

# How do biological traits affect brachiopod taxonomic survival?

A hierarchical Bayesian approach

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## Observation

At K/Pg mass extinction, biological traits (except geographic range) have no effect on taxonomic survival.

(Jablonski, 1986, *Science*)

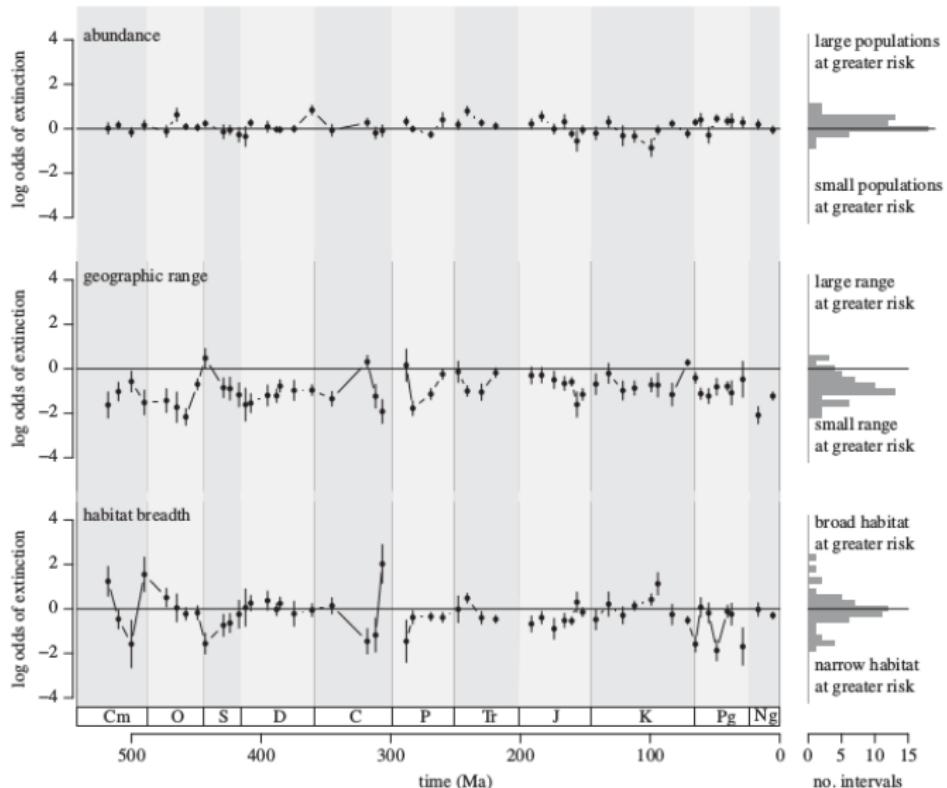
# Macroevolutionary process hypotheses

As extinction risk increases,  
the effect of geographic range  
increases.



As extinction risk increases,  
the effects of other traits  
decrease.

# Relationship between range size and extinction risk



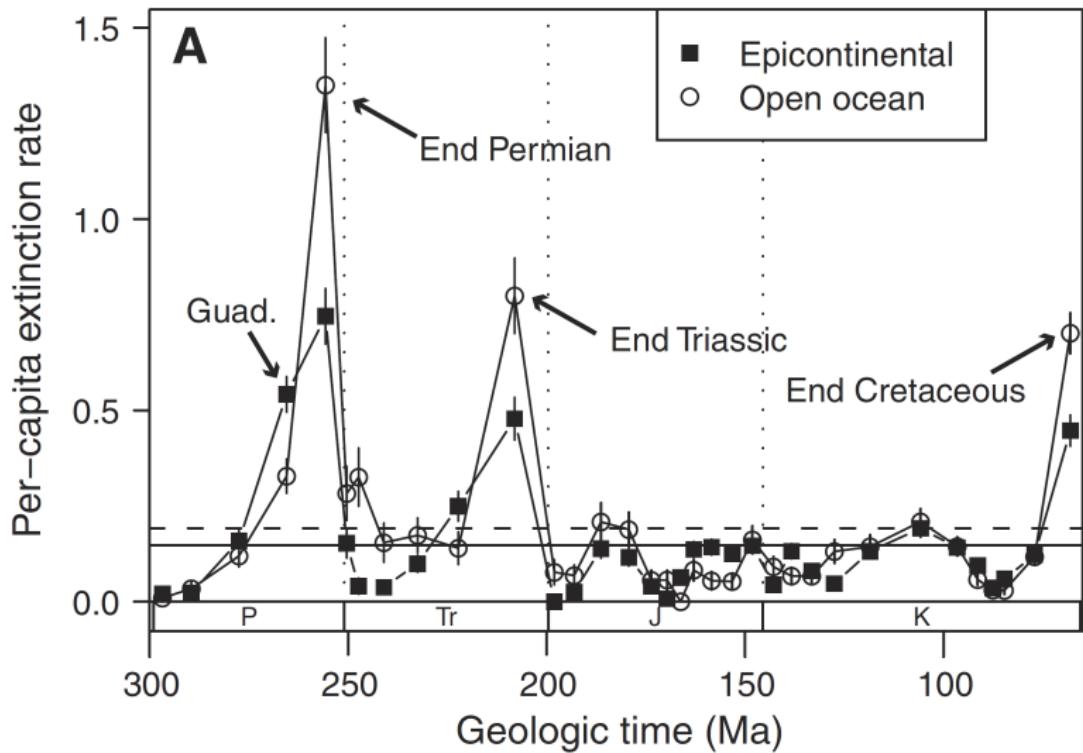
(Harnik and Simpson 2013 Proc B)

