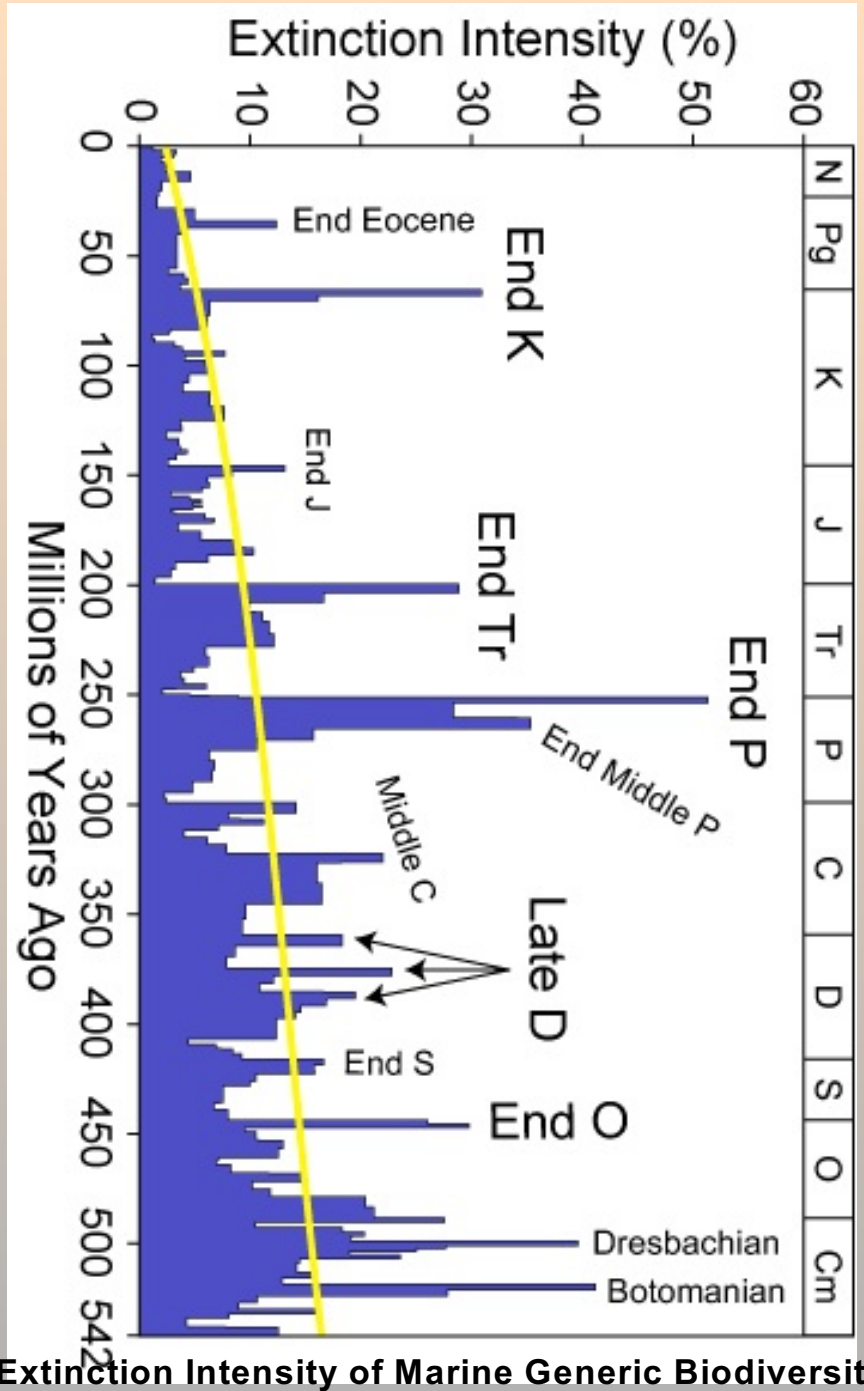


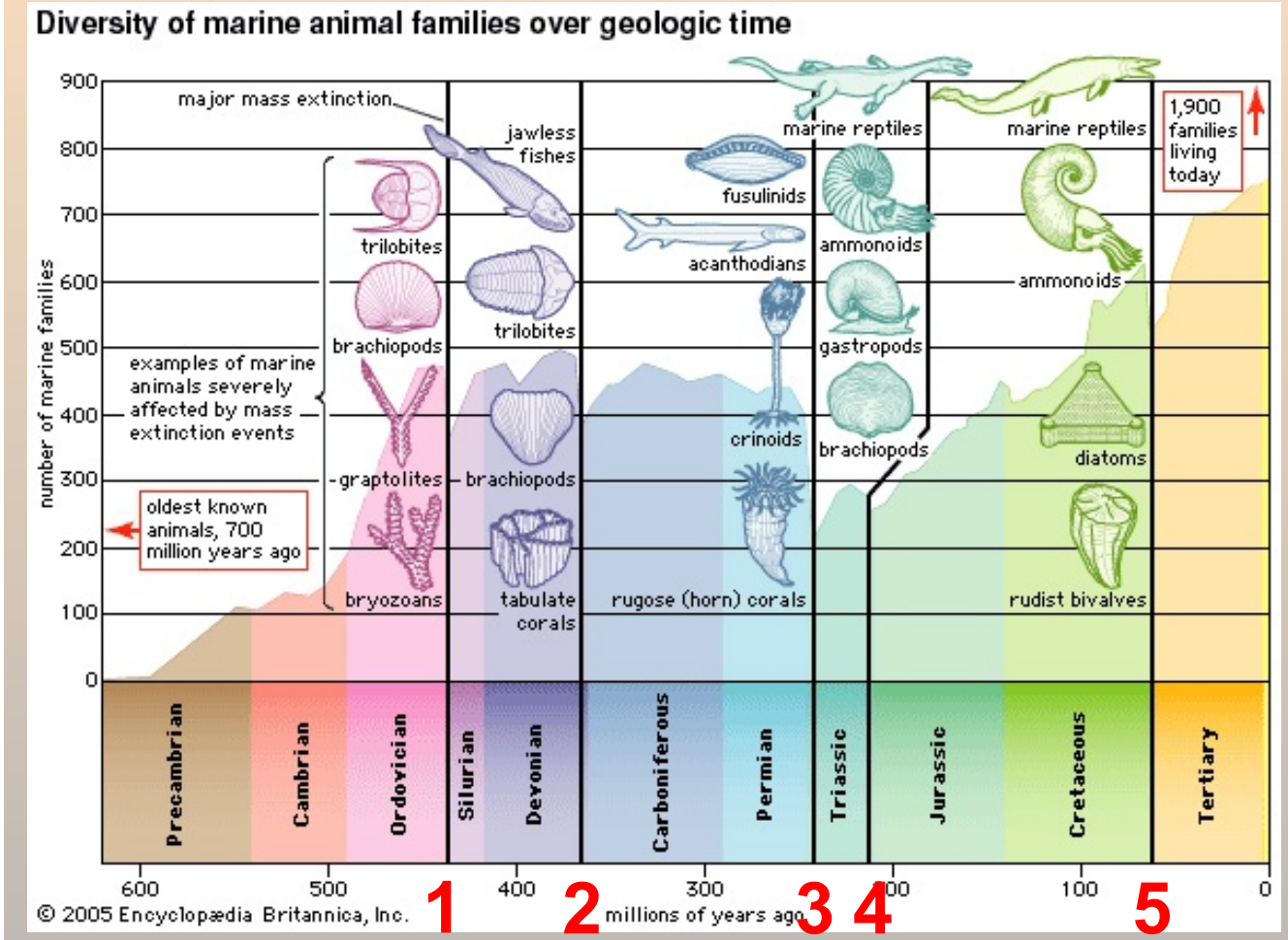
Extinction Intensity of Marine Generic Biodiversity

Mass Extinctions: THE BIG ONES

Bad Genes or Bad Luck?

