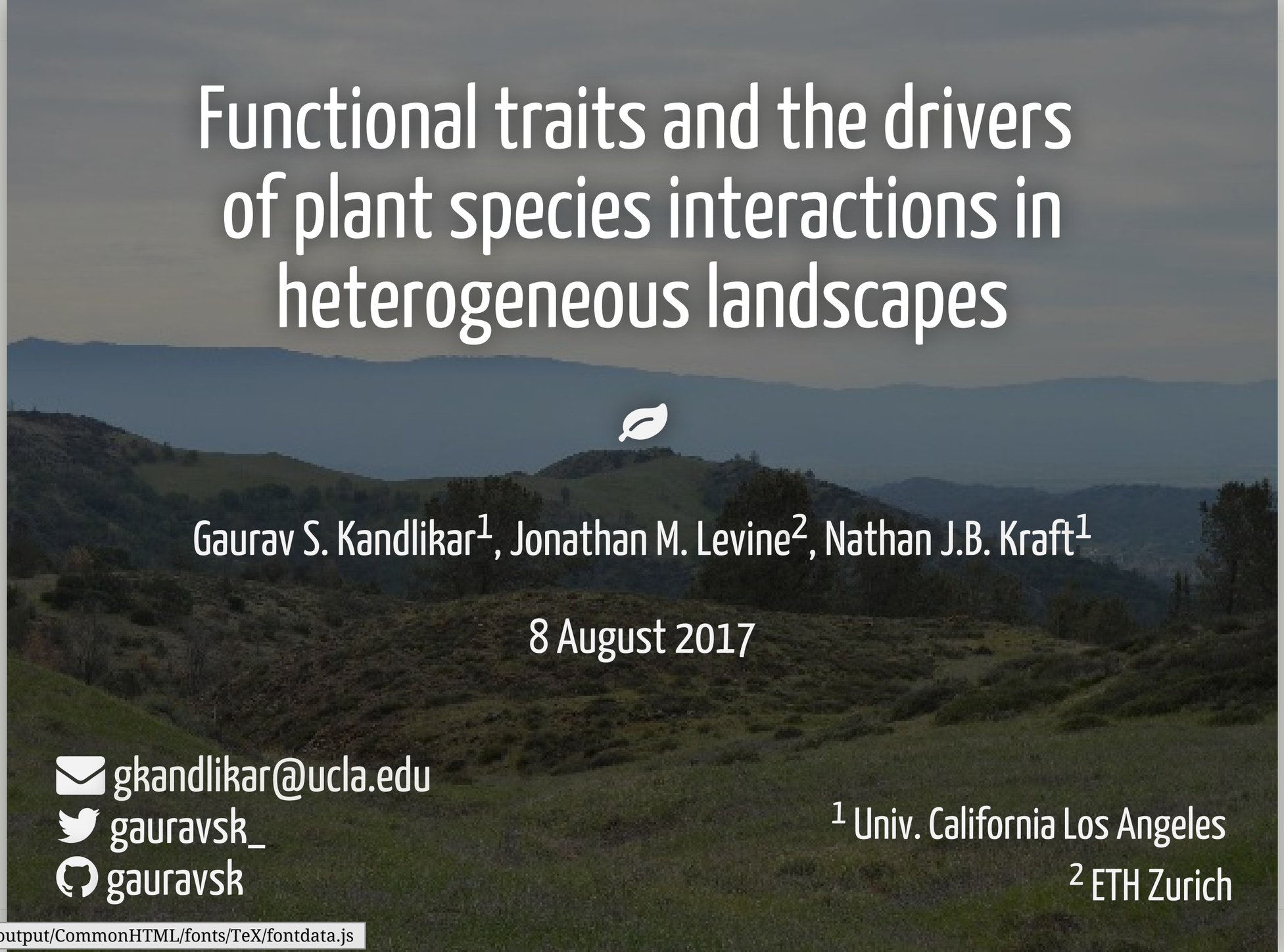

Functional traits and the drivers of plant species interactions in heterogeneous landscapes

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Functional traits as predictors of species interactions

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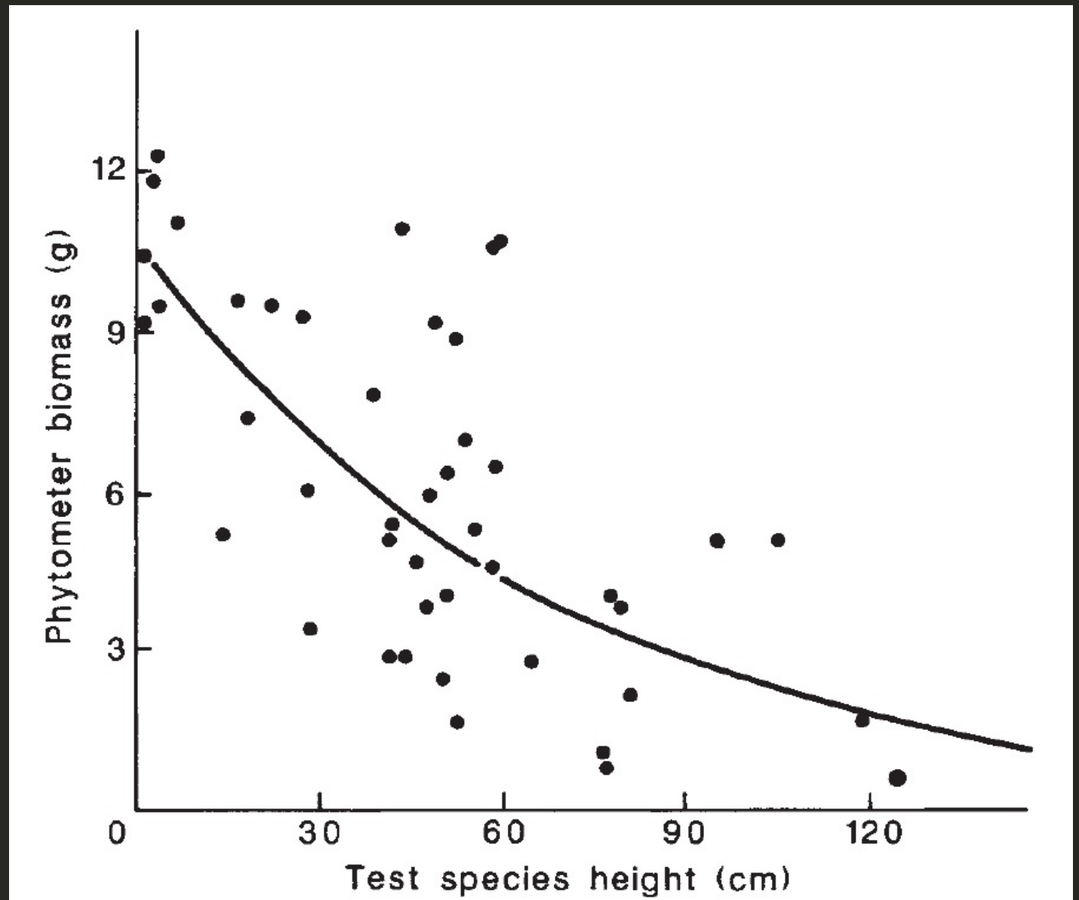

Fig. 2 Phytometer biomass (*L. salicaria*) as a function of test species height (TSH) ($n = 44$). PB = exp (2.392 − 0.016 TSH); $F = 36.263$, $P < 0.05$, $r^2 = 0.64$.

Gaudet & Keddy (1988) Nature

Trait dispersion patterns across spatial scales

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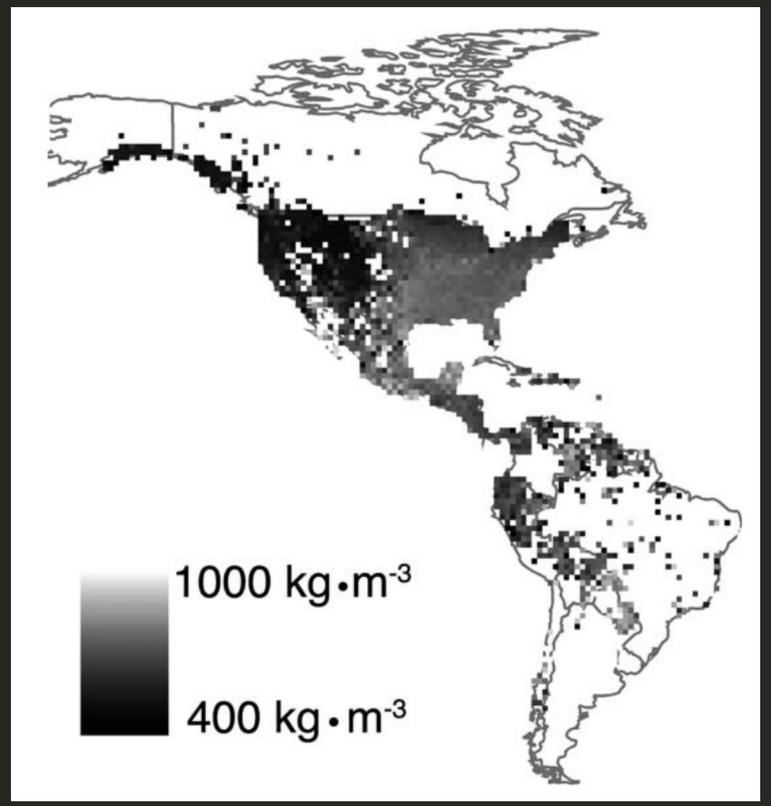