## Survival of the unspecialized

*When related phyla die out . . . more specialized phyla tend to become extinct before less specialized. This phenomenon is also far from universal, but it is so common that it does deserve recognition as a rule or principle in evolutionary studies: **the rule of the survival of the relatively unspecialized.***

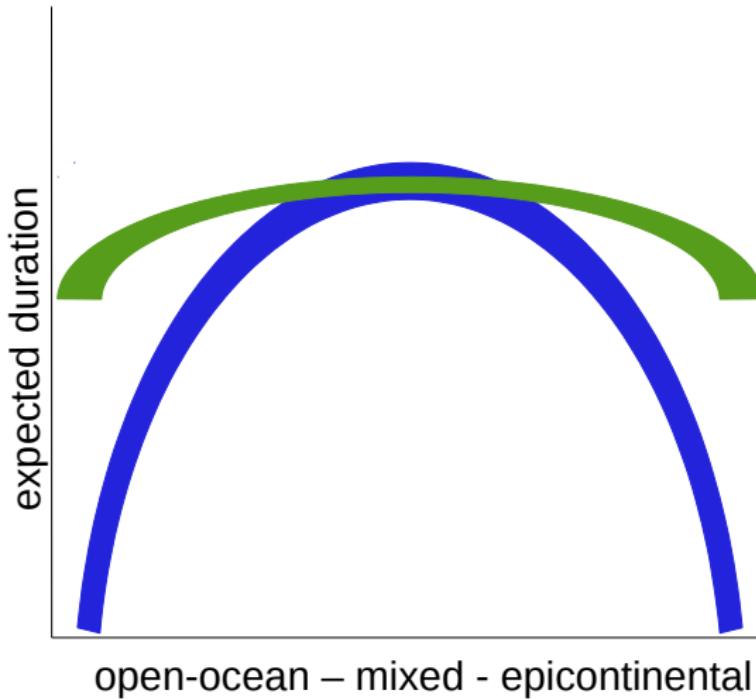
(Simpson, 1944, Tempo and Mode of Evolution, p. 143)

