



Life Cycles & Phenology

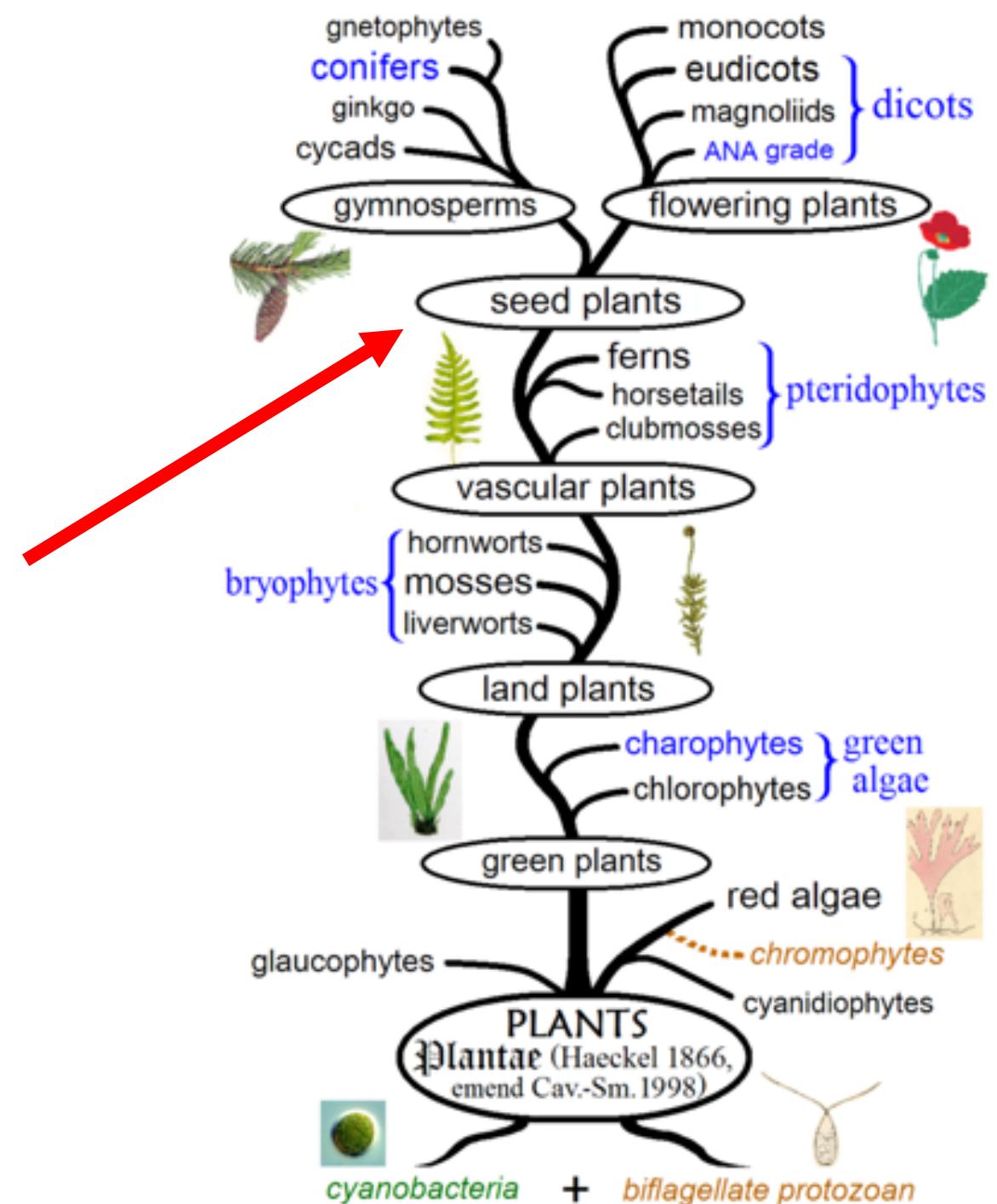
March 30, 2021

Life cycles

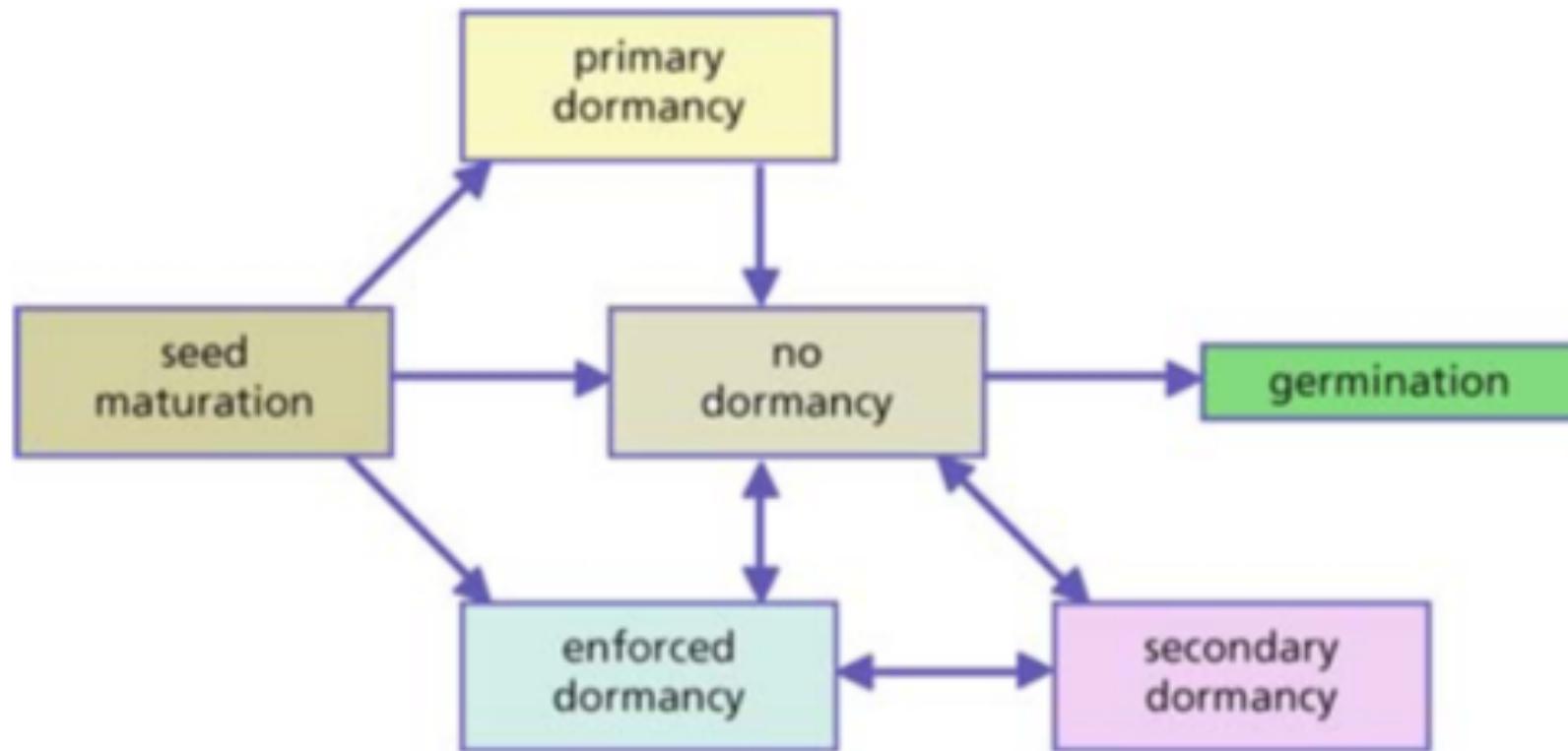


Seeds and germination

Not all plants have seeds! What's the benefit?



