



# Competition

April 6, 2021



# What is plant competition?

Grime (1977): “the tendency of neighboring plants to utilize the same quantum of light, ion of a mineral nutrient, molecule of water, or volume of space”

# What is plant competition?

Grime (1977): “the tendency of **neighboring plants** to utilize the same quantum of light, ion of a mineral nutrient, molecule of water, or volume of space”

Why neighboring?

# What is plant competition?

Grime (1977): “the tendency of neighboring plants to utilize the same quantum of light, ion of a mineral nutrient, molecule of water, or volume of space”

Not all abiotic and biotic drivers of plant fitness  
Why these specifically?

# What is plant competition?

Grime (1977): “the tendency of neighboring plants to utilize the same quantum of light, ion of a mineral nutrient, molecule of water, or volume of space”

“allows competition to be defined in relation to its mechanism rather than its effects, and the risk is avoided of confusion with mechanism operating through the direct impact of the physiochemical environment or through biotic effects such as selective predation”

# What is plant competition?

Grime (1977): “the tendency of neighboring plants to utilize the same quantum of light, ion of a mineral nutrient, molecule of water, or volume of space”

“allows competition to be **defined in relation to its mechanism rather than its effects**, and the risk is avoided of confusion with mechanism operating through the direct impact of the physiochemical environment or through biotic effects such as selective predation”

# What is plant competition?

Grime (1977): “the tendency of neighboring plants to utilize the same quantum of light, ion of a mineral nutrient, molecule of water, or volume of space”

“allows competition to be defined in relation to its mechanism rather than its effects, and the risk is **avoided of confusion with mechanism operating through the direct impact of the physiochemical environment** or through biotic effects such as selective predation”

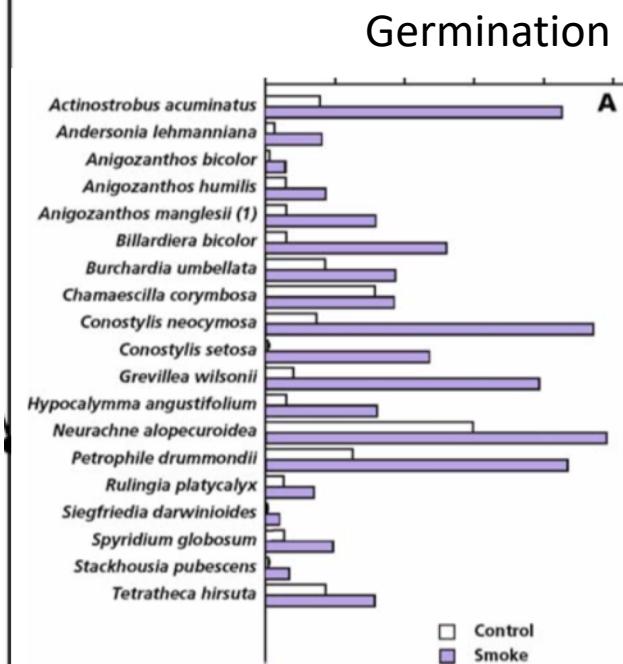
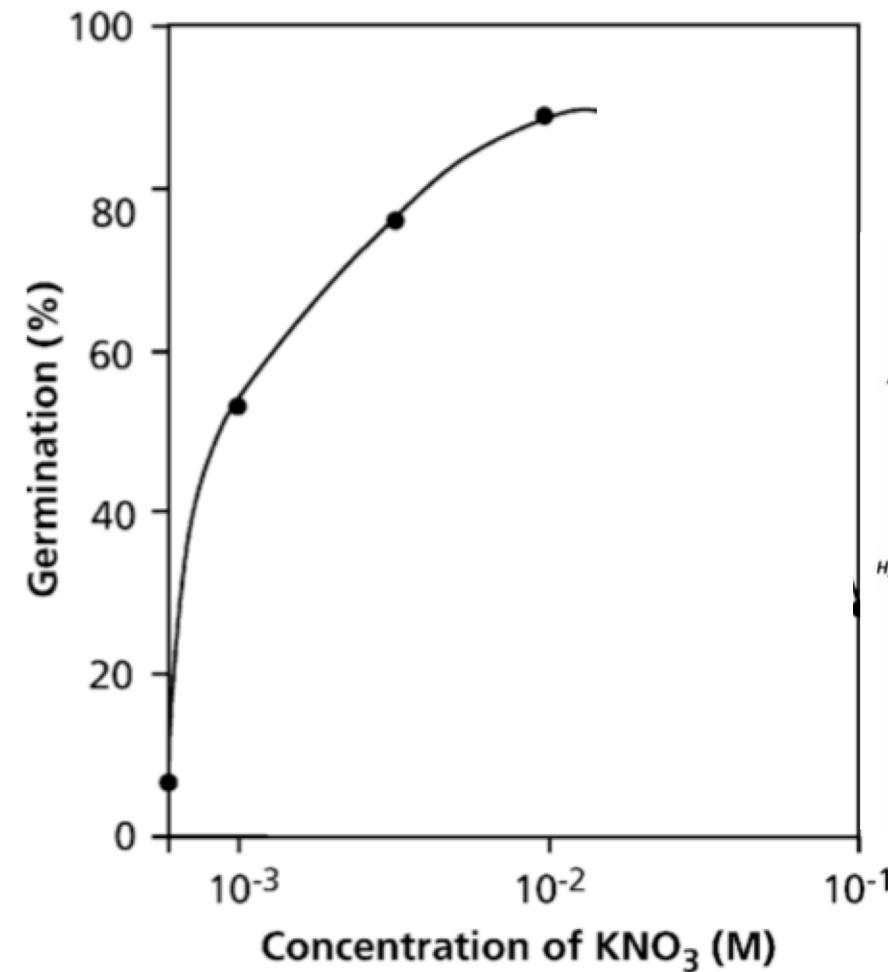
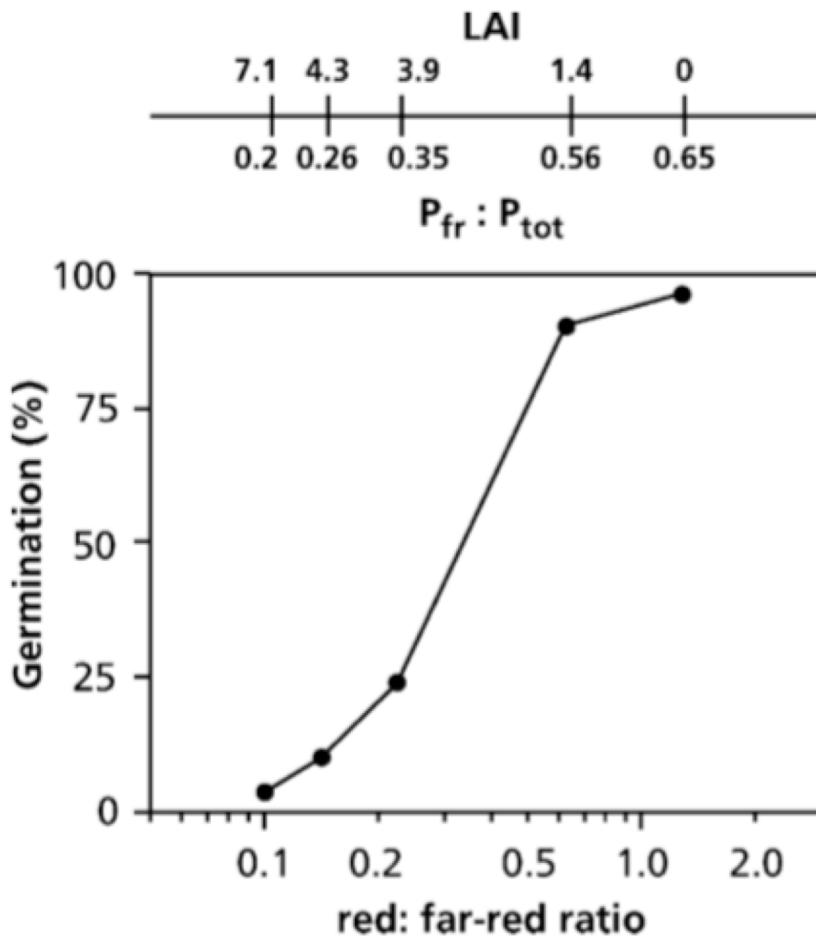
# What is plant competition?

