

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*)

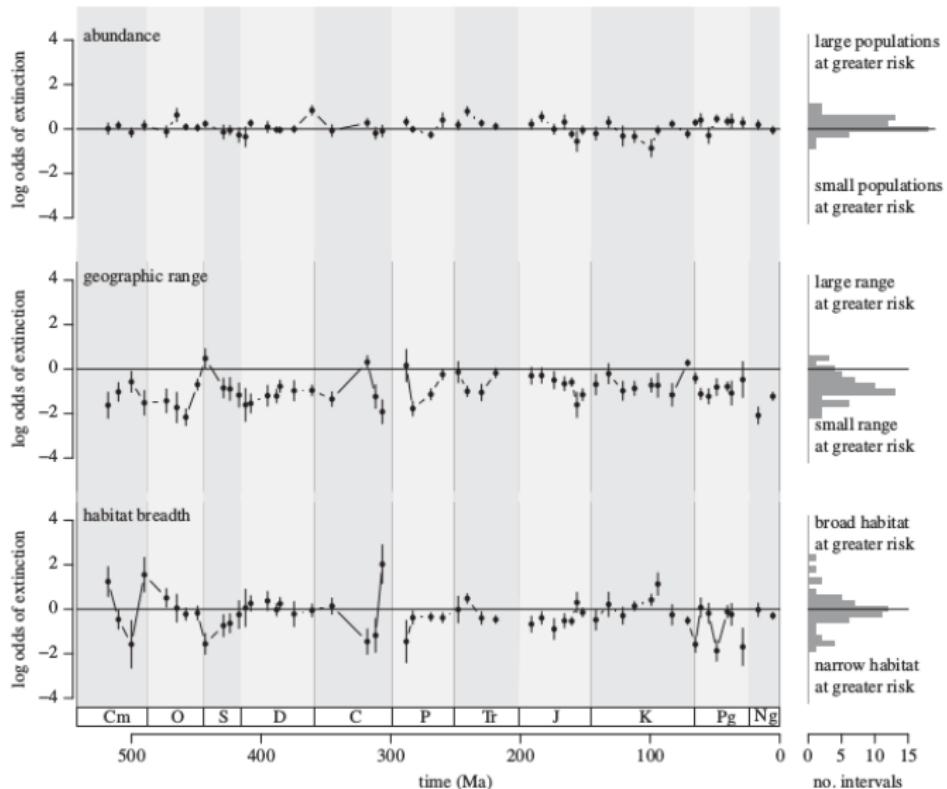
Macroevolutionary process hypotheses

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



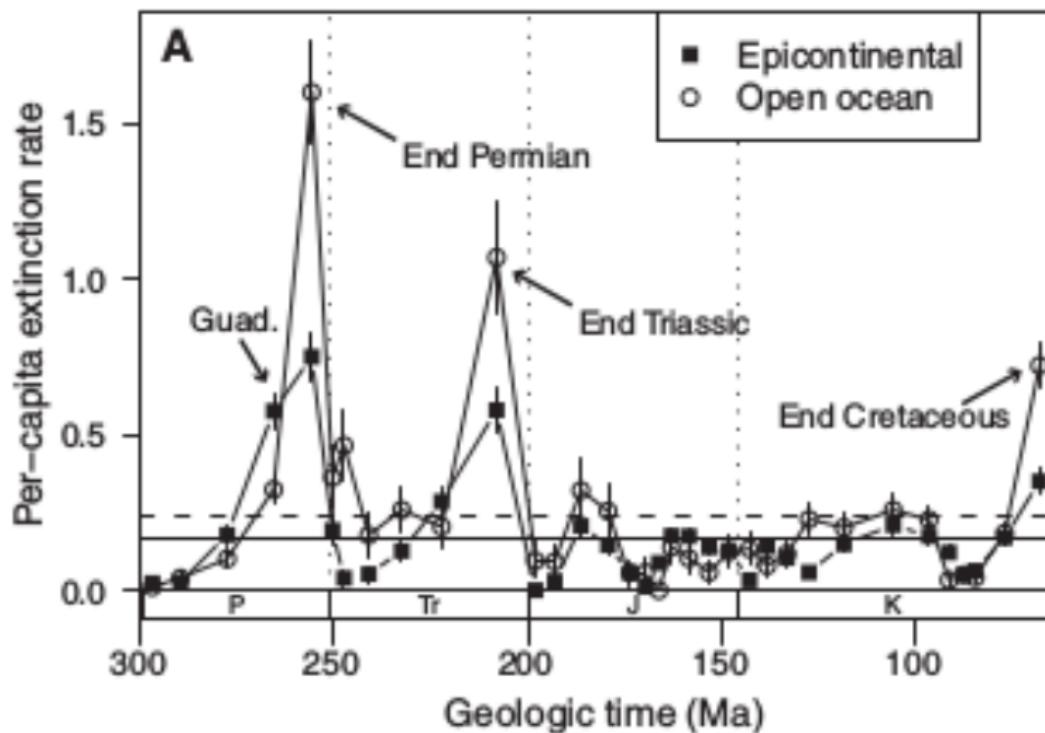
(Harnik and Simpson 2013 *Proc B*)

