Continue



The main difference between gradualism and punctuated equilibrium is that the gradualism is the selection and variation that occur in small increments whereas punctuated equilibrium is a radical change that occurs in a short period of time. Furthermore, gradualism helps to select better variations to the environment while punctuated equilibrium emphasizes consistent and cumulative changes to the species. Gradualism and punctuated equilibrium are two phenomena that bring variations to a particular species during evolution. Key Areas Covered 1. What is Gradualism – Definition, Facts, Importance2. What is Punctuated Equilibrium – Definition, Facts, Importance 3. What are the Similarities Between Gradualism and Punctuated Equilibrium – Outline of Common Features 4. What is the Difference Between Gradualism and Punctuated Equilibrium – Comparison of Key Differences Key Terms Genetic Changes, Gradualism, Neo Darwinism, Punctuated Equilibrium, Variation What is Gradualism Gradualism is the slow, steady changes of a particular species. Here, the selection and variation occur more gradually. Hence, gradualism takes a long period of time and the changes are hard to notice within a short period of time. In brief, the population changes over a long period of time while the changes are slow, constant, and consistent. Figure 1: Gradualism and Punctuated Equilibrium Gradualism is the basis of the classic Neo Darwinism and it is also called uniformitarianism. It assumes that the tree of life starts with a one-celled organism, which increases its complexity to form modern life forms gradually. But, fossil records do not support this concept of emerging from small, gradual changes. Besides, new life forms spurt in fossils rather than transitioning between types of species. What is Punctuated Equilibrium Punctuated equilibrium describes the punctuation of the slow evolution by short events, leading to rapid evolution. It was the theory proposed to explain the deviations of the fossil records from gradualism. According to punctuated equilibrium, the oppression caused by the environmental stress on a small, isolated population forces the population to produce variations fairly rapidly. Therefore, the genetic changes occur more rapidly. However, Neo Darwinism describes that genetic changes within a population are slow. Figure 2: Punctuated Equilibrium In punctuated equilibrium, it is considered that conditions of the environment are constant. However, the environment can also change due to climate changes or the introduction of new predators. This also can emphasize changes in a particular population that lives within that environment in a short period of time. In conclusion, punctuated equilibrium is the better model in describing the appearing of variations within a population. Gradualism and punctuated equilibrium are two phenomena that help to establish variations in species. Natural selection help to choose the best fitting type of organisms to the environment. Gradualism refers to the hypothesis that evolution proceeds by imperceptibly small, cumulative steps over long periods of time rather than by abrupt, major changes while punctuated equilibrium refers to the hypothesis that evolutionary development is marked by isolated episodes of rapid speciation between long periods of little or no change. Type of Variation Gradualism brings small variation to a particular species while punctuated equilibrium emphasizes consistent and cumulative changes to a species. Duration Furthermore, gradualism occurs over a long period of time while punctuated equilibrium occurs within a short period of time. Evolution Also, gradualism describes evolution as a slow process while punctuated equilibrium brings short events, which speed up the slow evolution. As a Model Fossil records do not prove gradualism while punctuated equilibrium is the better model to describe evolution. Conclusion Gradualism is the introduction of variations to a particular population over a long period of time while punctuated equilibrium is the quick variation in a particular population due to sudden changes in the environment called environmental stress within a short period of time. The main difference between gradualism and punctuated equilibrium is the appearance of variations in a particular population. Reference: 1. Saylo, Monalie C, et al. “Punctuated Equilibrium vs. Phyletic Gradualism.” International Journal of Bio-Science and Bio-Technology, vol. 3, ser. 4, Dec. 2011, pp. 27–42. 4, Available Here Image Courtesy: 1. “PunctuatedEquilibrium” By Miguel Chavez – Own work (CC BY-SA 4.0) via Commons Wikimedia 2. “Punctuated Equilibrium” By Ian Alexander – Own work (CC BY-SA 4.0) via Commons Wikimedia Gradualism is the idea that small changes build up over time to create big changes.Punctuated equilibrium suggests that species stay the same for a long time, then change quickly.Fossils are important evidence for both gradualism and punctuated equilibrium, but interpretations differ. Evolution takes a very long time to become visible. Generation after generation can come and go before any changes in a species are observed. There is some debate in the scientific community as to how quickly evolution occurs. The two generally accepted ideas for rates of evolution are called gradualism and punctuated equilibrium. Based on geology and the findings of James Hutton and Charles Lyell, gradualism states that large changes are actually the culmination very small changes that build up over time. Scientists have found evidence of gradualism in geologic processes, which the Prince Edward Island Department of education describes as the "...processes at work in the earth's landforms and surfaces. The mechanisms involved, weathering, erosion, and plate tectonics, combine processes that are in some respects destructive and in others constructive." Geologic processes are long, slow changes that occur over thousands or even millions of years. When Charles Darwin first began formulating his theory of evolution, he adopted this idea. The fossil record is evidence that supports this view. There are many transitional fossils that show structural adaptations of species as they transform into new species. Proponents of gradualism say that the geologic time