Grime (1977): “the tendency of neighboring plants to utilize the same quantum of light, ion of a mineral nutrient, molecule of water, or volume of space”

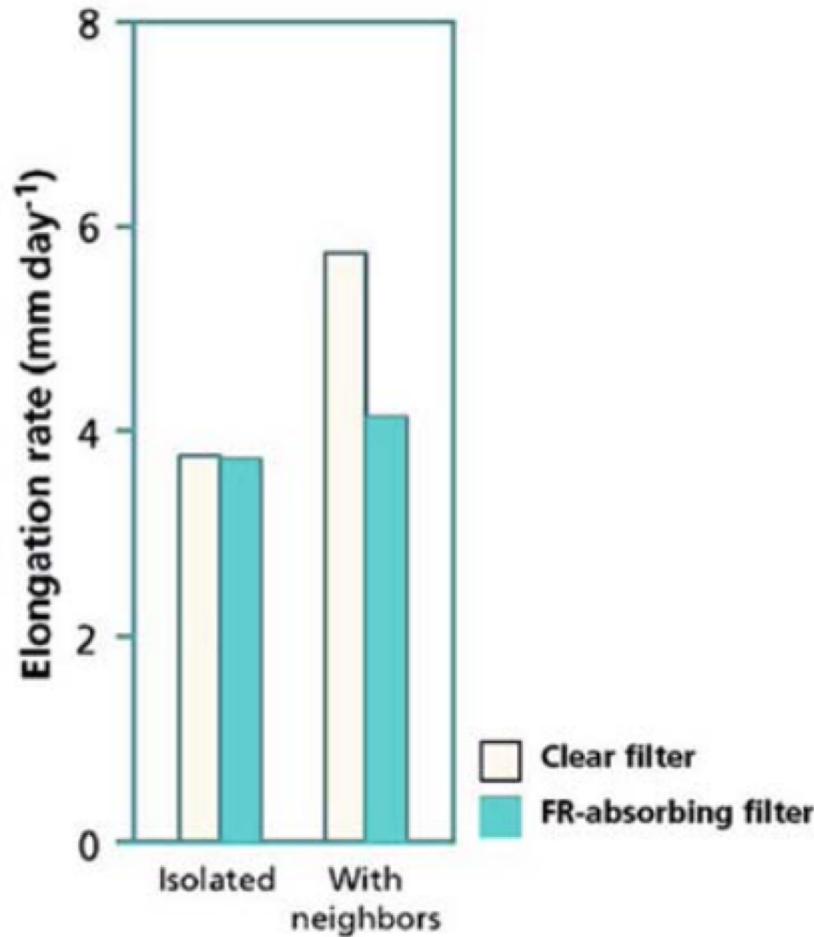
“allows competition to be defined in relation to its mechanism rather than its effects, and the risk is avoided of **confusion** with mechanism operating through the direct impact of the physiochemical environment or **through biotic effects such as selective predation**”

Plant perception of competition

# Perception by seeds: recap

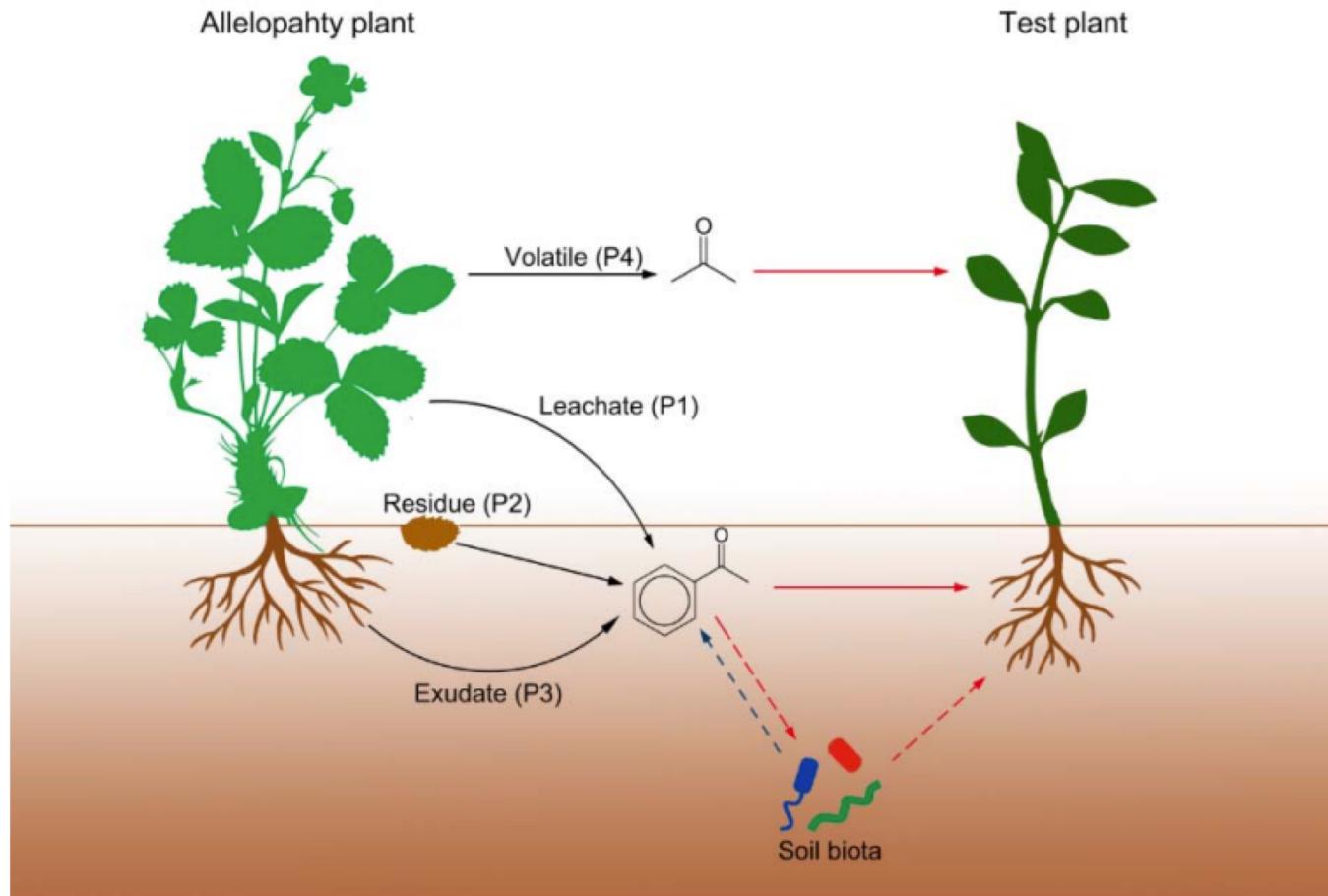


# Seedlings also perceive light from the canopy

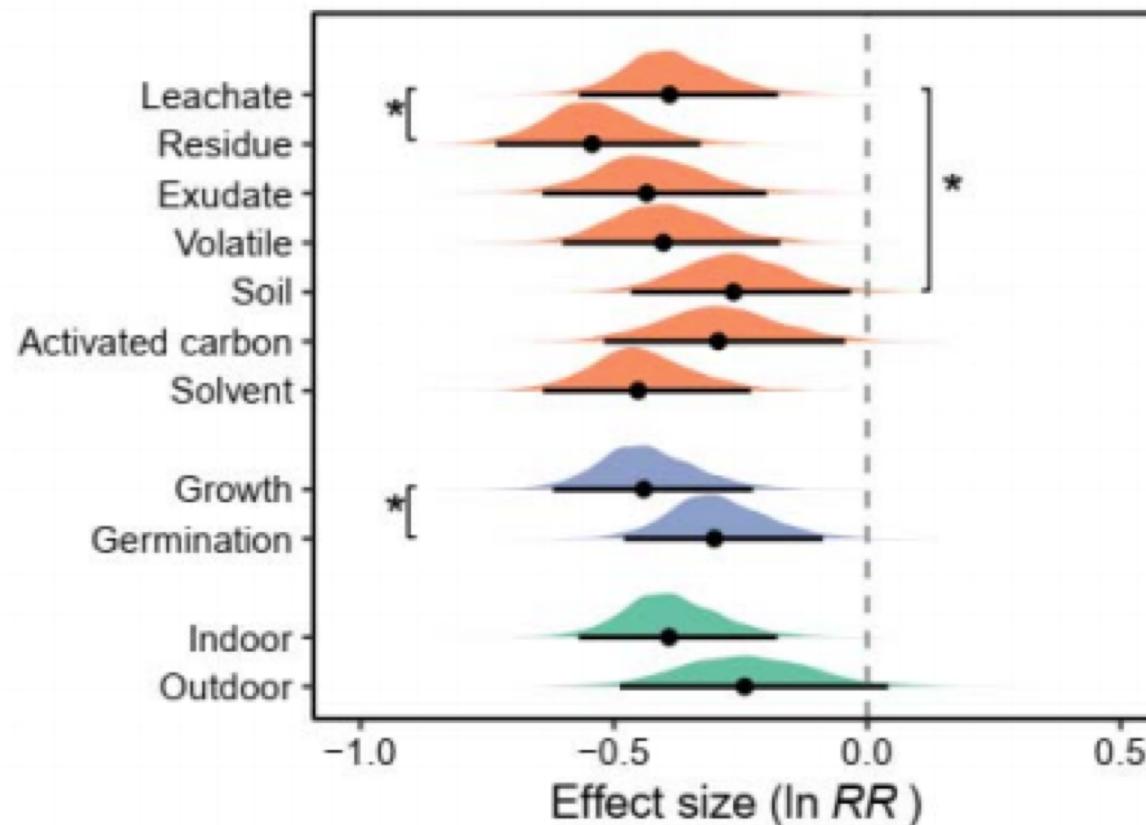


Stem elongation occurs when neighbors are present and reducing the ratio of red light to far red light. Plants are sensing they are under a canopy and elongating stems to access the limited light.

