

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*)

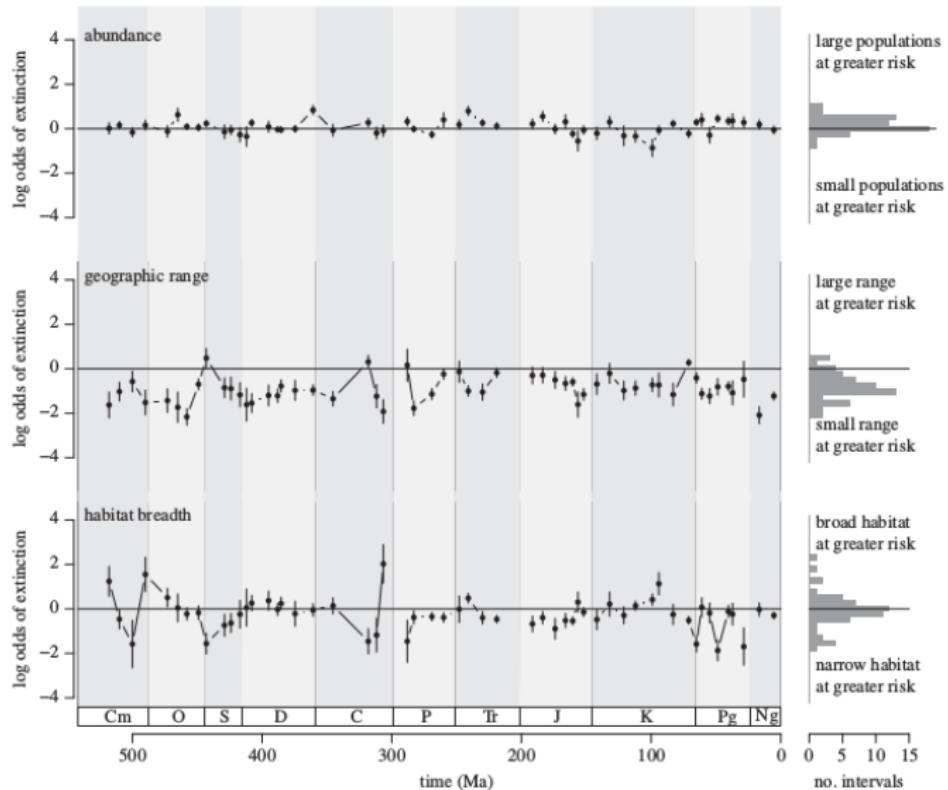
Macroevolutionary process hypotheses

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



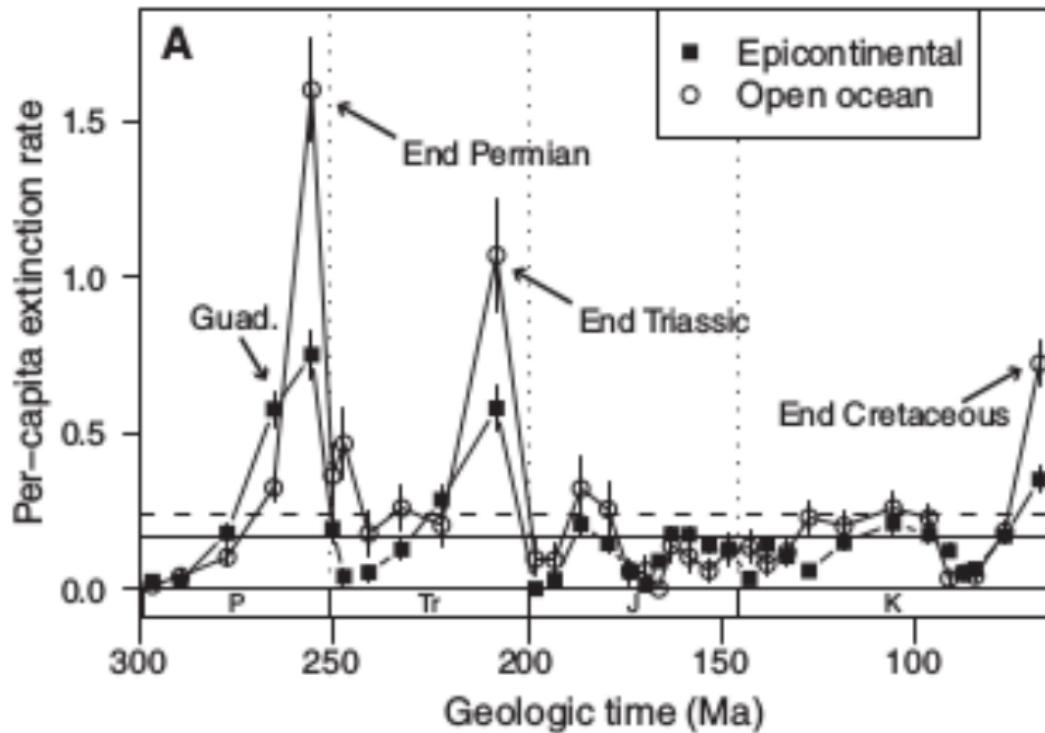
(Harnik and Simpson 2013 *Proc B*)

