

Large-scale temporal and spatial variation in insect body size

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Ecological importance of insect body size

Fecundity (Honěk 1993)

Population biology

(Siemann et al 1996; White et al 2007)

Disease transmission

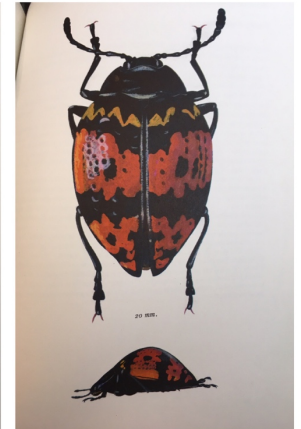
(Russell et al. 2011)

Food web structuring

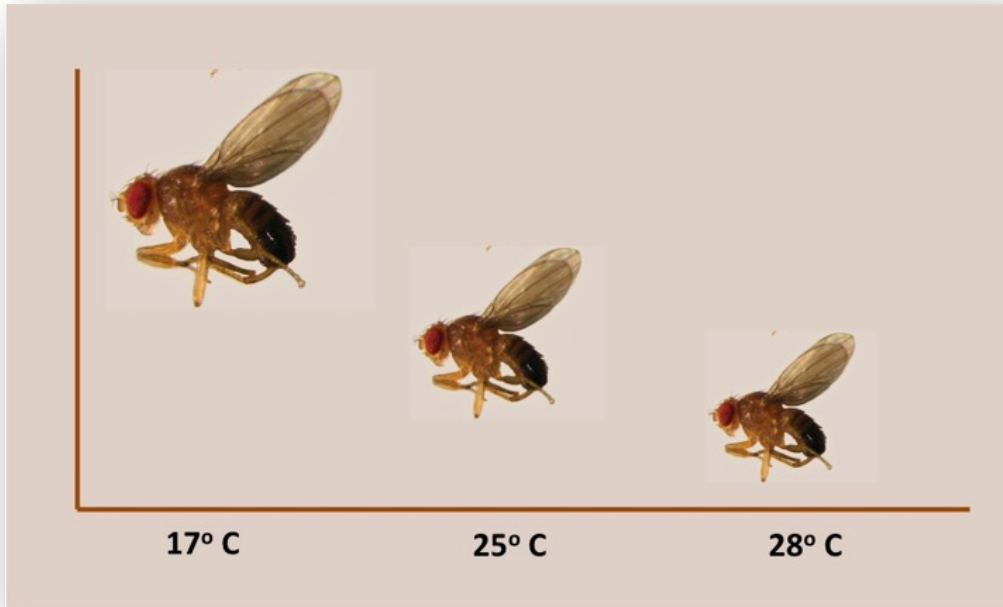
(DeLong et al 2015)

Ecosystem services

(Sheridan & Bickford 2011)



Temperature-Size Rule



e.g. Drosophila,
mature at a smaller
size when raised at
warmer temperatures

Shrinking bodies: universal response to warming?

Opinion

Cell
PRESS

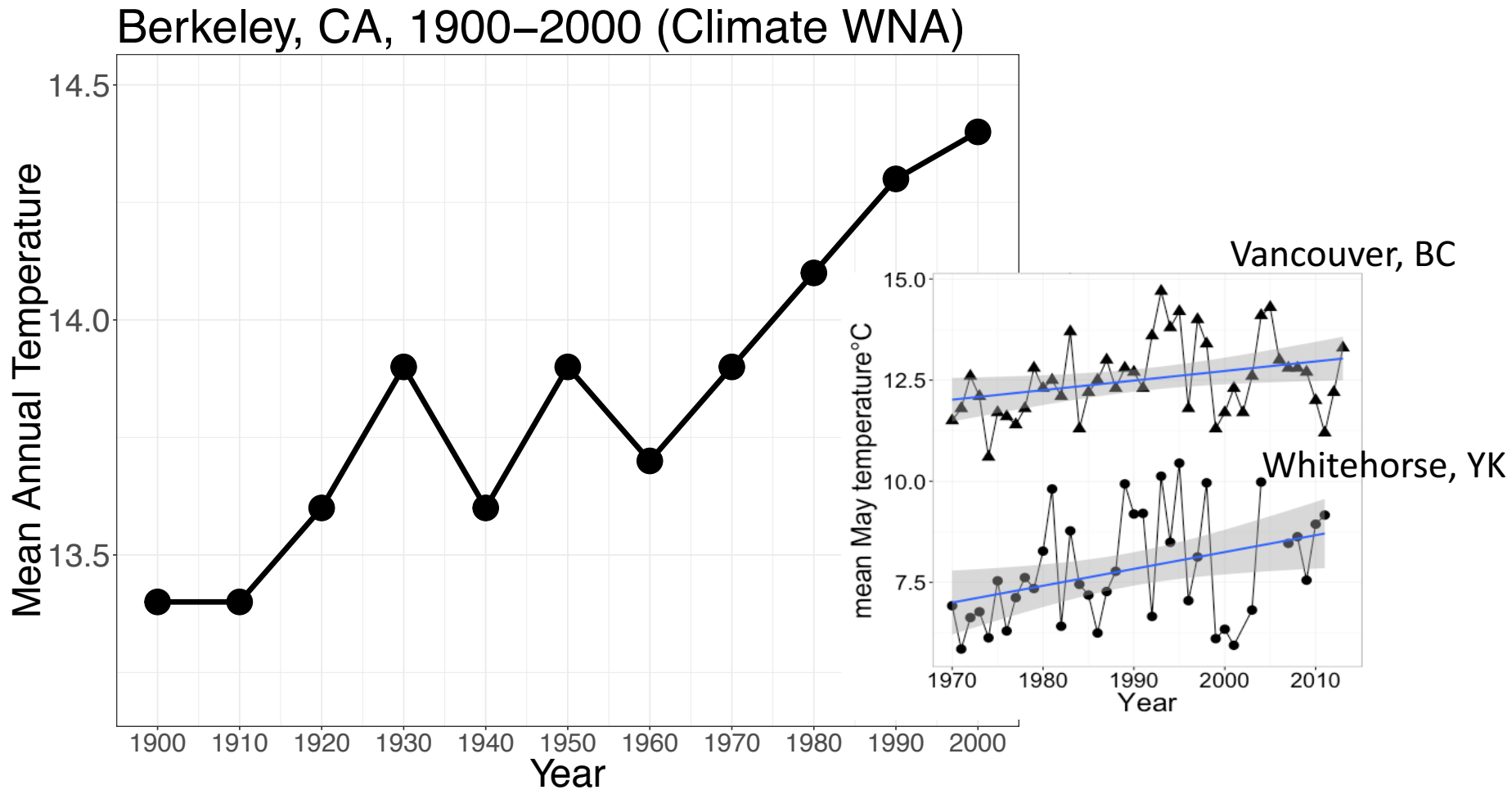
Declining body size: a third universal response to warming?

Janet L. Gardner¹, Anne Peters^{2,3}, Michael R. Kearney⁴,
Leo Joseph⁵ and Robert Heinsohn¹

¹ Fenner School of Environment and Society, Australian National University, Canberra, ACT 0200, Australia

Trends in Ecology and Evolution, 2011

Climate is warming steadily. Are insects shrinking?



