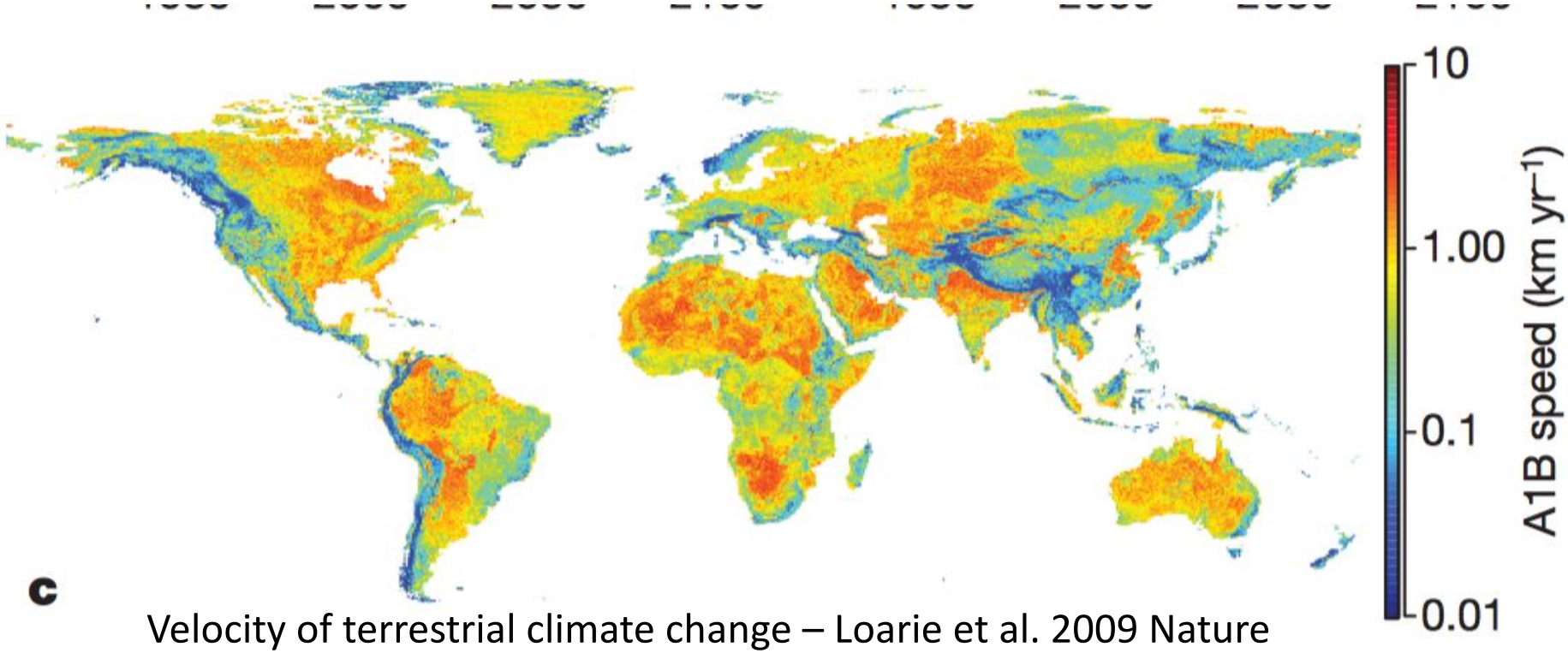
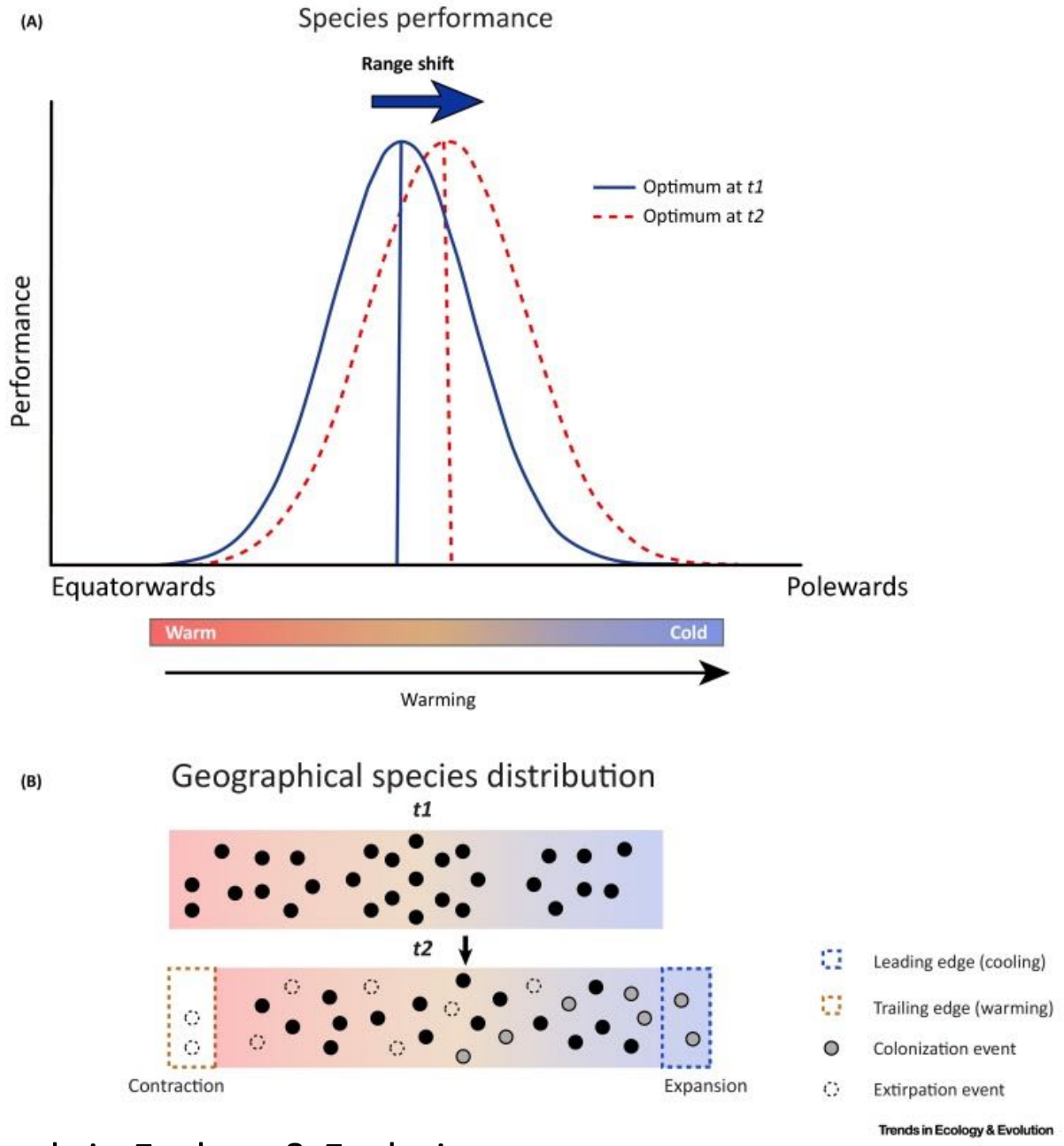
Thermal tolerance, range shifting, and rates of evolutionary change

