Organisms as modulators of ecosystem functioning in global drylands

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ECODESERT

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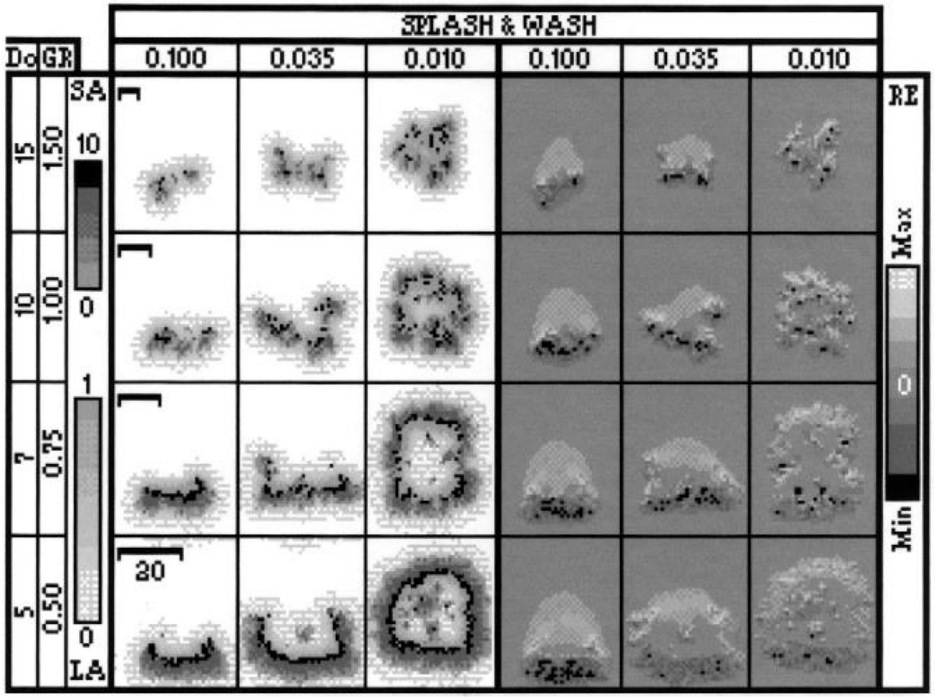
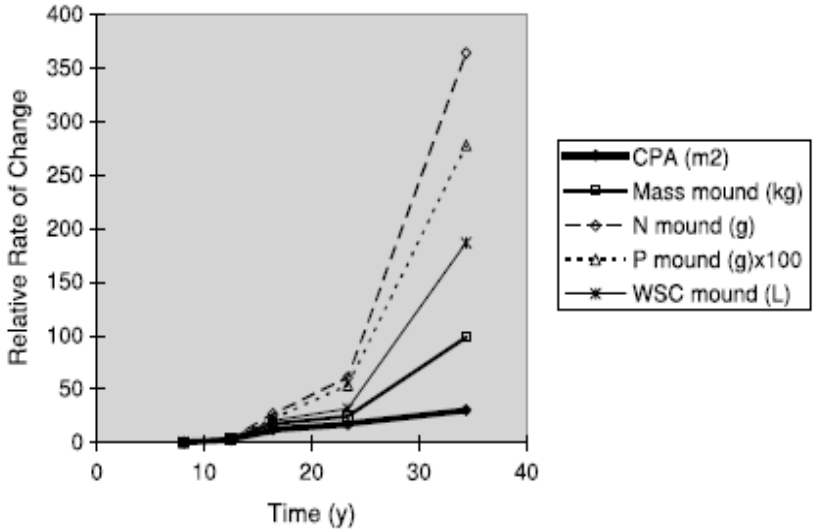
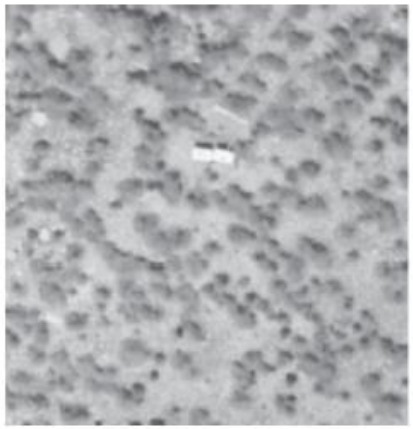
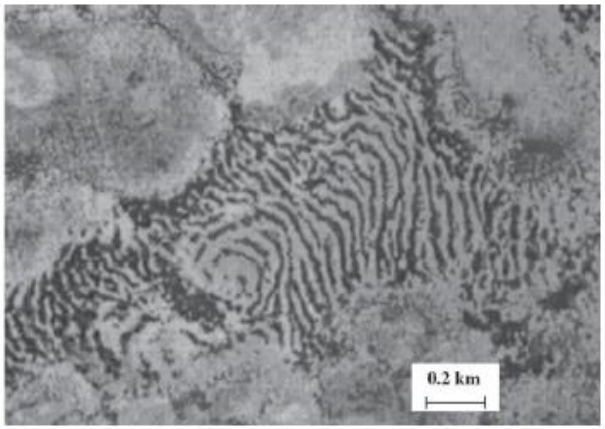
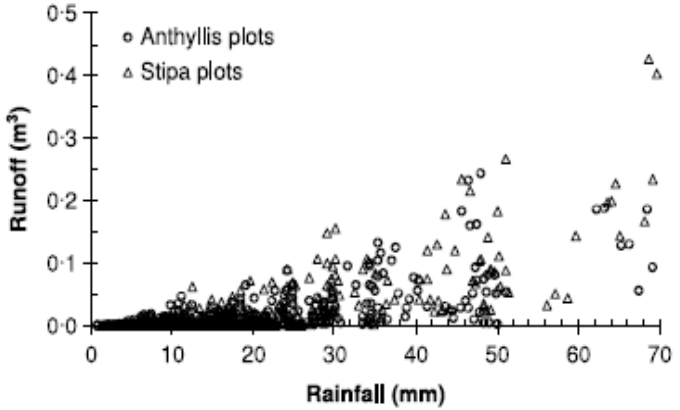
How organisms influence affect ecosystem functioning has been a central tenet of Juan´s research











Puigdefábregas *et al.* 1999. *Earth-Sci Rev* 48: 39–70

Boer & Puigdefábregas. 2005. ESP *Landforms* 30: 149–167

The EPES-BIOCOM survey

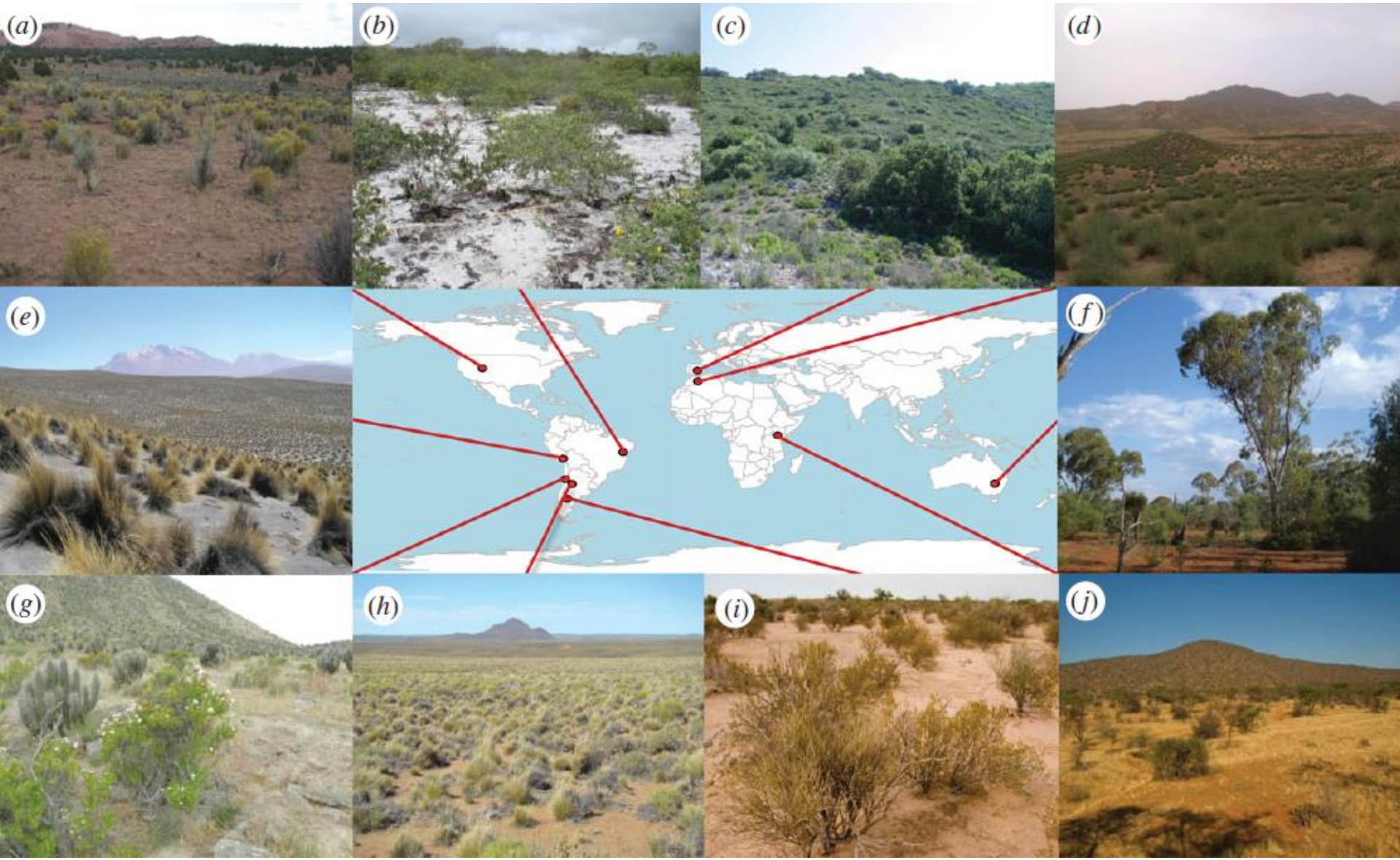
→ 236 drylands from all continents except Antarctica (21 countries).