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.***

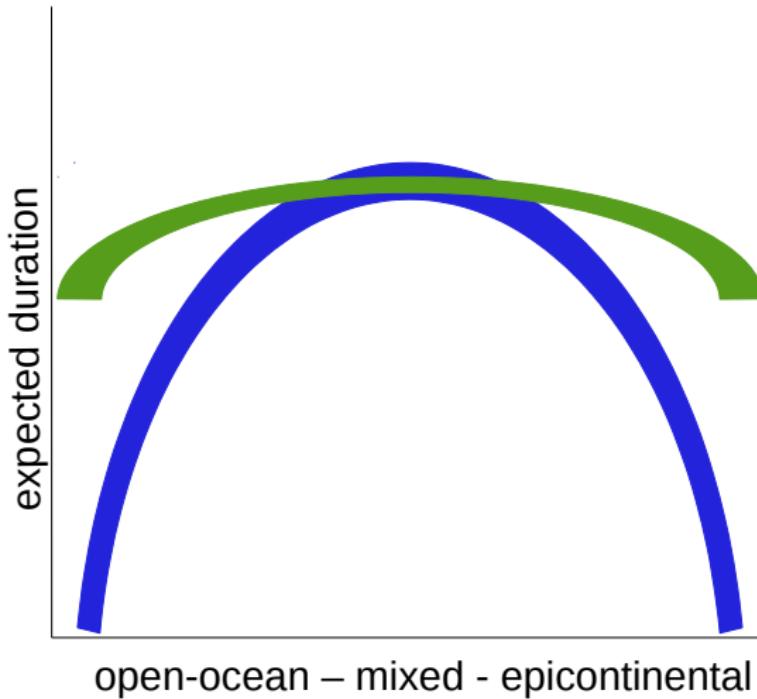
(Simpson, 1944, Tempo and Mode of Evolution, p. 143)