Dormancy - not all seeds germinate immediately



Two primary benefits of dormancy

1. Avoid poor growth conditions
2. Avoid competition

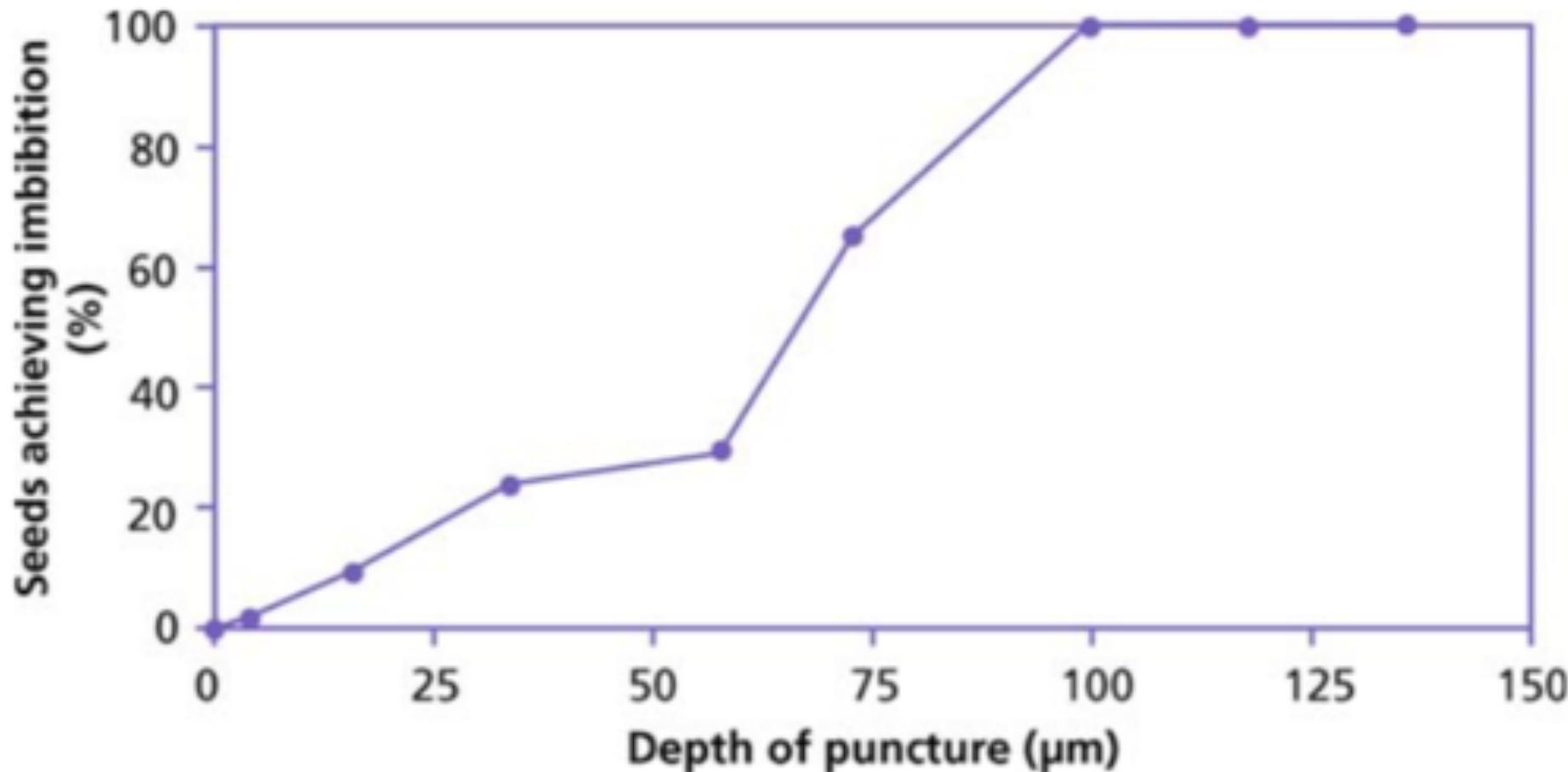
Two primary benefits of dormancy

1. Avoid poor growth conditions
2. Avoid competition

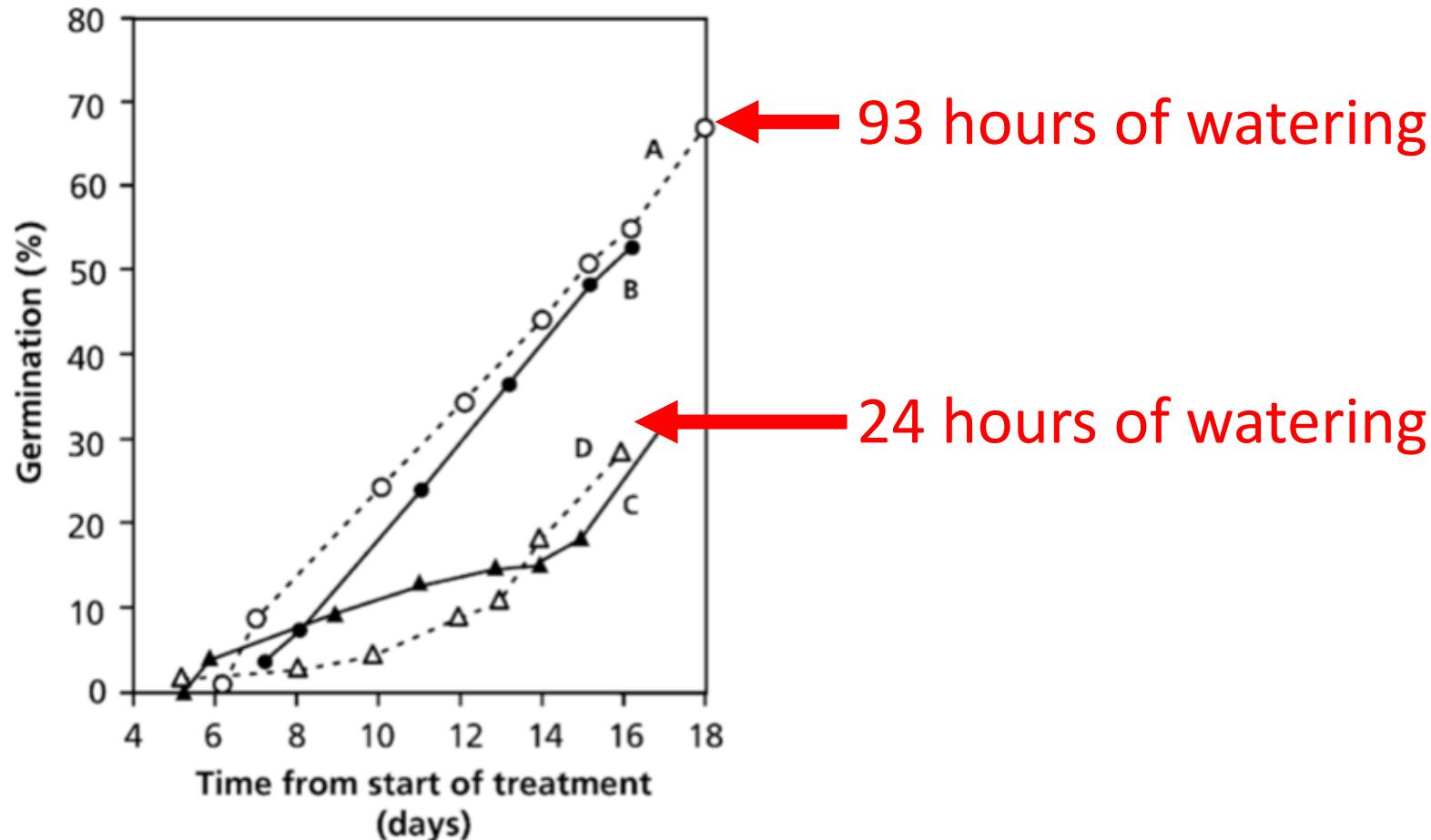
Knowing this, what would be the important cues to respond to? (Let's make a list)

Environmental cues

Water – some plants will only imbibe after seed coat is worn down



Water soluble inhibitors can also prevent germination during dry times



Light influences germination in 3 ways

1. A total light requirement
2. Intensity and duration
3. Spectral compositions of light

Light influences germination in 3 ways

1. A total light requirement

- Avoid being buried too deep in the soil (fatal germination)
- When soil is turned over, seeds emerge

2. Intensity and duration

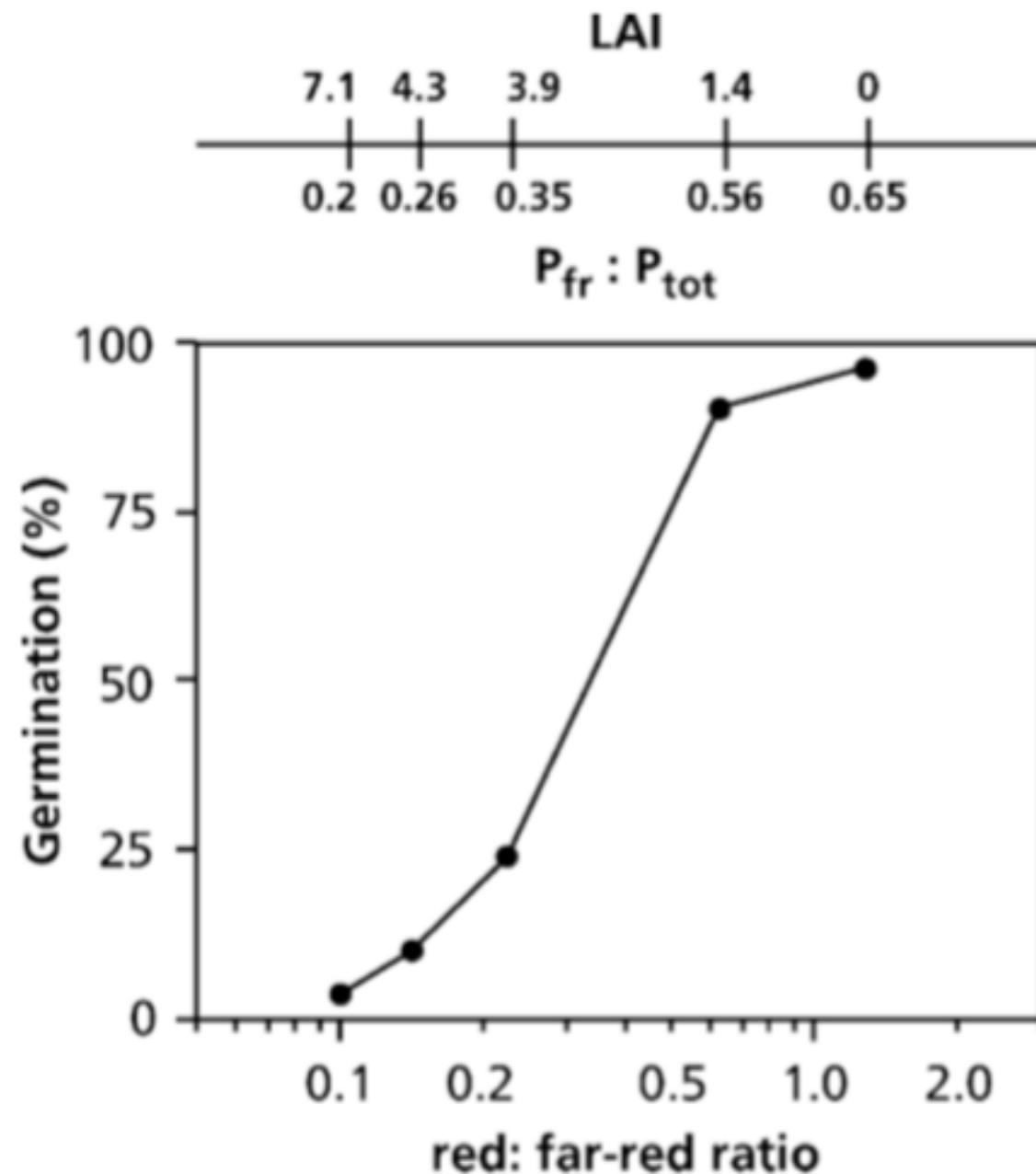
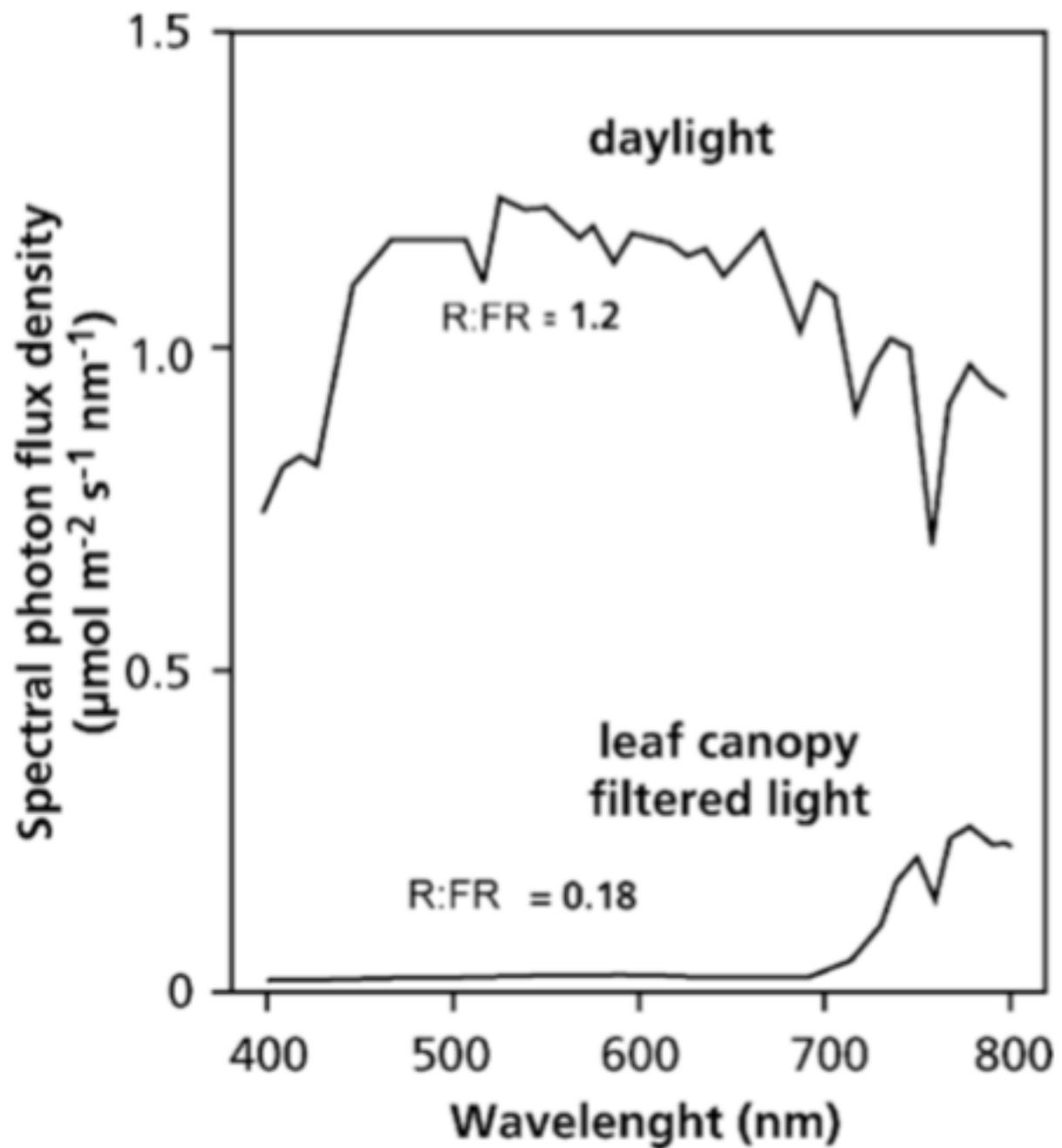
3. Spectral compositions of light

