**Temporal response of mammal body size to temperature**

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**Abstract**

**Introduction**

Current and future changes in the climate of the planet, in particular increasing global temperatures, have potential direct implications for the sizes of organisms. The relationship between the size of endotherm species and temperature is generally negative. This pattern is referred to as Bergmann’s rule due to it being initially described by the German biologist Karl Bergmann (Bergmann, 1847). Evidence for the prevalence of this rule among endotherm species has been documented for over a century [bunch of sources]. It has therefore recently been predicted that, due to increasing temperatures from climate change, endotherm species will be decreasing in size in the near future (Gardner et al., 2011; Sheridan and Bickford, 2011). Organismal size is an important ecological characteristic that affects many aspects of ecosystems, including resource use [source], interspecific interactions [source], and ecosystem processes [source]. Because of the diverse impacts of body size, changing sizes due to climate change could result in drastic changes in ecosystems.

There is some evidence that a negative temperature-body size relationship is not as common among endotherm species as previously believed (Riemer et al., 2018). Even if this relationship does occur, it is possible that the many other factors that affect body size in addition to temperature in ecosystems, including predator-prey interactions [source] and resource availability [source], have a more substantial impact. If temperature increases do not have a strong and directional impact on body size, it will be more difficult to predict how climate change will shift species body sizes. It is crucial to be able to predict these size changes because of the importance of size on the functioning of ecological systems. How body size responds to temperature over time also have been examined infrequently, though it has been shown that x [source] and y [source]. It is especially important to understand how size will change dynamically from shifting temperatures.

We addressed temporal shifts in body size due to temperature by compiling long-term time series of mammal communities from x locations. This consisted of size measurements for xxx,xxx individuals, which were used to determine average mass of xx species across at least 5 years. This was combined with a global temperature dataset to determine the strength and direction of the relationship between species mass and temperature. We were able to show how mammal size is impacted by temperature over time. This data-intensive approach addresses limitations of previous work on the temperature-mass relationship, which consisted of studies on single species and meta-analyses derived from those studies.

**Methods**

*Datasets* (size and temperature)

P1

* Source of size data = small mammal time series
* Requirements for each of the datasets
  + Ten+ years of continuous data
  + Individual size measurements
* Brief summary of three datasets
  + Portal = long term experimental plots in Chihuahan desert, purpose is looking at community dynamics in mammals, plants, and ants
  + Fray Jorge = similar long term experimental plants in Chilean national park…
  + Sevilleta = … (8 different sites combined as one due to close proximity and similar temperature regimes)
  + Portal and Fray Jorge downloaded using data retriever (dataset citations); additional metadata from Ecological Archives
  + Sevilleta downloaded from UNM digital repository (dataset citation); also metadata

P2

* Final combined dataset stats
  + Total number of individuals
  + Total number of species
  + Earliest and latest years
  + Table of stats (rmarkdown)
* Cleaning done on all datasets
  + Individuals
    - Only from rodent species
    - Have weight
    - Have species IDed
    - From control treatments if experimental (Portal & Fray Jorge)
    - If recaptured…
  + Only adult individuals
    - Portal = shown as non-juveniles
    - Fray Jorge = perforated females & descended testes males
    - Sevilleta = shown as adult
  + Species
    - Cutoffs: x individuals per year & species
    - x years per species
* Description of final mass datasets
  + Mean mass of each species in each year
  + Also sd of mean mass
  + Species ID, site

P3

* Combined cleaned datasets with temp dataset
* Description of temp dataset
  + From NOAA/U of D
  + Global raster
  + Spatial and temporal resolutions
  + (dataset citation)
* How size and temp datasets were combined
  + Get all site locations
    - Portal = mean of UTM coordinates included with data
    - Fray Jorge = decimal degrees from Aguilera et al., 2016
    - Sevilleta = mean of all site coords from included metadata
    - All converted to latlon then temp grid format
    - Plot of locations on month of temp data
  + Extract all monthly temps from raster for each site’s coords
  + Calculate mean annual temps from this
  + Combine yearly temp with each species from each year
  + This is final dataset

*Analysis*

P1

* How temp and species masses changed over time at each site
* Temp change over time for each site
  + Linear regression stats?
* Mass change over time for all species at each site
  + Linear regression stats?

P2

* Combined mass and temp change
* Characterize with each species temp-mass relationship
* Linear regression
* Use r value instead of r2 to include direction
* Expect mostly negative
* Fully reproducible code on GitHub
* Cite packages used

**Results**

P1

* General conclusions across all sites
* 3 panel fig

P2

* Portal
  + Panel A: Temp tended to (increase/decrease)
  + Panel B: Of x species, y increased in size and z decreased in size
  + Panel C: Proportion of mrt relationships that were pos, neg, none were repectively x%, y%, and z%
* Fray Jorge
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**Discussion**

**Acknowledgements**

**References**

**Main figures**

* Site dataset metrics
* Site location map
* Yearly temp, yearly mass, mrt combined, and r distribution per site
* Mass change over time compared to temp change over time by species
* Table/plot of ARIMA model p-values

**Supplemental figures**

* Yearly mass split out by species
* Mrt split out by species