# Hypotheses of effect of environmental preference

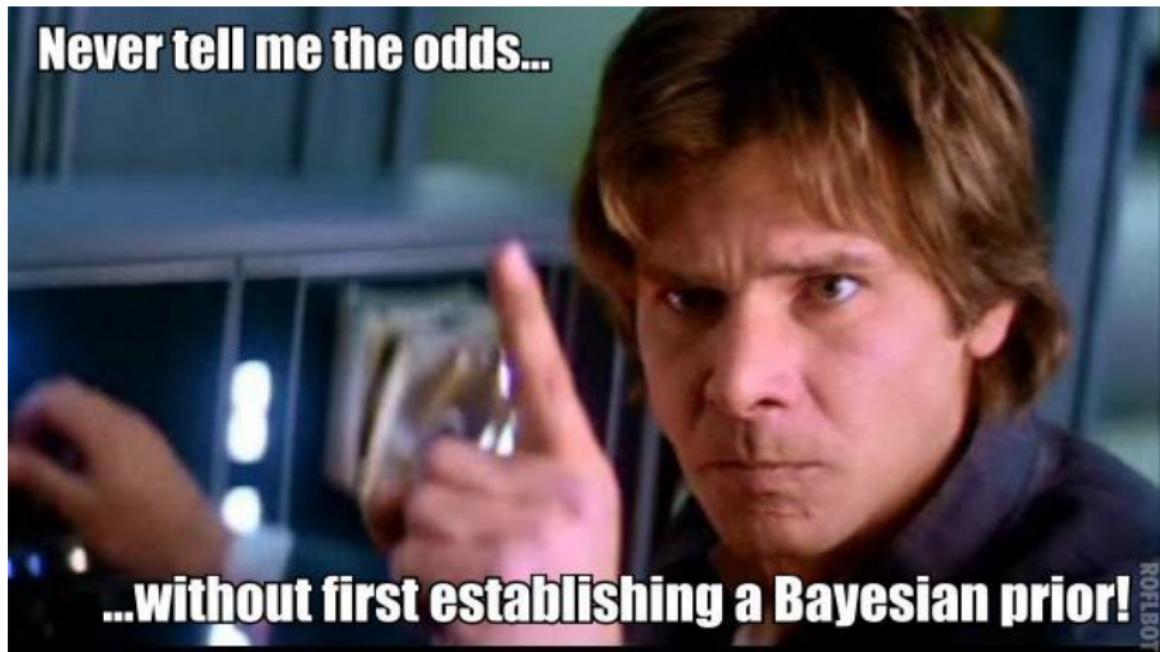


(Miller and Foote 2009 *Science*)

