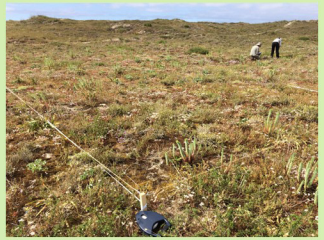



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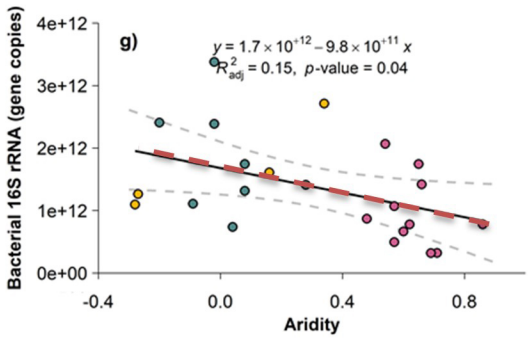

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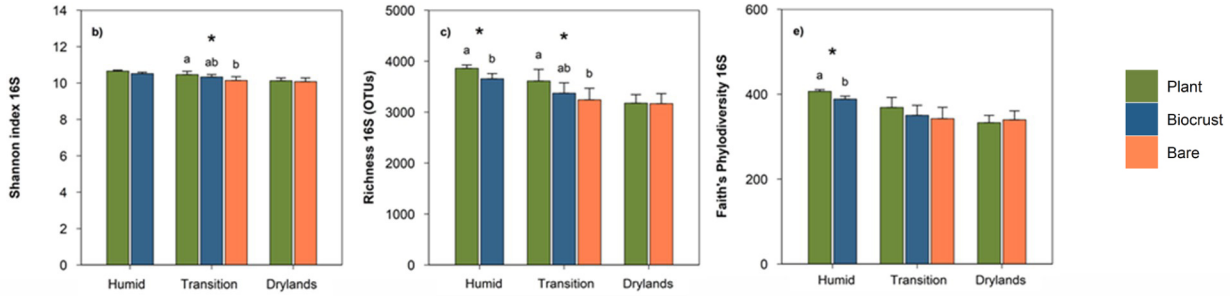

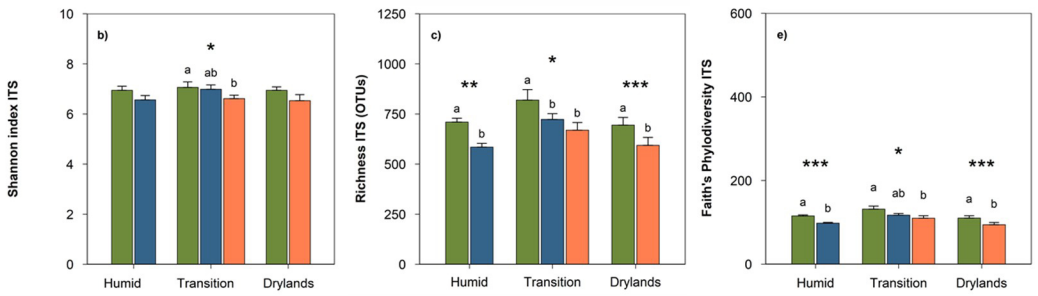

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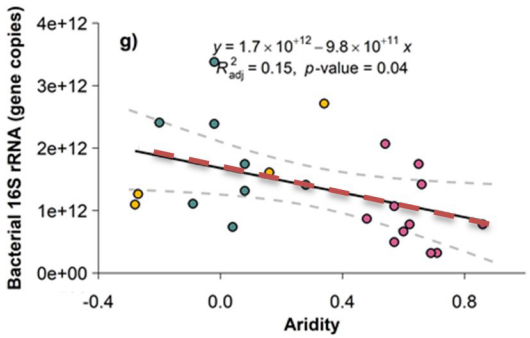

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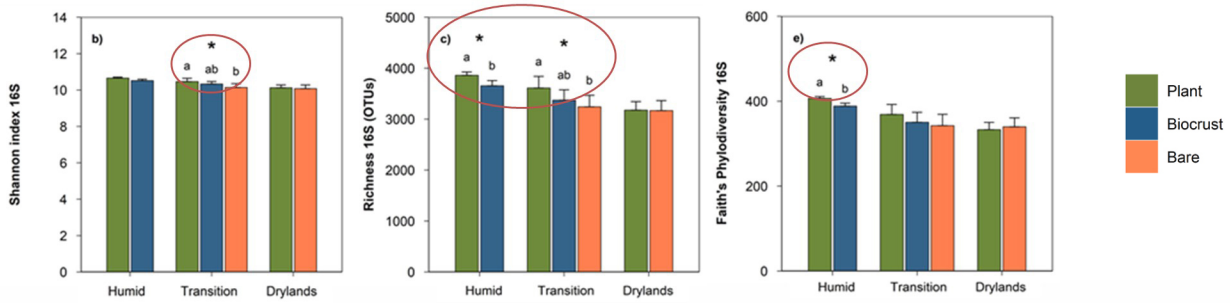