scale helps show how species have changed over the different eras since life began on Earth. Punctuated equilibrium, by contrast, is based on the idea that since you cannot see changes in a species, there must be very long periods when no changes occur. Punctuated equilibrium asserts that evolution occurs in short bursts followed long periods of equilibrium. Put another way, long periods of equilibrium (no change) are "punctuated" by short periods of rapid change. Proponents of punctuated equilibrium included such scientists as William Bateson, a strong opponent of Darwin's views, who argued that species do not evolve gradually. This camp of scientists believes that change happens very rapidly with long periods of stability and no change in between. Usually, the driving force of evolution is some sort of change in the environment that necessitates a need for quick change, they argue. Strangely enough, scientists in both camps cite the fossil record as evidence to support their views. Proponents of punctuated equilibrium point out that there are many missing links in the fossil record. If gradualism is the correct model for the rate of evolution, they argue, there should be fossil records that show evidence of slow, gradual change. Those links never really existed, to begin with, say the proponents of punctuated equilibrium, so that removes the issue of missing links in evolution. Darwin also pointed to fossil evidence that showed slight changes in the body structure of the species over time, often leading to vestigial structures. Of course, the fossil record is incomplete, leading to the problem of the missing links. Currently, neither hypothesis is considered more accurate. More evidence will be needed before gradualism or punctuated equilibrium is declared the actual mechanism for the rate of evolution. The gradualism model of evolution proposes that a progenitor species gradually gave rise to many new species, with no special mechanisms accounting for the origins of new genera or groups of higher classifications—only the accumulation of many small changes in the frequencies of alleles in gene pools. The punctuated equilibrium model of evolutionary change supposes long periods of little or no change interspersed with short intervals of rapid change. Charles Darwin, author of On the Origin of Species by Means of Natural Selection (1859), believed that morphological change was inevitable and proceeded slowly, encompassing slight, successive, and gradual changes within lineages. Speciation, therefore, was the result of the gradual accumulation of changes within ancestral populations over time, ultimately leading to the formation of recognizably new and different species. According to Darwin, sudden, large-scale changes were improbable or impossible—an idea epitomized by the phrase Natura non facit saltum, or “Nature never makes leaps.” Darwin’s concept of the slow and gradual transformation of a species’ entire ancestral population into distinct descendant species over time has been termed “phyletic gradualism,” or anagenesis. If true, the expectation of anagenic transformation leads to the supposition that the fossil record for any lineage should contain an “inconceivably great” number of intermediate forms. Darwin, however, realized that the fossil record is, in fact, not littered with an “interminable” and “enormous” number of intermediate forms. Darwin’s solution to this problem with his theory was presented in a chapter of his book On the Origin of Species by Means of Natural Selection titled “On the Imperfection of the Geological Record.” Here Darwin persuasively argued that the paleontological record of the past is extremely imperfect because of degradation of fossiliferous deposits and differential rates of deposition and fossilization among lineages. He also noted that, on geologic time scales, persistent, long-lived and widespread species are more likely to appear in the fossil record than short-lived species or species confined to narrow geographic ranges. The “Modern Synthesis,” Microevolution, and Species Formation In the 1930’s and 1940’sDarwin’s theory of natural selection was melded with then-current knowledge of genetics, heritability, and mathematics to produce the modern synthesis theory of evolution. Under this paradigm, evolution came to be defined as a change in gene frequency over time. The microevolutionary processes of mutation, migration, random genetic drift, and natural selection were recognized as the primary mechanisms that alter gene frequencies. At this time other authorities began to carefully consider the mechanism(s) by which species arise. One particularmode of species formation, and one supported by considerable empirical evidence, is termed the allopatric model of speciation. Allopatric species are formed as subpopulations of a more widespread ancestral species become geographically isolated and, in time, reproductively isolated from one another. Paleospecies and Punctuated Equilibria These ideas, particularly those of gradual, inevitable change by microevolutionary processes and the imperfection of the fossil record, and were accepted by paleontologists for more than a century. However, in 1972 Niles Eldredge and Stephen J. Gould published a paper in which paleontologists were challenged to examine fossil sequences (and gaps) more objectively. Eldredge and Gould drew three important conclusions about the fossil record. First, some gaps in the fossil record are real and cannot be attributed to other factors; gradual series of transitional forms do occur, but they are extremely rare. Second, paleospecies often persist for millions of years without substantial morphological change. Third, they recognized that paleospecies found in older strata are sometimes rapidly replaced by morphologically different taxa in younger deposits. Thus, a literal interpretation of the fossil record requires the acknowledgment of short, rapid bursts of evolution. That is,within the paleontological history of a lineage, morphological stasis is occasionally interrupted by near-instantaneous (in geological time) formation of morphologically different species. If these gaps are real, how are they to be explained? How is one species suddenly (in geologic time) replaced by a