"Move, adapt, or die"



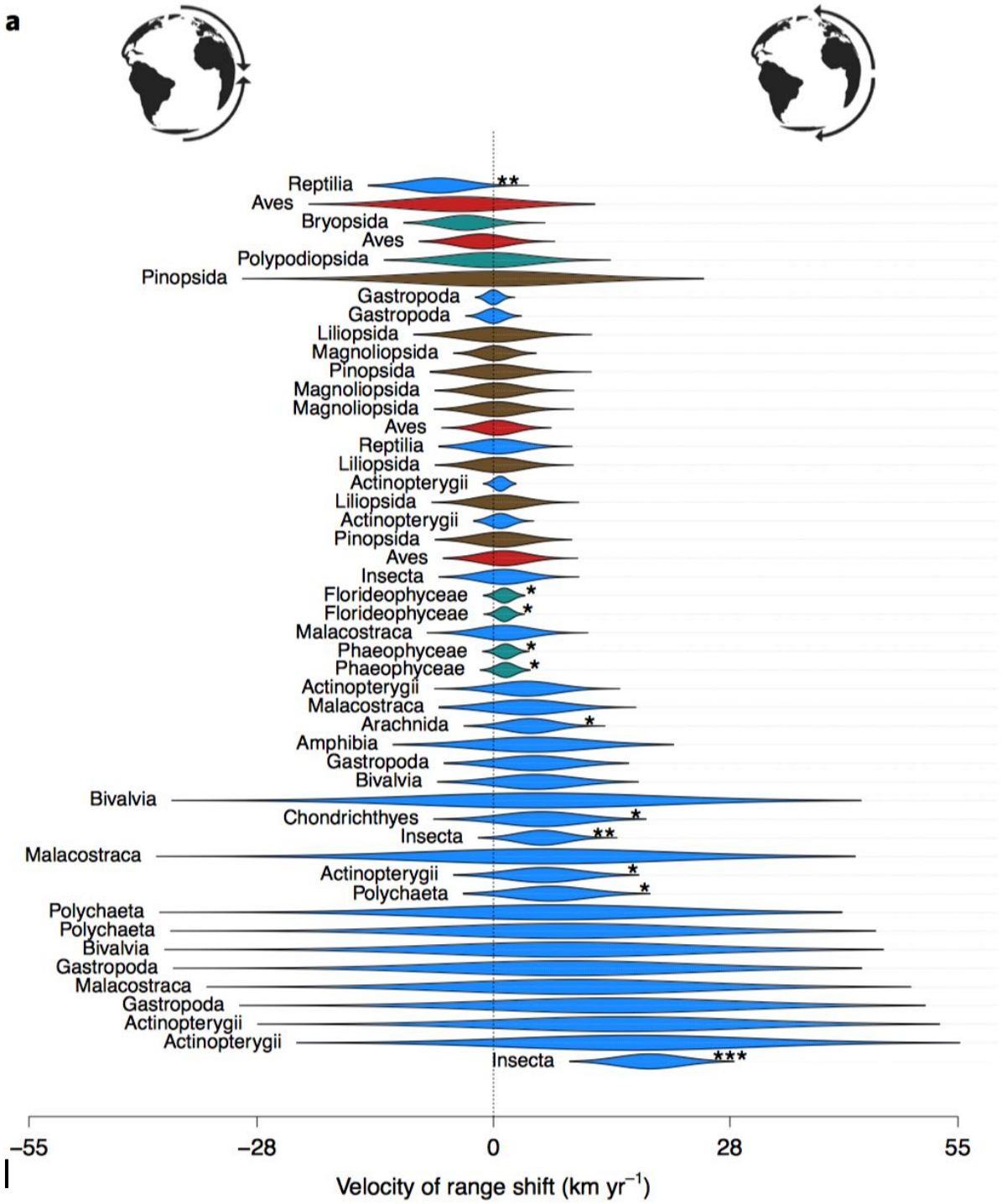
Velocity of terrestrial climate change – Loarie et al. 2009 Nature