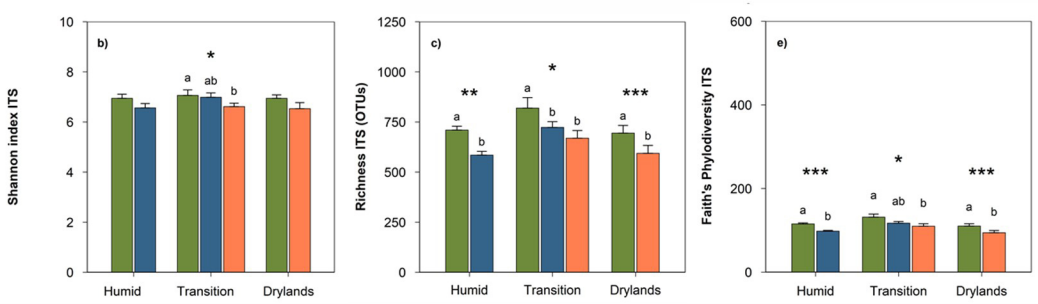

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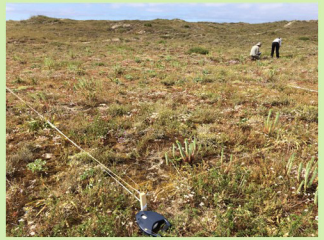

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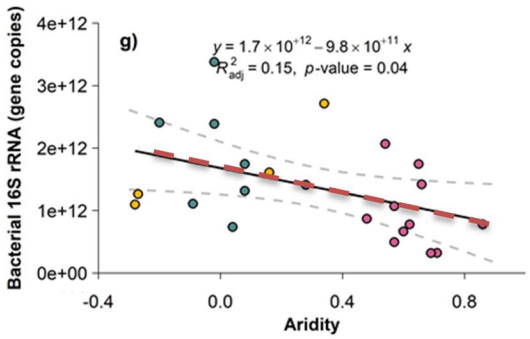

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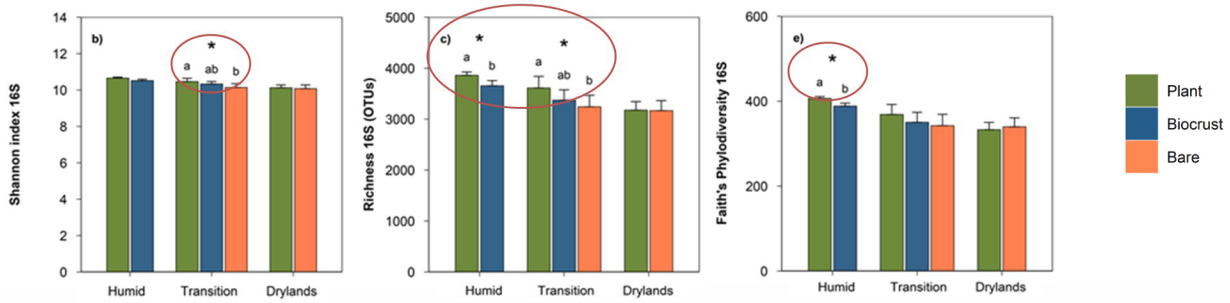

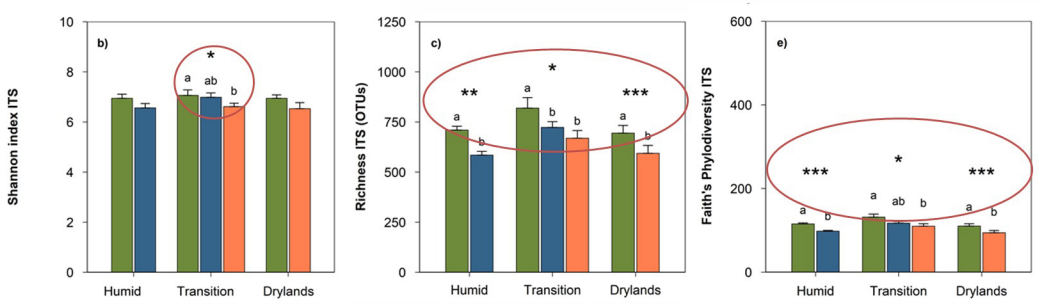

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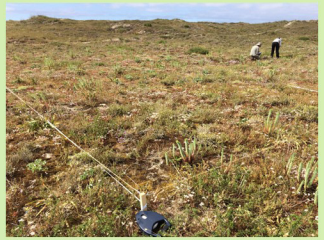