→ Standardized vegetation and soil surveys conducted in all the sites

→ At each site, we quantified primary productivity and multiple soil variables related to C, N and P cycling (“functions”).

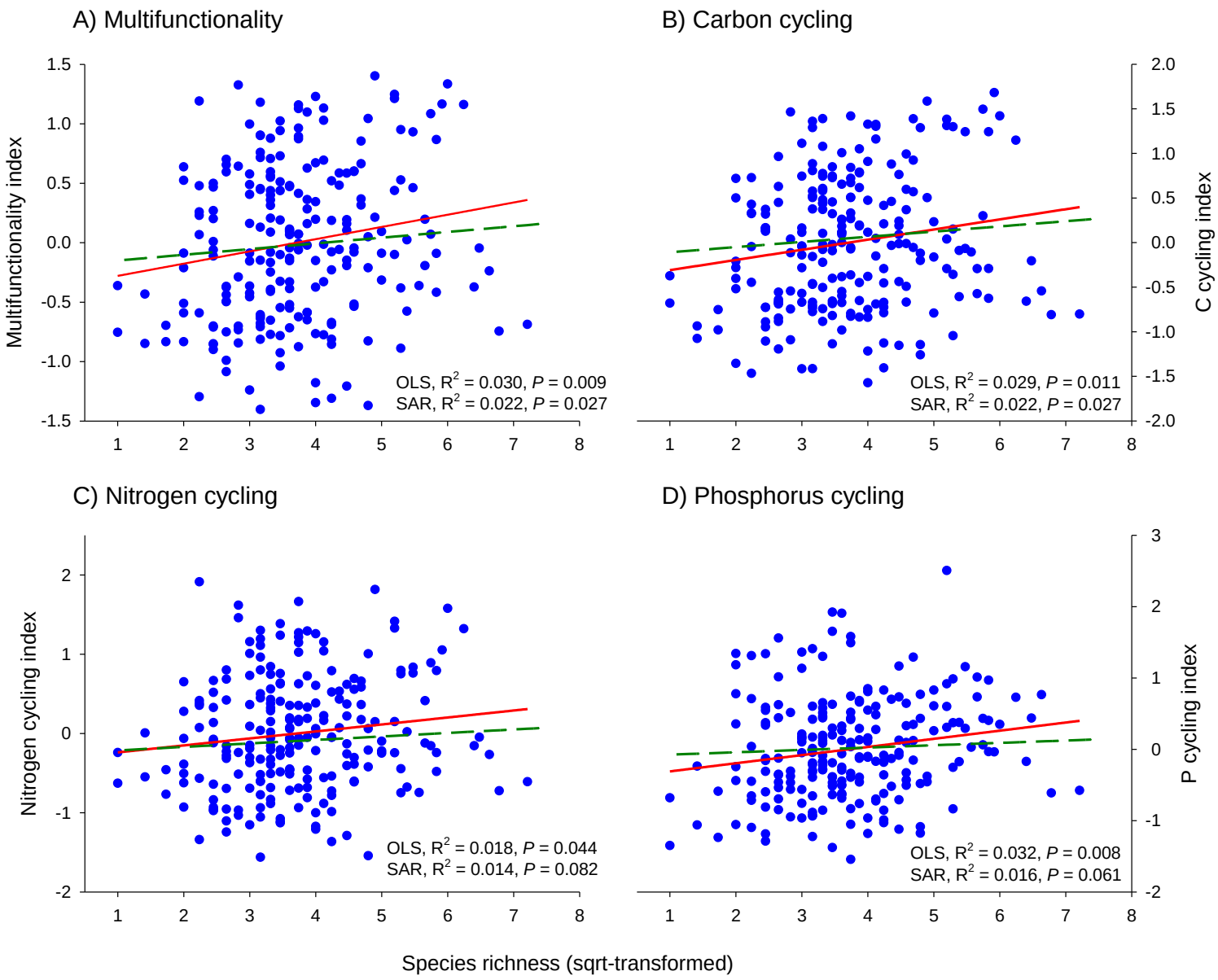
→ These variables are proxies of nutrient cycling, biological productivity, and buildup of nutrient pools, which are critical determinants of ecosystem functioning in drylands.

