

How do biological traits affect brachiopod taxonomic survival?

A hierarchical Bayesian approach

Peter D Smits

Committee on Evolutionary Biology, University of Chicago



The Paleobiology Database
revealing the history of life



Observation

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

(Jablonski, 1986, *Science*)

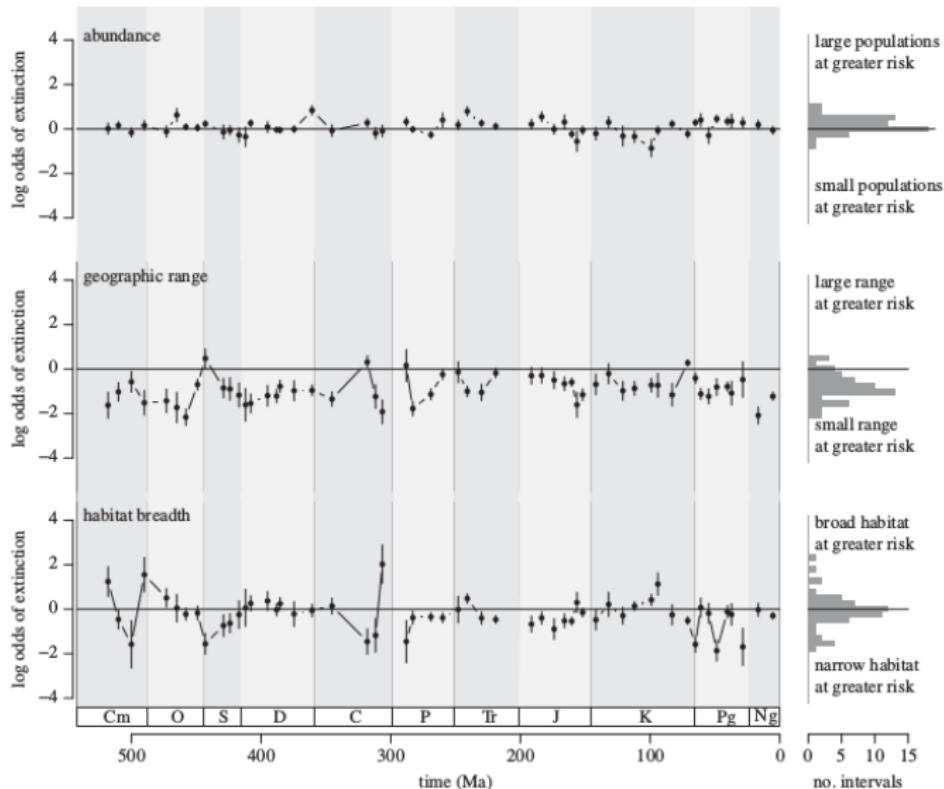
Macroevolutionary process hypotheses

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



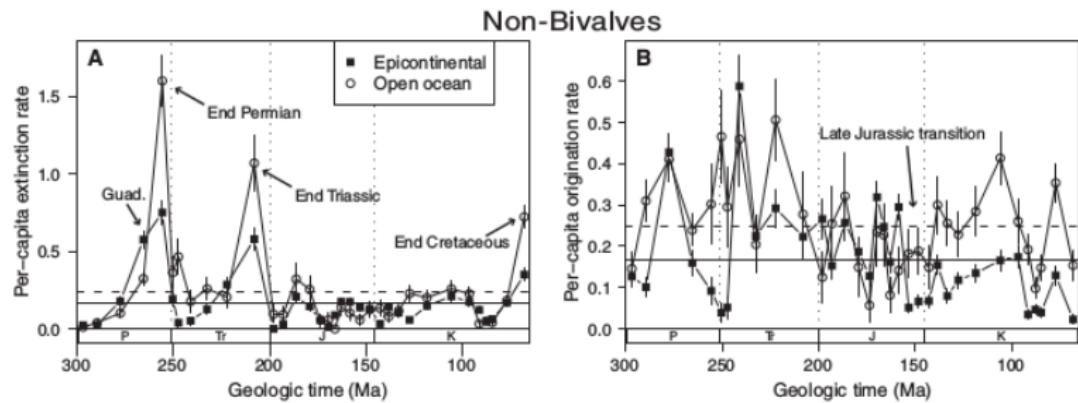
(Harnik and Simpson 2013 *Proc B*)

