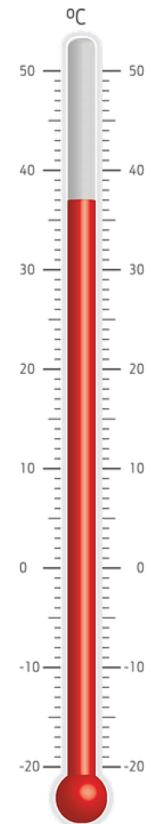


Plant responses to temperature over space and time

February 16, 2021

Class questions

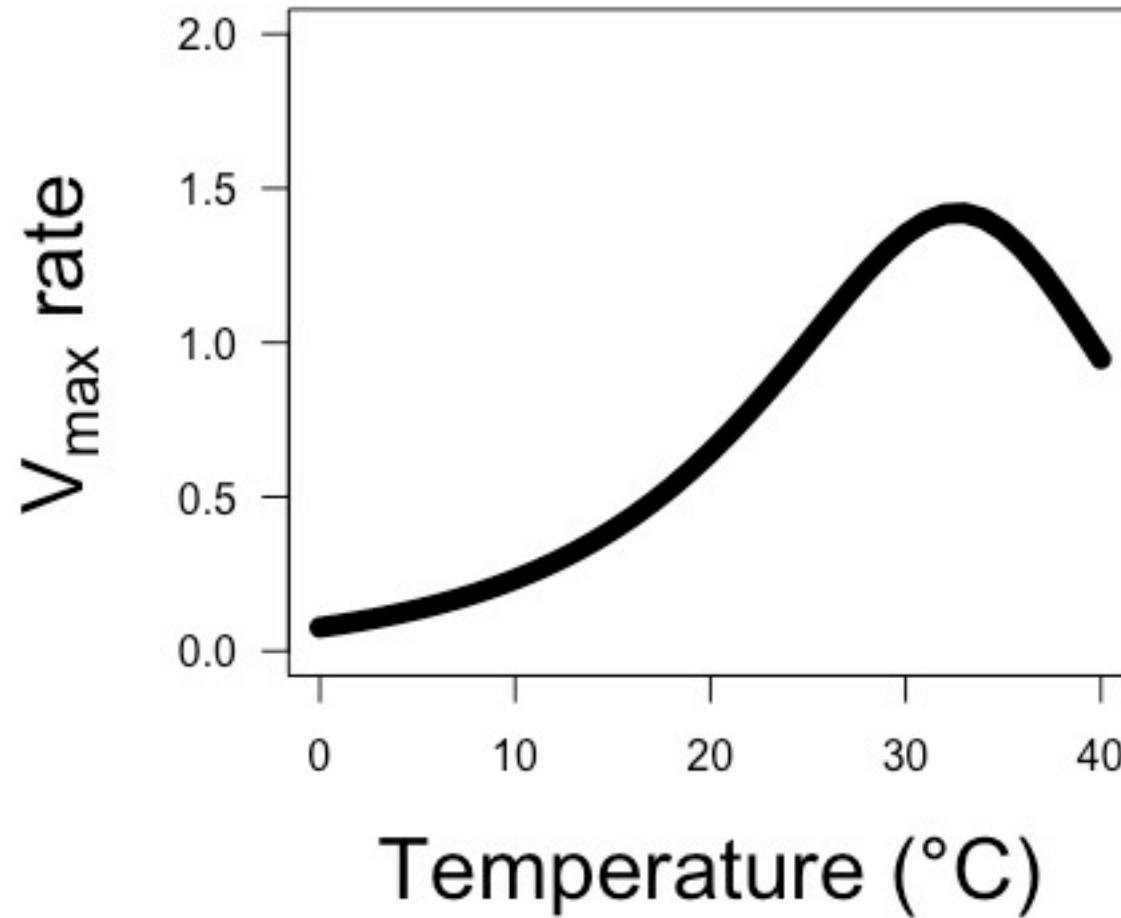
1. How does temperature vary over space and time?



Class questions

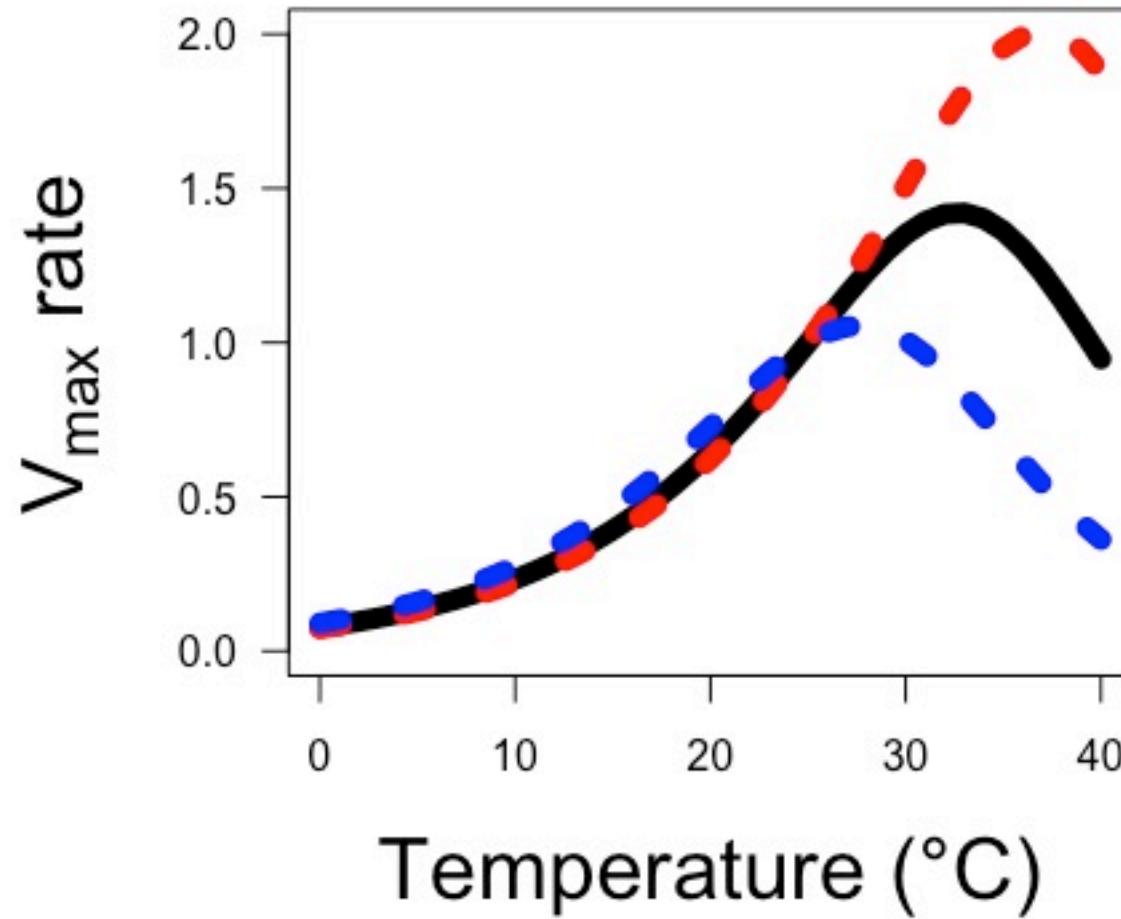
1. How does temperature change in natural environments?
2. Why does temperature variation matter for plants?