We captured the wide variety of vegetation found in global drylands



Maestre *et al.* 2012. *Phil Trans R Soc B* 367: 3062-3075

Plant species richness and multifunctionality



Plant species richness is an important multifunctionality predictor

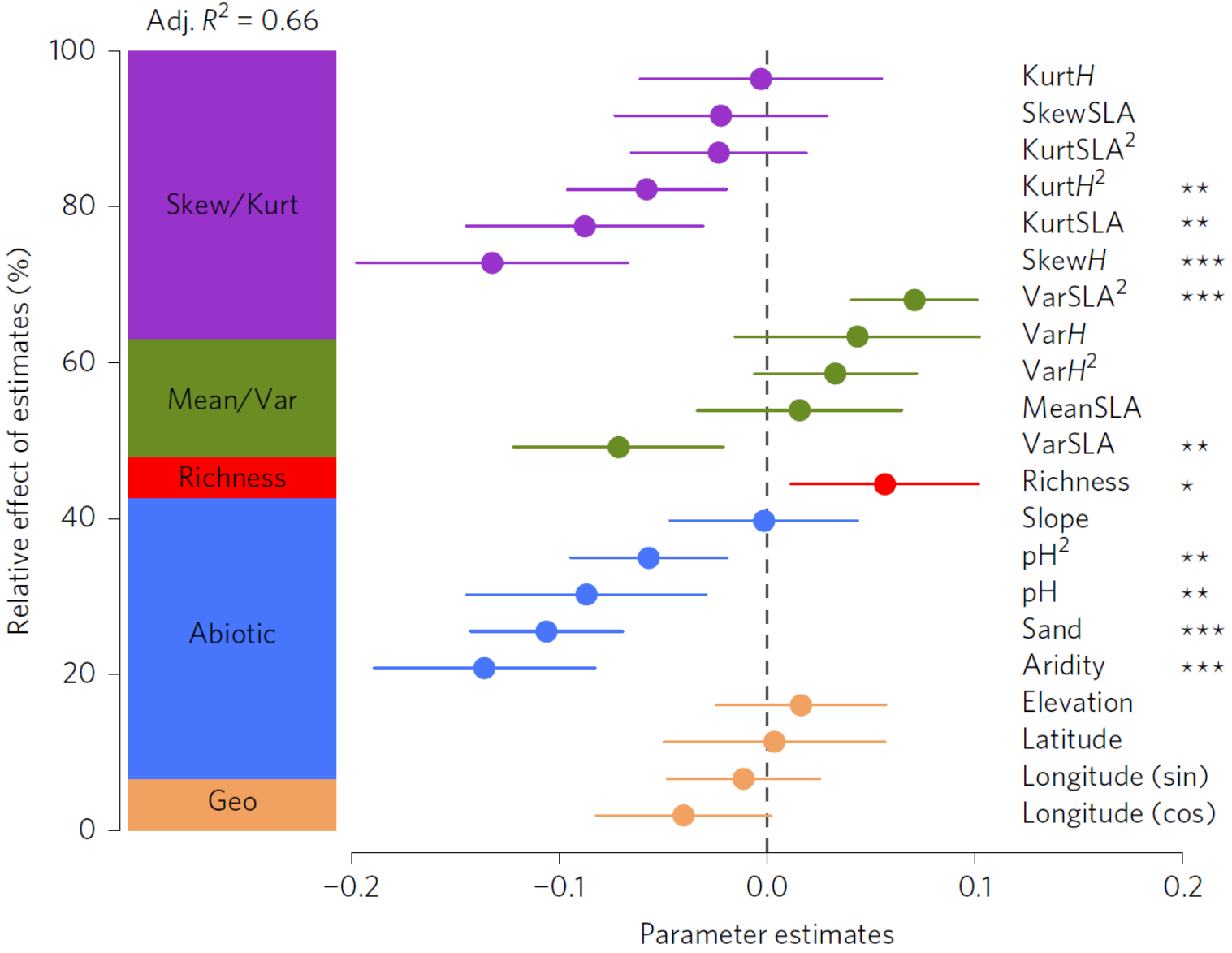
Species richness	Abiotic		Climatic				Geographic			R^2	AIC_c	ΔAIC_c	w_i
	SL	SA	C1	C2	C3	C4	LA	LO	EL				
■	■	■	■		■	■	■	■	■	0.564	282.750	0	0.217
■	■	■	■			■	■	■	■	0.559	283.226	0.475	0.171
■	■	■				■	■	■	■	0.554	283.595	0.845	0.143
■	■	■	■	■			■	■	■	0.558	283.862	1.111	0.125
■	■	■	■	■	■	■	■	■	■	0.565	284.502	1.751	0.091
■	■	■	■		■		■	■	■	0.556	284.637	1.887	0.085
■	■	■		■	■	■	■	■	■	0.561	284.677	1.927	0.083
■	■	■	■	■		■	■	■	■	0.560	285.035	2.285	0.069

SA = sand content , SL = slope, A1 = axis 1 of climatic PCA (mean annual precipitation, r = 0.910), A2 = axis 2 of climatic PCA (mean temperature of the driest quarter, r = 0.901), A3 = axis 3 of climatic PCA (precipitation in the driest quarter, r = 0.946), A4 = axis 4 of climatic PCA (annual mean temperature [r = 0.682] and mean temperature of the wettest quarter, r = 0.884), LA = lattitude, LO = longitude, and EL = elevation.

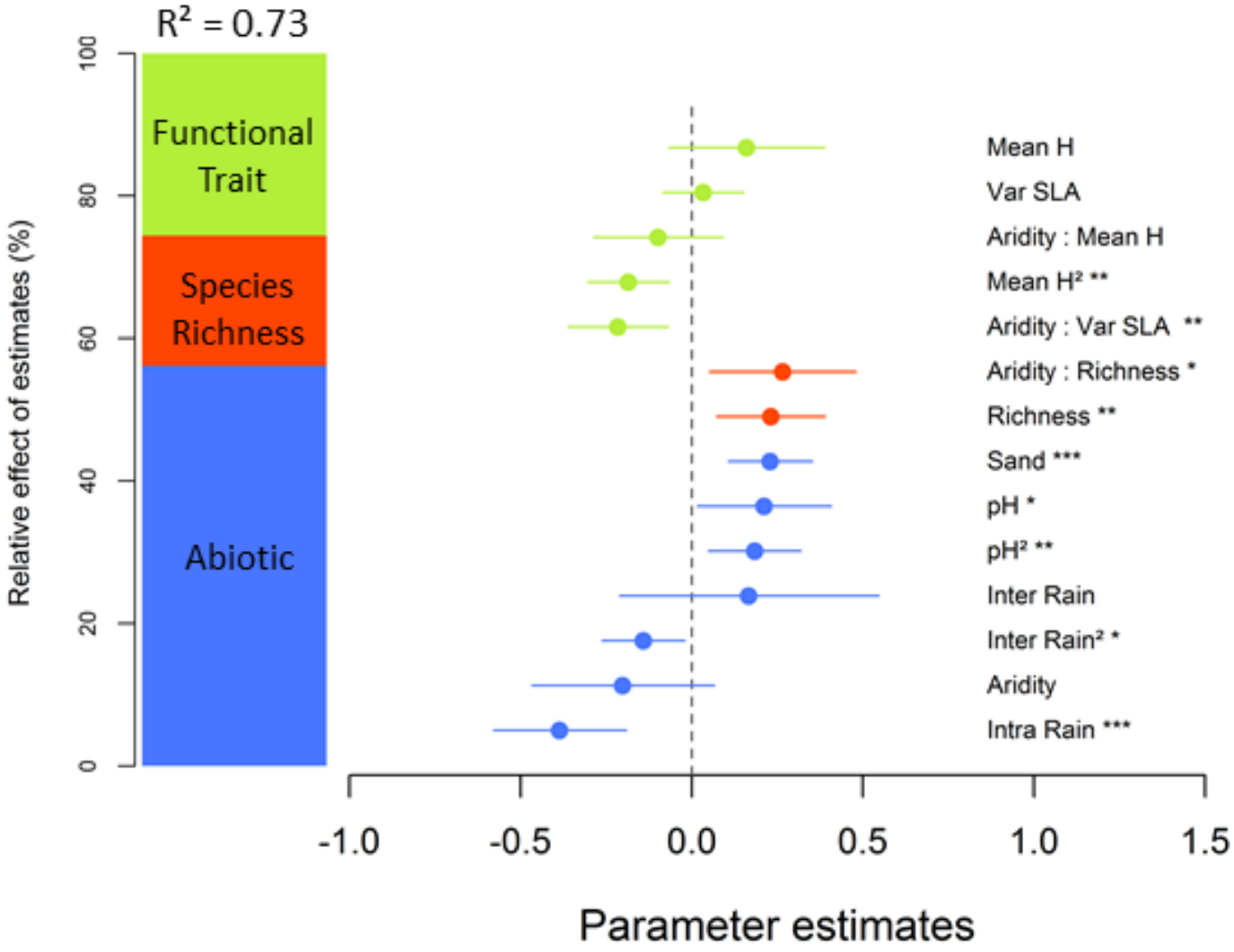
→ Best model without species richness: $R^2 = 0.539$, $AIC_c = 293.236$, and $\Delta AIC_c = 10.486$

→ Most parsimonious model without species richness: $R^2 = 0.515$, $AIC_c = 300.078$, and $\Delta AIC_c = 17.328$

Plant trait diversity is a key multifunctionality driver



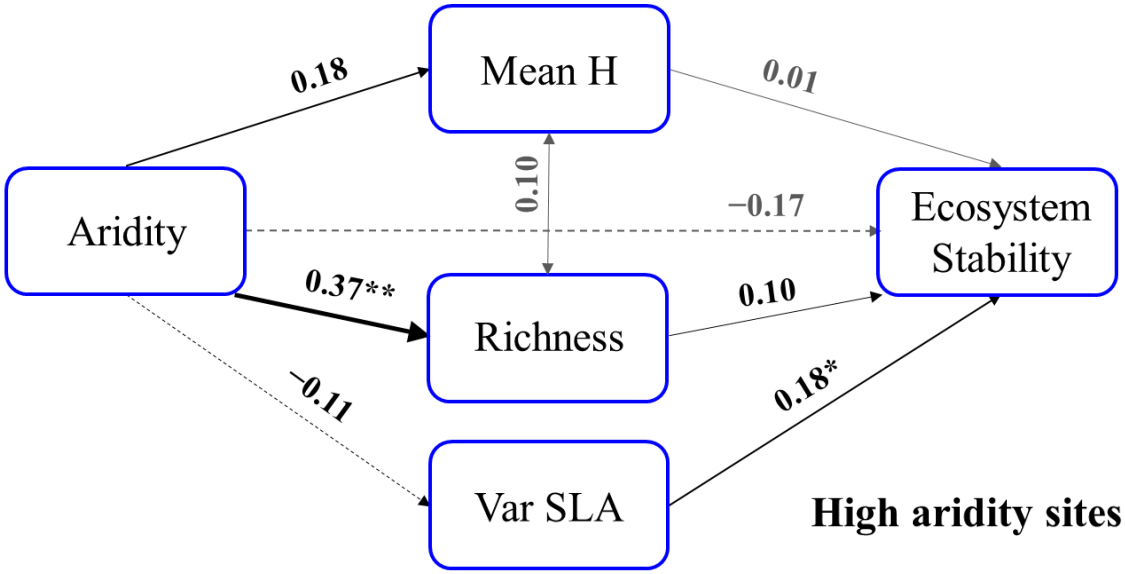
The role of plant diversity on ecosystem stability is as important as that of climate and soil factors