## Hypotheses of effect of environmental breadth

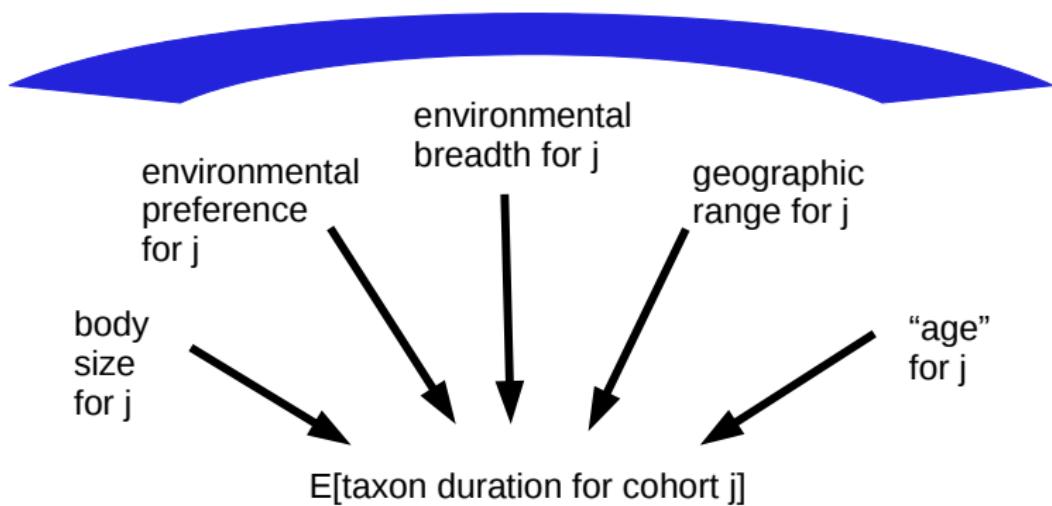


## Hierarchical bayesian model



# Hierarchical survival model

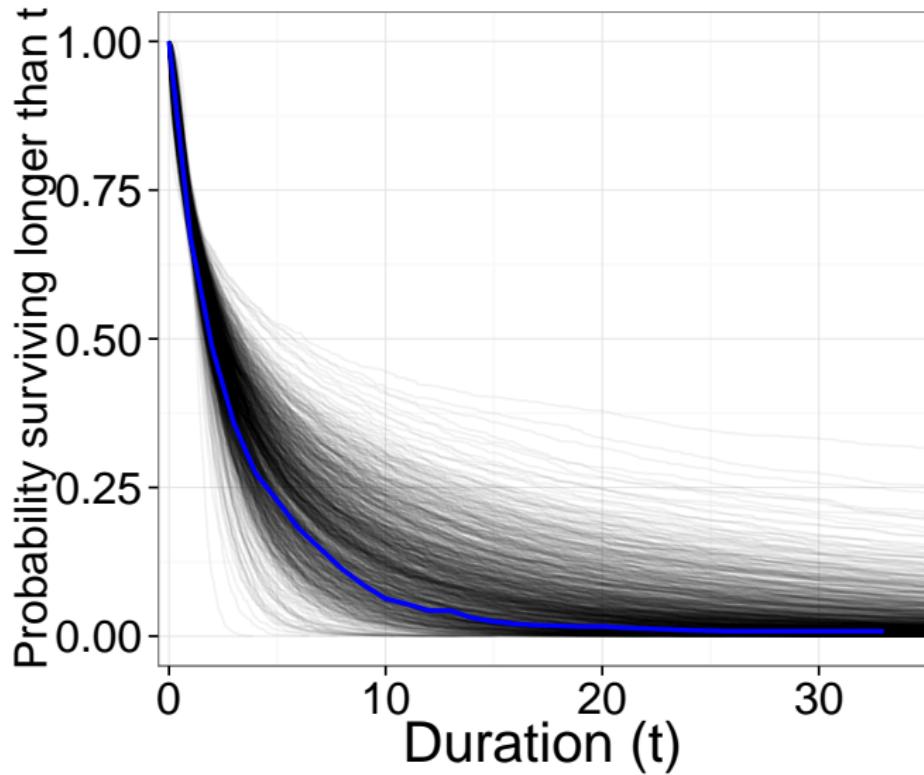
correlation of effects over time



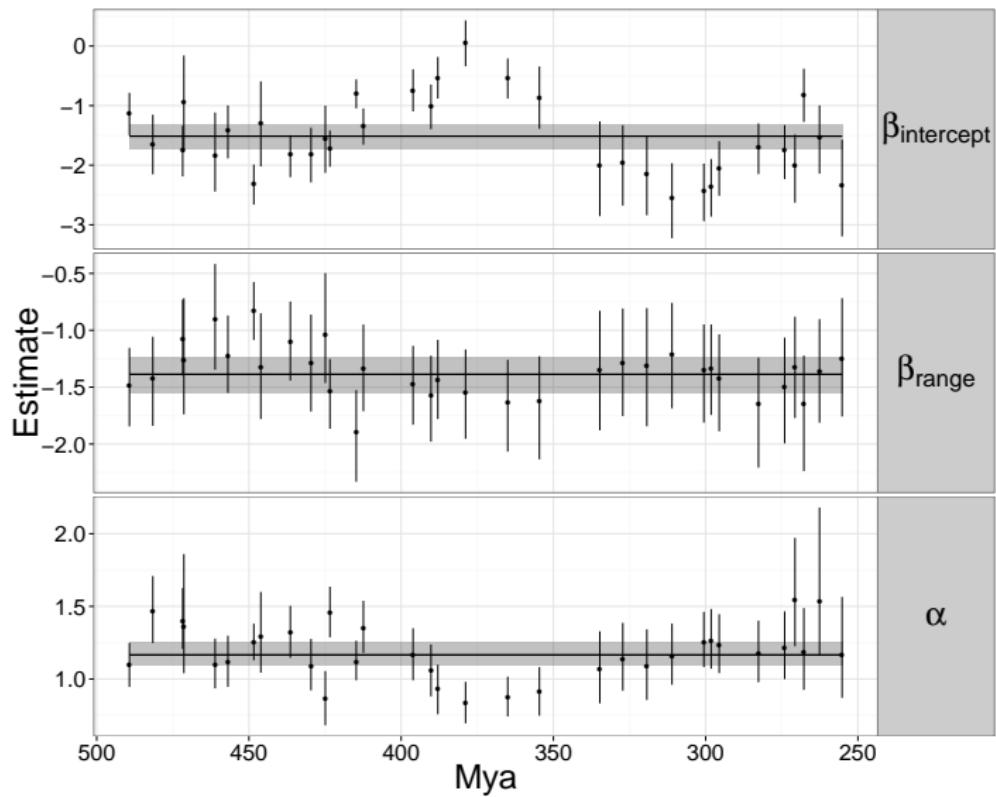