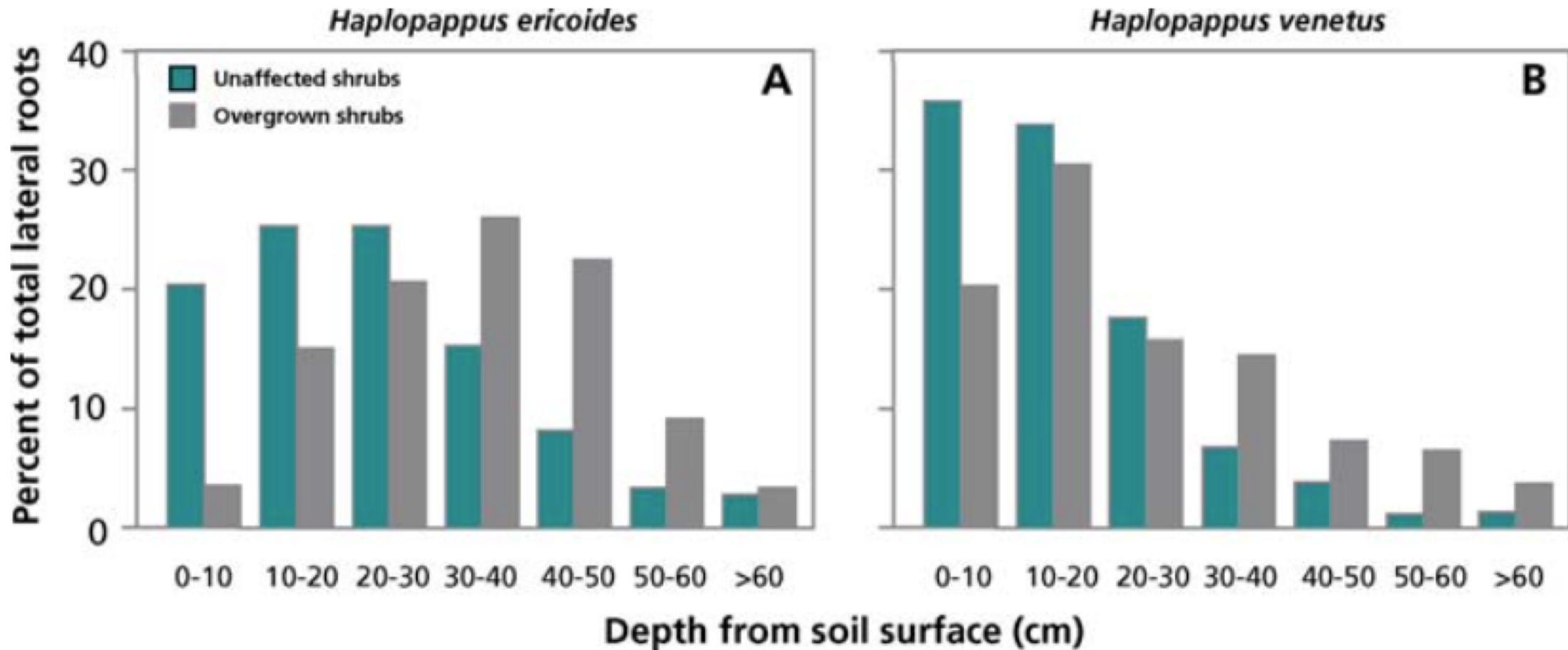
# Allelopathy: plant chemical sensing



# Allelopathy tends to have negative impacts on plants



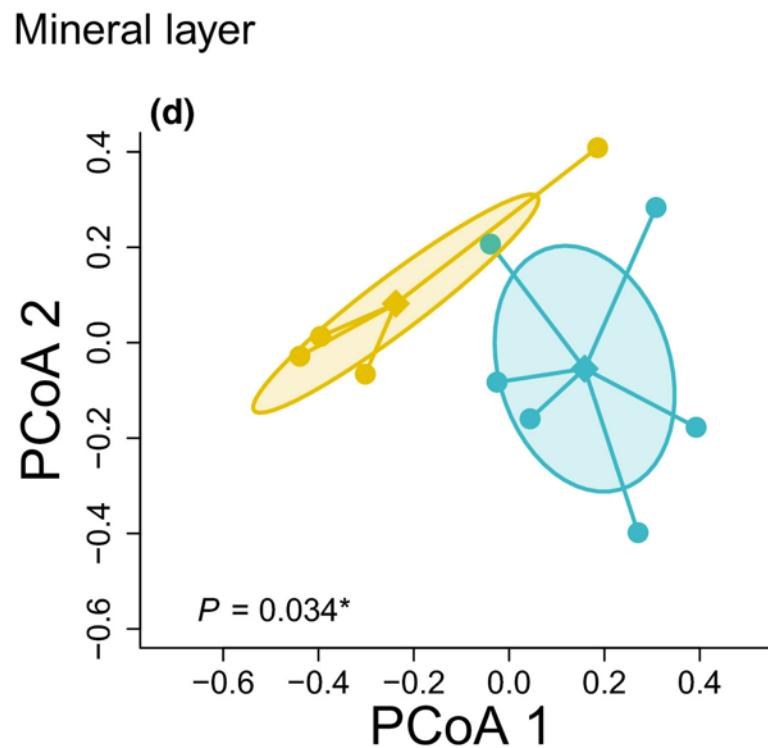
# Allelopathy can stimulate plastic responses



Increased belowground competition

# Allelopathy and invasion example

# Allelopathy and invasion

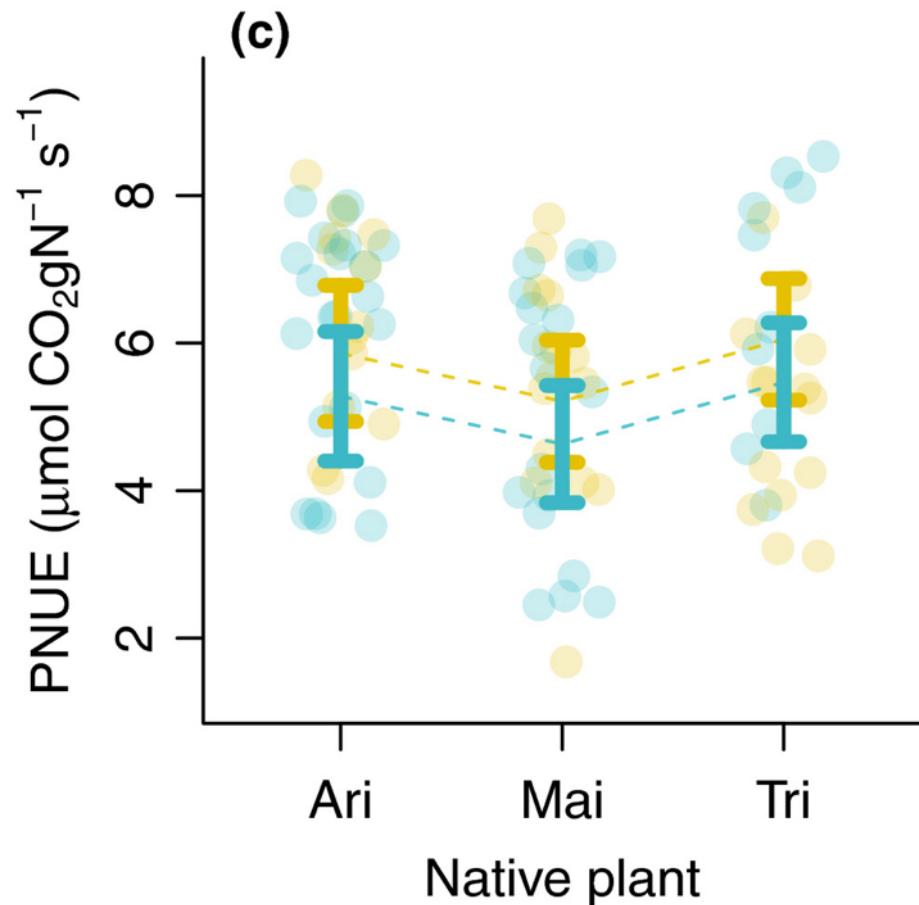


Gold: invader present  
Blue: invader absent



Garlic mustard is an  
allelopathic invader that  
alters microbial  
communities ...