- ★ Virtually all organisms eventually become extinct
- ★ Population size of taxa decline over time; most genera and species disappear
- ★ Continued coming and going occurs in the background as new taxa originate
- ★ When large percentage of known taxa all undergo extinction during one interval of time, then MASS extinction
- ★ Results from severe global physical perturbation

Raup & Sepkoski (1982)

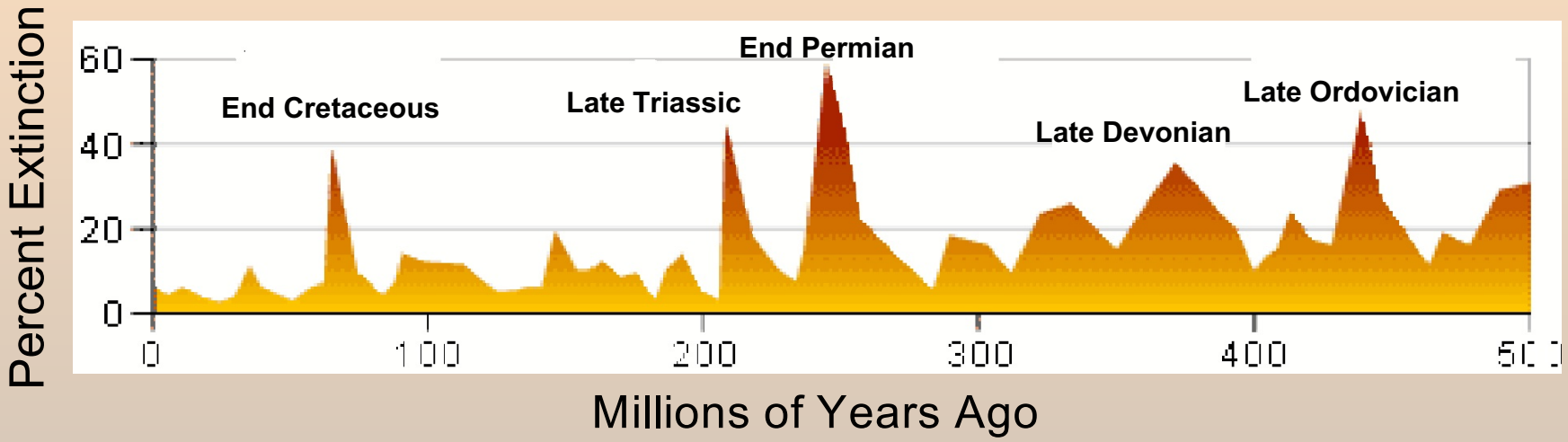


★ Plotted number of extinctions of marine invertebrate families per million years

★ Steady background extinction averaging between 2.0-4.6 families/Ma

★ Five intervals stood out as anomalous – **The Big Five** (Ordovician; Devonian; Permian-Triassic; Triassic; Cretaceous)

How to Avoid Background Extinction?



★ Wide geographically ranging taxa resist extinction better,; local events don't impact the population

★ Taxa with planktonic larvae can disperse widely

★ Van Valen's survivorship curve showed majority of taxa had short durations, fewer and fewer with longer durations

★ Chance of extinction is independent of how long it has survived

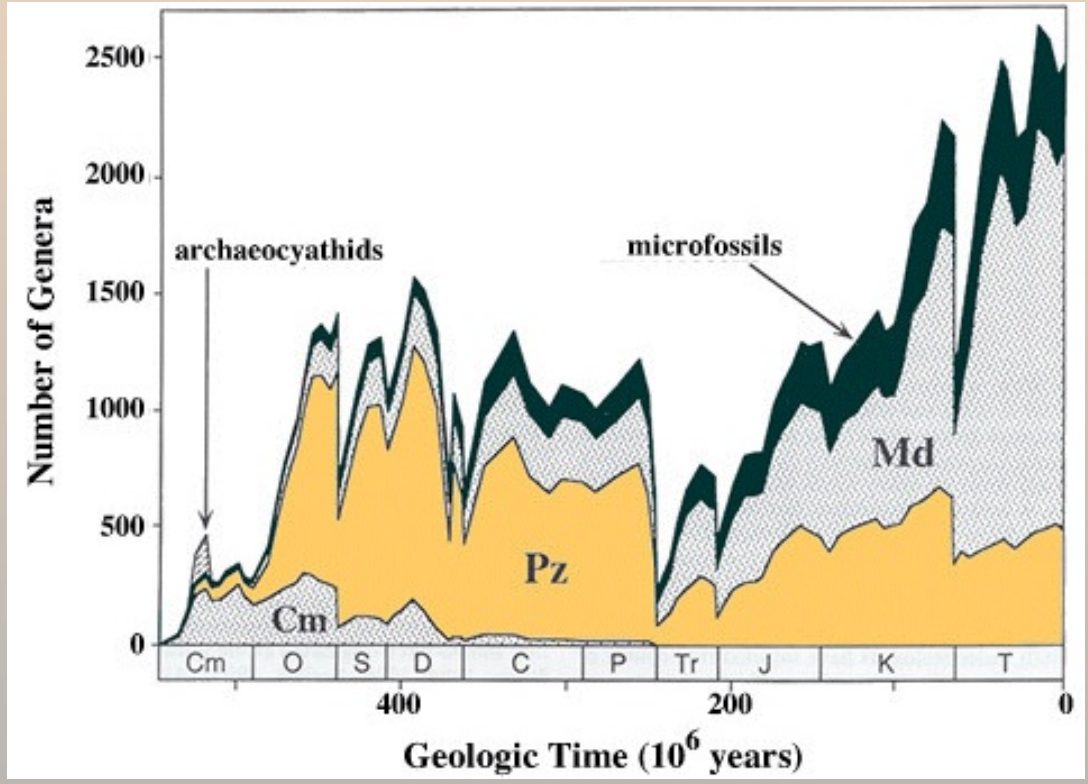
★ Short-lived and long-lived taxa have the same probability of experiencing extinction