Processes that respond to
temperature: Enzymatic potential



Enzyme rate (V_{max}) is the result of both the activation rate and deactivation rate

Leads to a peaked exponential response

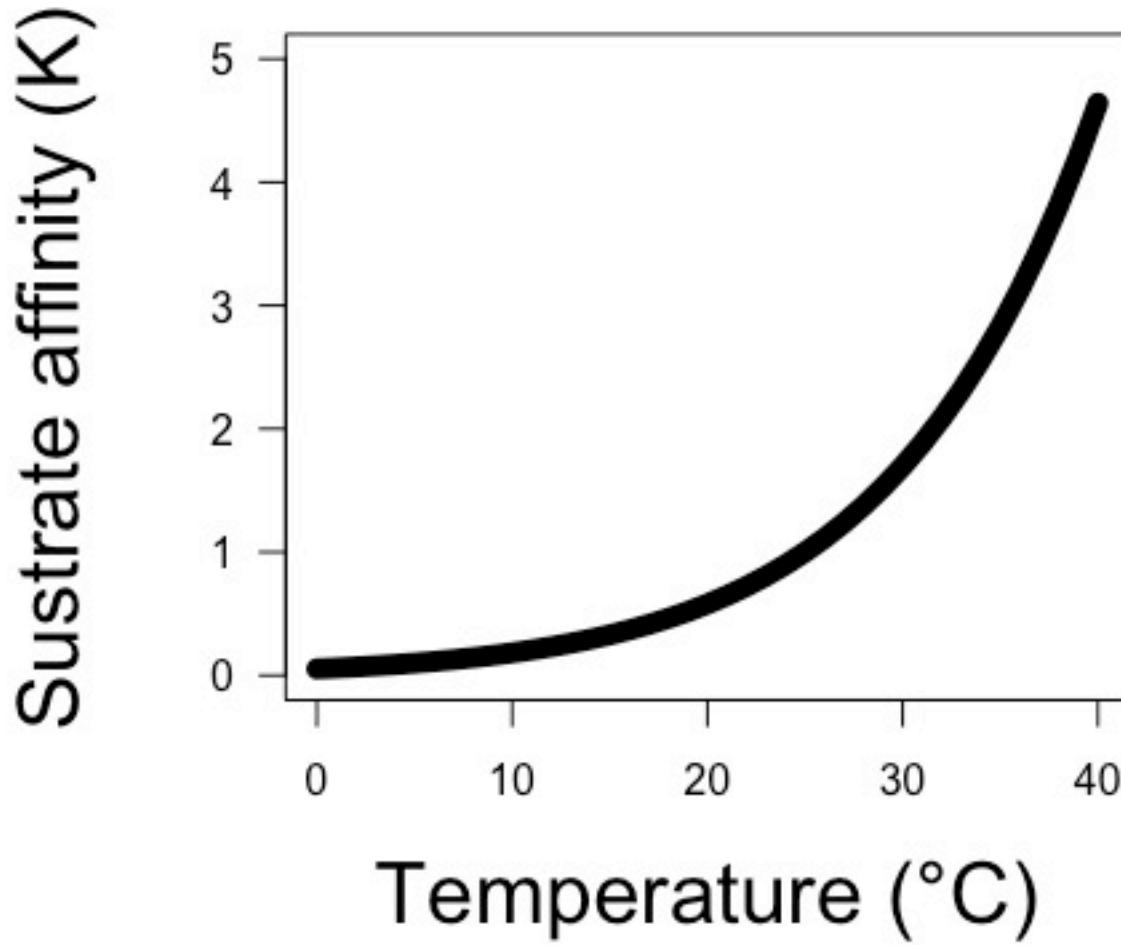


This peak may change based on acclimation

Red = warm acclimated

Blue = cold acclimated

Processes that respond to
temperature: Substrate affinity

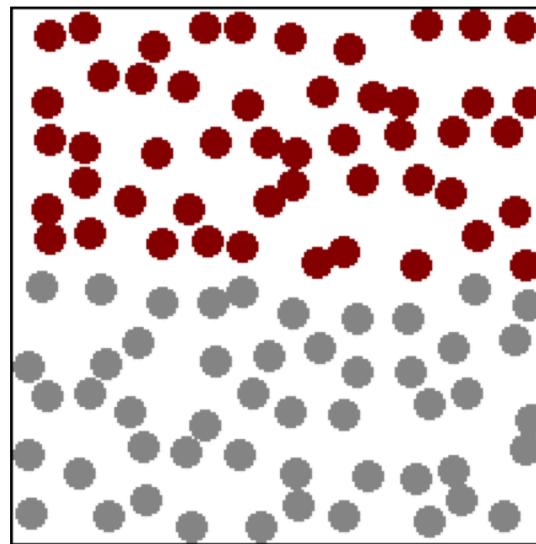


Substrate affinity increases with temperature

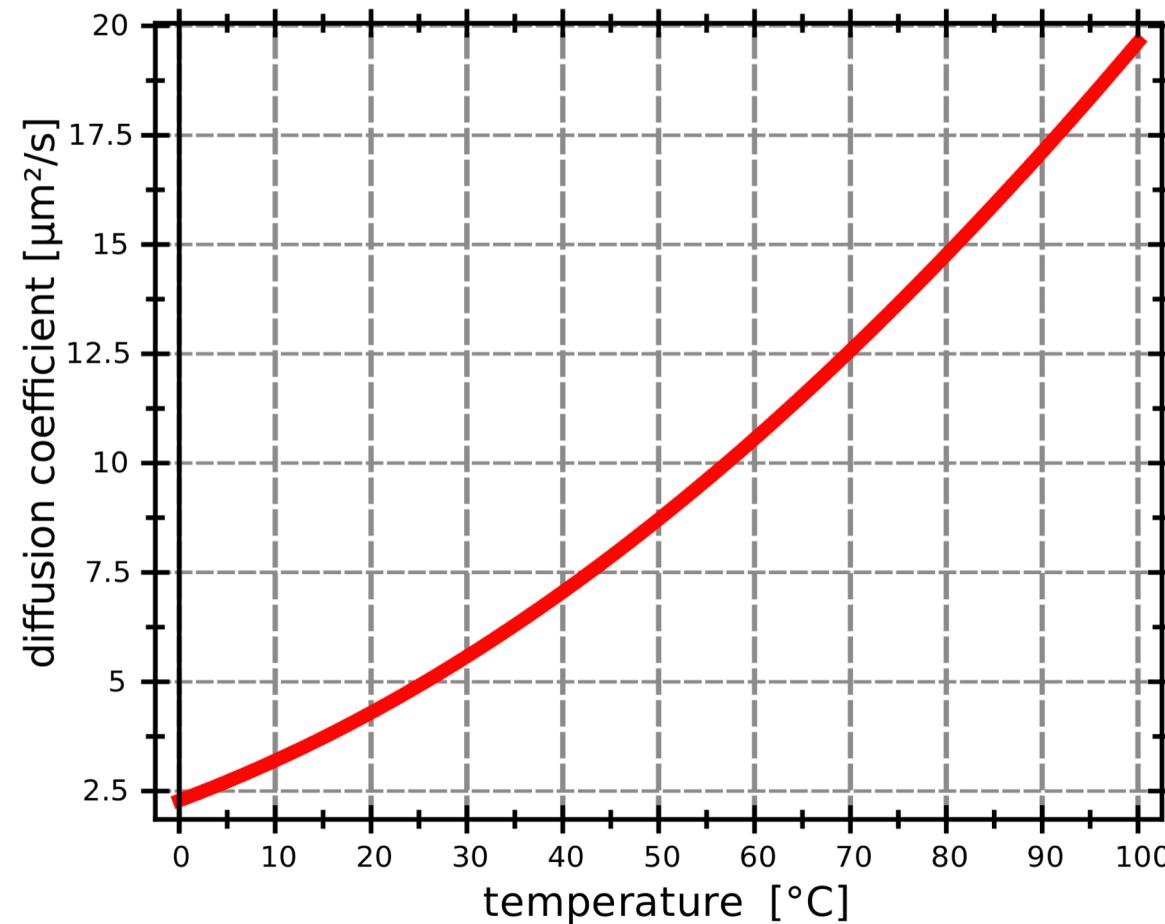
The change is dependent on the substrate and enzyme

