

I. Rates of extinction: the extinction rates of species are independent of the "age" of the species — species do not become "senile" and "die". There is a constant probability of extinction for a species.

- A. pseudoextinction: a species disappearing from the fossil record because it has transformed into a new species, or split into two new species.
- B. real extinction: the end of a shared gene pool on earth

II. Causes of extinction

- A. biological: many species obviously go extinct for reasons of predation, competition, parasitism and the like. These causes are almost impossible to discern from the fossil record, and can essentially only be studied in modern species.
- B. physical: easier to study from the fossil record, since physical changes such as volcanoes, climate changes, and asteroids leave physical traces on the planet. The difficulty is not correlating physical changes with extinctions, it is trying to prove cause and effect, especially when the effect may be delayed in time from the cause.
- C. Leigh Van Valen's "Red Queen" hypothesis: basically states that species are always evolving as fast as they can to meet new challenges, but since all other species are doing the same, all each species can do in general is to stay in the same relative place. Since the chance that a species will outcompete/outpredate/out parasitize another species is constant, the probability of extinction for a species is constant in absolute time. This has not been well-tested.

III. Types of Extinction

- A. "background" extinction: the kind of normal extinction that goes on continuously due to biological and minor physical causes
- B. "mass extinctions": an exceptionally large number of groups going extinct at once. Used to define the geological time scale.
 - 1. The end-Permian was the biggest.
 - 2. The K-T is the best-studied, and the asteroid impact which created the Chicxulub Crater in Yucatan is the cause.
- C. Sepkowski and Raup proposed that their finding of a 26 million year cycle of mass extinction is caused by a "dark star" sending asteroids to earth about every 26 million years. Their findings have been challenged statistically, biologically, and astronomically, but it makes a good story. See the book "*The Nemesis Affair*" by David Raup [1986: Norton Pub. Co.] for the story as it stood in the mid 1980s.