Light influences germination in 3 ways

1. A total light requirement
2. Intensity and duration
 - Take advantage of disturbance
3. Spectral compositions of light

Light influences germination in 3 ways

1. A total light requirement
2. Intensity and duration
3. Spectral compositions of light
 - Plants can sense what is happening above them!



Temperature influences dormancy in two ways

1. Absolute temperature
2. Temperature fluctuations

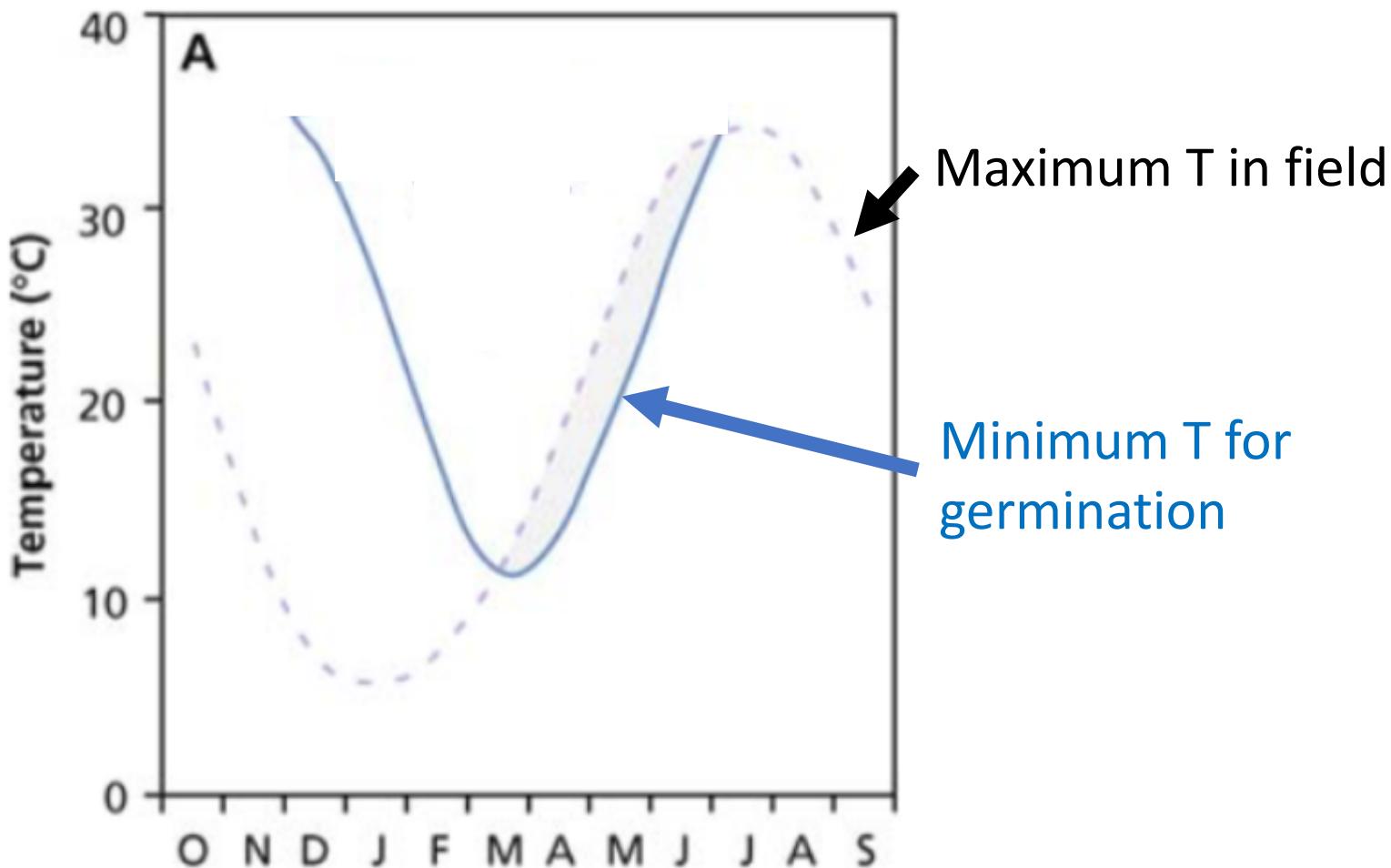
Temperature influences dormancy in two ways