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.***

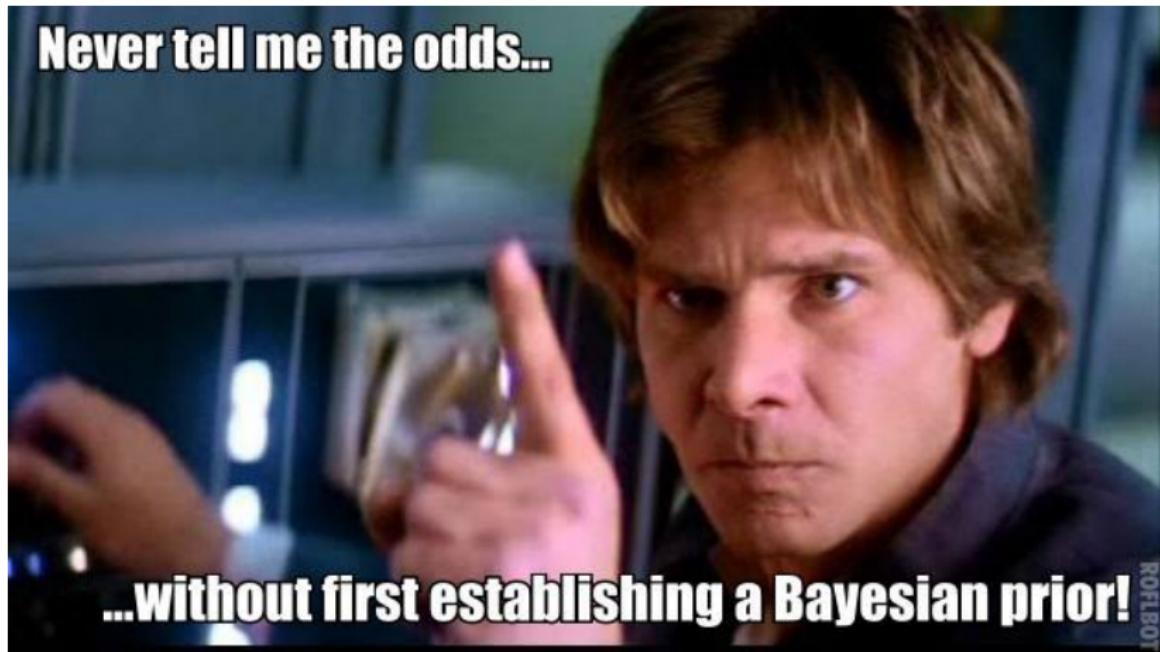
(Simpson, 1944, Tempo and Mode of Evolution, p. 143)

Hypotheses of effect of environmental preference



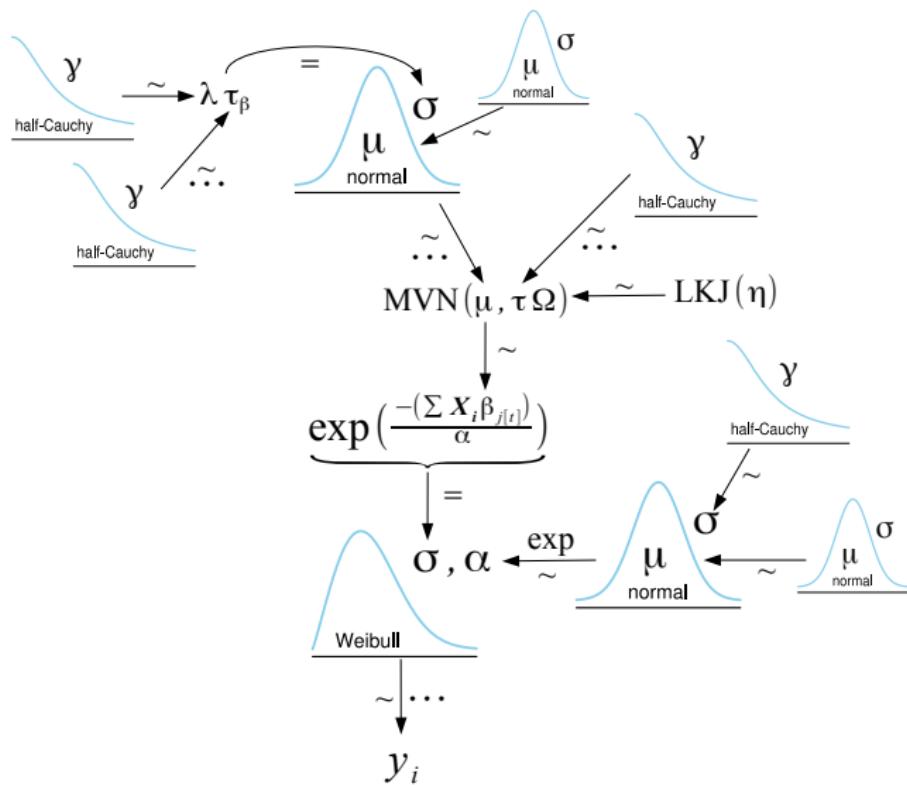
(Miller and Foote 2009 *Science*)