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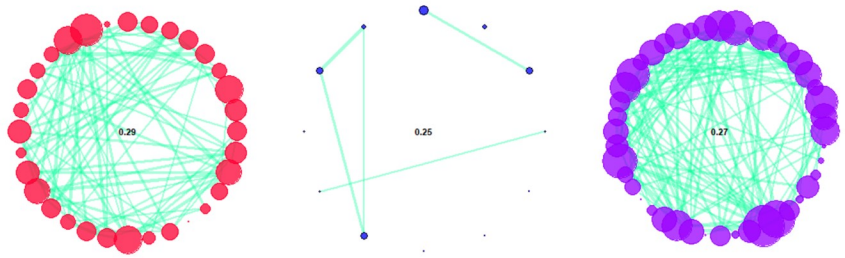
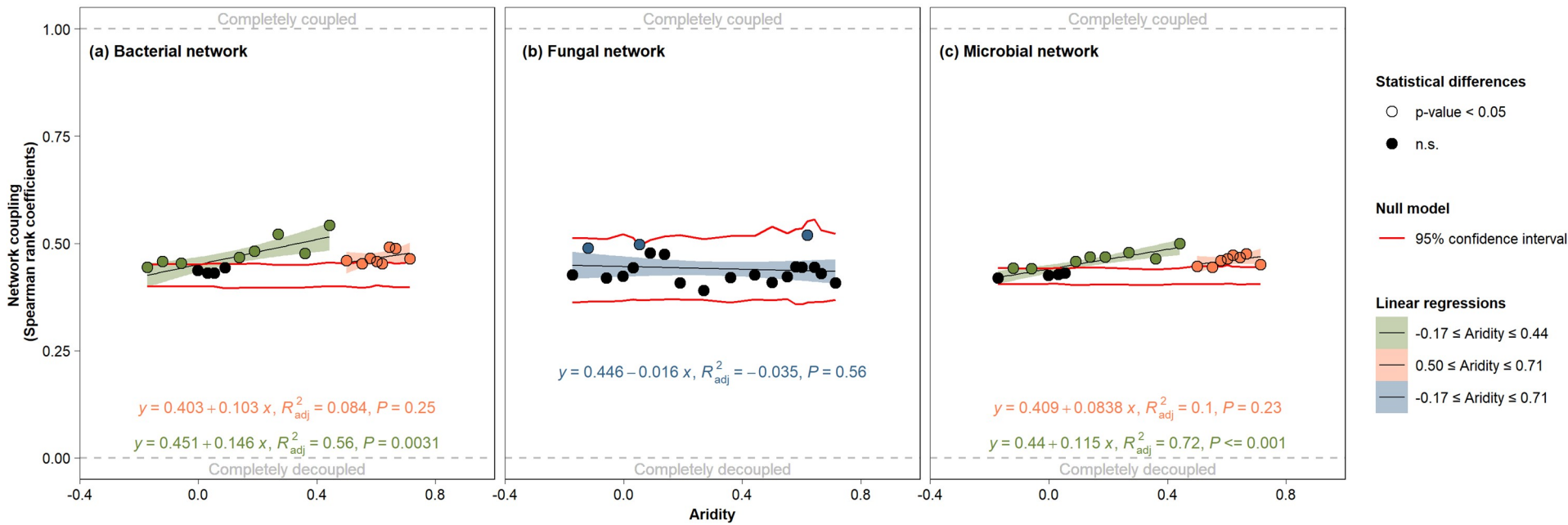


Bacterial networks + Fungal networks = Microbial networks



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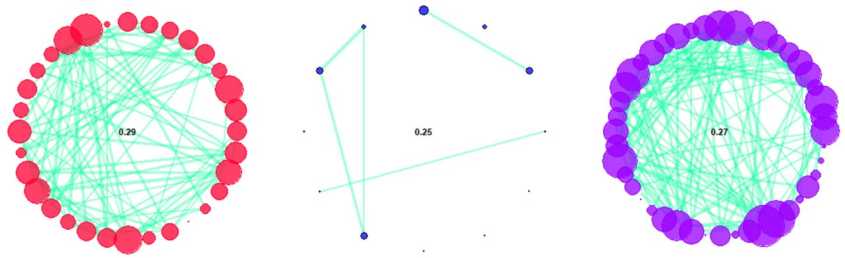

