Competition

April 6, 2021

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Why neighboring?

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Not all abiotic and biotic drivers of plant fitness

Why these specifically?

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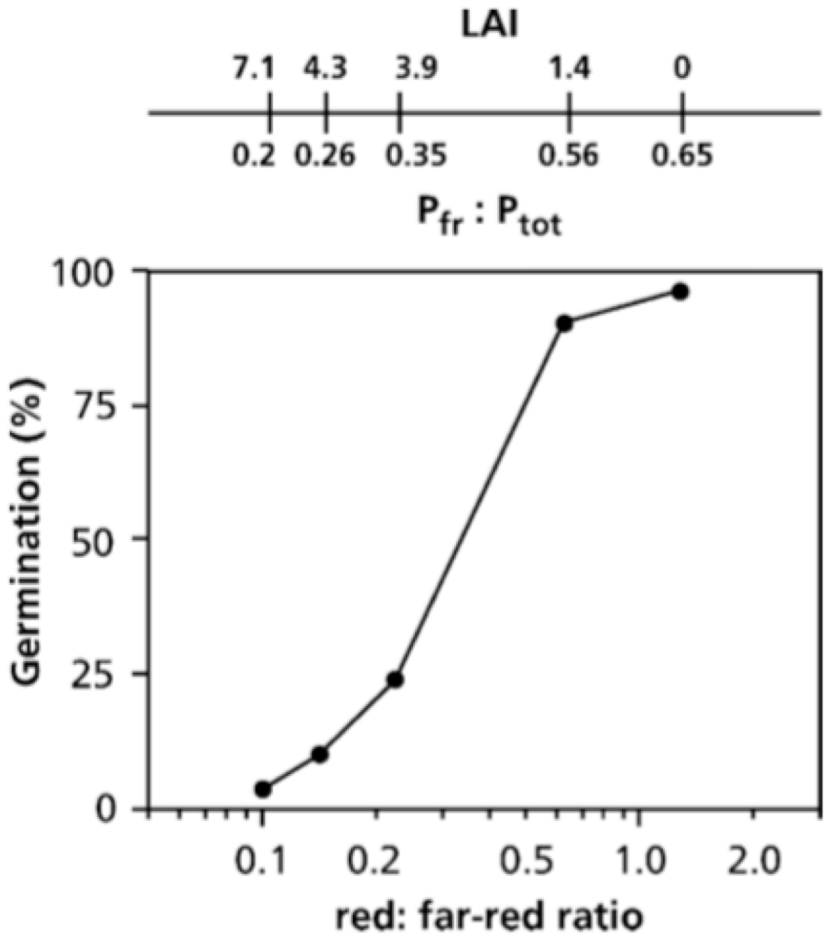
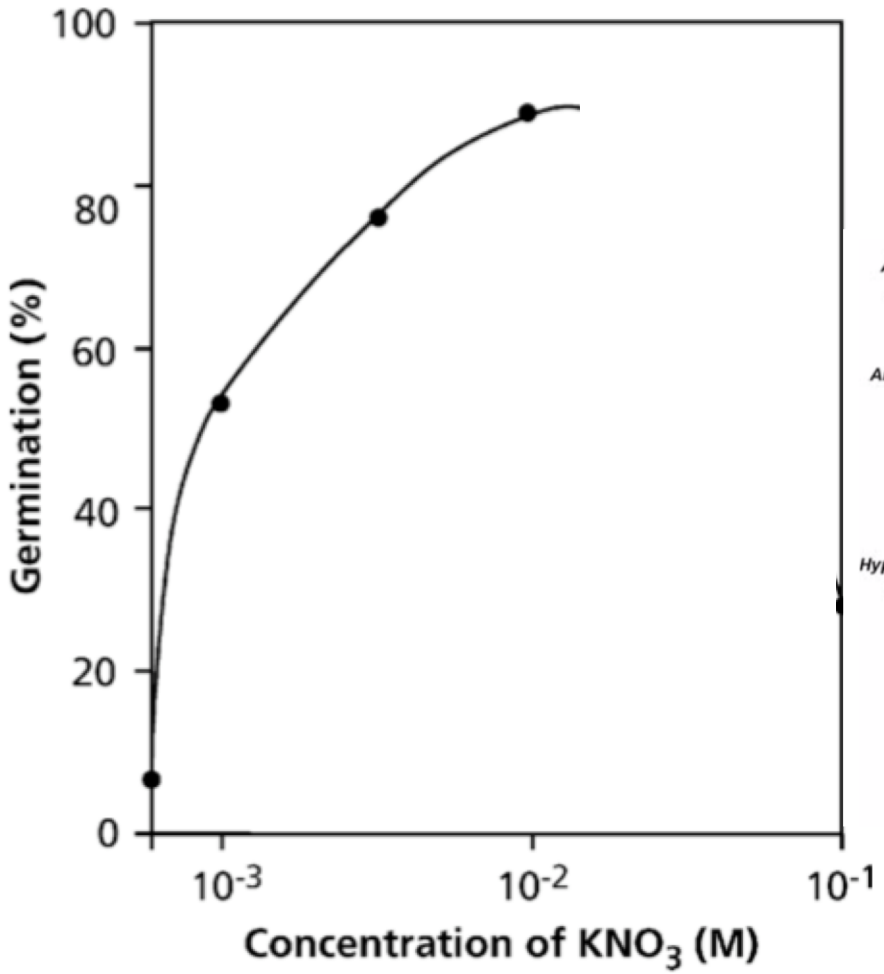
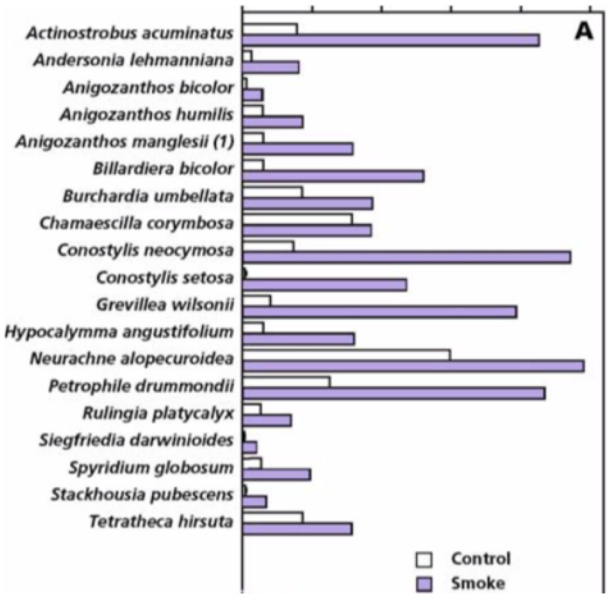
Plant perception of competition