# Allelopathy and invasion

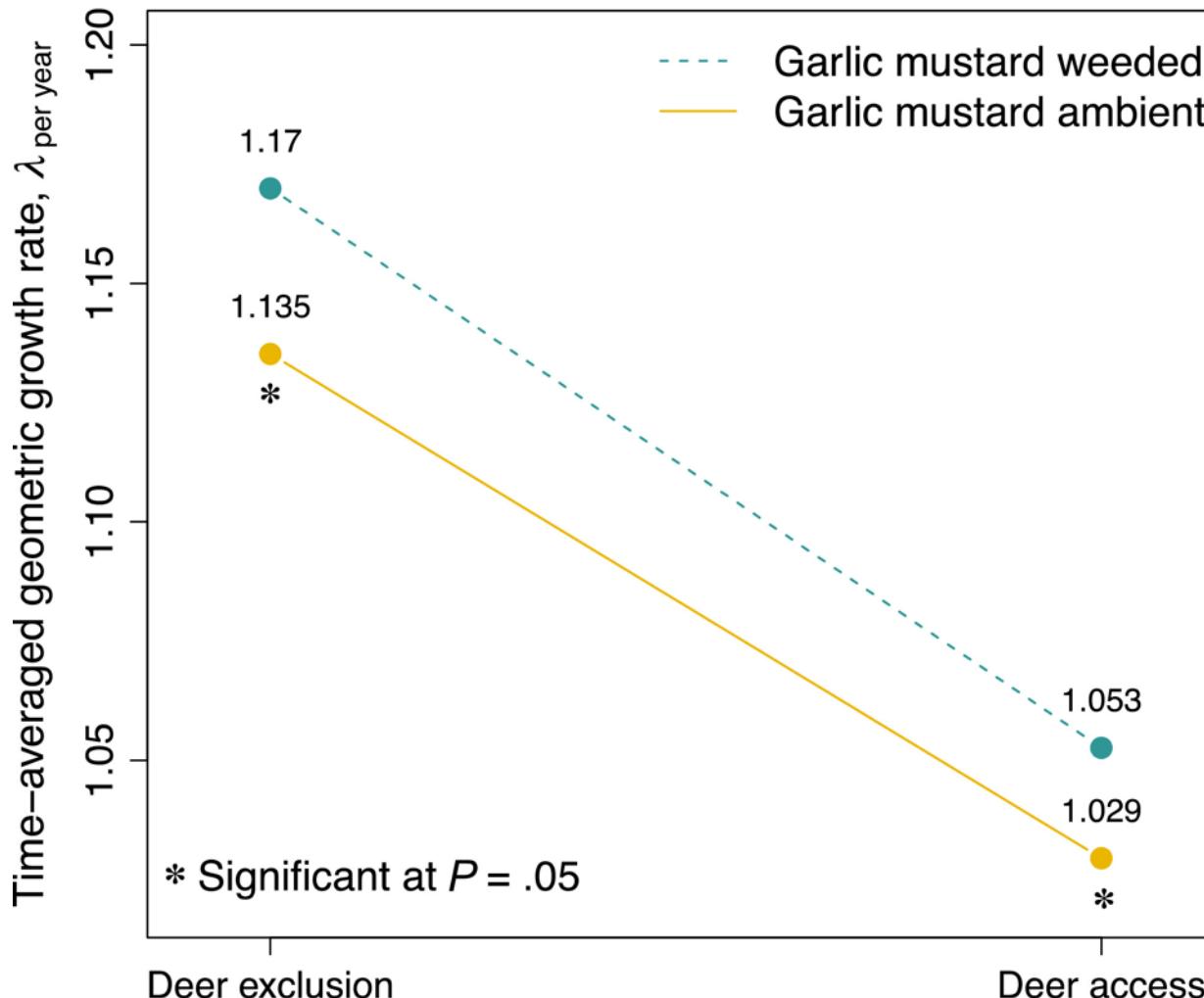


Gold: invader present  
Blue: invader absent



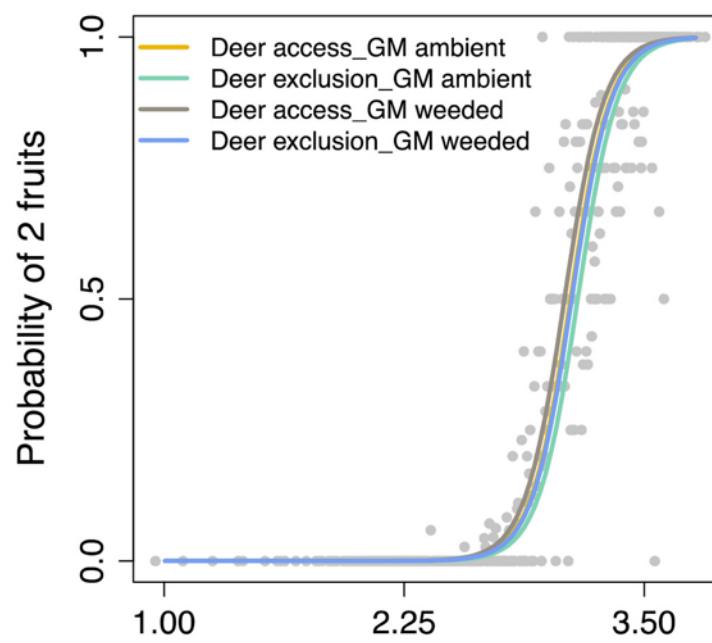
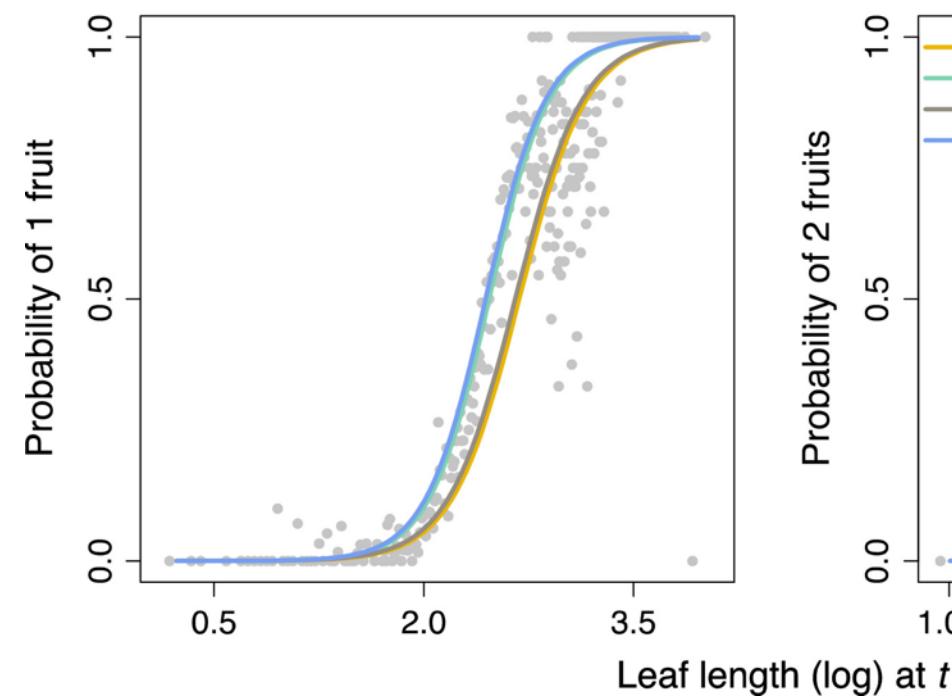
...which influences native plant traits ...

# Allelopathy and invasion



... and reduces native plant growth ...

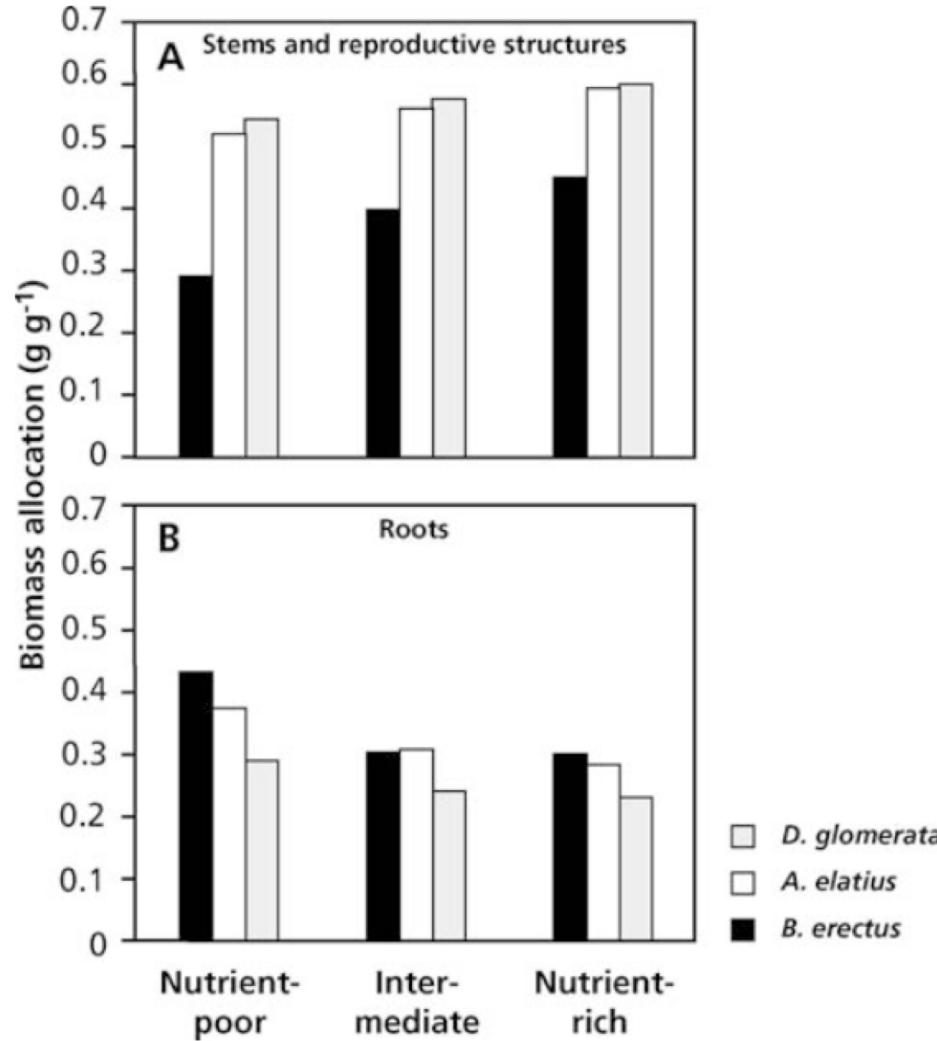
# Allelopathy and invasion



... and fitness!

