Do native and invasive species share similar carbon capture strategies?

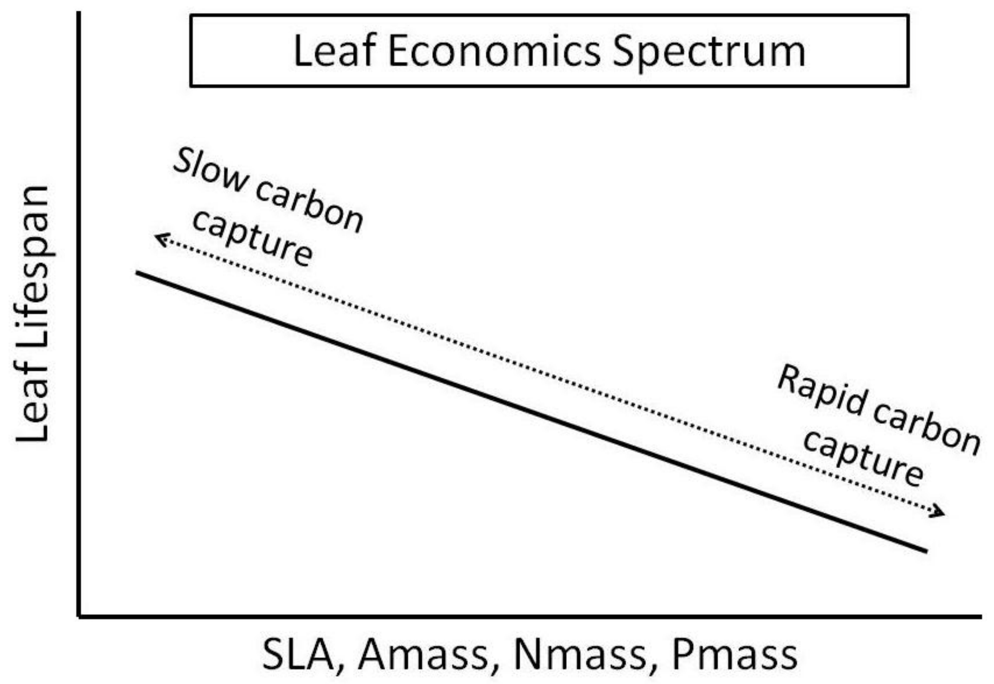
Monica A. Nguyen and Jennifer L. Funk
Schmid College of Science and Technology, Chapman University, Orange, CA

CHAPMAN UNIVERSITY
SCHMID COLLEGE OF SCIENCE AND TECHNOLOGY

Introduction

➢Understanding the differences between native and invasive species may help identify potential invaders and suggest management strategies or functionally similar native species for restoration in invaded communities.

➢Growing evidence suggests that across species, several key leaf traits are strongly related, forming a single leaf economics spectrum (LES) of slow to rapid carbon capture[1,2].



➢Studies have suggested native and invasive species occupy the "slow" and "fast" ends of this spectrum, respectively[3,4,5].

➢If this paradigm is not supported in all communities, however, understanding the ecological strategies of invaders may prove more complex.

➢Looking for evidence of consistency in trait relationships among co-occurring native and invasive species, we examined relationships among four leaf traits from sites across five Mediterranean climate ecosystems.

Methods

We selected eight moderately to heavily invaded communities across the five Mediterranean climate regions.

Mediterranean Climate Ecosystem (MCE)	Community	Site
Australia	Banksia woodland	Perth, Australia
	Coastal banksia woodland	Perth, Australia
California	Coastal sage scrub	Irvine, California
	Serpentine grassland	Portola, California
Chile	Sclerophylous woodland	Santiago, Chile
Spain	Coastal grassland	Bolonia, Spain
South Africa	Acid-sands fynbos	Pella, South Africa
	Renosterveld	Tygerberg, South Africa

We collected functional trait data from five individuals of the most common invasive and native species at each site, measuring:

- **Photosynthetic capacity (A_{mass})**
- **Specific leaf area (SLA)**
- **Foliar N concentration (N_{mass})**
- **Foliar P concentration (P_{mass})**

Statistical Analyses

We performed standardized major axis (SMA) regression for each possible combination of traits within each region and across regions (Fig. 1).