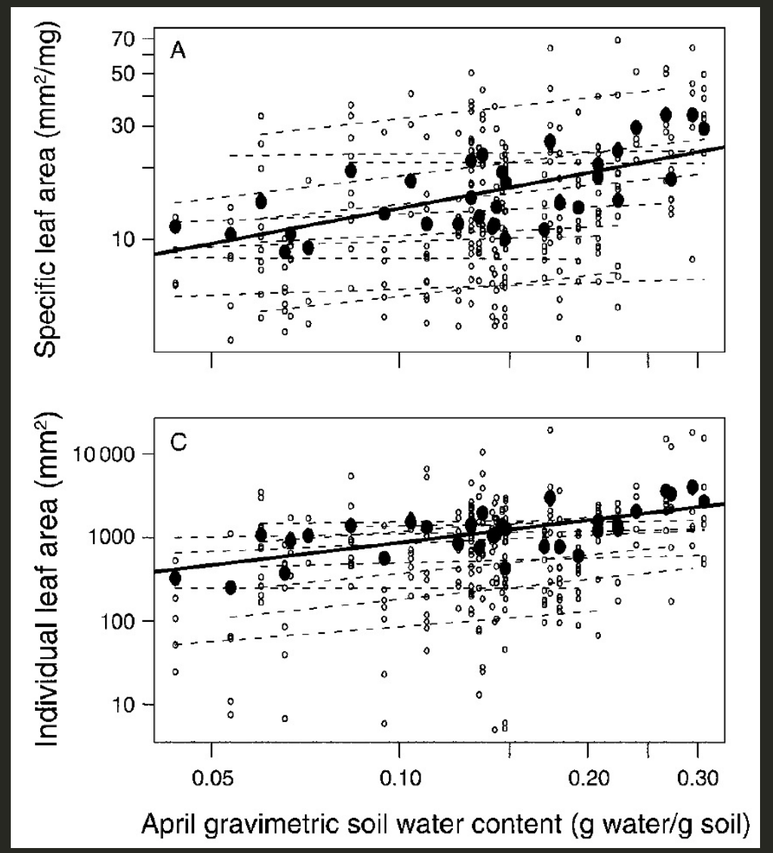

Swenson & Enquist (2007) Am J. Botany; Conwell & Ackerly (2009) Ecol. Monographs

Trait patterns are imperfect proxies for ecological patterns

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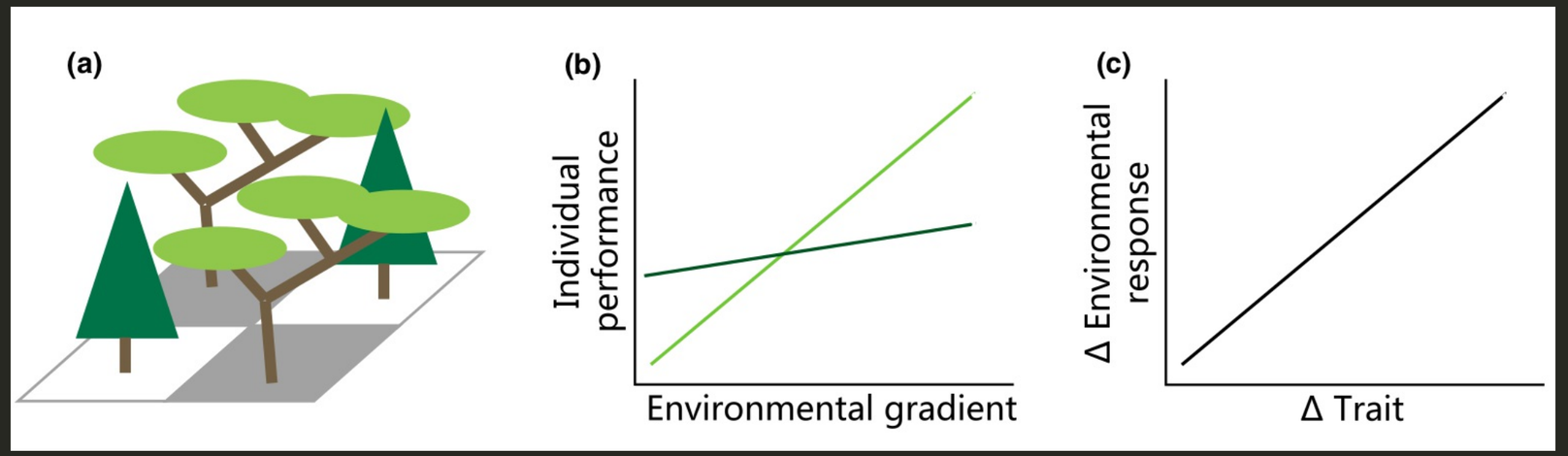

Adler et al. 2013 Ecol. Letters

Parameterizing annual plant demography

$$\frac{N_{t+1,x,j}}{N_{t,x,j}} = (1 - g_{x,j}) * s_j + g_{x,j} * \frac{\lambda_{x,j}}{1 + r_j * \eta_x}$$

Chesson (2000) Theor. Pop. Biol, Levine & HilleRisLambers (2007) Nature

Parameterizing annual plant demography

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Parameter	Description
$g_{x,j}$	Gerimation rate at site x
s_j	Seedbank survival rate
$\lambda_{x,j}$	Seed production of species at site x in the absense of competitors
r_j	Response of species to competitors
η_x	Size of competitive community at site x

Chesson (2000) Theor. Pop. Biol, Levine & HilleRisLambers (2007) Nature

Spatial storage effects can promote species coexistence

The spatial storage effect can stabilize species coexistence given three conditions:

- Species-specific environmental responses
- Covariance between environmental response and competition
- Buffered population growth

Chesson (2000) Theor. Pop. Biol

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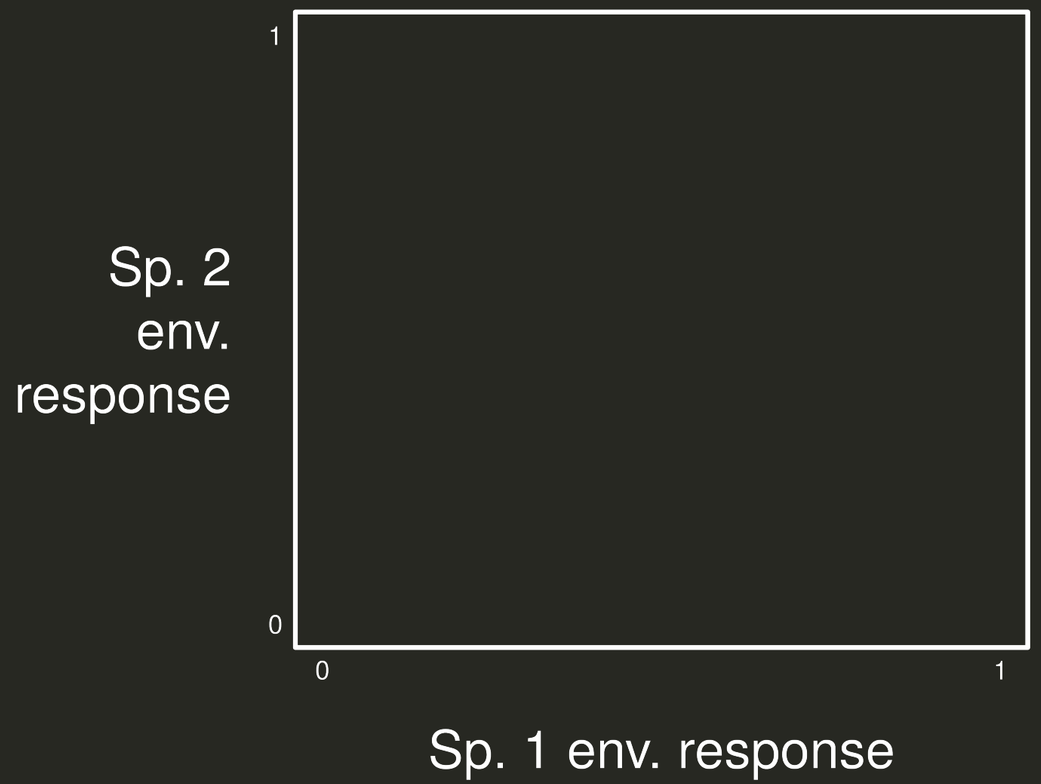
The contribution of storage effects ΔI follows