1. Absolute temperature

- Cue to germinate at optimal time in season

2. Temperature fluctuations

Summer Annual

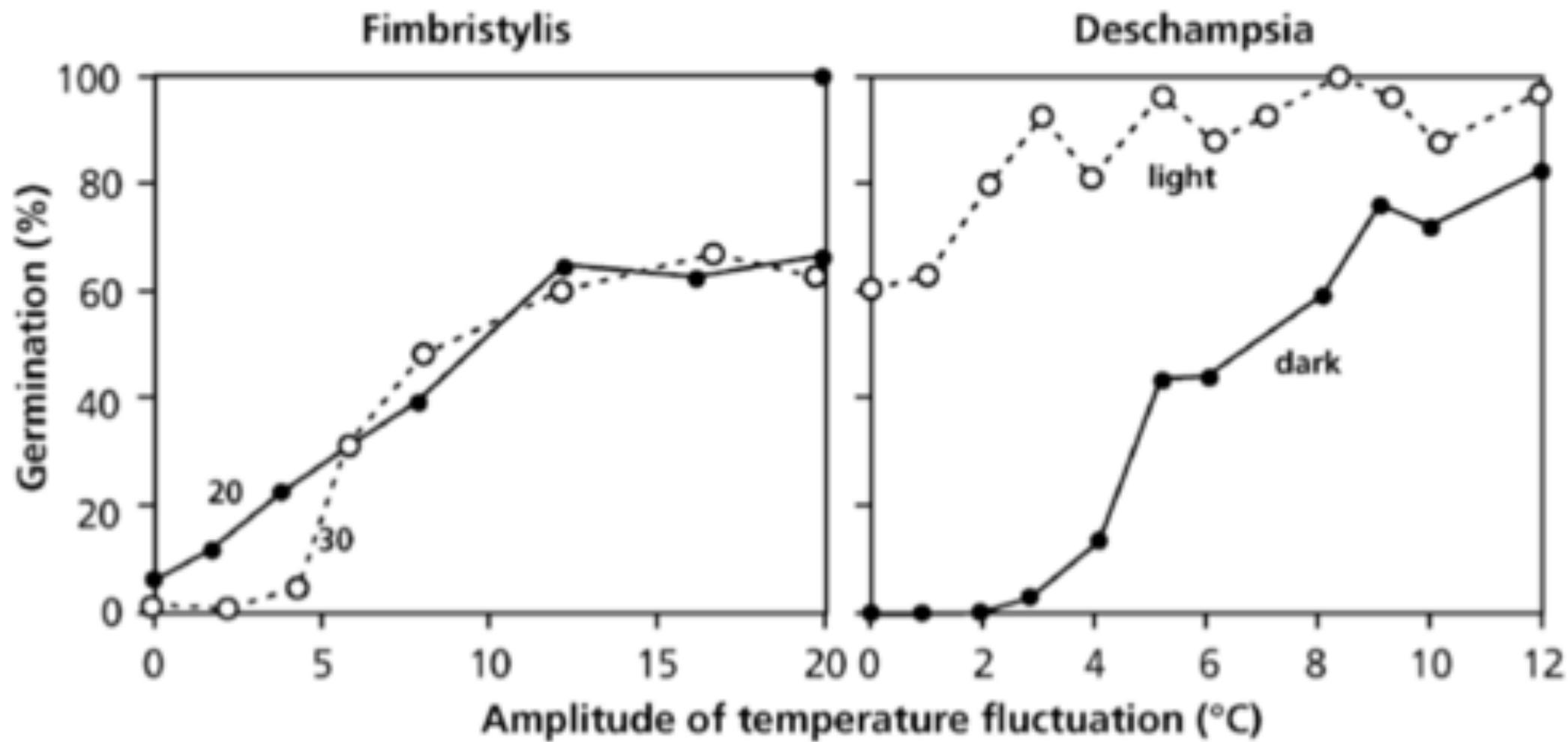


Temperature influences dormancy in two ways

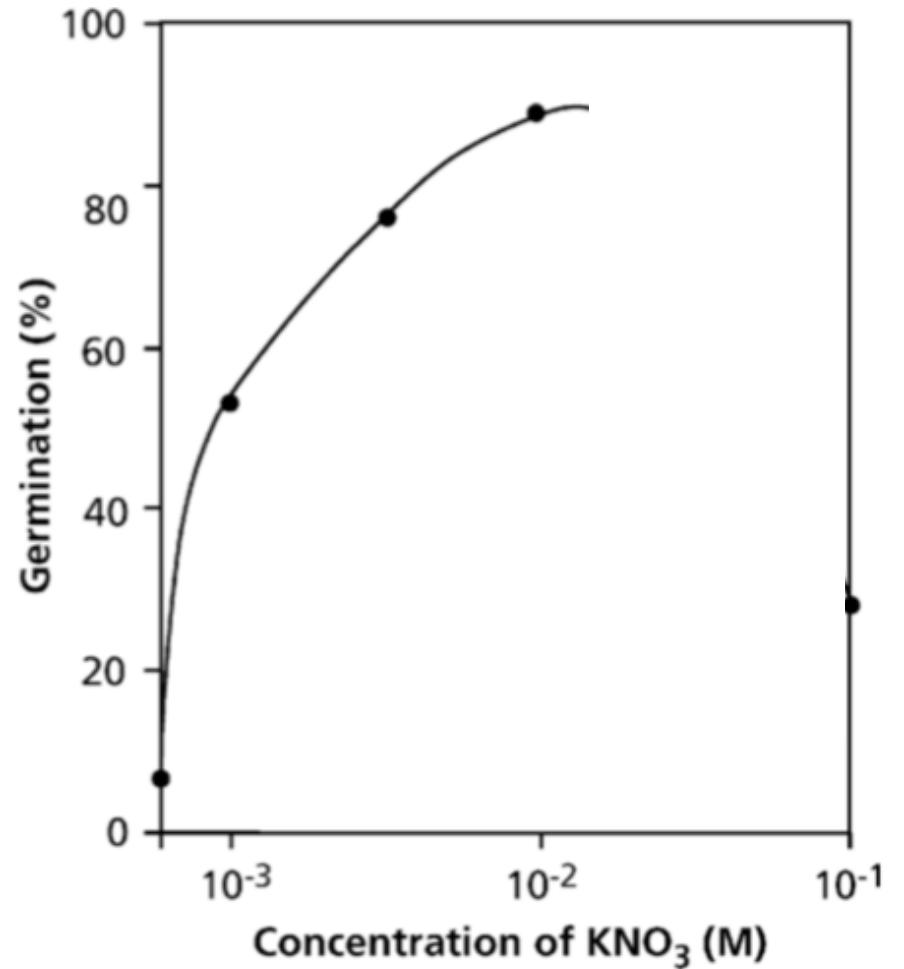
1. Absolute temperature

2. Temperature fluctuations

- Mechanism to sense soil depth

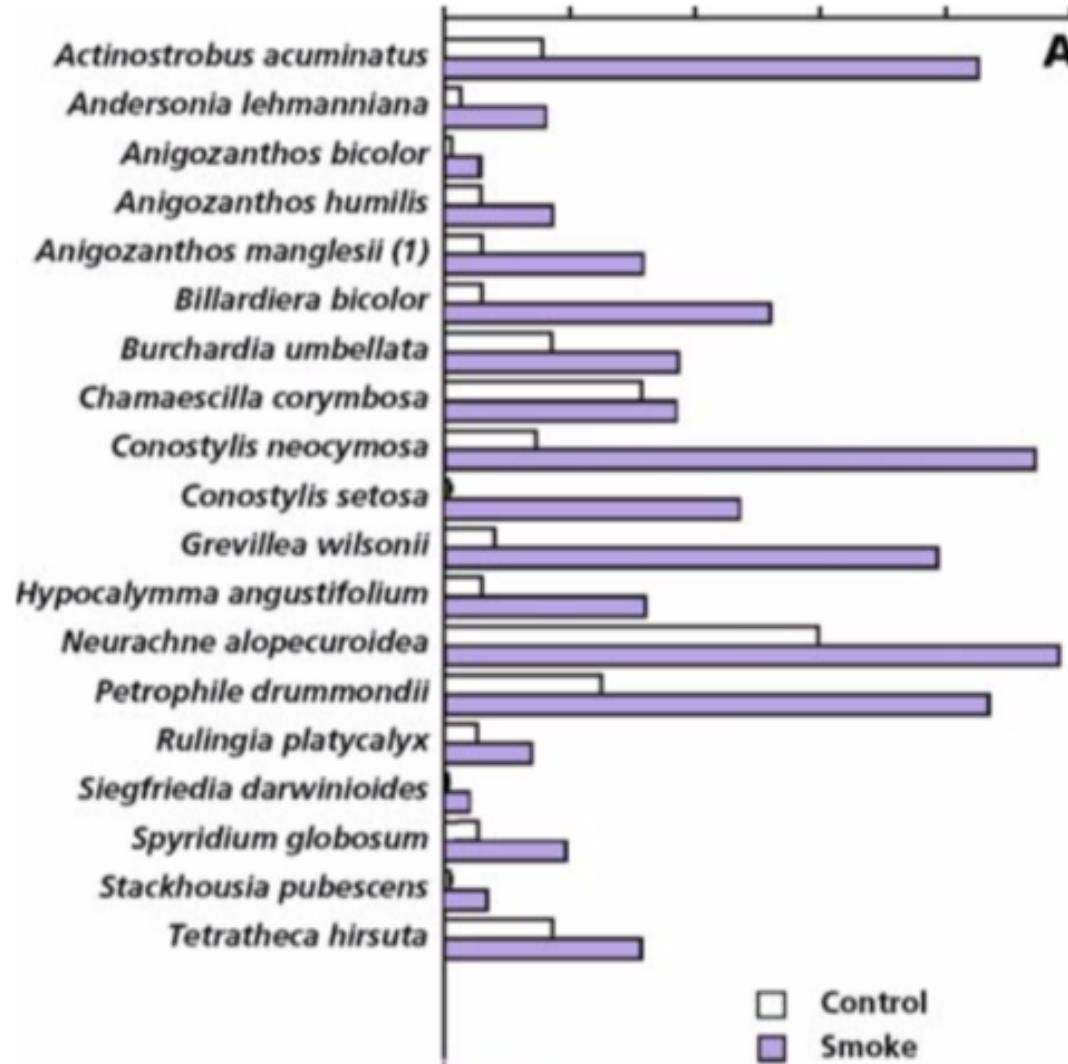


Presence of nitrate can signal competition



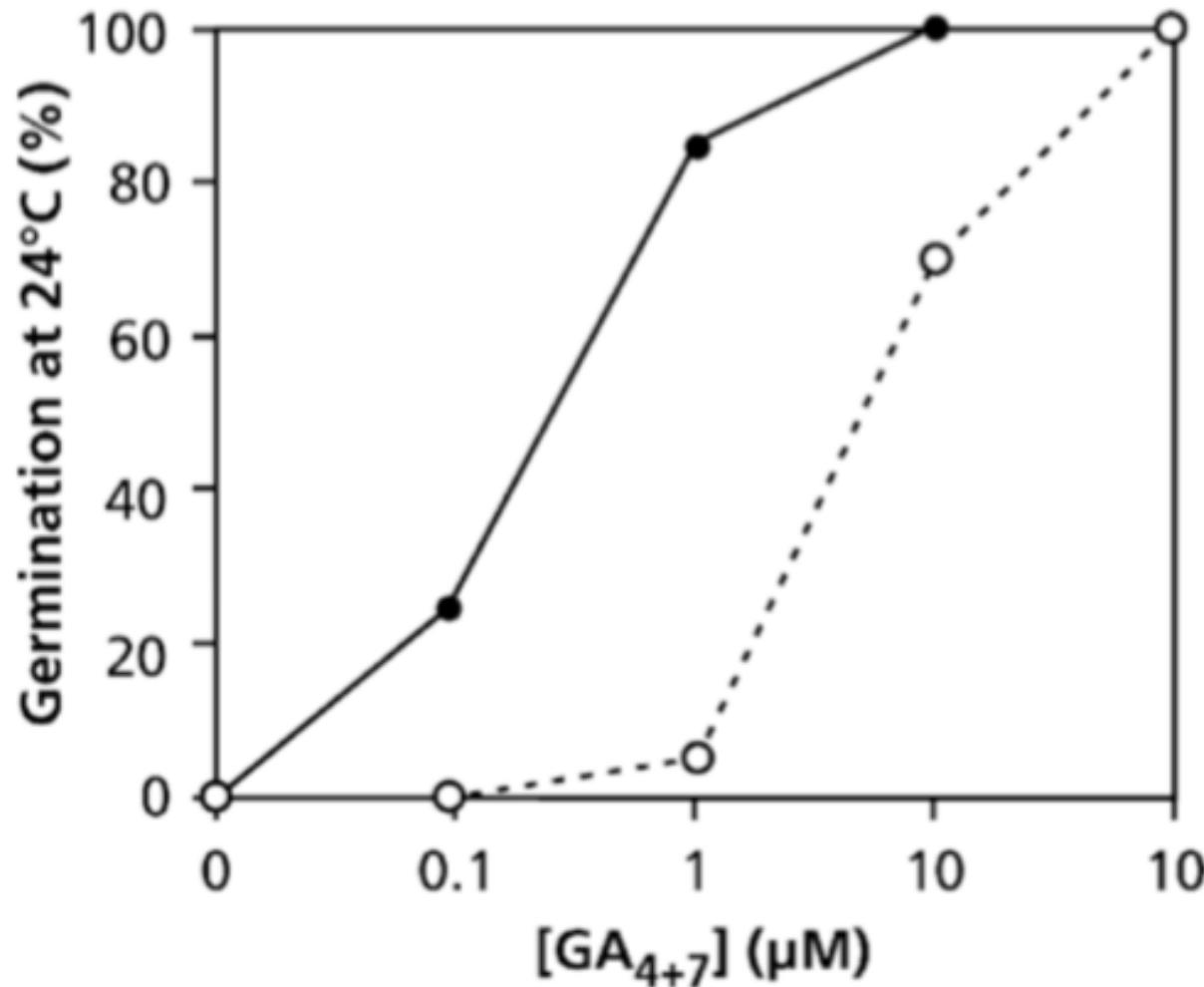
More NO_3^- = less competition

Smoke can also enhance germination



Mechanism for dormancy release

Dormancy release signals: an increase in the ratio of gibberrellic acid (GA) to abscisic acid (ABA)



Summary

TABLE 1. A summary of the possible ecological significance of environmental factors involved in breaking seed dormancy.