Use collections from the Beaty Biodiversity Museum to test insect responses to warming

Insect Ecology class project, spring 2016



Karen Needham
Assistant Curator
Spencer Entomological Collection
Beaty Biodiversity Museum



Biol411, Insect Ecology Students (23)

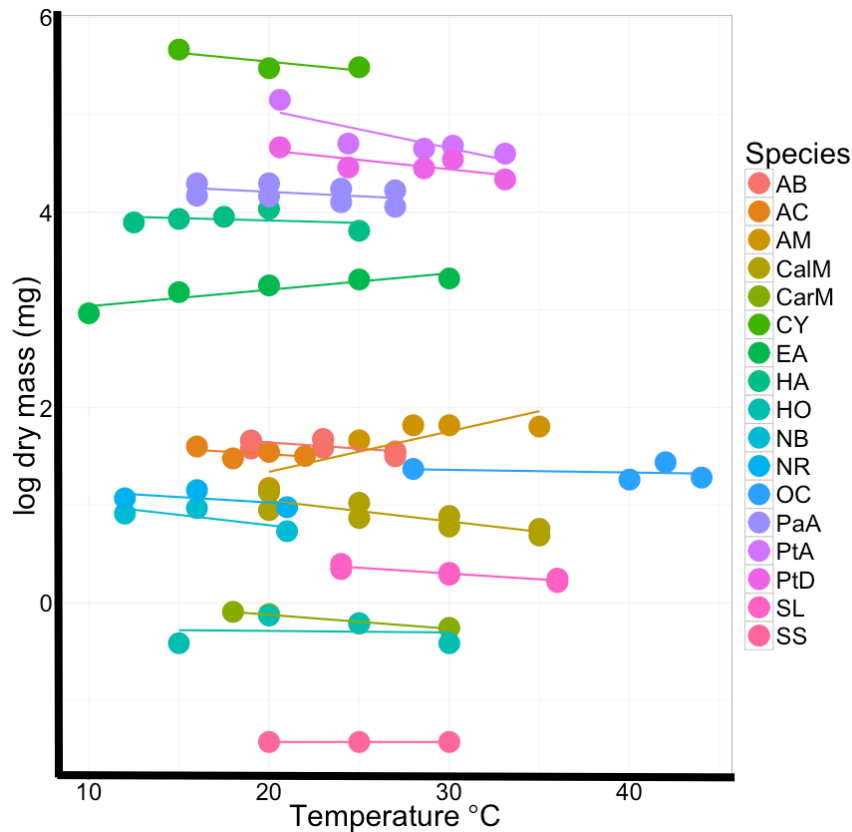
Why beetles?

- Hugely diverse: 350,000 described species
- Every ecosystem; diverse ecological roles
- Readily available in the Beaty Biodiversity Museum



First: Do beetles show 'temperature-size rule' in the lab? → meta-analysis

Do beetles show 'temperature-size rule' in the lab? Meta-analysis: Mostly Yes

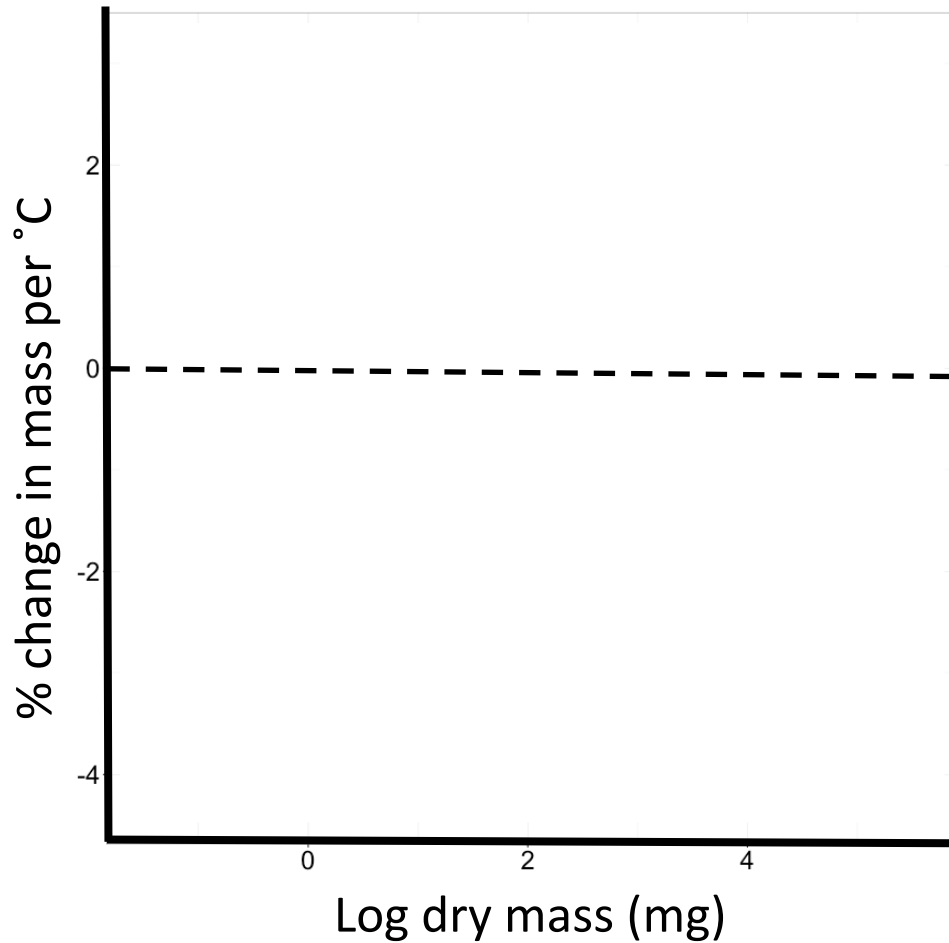


20 studies:

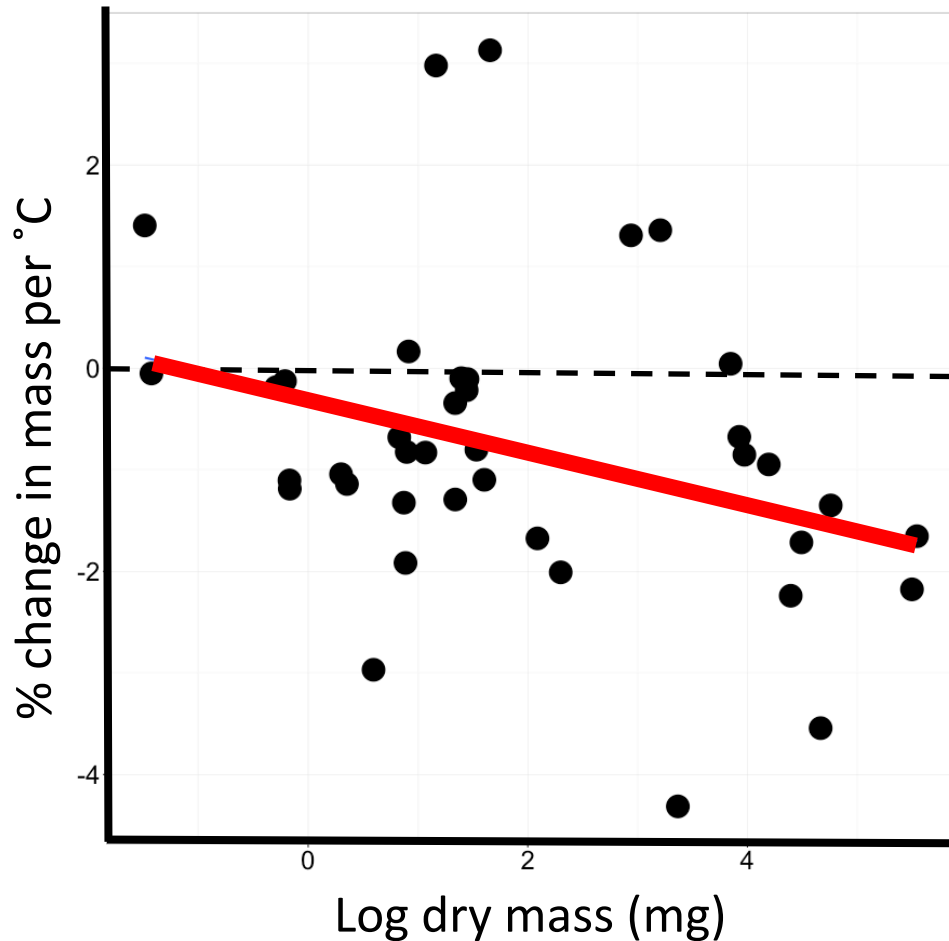
Most species decreased in size as rearing temperature increased; no effect of sex