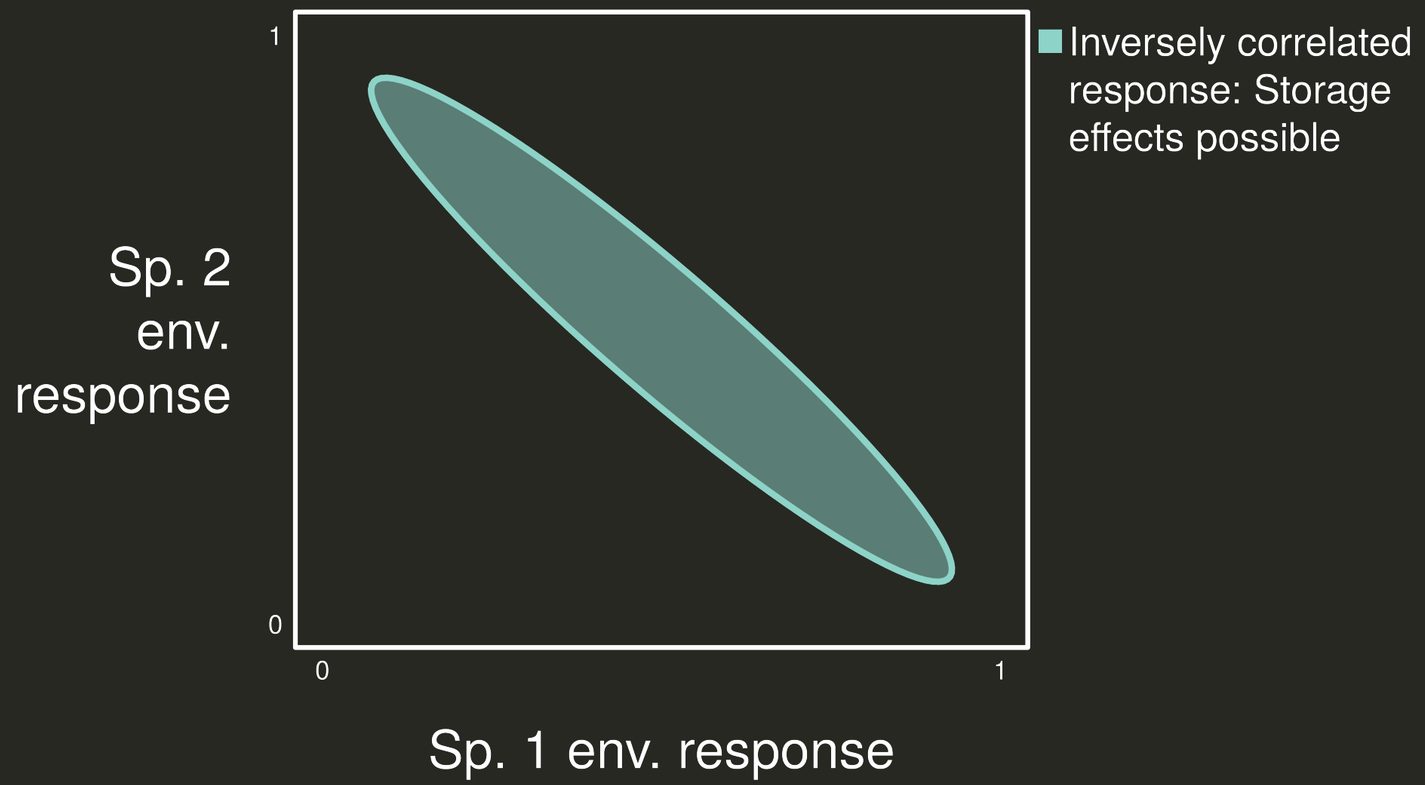
$$\Delta I \sim (1 - \text{correlation in environmental response})$$