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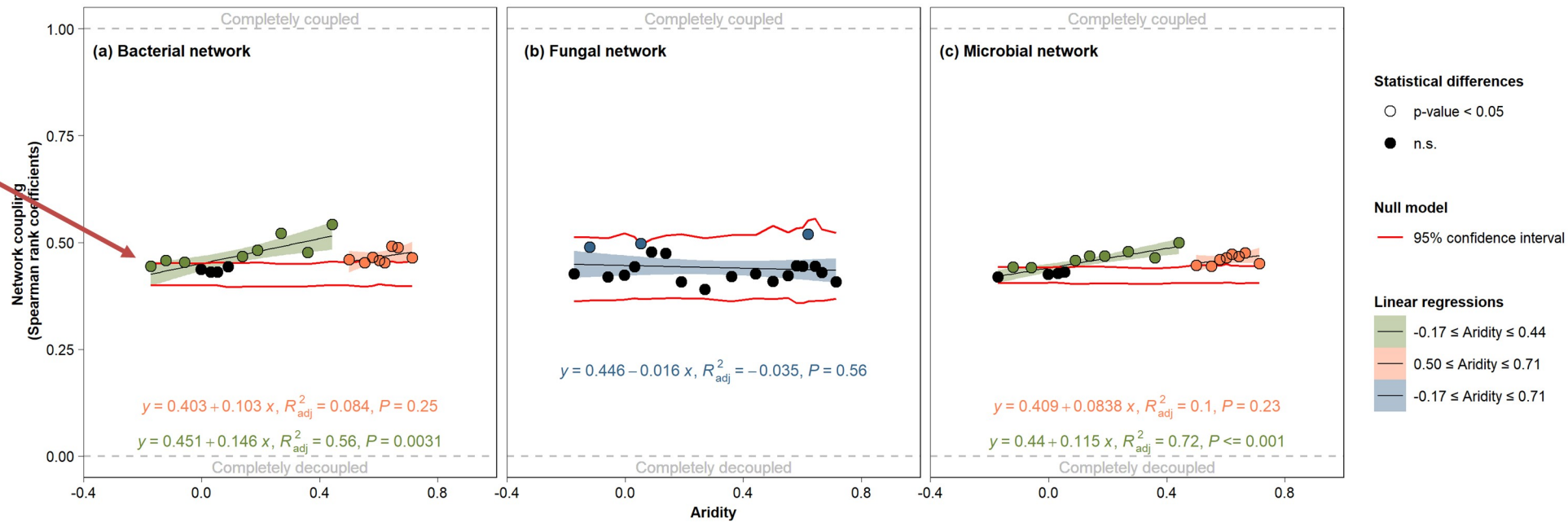
Window size = 5 dune sites



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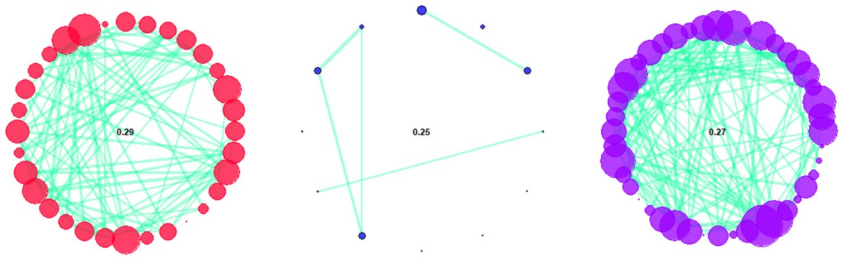