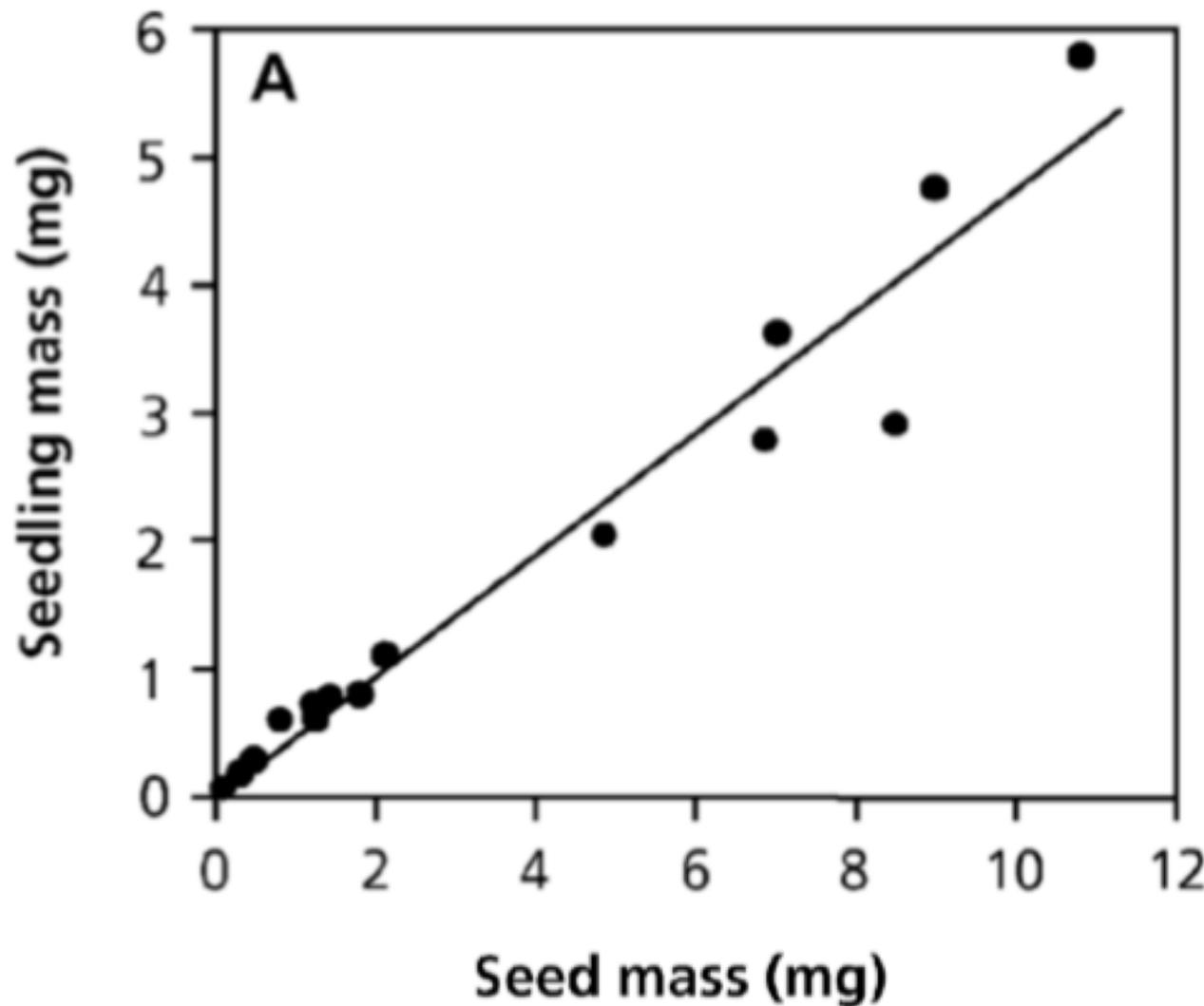
Environmental factor	Ecological role
Light	Gap detection Sensing depth in soil
Diurnal temperature fluctuation	Increasing longevity in seed bank Gap detection Sensing depth in soil and water
Nitrate	Gap detection Nutrient availability
Rain event in desert	Detection of water availability
Smoke	Response to fire
High temperature	Response to fire
Seasonal temperature regime	Detection of suitable season Increasing longevity in soil
Time	Avoidance of unsuitable season Spreading risks in time

Seedling/juvenile phase

Being a seedling is tough

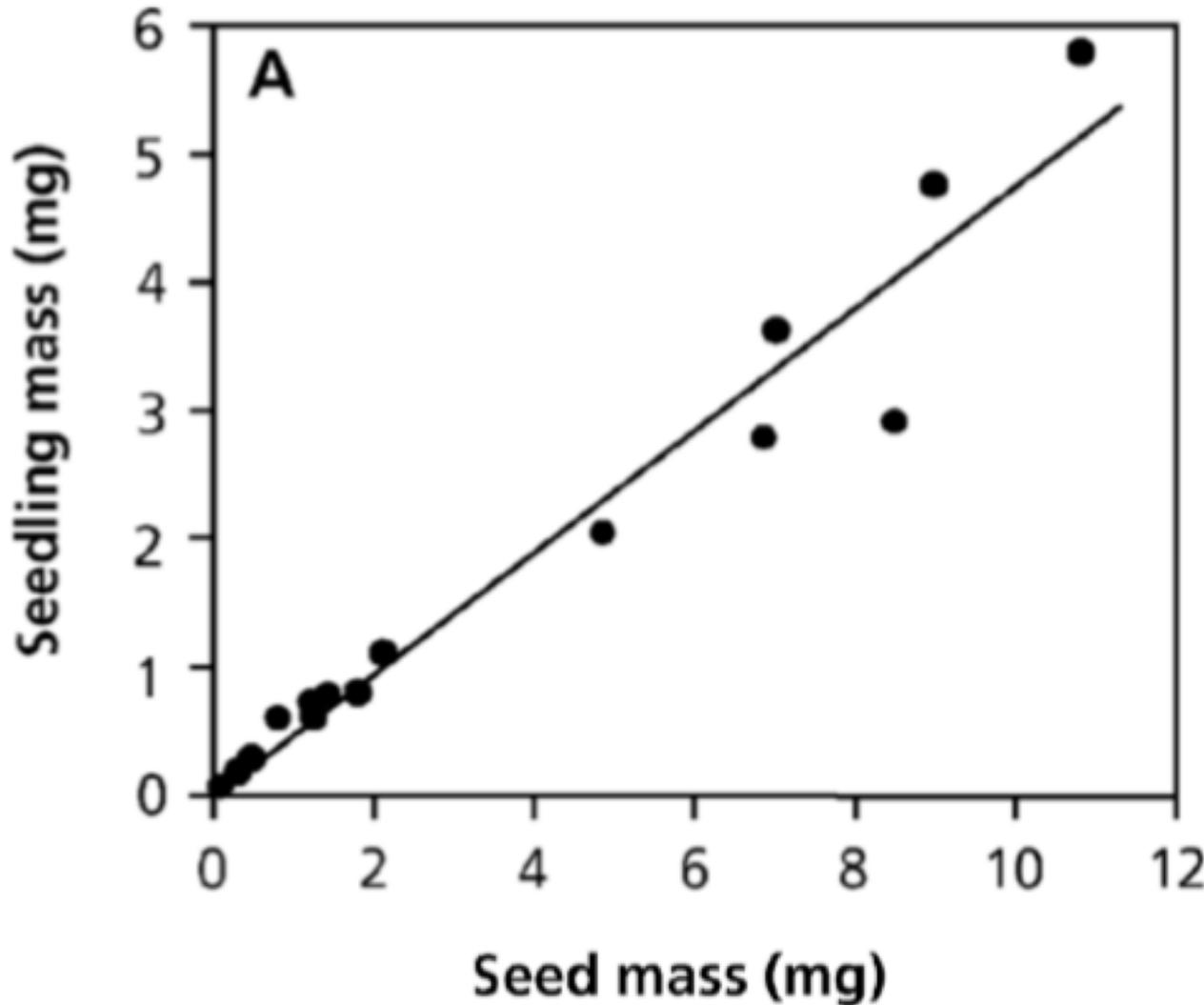
- Low light
- Prone to desiccation
- Resources determined by seed size

Seed size trade-offs

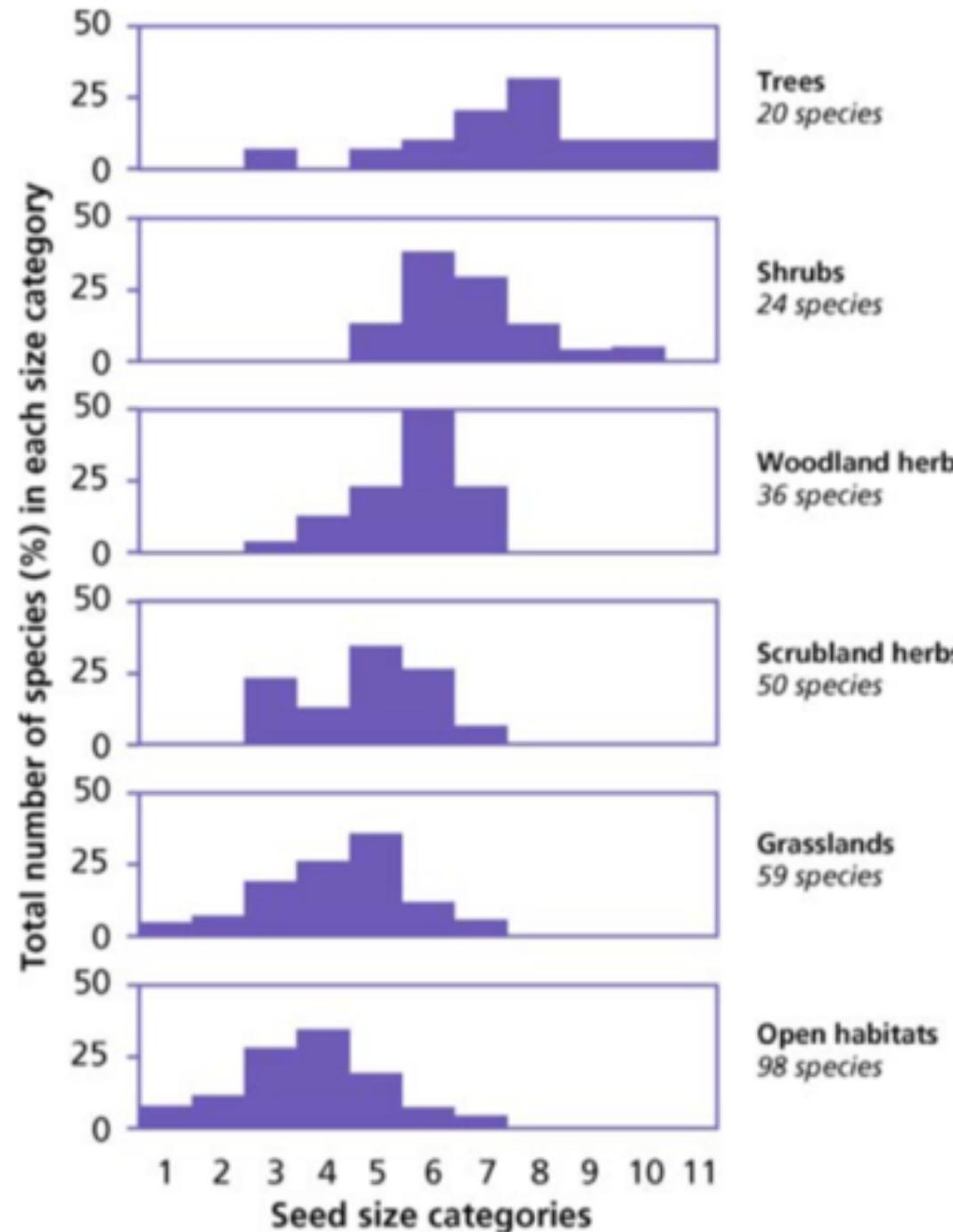


Bigger seeds = bigger seedlings

Seed size trade-offs



What's the tradeoff??