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.***

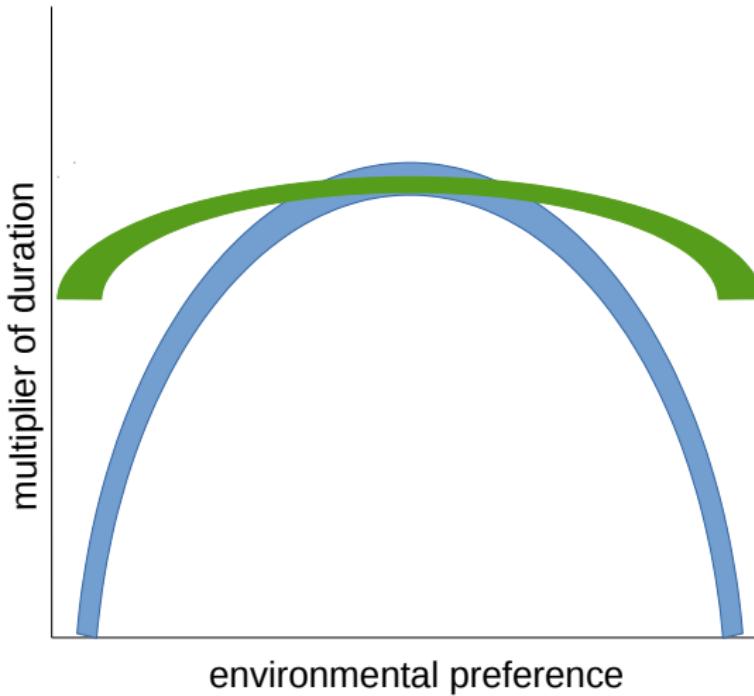
(Simpson, 1944, Tempo and Mode of Evolution, p. 143)