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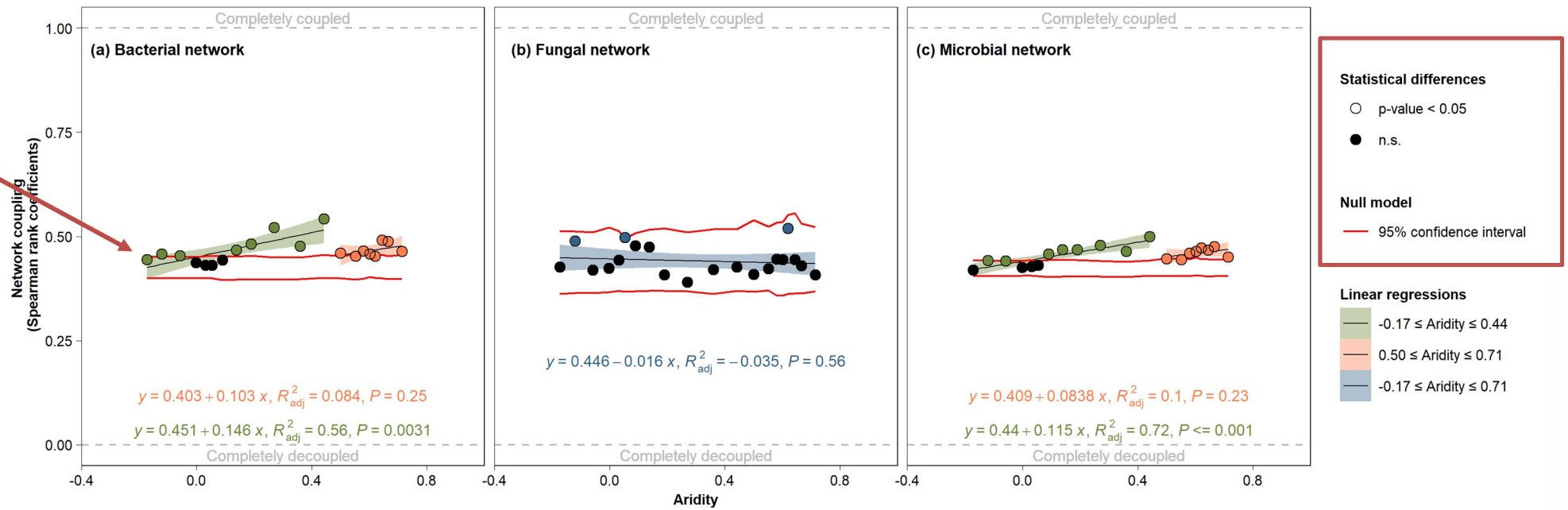
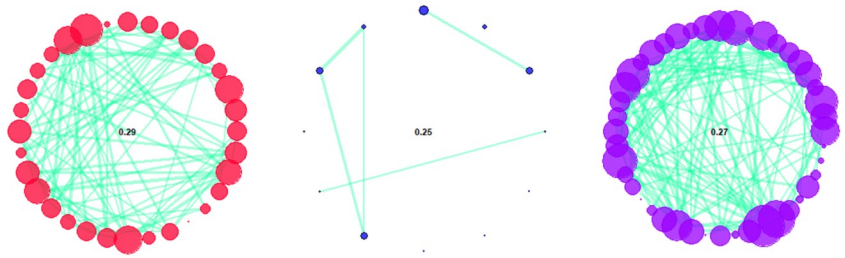
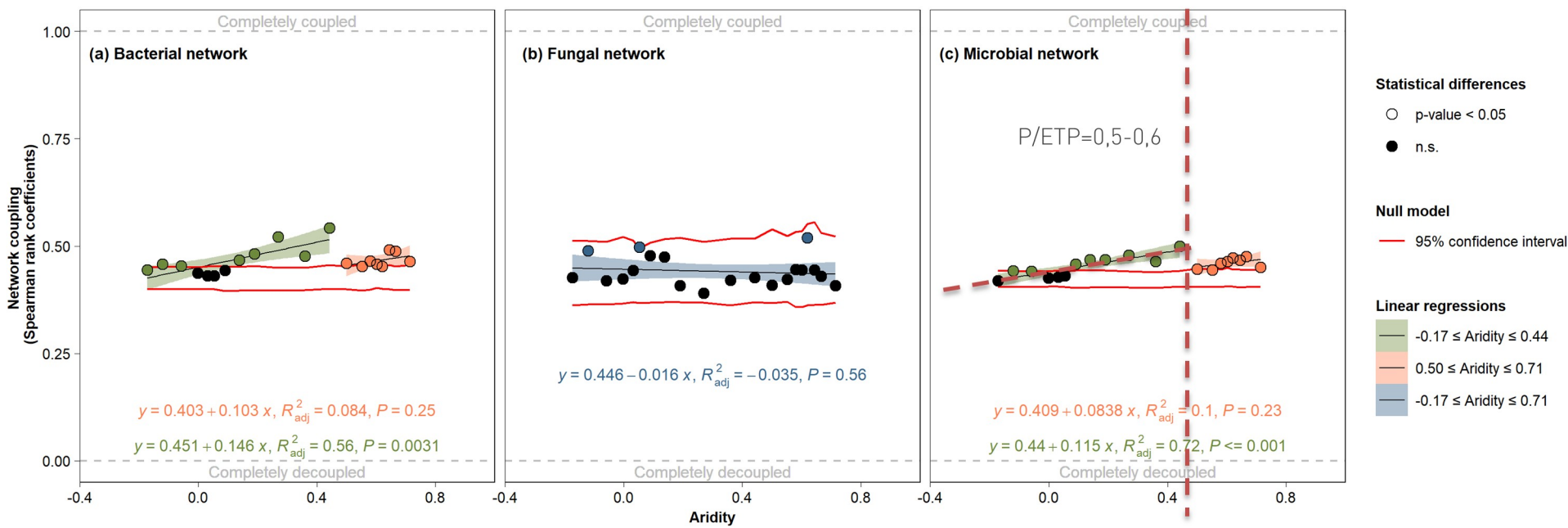