Chesson (2000) Theor. Pop. Biol

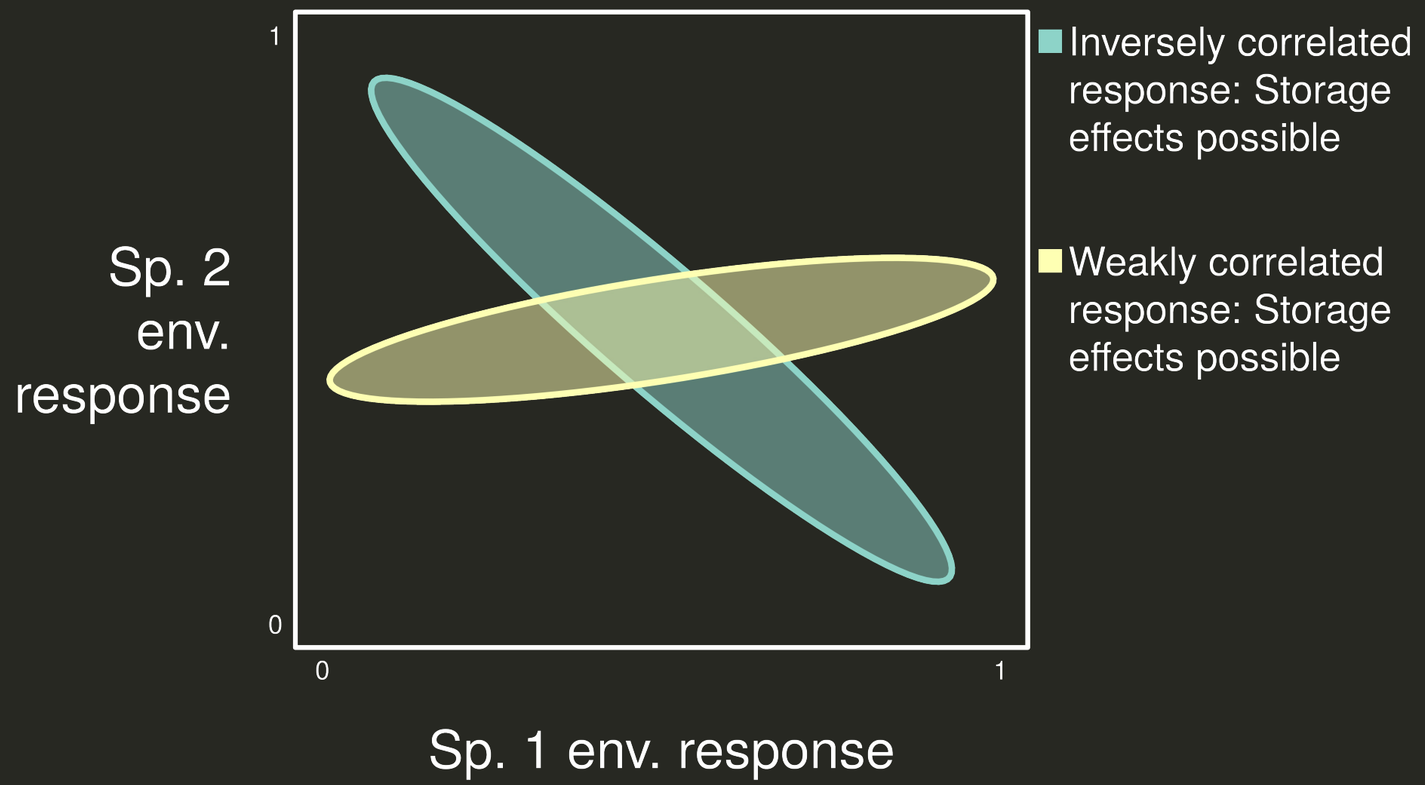
Correlated environmental responses



Correlated environmental responses



Correlated environmental responses



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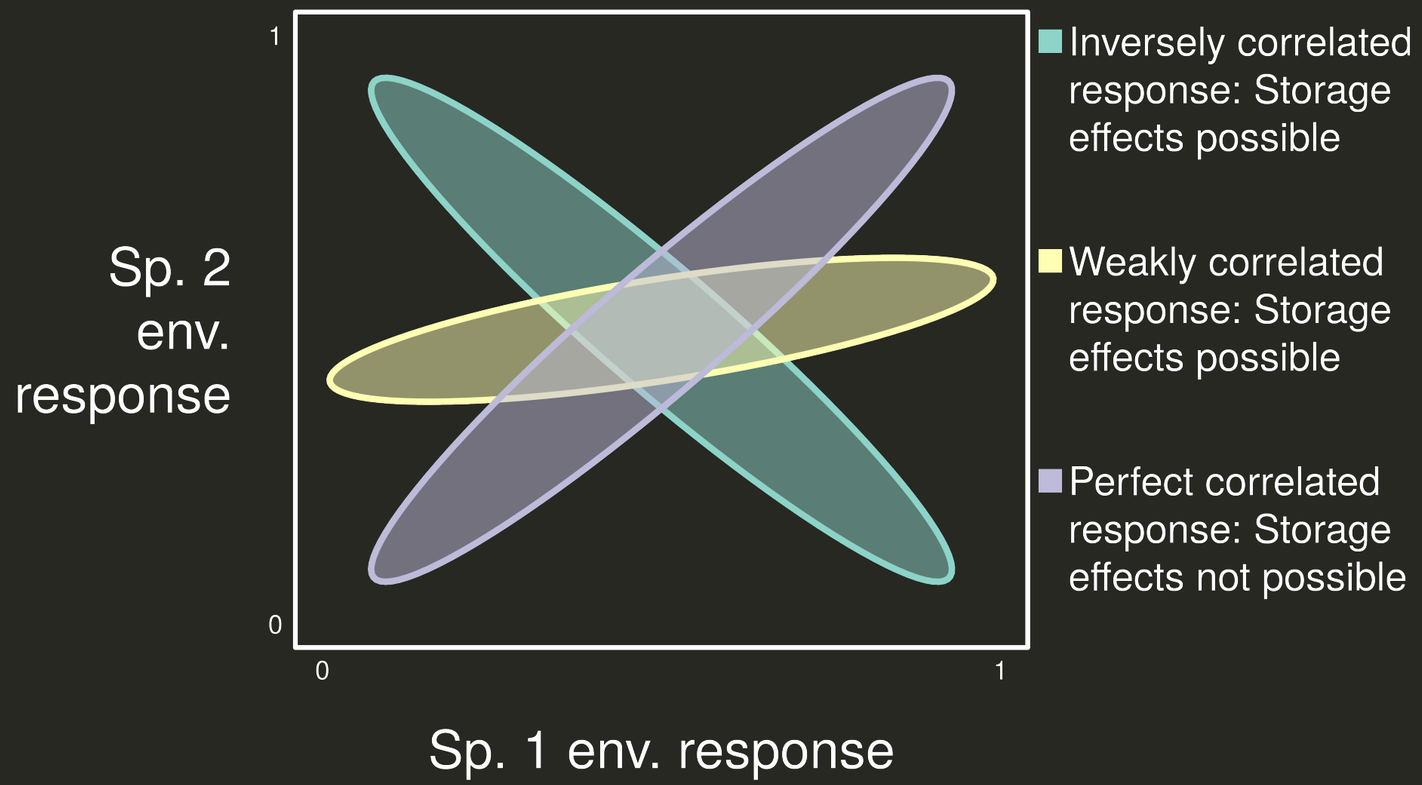

Which functional traits drive correlated environmental responses?

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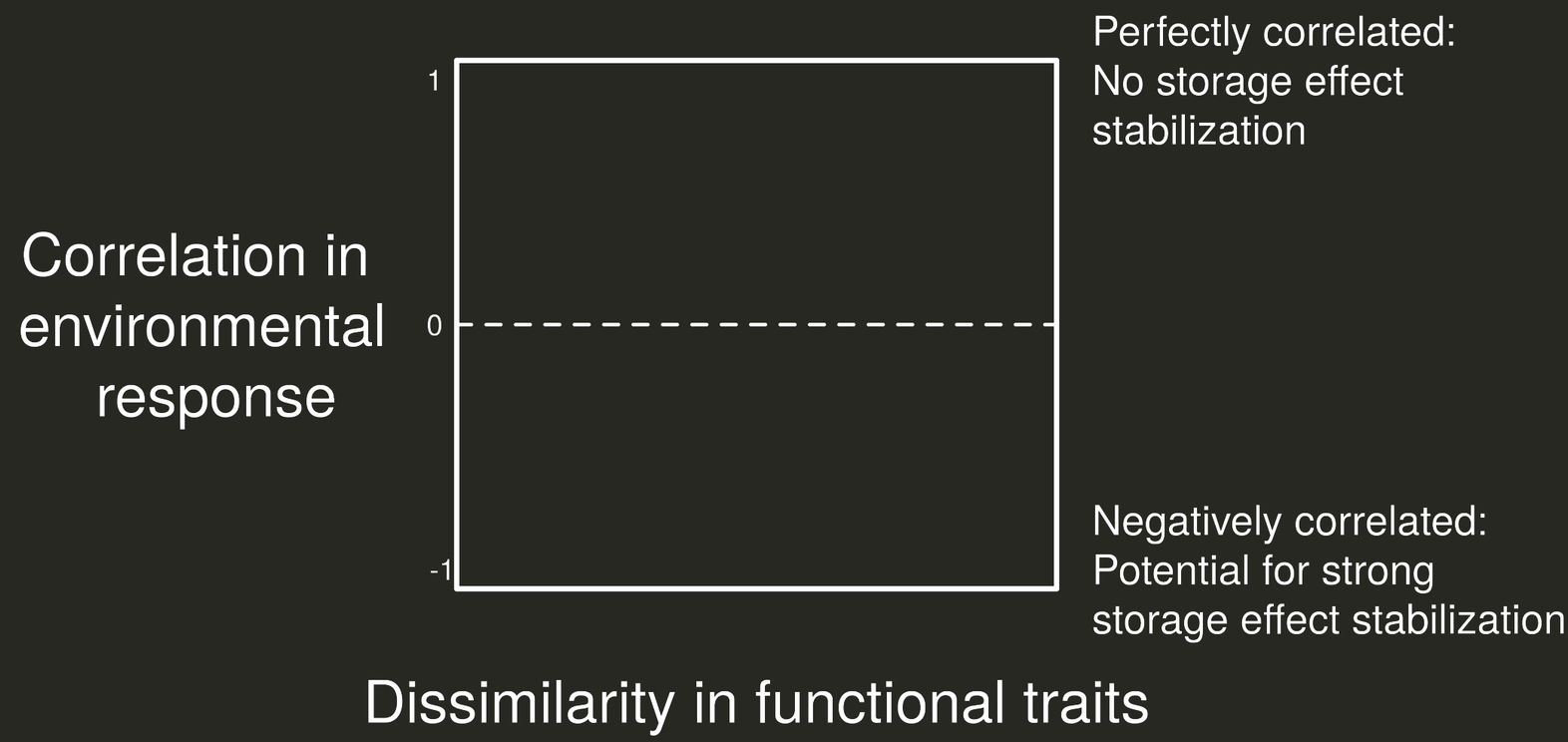
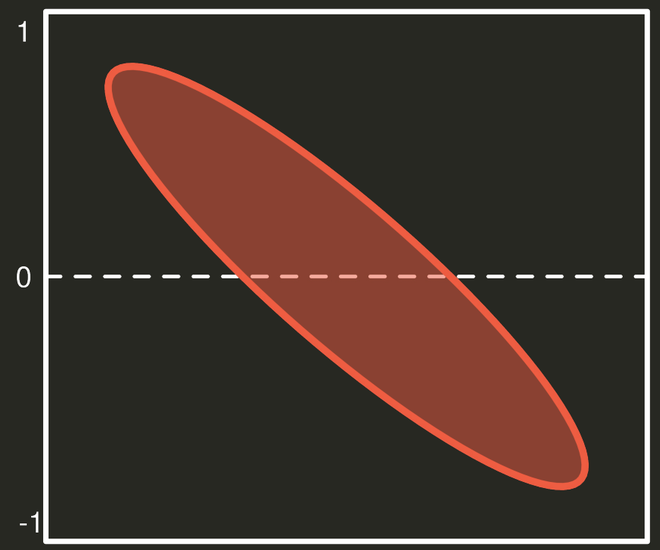


Which functional traits drive correlated environmental responses?

Correlation in environmental response



Perfectly correlated:
No storage effect stabilization

Negatively correlated:
Potential for strong storage effect stabilization

Dissimilarity in functional traits

Questions

- Q1: How correlated are species pairs in their environmental responses?
- Q2: Do functionally dissimilar species pairs tend to be less correlated in their environmental responses?