Temp: $\chi^2_{(3)}=35.8, p<0.001$

Relationship between body size and how much a species responds to temperature?



Are larger-bodied species reacting differently to temperature change?



RMA regression:
 $p = 0.02$; $r = -0.32$

Avg change in body mass per °C
 -0.77% (± 0.46 95% CI)

→ Larger beetles
shrink more

Examine long-term body size trends using museum collections

Region 1, BC



Pterostichus algidus



Pterostichus melanarius



Staphinotus angusticollis



Carabus nemoralis

Region 2, BC



Amara quenseli



Cymindis planipennis

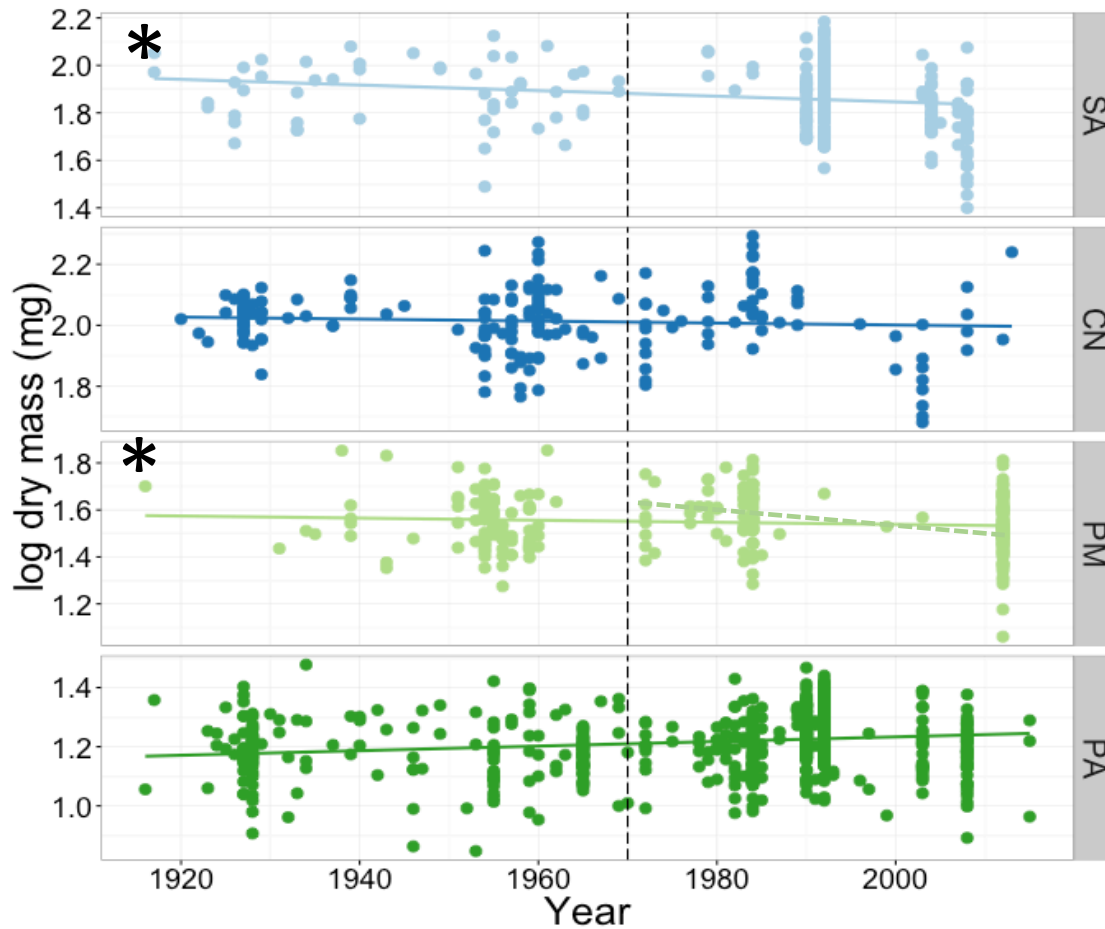


Harpalus fraternus



Euryderus grossus

Region 1 All Years: 2/4 beetles decreased in size



Staphinotus angusticollis



Carabus nemoralis

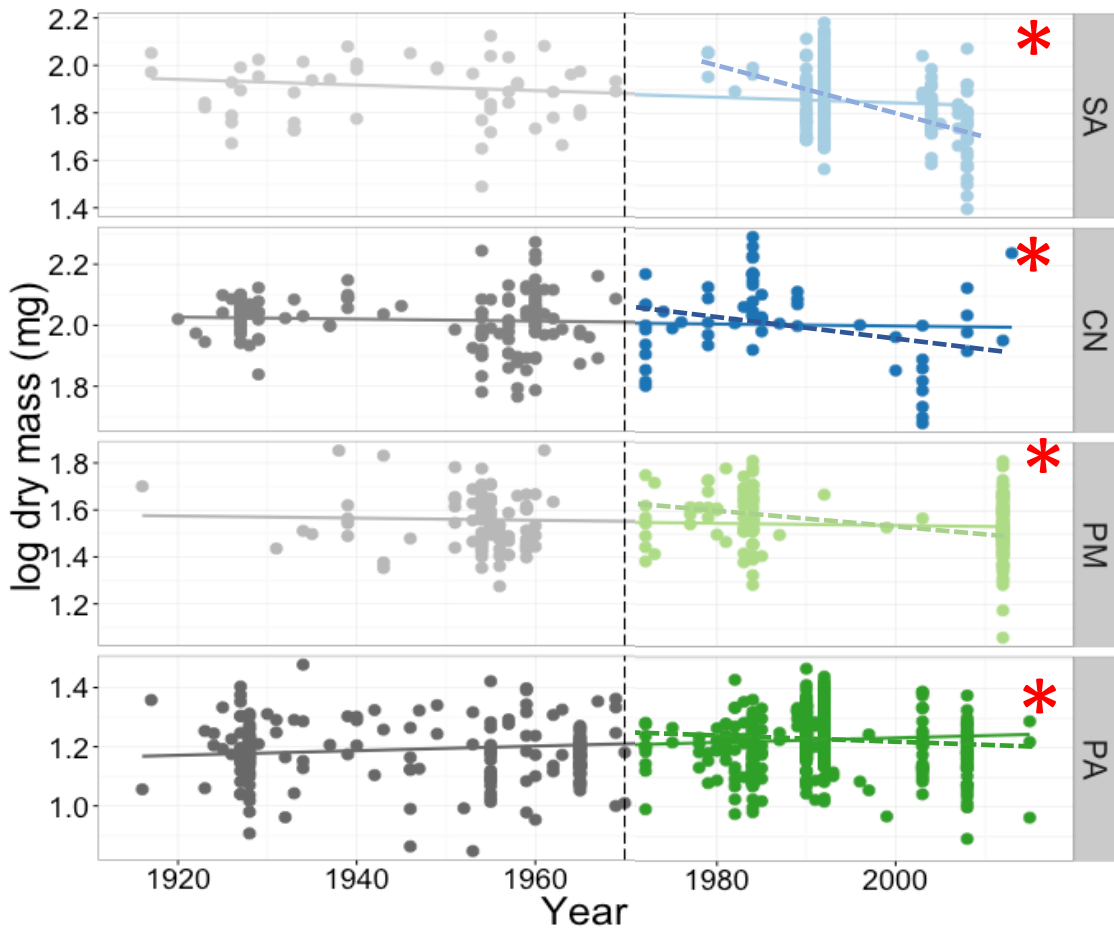


Pterostichus melanarius