Processes that respond to
temperature: Diffusion

Diffusion: movement from area of low concentration to high concentration



Diffusion rates increase with temperature
(Fick's law coefficient increases)



Class questions

1. How does temperature change in natural environments?
2. Why does temperature variation matter for plants?

Respiration and temperature

Respiration and temperature

1. Enzymatic rates increase with T
2. Substrate affinity increases with T

Respiration and temperature

1. Enzymatic rates increase with T
2. Substrate affinity increases with T

What should the response look like?

Photosynthesis and temperature

Photosynthesis and temperature

1. Enzymatic rates increase with T
2. Substrate affinity increases with T

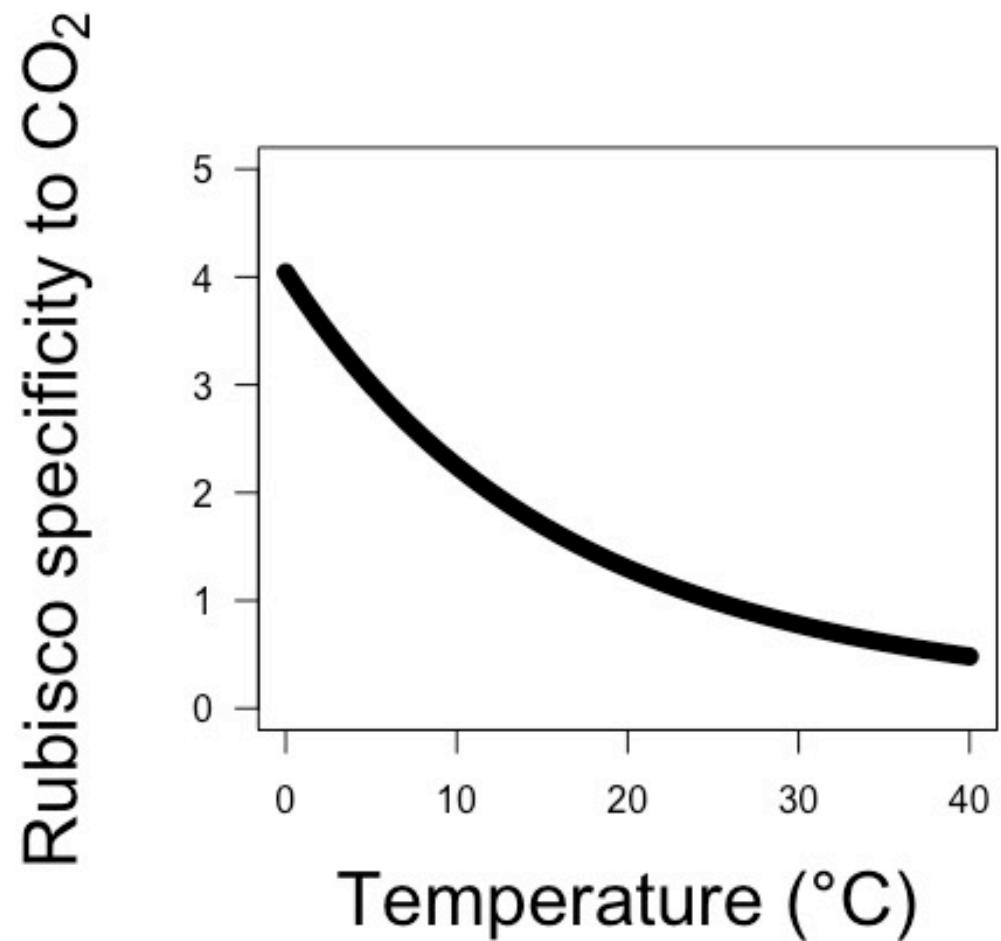
Photosynthesis and temperature

1. Enzymatic rates increase with T
2. Substrate affinity increases with T

What should the response look like?

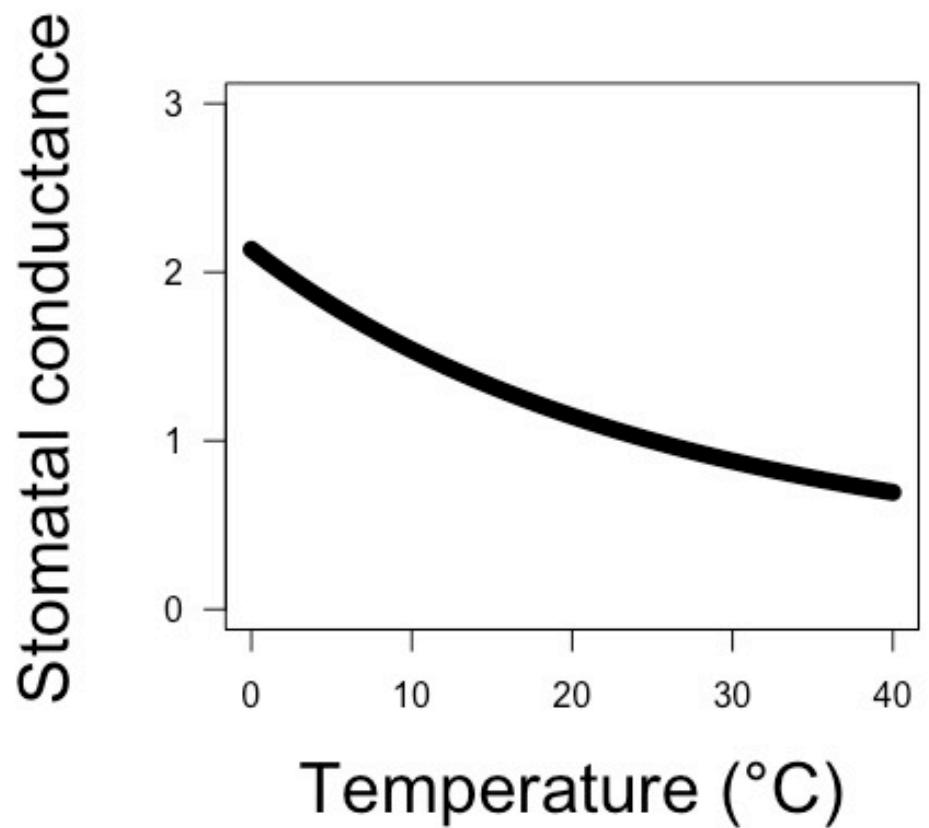
Photosynthesis and temperature

1. Enzymatic rates increase with T
2. Substrate affinity increases with T
3. Rubisco likes O₂ more at higher T!



Photosynthesis and temperature

1. Enzymatic rates increase with T
2. Substrate affinity increases with T
3. Rubisco likes O₂ more at higher T!
4. Stomata close at higher T!