morphologically modified form in the fossil record? To answer these questions, Eldredge and Gould developed the theory of punctuated equilibria that, in essence, fused a literal interpretation of the fossil record with the mode of speciation most often observed in extant populations (such as the allopatric model of speciation). Eldredge and Gould’s theory of punctuated equilibria is based on the following postulates or observations. First, speciation typically occurs via allopatric speciation. Second, the origin of descendant species is, in geological time, rapid and occurs in a limited geographic area. Third, most adaptive change occurs at the time of speciation. Fourth, speciation is typically followed by long periods of morphological stasis, particularly within large, widespread species. Fifth, the abrupt appearance of a new species within the range of the ancestral species is a result of ecological succession, immigration, or competition. Finally, apparent adaptive trends (such as macroevolutionary trends) observed in the fossil record are the result of species selection within lineages over time. The authors reasoned that as long as a species is capable of successfully exploiting its habitat, adaptations that originated at the time of speciation are unlikely to be altered, and morphological stasis is the result. Thus, in terms of the geologic time scale, most species seem to persist unchanged over long periods of time. The origin of a new species, its growth in numbers, and the extension of its geographic range are, therefore, determined by reproductive and ecological characteristics. In short, under the punctuated equilibrium model new species can be successful if they are sufficiently distinct in their habitat requirements and if they are able to compete with or outcompete close relatives should they come into contact with one another. This theory of speciation and diffential reproduction and survival of species produces well-documented, large-scale evolutionary patterns or “macroevolutionary” trends. Punctuated Equlibria and PlantsThe theory of punctuated equilibria was constructed based on studies of animal fossils; unfortunately, no mention is made of plants. The theory has therefore received less attention from paleobotanists. It is true that in extant plants rapid changes in physiological or morphological characteristics associated with speciation are not uncommon. However, such phenomena are rarely documented in the fossil record.For example, interspecific hybridization or polyploidization may (almost instantaneously) form new, reproductively isolated species whose niches may differ from those of their immediate progenitors. Thus, in plants, rapid species formation is empirically known. Stasis is also known from the fossil records of some plant lineages. For example, in terms of floral structure, extant members of the Loraceae, Chloranthaceae, Nymphaceae, and the magnoliids scarcely differ from their early- to mid-Cretaceous ancestors. Morphological stasis is also observed in gingkos, Metasequoia, cycads, lycopods, sphenopsids, and ferns as well as the genus Pinus, which arose in the Jurassic. Rapid radiations are also documented in the plant fossil record, as occurred after the rise of angiosperms during the early Cretaceous. Thus, the plant fossil record provides clear evidence for stasis in some lineages and rapid diversification in others. Despite these observations, paleobotanical examples of lineages whose evolution fits the predictions of the punctuated equilibrium model are few.BibliographyEldredge, N. Time Frames. New York: Simon and Schuster, 1985. Examples of different tempos of evolution as judged from the fossil record, including an extensive bibliography.Eldredge, N., and S. J. Gould. “Punctuated Equilibria: An Alternative to Phyletic Gradualism.” In Models in Paleobiology, edited by T. J. M. Schopf. San Francisco: Freeman, Cooper, 1972. The original description of the theory of punctuated equilibria.Freeman, S., and J. C. Herron. Evolutionary Analysis. 2d ed. Upper Saddle River, N.J.: Prentice Hall, 2001. A concise explanation of the theory of punctuated equilibria. Includes examples of studies that support the theory and others that do not. Gradualism and punctuated equilibrium are two contrasting theories that explain the pace of evolution. Gradualism suggests that evolution occurs slowly and steadily over long periods of time, with small and incremental changes accumulating to result in significant transformations. On the other hand, punctuated equilibrium proposes that evolution occurs in rapid bursts of change, separated by long periods of stability. While gradualism emphasizes the importance of gradual and continuous adaptations, punctuated equilibrium highlights the significance of sudden and dramatic events that drive evolutionary change. Both theories offer valuable insights into the process of evolution, but they differ in their emphasis on the pace and pattern of change. In the field of evolutionary biology, two contrasting theories have emerged to explain the pace and pattern of evolutionary change: gradualism and punctuated equilibrium. These theories offer different perspectives on how species evolve over time, with each proposing distinct mechanisms and patterns. While gradualism suggests that evolution occurs through slow and continuous changes, punctuated equilibrium argues that species experience long periods of stasis followed by rapid bursts of evolutionary change. In this article, we will explore the attributes of both gradualism and punctuated equilibrium, highlighting their key differences and similarities.GradualismGradualism, as the name suggests, posits that evolutionary change occurs gradually and continuously over long periods of time. According to this theory, species evolve through the accumulation of small, incremental changes in their genetic makeup. These changes are driven by natural selection, where advantageous traits are favored and passed on to subsequent generations. Gradualism assumes that the rate of evolution remains relatively constant, resulting in a smooth and linear progression of species over time.One of the main attributes of gradualism is the concept of transitional forms. Transitional forms are intermediate stages