3 Results and discussion
Climate effects on soil microbial networks



Bacterial networks + Fungal networks = Microbial networks

Increases in aridity drove a strong increase in the coupling of the soil microbial network until a specific threshold beyond which it remained constant.



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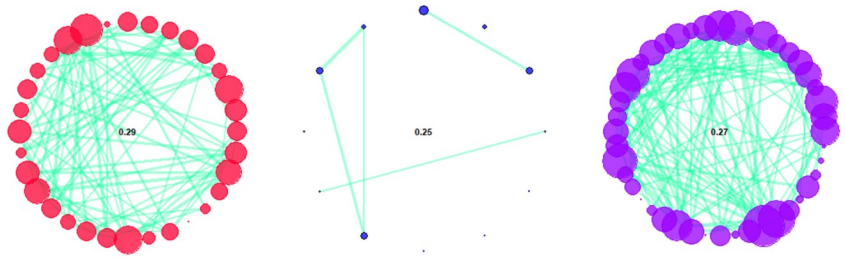

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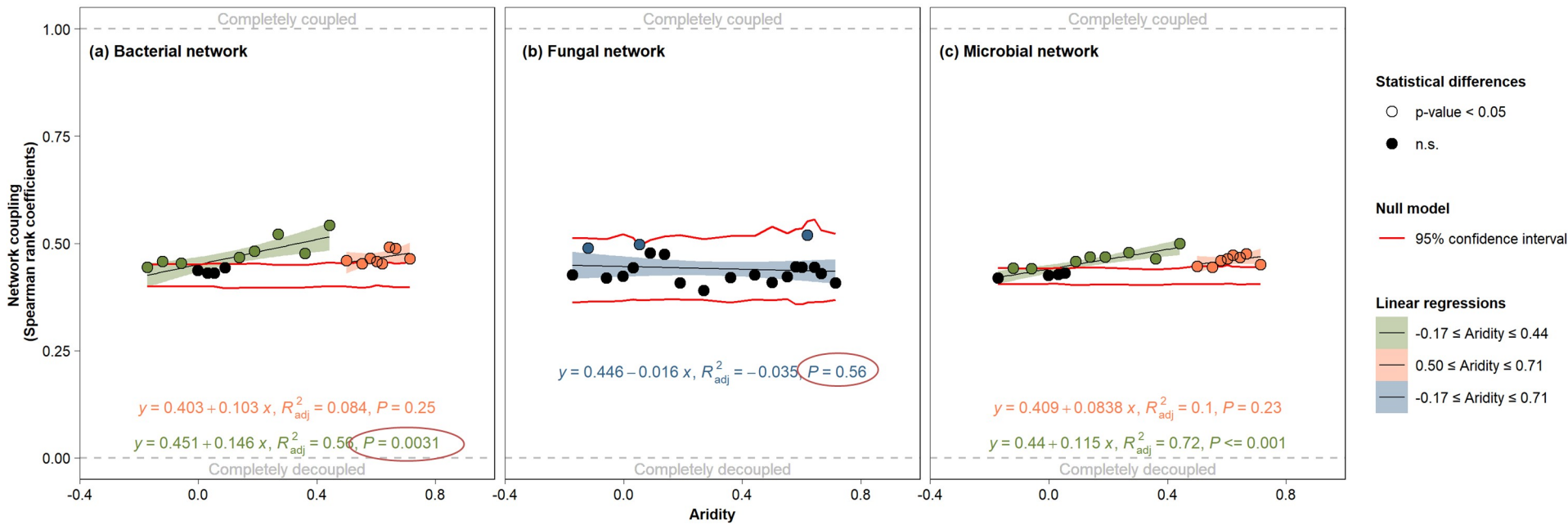