Move



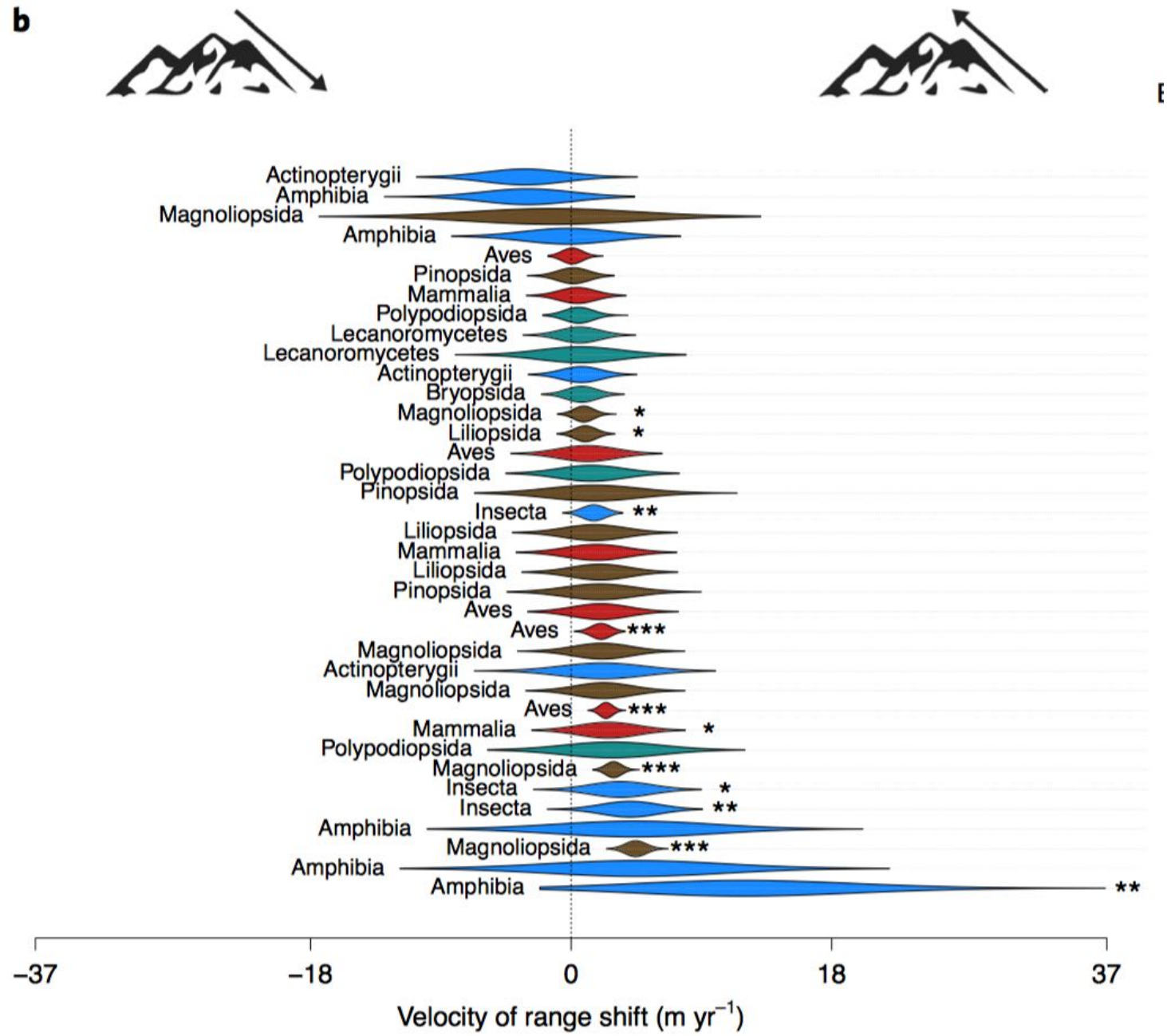
Brito-Morales et al. 2018 Trends in Ecology & Evolution