Are Mass Extinctions Destructive or Creative ?

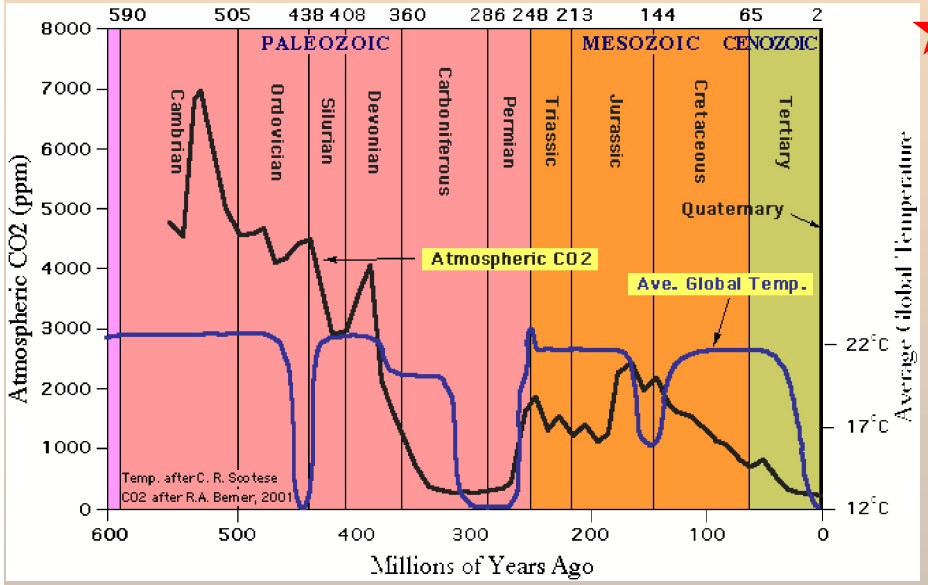
★ Mass extinction are **BOTH**

★ Breaks the evolutionary rigidity of ecosystems

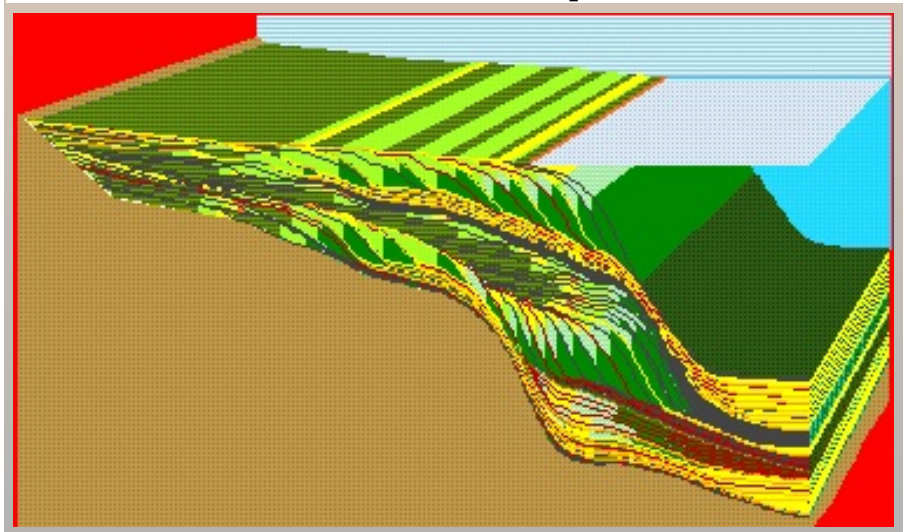
★ Allows opportunistic replacement



Intrinsic, Earth-Bound Factors



- **Global temperature change**
  - Affects shallow tropical water
  - Increases aridity or increased rainfall and climatic cooling
  - Critical factor in the geographic distribution of taxa
  - Long-term change results in migration of taxa; when barriers exist, extinction occurs

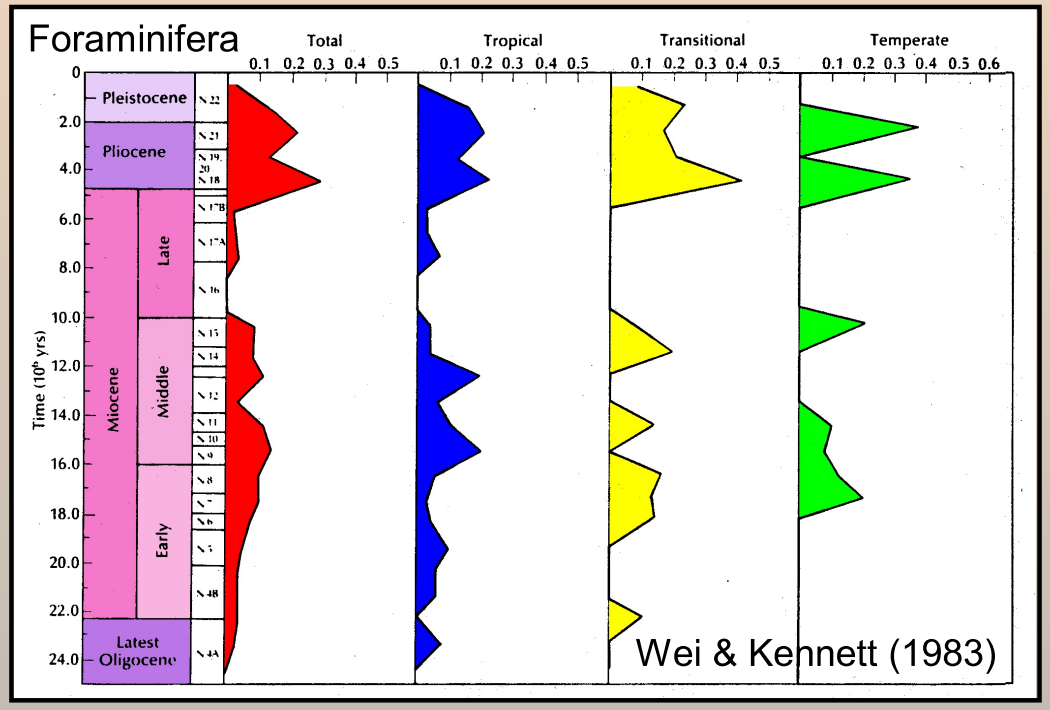


- **Marine regression**
  - Reduces habitable area on continental shelves;
  - Coupled with changes in temperature gradient, living space disappears
  - Vulnerable “Perched faunas”

More Earth-Bound Factors

★ Oceanographic effects

★ Changes in circulation patterns including upwelling and bottom-water overturn



★ Significant excursions in $\delta^{13}C$ associated with mass extinctions

★ Carbon sequestration indicated by black shales (- shift $\delta^{13}C$)

★ No $\delta^{13}C$ excursion means productivity favored and eutrophication

And Yet MORE Intrinsic Factors

★ **Volcanism**

★ Explosive and acidic producing dust and sulfurous gases (aerosols); can affect global cooling