Pterostichus aldigus

Region 1 post 1970: 4/4 decreased



Staphinotus angusticollis



Carabus nemoralis

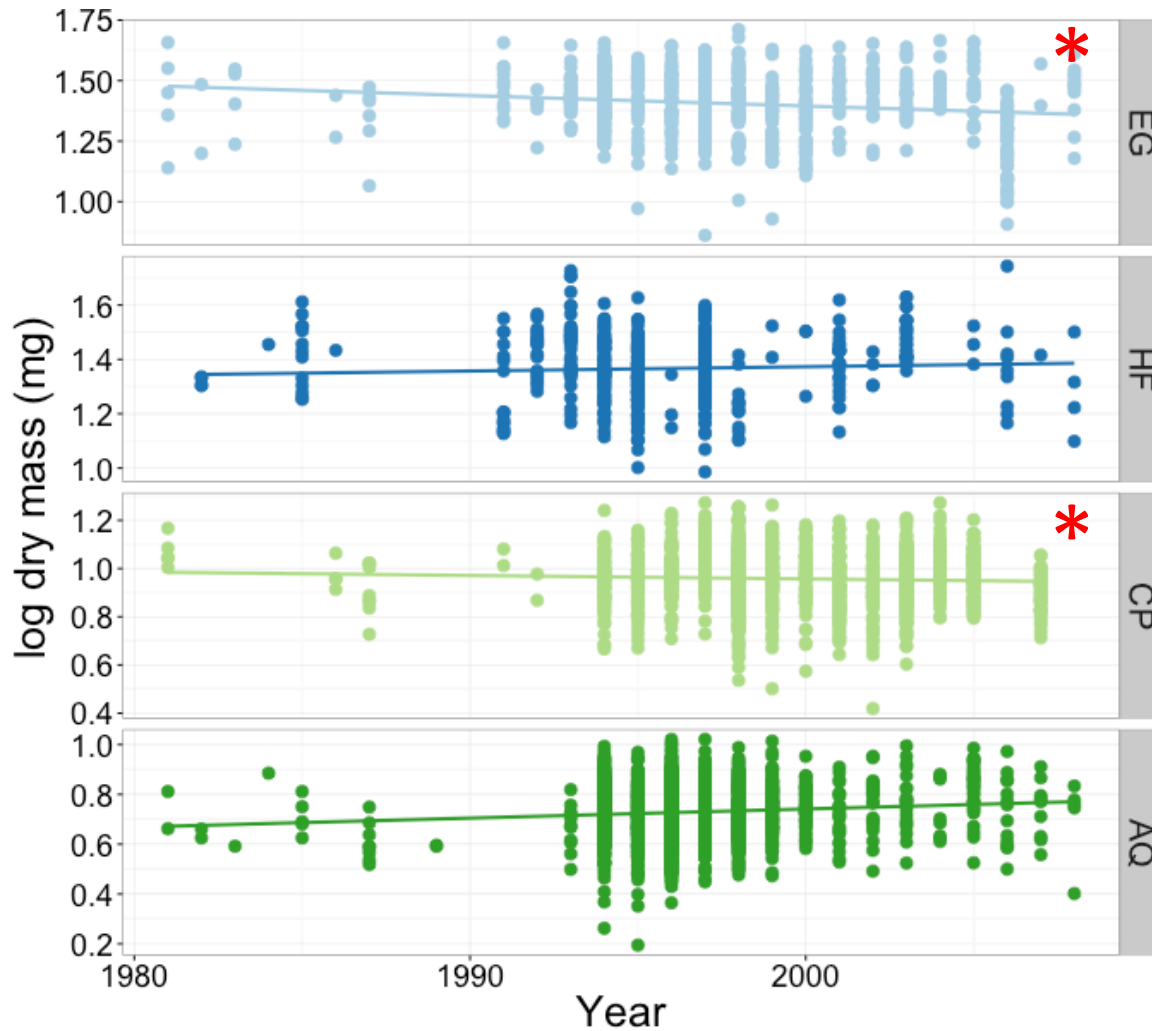


Pterostichus melanarius

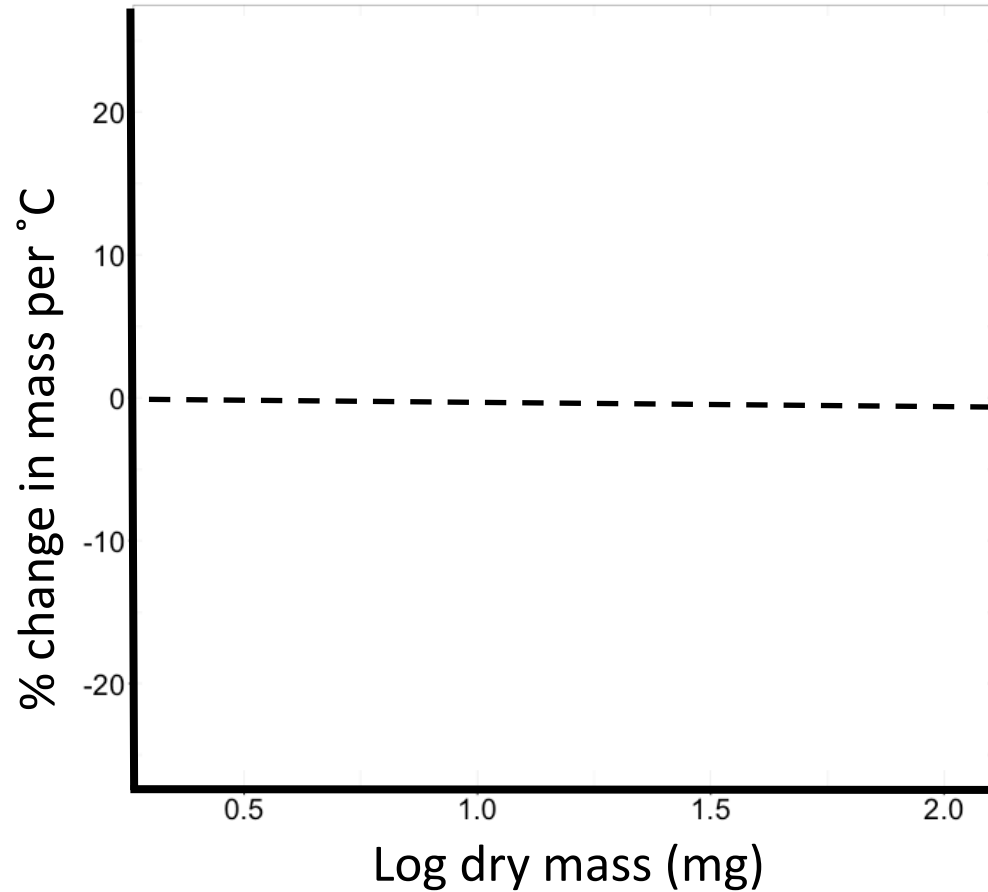


Pterostichus aldigus

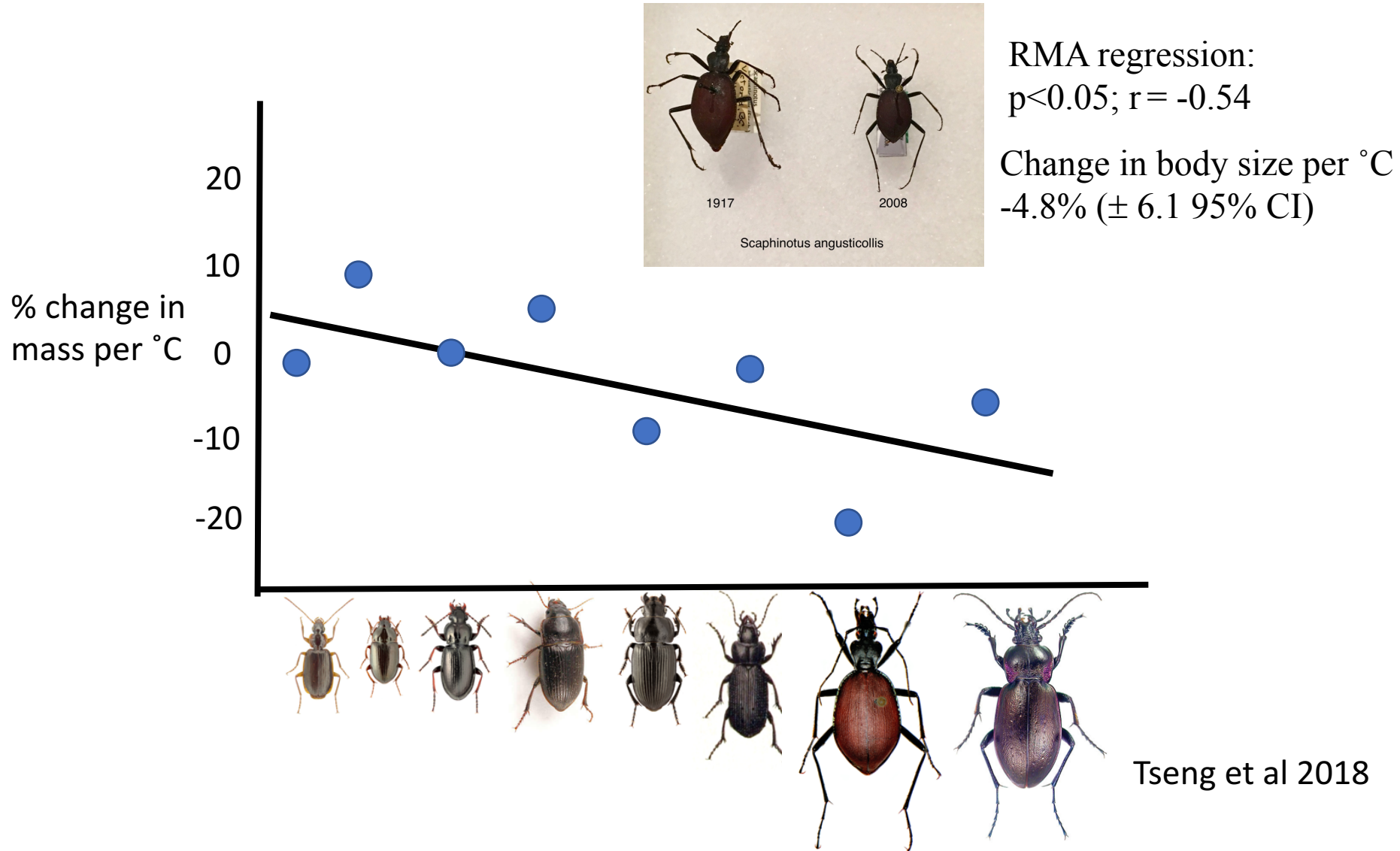
Region 2: 2/4 beetles decreased in size (1980-2015)



Museum data: are larger-bodies species reacting differently to temperature?