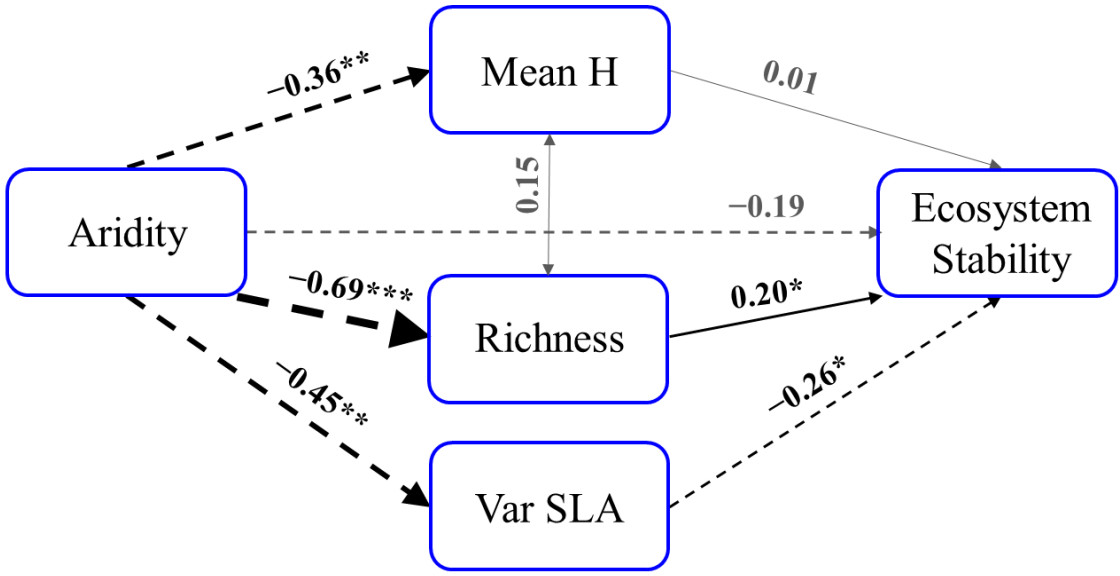
García-Palacios *et al.* 2018. *PNAS* 115: 8400-8405