Hypotheses of effect of environmental preference

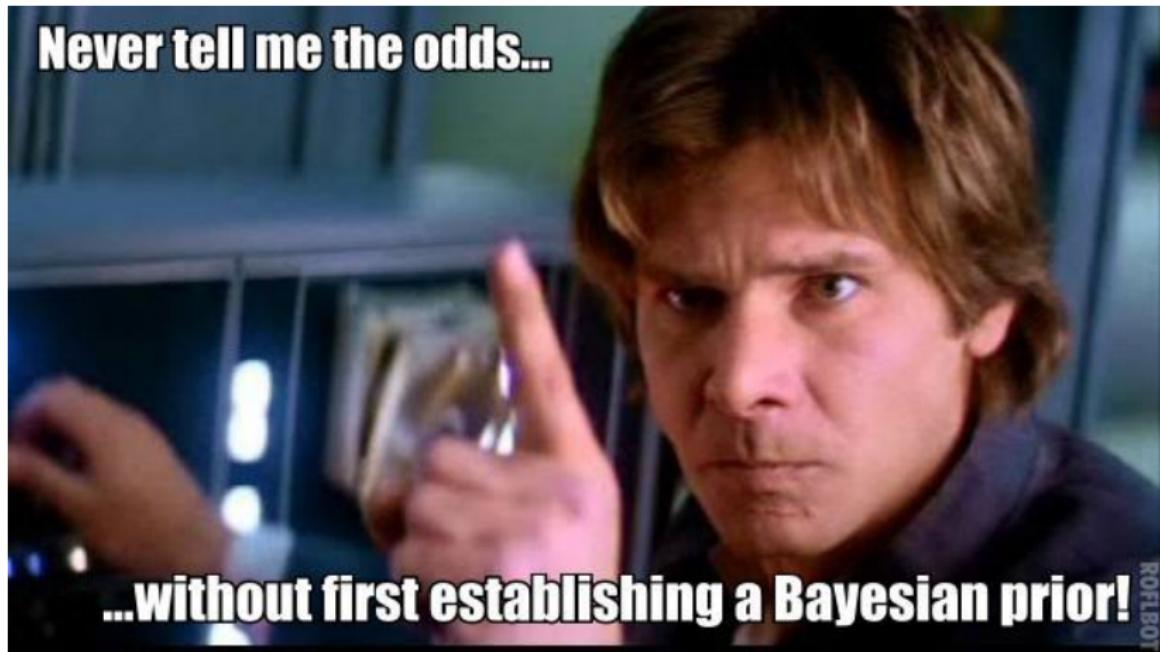


(Miller and Foote 2009 *Science*)

Hypotheses of effect of environmental breadth

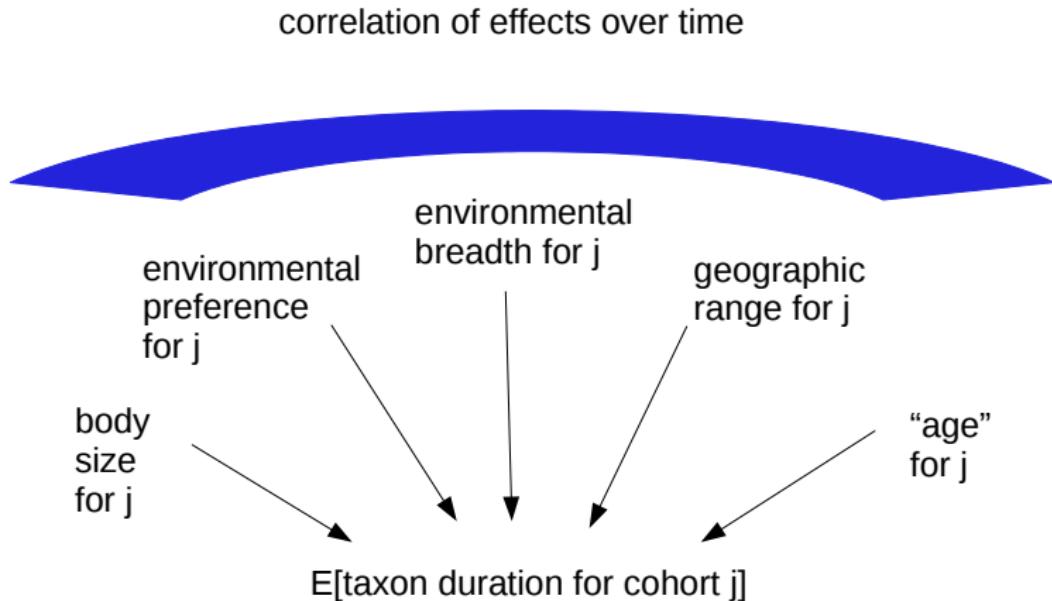


Hierarchical Bayesian modeling approach



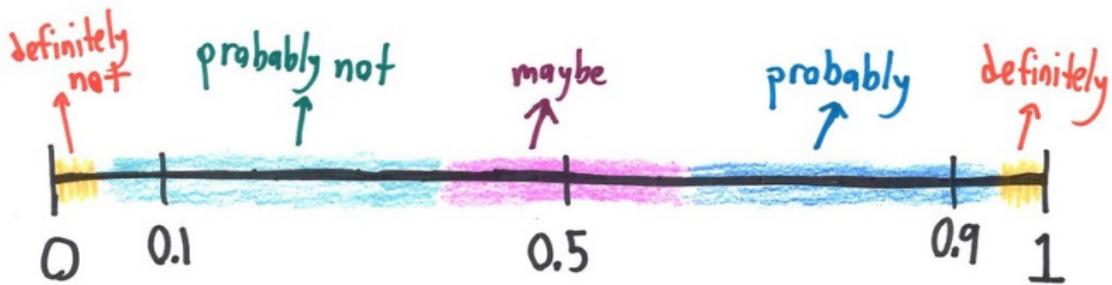
(www.countbayesie.com)