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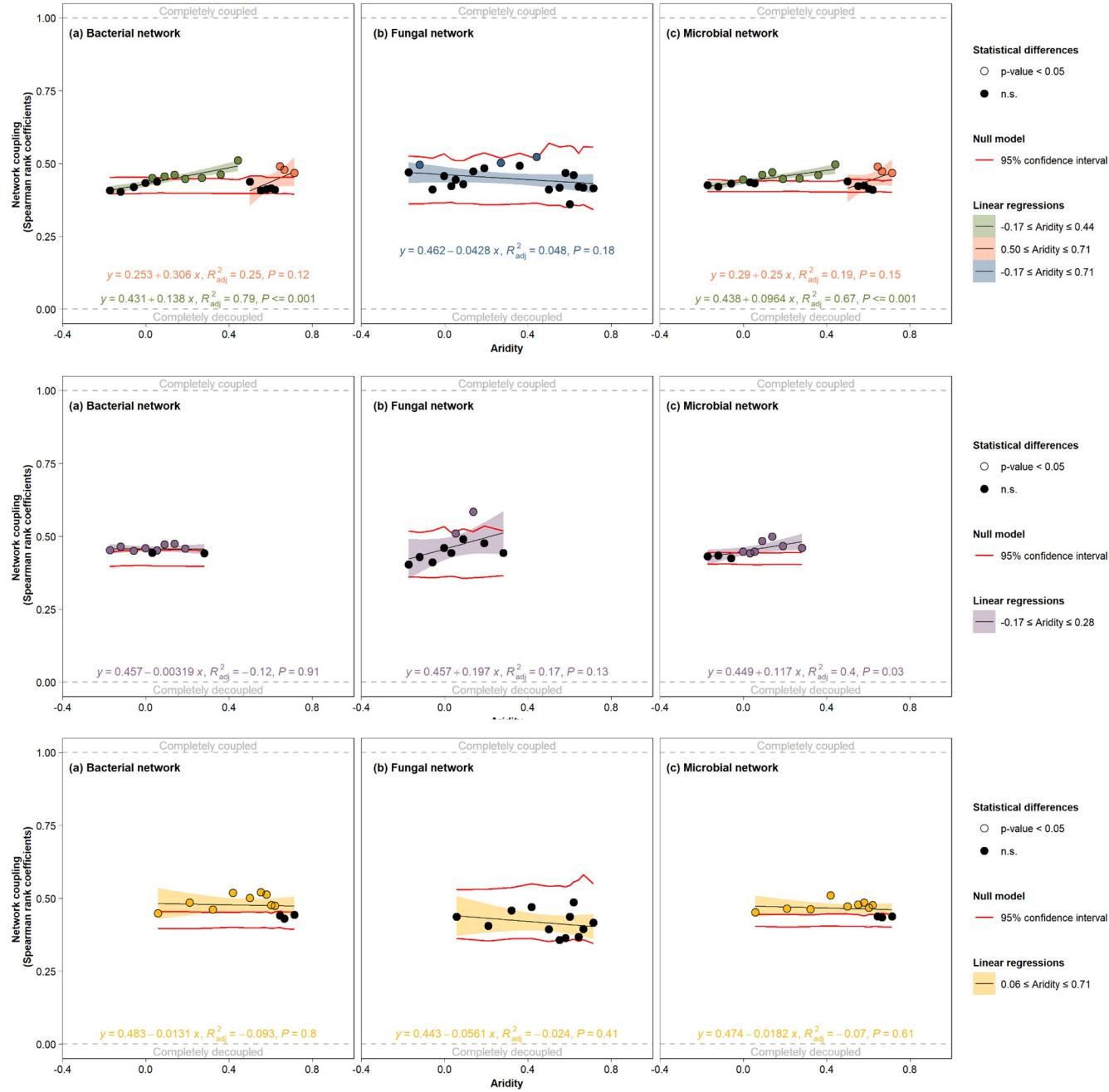
3 Results and discussion
Microsites as modulators of soil microbial networks

Microsites strongly drove the interactions between soil bacterial groups, but much less so for fungal groups.