Reproductive phase

Cost of reproduction

- Flowering and fruiting: up to 30% of NPP
 - Median: 10%
- In some cases, can require large storage reserves
- Trade-off between vegetative and reproductive growth

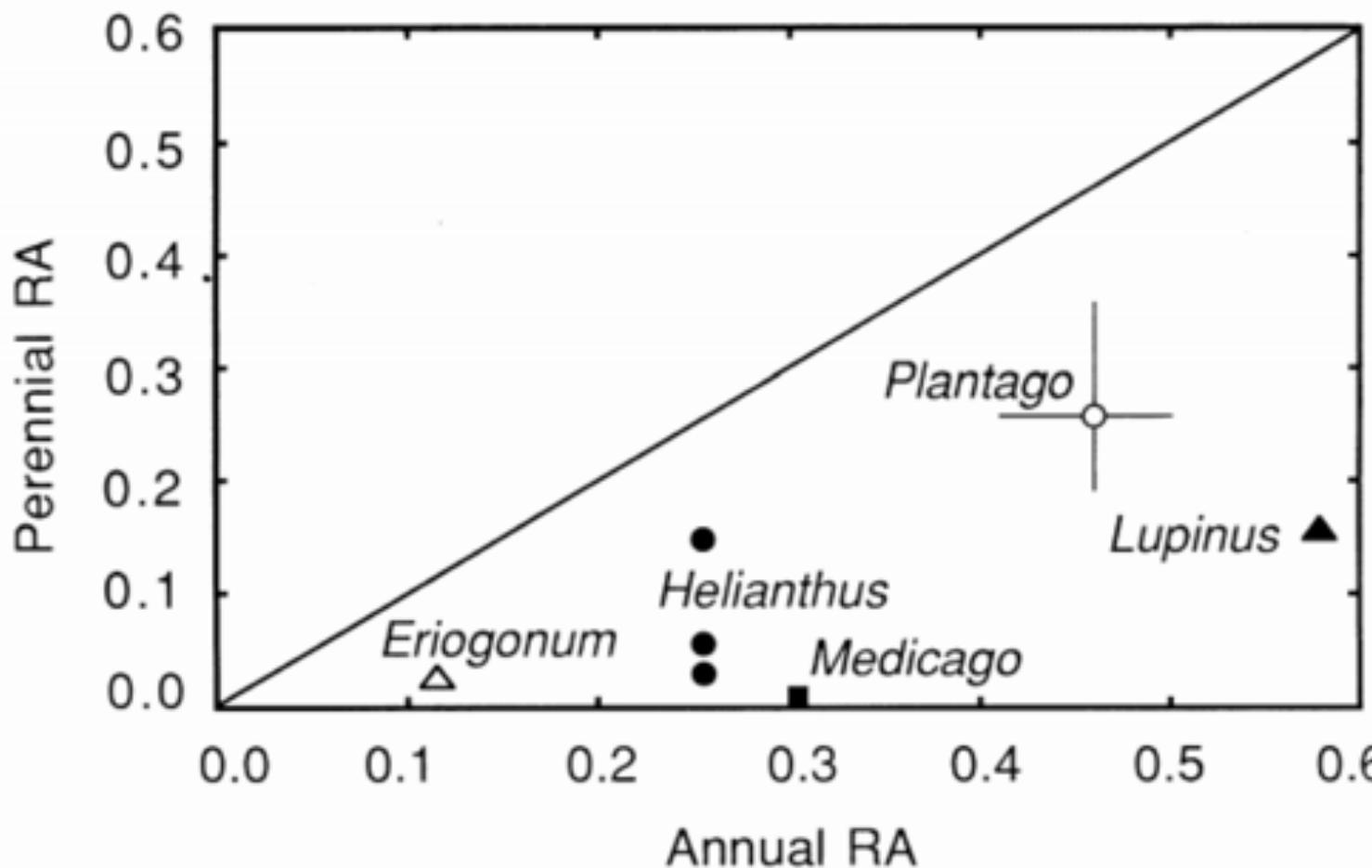


Figure 2. Relative reproductive allocation (RA) in congeneric or conspecific annuals and perennials. For *Lupinus*, *Medicago*, *Helianthus*, and *Eriogonum* the data are in units reproductive dry mass/total dry mass. For *Plantago*, the data are in units mg seeds/ 2 cm^2 leaf area. The *Lupinus* data are two-year means of naturally growing plants (one annual, one perennial species) (Pitelka 1977). The *Helianthus* data represent one annual and three perennial species (Gaines et al. 1974). The *Medicago* data represent one annual and one perennial species (Turkington and Cavers 1978). The *Plantago* data represent the mean and range of four perennial species and nine annual species (Primack 1979). The *Eriogonum* data reflect the annual and perennial subspecies of *E. inflatum*. Source: Chiariello, unpublished data.

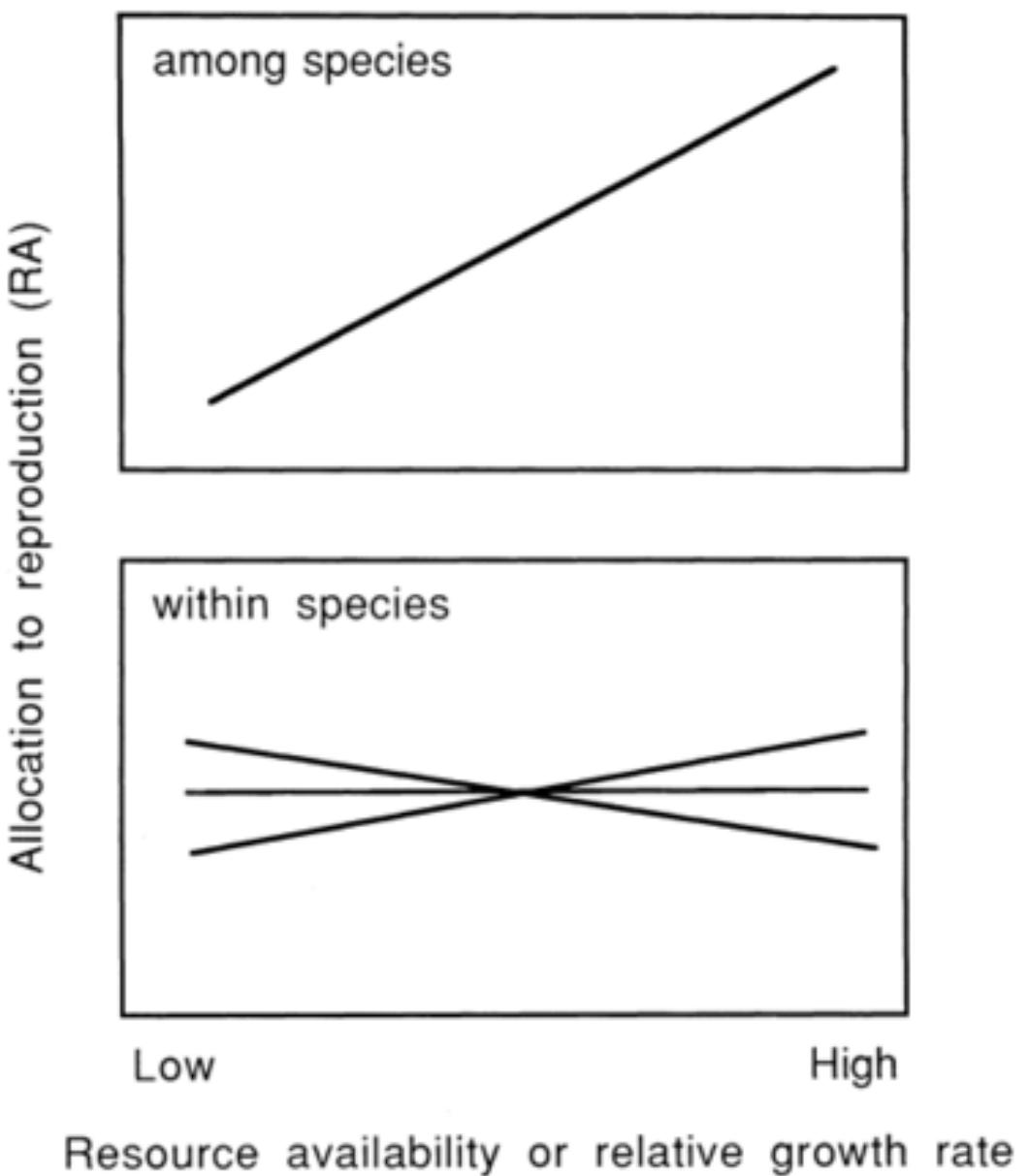


Figure 3. General trend in reproductive allocation (RA) among and within species as a function of resource availability, which we assume is related to plant relative growth rate. Among species, reproductive allocation increases with resource availability, partly because of the relationship between life history and habitat. Within species, reproductive allocation can increase or decrease with relative growth rate.

Generally the cost of female structures is greater than males structures

- Carbon allocation to female flowers can be 3x a male flower (Lambers book)
 - Nitrogen difference may be even greater

Some plants can reproduce vegetatively

- Carbon cost to reproduce sexually can be 10,000-fold greater than asexual reproduction in some places
- Why don't all plants reproduce asexually?