# Paleozoic brachiopods



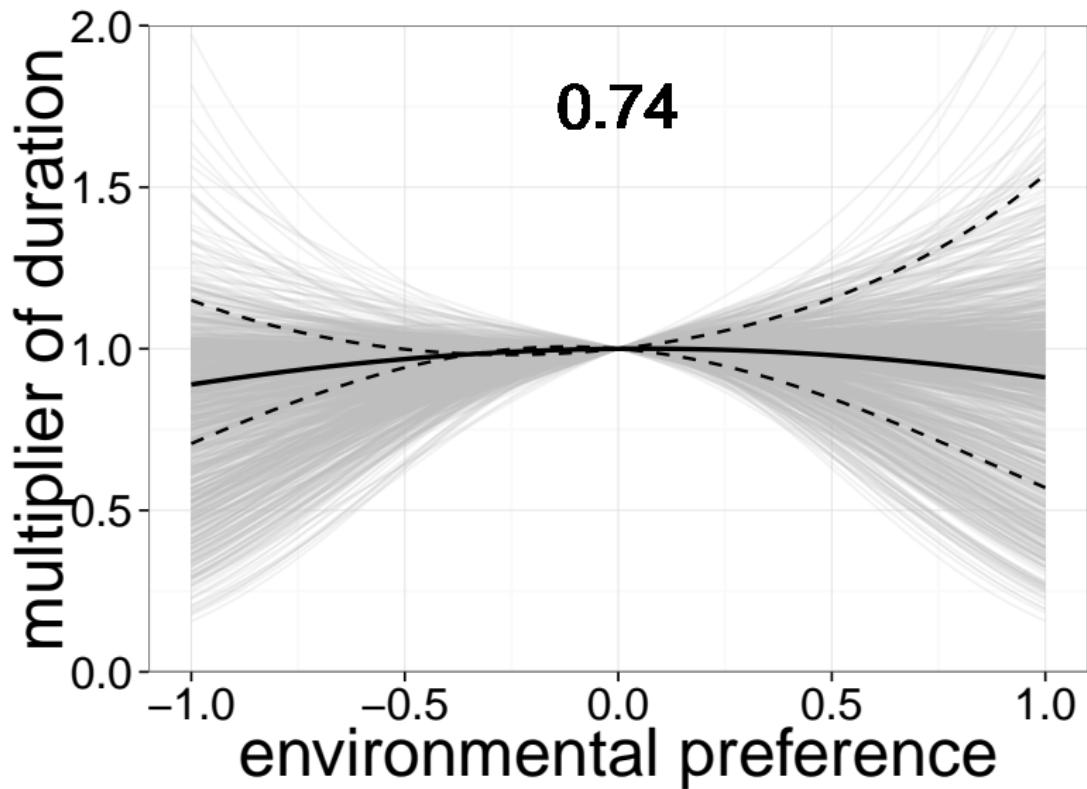
## Posterior predictive distribution of $S(t)$



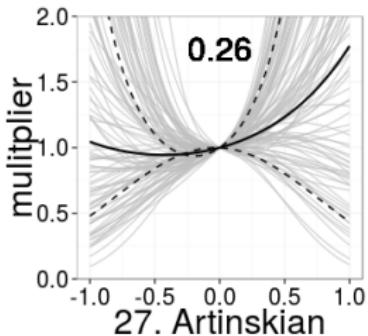
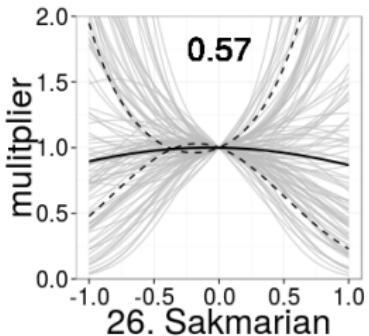
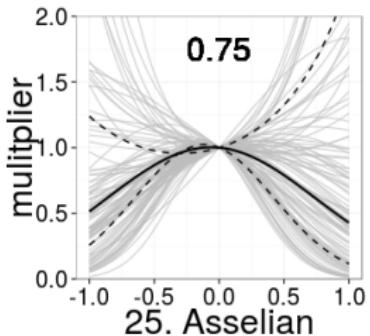
# Change in trait effects between cohorts