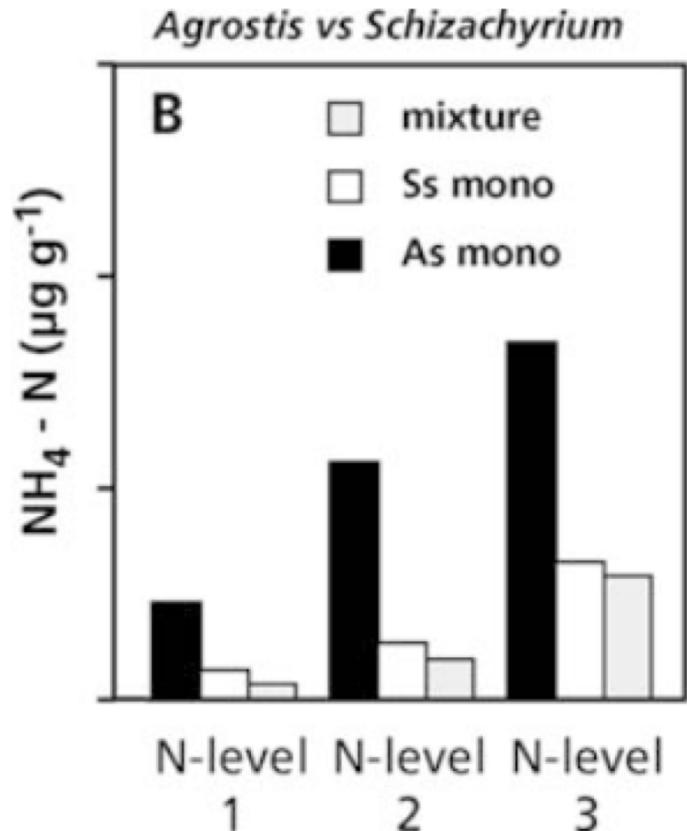
# Resource competition and traits

# Traits: nutrient competition



Nutrient stress promotes root competition,  
increasing root biomass allocation

# Traits: nutrient competition



Nutrient stress promotes root competition,  
**favoring low growth rate species**

Presence of slow growing *Schizachyrium* (Ss) reduces nutrient availability (R\* hypothesis), hampering growth of fast growing *Agrostis* (As)

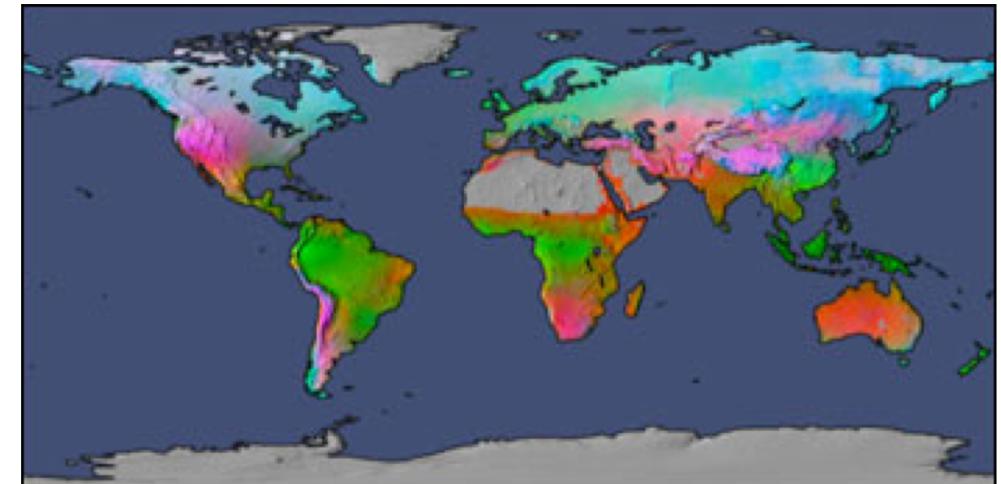
# Traits: water competition

- Toleration of soil low water potential
  - Similar to  $R^*$  for nutrients?
- Desiccation resistance
  - E.g., CAM and C4 photosynthesis
- Desiccation avoidance
  - Phenology

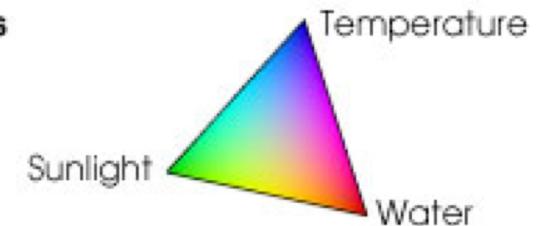


# Traits: light competition

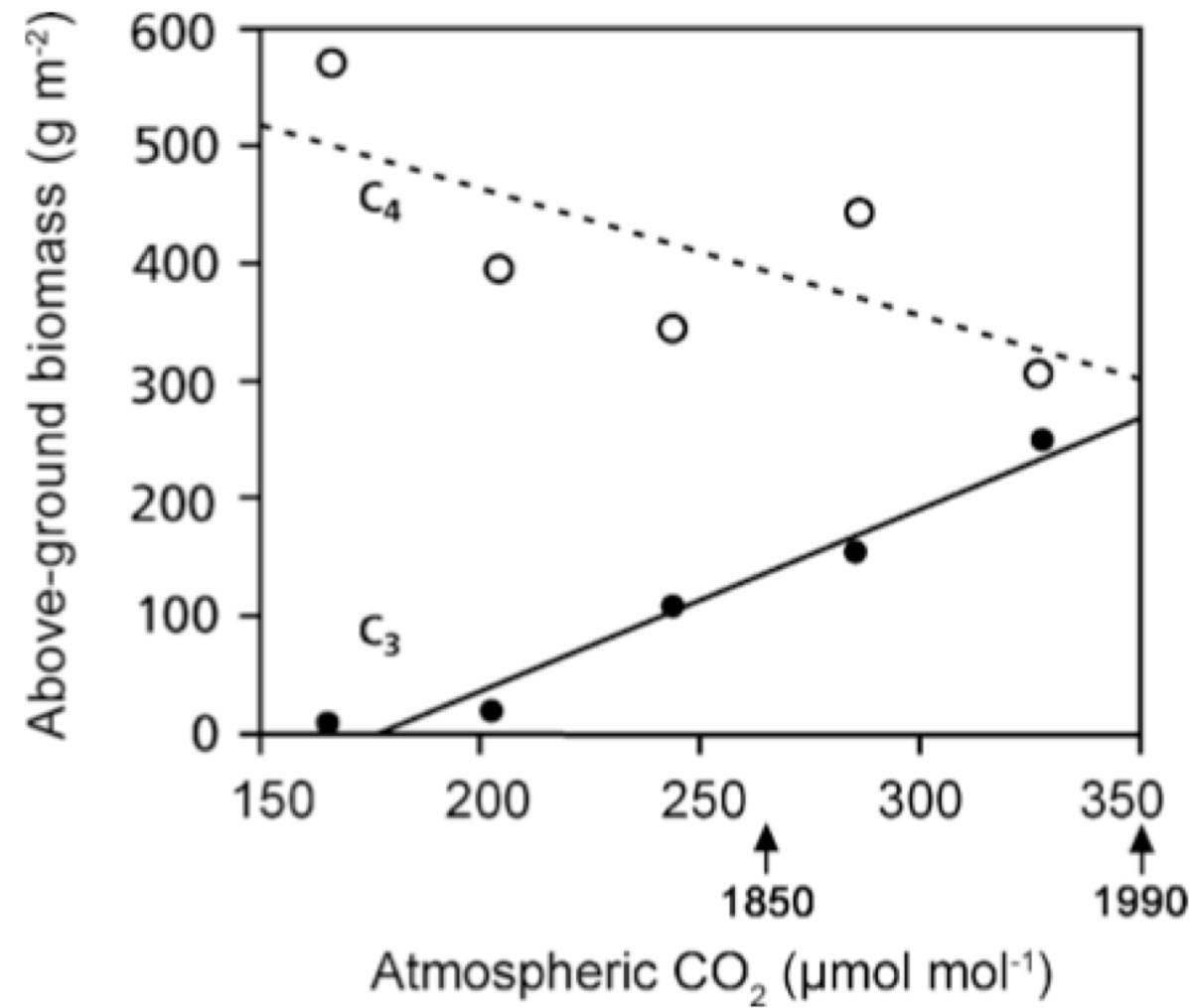
- Light competition only occurs when belowground resources are plentiful