Photosynthesis and temperature

1. Enzymatic rates increase with T
2. Substrate affinity increases with T
3. Rubisco likes O₂ more at higher T!
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What should the response look like?

Photosynthesis and temperature

1. Enzymatic rates increase with T
2. Substrate affinity increases with T
3. Rubisco likes O₂ more at higher T!
4. Stomata close at higher T!

Would this differ for C4 species?

Transpiration and temperature

Transpiration and temperature

1. Diffusion rates increase with T

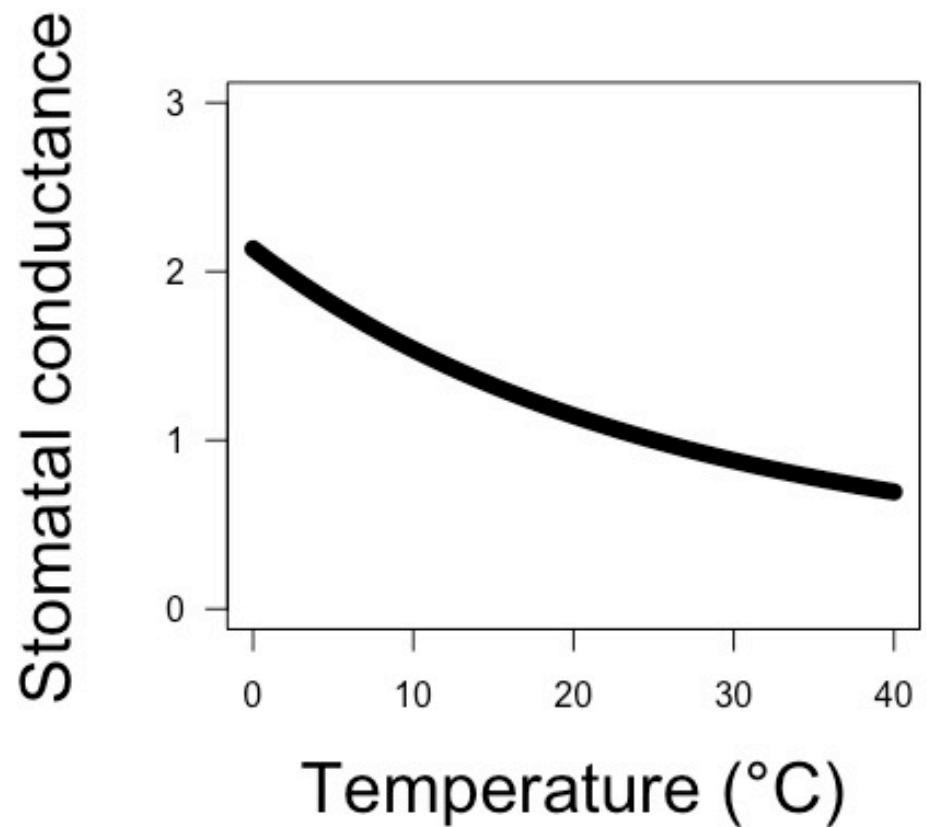
Transpiration and temperature

1. Diffusion rates increase with T

What should the response look like?

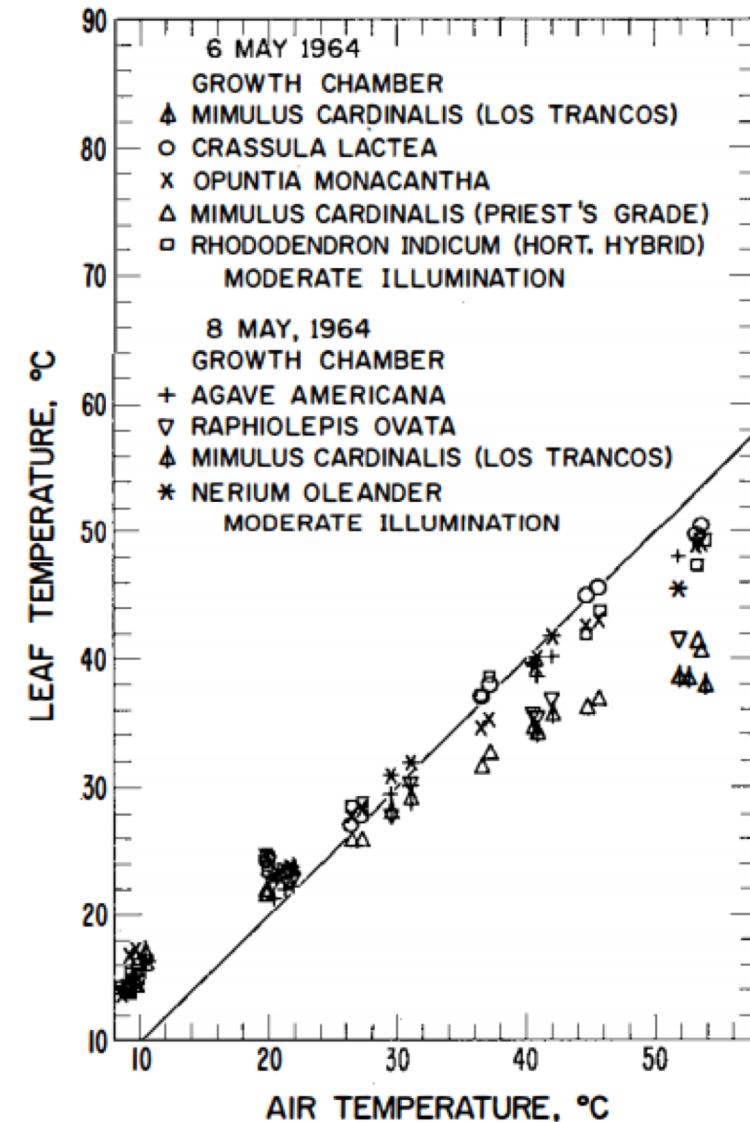
Transpiration and temperature

1. Diffusion rates increase with T
2. Stomata close with increased T!



Transpiration and temperature

1. Diffusion rates increase with T
2. Stomata close with increased T!
3. Leaves cool with increased T!



Transpiration and temperature

1. Diffusion rates increase with T
2. Stomata close with increased T!
3. Leaves cool with increased T!

What should the response look like?

Does this influence your thinking
on photosynthesis-temperature
responses?