Hypotheses of effect of environmental preference



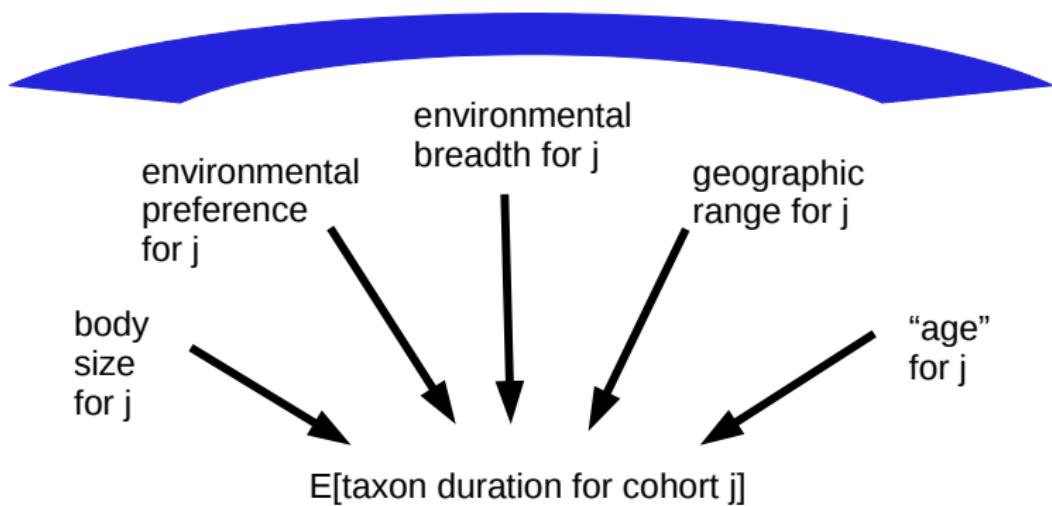
(Miller and Foote 2009 *Science*)