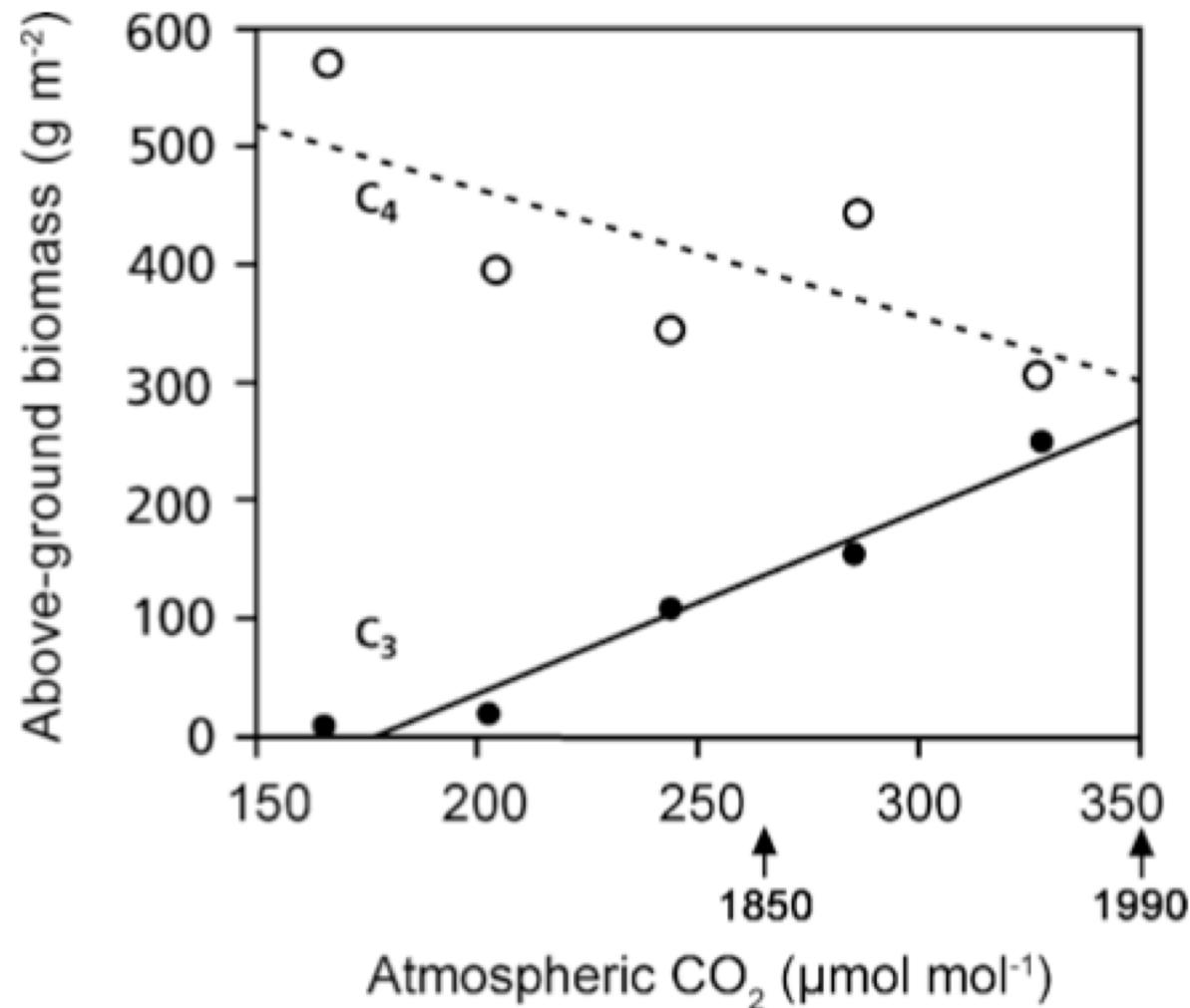
Potential Climate Limits



# Traits: CO<sub>2</sub> competition



# Traits: CO<sub>2</sub> competition



Are these competing according to Grime's definition?