Perception by seeds: recap

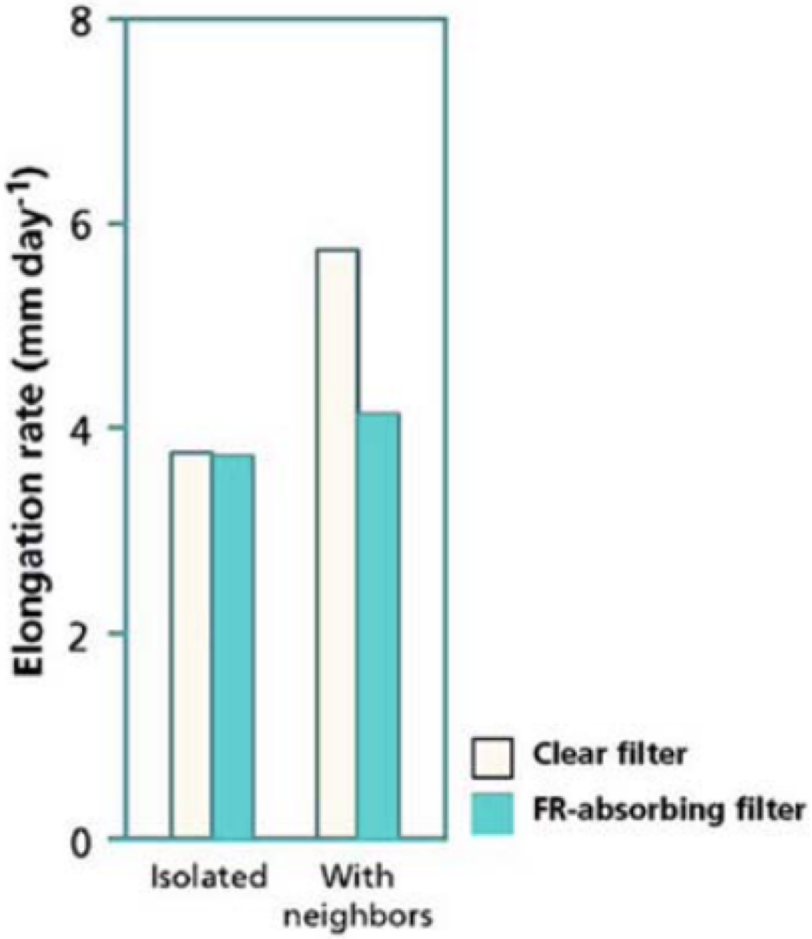




Germination

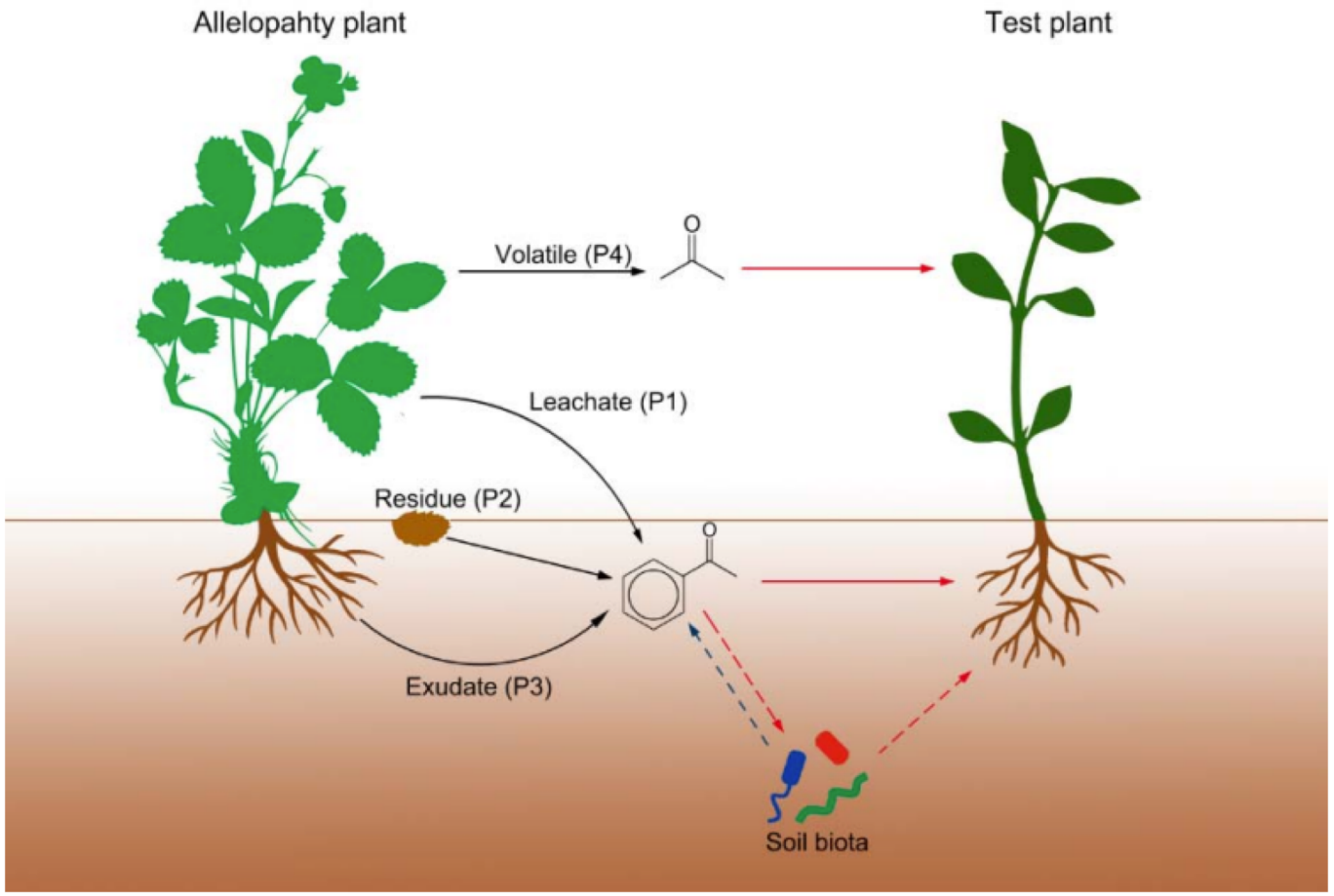


Seedlings also perceive light from the canopy



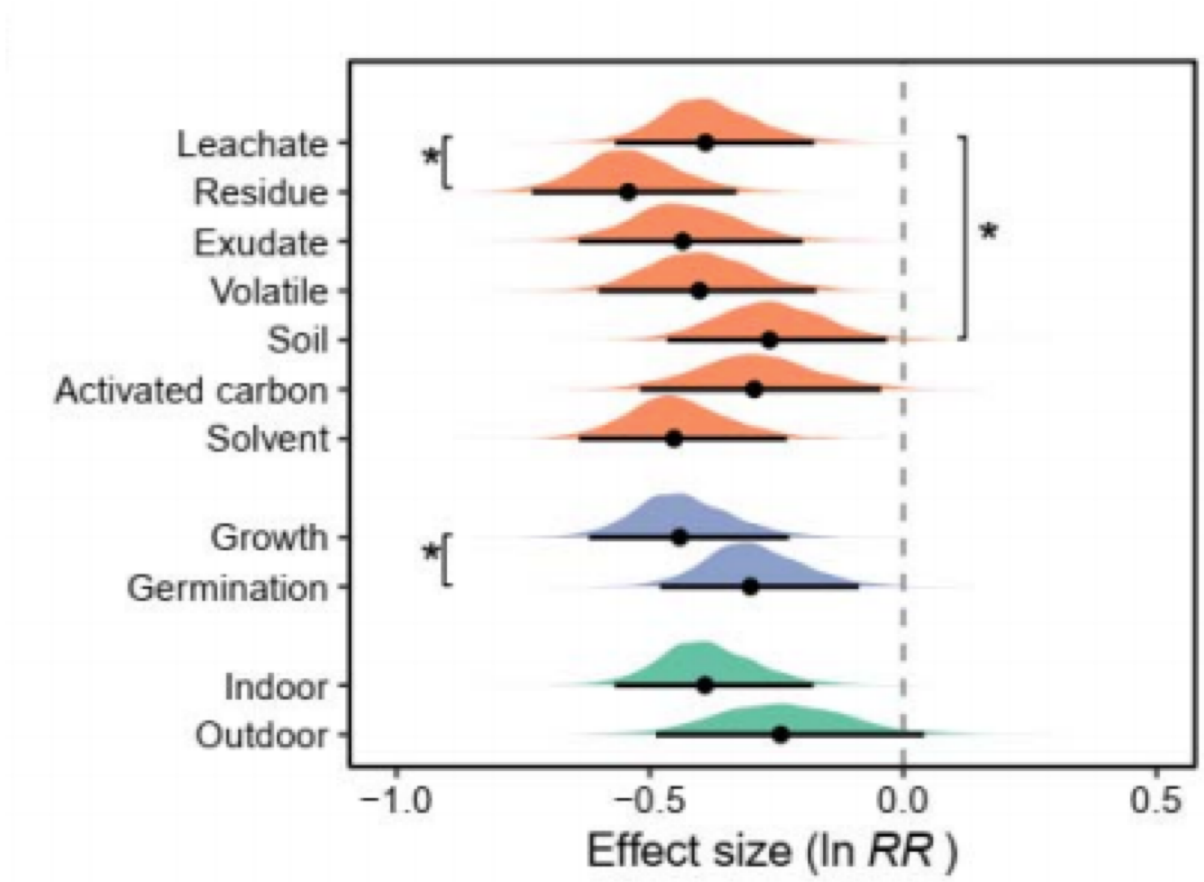
Stem elongation occurs when neighbors are present and reducing the ratio of red light to far red light. Plants are sensing they are under a canopy and elongating stems to access the limited light.