between two distinct species, representing the gradual transformation from one form to another. Fossil records often provide evidence of these transitional forms, supporting the idea that species evolve through a series of small changes. For example, the fossil record of whales shows a gradual transition from land-dwelling ancestors to fully aquatic creatures, with intermediate forms displaying characteristics of both.Another key attribute of gradualism is the notion of adaptive radiation. Adaptive radiation occurs when a single ancestral species diversifies into multiple descendant species, each occupying different ecological niches. This process is thought to happen gradually over time as species adapt to new environments or exploit unoccupied niches. The classic example of adaptive radiation is the finches observed by Charles Darwin in the Galapagos Islands, where different beak shapes evolved to suit various food sources.Furthermore, gradualism suggests that speciation, the formation of new species, occurs through the gradual accumulation of genetic differences. This process is often driven by geographic isolation, where populations become separated and experience different selective pressures. Over time, these divergent selective pressures lead to the accumulation of genetic differences, eventually resulting in reproductive isolation and the formation of distinct species.In summary, gradualism proposes that evolution occurs through a slow and continuous process, driven by natural selection and the accumulation of small changes over time. It emphasizes transitional forms, adaptive radiation, and gradual speciation as key attributes of evolutionary change.Punctuated EquilibriumPunctuated equilibrium, in contrast to gradualism, suggests that species experience long periods of stasis, where little evolutionary change occurs, punctuated by relatively short bursts of rapid change. This theory, proposed by Niles Eldredge and Stephen Jay Gould in the 1970s, challenges the notion of gradual and continuous evolution put forth by gradualism.One of the main attributes of punctuated equilibrium is the concept of species stability. According to this theory, species tend to remain relatively unchanged for extended periods, with little or no morphological or genetic variation. This stability is thought to be a result of stabilizing selection, where individuals with traits close to the average of the population are favored. As a result, species exhibit long periods of stasis, maintaining their form and function over time.However, punctuated equilibrium also proposes that species occasionally undergo rapid bursts of evolutionary change, known as speciation events. These events are thought to be triggered by various factors, such as environmental changes or the opening of new ecological niches. During these periods of rapid change, new species may arise relatively quickly, often leaving behind little fossil evidence due to their limited duration.Another attribute of punctuated equilibrium is the concept of allopatric speciation. Allopatric speciation occurs when populations become geographically isolated, leading to the formation of new species. This process is thought to happen relatively rapidly, as the isolated populations experience different selective pressures and accumulate genetic differences. Once the populations come into contact again, they may no longer be able to interbreed, resulting in reproductive isolation and the formation of distinct species.In summary, punctuated equilibrium proposes that species experience long periods of stasis, interrupted by rapid bursts of evolutionary change. It emphasizes species stability, speciation events, and allopatric speciation as key attributes of evolutionary dynamics.Comparing Gradualism and Punctuated EquilibriumWhile gradualism and punctuated equilibrium offer contrasting views on the pace and pattern of evolutionary change, it is important to note that they are not mutually exclusive. Both theories provide valuable insights into the complex nature of evolution and can be applied to different contexts and species.One key difference between gradualism and punctuated equilibrium lies in the rate of evolutionary change. Gradualism suggests a relatively constant rate of change, resulting in a smooth and continuous progression of species over time. In contrast, punctuated equilibrium proposes long periods of stasis followed by rapid bursts of change. This difference in rate can be attributed to various factors, such as the stability of the environment or the occurrence of specific events triggering rapid evolution.Another difference lies in the pattern of speciation. Gradualism suggests that speciation occurs gradually through the accumulation of genetic differences, often driven by geographic isolation. Punctuated equilibrium, on the other hand, proposes that speciation events can happen relatively rapidly, triggered by environmental changes or the opening of new ecological niches. Both theories acknowledge the importance of speciation in driving evolutionary change but offer different perspectives on the tempo and mode of speciation.Despite these differences, gradualism and punctuated equilibrium also share some common attributes. Both theories recognize the role of natural selection in driving evolutionary change, albeit with different implications for the rate and pattern of change. Additionally, both theories acknowledge the existence of transitional forms, although gradualism places more emphasis on their gradual accumulation, while punctuated equilibrium suggests their limited occurrence due to the rapid nature of evolutionary change.Furthermore, both gradualism and punctuated equilibrium provide valuable frameworks for understanding the diversity of life on Earth. While gradualism may be more applicable to certain lineages or environments, punctuated equilibrium can help explain the rapid diversification observed in other cases. By considering the attributes of both theories, scientists can gain a more comprehensive understanding of the complex processes that shape the evolution of species.ConclusionIn conclusion, gradualism and punctuated equilibrium represent two contrasting theories in evolutionary biology, offering different perspectives on