Move



Lenoir et al. 2020 Nature Ecol Evol

Move

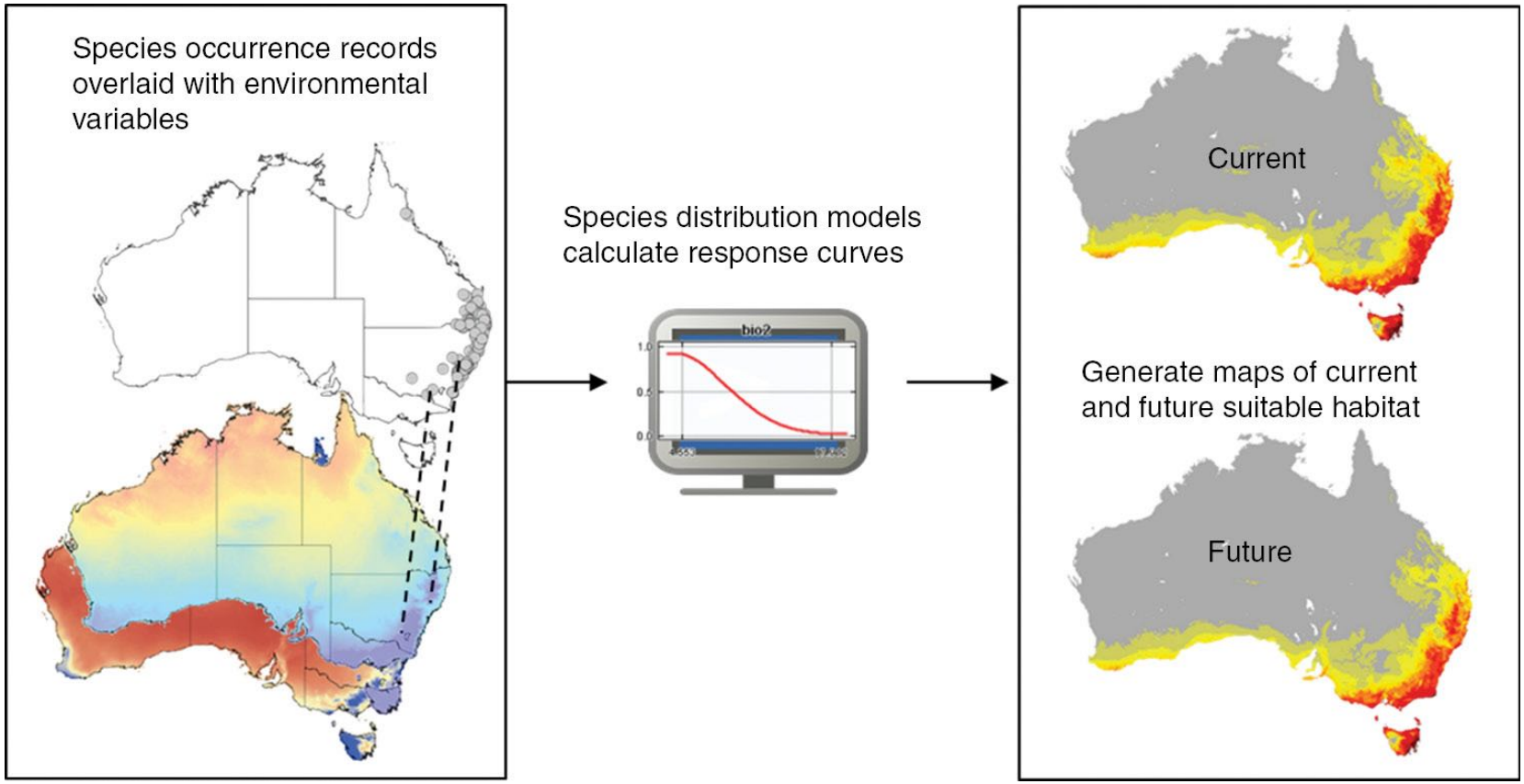


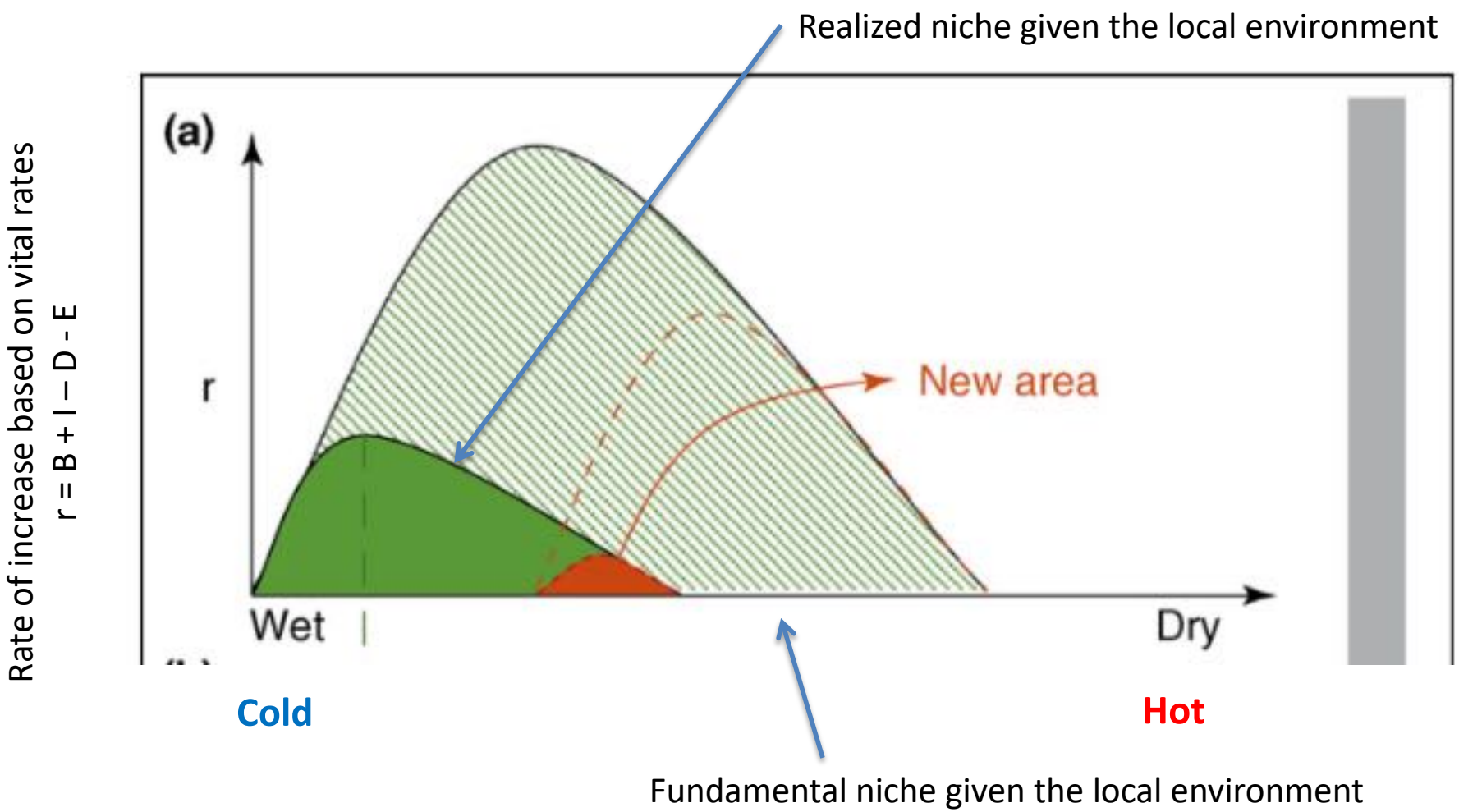
Lenoir et al. 2020 Nature Ecol Evol

Predicting future ranges

a naïve approach using species distribution models and projected climates

What are some implicit assumptions here?