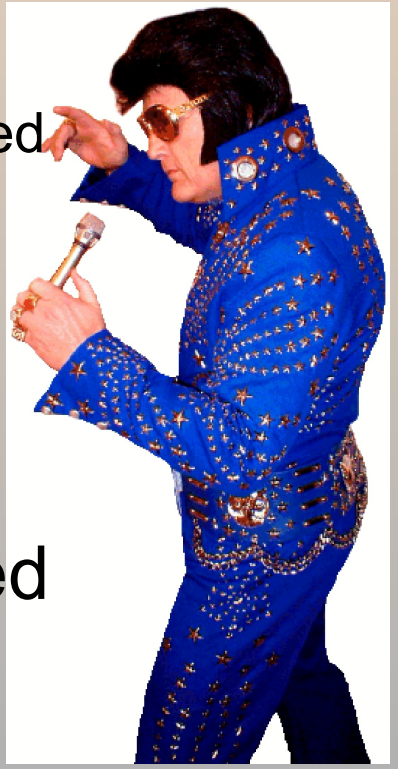
★ Extrusive with lava eruptions carrying large amounts of sulfur-rich gasses, generating sulfuric acid aerosols

Extrinsic Factors?

- **Visitors from Outer Space !!**
- Supernova radiations
  - Lethal blasts of radiation
- Bolide impacts
  - Meteorite or asteroid collisions with Earth

RECOVERY FROM MASS EXTINCTION

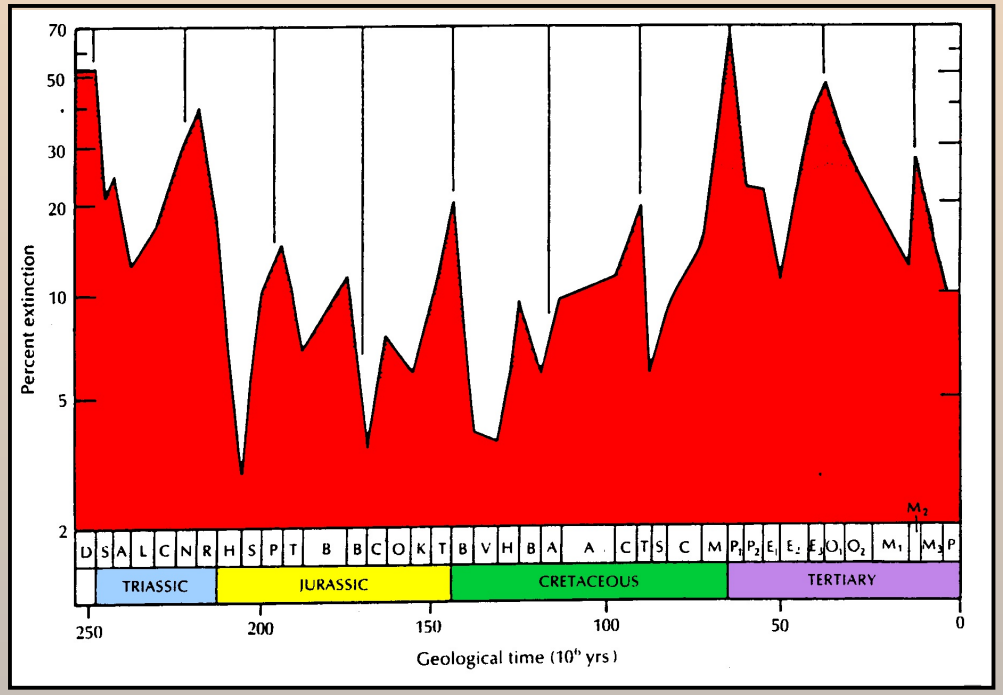
- Culminates in a survival interval (low taxonomic diversity)
- Lag phase may be comprised of
  - Rare forms of low diversity
  - Few dominant taxa (disaster species) adapted to stressed environments
- Rebound phase when some new taxa appear
- Elvis vs Lazarus taxa
- Recovery Interval with rapid and sustained diversification; new clades appear



Is There Periodicity to Extinction?

★ Fischer & Arthur (1977) and Raup & Sepkoski (1984)

★ Mass extinctions and less severe analogues occur at regular spacing throughout the Phanerozoic



★ Maximum extinction intensity is statistically non-random with respect to time @ 26 My peridodicity