

Edward Drinker Cope's Law of Acceleration of Growth

The Law of Acceleration of Growth is a theory proposed by Edward Drinker Cope in the US during the nineteenth century. Cope developed it in an attempt to explain the evolution of genera by appealing to changes in the developmental timelines of organisms. Cope proposed this law as an additional theory to natural selection. He argued that the evolution of genera, the more general groups within which biologists group species, occurs when the individuals in a species move through developmental stages faster than did their ancestors, but within the same fixed period of gestation, and thus can undergo new developmental stages and develop new traits. The Law of Acceleration compliments Cope's Law of Retardation of Growth. He described the later law as the process by which organisms revert to an ancestral stage. In these cases, forces suppress the most recent traits or stages common to the development of individuals from different species within the same genus. Cope described evolution as progressive and following a predetermined path, a perspective about evolution sometimes called orthogenetic. Cope's was one among many orthogenic theories in the second half of the nineteenth century. Furthermore, the theory was part of a trend in the nineteenth century in which some biologists claimed that the changes in developmental timing of organisms could explain large changes in biological forms throughout natural history.

Cope worked in the US studying a range of subjects including reptiles, fossils, and the processes by which evolution occurs. He lived from 1840 to 1897 in Pennsylvania, where he was a professor at the University of Pennsylvania in Philadelphia. Upon publication in 1859 of Charles Darwin's *On the Origin of Species by Means of Natural Selection*, many scientists found the evidence for evolution and common ancestry of animals compelling, but they debated Darwin's proposed mechanism by which evolution occurs: natural selection. Additionally, scientists debated whether or not evolution was progressive or undirected. Many scientists noted a parallel between the development of an organism and the evolution of their species, called the law of parallelism, and some attempted to explain this phenomenon. Cope aimed to address these issues with the Law of Acceleration. He claimed that the mechanism of evolution was predetermined and progressive.

Cope first proposed the Law of Acceleration in "On the Origin of Genera" published in 1868. He defended the theory that species evolved, but rejected the mechanism of natural selection as the sole process by which the larger, genus level changes occurred. He claimed that natural selection can only eliminate the unfit, but cannot create more fit individuals. He argued that there was no satisfactory theory of how variation arises. The theory of natural selection presupposes that variation of individuals arises randomly, but the Law of Acceleration, as described in "On the Origin of Genera," claims that the variations of individuals on which natural selection acts are those traits added to the end of the each individual's development in an entire species. According to Cope's Law, development of fetal and infant individuals within a species can speed up with evolution, so that the individual moves through developmental stages more rapidly and there is time for new traits to be added at the end of the development process. Cope argued that a creator determined which genera would develop more rapidly and therefore accrue more traits. In this view, acceleration of development is a directed process determined by God.

During the second half of the nineteenth century, scientists increasingly tried to describe the world in purely naturalistic terms. This effort put pressure on Cope to find a natural mechanism for evolution of genera, rather than a supernatural one. Cope therefore changed the Law of Acceleration to incorporate a natural cause for variation of individuals within a genera. In 1871, he published "The Laws of Organic Development" and revised his Law of Acceleration by attributing variation and acceleration of individuals within a genera to guided forces internal to those individuals. For instance, the wants, desires, and movements of organisms could guide the changes in their forms. The inter-

nal force, which Cope called bathmism, enabled the acceleration of developmental processes and the addition of characters to organisms at the end of developmental processes.

Other biologists in the US held similar theories as Cope, including Alpheus Hyatt at Boston University in Boston, Massachusetts, and Alpheus Packard at Brown University in Providence, Rhode Island. Both Hyatt and Packard were influenced by the theistic biological theories of Louis Agassiz at Harvard University in Cambridge, Massachusetts. Moreover, many of those scientists argued that evolution is determined and progressive, or orthogenetic. Cope claimed that Darwin's concept of natural selection could only account for the small superficial changes between species, not for the large changes between genera. According to Cope, Darwin had correctly identified natural selection as the cause of species, but acceleration of the developmental process of individuals causes the larger changes between genera.

Cope's Law of Acceleration was one of many theories constructed in the second half of the nineteenth century that aimed to describe evolution as acting by different mechanisms other than natural selection. For instance, in 1866 Ernst Haeckel in Germany published on his biogenetic law, which argued that as an organism within a species develops, its stages replay the adult stages of individuals in those species from which the organism's species evolved. Hyatt and Packard produced similar theories, but their theories differed from Cope's in the emphasis placed on natural selection, the origin of variability, and whether or not there was predetermined progress in evolution.

Cope's Law of Acceleration lost support when scientists rediscovered and confirmed Gregor Mendel's principles of genetics in the first decade of the twentieth century. When Cope composed his law, scientists could not explain how offspring inherited traits from their parents. With the rediscovery of Mendel's principles, biologists discovered that heredity occurs by the transmission of discrete genetic traits from both parents to their offspring, and that mutation and the recombination of the genetic code can cause novel traits in the offspring of organisms. With Mendel's framework, biologists doubted that evolution occurred by changes arising simultaneously in all individuals of a species, as Cope's law had proposed.

Sources

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