Allelopathy: plant chemical sensing



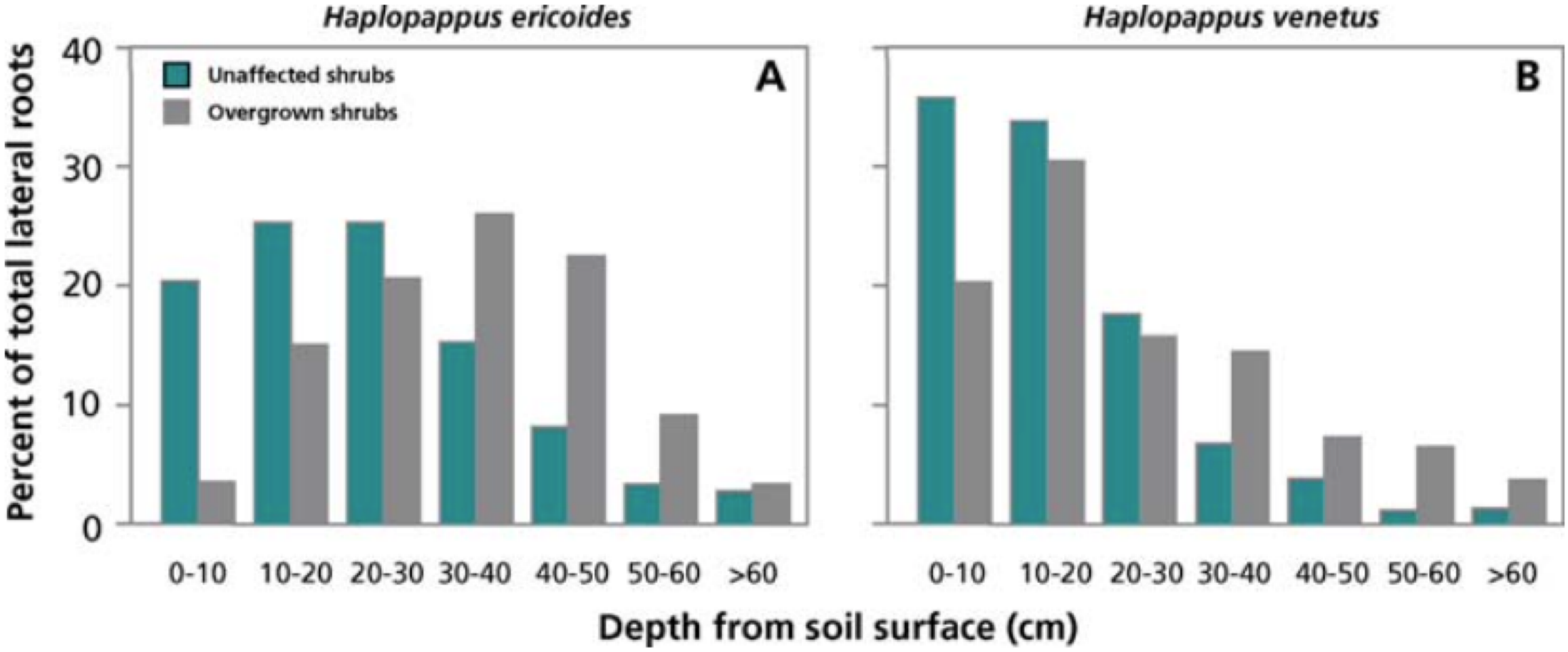
Zhang et al. (2020)

Allelopathy tends to have negative impacts on plants



Zhang et al. (2020)

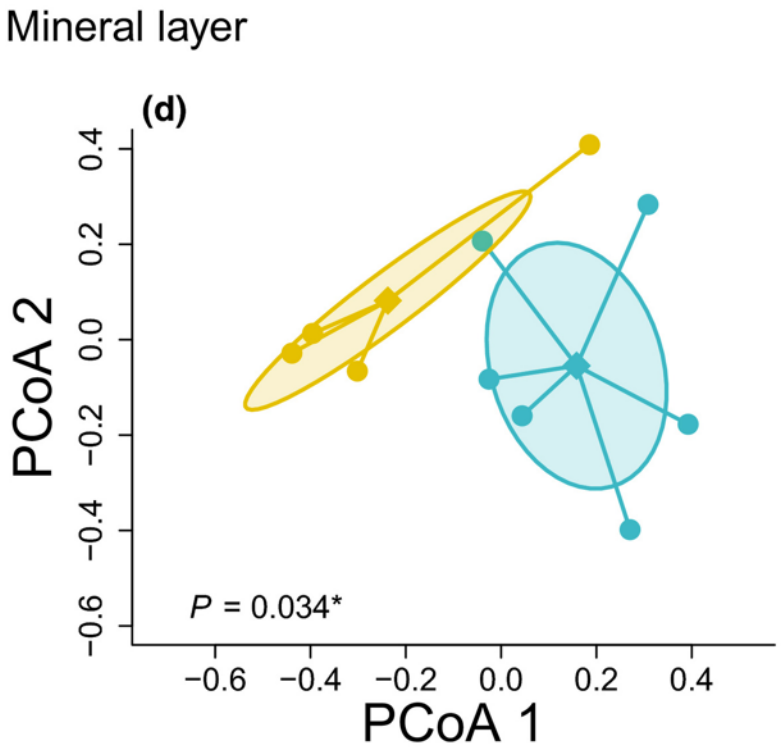
Allelopathy can stimulate plastic responses



Increased belowground competition

Allelopathy and invasion example

Allelopathy and invasion

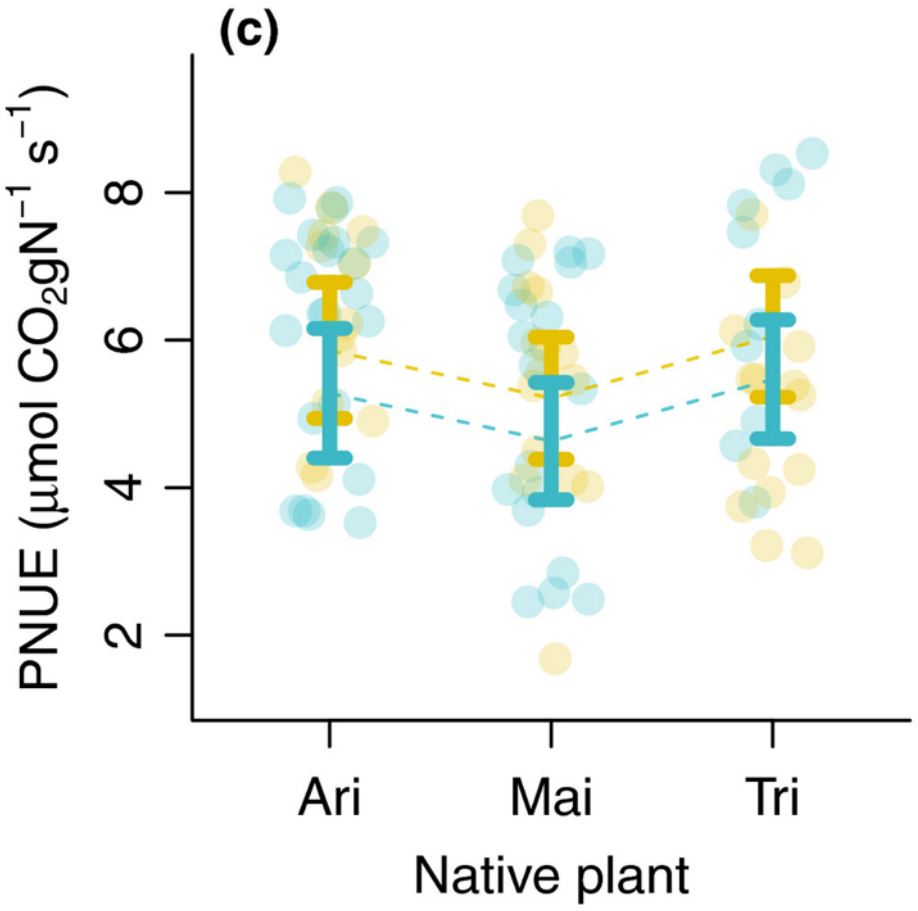


Gold: invader present
Blue: invader absent

Garlic mustard is an allelopathic invader that alters microbial communities …

Bialic-Murphy et al. (2020)