Climate mediates the biodiversity-ecosystem stability relationship globally

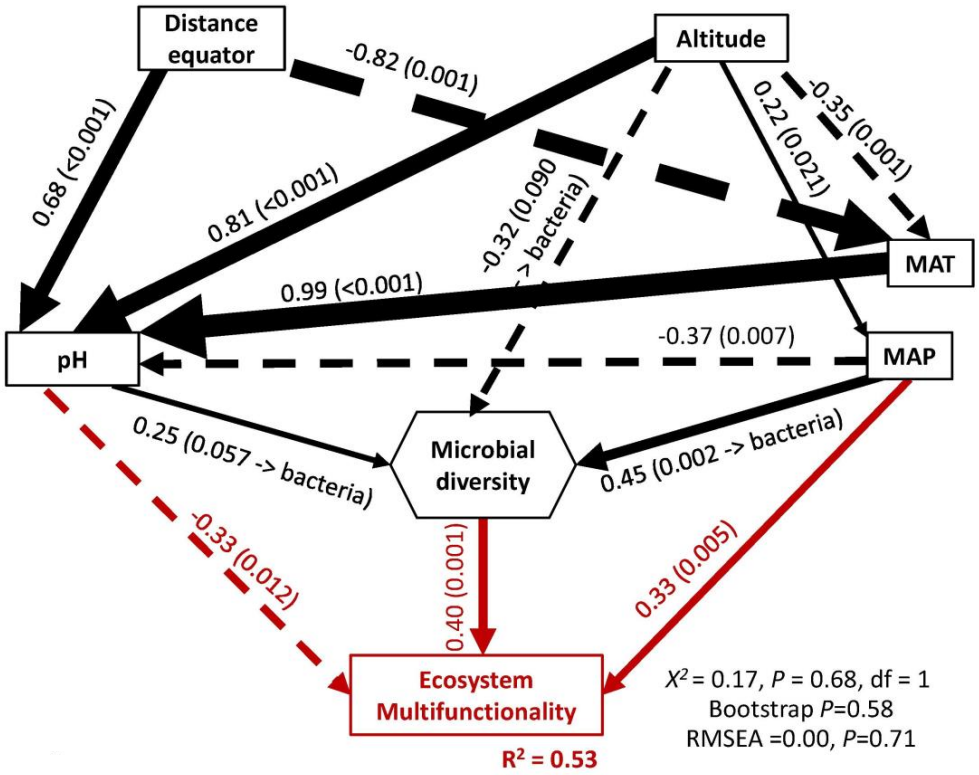
Low aridity sites

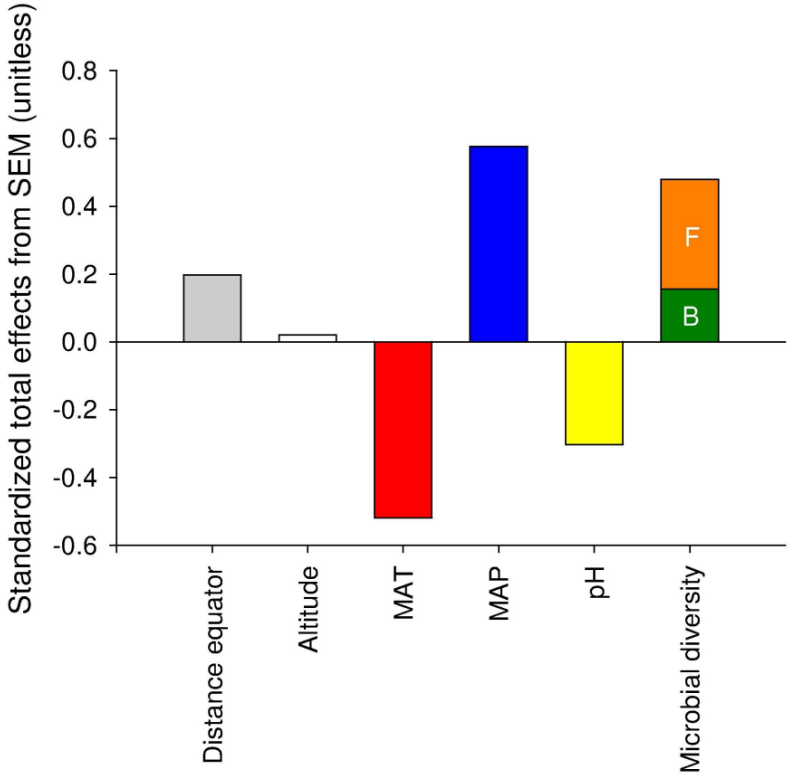


High aridity sites

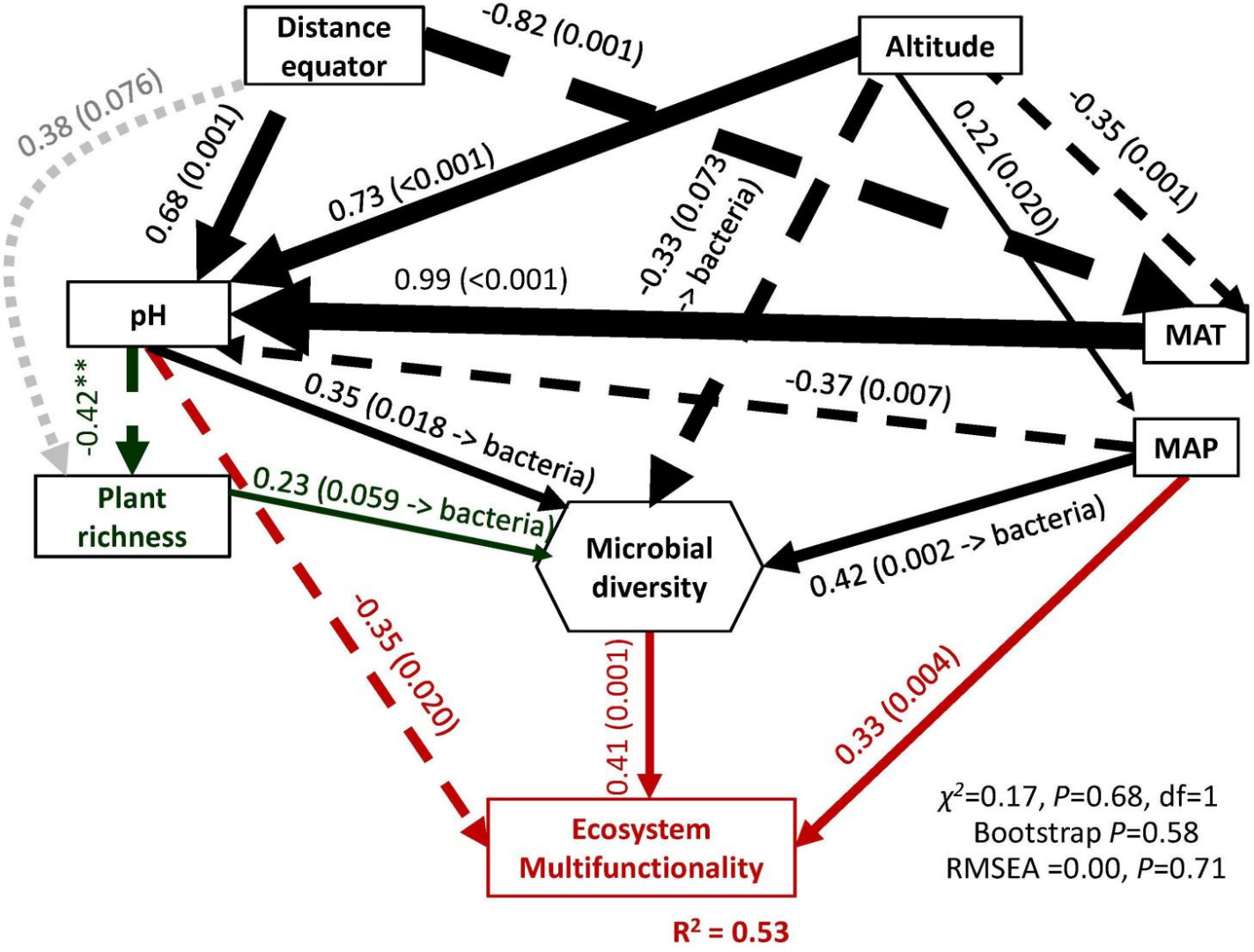


Microbial diversity is a key driver of multifunctionality

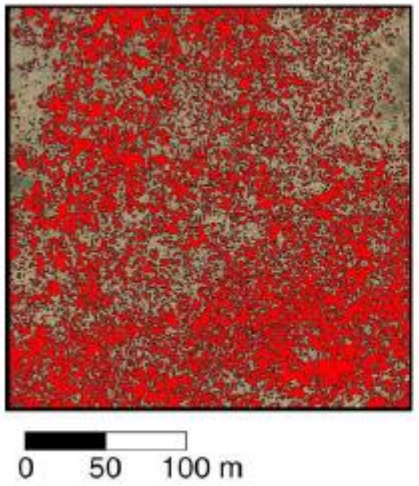


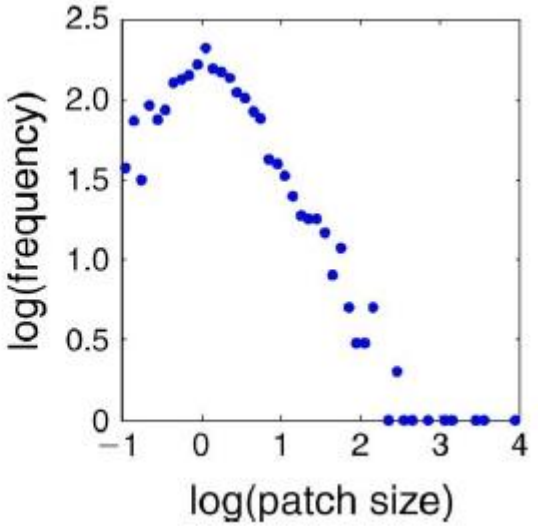


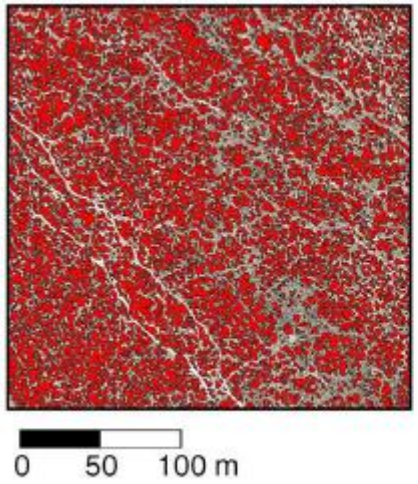
Effects of plant diversity on multifunctionality are mediated by microbial diversity