Temperature responses of leaf net photosynthesis: the role of component processes

Yan-Shih Lin , Belinda E. Medlyn, David S. Ellsworth

Tree Physiology, Volume 32, Issue 2, February 2012, Pages 219–231,

<https://doi.org/10.1093/treephys/tpr141>

Published: 25 January 2012 [Article history ▾](#)



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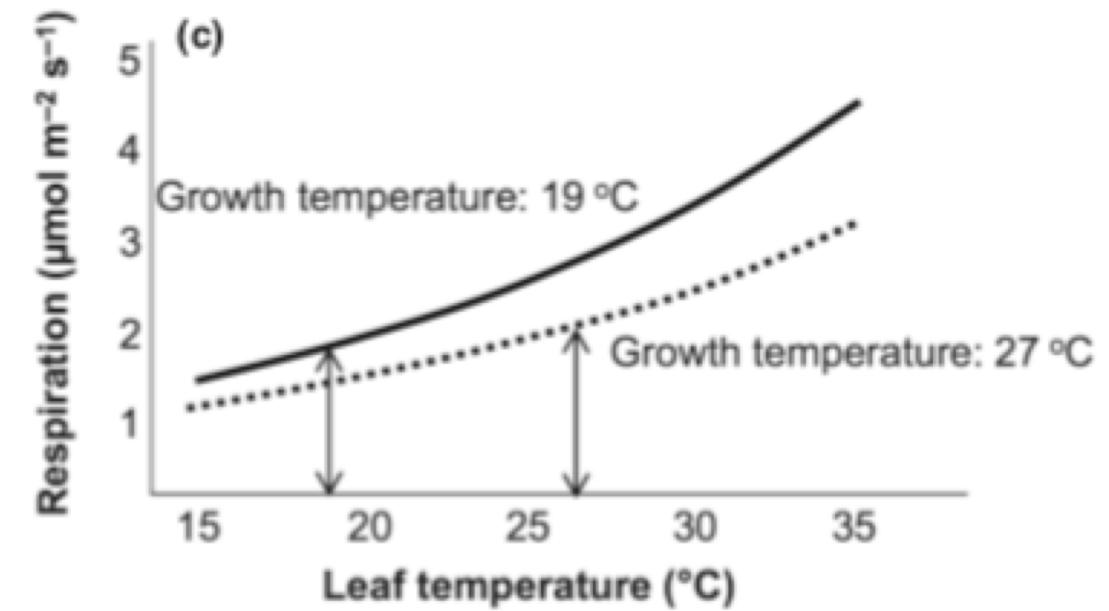
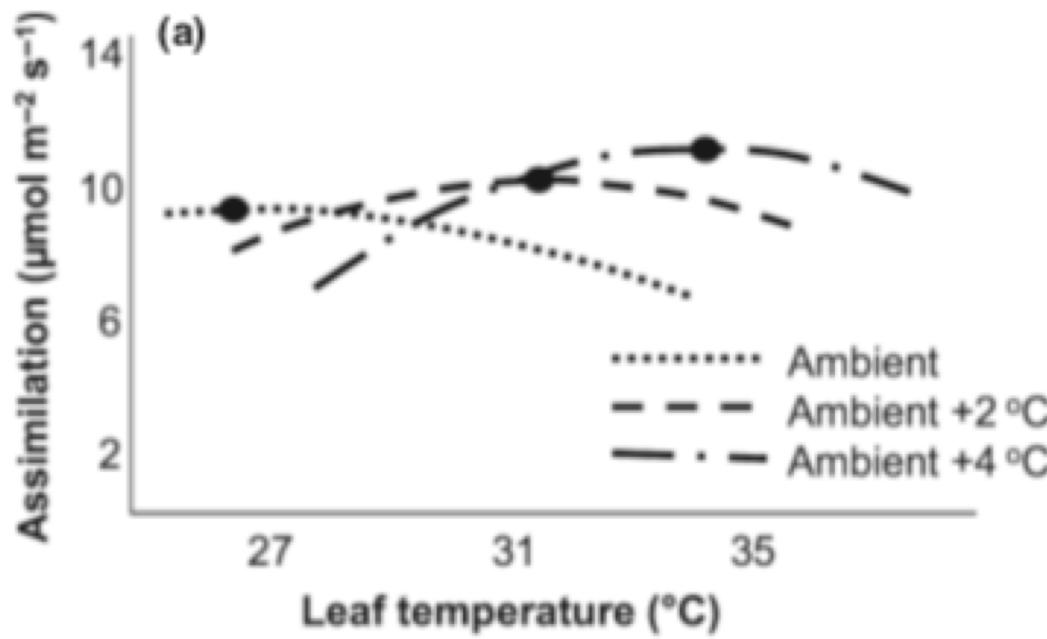
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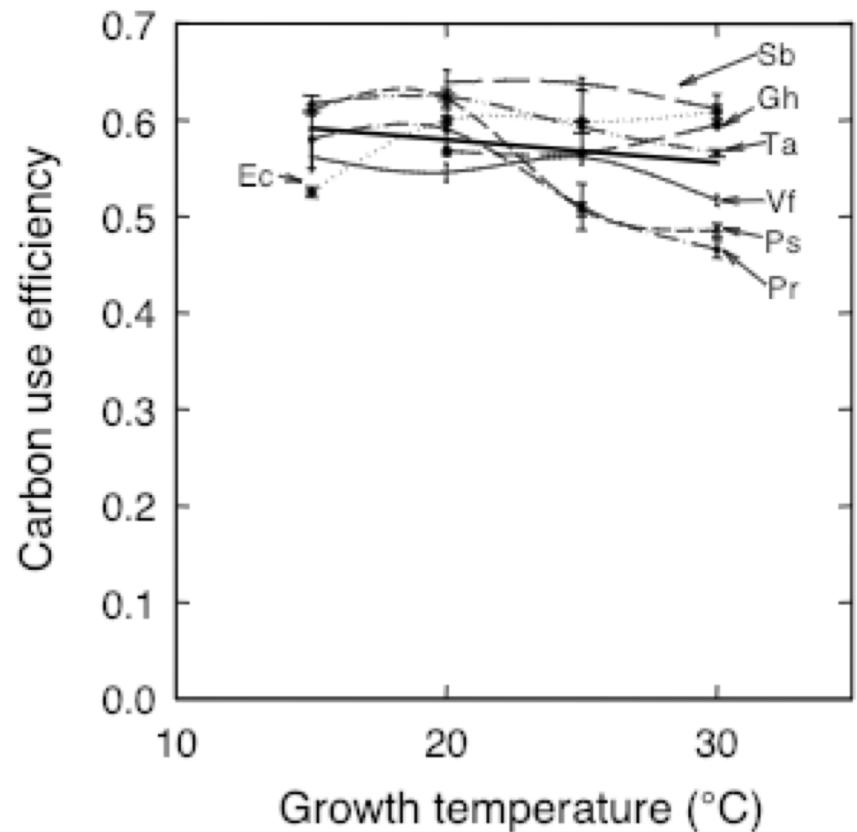
Permissions

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But now what about acclimation!

Acclimation leads to a roughly homeostatic response!