Allelopathy and invasion



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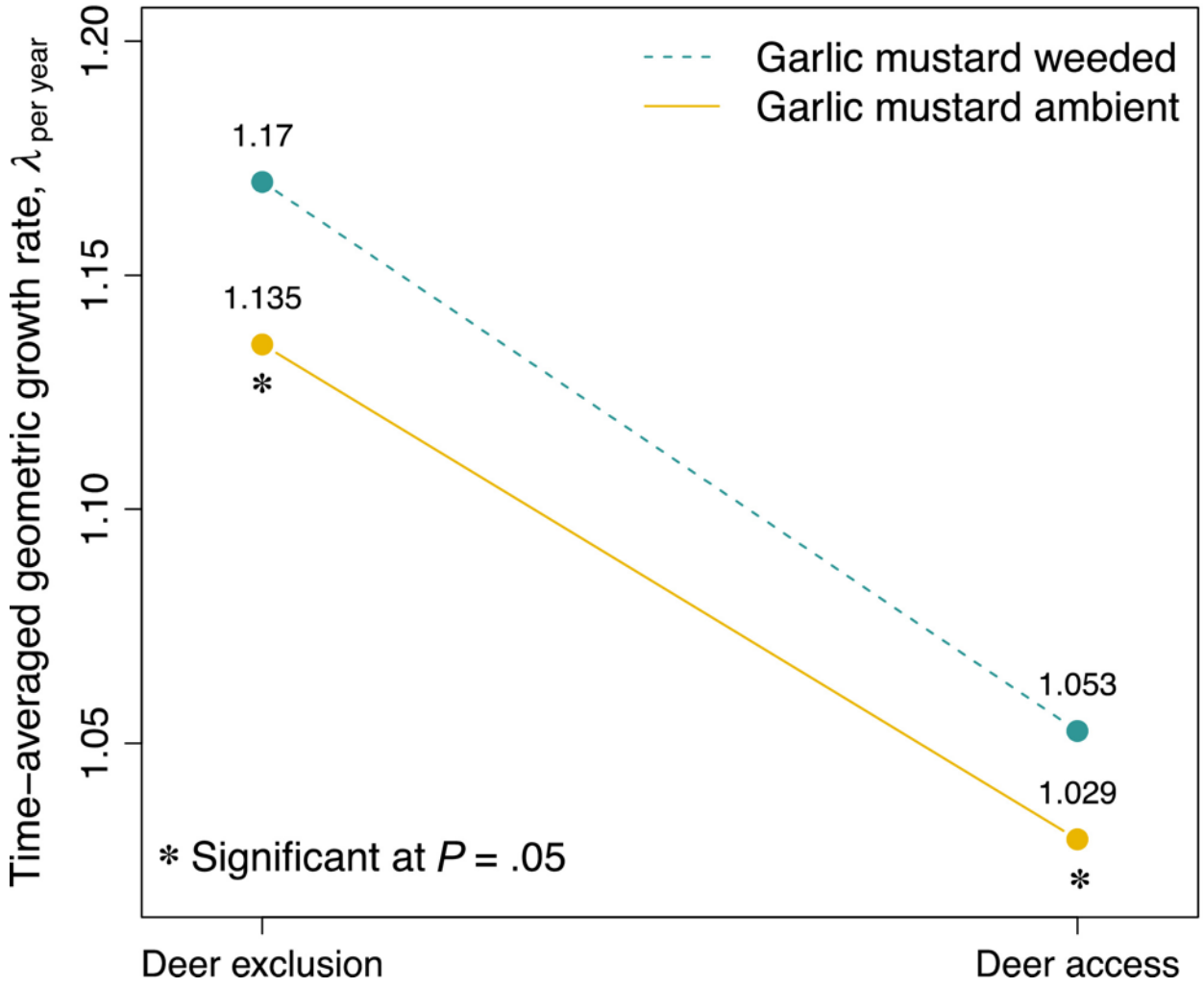
…which influences native plant traits …

Bialic-Murphy et al. (2020)

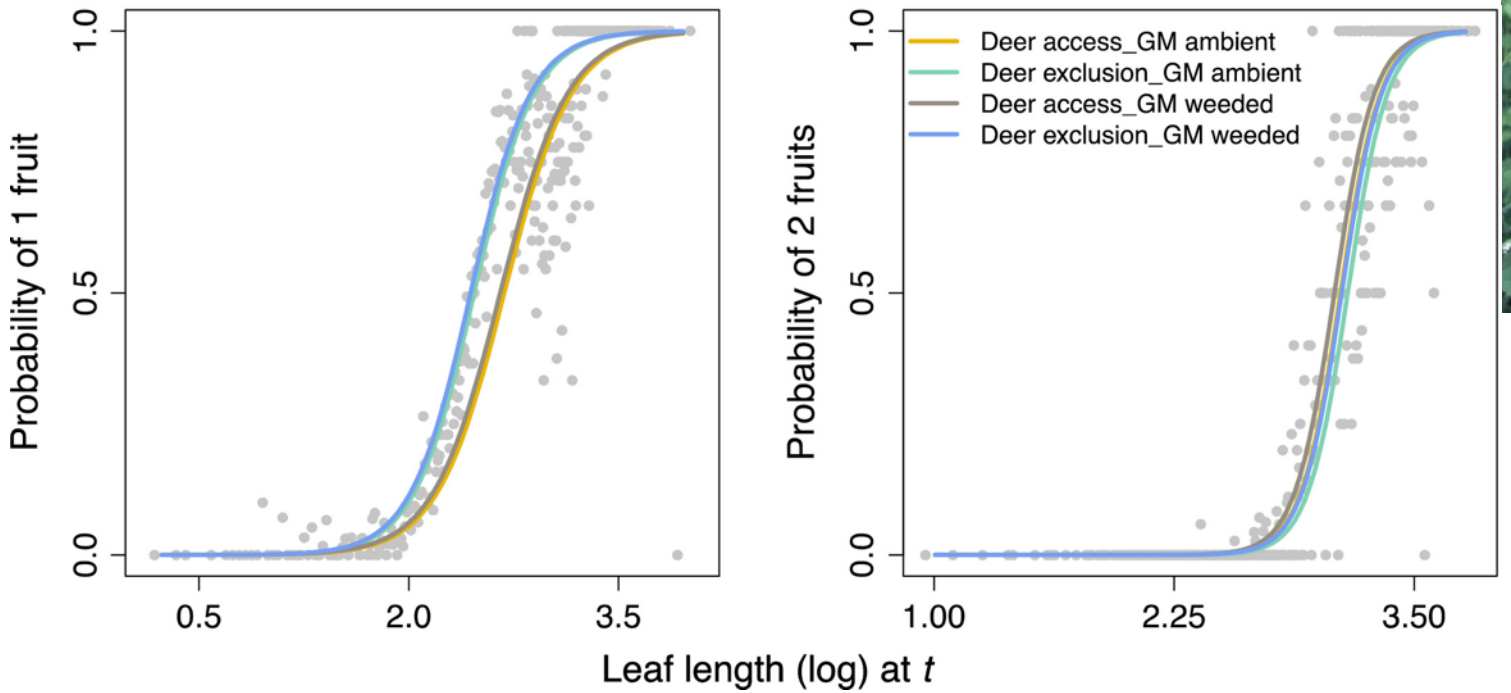
Allelopathy and invasion



… and reduces native plant growth …

Bialic-Murphy et al. (2019)

Allelopathy and invasion

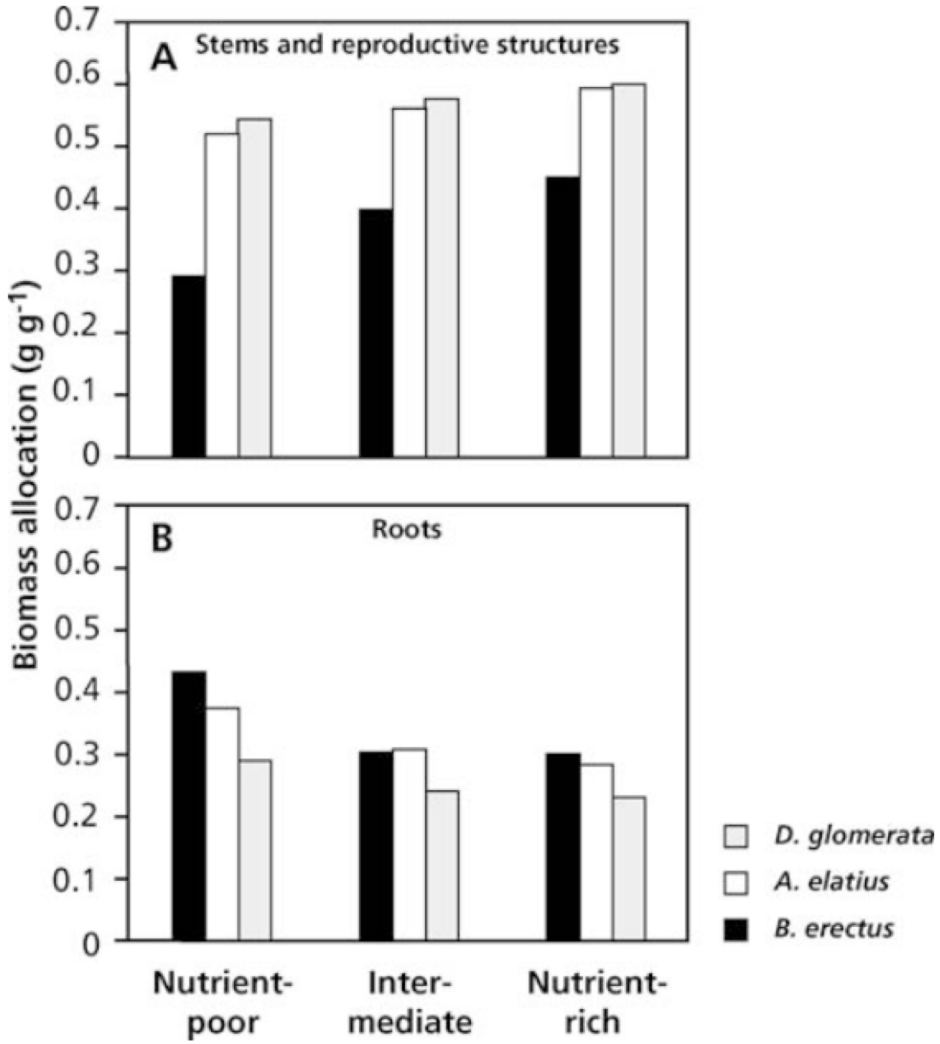


… and fitness!