Hypotheses of effect of environmental breadth



Hierarchical survival model

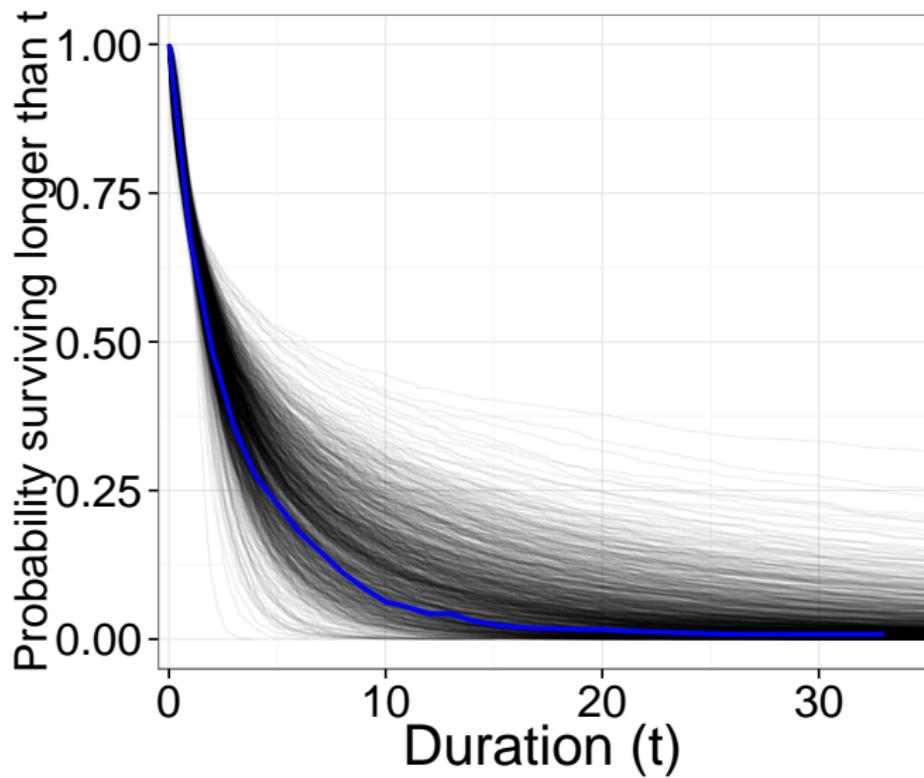
correlation of effects over time



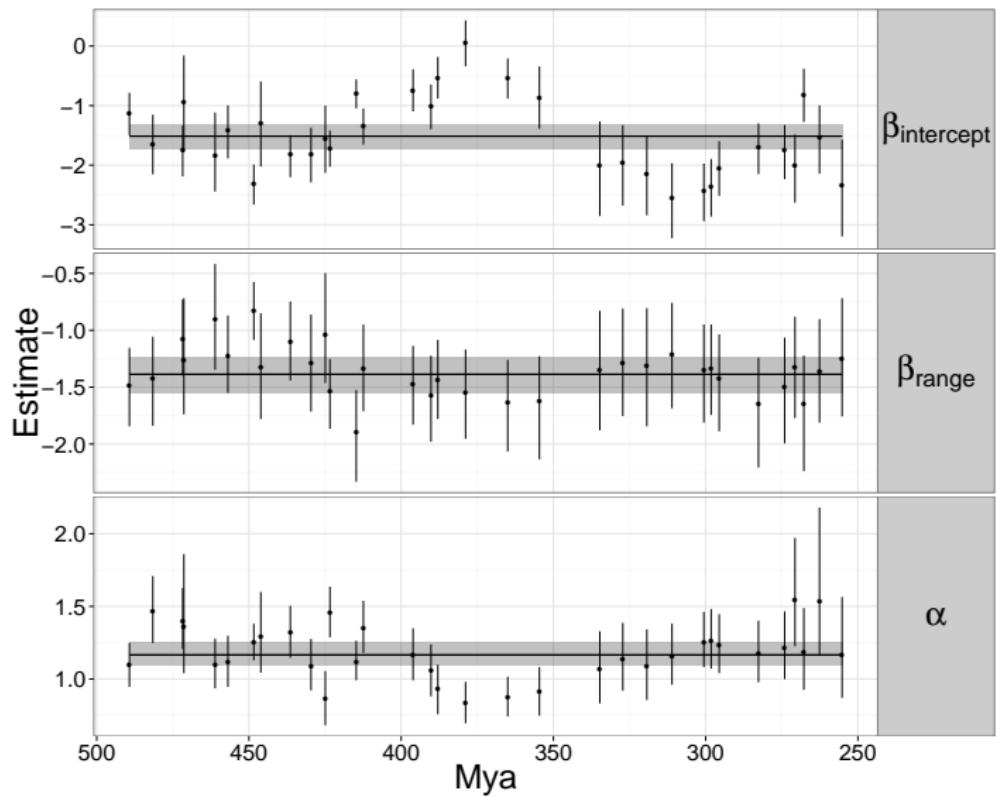
Paleozoic brachiopods



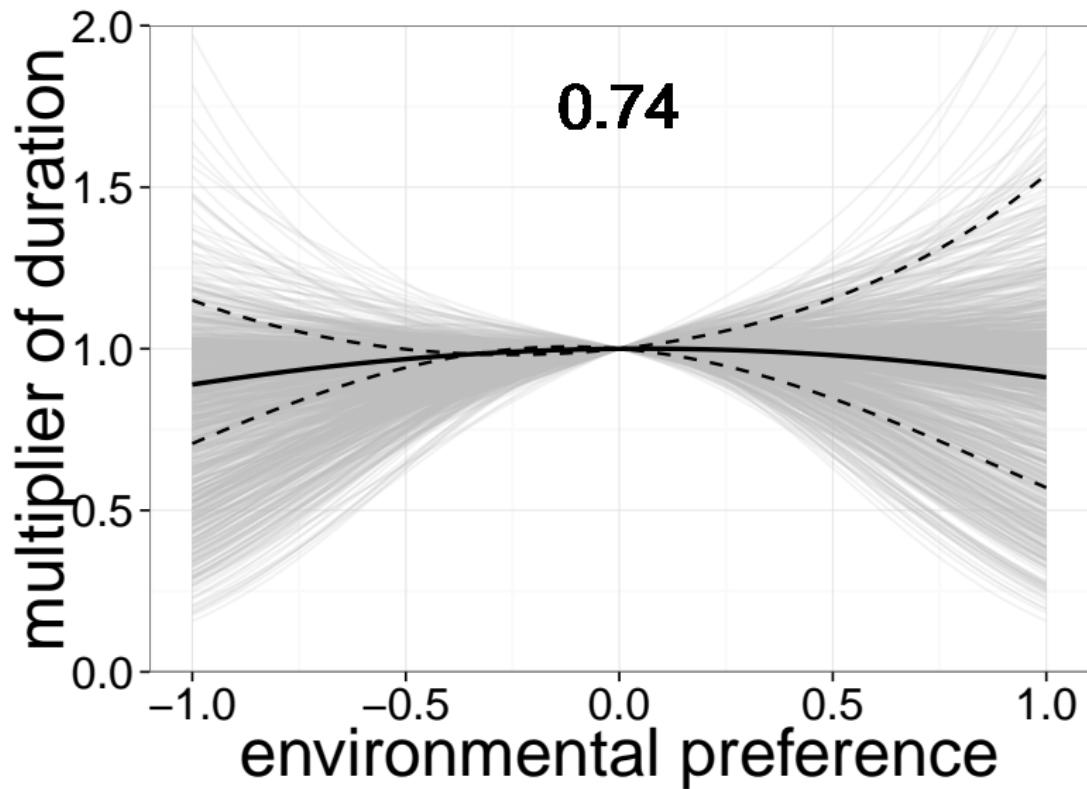
Posterior predictive distribution of $S(t)$



