

Cenozoic mammals and the biology of extinction

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All species that have ever lived are, to a first approximation, dead.

(Raup 1986 The Nemesis Affair)

Question

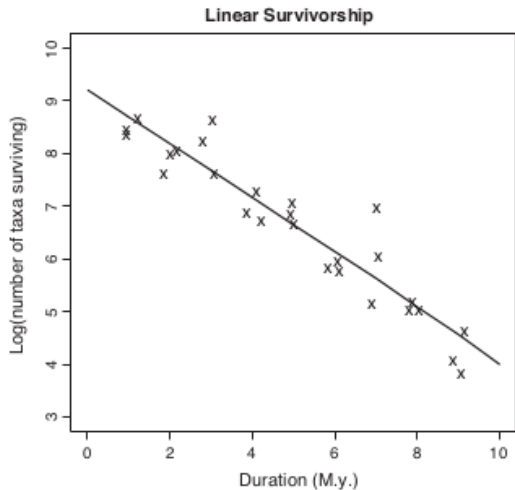
Why do certain taxa go extinct while others do not?

In context of this study

Rephrased

How does a taxon's **adaptive zone** affect **extinction risk**?

Van Valen's observation



(Liow et al. 2011 *TREE*)

Law of Constant Extinction

Definition

Extinction rate, in a given adaptive zone, is taxon–age independent.

(Van Valen 1973 *Evol. Theory*)

Questions

- ▶ Do traits related to environmental preference have different distributions of taxonomic duration?
 - ▶ Is survival best modeled by a single trait or multiple?
 - ▶ How do other factors, such as climate, affect these patterns?
- ▶ Is extinction taxon-age independent or dependent?
- ▶ Do genera and species have fundamentally different survival distributions?

Survival

Important terms

$S(t)$: probability of survival till age t

$h(t)$: instantaneous failure rate at t ,
does not have to be constant or monotonic

$f(t) = h(t)S(t)$: probability density function

Formalization of Van Valen

Law of Constant Extinction

Hazard is constant with respect to time (**exponential survival**).

$$h(t) = \lambda \iff S(t) = \exp^{-\lambda t}$$

Study system



- ▶ Mammals
- ▶ Cenozoic (~ 65 My)
- ▶ North America, Europe, South America
- ▶ traits
 - ▶ diet: carnivore, herbivore, omnivore, insectivore
 - ▶ locomotion: ground dwelling, arboreal, scansorial
 - ▶ body size

Approach

Predictions

Results

Acknowledgements

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▶ Discussion

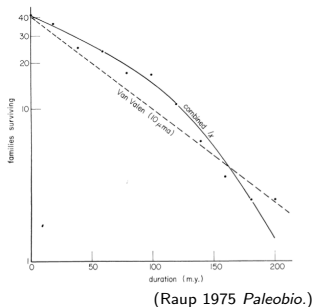
- ▶ David Bapst, Megan Boatright, Ben Frable, Colin Kyle, Darcy Ross, Liz Sander
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The **Field**
Museum

Hinds Evolutionary Biology
Grad Student Research Award

Differential preservation and survival



two groups in four scenarios

- ▶ = birth, death;
= preservation
- ▶ = birth, death;
! = preservation
- ▶ ! = birth, death;
= preservation
- ▶ ! = birth, death;
! = preservation