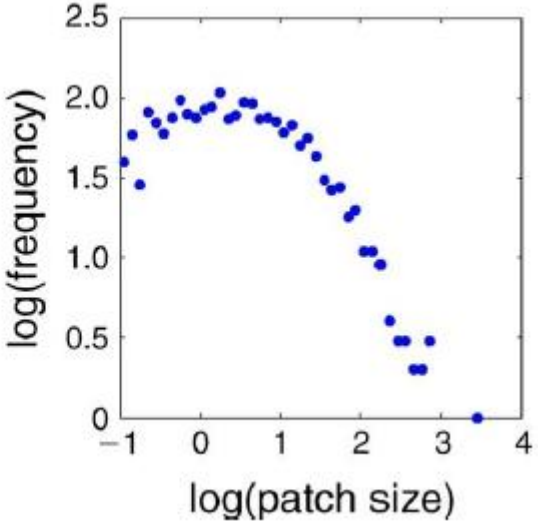


Plant spatial patterns and ecosystem functioning

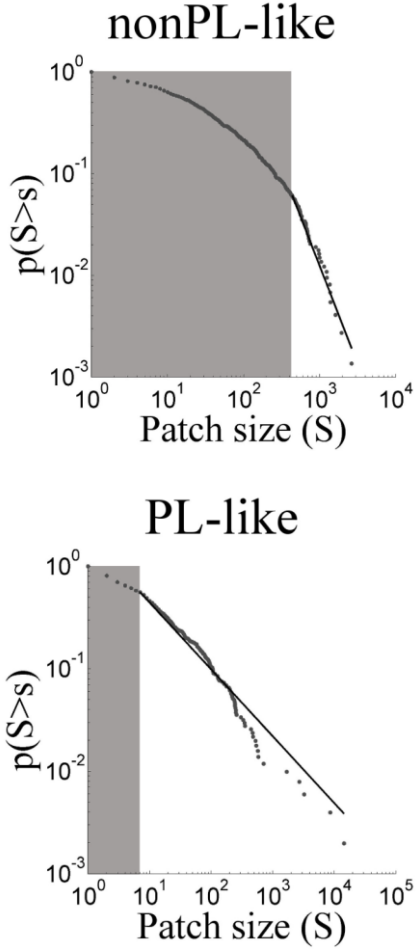


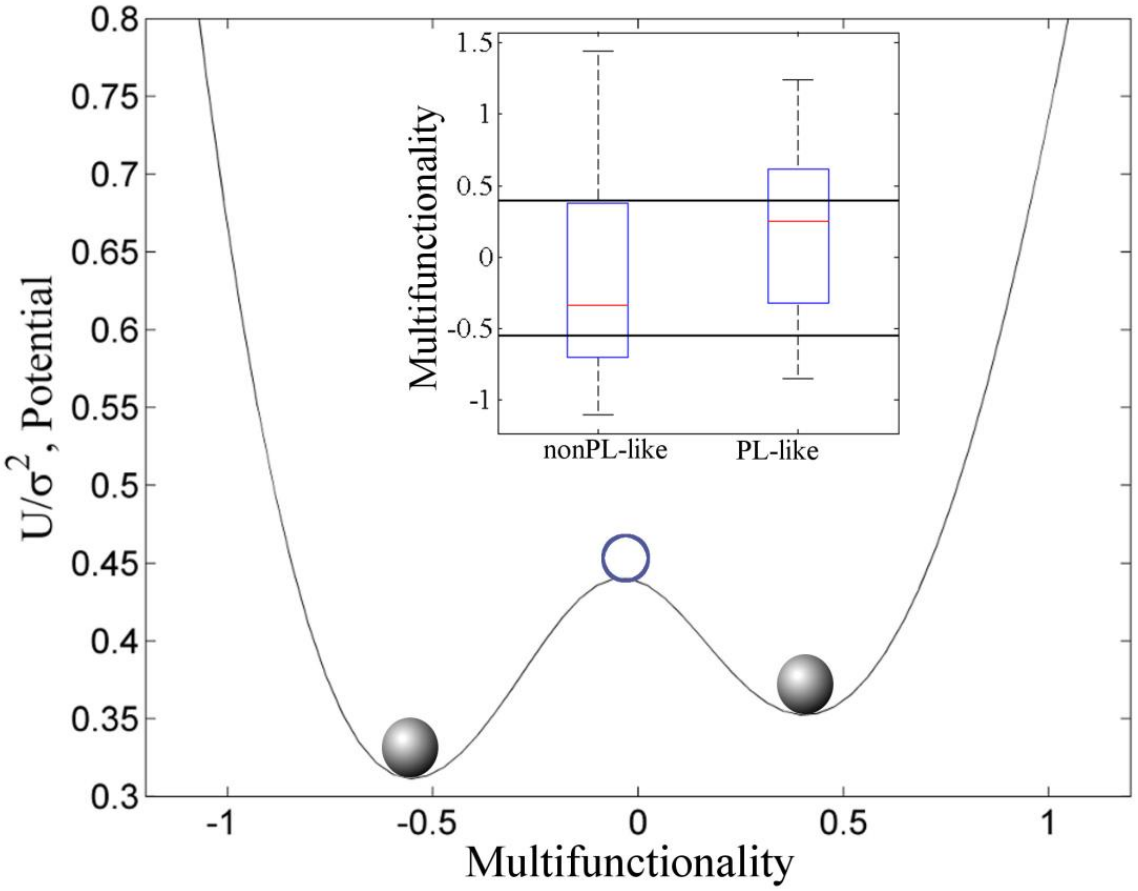






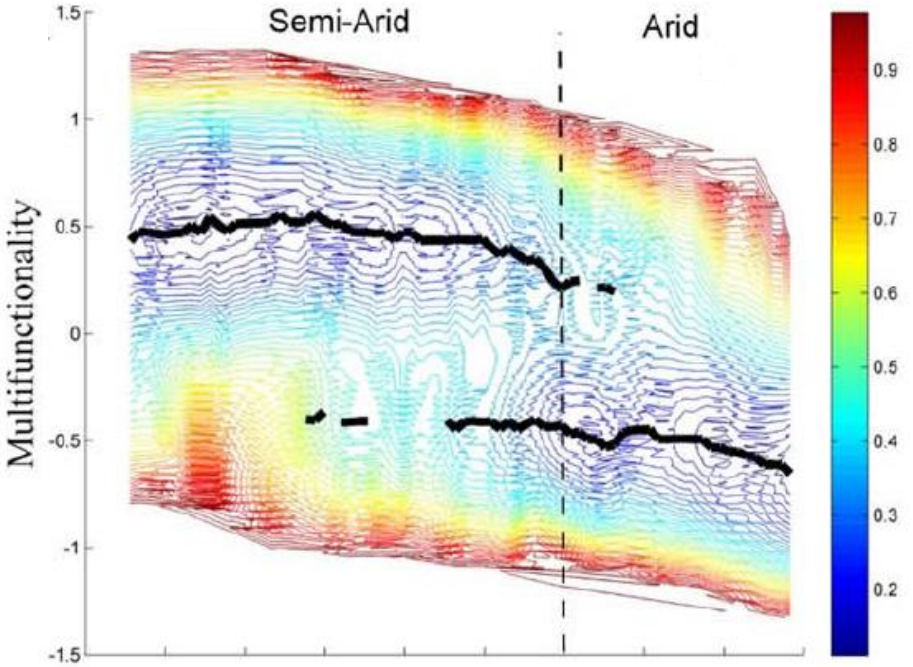
→ The frequency distribution of patch sizes was typically hump-shaped (log scale), with abundant small patches and a fewer large patches.

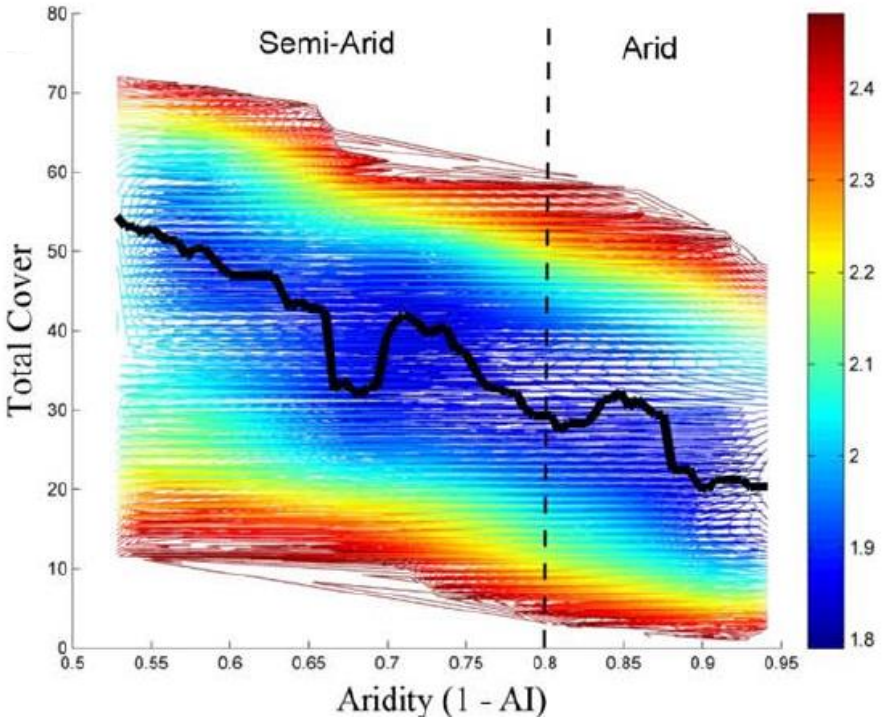


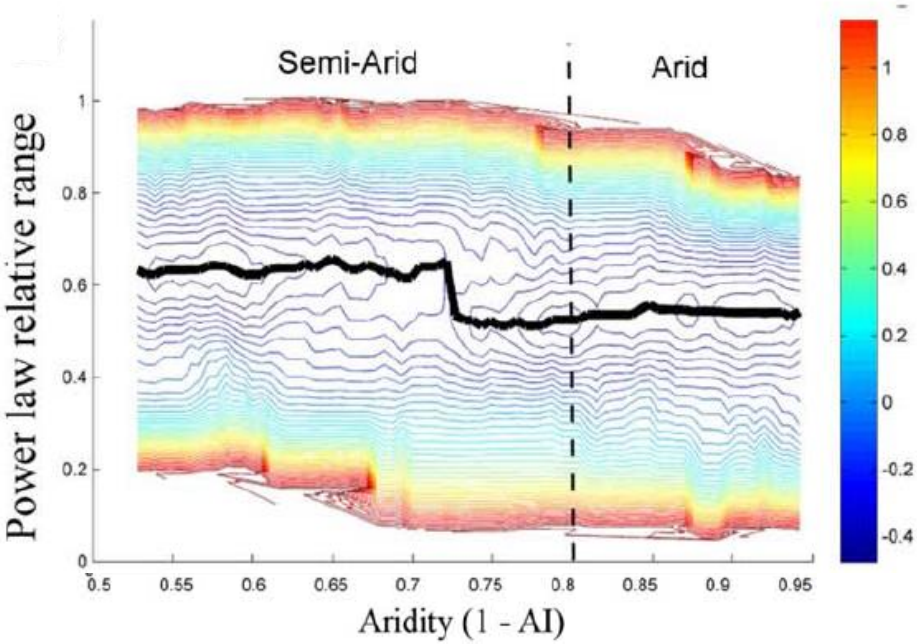


→ The type of patch-size distribution was significantly associated with the two multifunctionality states observed.