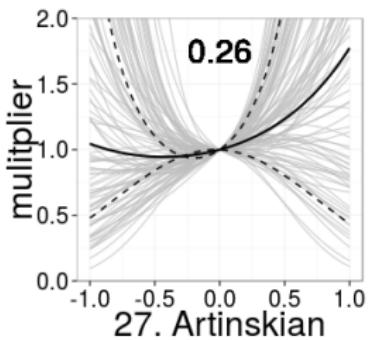
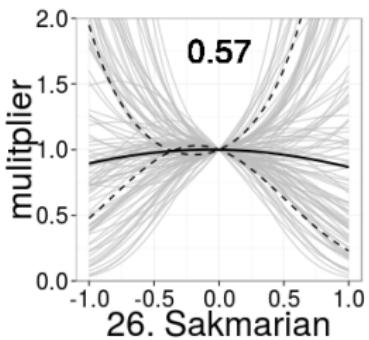
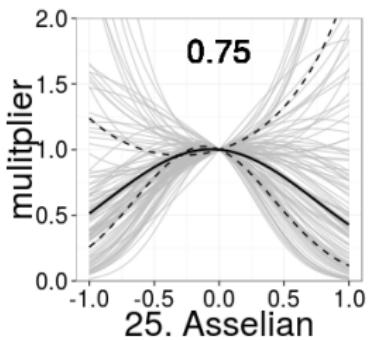
Change in trait effects between cohorts



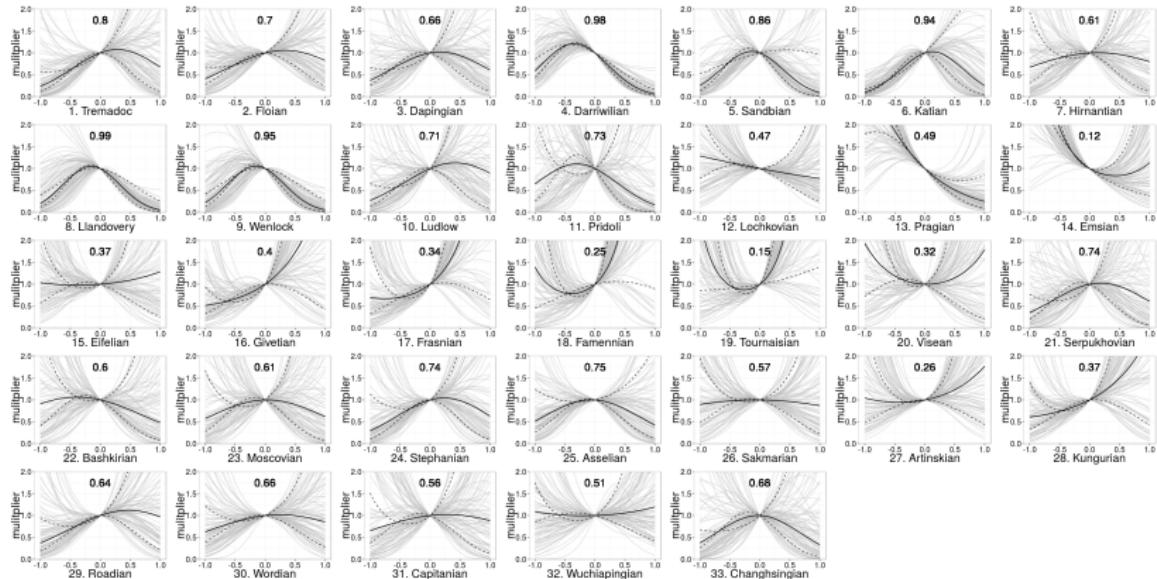
Overall effect of environmental preference