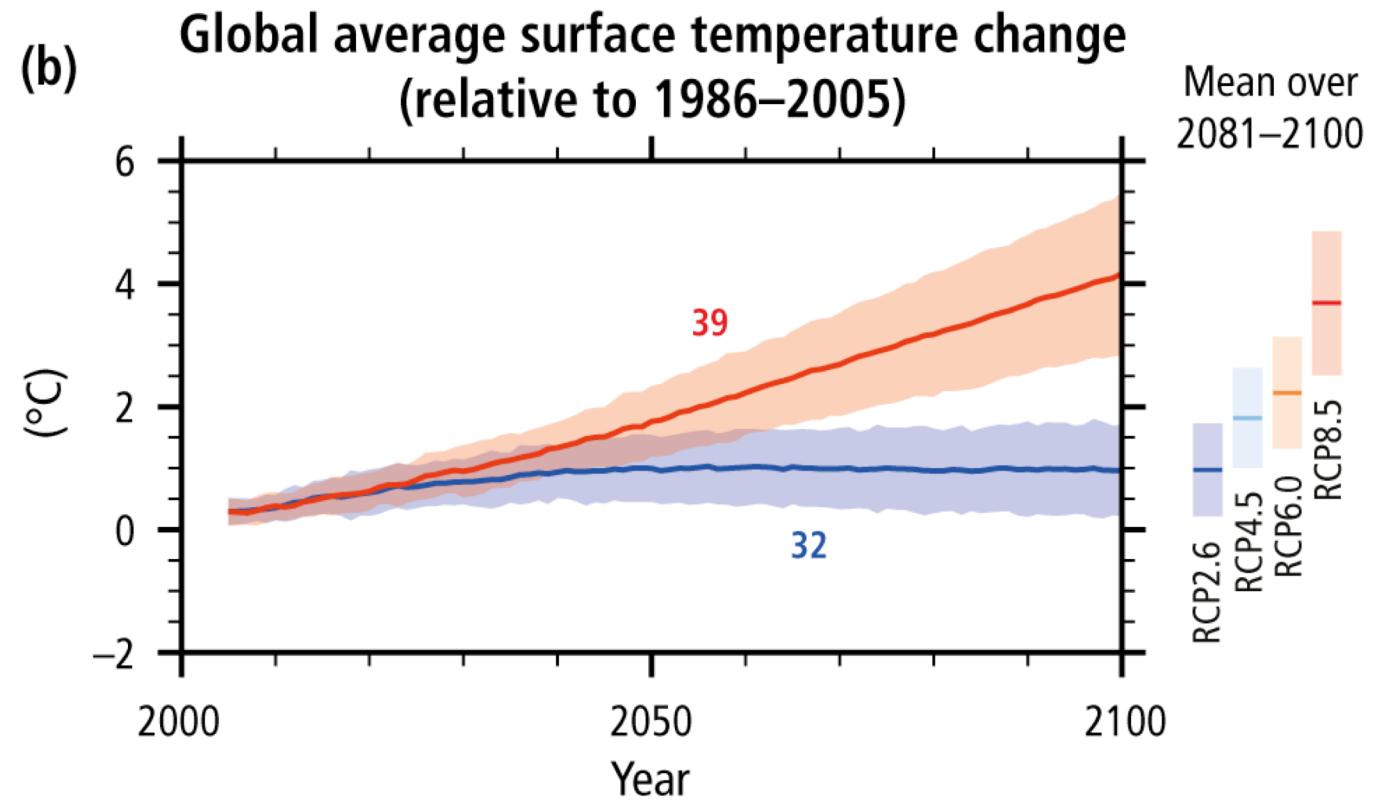
CUE = photosynthesis / respiration

Fig. 3. The carbon use efficiency of whole plants (including roots in inert potting medium) for a range of plant species grown continuously at various temperatures between 15 and 30°C. Ec, *Eucalyptus camaldulensis*; Pr, *Pinus radiata*; Ps, *Pisum sativum*; Vf, *Vicia faba*; Ta, *Triticum aestivum*; Gh, *Gossypium hirsutum*; Sb, *Sorghum bicolor*. Data are derived from Gifford *et al.* (1996b) and Gifford (1992). Error bars are standard errors of the mean. The bold straight line is the linear regression through all the data.

Class questions

1. How does temperature change in natural environments?
2. Why does temperature variation matter for plants?
3. Does any of this even matter?

Will a 3-5°C increase in temperature matter?
Why or why not?

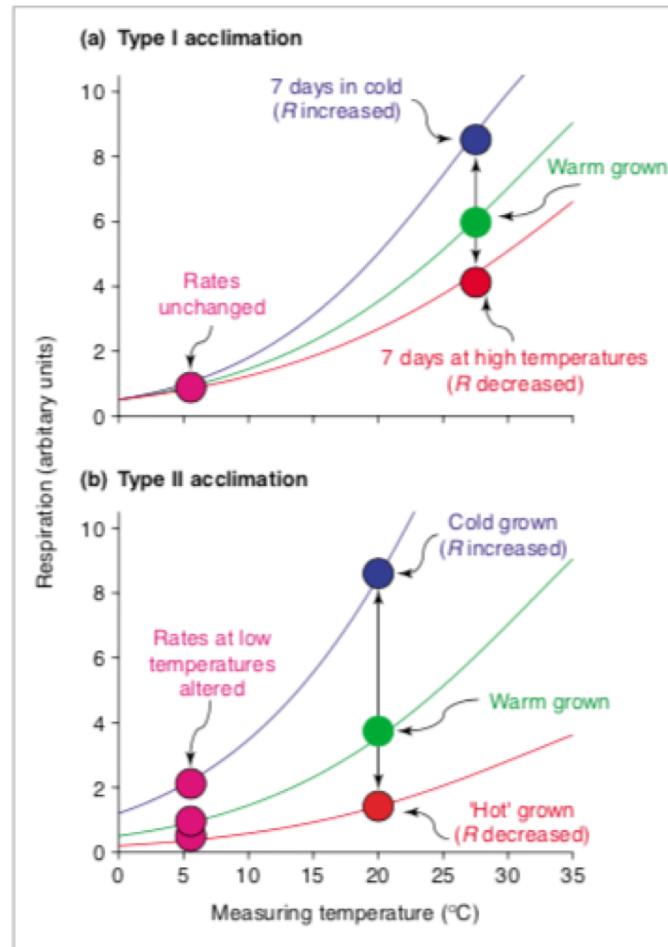


Thermal acclimation and the dynamic response of plant respiration to temperature

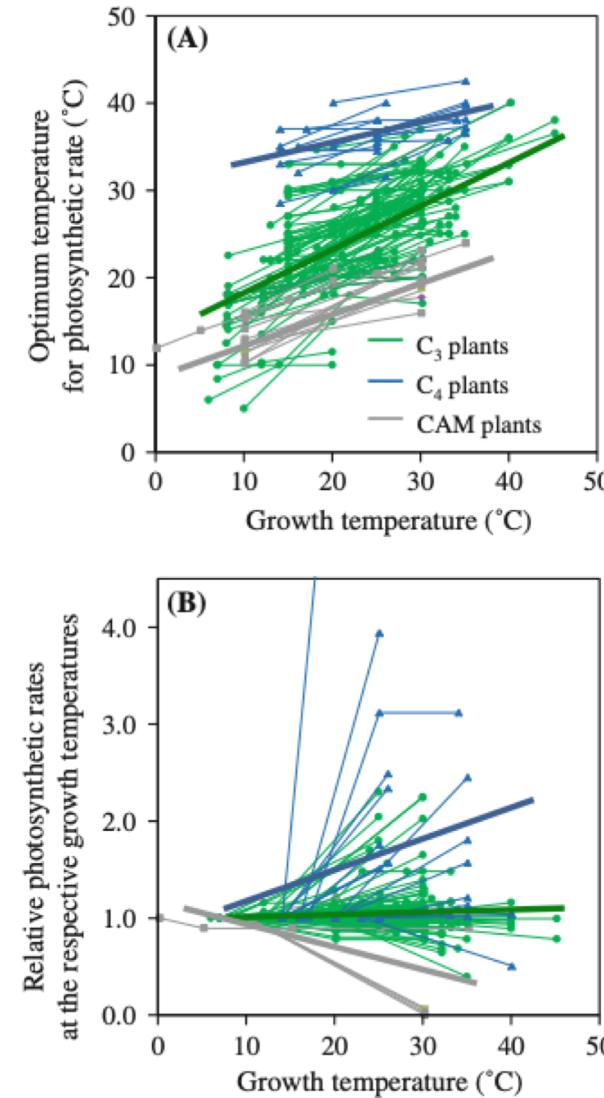
Atkin and Tjoelker (2003). Trends in Plant Science

Let's talk about acclimation

Seems pretty cut and dry!