the pace and pattern of evolutionary change. Gradualism proposes that evolution occurs through slow and continuous changes, emphasizing transitional forms, adaptive radiation, and gradual speciation. Punctuated equilibrium, on the other hand, suggests that species experience long periods of stasis punctuated by rapid bursts of change, highlighting species stability, speciation events, and allopatric speciation. While these theories differ in their views on the rate and pattern of evolution, they also share common attributes and can be applied to different contexts. By considering the attributes of both gradualism and punctuated equilibrium, scientists can gain a more nuanced understanding of the complex dynamics of evolution. Comparisons may contain inaccurate information about people, places, or facts. Please report any issues. Gradualism, punctuated equilibrium, evolution, and natural selection are concepts that explore the mechanisms by which species change over time. Gradualism proposes a gradual accumulation of small changes within a population, while punctuated equilibrium emphasizes rapid periods of change interspersed with longer periods of stasis. Despite their contrasting perspectives, these theories share a common goal of explaining the processes that drive the development and diversification of life on Earth. Gradualism and Punctuated Equilibrium: Commonalities1. Both mechanisms acknowledge the role of natural selection. Natural selection drives the evolutionary process by selecting individuals with traits that provide a survival advantage.2. Common Ancestor: Both gradualism and punctuated equilibrium propose that all living organisms share a common ancestor from which they have evolved.3. Genetic Variation: Both theories recognize the importance of genetic variation within populations. Variation occurs due to mutations, providing the raw material for natural selection to work upon.4. Fossil Record: Both gradualism and punctuated equilibrium use the fossil record as evidence to support their respective theories. Gradualists point to gradual changes in the fossil record, while proponents of punctuated equilibrium highlight periods of rapid change interspersed with longer periods of stasis.5. Time Scales: Both theories acknowledge that evolution occurs over long time scales, spanning millions of years. However, punctuated equilibrium suggests that evolutionary change can occur in relatively short bursts, while gradualism proposes a more gradual, continuous process.6. Speciation: Both theories propose mechanisms for speciation, the process by which new species arise. Gradualism suggests that speciation occurs through a gradual accumulation of small genetic changes, while punctuated equilibrium posits that speciation can occur during periods of rapid change.7. Role of Extinction Events: Both theories recognize that extinction events can significantly influence evolutionary trajectories. Punctuated equilibrium emphasizes the role of mass extinctions in creating opportunities for the diversification of new species.8. __Relative Importance**: While both theories offer plausible explanations for evolutionary change, their relative prominence has shifted over time. Early on, gradualism was the dominant theory. However, punctuated equilibrium gained traction in the late 20th century, especially in the context of fossil discoveries that suggested periods of rapid change in the geologic record. Gradualism and Punctuated Equilibrium: Commonalities Gradualism and punctuated equilibrium are two contrasting viewpoints on how evolution occurs. Despite their differences, they share some key commonalities: 1. Both mechanisms acknowledge the role of natural selection. Natural selection drives the evolutionary process by selecting individuals with traits that provide a survival advantage. 2. Common Ancestor: Both gradualism and punctuated equilibrium propose that all living organisms share a common ancestor from which they have evolved. 3. Genetic Variation: Both theories recognize the importance of genetic variation within populations. Variation occurs due to mutations, providing the raw material for natural selection to work upon. 4. Fossil Record: Both gradualism and punctuated equilibrium use the fossil record as evidence to support their respective theories. Gradualists point to gradual changes in the fossil record, while proponents of punctuated equilibrium highlight periods of rapid change interspersed with longer periods of stasis. 5. Time Scales: Both theories acknowledge that evolution occurs over long time scales, spanning millions of years. However, punctuated equilibrium suggests that evolutionary change can occur in relatively short bursts, while gradualism proposes a more gradual, continuous process. 6. Speciation: Both theories propose mechanisms for speciation, the process by which new species arise. Gradualism suggests that speciation occurs through a gradual accumulation of small genetic changes, while punctuated equilibrium posits that speciation can occur during periods of rapid change. 7. Role of Extinction Events: Both theories recognize that extinction events can significantly influence evolutionary trajectories. Punctuated equilibrium emphasizes the role of mass extinctions in creating opportunities for the diversification of new species. 8. __Relative Importance**: While both theories offer plausible explanations for evolutionary change, their relative prominence has shifted over time. Early on, gradualism was the dominant theory. However, punctuated equilibrium gained traction in the late 20th century, especially in the context of fossil discoveries that suggested periods of rapid change in the geologic record. Question 1: What fundamental similarities characterize the concepts of gradualism and punctuated equilibrium? See also Unlock Customer Behavior: Behavioral Map Marketing AnalysisAnswer: Gradualism and punctuated equilibrium share the common view of evolution as a process driven by the accumulation of genetic changes over time. Both models recognize that natural selection is the primary mechanism responsible for the long-term modification of species. Question 2: How do gradualism and punctuated equilibrium differ in their perspectives on the rate of evolutionary