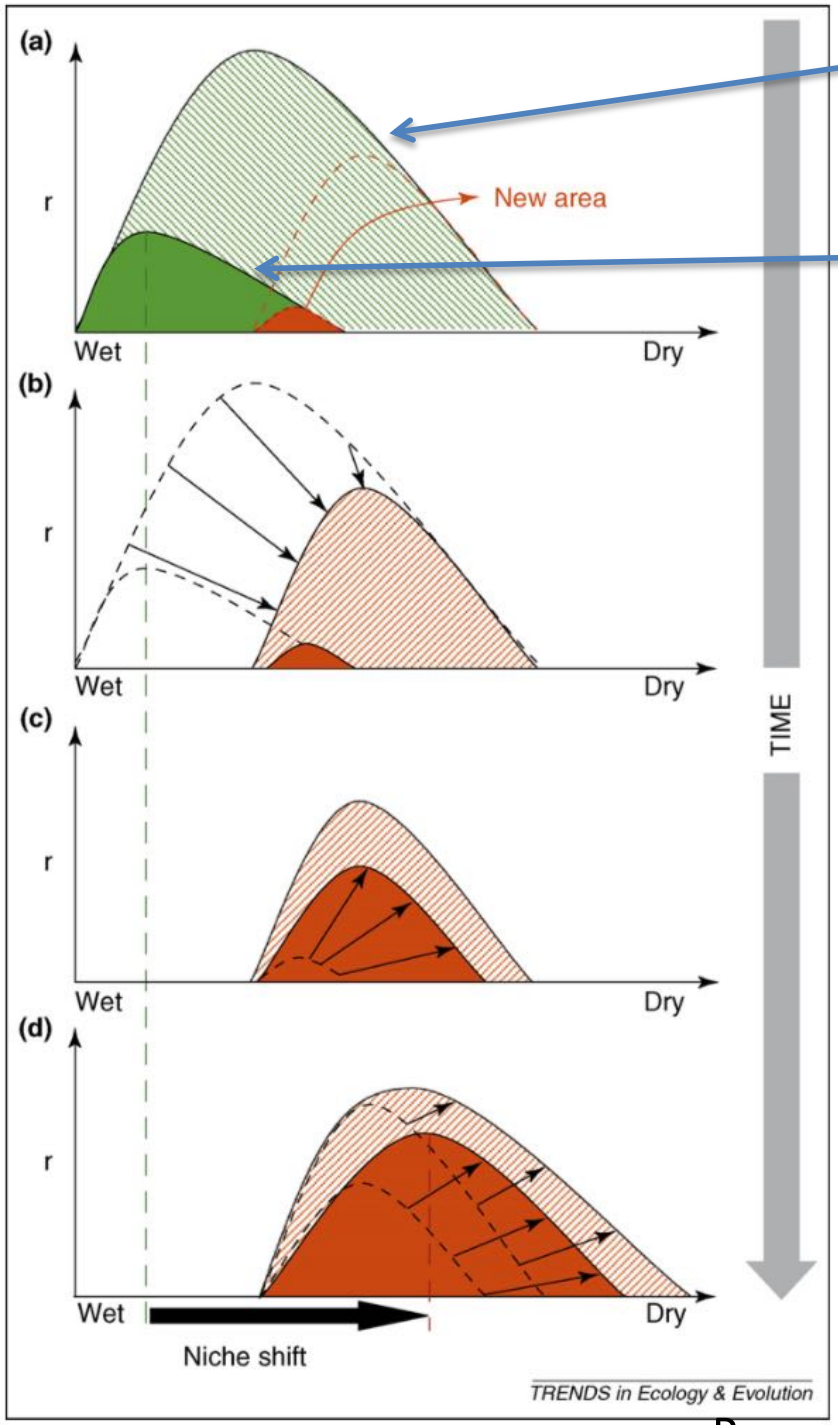




What does an SDM/ENM estimate?

Pearman et al. 2008 Trends in Ecology & Evolution

Rate of increase based on vital rates
r = B + I – D - E



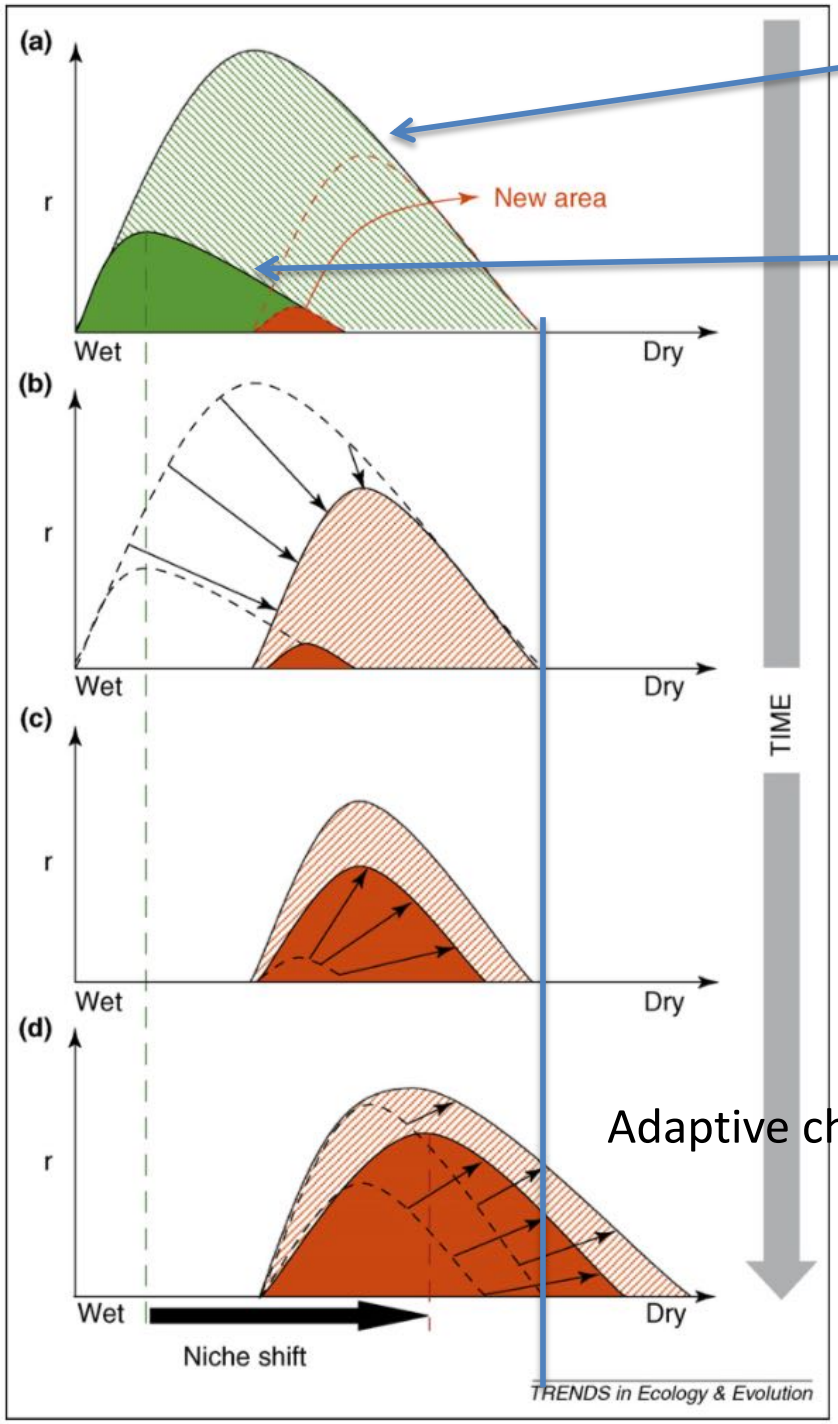
Fundamental niche given the local environment

Realized niche given the local environment

Which of these represents
- niche shifting?
- niche evolution?