Plant

Biocrust

Bare soil



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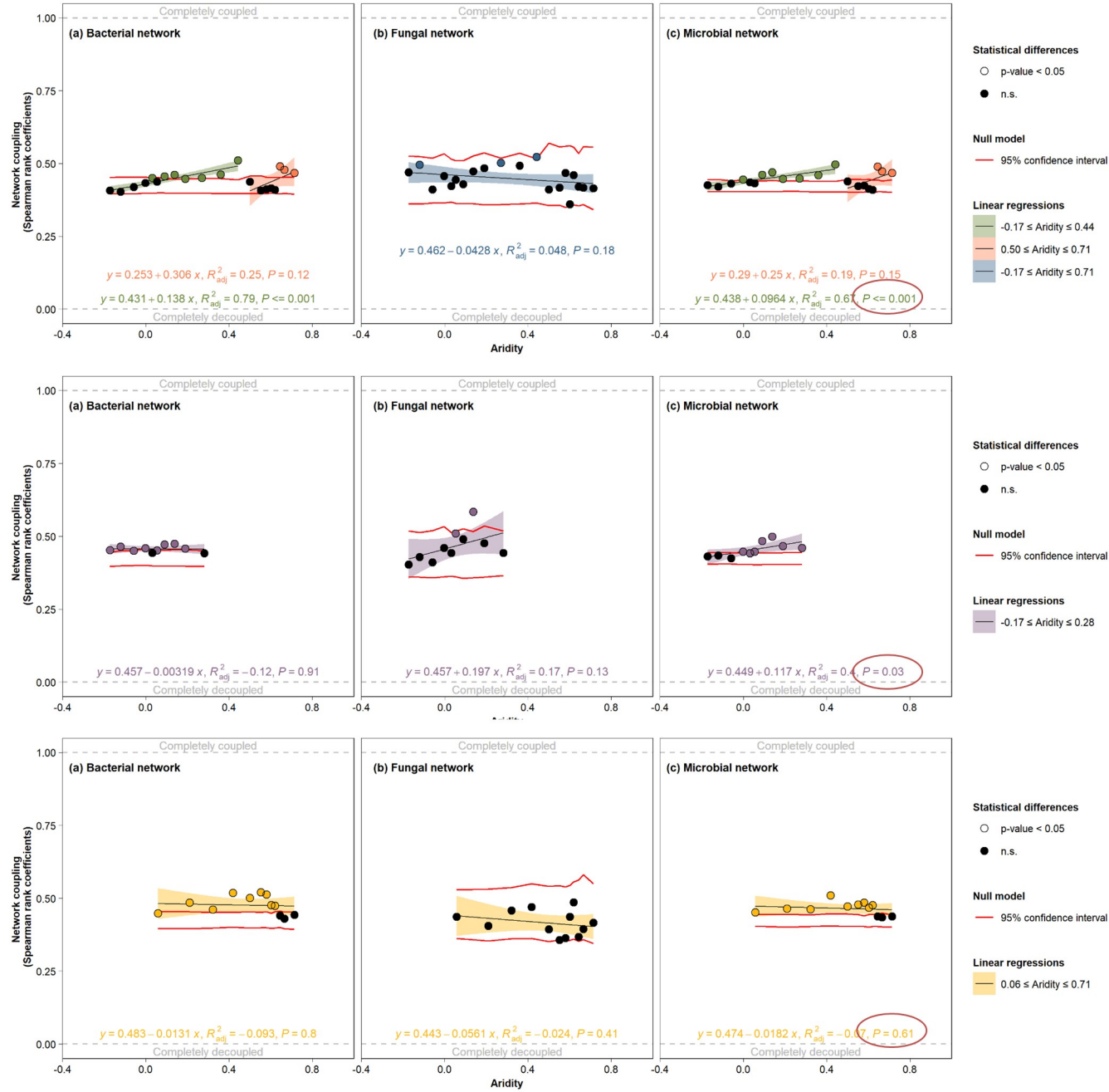

Highlights

- Aridity decreased total vegetation cover and favoured the formation of shrub-dominated patches.
- Aridity negatively impacted soil bacterial abundance, microbial diversity, nutrient contents and potential N mineralization.
- Aridity caused a strong increase in the coupling of the soil microbial networks until a specific threshold (AI=0,5-0,6) beyond which it remained constant.
- Soil bacterial communities were more sensitive to changes in aridity than fungal communities.

Acknowledgements:

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Thanks for your attention!

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Next steps

- Incorporation of spatial and environmental information to discern the complex ecological mechanisms driving the microbial community assembly
- Explore for ecological clusters associated to microhabitats: identification of taxa that tend to co-occur (i.e. 'generalists') from those that exclusively occurred in one of the microhabitats (i.e. 'specialists')
- Identify keystone taxa (e.g. aridity sensitive vs. aridity tolerant).

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