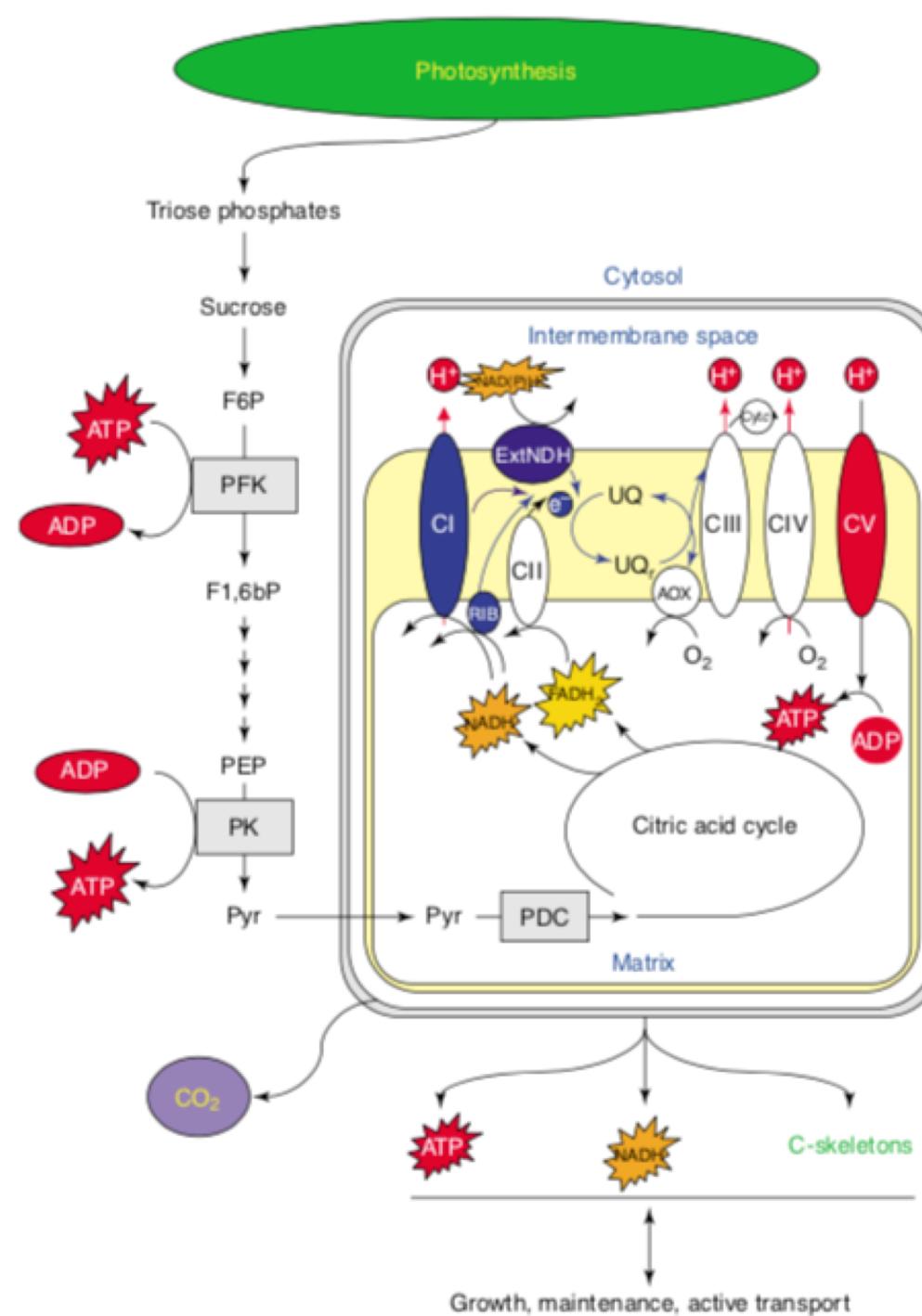
It turns out acclimation can be quite variable