→ Sites with patch-size distributions following a power law have enhanced multifunctionality.



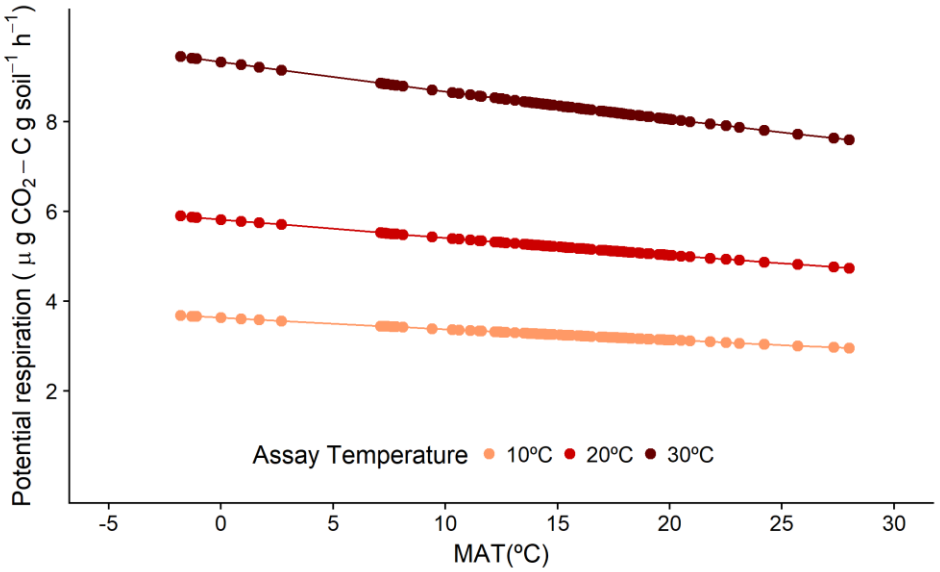


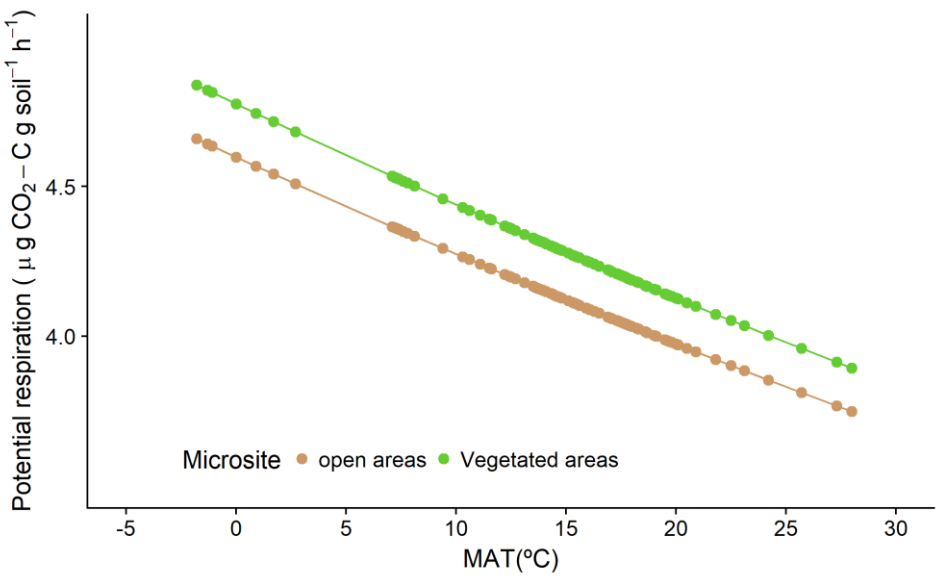


→ Cover smoothly decreased with aridity, but spatial pattern showed an abrupt change that matched the co-occurrence of the MF states observed.

→ These results were not confounded by the effects of aridity.

Soil microbial respiration adapts to ambient temperature in global drylands

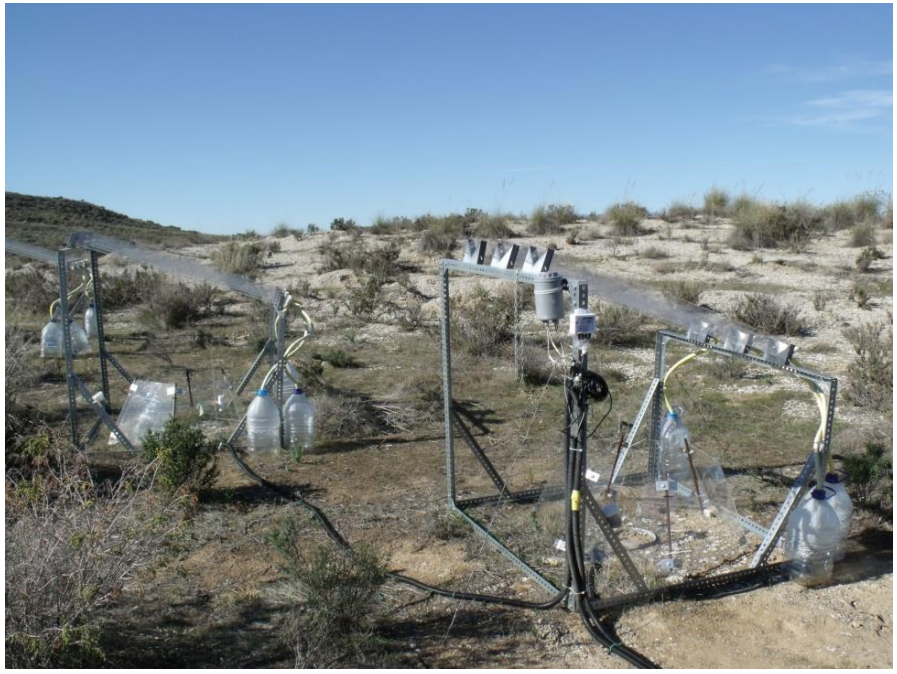


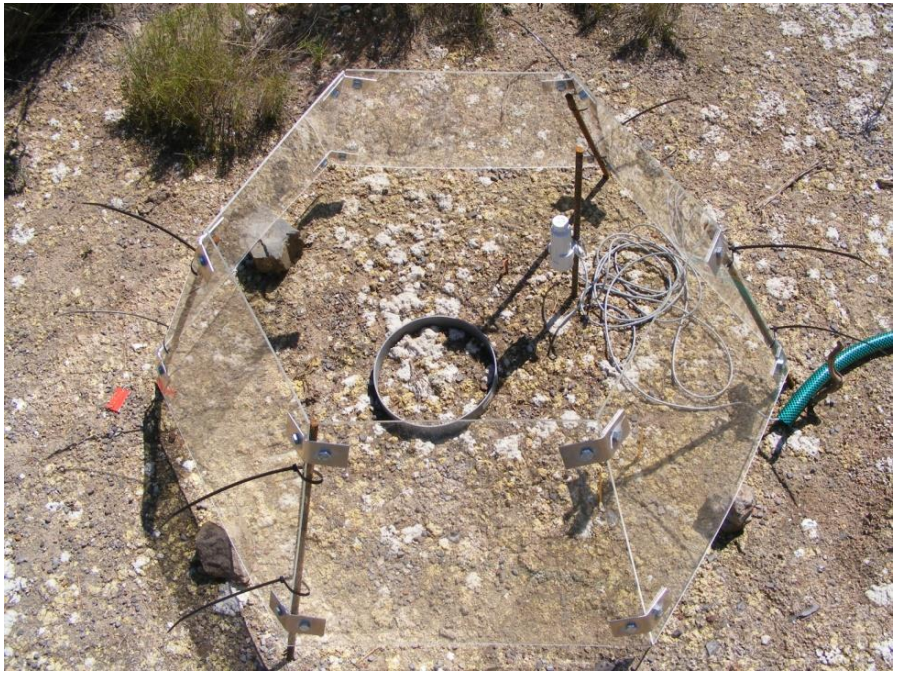


→ Under excess substrate and controlled microbial biomass, lower respiratory rates were found in sites with higher mean annual temperatures.