Bialic-Murphy et al. (2019)

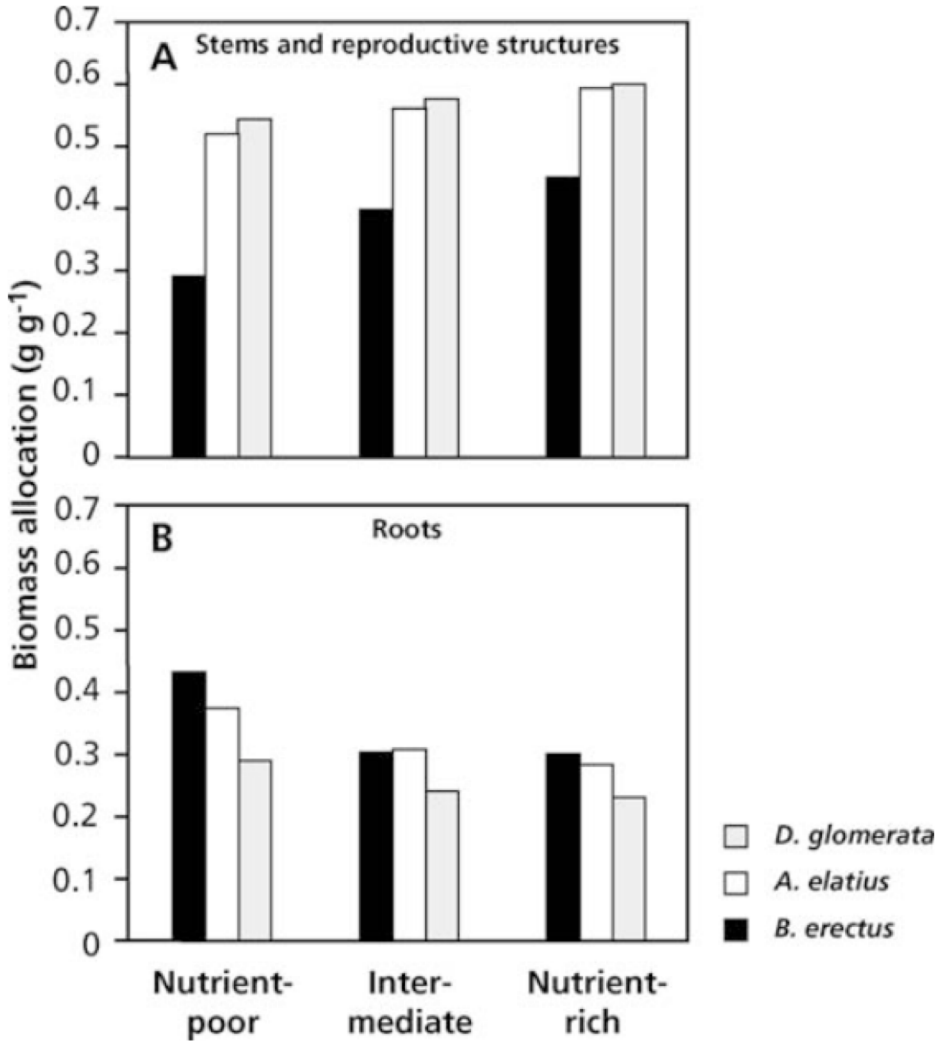
Resource competition and traits

Traits: nutrient competition



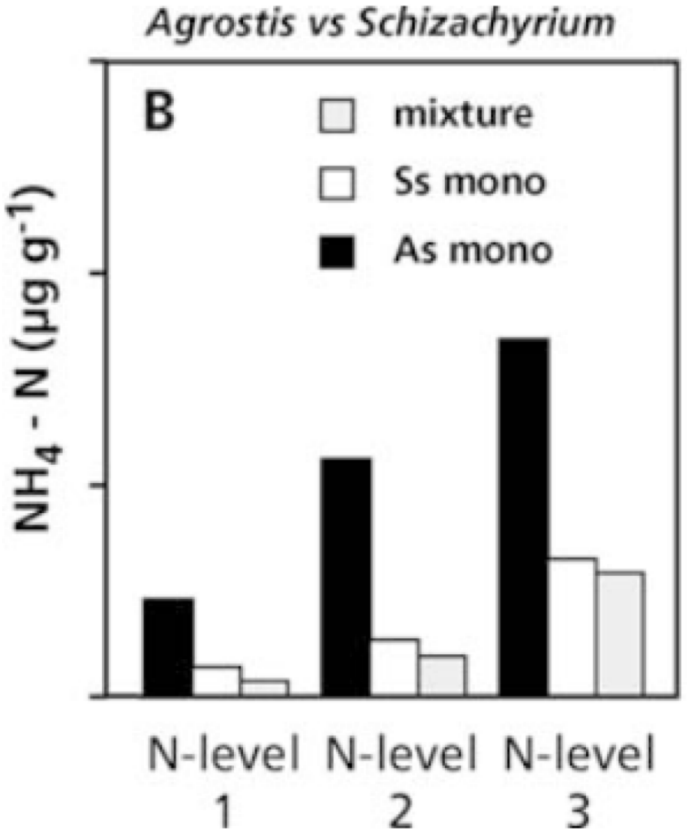
Nutrient stress promotes root competition,
increasing root biomass allocation

Traits: nutrient competition



Nutrient stress promotes root competition,
favoring low growth rate species

Traits: nutrient competition



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

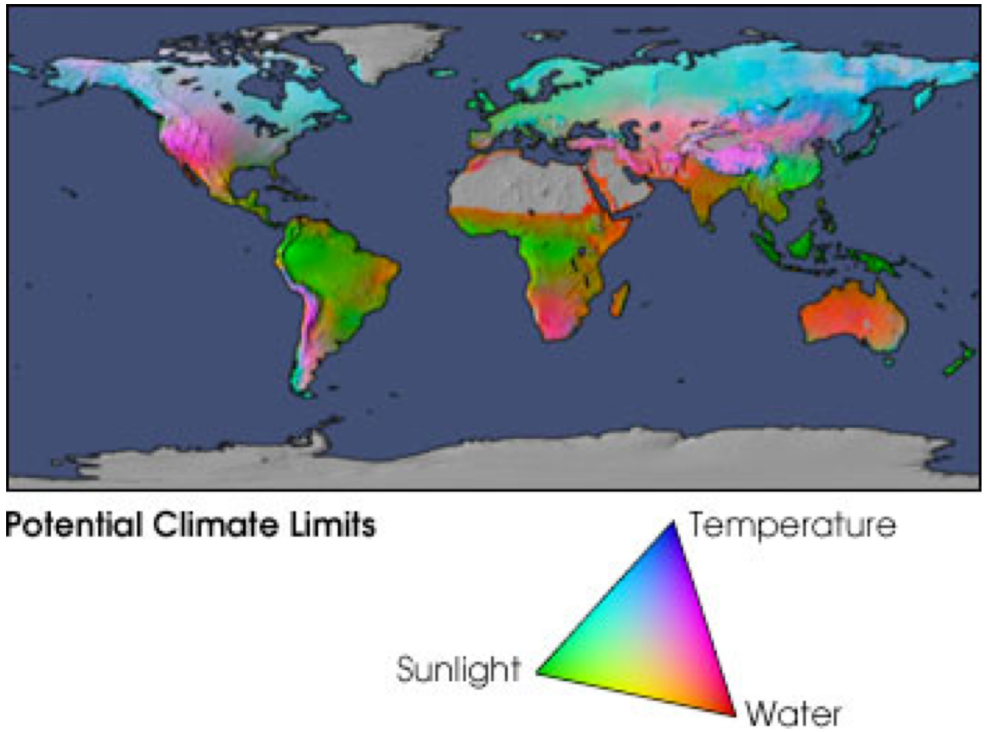
Nutrient stress promotes root competition,
favoring low growth rate species