Hierarchical Bayesian modeling approach

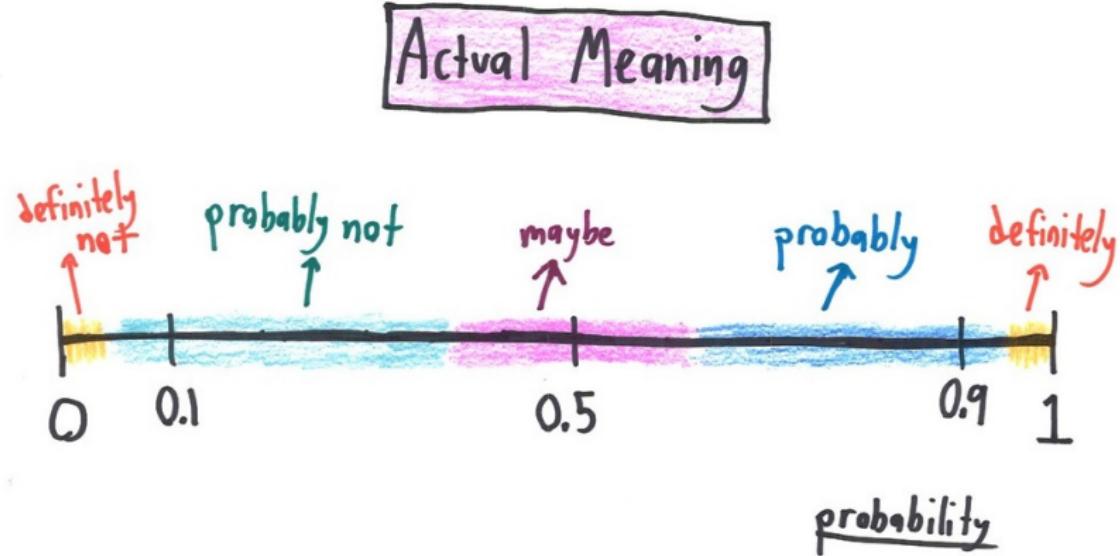


(www.countbayesie.com)