Pearman et al. 2008 Trends in Ecology & Evolution

Rate of increase based on vital rates
r = B + I – D - E



Fundamental niche given the local environment

Realized niche given the local environment

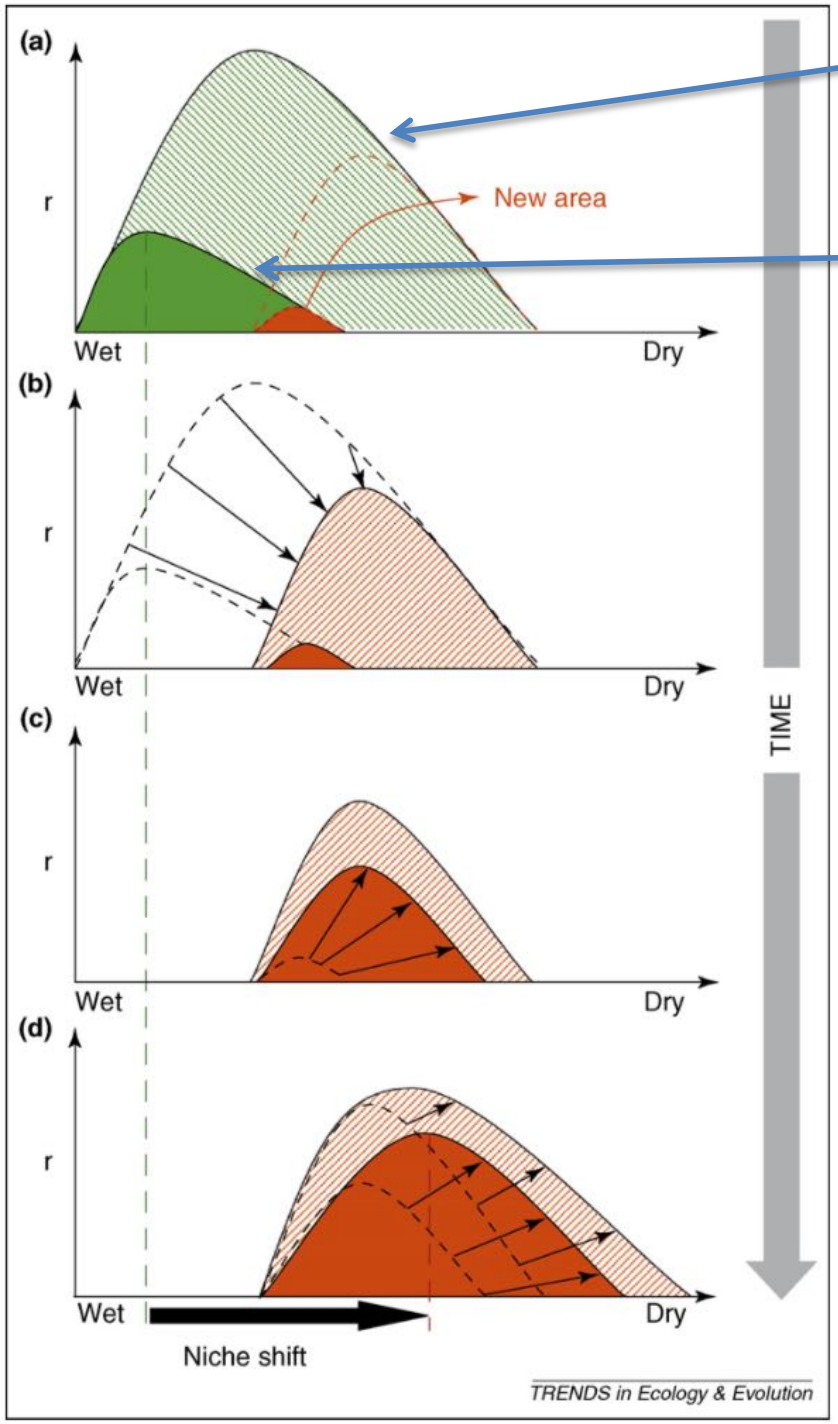
Change of habitat

Biotic release and other constraints

Adaptive change

Rate of increase based on vital rates

$r = B + I - D - E$