change? Answer: Gradualism proposes a slow and continuous process of evolutionary divergence, with gradual changes in gene frequencies over many generations. Punctuated equilibrium, in contrast, suggests periods of relatively rapid speciation (punctuated) followed by long intervals of stability (equilibrium). Question 3: What are the implications of gradualism and punctuated equilibrium for our understanding of species origins? Answer: Gradualism supports the idea that new species arise through a gradual accumulation of small genetic changes. Punctuated equilibrium suggests that new species can originate rapidly through significant genetic changes during short, discrete periods of speciation. Alright guys that’s all she wrote for today’s article. I hope that I was able to shed some light on the similarities and differences between gradualism and punctuated equilibrium. If you’re still a little confused, don’t worry, I’ll be here to answer any questions you might have in the comments section. And don’t forget to check back later for more awesome science stuff. Later taters! Gradualism is the idea that small changes build up over time to create big changes.Punctuated equilibrium suggests that species stay the same for a long time, then change quickly.Fossils are important evidence for both gradualism and punctuated equilibrium, but interpretations differ. Evolution takes a very long time to become visible. Generation after generation can come and go before any changes in a species are observed. There is some debate in the scientific community as to how quickly evolution occurs. The two generally accepted ideas for rates of evolution are called gradualism and punctuated equilibrium. Based on geology and the findings of James Hutton and Charles Lyell, gradualism states that large changes are actually the culmination very small changes that build up over time. Scientists have found evidence of gradualism in geologic processes, which the Prince Edward Island Department of education describes as the "...processes at work in the earth's landforms and surfaces. The mechanisms involved, weathering, erosion, and plate tectonics, combine processes that are in some respects destructive and in others constructive." Geologic processes are long, slow changes that occur over thousands or even millions of years. When Charles Darwin first began formulating his theory of evolution, he adopted this idea. The fossil record is evidence that supports this view. There are many transitional fossils that show structural adaptations of species as they transform into new species. Proponents of gradualism say that the geologic time scale helps show how species have changed over the different eras since life began on Earth. Punctuated equilibrium, by contrast, is based on the idea that since you cannot see changes in a species, there must be very long periods when no changes occur. Punctuated equilibrium asserts that evolution occurs in short bursts followed long periods of equilibrium. Put another way, long periods of equilibrium (no change) are "punctuated" by short periods of rapid change. Proponents of punctuated equilibrium included such scientists as William Bateson, a strong opponent of Darwin's views, who argued that species do not evolve gradually. This camp of scientists believes that change happens very rapidly with long periods of stability and no change in between. Usually, the driving force of evolution is some sort of change in the environment that necessitates a need for quick change, they argue. Strangely enough, scientists in both camps cite the fossil record as evidence to support their views. Proponents of punctuated equilibrium point out that there are many missing links in the fossil record. If gradualism is the correct model for the rate of evolution, they argue, there should be fossil records that show evidence of slow, gradual change. Those links never really existed, to begin with, say the proponents of punctuated equilibrium, so that removes the issue of missing links in evolution. Darwin also pointed to fossil evidence that showed slight changes in the body structure of the species over time, often leading to vestigial structures. Of course, the fossil record is incomplete, leading to the problem of the missing links. Currently, neither hypothesis is considered more accurate. More evidence will be needed before gradualism or punctuated equilibrium is declared the actual mechanism for the rate of evolution. Gradualism is the idea that small changes build up over time to create big changes.Punctuated equilibrium suggests that species stay the same for a long time, then change quickly.Fossils are important evidence for both gradualism and punctuated equilibrium, but interpretations differ. Evolution takes a very long time to become visible. Generation after generation can come and go before any changes in a species are observed. There is some debate in the scientific community as to how quickly evolution occurs. The two generally accepted ideas for rates of evolution are called gradualism and punctuated equilibrium. Based on geology and the findings of James Hutton and Charles Lyell, gradualism states that large changes are actually the culmination very small changes that build up over time. Scientists have found evidence of gradualism in geologic processes, which the Prince Edward Island Department of education describes as the "...processes at work in the earth's landforms and surfaces. The mechanisms involved, weathering, erosion, and plate tectonics, combine processes that are in some respects destructive and in others constructive." Geologic processes are long, slow changes that occur over thousands or even millions of years. When Charles Darwin first began formulating his theory of evolution, he adopted this idea. The fossil record is evidence that supports this view. There are many transitional fossils that show structural adaptations of species as they transform into new species. Proponents of gradualism say that the geologic time scale helps show how species have changed over the different eras since life began on Earth. Punctuated equilibrium, by contrast, is based on the idea that since you cannot see changes in a species, there must be very long periods when no changes occur. Punctuated