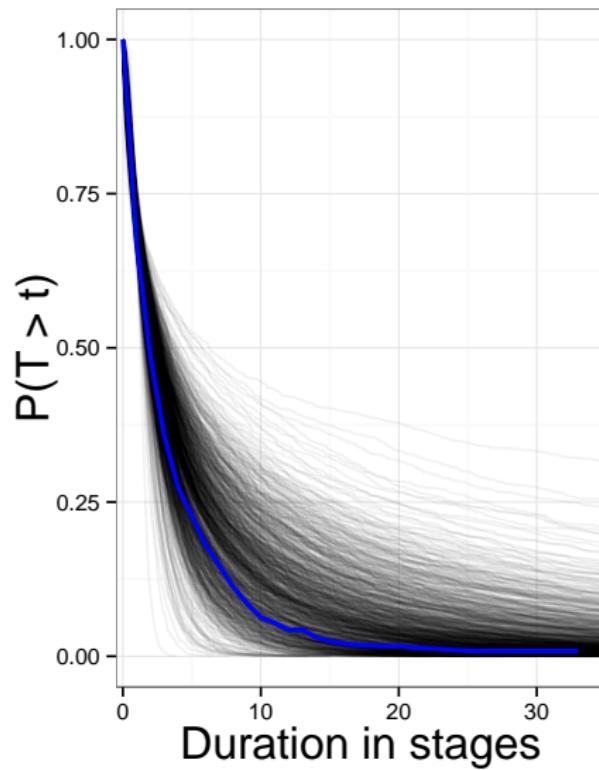
Hierarchical survival model



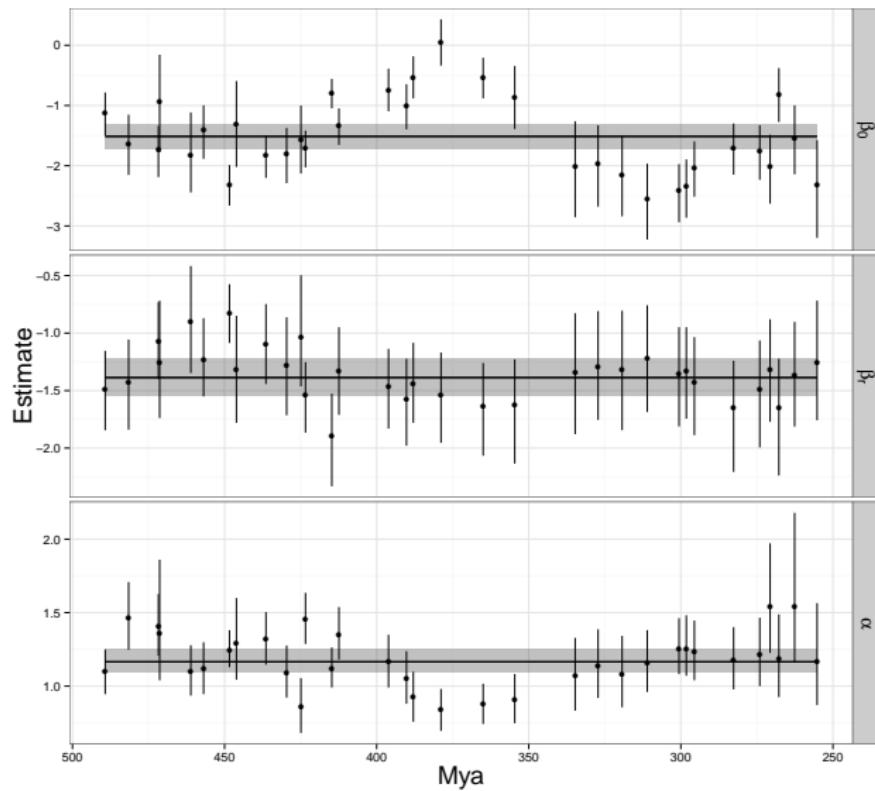
Refresher on probability



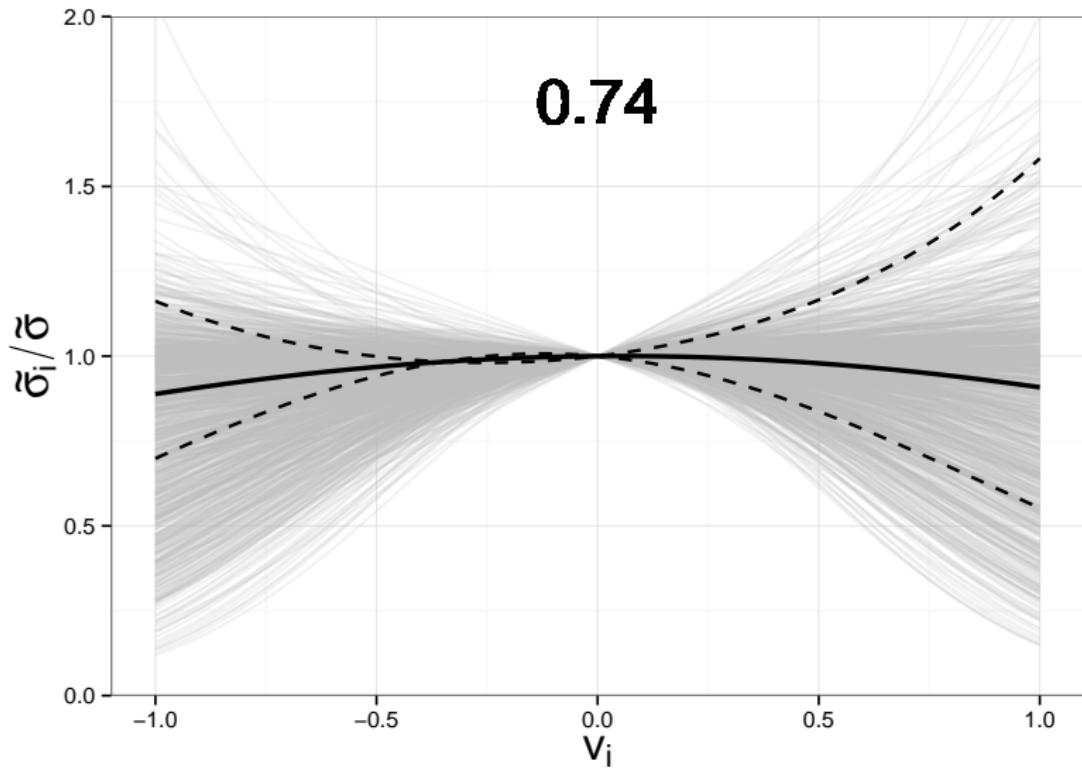
Posterior predictive distribution of $S(t)$