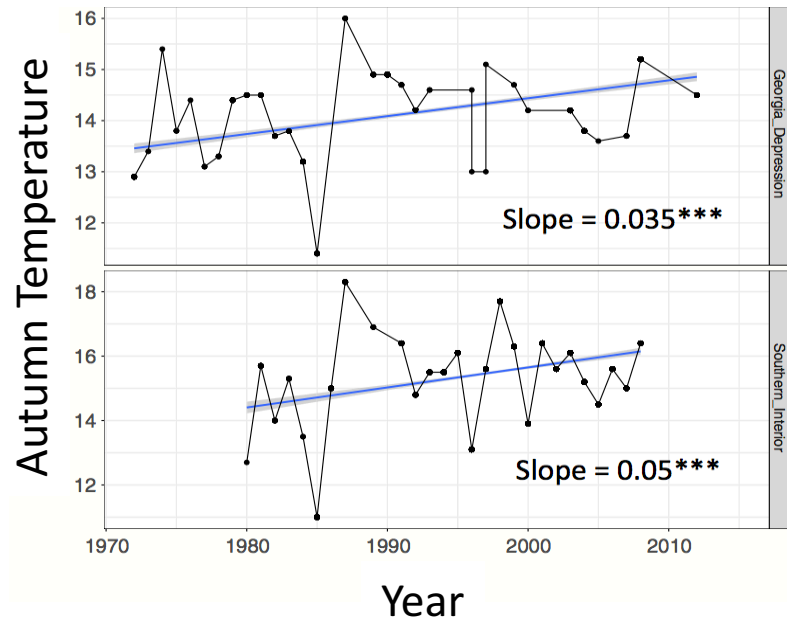


Museum data: larger-bodied beetles have shrunk more

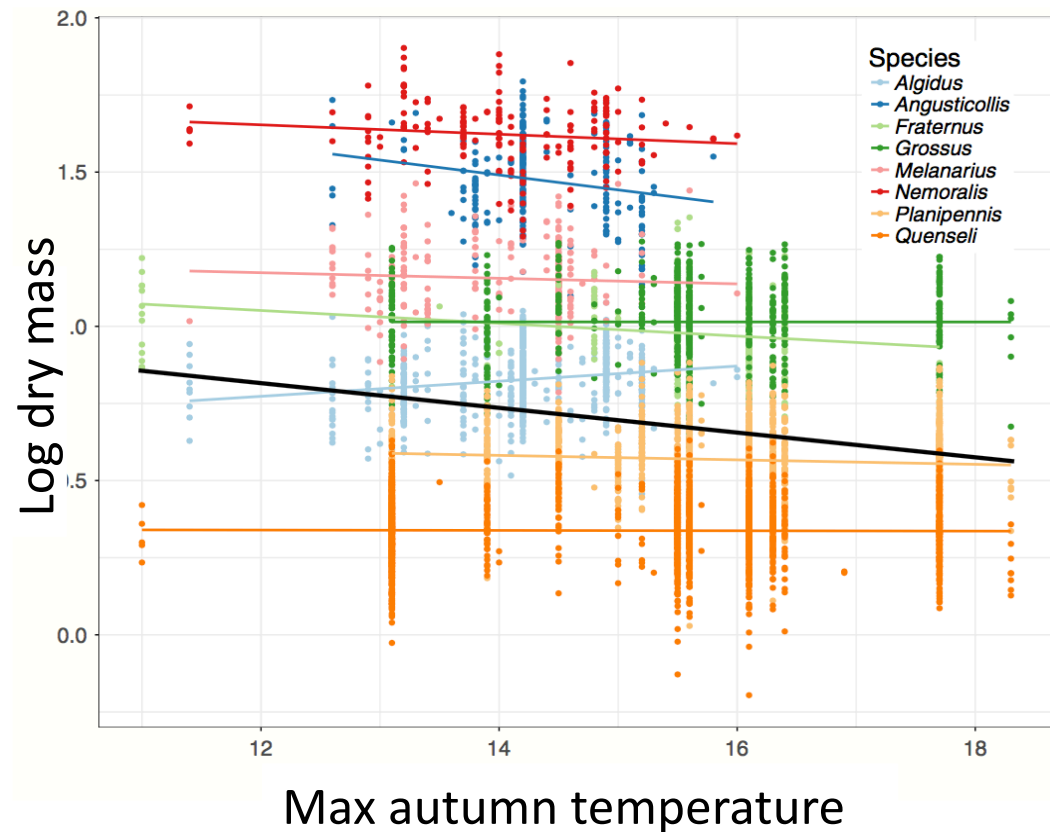


Changes in body size linked to autumn temperatures

Autumn temperatures have increased



Beetle body size decreases with increasing autumn temperatures



Shrinking beetles – Summary

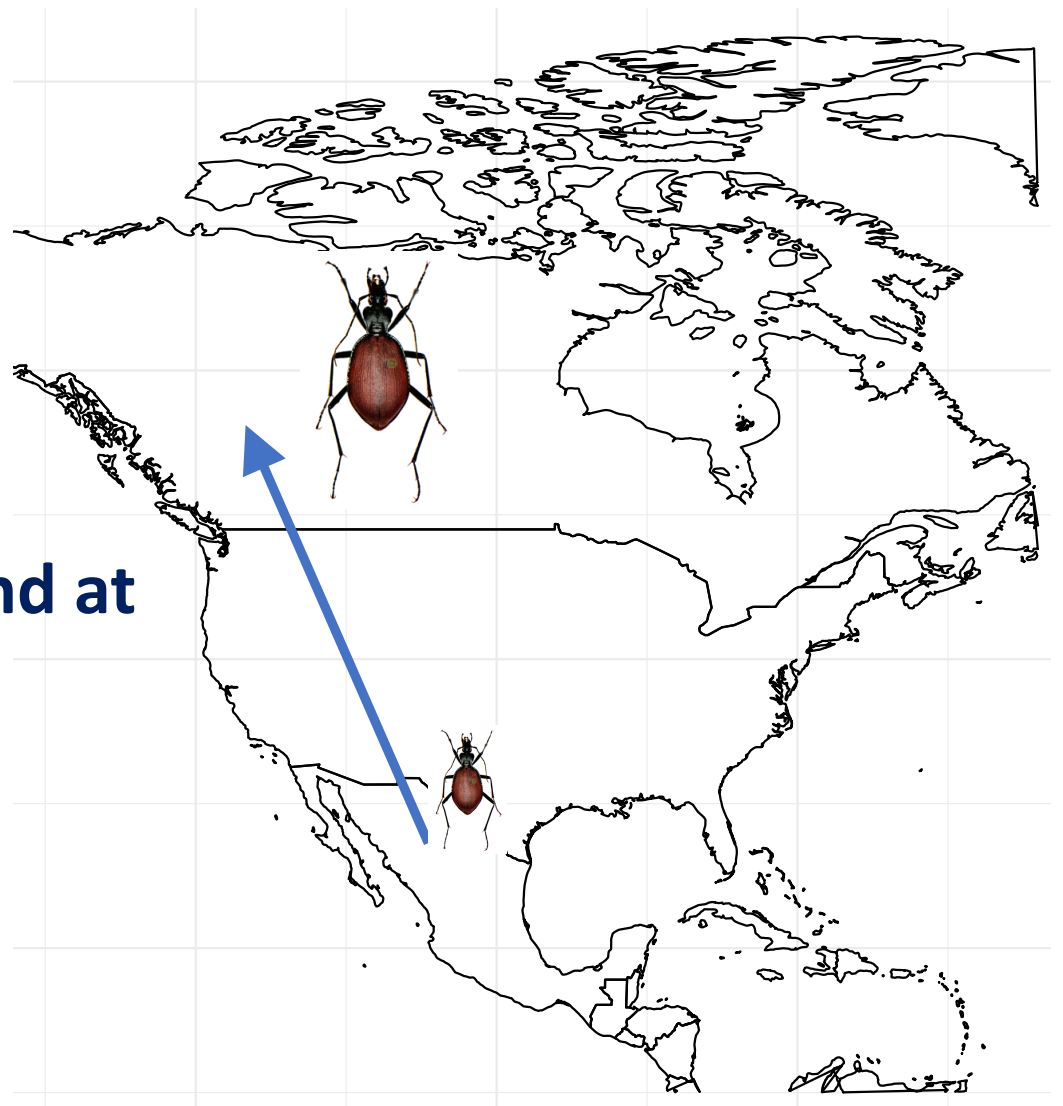
- Beetles decrease in size as temperature warms
- Larger-bodied species decrease more
- Are these patterns reflected across latitudinal gradients?



