

Gradualism Vs. Catastrophism

Encyclopedia Article

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Ever since the work of George Cuvier in the late 1700's, the evolutionary mechanisms driving speciation have been debated by both scientists and the general public. Cuvier was a French naturalist who demonstrated the reality of extinctions of **species** throughout natural history. He asserted that extinctions occurred on a wide scale due to sudden catastrophic events. Cuvier's contemporaries favored extinctions by processes that are more gradual. These two schools of thought, catastrophism and gradualism are still debated today.

The fossil record has shown that mass extinctions have occurred five times (65, 208, 245, 360 and 438 million years ago). Following these extinctions, there has been a large increase in the numbers of new species represented in the fossil record. Scientists speculate that after mass extinctions, species diversity is low and many ecological niches are vacant. There are greater opportunities for new variants to become established, eventually giving rise to new species. It is clear that mass extinctions create the opportunity for highly significant mechanisms such as genetic drift, **gene flow** and **natural selection** to occur and drive the course of **evolution**.

How the mass extinctions occur is the crux of the gradualism/catastrophism debate. Gradualism postulates that evolutionary change is slow and progressive. One model of gradualism acknowledges that the fossil record shows long periods of no change in species, followed by rapid speciation. This is referred to as **punctuated equilibrium** and is championed by Stephan Jay Gould and Niles Eldredge as part of the Modern Synthesis model of evolution.

Catastrophism proposes that mass extinctions occurred by hugely destructive events such as supernovas, global volcanism and earthquakes or extra-terrestrial events like impacts from comets or asteroids.

The work of Luis Alvarez and colleagues have found high iridium concentrations in rocks at the Cretaceous-Tertiary geological boundary (65 million years ago) that may have been caused by the impact of a large asteroid with the surface of the Earth. In addition, an enormous impact crater of an appropriate age has been found at Chicxulub, Mexico. Alvarez hypothesized that an impact by a large asteroid was responsible for the Tertiary mass extinction due to resulting catastrophic climactic changes. However, these mass extinctions were not instantaneous suggesting a mix of both catastrophic and gradualistic factors.

Whether by gradualism or catastrophism, it is clear that the Tertiary mass extinctions provided the evolutionary opportunities for the emergence of mammals and eventually, *Homo sapiens*.