Cenozoic mammals and the biology of extinction

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Extinction

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

(Raup 1986 The Nemesis Affair)

Foundation

Question

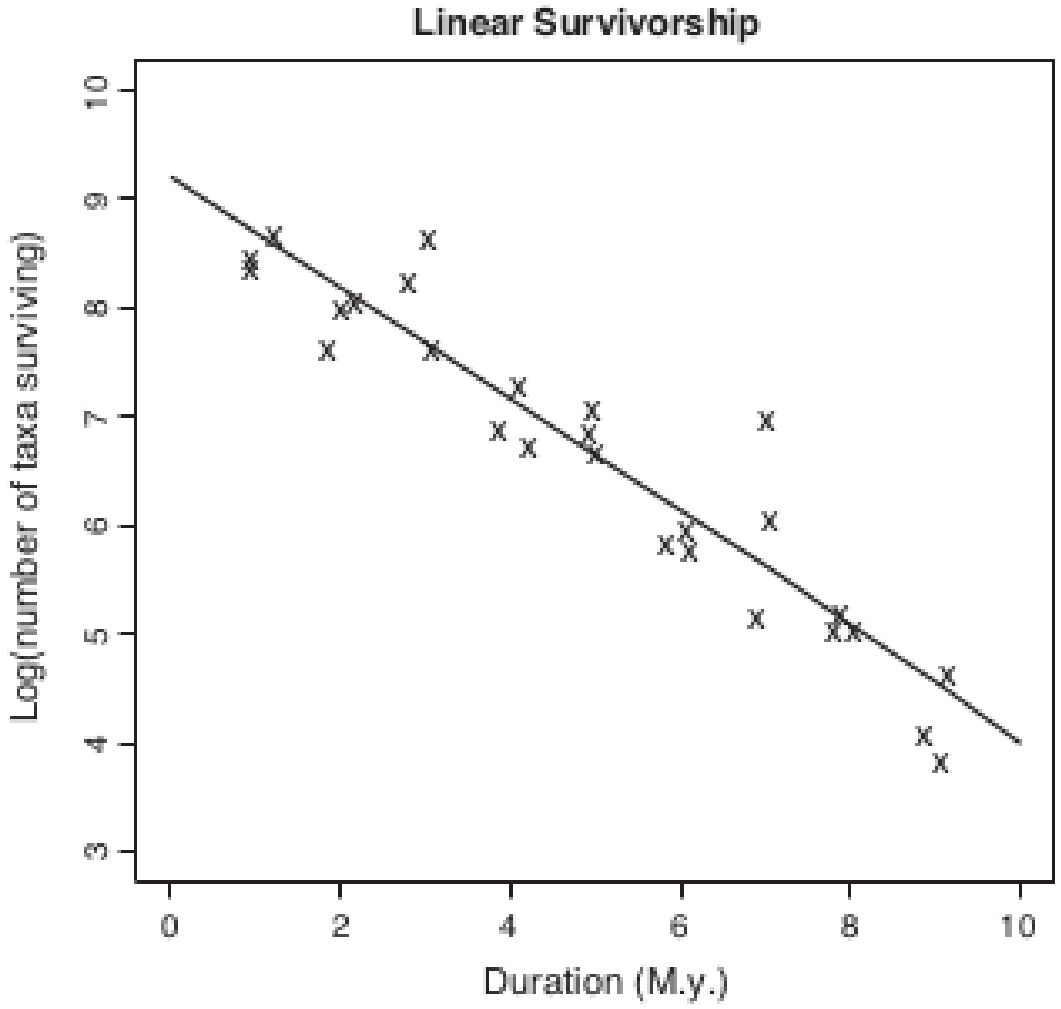
Why do certain taxa go extinct while others do not?

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*)