Study system: plant species

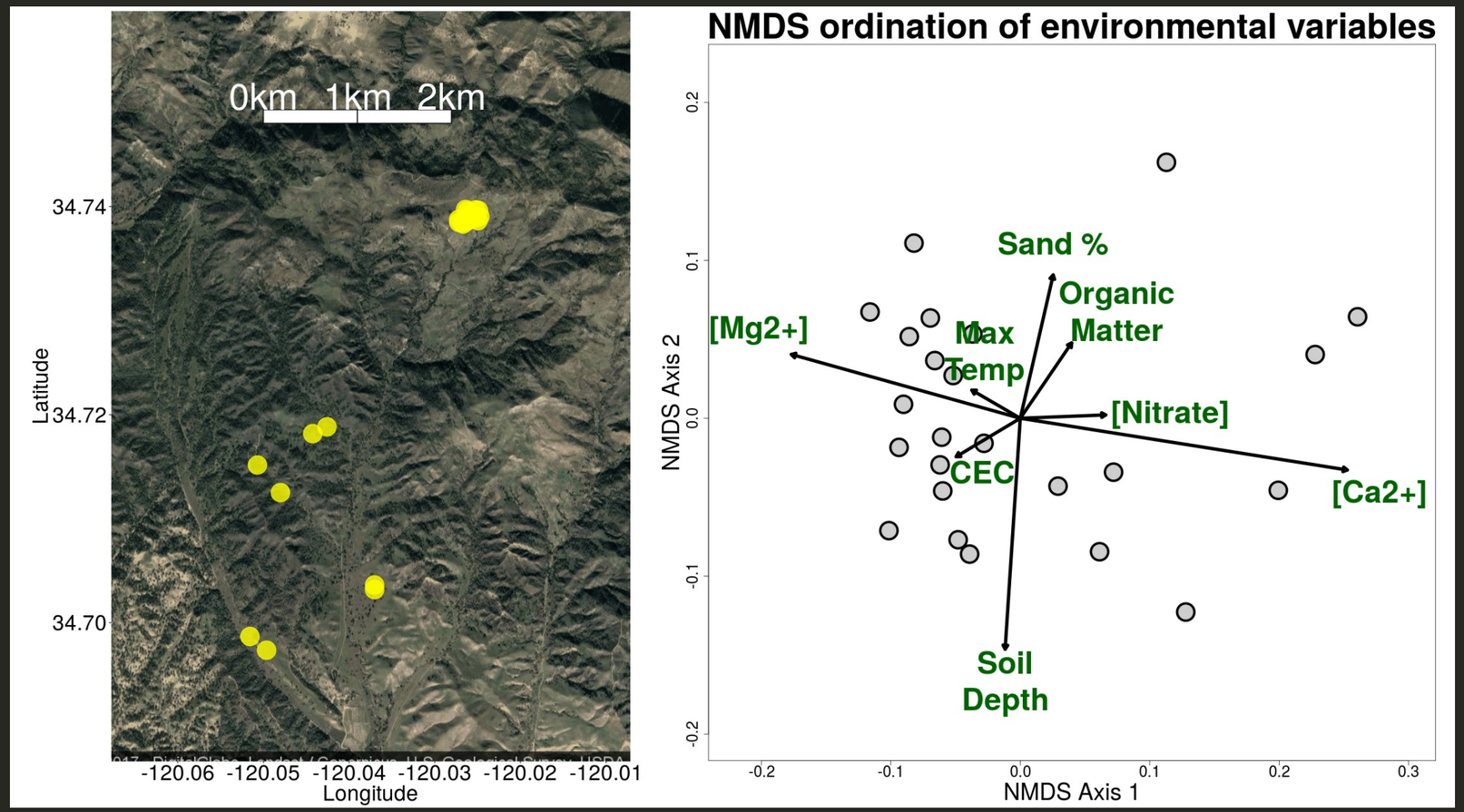
Agoseris heterophylla | *Centaurea melitensis* | *Chaenactis glabriuscula* | *Lasthenia californica* | *Hemizonia congesta* | *Micropus californicus*

Amsinckia menziesii | *Clarkia purpurea* | *Clarkia bottae* | *Euphorbia peplus* | *Medicago polymorpha* | *Lotus wrangelianus*

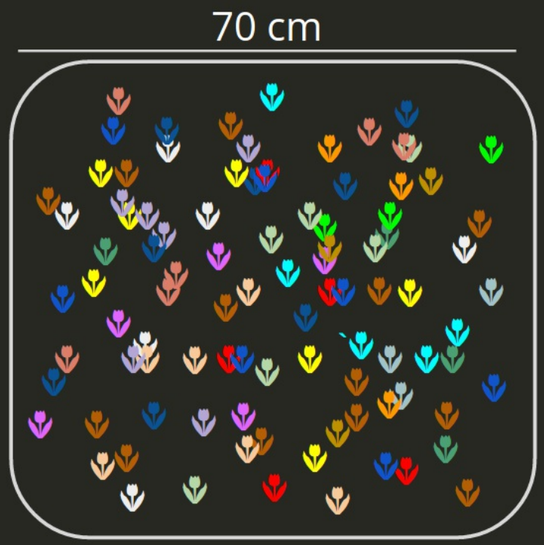
Bromus madritensis | *Hordeum murinum* | *Vulpia microstachys* | *Salvia columbariae* | *Plantago erecta*

Images from CalPhotos (http://calphotos.berkeley.edu/)

Study system: environment



Study system: experimental setup



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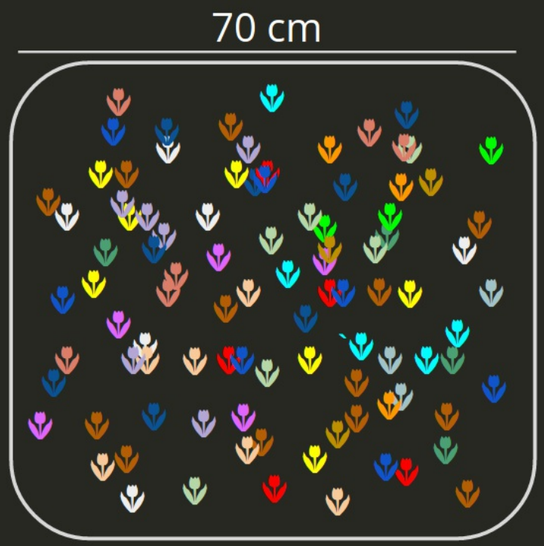

$$\boxed{\frac{N_{t+1,x,j}}{N_{t,x,j}}} = (1 - \boxed{g_{x,j}}) * s_j + g_{x,j} * \frac{\boxed{\lambda_{x,j}}}{1 + \alpha_x * \eta_x}$$