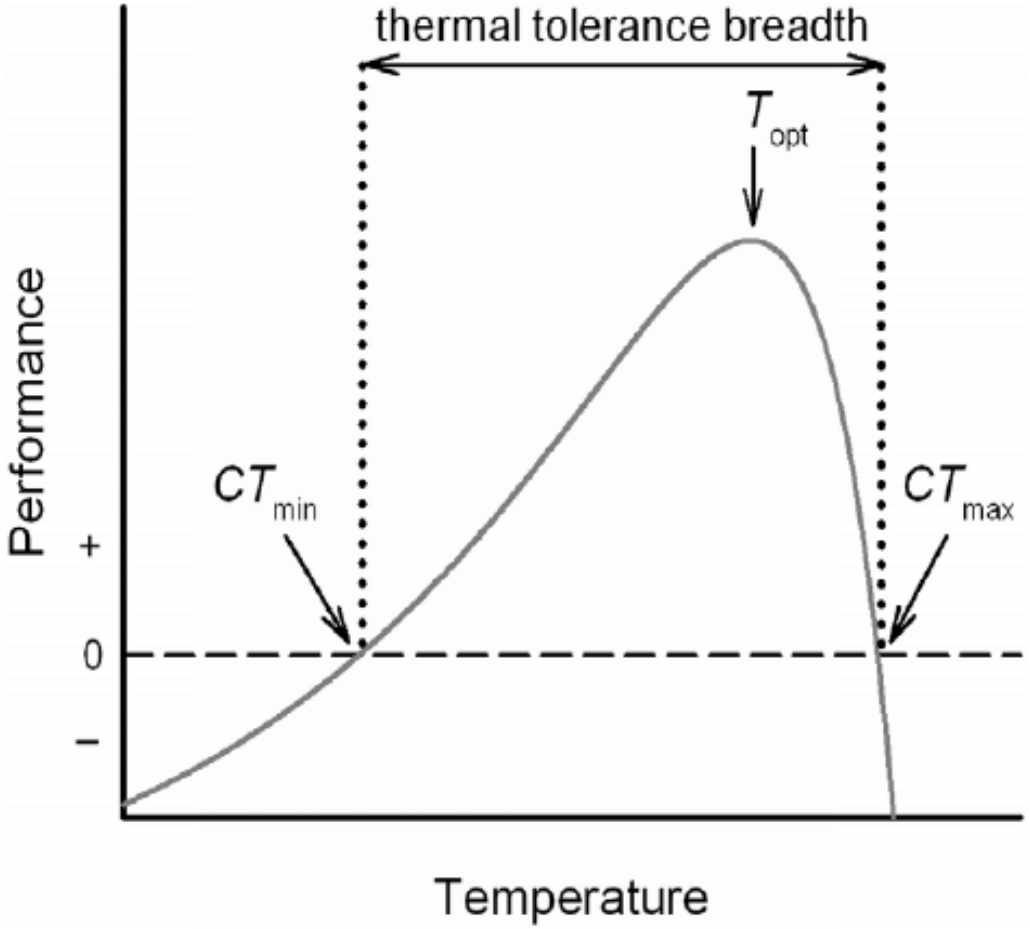


Fundamental niche given the local environment

Realized niche given the local environment

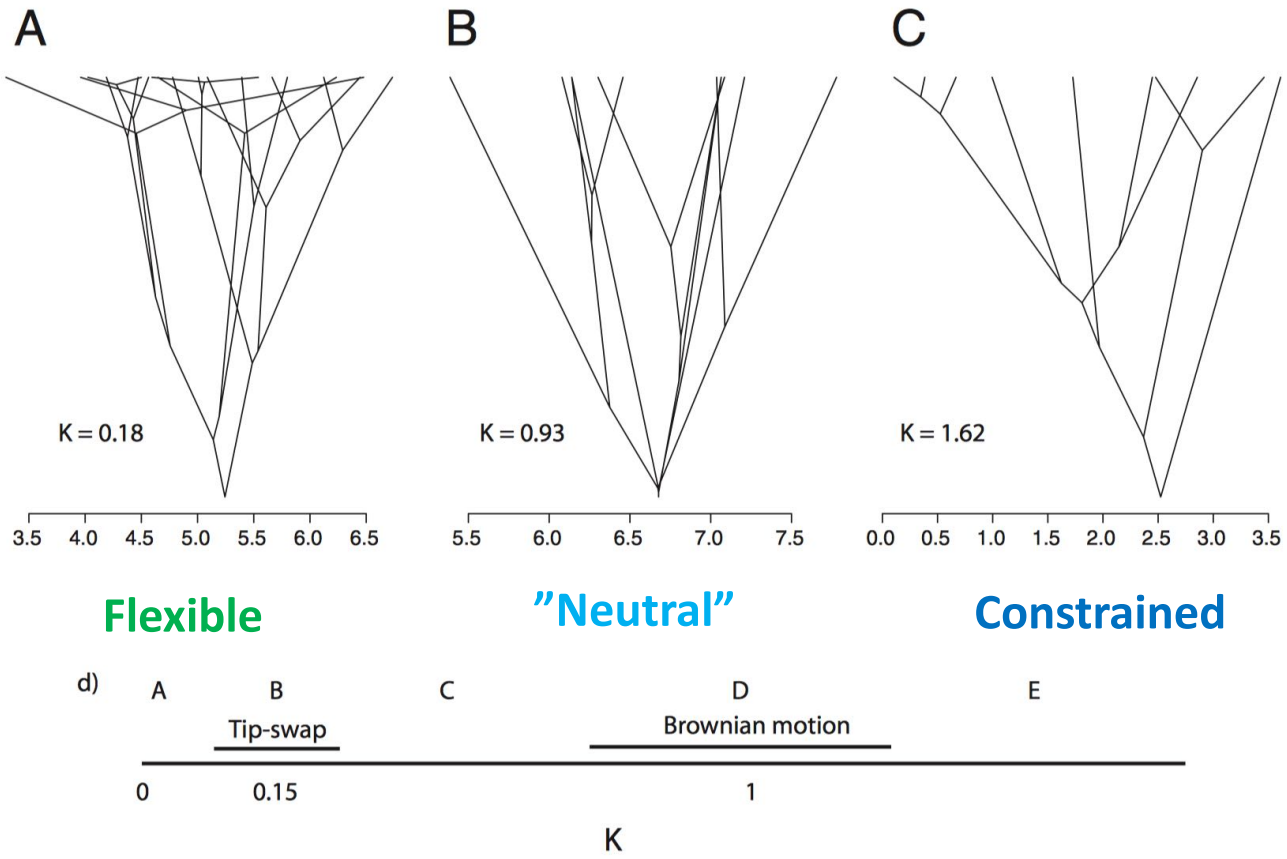
Adapt

Thermal performance curves describe fundamental niches



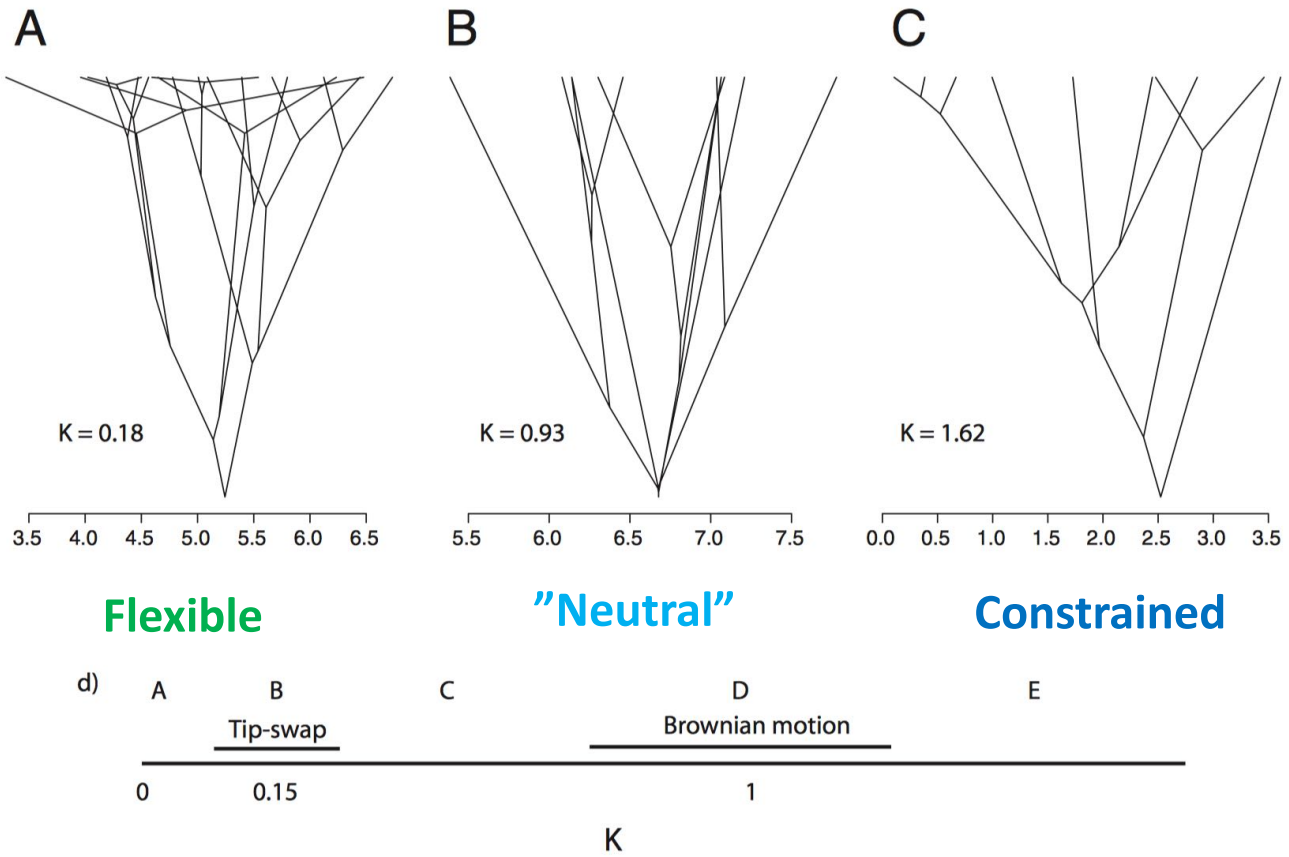
CT = Critical temperature

Phylogenies can provide insights on rates of evolutionary change (adaptation)