Hierarchical survival model



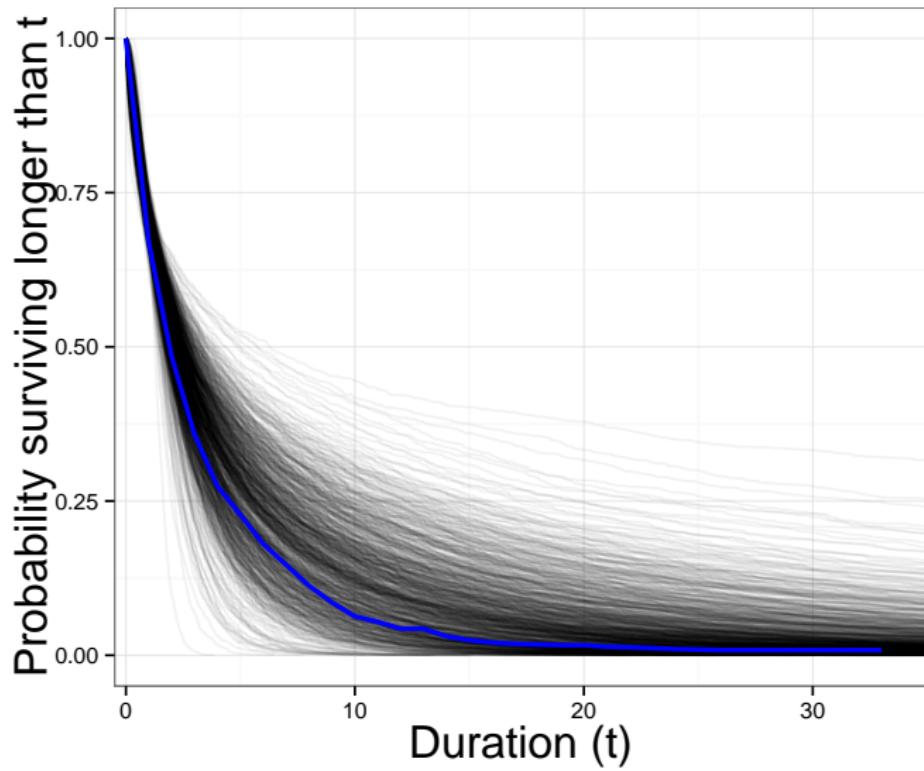
Refresher on probability

Actual Meaning

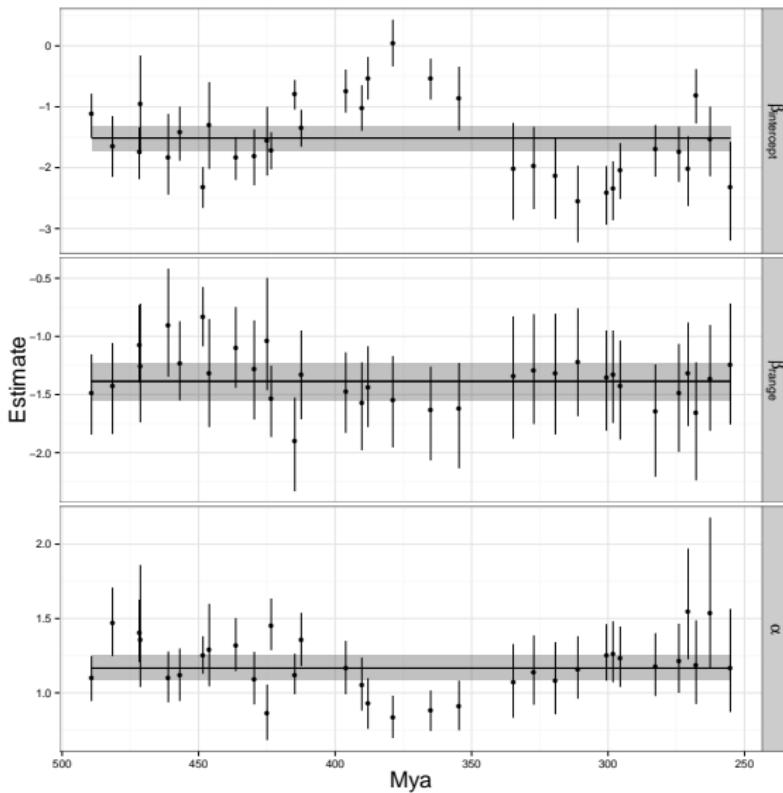


probability

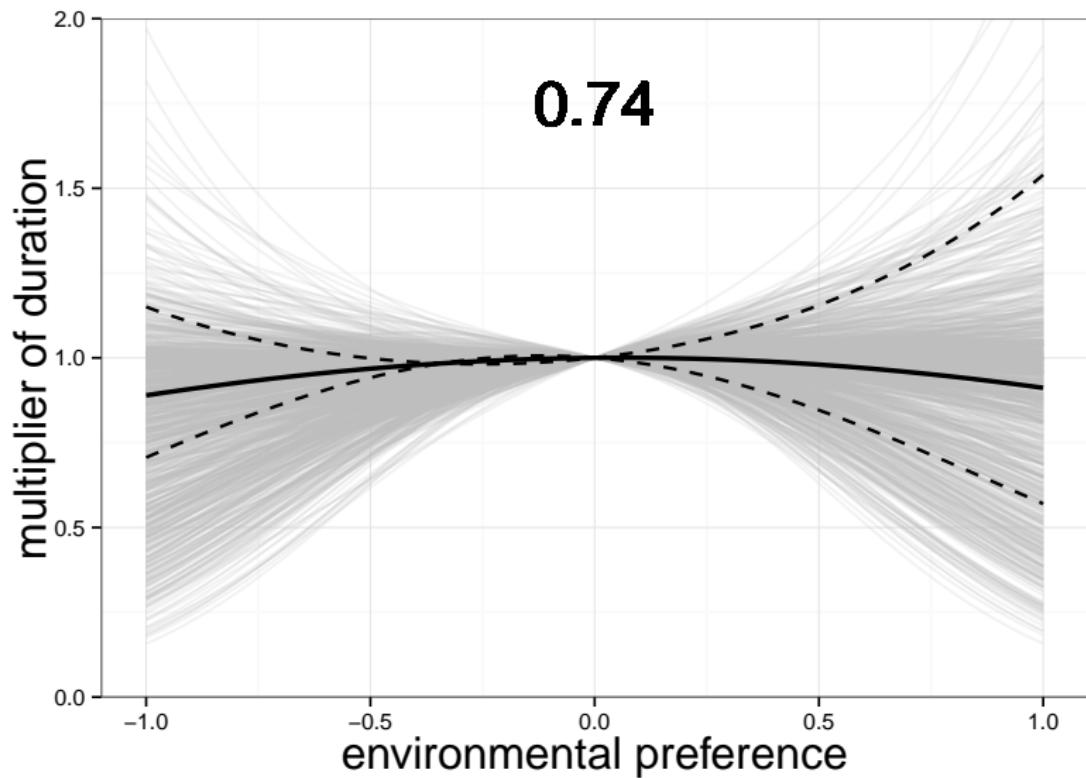