Photo: Nathan Kraft

Q1 results: Species-specific environmental responses

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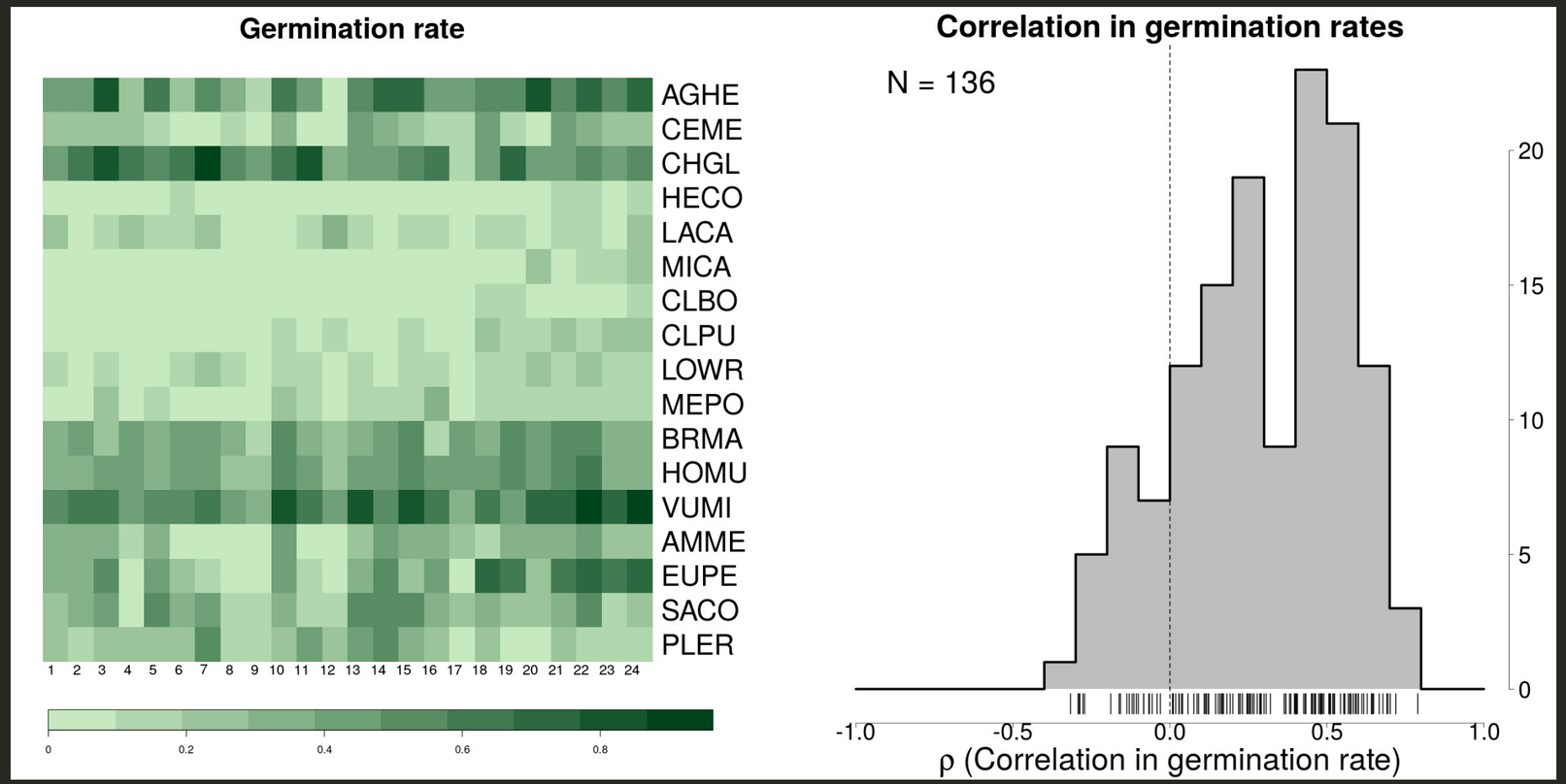
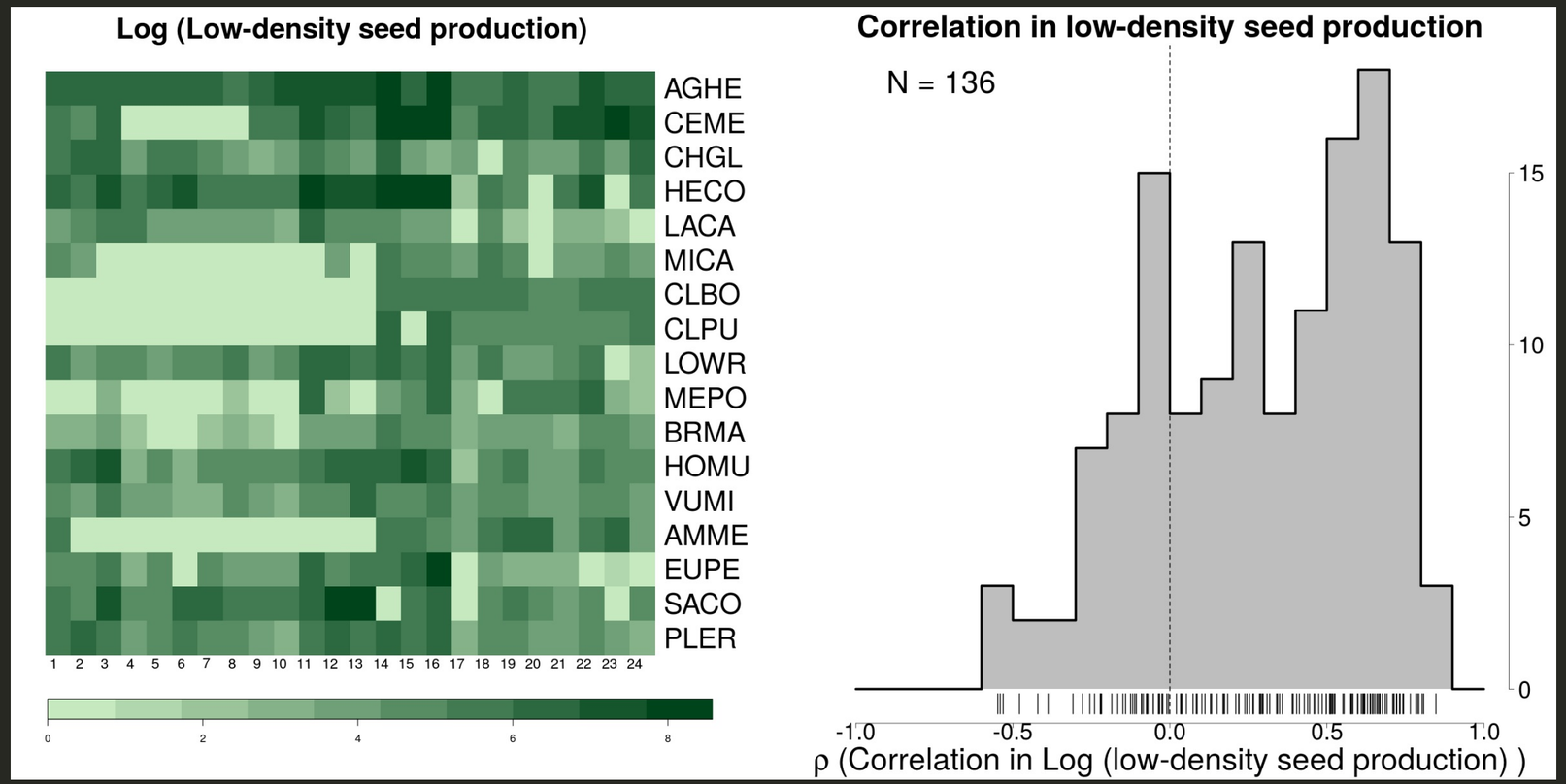


Preliminary results

Q1 results: Species-specific environmental responses



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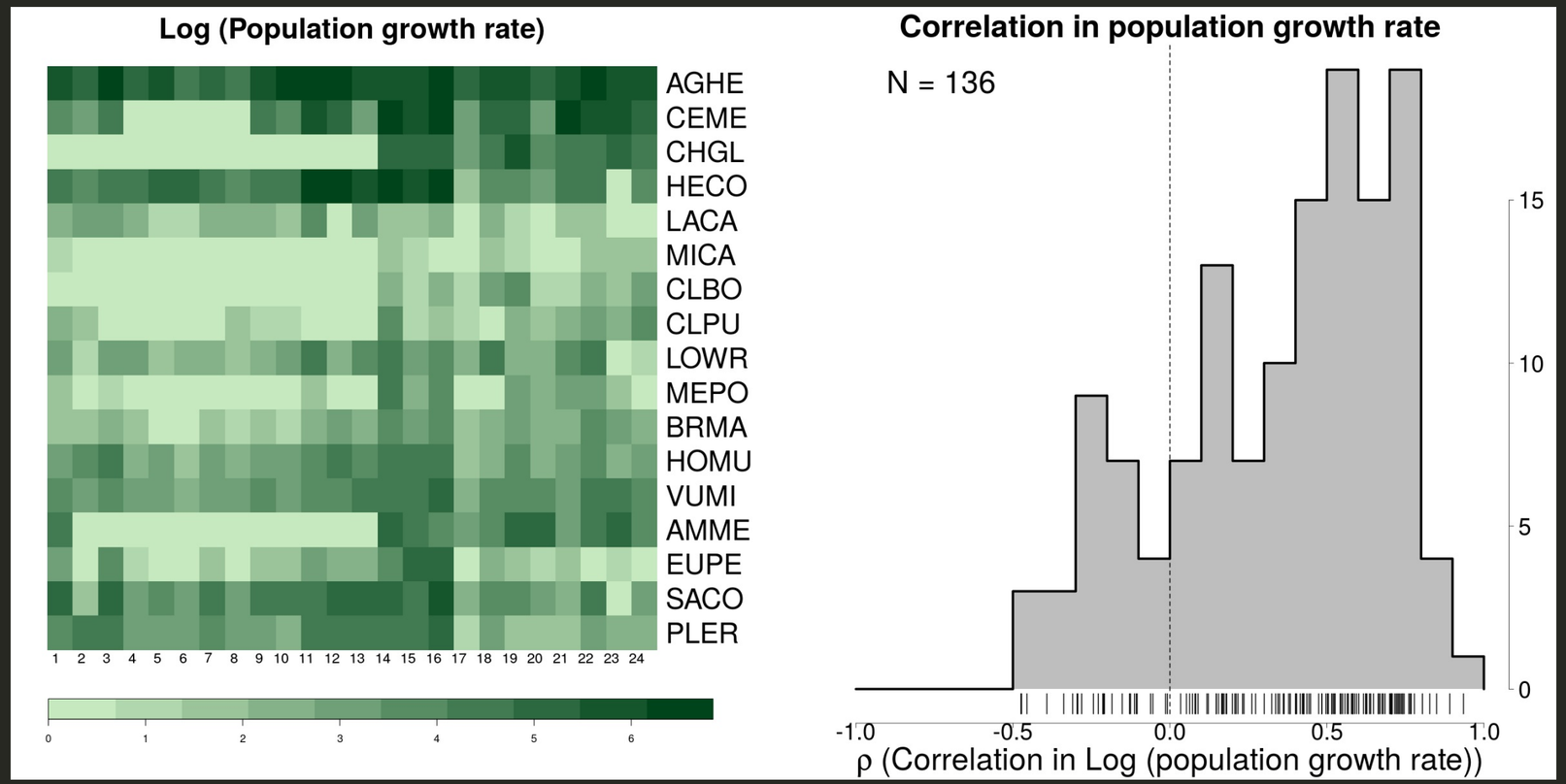

Preliminary results

Q2: Functional correlates of demographic responses

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- Leaf traits
  - Leaf size
  - Specific leaf area
  - Leaf dry matter content
  - Leaf drought tolerance (Osmotic potential)
- Seed mass
- Specific root length
- Whole plant traits
  - Maximum height
  - Canopy shape index (ordinating species from primarily vertical growth to prostrate growth)