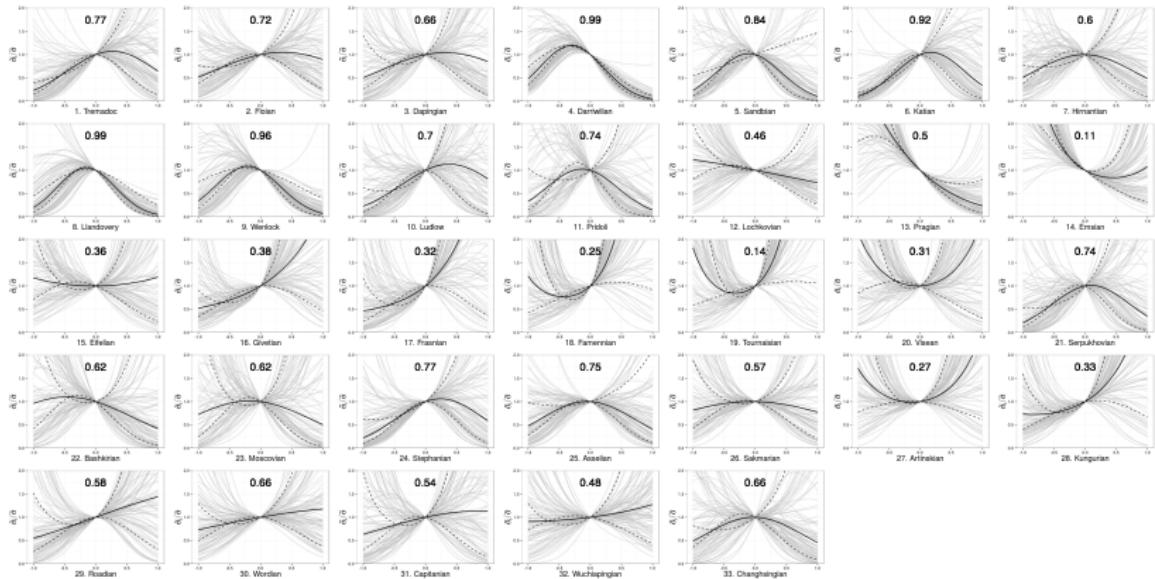
Change in trait effects between cohorts



Overall effect of environmental preference

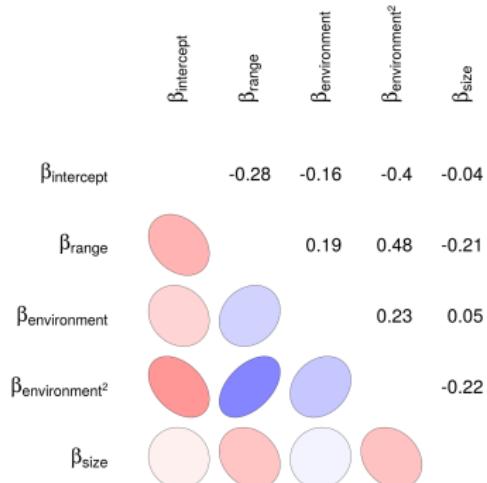


Change in effect of environment between cohorts

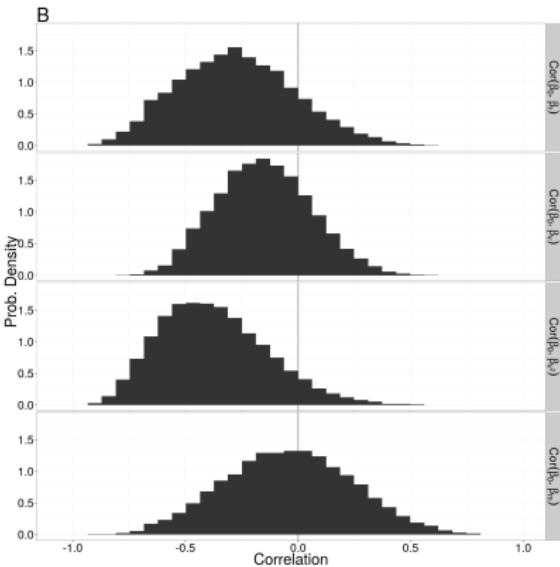


Correlation of effects between cohorts

A



B



Conclusions

- ▶ No effect of body size, environmental preferences equal.
 - ▶ Very weak support for survival of unspecialized as generalization.
- ▶ Correlation between effect of geographic range and curvature of effect of environmental preference.
 - ▶ Effect of geographic range increases, curvature/effect of environmental preference decreases.
- ▶ As extinction risk increases, the effect of geographic range “washes out” the effects of other traits.

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,
Graeme Lloyd,
Arnold Miller,
Carl Simpson,
Peter Wagner