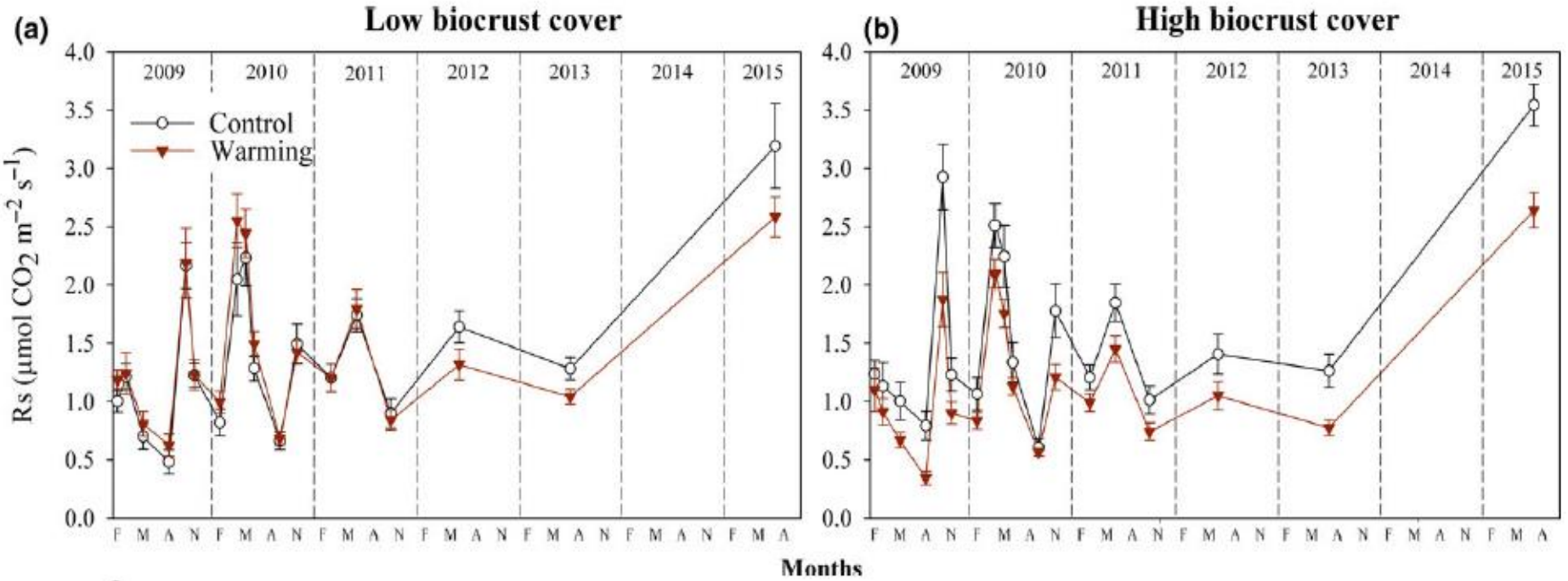
→ This effect was observed regardless the microsite considered (open vs. vegetated areas).

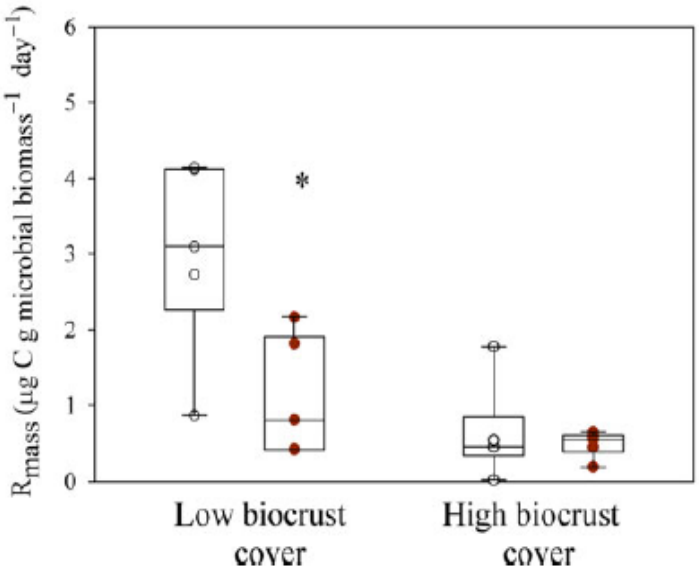
Do we have experimental evidence of these patterns?





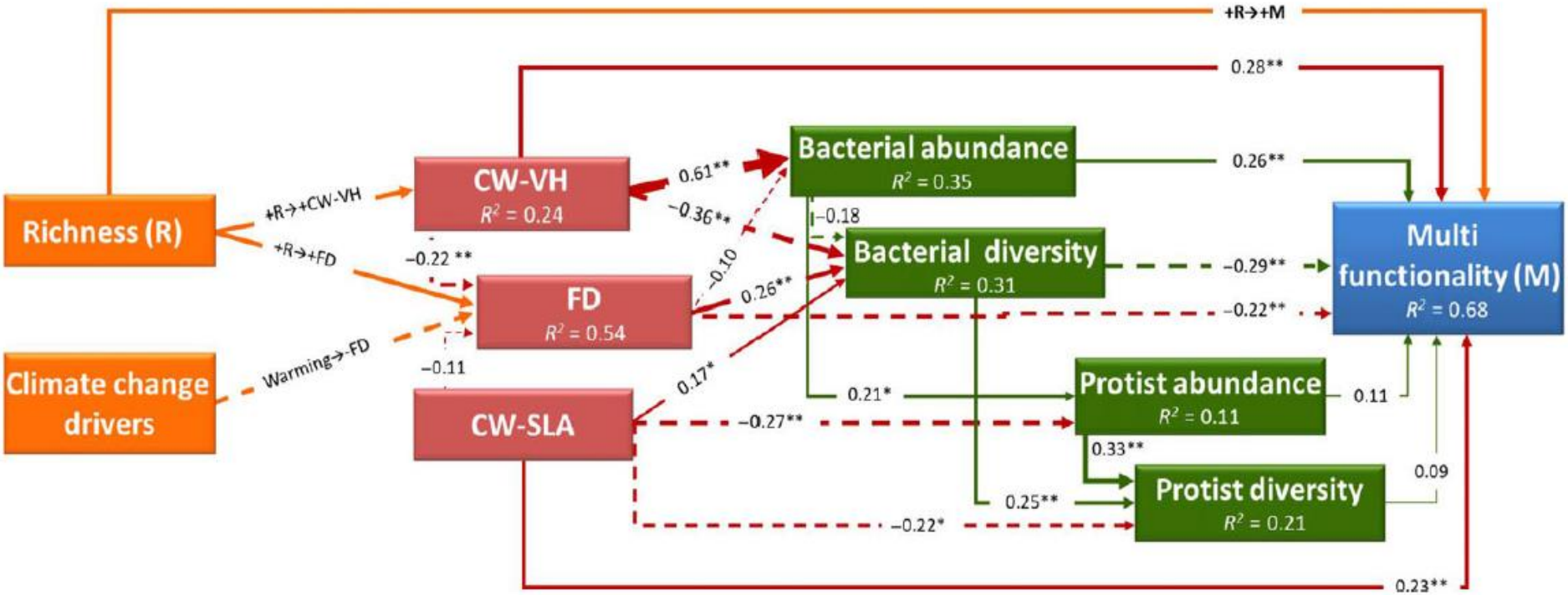
Biocrusts regulate soil respiration responses to warming

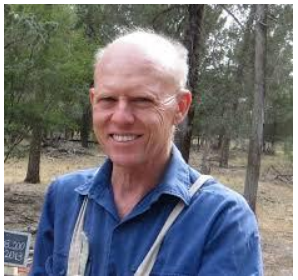




García-Palacios *et al.* 2018. *Global Change Biol* 24:4645–4656

Cascading effects from plants to soil microorganisms explain how biodiversity and climate change affect ecosystem functioning



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