Posterior predictive distribution of $S(t)$



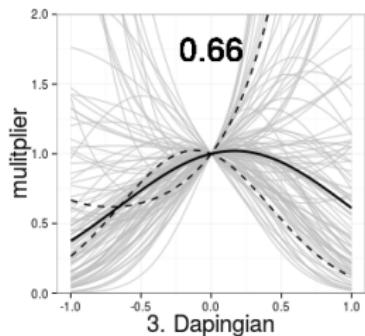
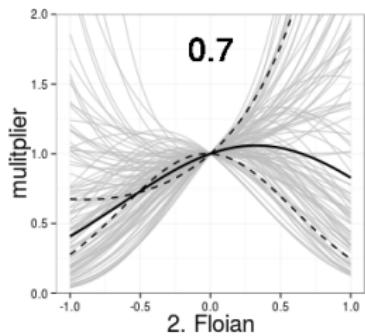
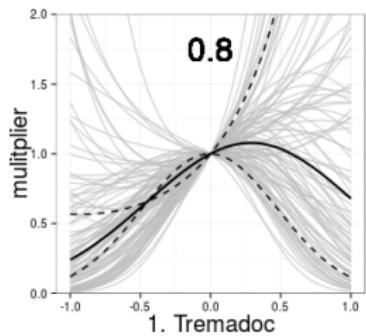
Change in trait effects between cohorts