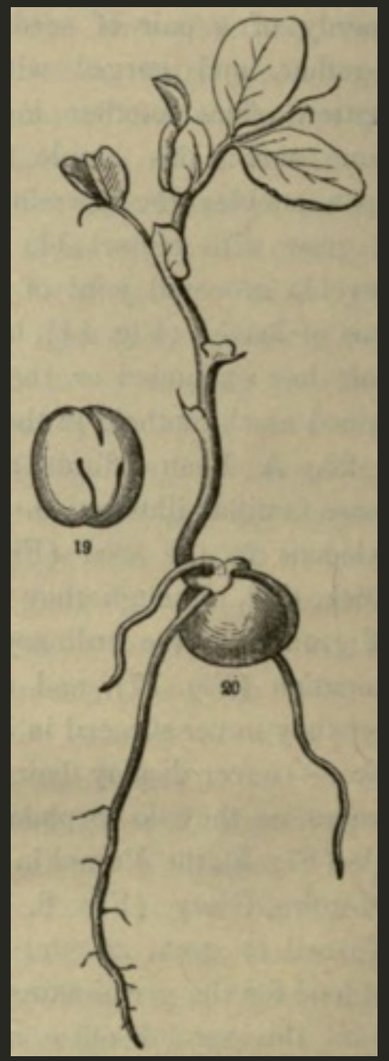
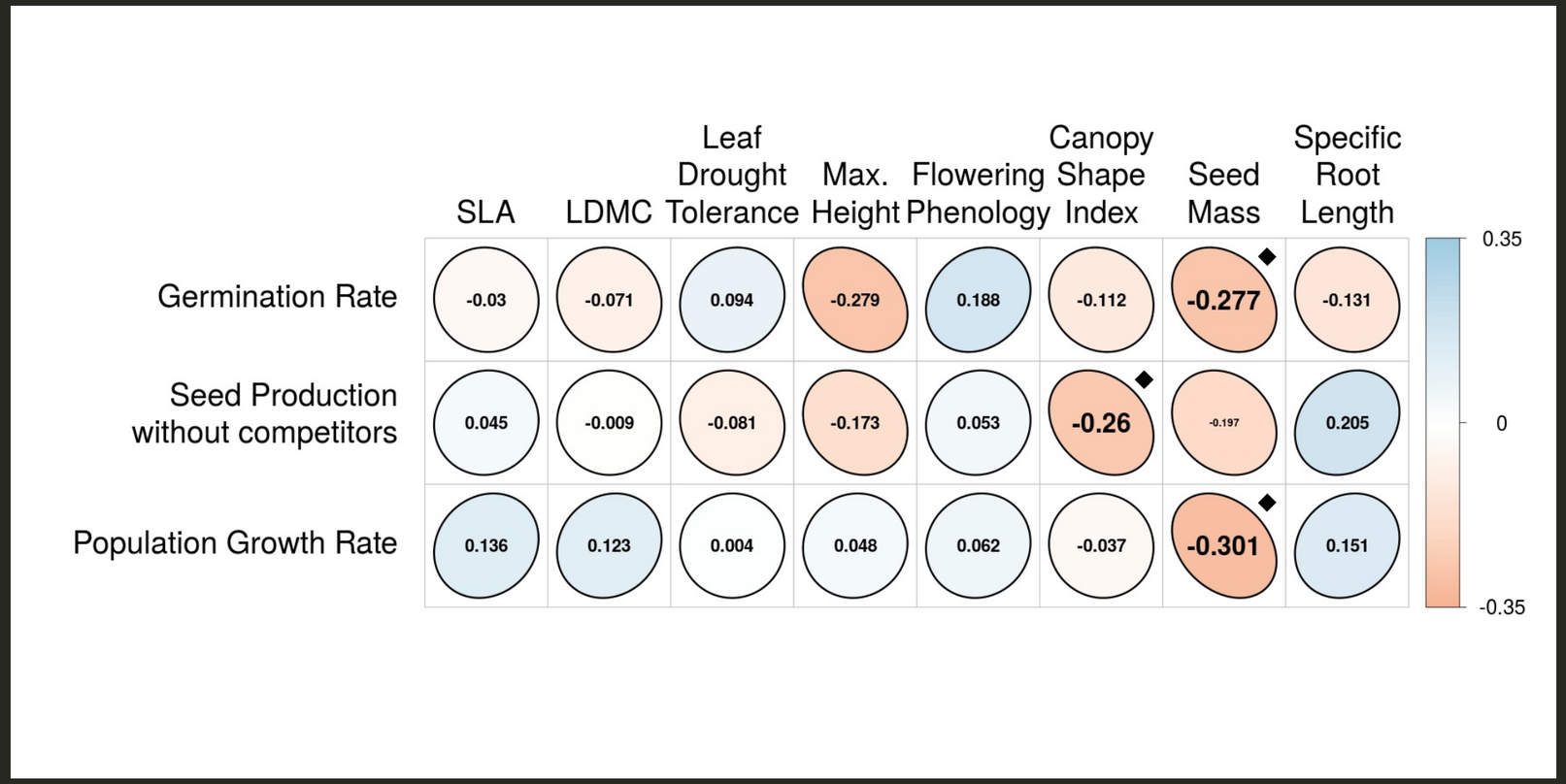


Image from *Elements of Botany*, Asa Gray

Q2 results: Functional correlates of demographic responses



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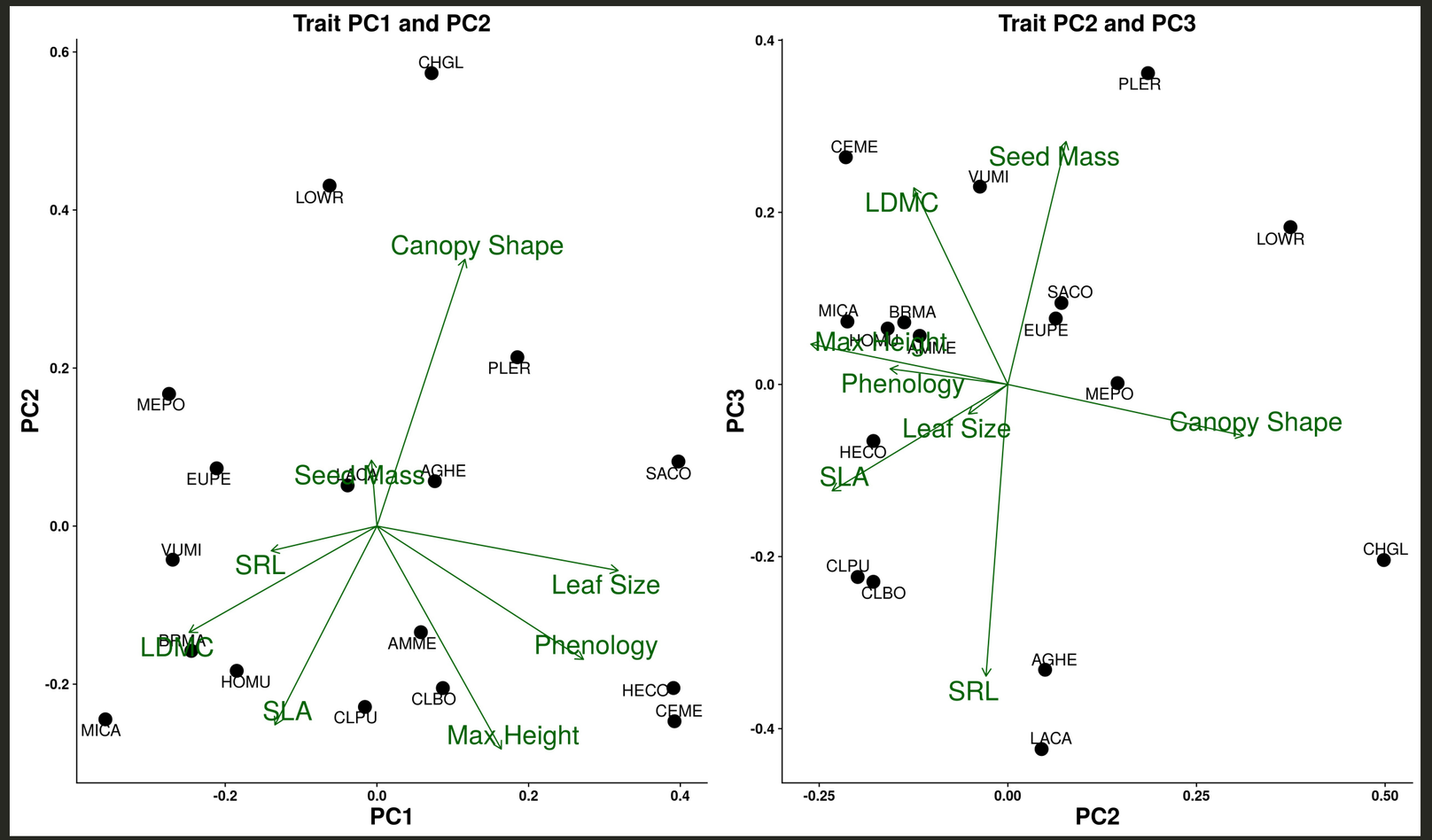