Larrea tridentata

Life cycle diversity

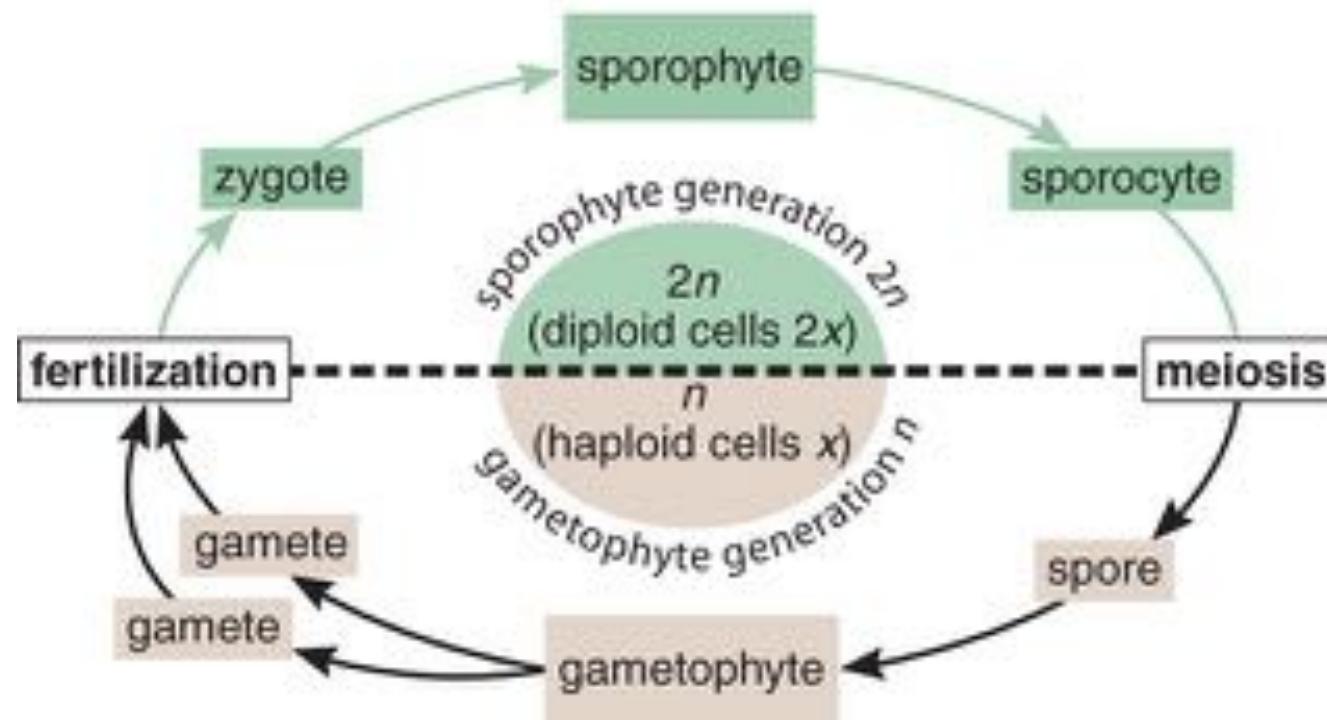
Timing of development

1. Annuals
2. Perennials
3. Bi-ennials

Where would you expect each to dominate?

Time spent as a gametophyte

- Bryophytes are gametophyte ($1n$) dominant
 - What's the advantage of sporophyte dominance?



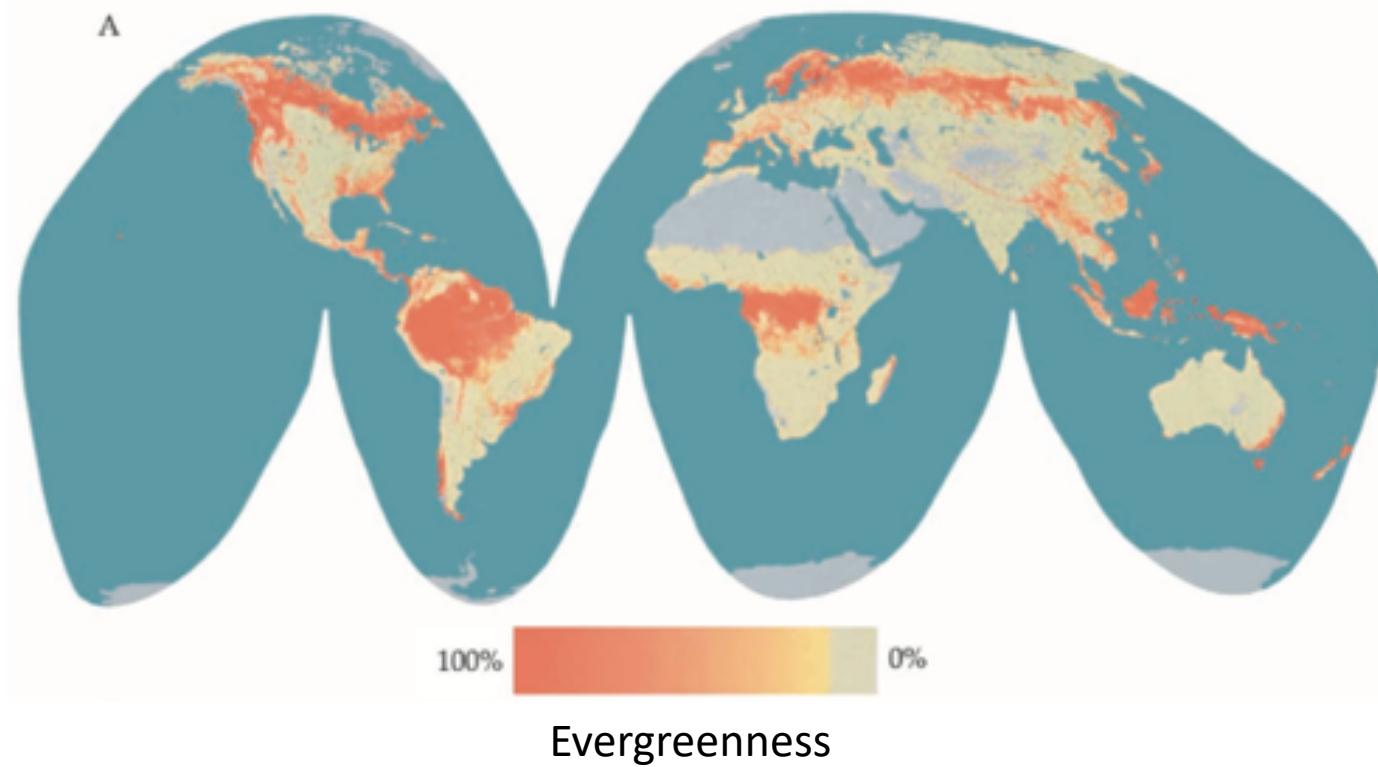
Phenology

What are the benefits of being
deciduous or evergreen?

What are the costs of being
deciduous or evergreen?

Bimodality of phenological strategies

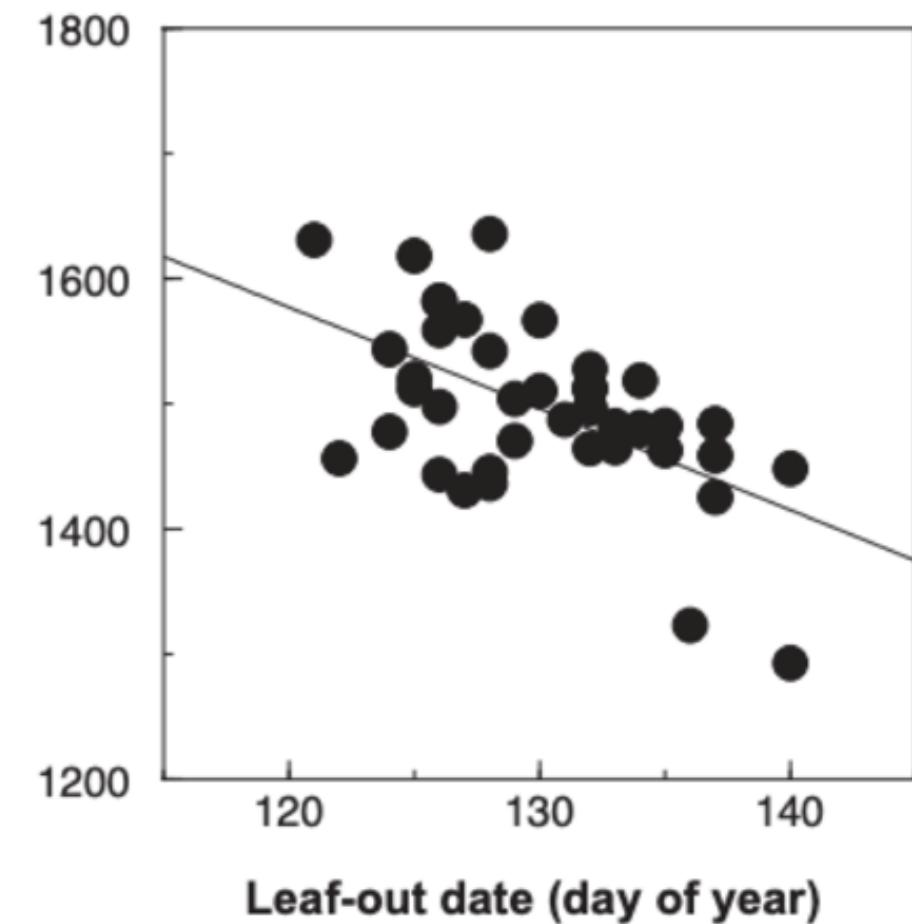
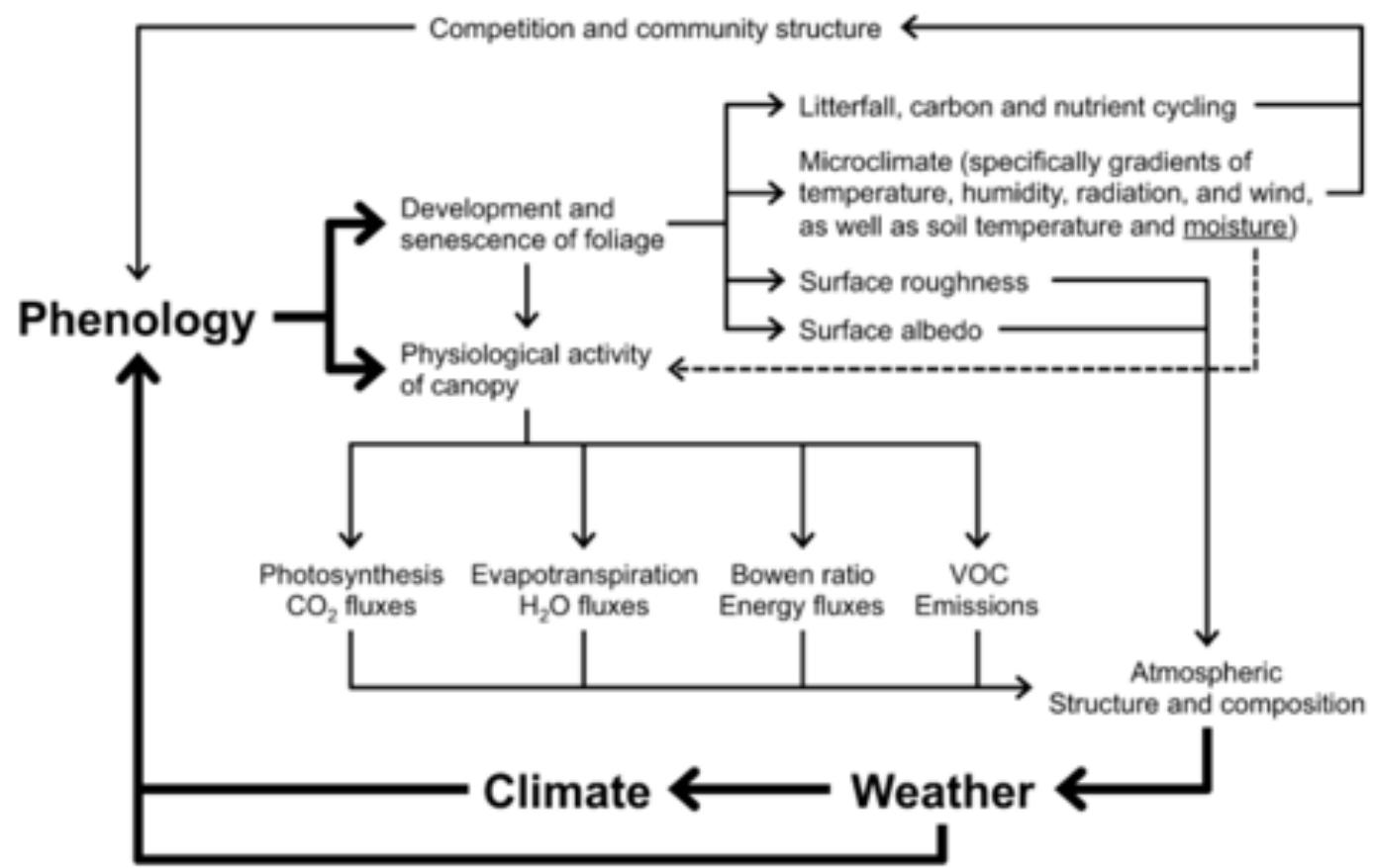
- Many evergreens in high and equatorial latitudes, but not so many in mid latitudes