Methods

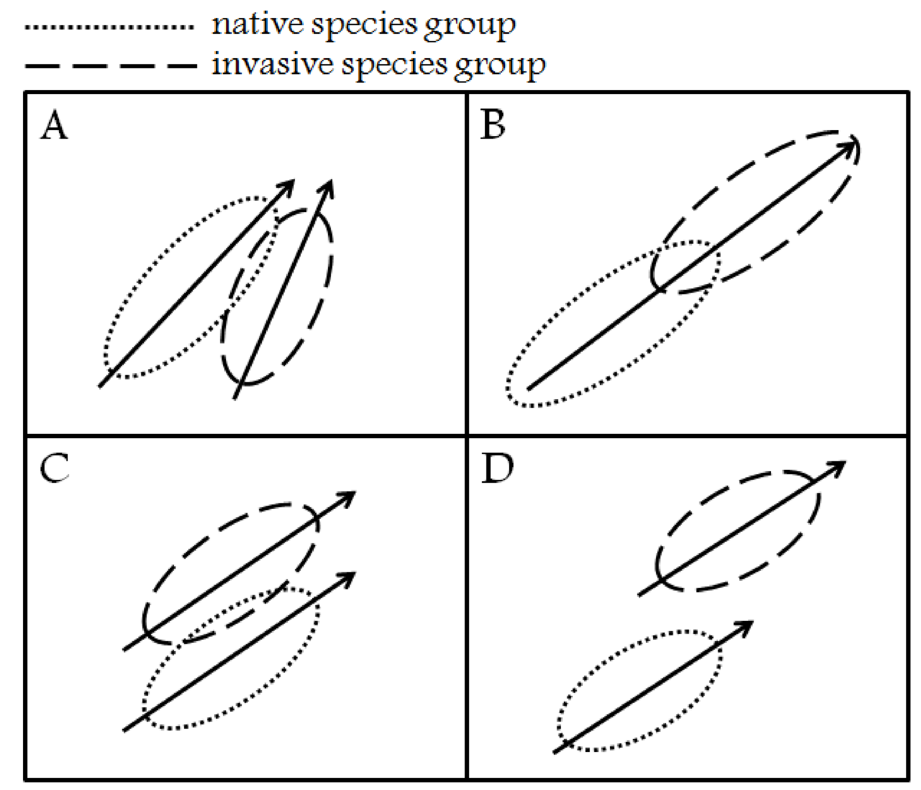


Figure 1. Following SMA regression, native and invasive species groups may exhibit:

A. Different slopes
B. Shift along a common slope
C. Shift in elevation
D. Shift along a common slope with shift in elevation

Results

Combined data

•Across the Mediterranean data set, slopes for all leaf trait relationships did not differ significantly between native and invasive species (Table 1).

•All relationships exhibited a shift along a common slope, with invasive species tending to occupy regions of higher trait values than native species (Table 1, Figure 2).

Regional data

•Shifts along slope were more common in Western Australia and South Africa than in Chile, while no shifts along slope were observed in California and Spain (Table 2).