# Competitive strategies

# r-K continuum



$$\frac{dN}{dt} = rN \left(1 - \frac{N}{K}\right)$$

N = population size

t = time

r = population growth rate

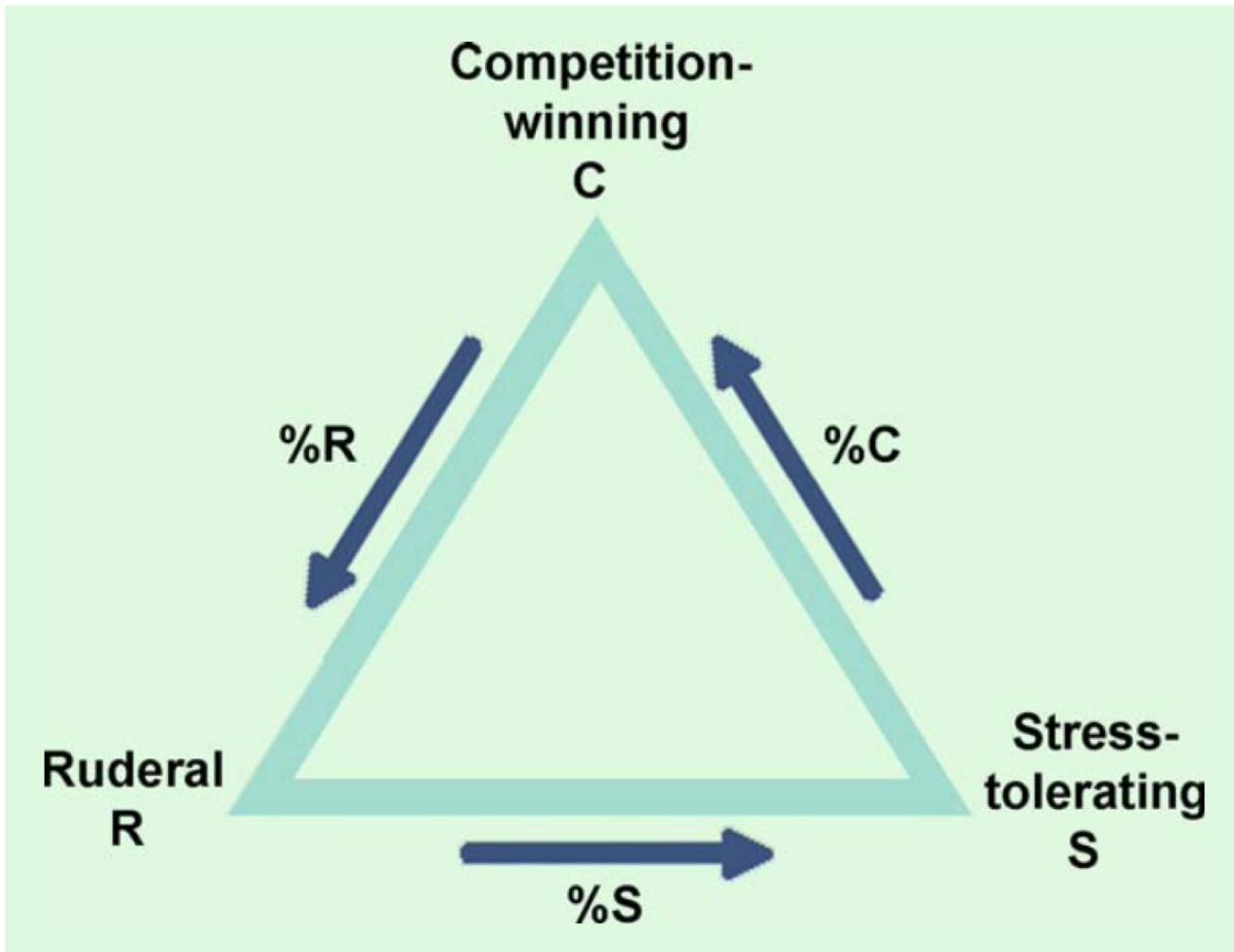
K = carrying capacity

# r-K continuum

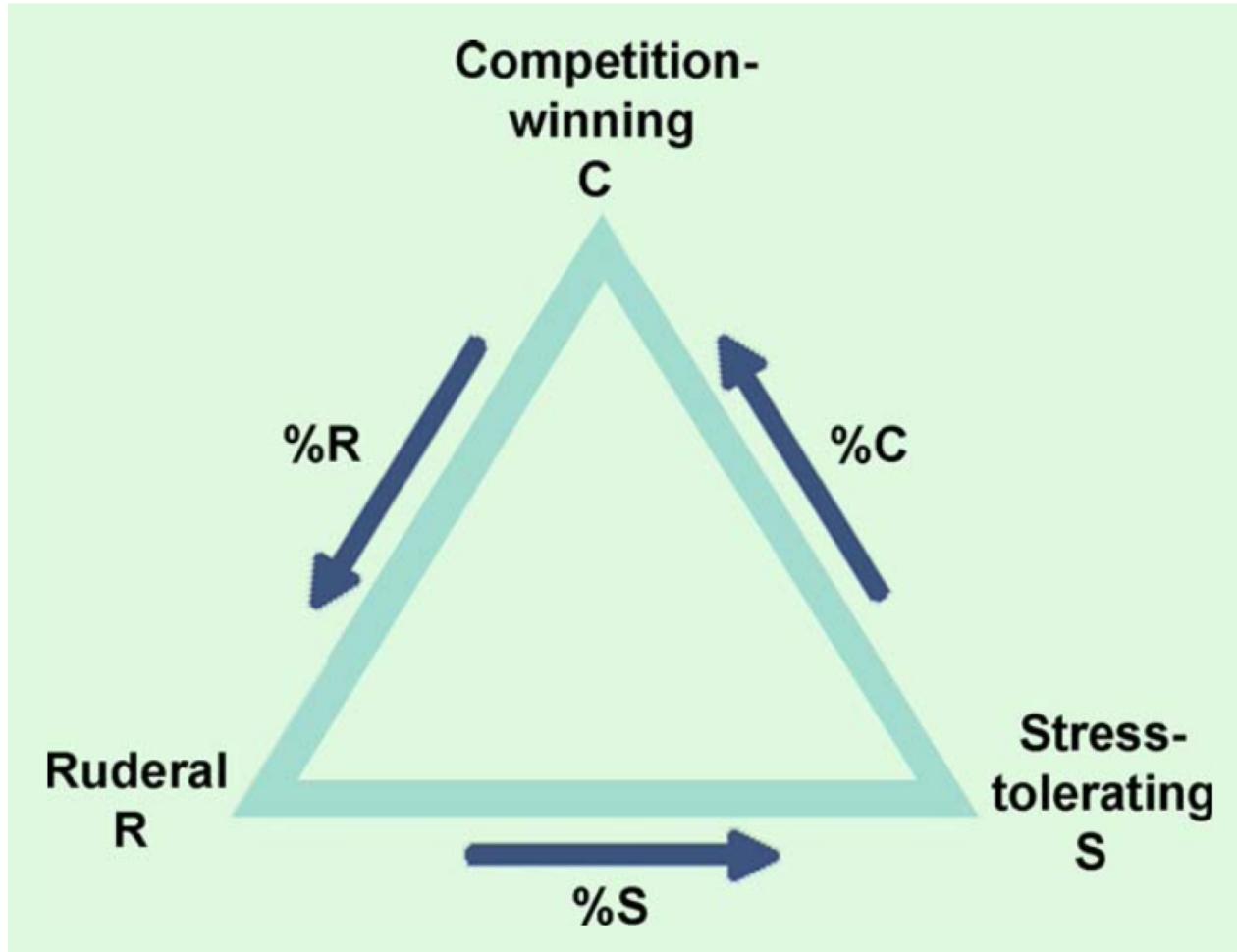


Where would r species dominate?  
Where would K species dominate?

# Grime's (1977) triangle



# Grime's (1977) triangle



What is different from r-K?

# Grime's (1977) triangle

SUGGESTED BASIS FOR THE EVOLUTION OF THREE STRATEGIES IN VASCULAR PLANTS

INTENSITY OF DISTURBANCE	INTENSITY OF STRESS	
	Low	High
Low .....	Competitive strategy	Stress-tolerant strategy
High.....	Ruderal strategy	No viable strategy

TABLE 3

MORPHOGENETIC RESPONSES TO DESICCATION, SHADING, OR MINERAL NUTRIENT STRESS OF COMPETITIVE, STRESS-TOLERANT, AND RUDERAL PLANTS AND THEIR ECOLOGICAL CONSEQUENCES IN THREE TYPES OF HABITAT

STRATEGY	RESPONSE TO STRESS	CONSEQUENCES		
		Habitat 1*	Habitat 2†	Habitat 3‡
Competitive . . . . .	Large and rapid changes in root: shoot ratio, leaf area, and root surface area	Tendency to sustain high rates of uptake of water and mineral nutrients to maintain dry-matter production under stress and to succeed in competition	Tendency to exhaust reserves of water and/or mineral nutrients both in rhizosphere and within the plant; etiolation in response to shade increases susceptibility to fungal attack	Failure rapidly to produce seeds reduces chance of rehabilitation after disturbance
Stress tolerant . . . . .	Changes in morphology slow and often small in magnitude	Overgrown by competitors	Conservative utilization of water, mineral nutrients, and photosynthate allows survival over long periods in which little dry-matter production is possible	
Ruderal. . . . .	Rapid curtailment of vegetative growth and diversion of resources into seed production		Chronically low seed production fails to compensate for high rate of mortality	Rapid production of seeds ensures rehabilitation after disturbance

\* In the early successional stages of productive, undisturbed habitats (stresses mainly plant induced and coinciding with competition).

† In either continuously unproductive habitats (stresses more or less constant and due to unfavorable climate and/or soil) or in the late stages of succession in productive habitats.

‡ In severely disturbed, potentially productive habitats (stresses either a prelude to disturbance, e.g., moisture stress preceding drought fatalities, or plant induced, between periods of disturbance).

# Westoby (1998) Leaf-Height-Seed theory

- SLA describes the competition-stress tolerance tradeoff
- Plant height and seed mass reflect aspects of coping with disturbance



Published: 23 December 2015

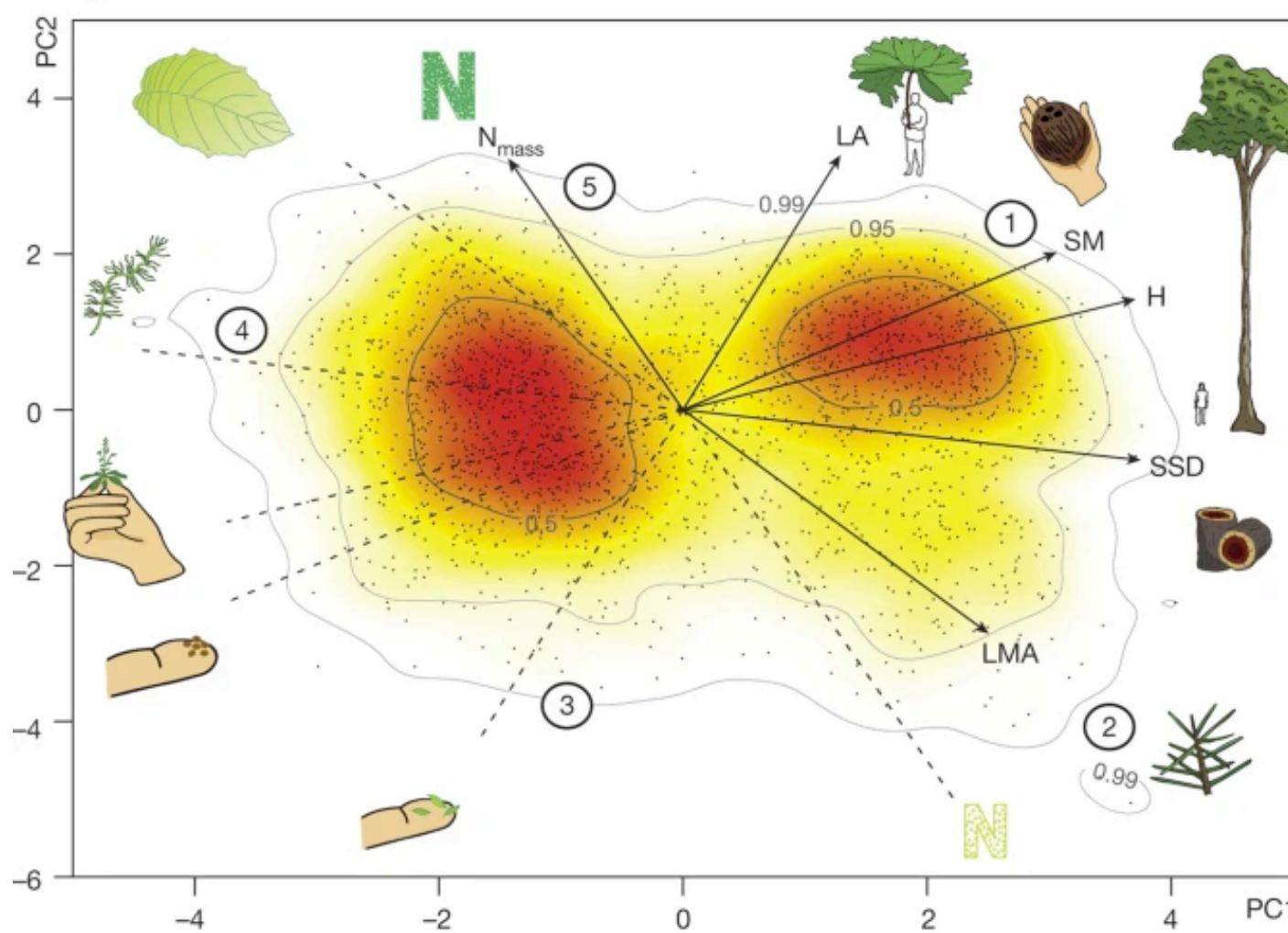
# The global spectrum of plant form and function