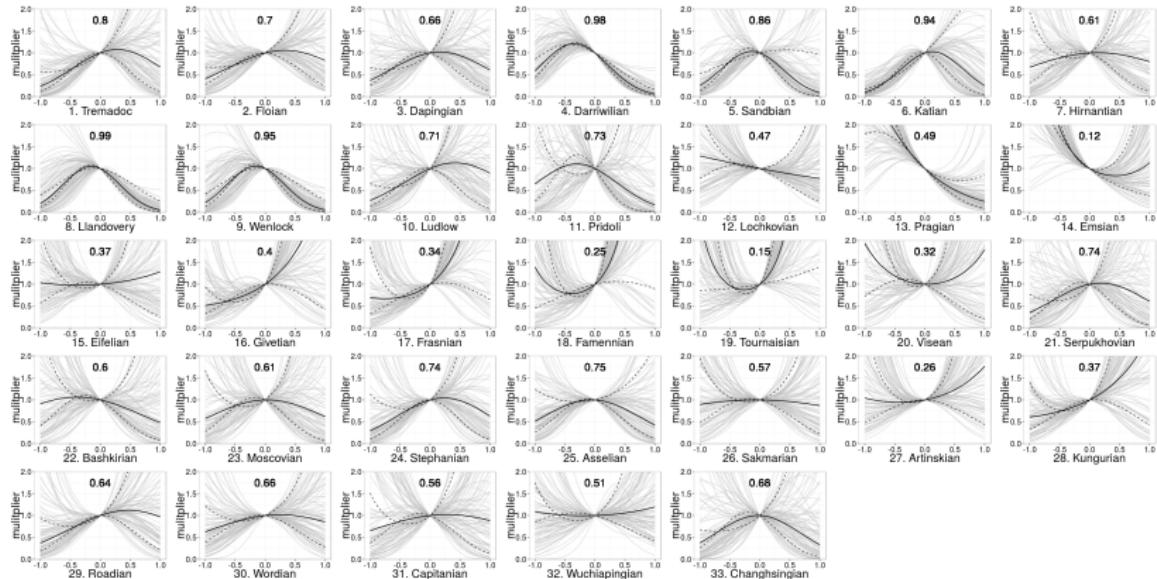
## Overall effect of environmental preference



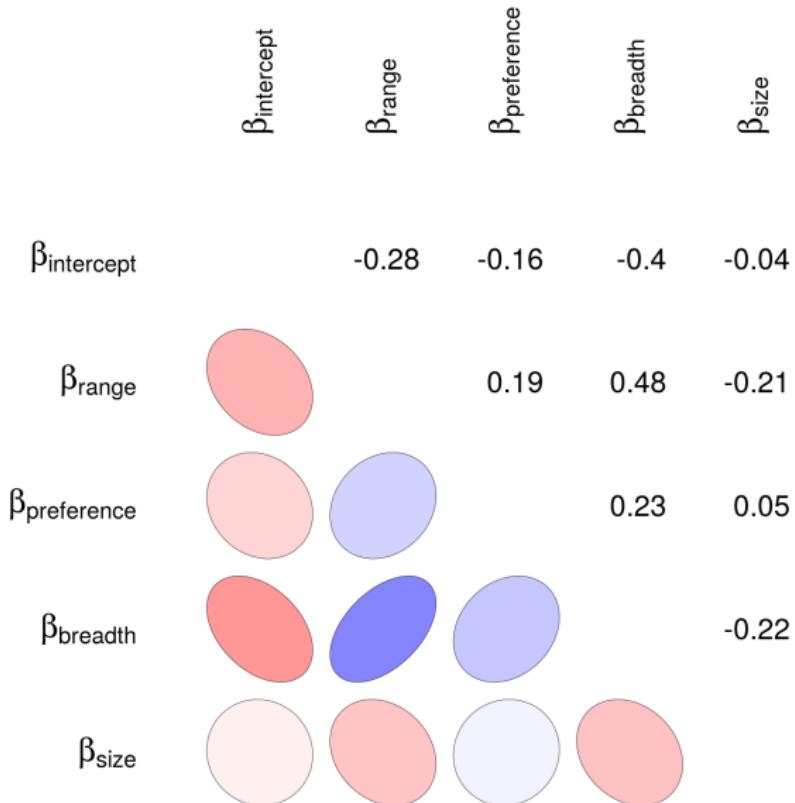
# Change in effect of environment between cohorts



# Change in effect of environment between cohorts



# Correlation of effects between cohorts



## Effect summary

- ▶ Effect of geographic range consistent with prior expectations.
- ▶ No effect of body size; environmental preference equal.
- ▶ Weak support for survival of unspecialized as generalization.

## Correlation of effects

- ▶ Correlation between baseline extinction risk and effects of geographic range as well as environmental breadth.
- ▶ Correlation between effect of range and effect of environmental breadth.
  - ▶ As effect of geographic range increases, decrease in selection on environmental breadth.

## Macroevolutionary process

- ▶ As extinction risk increases, the effect of geographic range “washes out” the effects of other traits.
  - ▶ Support for hypotheses presented in Jablonski 1986 Science, Raup 1994 PNAS.

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