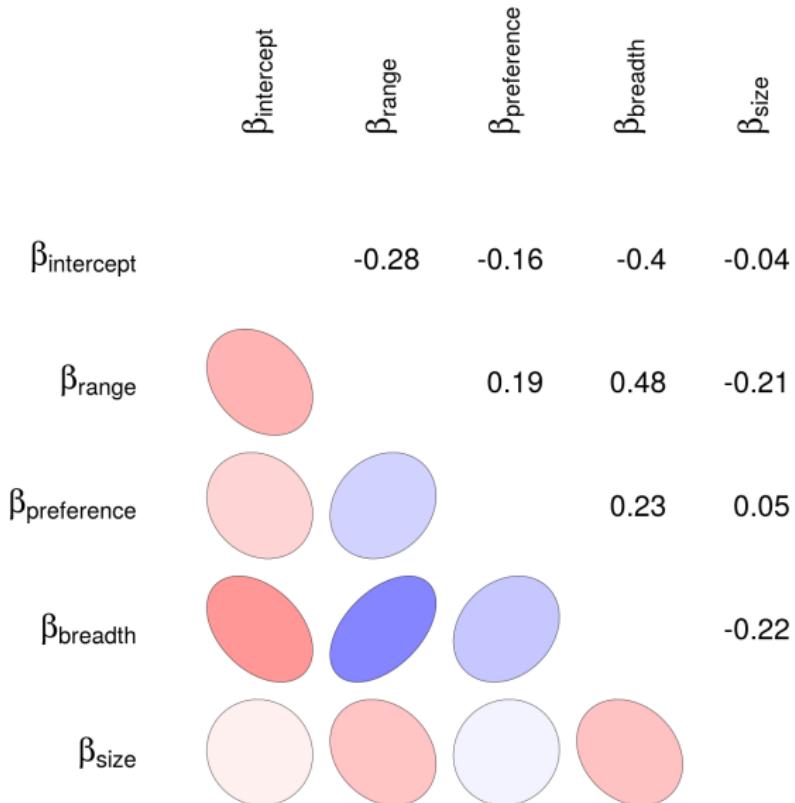
Change in effect of environment between cohorts



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.

Acknowledgements

- ▶ Advising
 - ▶ Kenneth D. Angielczyk,
Michael J. Foote,
P. David Polly,
Richard H. Ree,
Graham Slater
- ▶ Angielczyk Lab
 - ▶ David Grossnickle,
Dallas Kentzel,
Jackie Lungmus
- ▶ Foote lab
 - ▶ Marites Villarosa Garcia,
Nadia Pierrehumbert
- ▶ Stewart Edie,
Elizabeth Sander,
Laura Southcott,
Courtney Stepien
- ▶ David Bapst,
Ben Frable,
Arnold Miller,
Peter Wagner



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