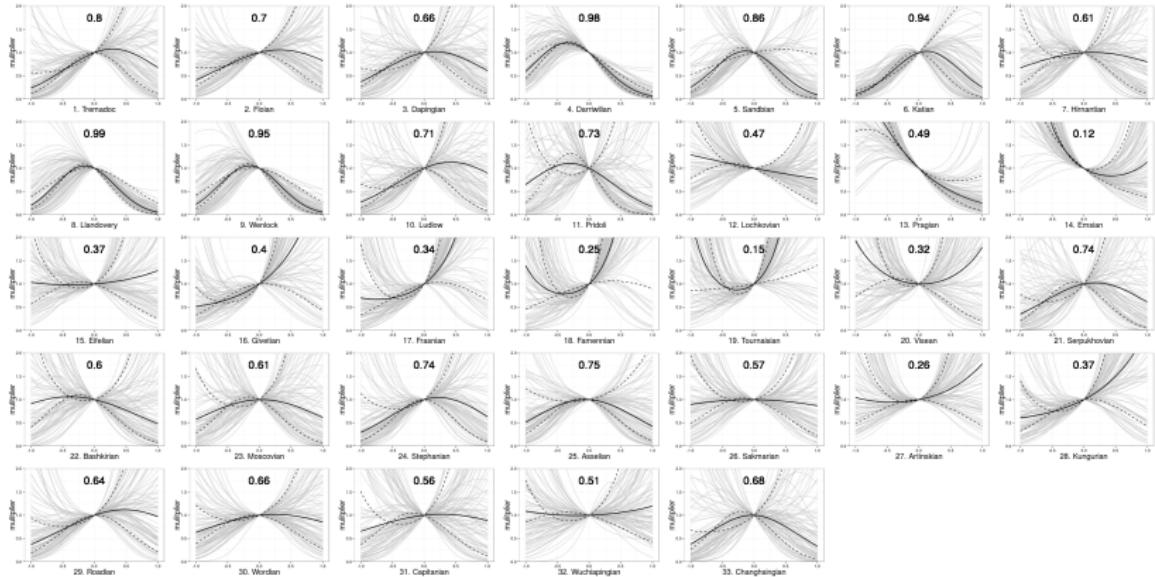
Overall effect of environmental preference



Change in effect of environment between cohorts

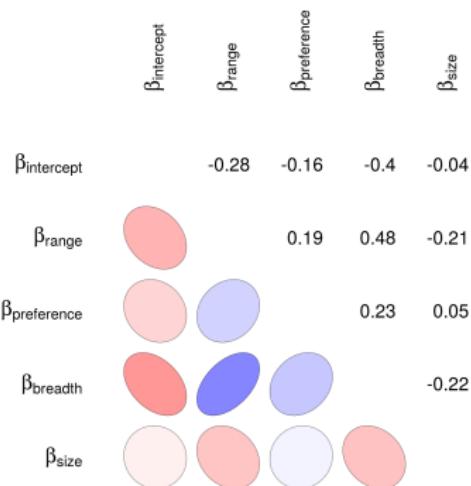


Change in effect of environment between cohorts

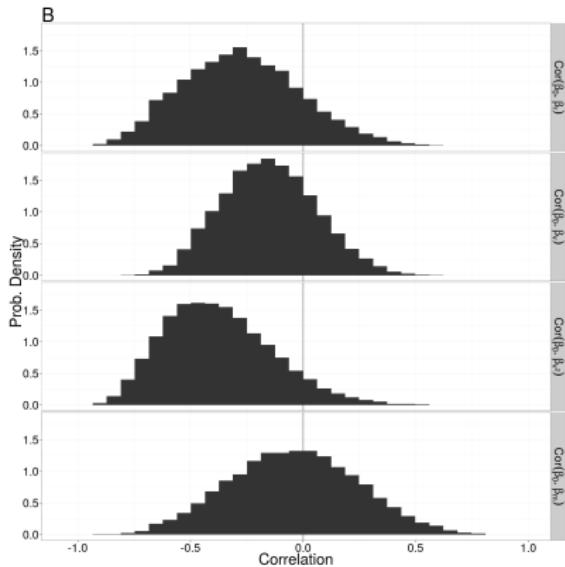


Correlation of effects between cohorts

A



B



Effect summary

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

Correlation of effects

- ▶ Evidence for correlation between baseline extinction risk and geographic range and effect of 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 by Raup in the 90's.

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