Traits: water competition

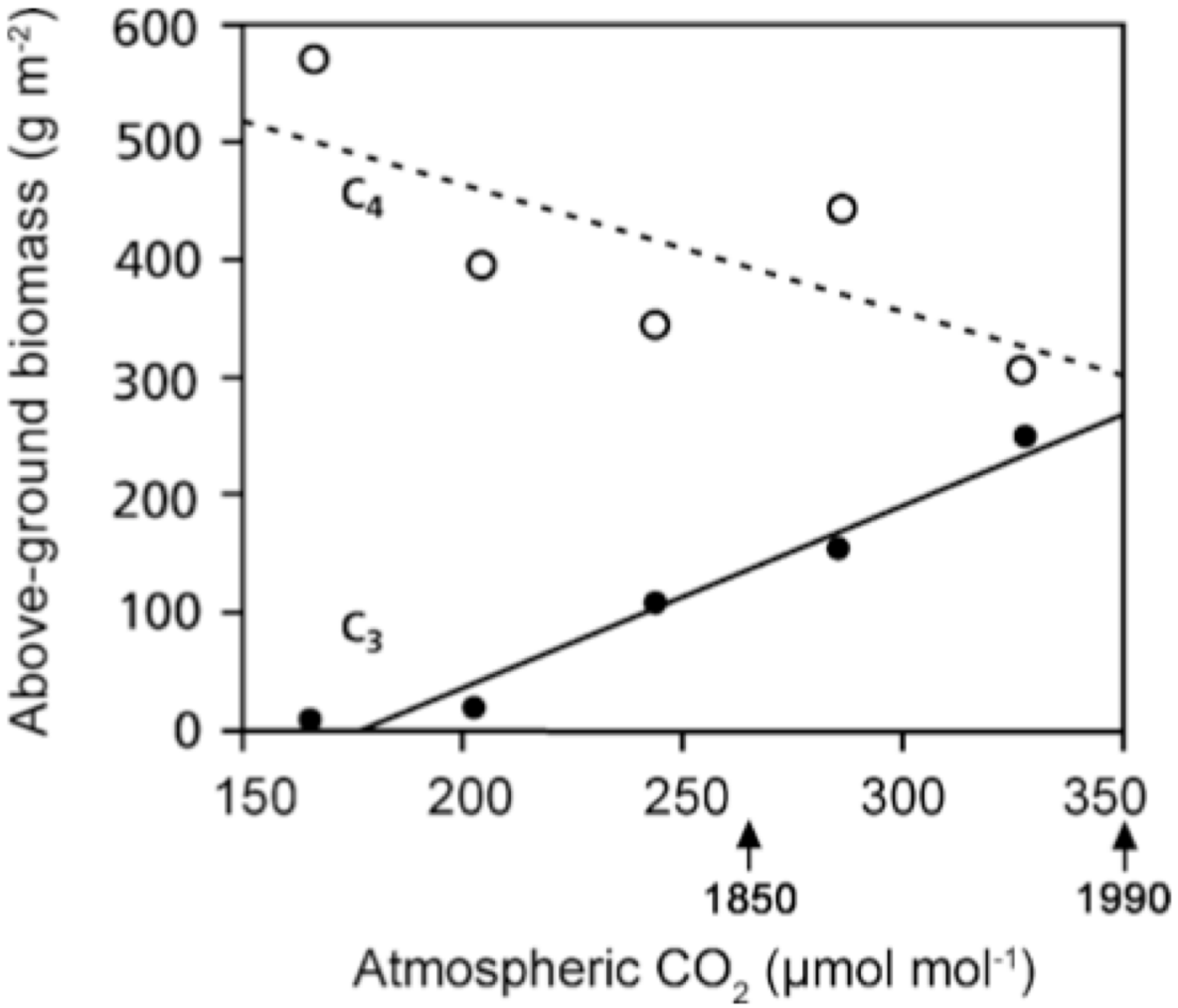
- Toleration of soil low water potential
  - Similar to R* for nutrients?
- Desiccation resistance
  - E.g., CAM and C4 photosynthesis
- Desiccation avoidance
  - Phenology

Traits: light competition

- Light competition only occurs when belowground resources are plentiful



Traits: CO_2 competition



Competitive strategies

r-K continuum

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

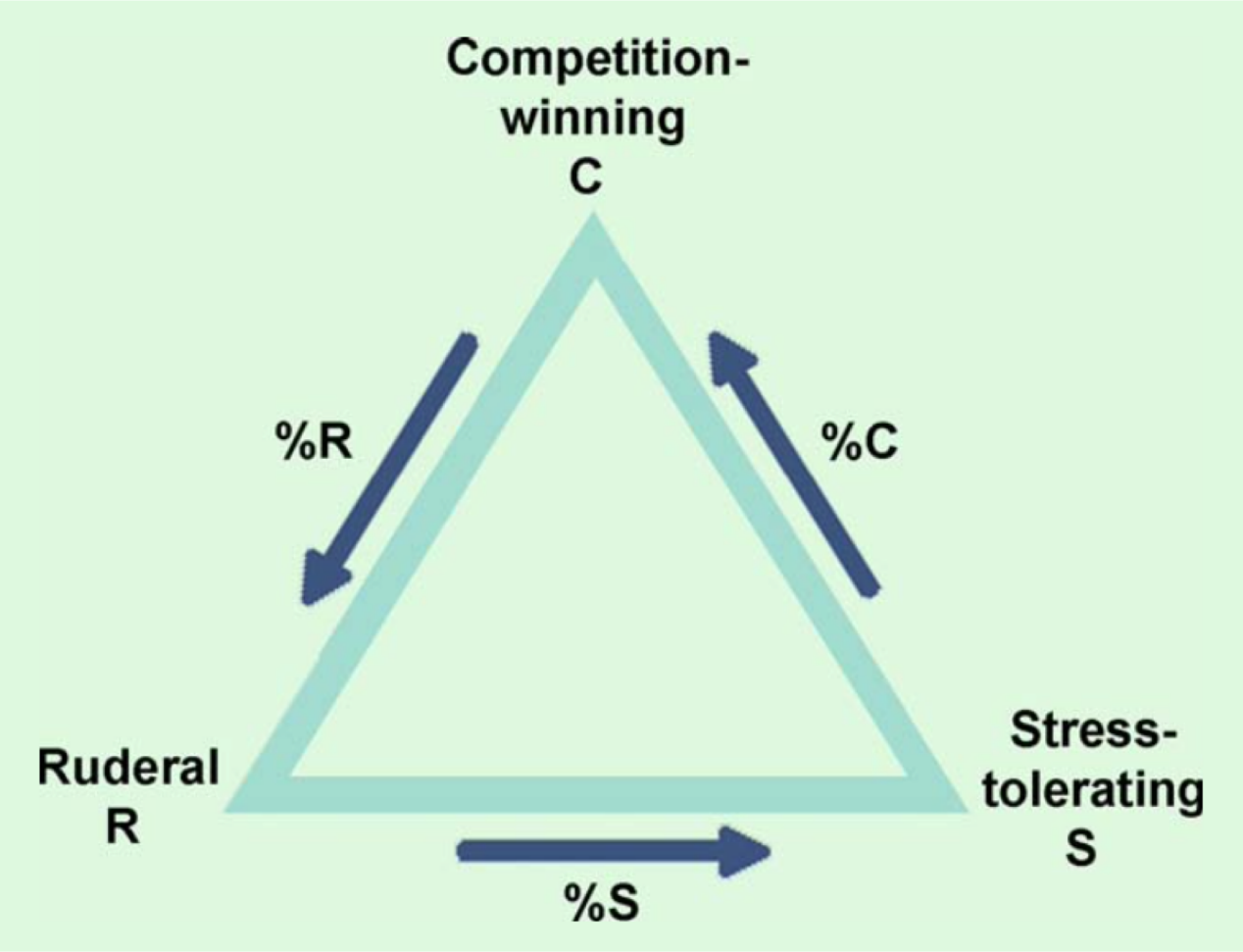
N = population size
t = time
r = population growth rate
K = carrying capacity