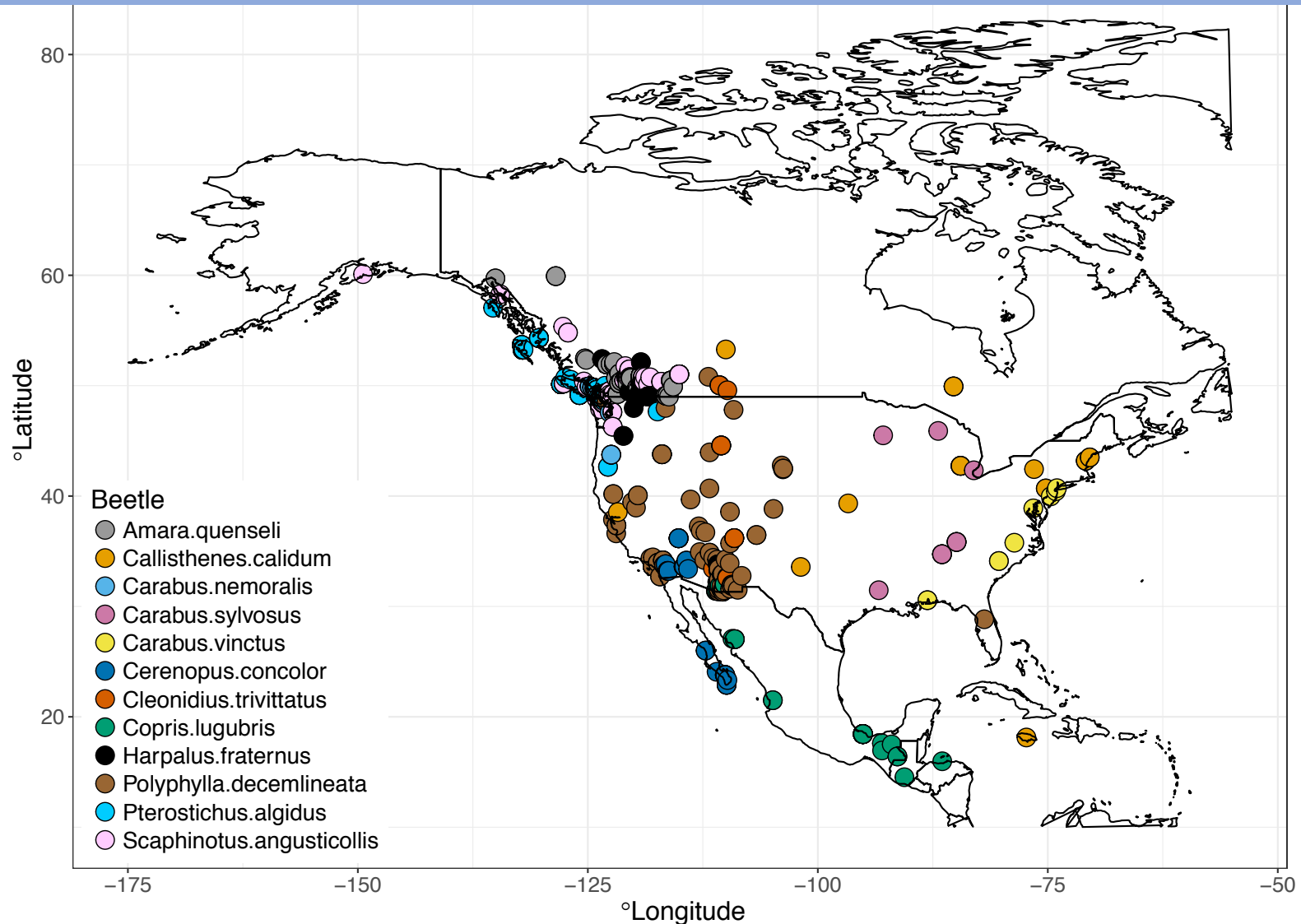
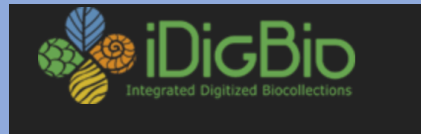
Body size – latitude relationships

**Bergmann's Rule:
(Bergmann 1847)**

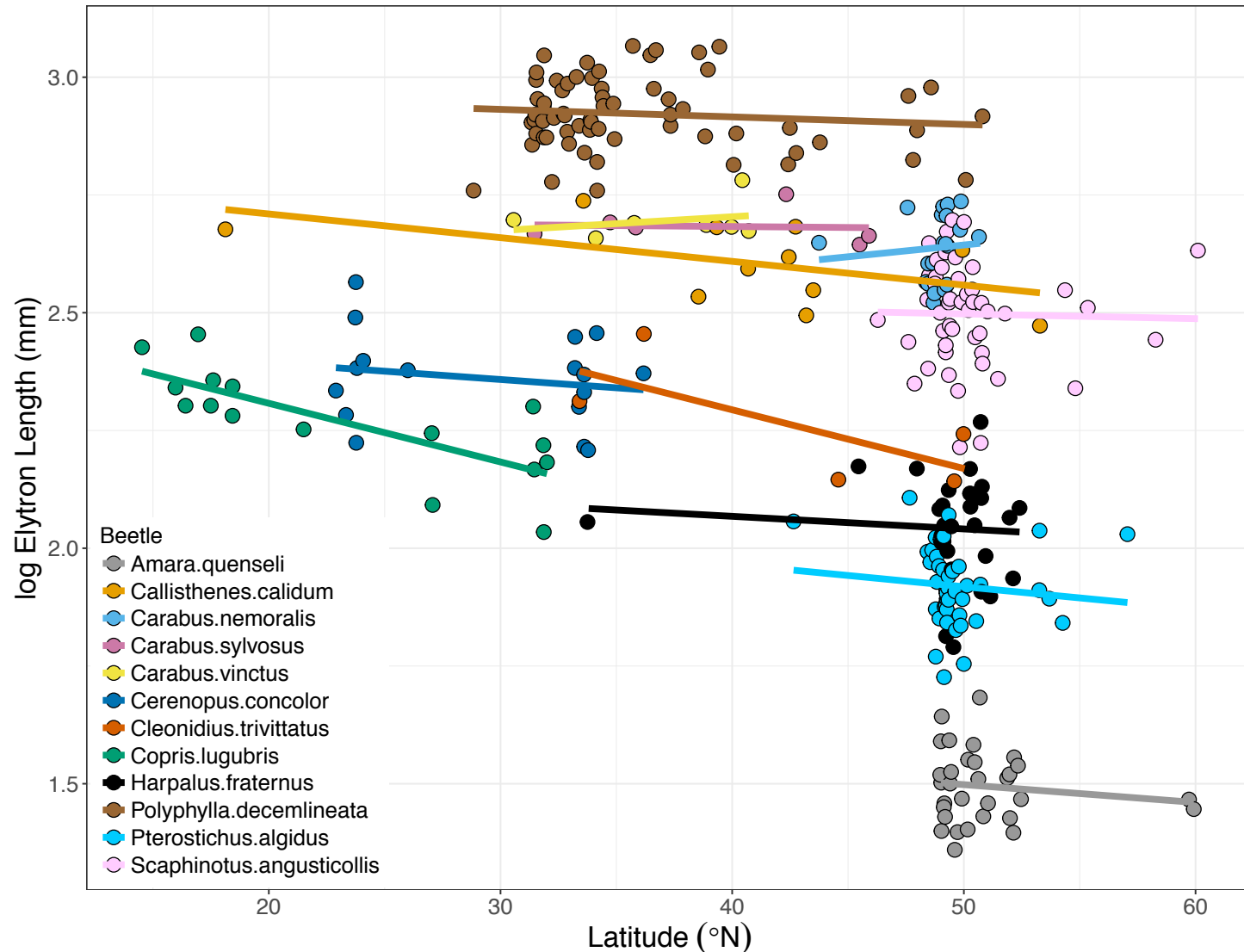
**Within species: larger-
bodied individuals found at
higher latitudes**