Sandra Díaz [✉](#), Jens Kattge, [...] Lucas D. Gorné

Nature 529, 167–171(2016) | [Cite this article](#)

11k Accesses | 836 Citations | 208 Altmetric | [Metrics](#)

a



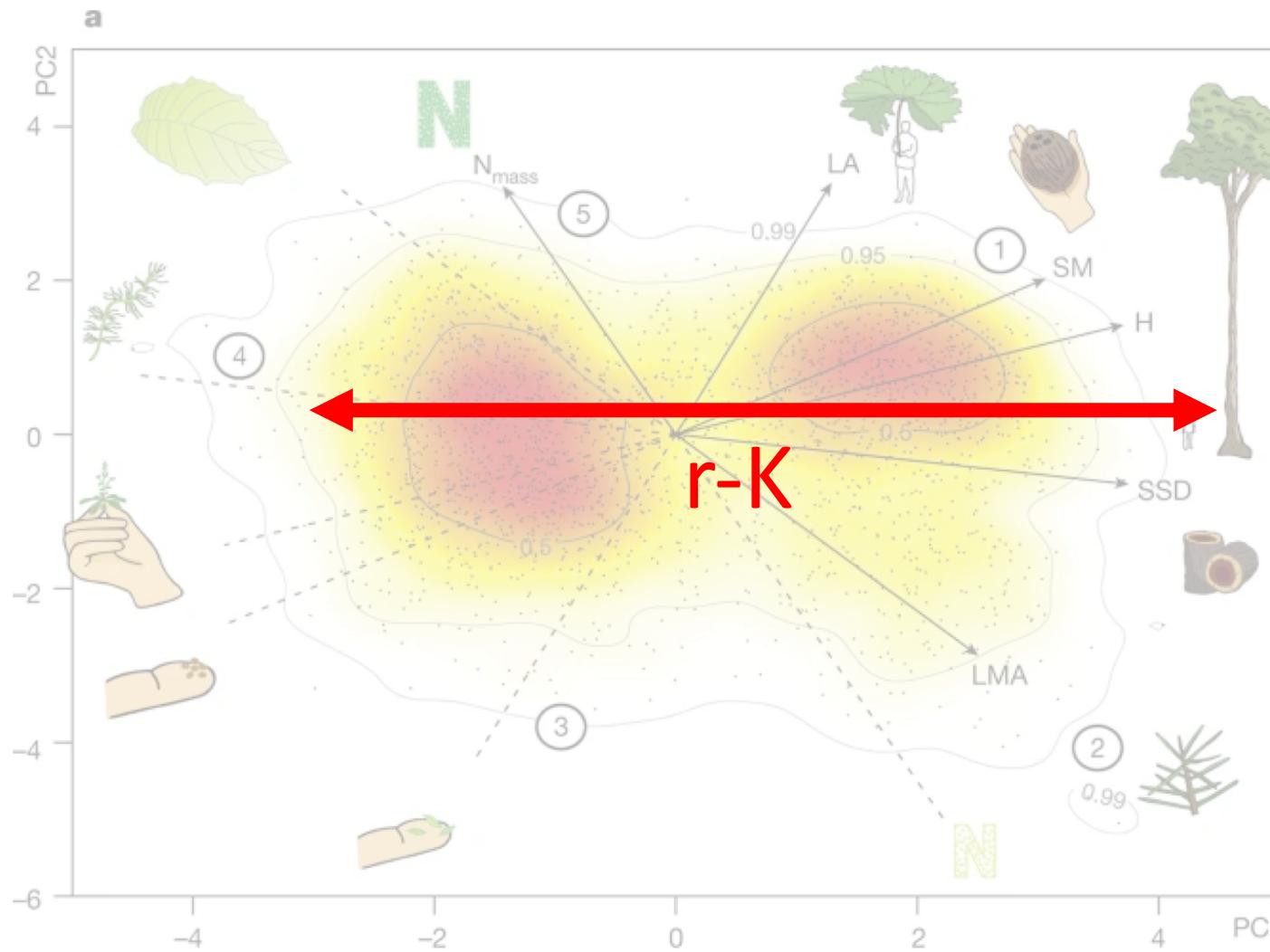
Published: 23 December 2015

# The global spectrum of plant form and function

Sandra Díaz [✉](#), Jens Kattge, [...] Lucas D. Gorné

Nature 529, 167–171(2016) | [Cite this article](#)

11k Accesses | 836 Citations | 208 Altmetric | [Metrics](#)



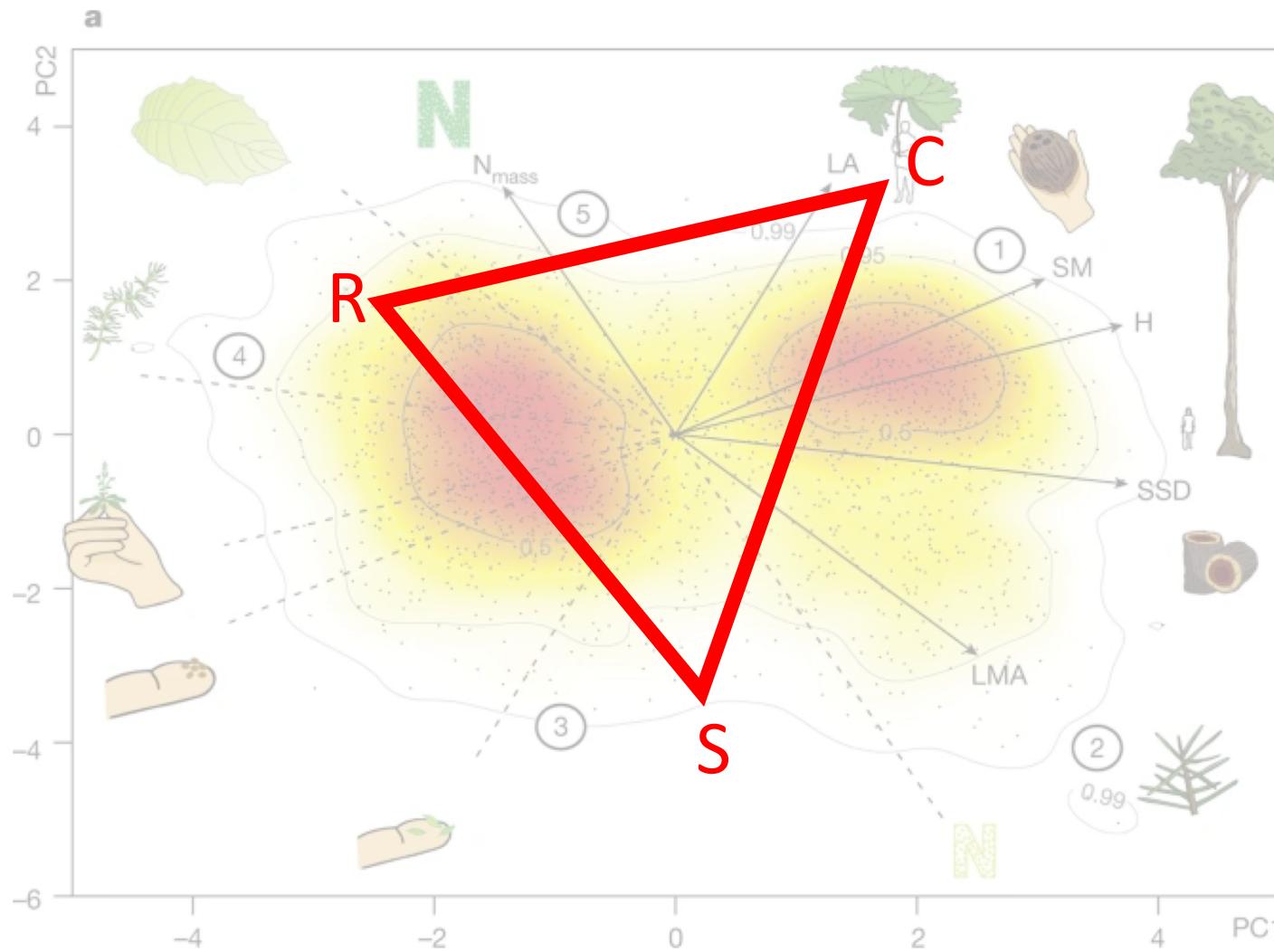
Published: 23 December 2015

# The global spectrum of plant form and function

Sandra Díaz [✉](#), Jens Kattge, [...] Lucas D. Gorné

Nature 529, 167–171(2016) | [Cite this article](#)

11k Accesses | 836 Citations | 208 Altmetric | [Metrics](#)



Published: 23 December 2015

# The global spectrum of plant form and function

Sandra Díaz [✉](#), Jens Kattge, [...] Lucas D. Gorné

Nature 529, 167–171(2016) | [Cite this article](#)

11k Accesses | 836 Citations | 208 Altmetric | [Metrics](#)