r-K continuum

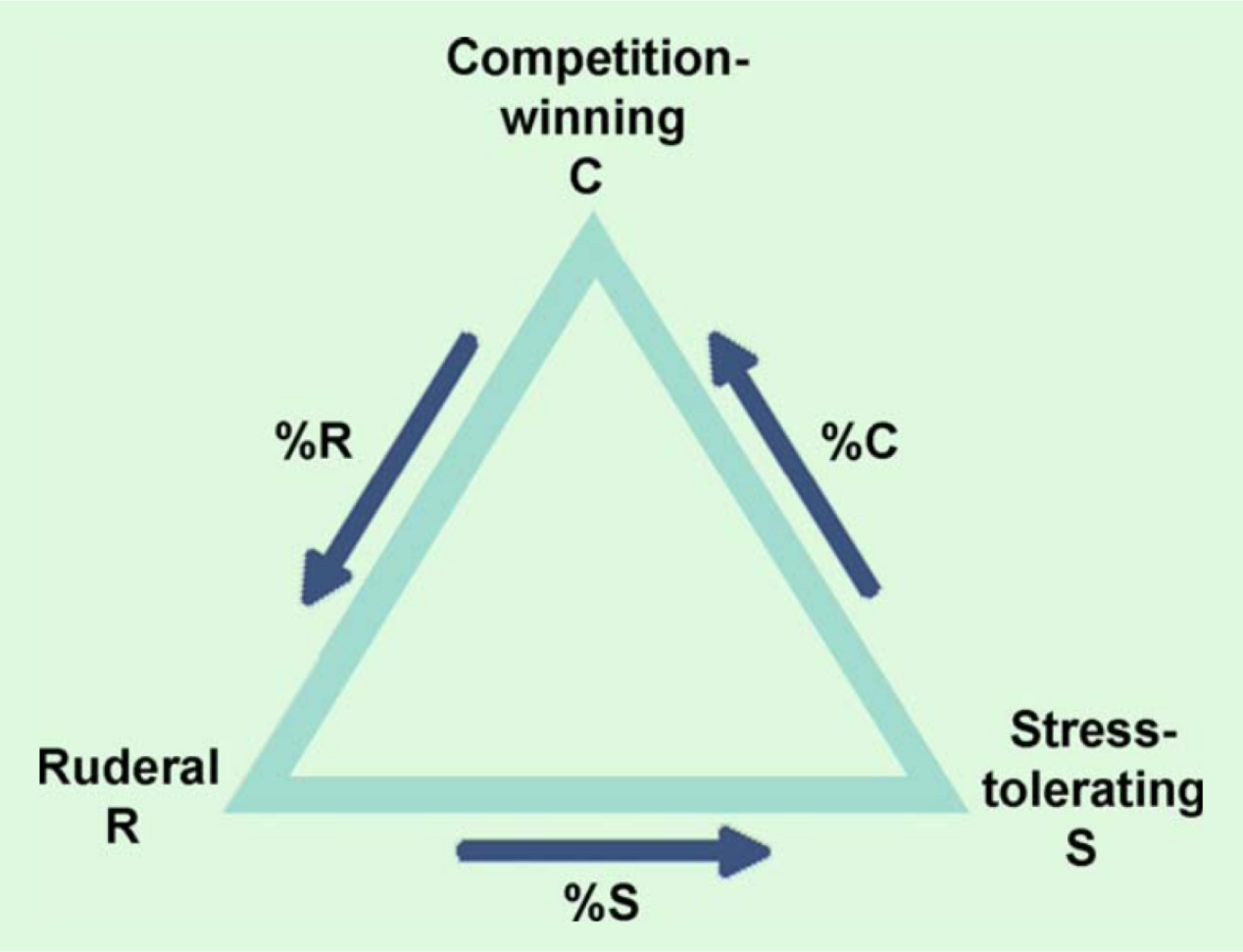
Where would r species dominate?

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		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	Overgrown by competitors	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

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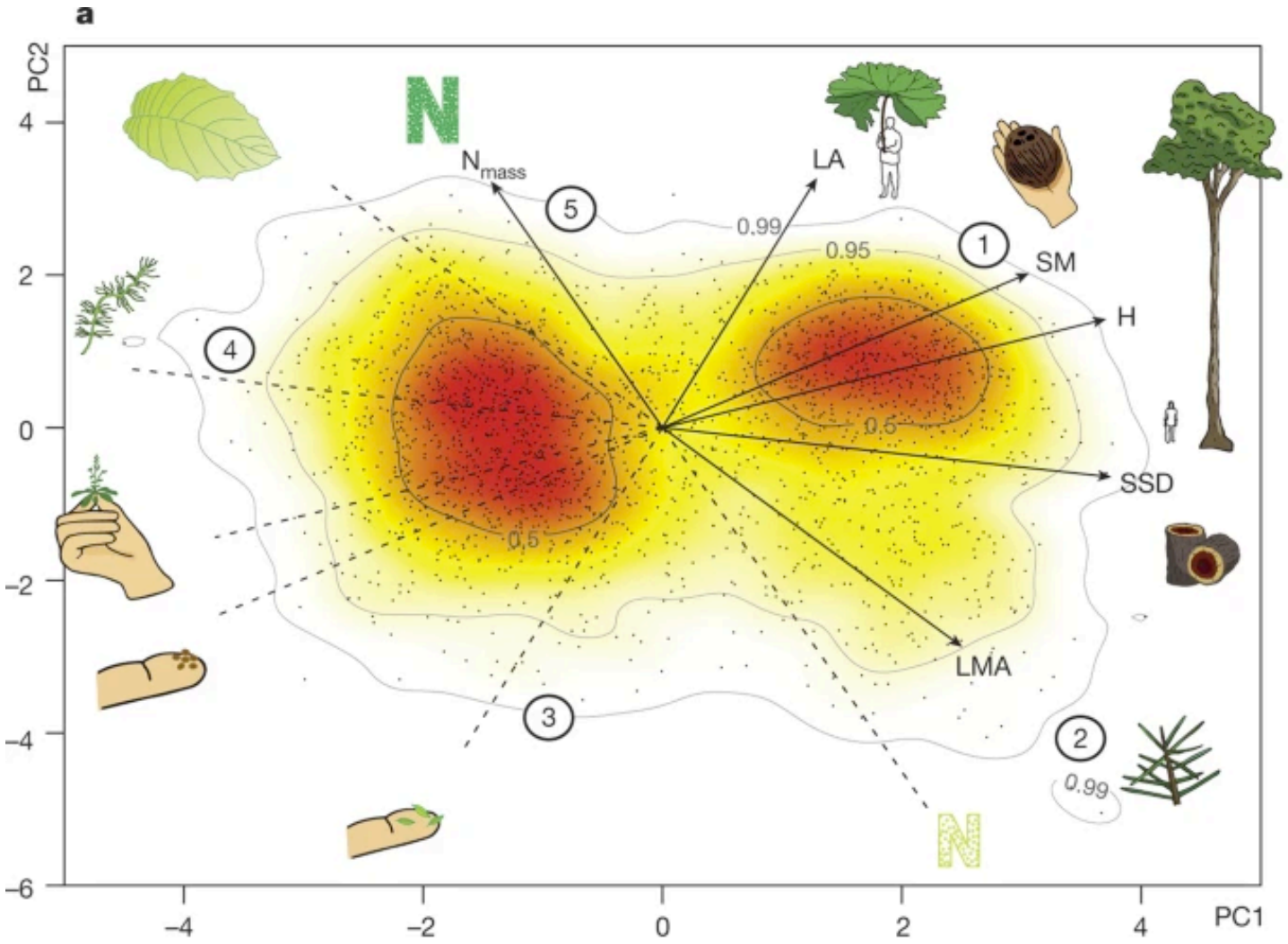

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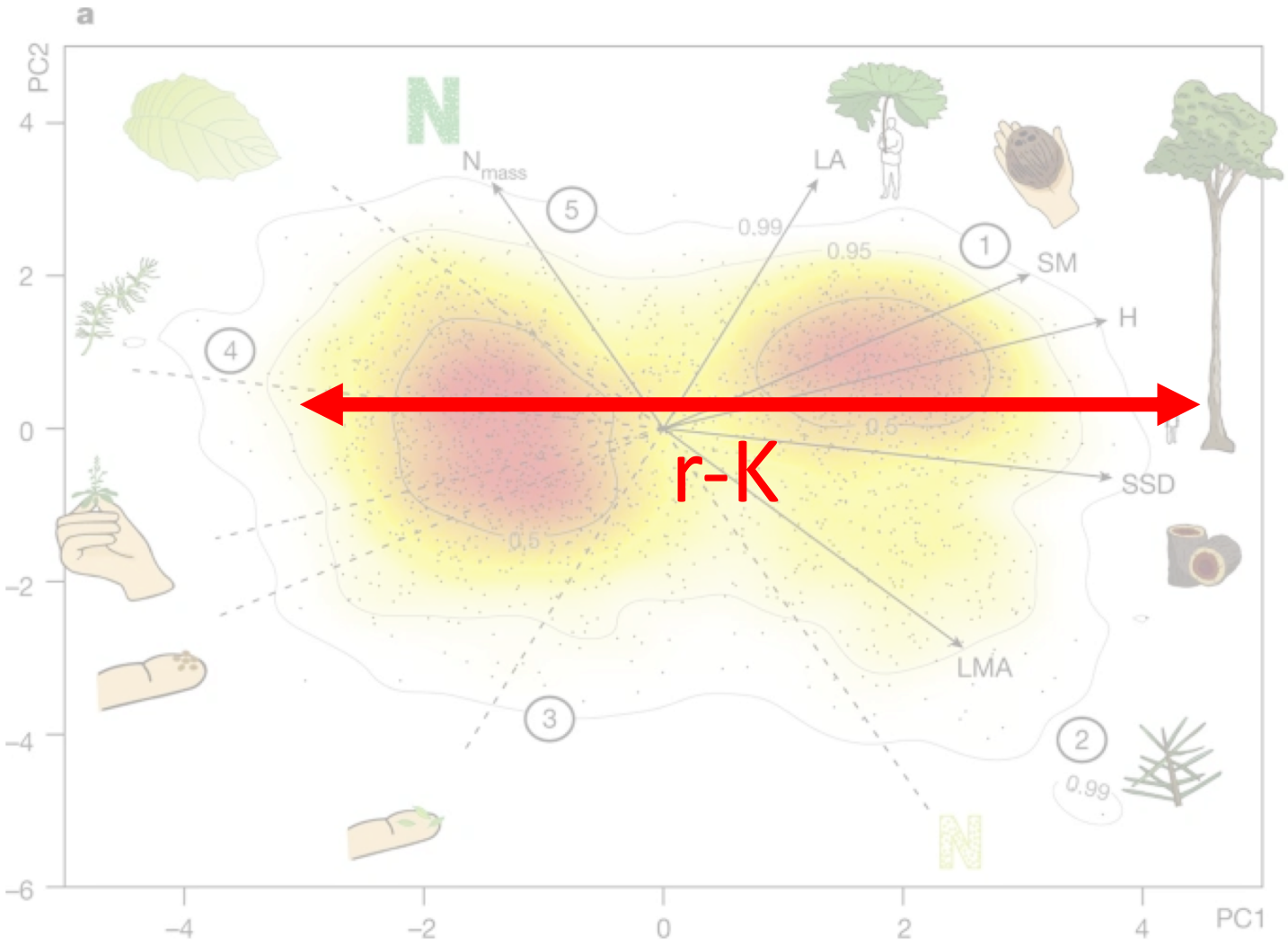