Ackerly 2009 PNAS

Phylogenies can provide insights on rates of evolutionary change (adaptation)

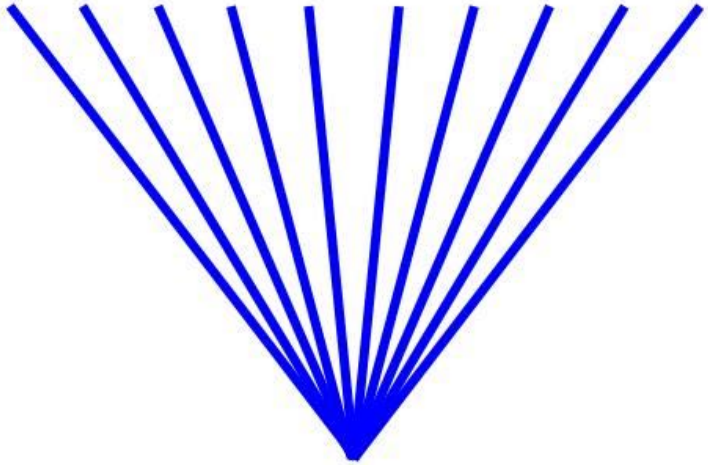


Blomberg's K

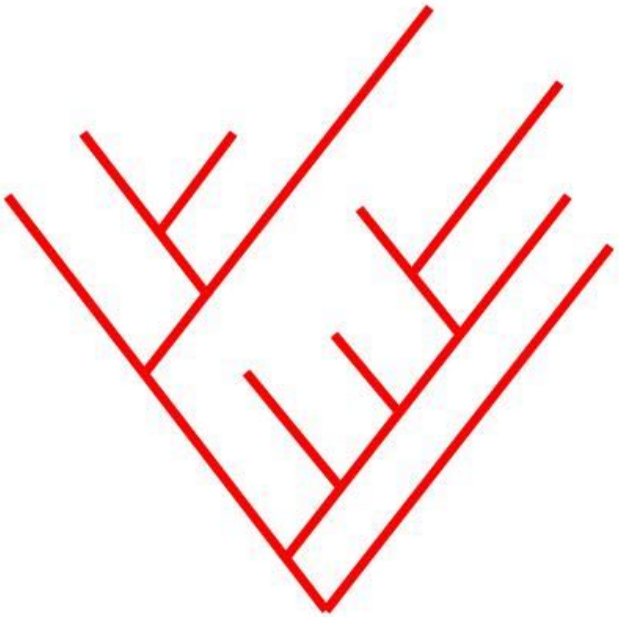
Complication - testing correlations across species

(for example, what is the correlation between CTmax and observed maximum temperatures?)

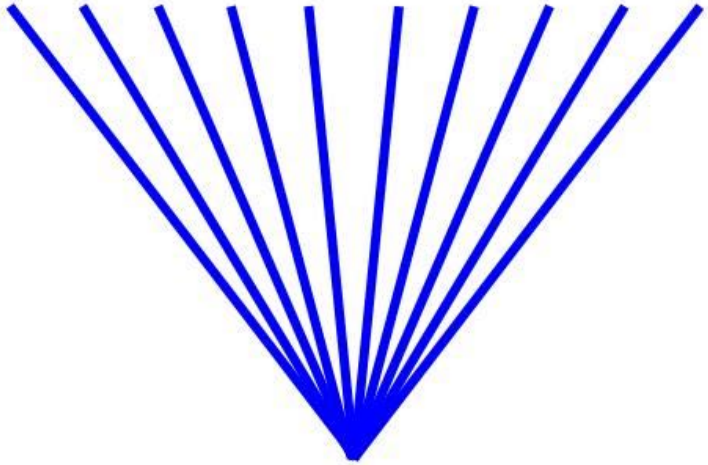
What Conventional Statistical Methods Assume



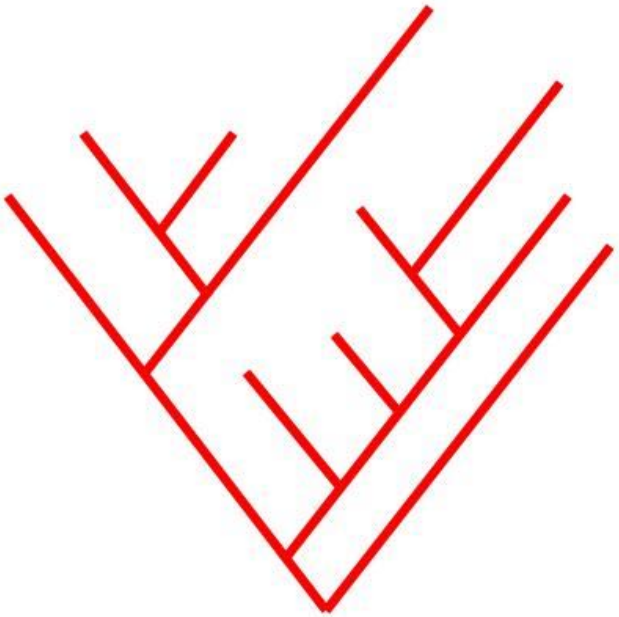
What Evolution Provides



What Conventional Statistical Methods Assume



What Evolution Provides



Two somewhat different approaches

1) Incorporate phylogenetic information in your statistical analyses
2) Focus on contrasts between closely related species that differ in the trait of interest

Thermal tolerance, range shifting, and rates of evolutionary change projects

- Focus on a monophyletic group of organisms
- Develop a hypothesis about thermal tolerance
- Your hypothesis might include information about realized or fundamental niches and maybe range shifting
- Test your hypothesis
- Analyses will be in R (no BCCVL)