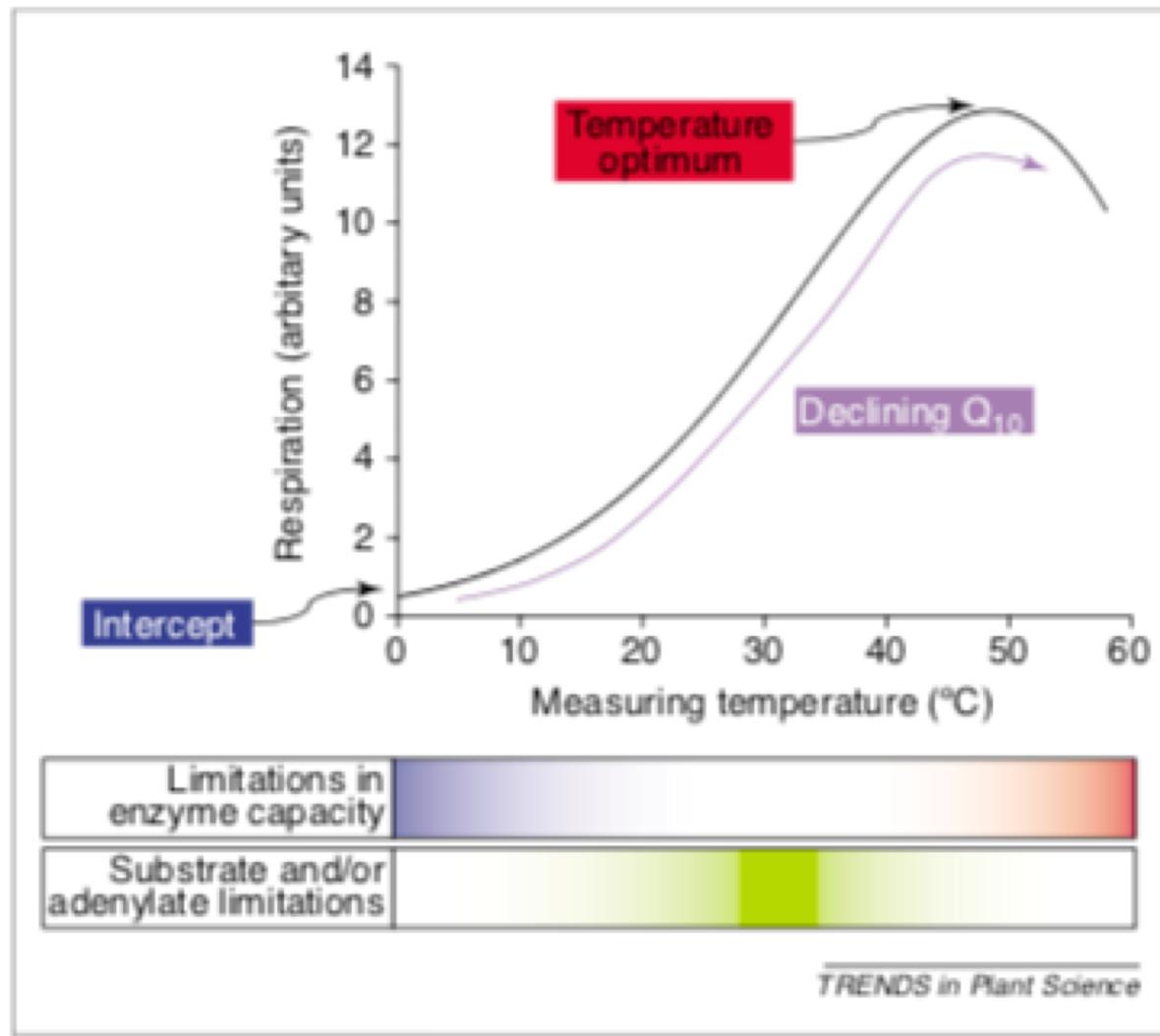


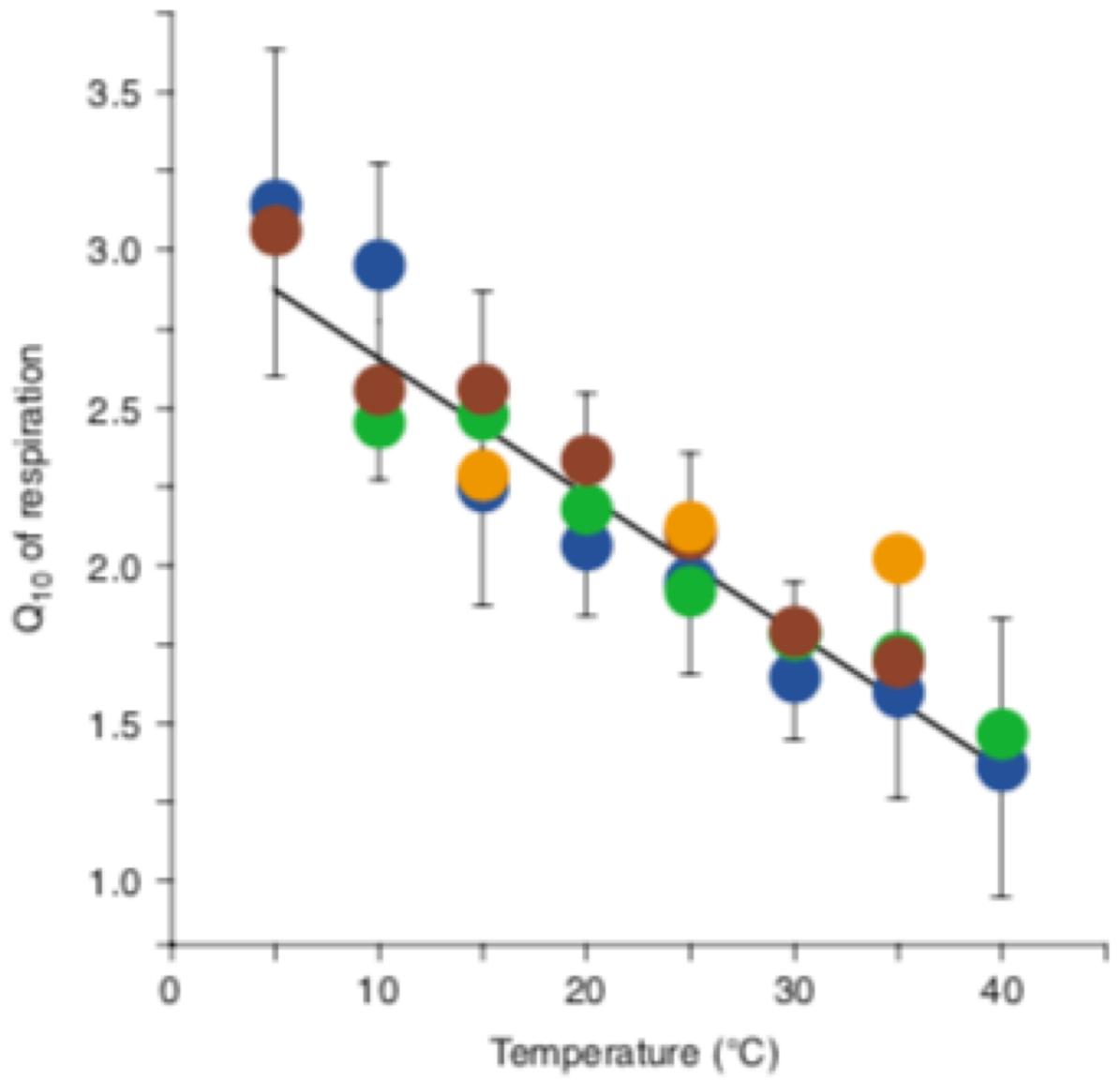
Given what you know about temperature responses: Why would plants acclimate?

Why wouldn't they?

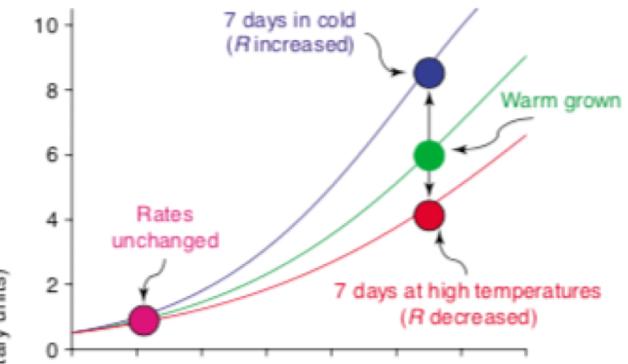
Figures for ease of viewing



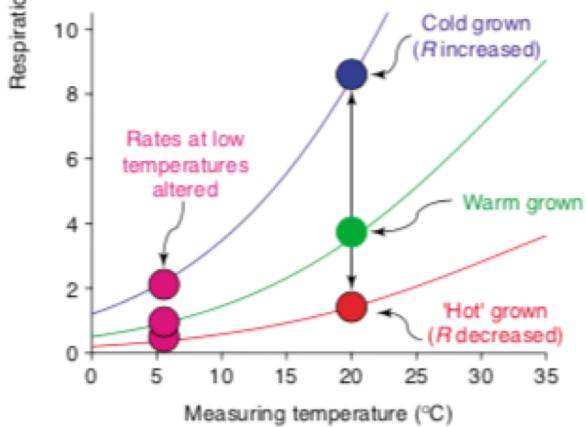




(a) Type I acclimation



(b) Type II acclimation



(c) Impacts of acclimation