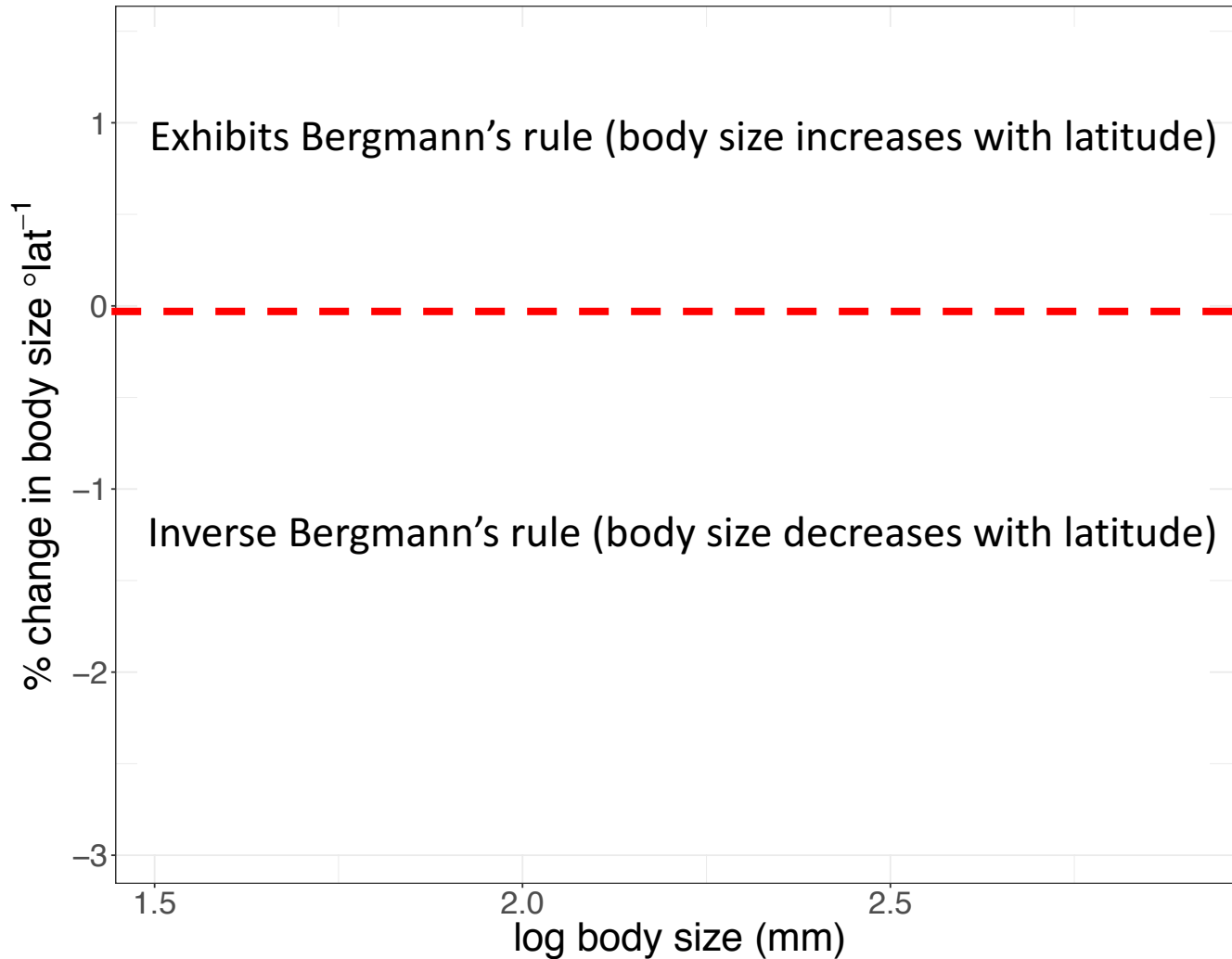
Measured 4000 individuals, 12 species



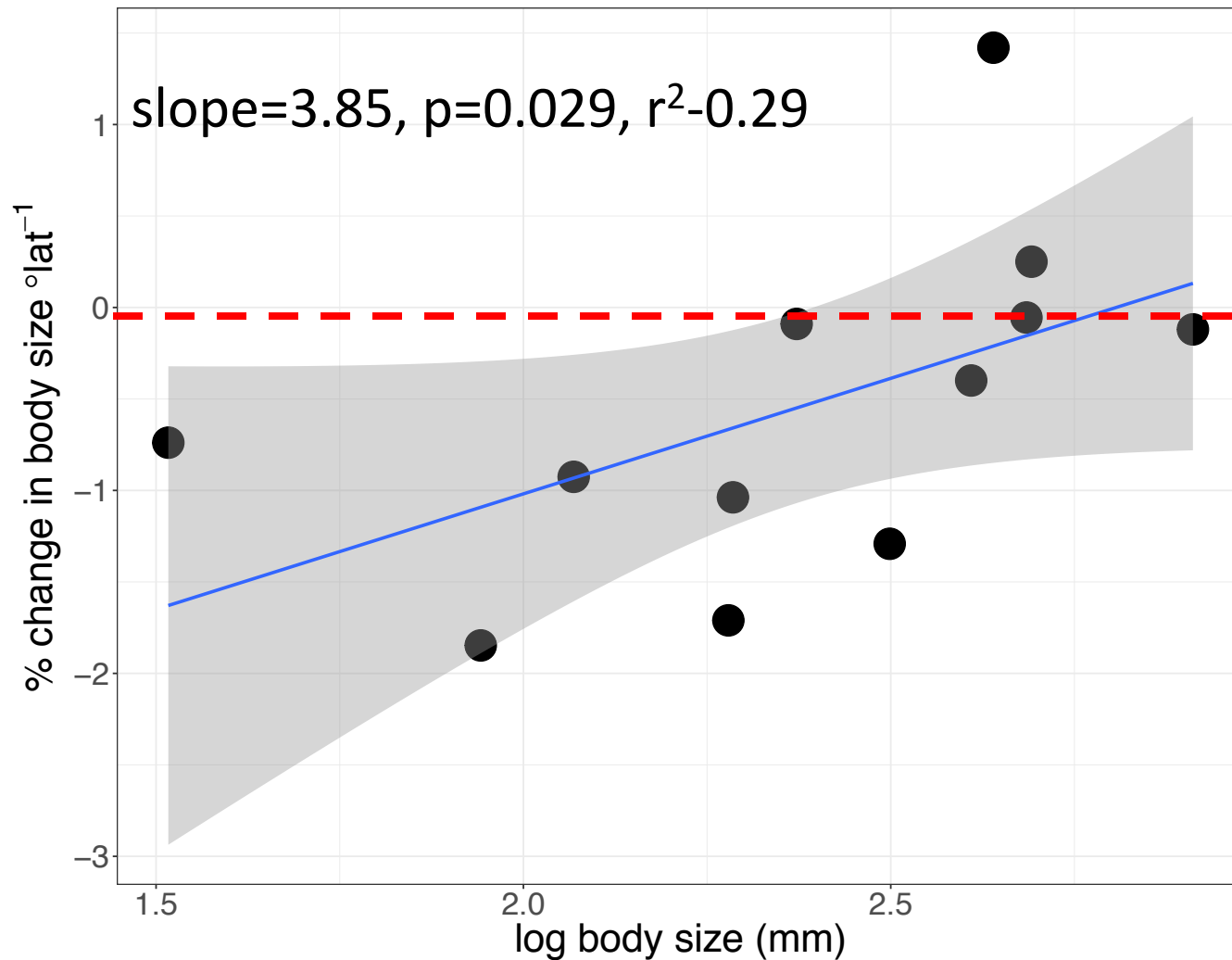
Lots of interspecific variation in latitude-body size relationships



But similar to temperature results – larger beetles show



Most beetles decrease in size with latitude; but not larger-bodied beetles



Bergmann's rule
(body size increases
with latitude)

Inverse Bergmann's
rule (body size
decreases with
latitude)

Summary

- Larger-bodied beetles are shrinking with climate change;
- Larger-bodied beetles more likely to increase in size with latitude; opposite for smaller beetles



Summary

- Lab responses to temperature predict
 - responses to temperature in nature
 - some responses to latitude in nature
- Understanding large-scale temporal and spatial patterns facilitated by physical and digital natural history collections



Thanks for listening!

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Come Join Us!



Photo by Derek Tan