Preliminary results

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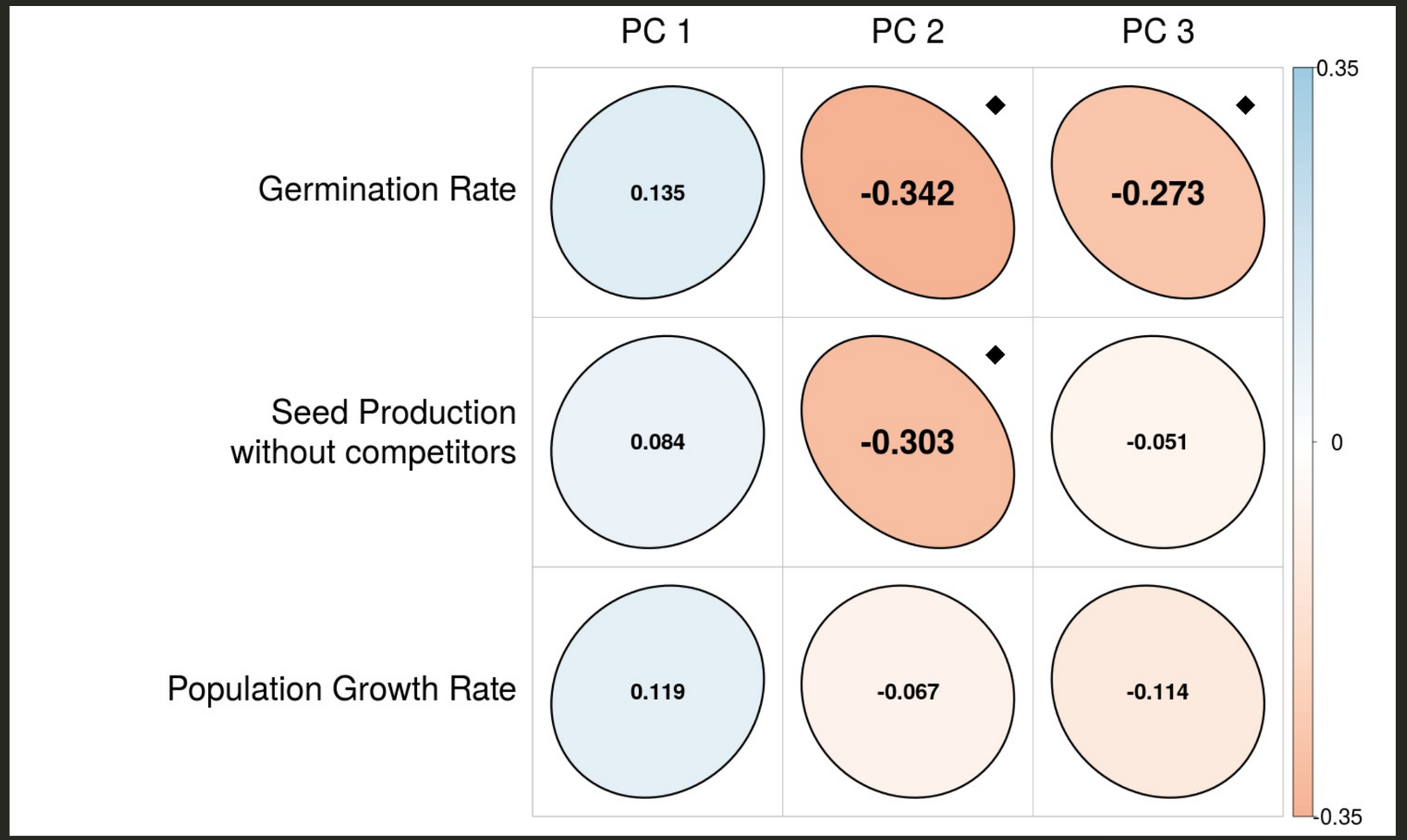

Preliminary results

Q2 results: Species vary in their germination response to soil texture and depth

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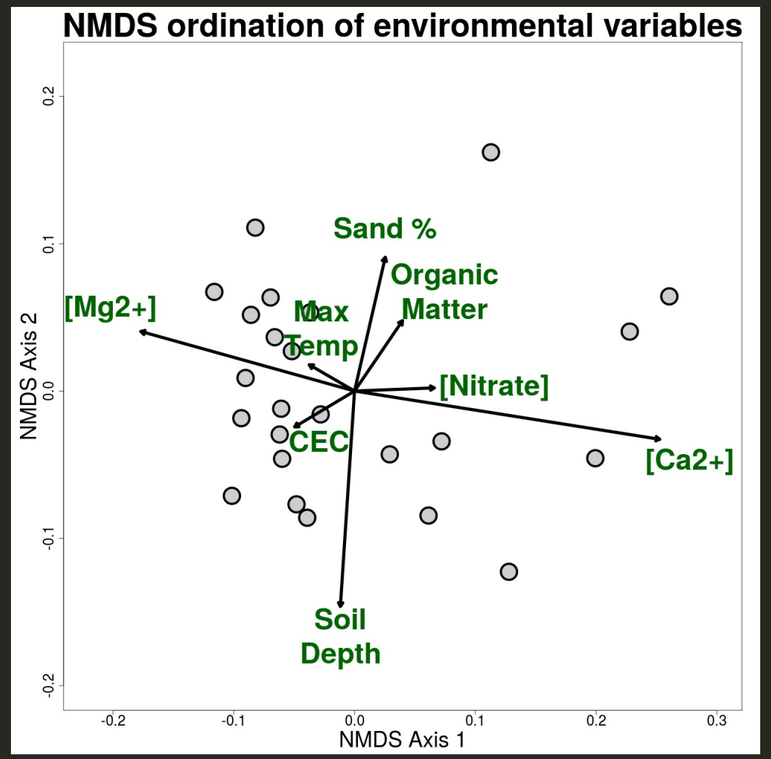

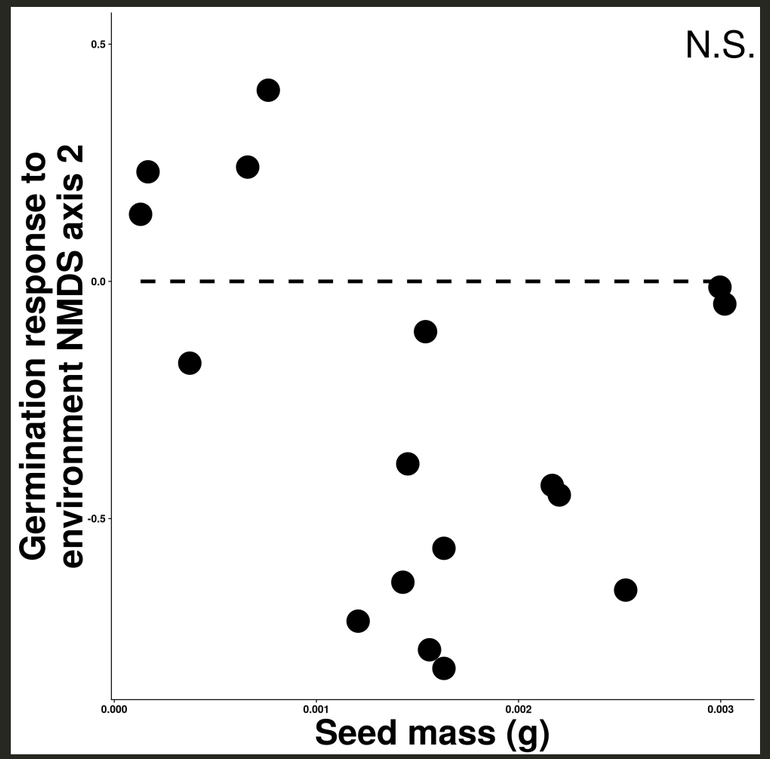

Preliminary results

Summary

In our system, ...

- Most species pairs tend to have positive but imperfect correlations in environmental response
- Seed and whole-plant functional traits, but not leaf economics traits, may serve as predictors of correlation in environmental response

Next steps

- Predicting demographic correlation from multi-trait models
- Testing whether plasticity in functional traits influences demographic responses

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- Predicting demographic correlation from multi-trait models
- Testing whether plasticity in functional traits influences demographic responses
- Testing whether turnover in soil bacterial and fungal communities explain variation in plant performance and species interactions in our system

Take-home messages

- The functional trait approach holds tremendous value for plant ecologists
- The choice of functional traits should come from an understanding of the of demographic drivers of community dynamics
- Importance of functional traits may depend on scale of the question

Huang et al. (2016) Ecology, Kraft et al. (2015) PNAS

Thank you!

- Kraft Lab at UCLA:
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  - Andy Kleinhesselink
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  - NSF Graduate Research Fellowship Program

Get in touch!

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rmd source available at https://github.com/gauravsk/esa-2017-talk