Trait pair (X&Y)	Plant type	n	r^2	P	Different slopes? (P)	Shift in elevation (P)	Shift along slope (P)
SLA and A_{mass}	Invasive	45	0.469	**<0.001**	0.142	0.093	**0.001**
	Native	129	0.711	**<0.001**			
SLA and N_{mass}	Invasive	46	0.009	0.539	0.272	0.289	**<0.001**
	Native	129	0.248	**<0.001**			
SLA and P_{mass}	Invasive	45	0.221	**0.001**	0.058	**0.048**	**<0.001**
	Native	110	0.424	**<0.001**			
N_{mass} and A_{mass}	Invasive	45	0.066	0.088	0.925	0.916	**0.002**
	Native	129	0.333	**<0.001**			
P_{mass} and A_{mass}	Invasive	44	0.101	**0.035**	0.689	0.372	**0.002**
	Native	110	0.373	**<0.001**			
N_{mass} and P_{mass}	Invasive	45	0.089	**0.046**	0.389	0.711	**0.005**
	Native	110	0.449	**<0.001**			

Table 1. Analysis results of SMA regressions of all trait combinations across all Mediterranean regions. Values in bold represent significant results (P≤0.05).

	California			Spain		
Trait pair (X&Y)	Different slopes?	Shift in elevation	Shift along slope	Different slopes?	Shift in elevation	Shift along slope
SLA and A_{mass}	0.079	0.533	0.108	0.145	0.103	0.779
SLA and N_{mass}	**0.017**			0.731	0.694	0.257
SLA and P_{mass}	**0.005**			0.339	0.665	0.533
N_{mass} and A_{mass}	0.294	0.391	0.616	0.346	0.11	0.614
P_{mass} and A_{mass}	0.518	0.146	0.99	**0.043**		
N_{mass} and P_{mass}	0.846	0.476	0.405	0.177	0.426	0.423

Table 2. Analysis results of SMA regressions of all trait combinations for five MCEs. Values in bold represent significant P-values (P≤0.05). Trait combinations with significantly different slopes were not tested for shifts in elevation or along slope.

	Chile			South Africa			Western Australia		
Trait pair (X&Y)	Different slopes?	Shift in elevation	Shift along slope	Different slopes?	Shift in elevation	Shift along slope	Different slopes?	Shift in elevation	Shift along slope
SLA and A_{mass}	0.212	0.236	**0.002**	0.896	0.205	**0.001**	0.275	**0.02**	**<0.001**
SLA and N_{mass}	**0.041**			0.11	0.328	**<0.001**	0.887	**0.009**	**<0.001**
SLA and P_{mass}	0.457	0.864	**0.012**	0.276	0.526	**<0.001**	0.558	**0.014**	**<0.001**
N_{mass} and A_{mass}	0.254	**0.006**	0.055	**0.05**			0.628	0.101	**<0.001**
P_{mass} and A_{mass}	0.595	0.382	**0.001**	0.358	0.914	**0.006**	0.654	**0.033**	**0.001**
N_{mass} and P_{mass}	**0.011**			**0.023**			0.726	0.986	**0.003**