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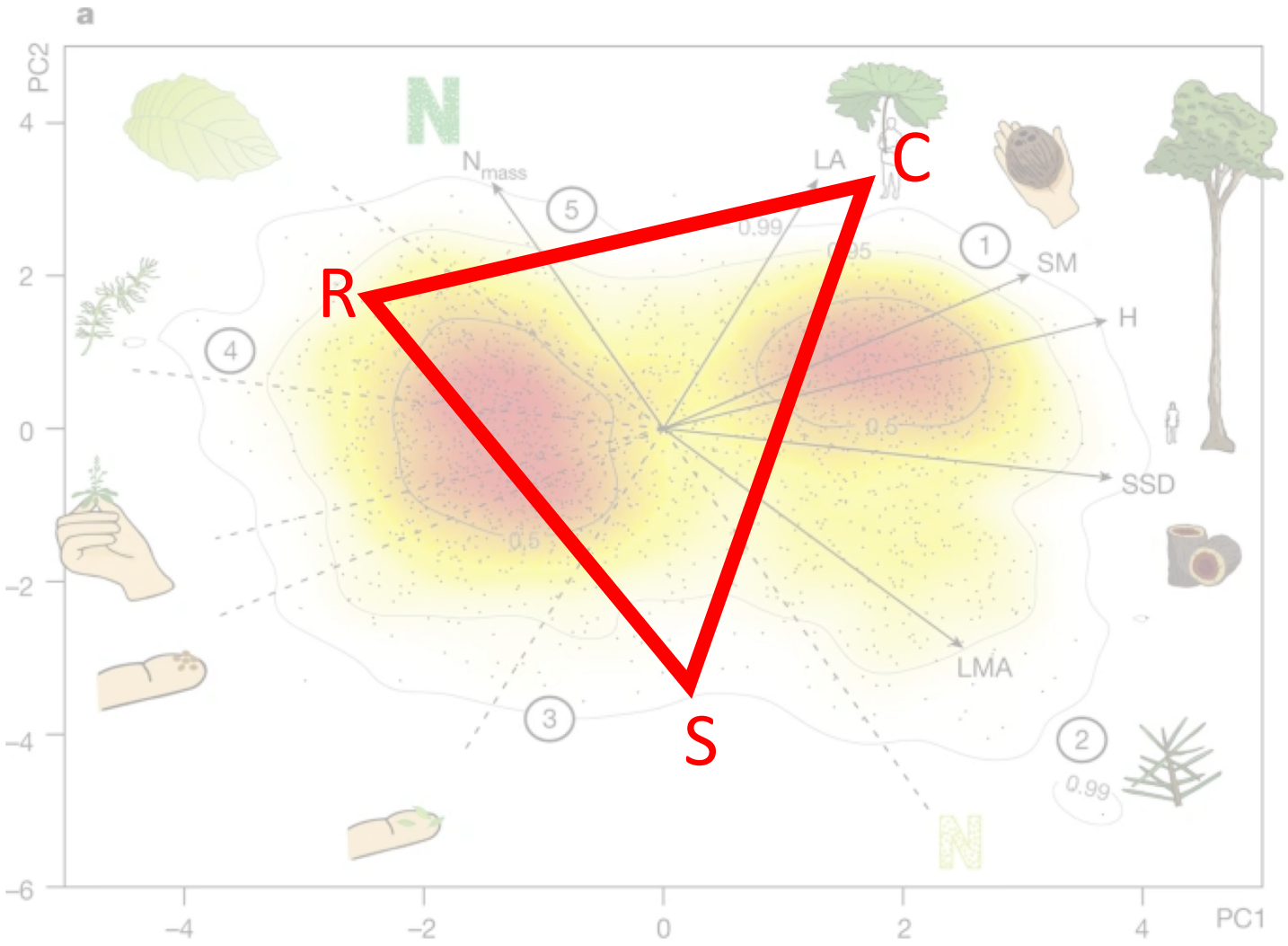

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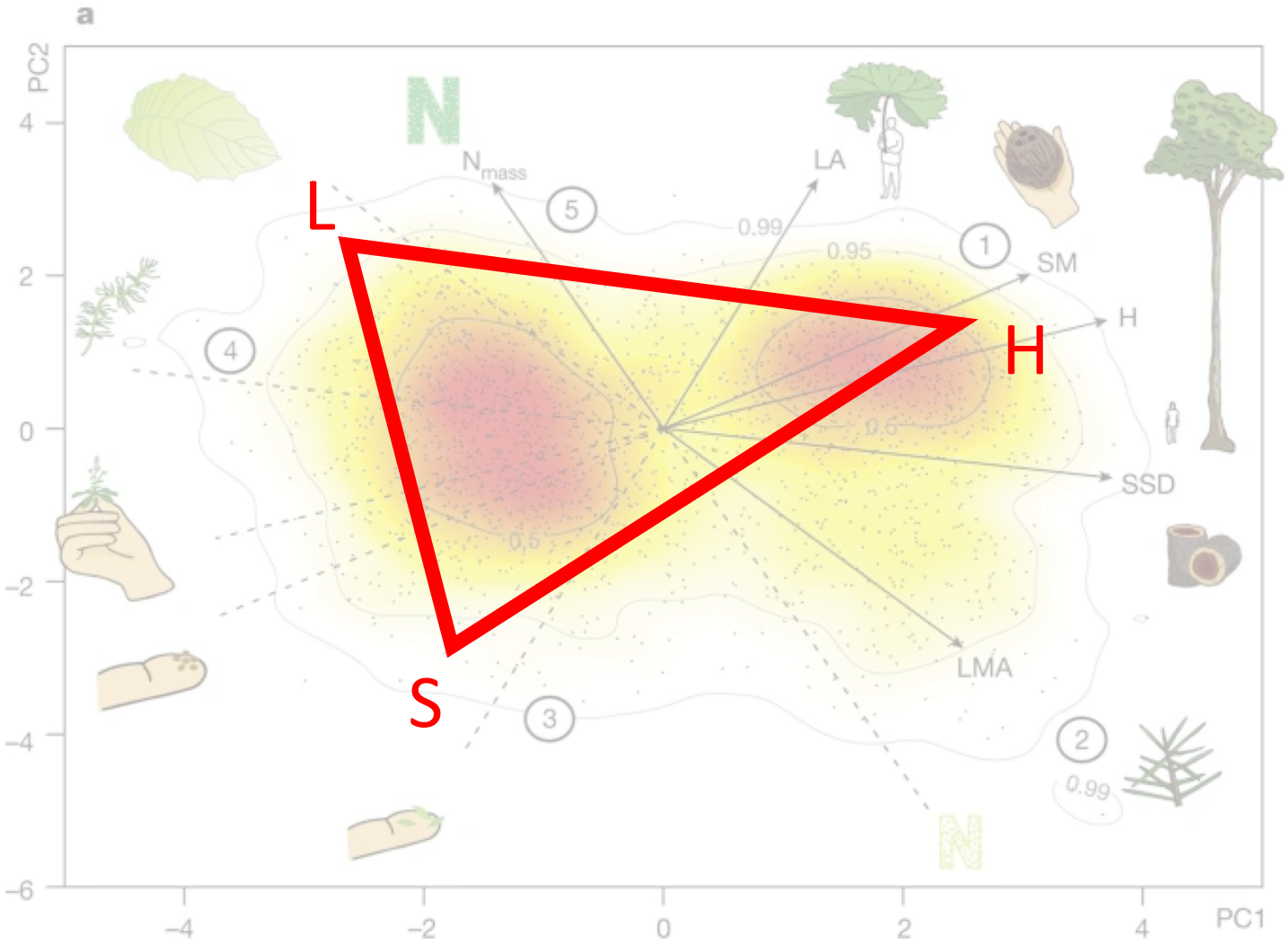

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