Biology and extinction

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 constant or monotonic

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

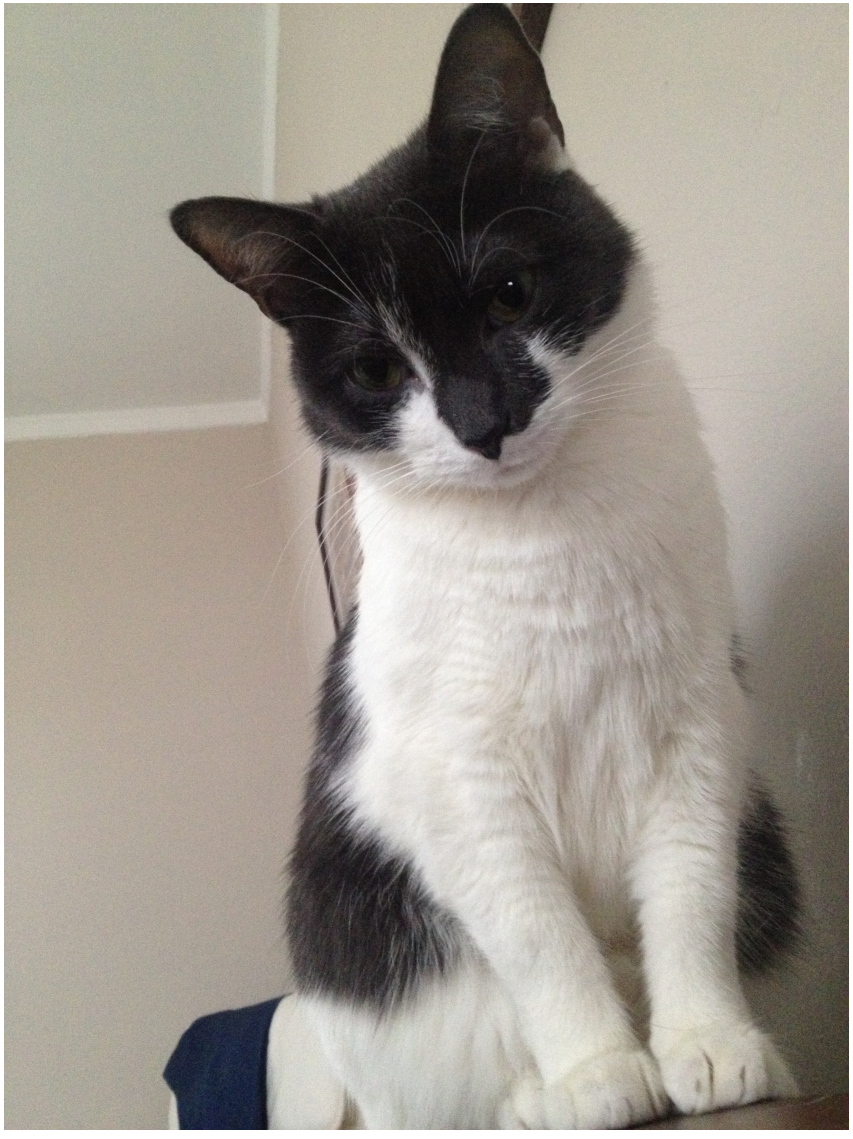
Formalization of Van Valen

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
  - North America:
    1003 genera, 2366 species
  - Europe:
    658 genera, 1767 species
- Cenozoic ($\sim$ 65 My)
- traits
  - diet: carnivore, herbivore, omnivore, insectivore
  - locomotion:
    ground dwelling,
    arboreal, scansorial
  - body size

Approach

Predictions

Results

Acknowledgements

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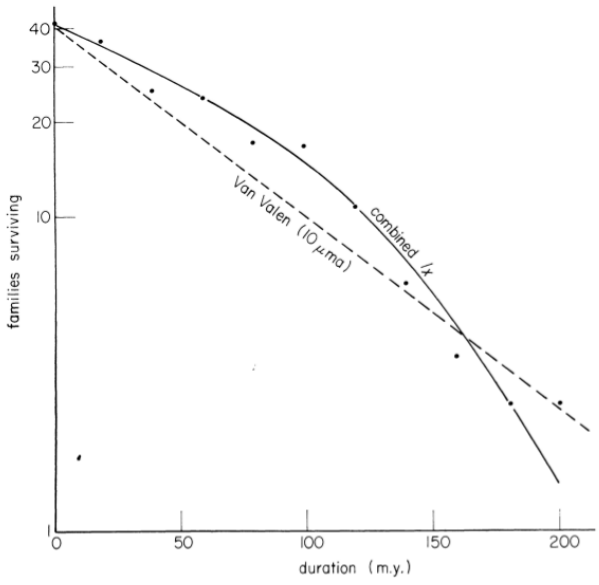
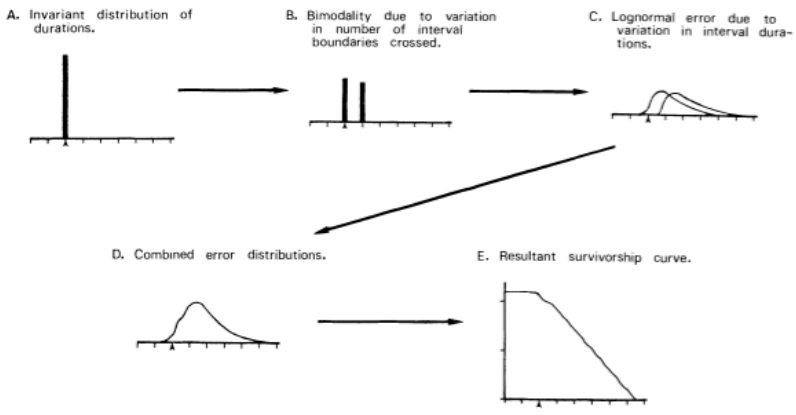
The Field Museum

Hinds Evolutionary Biology Grad Student Research Award

Differential preservation and survival



(Raup 1975 *Paleobio.*)



(Sepkoski 1975 *Paleobio.*)

two groups in four scenarios

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