Results

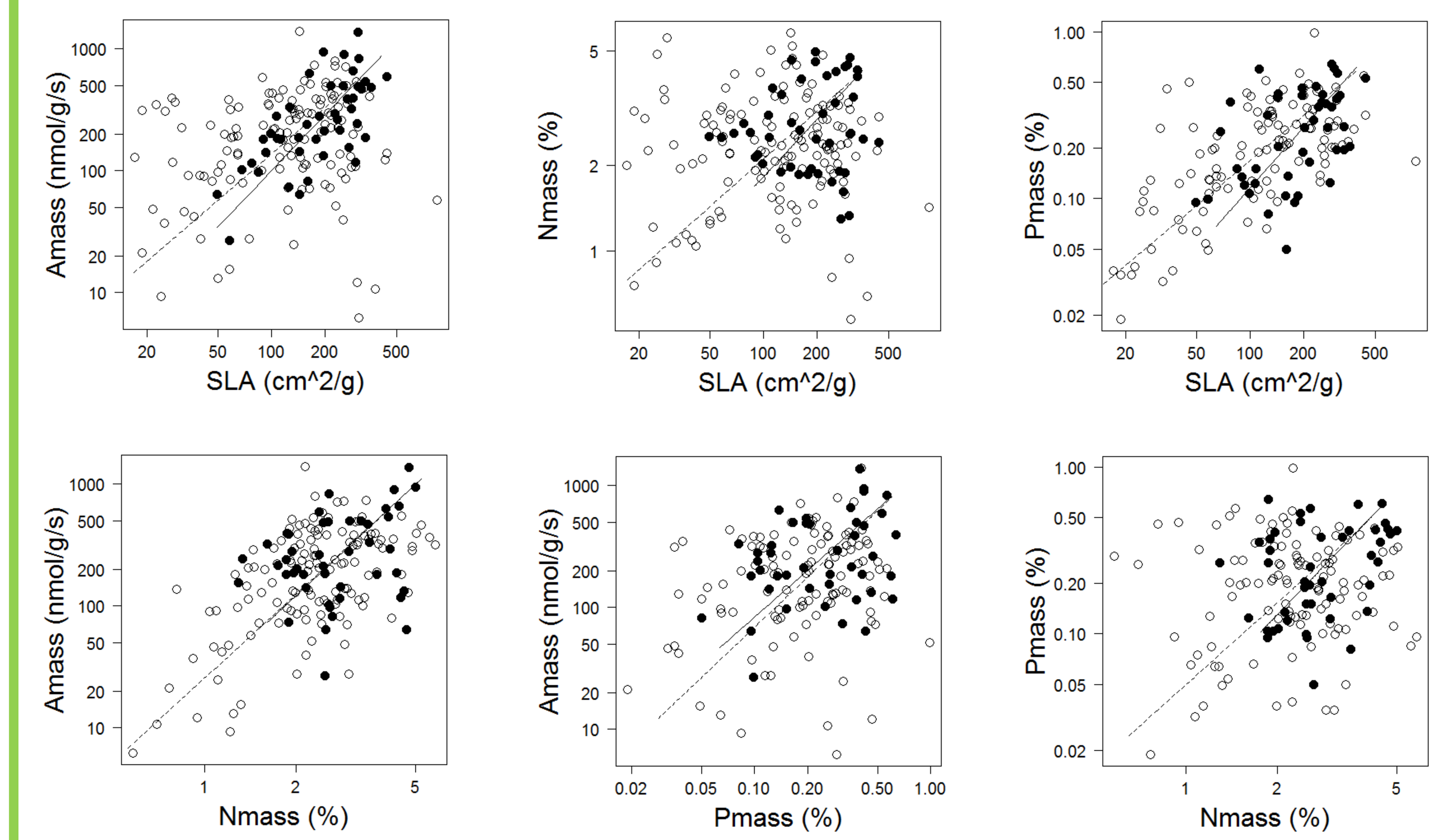


Figure 2. Standardized major axis regressions for all possible combinations of traits for the combined Mediterranean data set. Filled circles and solid lines represent invasive species; open circles and dashed lines represent native species. Axes are $\log_{10}$ scaled.

Discussion

➢*Combined data*: Invasive species were shifted along a common slope toward higher trait values, which suggests native and invasive species have similar carbon capture strategies (i.e., similar slopes), but occupy the slow and fast end of the spectrum, respectively.

➢*Regional data*: When analyzed regionally, differences emerge. Native and invasive species in California and Spain, despite common slopes, were not separated along those slopes. Differences may be driven by life form. Species sampled in South Africa and Western Australia were distinct (woody natives, herbaceous invaders), while species in California and Spain were more comparable.

➢By focusing only on four traits, this study potentially overlooks other key differences between native and invasive species (e.g., phenological differences).

➢Overall, our context-dependent results suggest using LES relationships to infer broad functional differences between native and invasive species at the community and regional level must be approached with caution.

Management implications:

➢Native and invasive species of similar life form may not follow the paradigm of slow and fast carbon capture, meaning resource-based management strategies may not be as effective.

➢Where native and invasive species share strategies, we can identify:

- similar and different native species that may be able to successfully compete or coexist with invasive species.
- other ecological differences that might allow selective control of invasive species (e.g., earlier germination of invasives)

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