Givnish's paradoxes

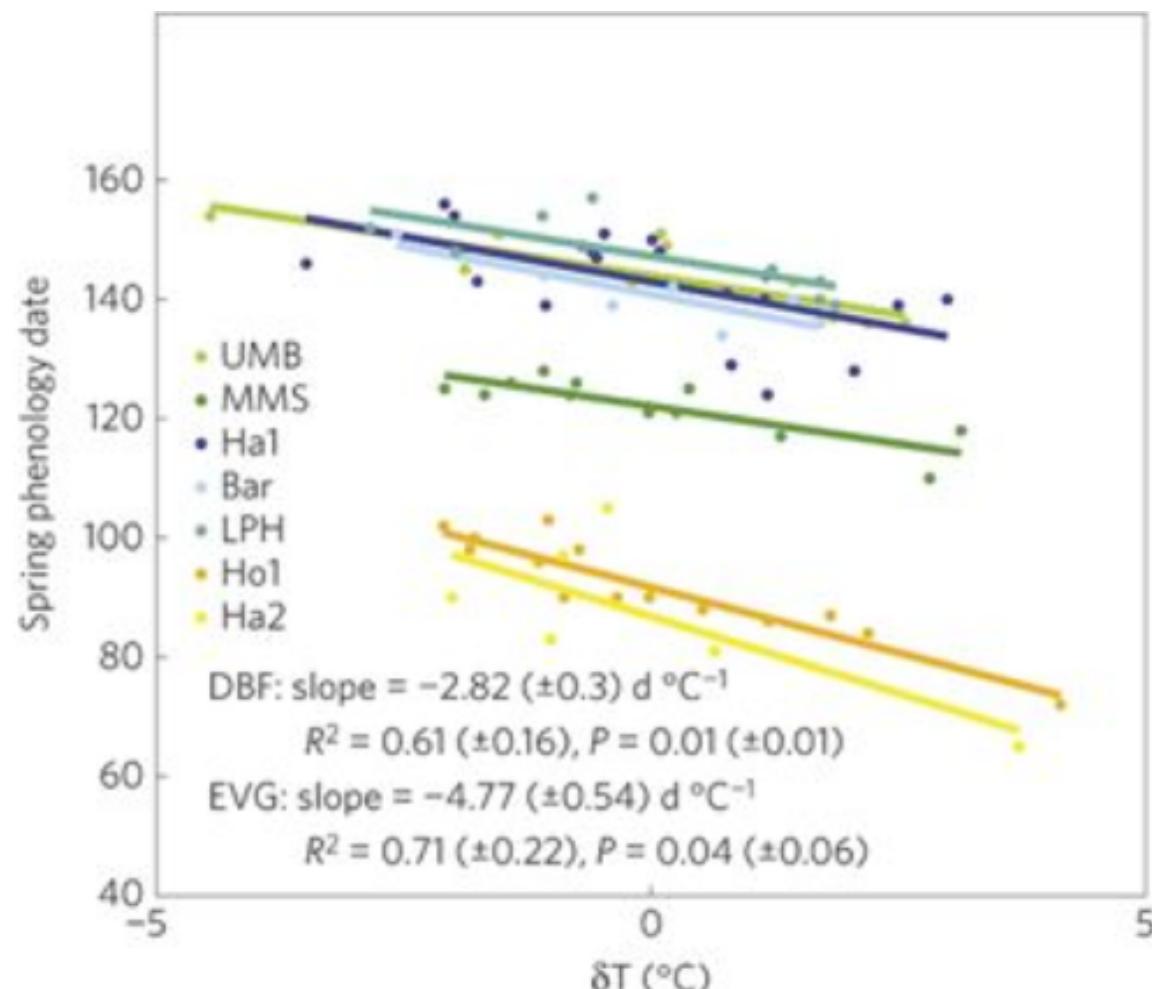
1. Why are boreal forests dominate by evergreens when they are exposed to intense thermal seasonality and winter drought?
2. Why do deciduous larches often dominate nutrient-poor bogs and swamps in the boreal zone?
3. Why do evergreen leaf exchanges dominate nutrient-poor sites in the seasonally dry subtropics?

The importance of leaf phenology

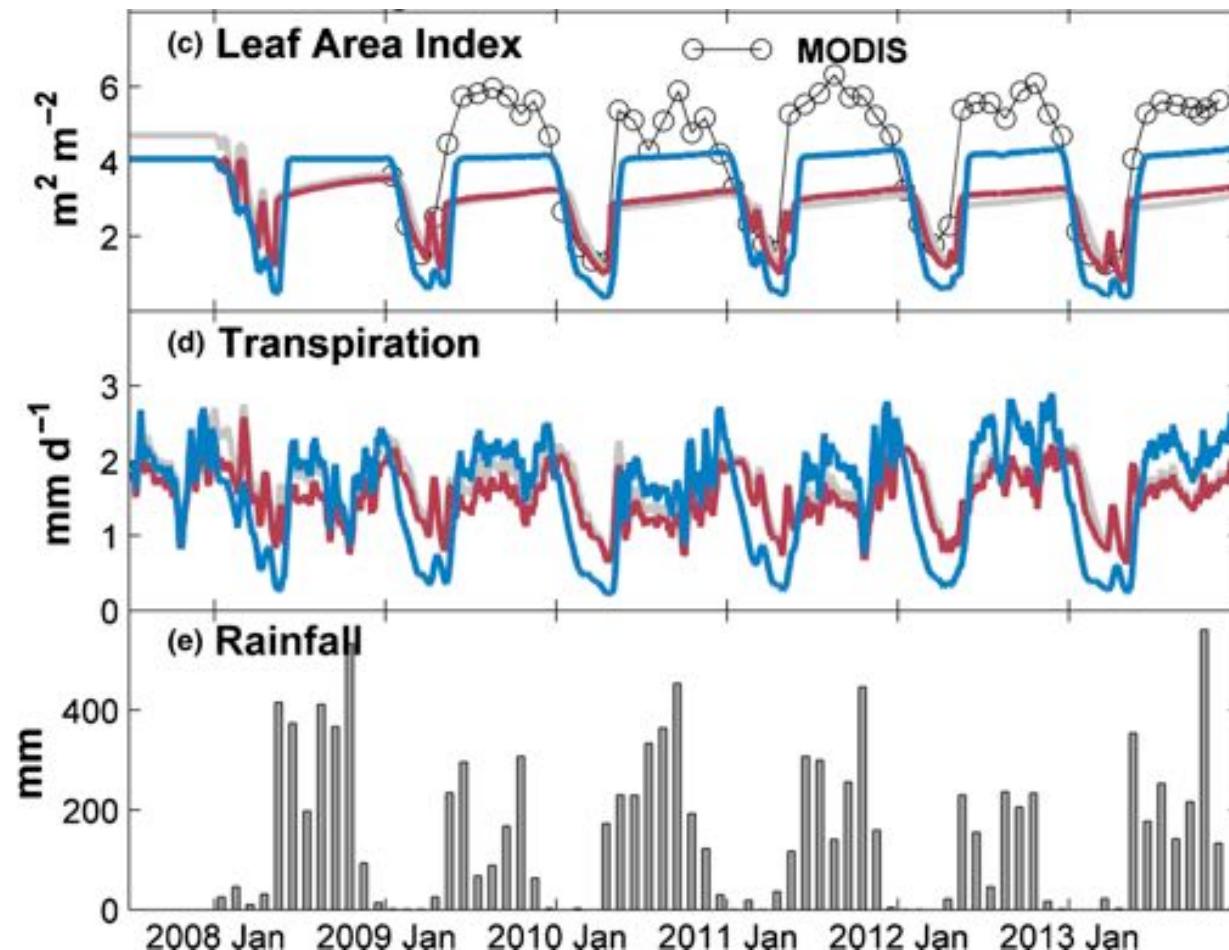


The timing of leaf phenology

In temperate regions, temperature determines Spring leaf out



Water is more important in tropical climates



Autumn phenology is
much harder to predict...

maybe determined by
spring phenology?