equilibrium asserts that evolution occurs in short bursts followed long periods of equilibrium. Put another way, long periods of equilibrium (no change) are "punctuated" by short periods of rapid change. Proponents of punctuated equilibrium included such scientists as William Bateson, a strong opponent of Darwin's views, who argued that species do not evolve gradually. This camp of scientists believes that change happens very rapidly with long periods of stability and no change in between. Usually, the driving force of evolution is some sort of change in the environment that necessitates a need for quick change, they argue. Strangely enough, scientists in both camps cite the fossil record as evidence to support their views. Proponents of punctuated equilibrium point out that there are many missing links in the fossil record. If gradualism is the correct model for the rate of evolution, they argue, there should be fossil records that show evidence of slow, gradual change. Those links never really existed, to begin with, say the proponents of punctuated equilibrium, so that removes the issue of missing links in evolution. Darwin also pointed to fossil evidence that showed slight changes in the body structure of the species over time, often leading to vestigial structures. Of course, the fossil record is incomplete, leading to the problem of the missing links. Currently, neither hypothesis is considered more accurate. More evidence will be needed before gradualism or punctuated equilibrium is declared the actual mechanism for the rate of evolution. Skip to main content Reddit and its partners use cookies and similar technologies to provide you with a better experience. By accepting all cookies, you agree to our use of cookies to deliver and maintain our services and site, improve the quality of Reddit, personalize Reddit content and advertising, and measure the effectiveness of advertising. By rejecting non-essential cookies, Reddit may still use certain cookies to ensure the proper functionality of our platform. For more information, please see our Cookie Notice and our Privacy Policy. Gradualism is the idea that small changes build up over time to create big changes.Punctuated equilibrium suggests that species stay the same for a long time, then change quickly.Fossils are important evidence for both gradualism and punctuated equilibrium, but interpretations differ. Evolution takes a very long time to become visible. Generation after generation can come and go before any changes in a species are observed. There is some debate in the scientific community as to how quickly evolution occurs. The two generally accepted ideas for rates of evolution are called gradualism and punctuated equilibrium. Based on geology and the findings of James Hutton and Charles Lyell, gradualism states that large changes are actually the culmination very small changes that build up over time. Scientists have found evidence of gradualism in geologic processes, which the Prince Edward Island Department of education describes as the "...processes at work in the earth's landforms and surfaces. The mechanisms involved, weathering, erosion, and plate tectonics, combine processes that are in some respects destructive and in others constructive." Geologic processes are long, slow changes that occur over thousands or even millions of years. When Charles Darwin first began formulating his theory of evolution, he adopted this idea. The fossil record is evidence that supports this view. There are many transitional fossils that show structural adaptations of species as they transform into new species. Proponents of gradualism say that the geologic time scale helps show how species have changed over the different eras since life began on Earth. Punctuated equilibrium, by contrast, is based on the idea that since you cannot see changes in a species, there must be very long periods when no changes occur. Punctuated equilibrium asserts that evolution occurs in short bursts followed long periods of equilibrium. Put another way, long periods of equilibrium (no change) are "punctuated" by short periods of rapid change. Proponents of punctuated equilibrium included such scientists as William Bateson, a strong opponent of Darwin's views, who argued that species do not evolve gradually. This camp of scientists believes that change happens very rapidly with long periods of stability and no change in between. Usually, the driving force of evolution is some sort of change in the environment that necessitates a need for quick change, they argue. Strangely enough, scientists in both camps cite the fossil record as evidence to support their views. Proponents of punctuated equilibrium point out that there are many missing links in the fossil record. If gradualism is the correct model for the rate of evolution, they argue, there should be fossil records that show evidence of slow, gradual change. Those links never really existed, to begin with, say the proponents of punctuated equilibrium, so that removes the issue of missing links in evolution. Darwin also pointed to fossil evidence that showed slight changes in the body structure of the species over time, often leading to vestigial structures. Of course, the fossil record is incomplete, leading to the problem of the missing links. Currently, neither hypothesis is considered more accurate. More evidence will be needed before gradualism or punctuated equilibrium is declared the actual mechanism for the rate of evolution. Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Theory in evolutionary biology This article is about the theory in evolutionary biology. For the theory of social change, see Punctuated equilibrium in social theory. For the album by Wino (Scott Weinrich), see Punctuated Equilibrium (album). The punctuated equilibrium model (top) consists of morphological stability followed by rare bursts of evolutionary change via rapid cladogenesis – vertical equilibrium states separated by horizontal "jump" phases. In contrast, phyletic gradualism (below), is a more gradual, continuous model of evolution – with accumulation of small incremental changes represented by slanted bars that split at branch-points, where two separate modes of life are feasible but of which, each prospers best with divergent specializations. Part of a series onEvolutionary biologyDarwin's finches by John Gould Index Introduction Main Outline Glossary Evidence History Processes and outcomes Population genetics Variation Diversity Mutation Natural selection Adaptation Polymorphism Genetic drift Gene flow Speciation Adaptive radiation Co-operation Coevolution Coextinction Contingency Divergence Convergence Parallel evolution Extinction Natural history Origin of life Common descent History of life Timeline of evolution Human evolution Recent human evolution Phylogeny Biodiversity Biogeography Classification Evolutionary taxonomy Cladistics Transitional fossil Extinction event History of evolutionary theory Overview Renaissance Before Darwin Darwin Origin of Species Before synthesis Modern synthesis Molecular evolution Evo-devo Current research History of speciation History of paleontology (timeline) Fields and applications Applications of evolution Biosocial criminology Ecological genetics Evolutionary aesthetics Evolutionary anthropology Evolutionary computation Evolutionary ecology Evolutionary economics Evolutionary epistemology Evolutionary ethics Evolutionary game theory Evolutionary linguistics Evolutionary medicine Evolutionary neuroscience Evolutionary physiology Evolutionary psychology Experimental evolution Invasion genetics Island biogeography Phylogenetics Paleontology Selective breeding Speciation experiments Sociobiology Systematics Universal Darwinism Social implications Eugenics Evolution as fact and theory Dysgenics Social effects Creation–evolution controversy Theistic evolution Objections to evolution Level of support Nature-nurture controversy Evolutionary biology portal Categoryvte In evolutionary biology, punctuated equilibrium (also called punctuated equilibria) is a theory that proposes that once a species appears in the fossil record, the population will become stable, showing little evolutionary change for most of its geological history.[1] This state of little or no morphological change is called stasis. When significant evolutionary change occurs, the theory proposes that it is generally restricted to rare and geologically rapid events of branching speciation called cladogenesis. Cladogenesis is the process by which a species splits into two distinct species, rather than one species gradually transforming into another. Punctuated equilibrium is commonly contrasted with phyletic gradualism, the idea that evolution generally occurs uniformly by the steady and gradual transformation of whole lineages (anagenesis).[2] In 1972, paleontologists Niles Eldredge and Stephen Jay Gould published a landmark paper developing their theory and called it punctuated equilibria.[1] Their paper built upon Ernst Mayr's model of geographic speciation,[3] I. M. Lerner's theories of developmental and genetic homeostasis,[4] and their own empirical research.[5][6] Eldredge and Gould proposed that the degree of gradualism commonly attributed to Charles Darwin[7] is virtually nonexistent in the fossil record, and that stasis dominates the history of most fossil species. Punctuated equilibrium originated as a logical consequence of Ernst Mayr's concept of genetic revolutions by allopatric and especially peripatric speciation as applied to the fossil record. Although the sudden appearance of species and its relationship to speciation was proposed and identified by Mayr in 1954,[3] historians of science generally recognize the 1972 Eldredge and Gould paper as the basis of the new paleobiological research program.[8][9][10][11] Punctuated equilibrium differs from Mayr's ideas mainly in that Eldredge and Gould placed considerably greater emphasis on stasis, whereas Mayr was concerned with explaining the morphological discontinuity (or "sudden jumps")[12] found in the fossil record.[8] Mayr later complimented Eldredge and Gould's paper, stating that evolutionary stasis had been "unexpected by most evolutionary biologists" and that punctuated equilibrium "had a major impact on paleontology and evolutionary biology."[8] A year before their 1972 Eldredge and Gould paper, Niles Eldredge published a paper in the journal Evolution which suggested that gradual evolution was seldom seen in the fossil record and argued that Ernst Mayr's standard mechanism of allopatric speciation might suggest a possible resolution.[5] The Eldredge and Gould paper was presented at the Annual Meeting of the Geological Society of America in 1971.[1] The symposium focused its attention on how modern microevolutionary studies could revitalize various aspects of paleontology and macroevolution. Tom Schopf, who organized that year's meeting, assigned Gould the topic of speciation. Gould recalls that "Eldredge's 1971 publication [on Paleozoic trilobites] had presented the only new and interesting ideas on the paleontological implications of the subject—so I asked Schopf if we could present the paper jointly."[13] According to Gould "the ideas came mostly from Niles, with yours truly acting as a sounding board and eventual scribe. I coined the term punctuated equilibrium and wrote most of our 1972 paper, but Niles is the proper first author in our pairing of Eldredge and Gould."[14] In his book Time Frames Eldredge recalls that after much discussion the pair "each wrote roughly half. Some of the parts that would seem obviously the work of one of us were actually first penned by the other—I remember for example, writing the section on Gould's snails. Other parts are harder to reconstruct. Gould edited the entire manuscript for better consistency. We sent it in, and Schopf reacted strongly against it—thus signaling the tenor of the reaction it has engendered, though for shifting reasons, down to the present day."[15] John Wilkins and Gareth Nelson have argued that French architect Pierre Trémaux proposed an "anticipation of the theory of punctuated equilibrium of Gould and Eldredge."[16] Main article: Rate of evolution The fossil record includes well documented examples of both phyletic gradualism and punctuational evolution.[17] As such, much debate persists over the prominence of stasis in the fossil record.[18][19] Before punctuated equilibrium, most evolution biologists considered stasis to be rare or unimportant.[8][20][21] The paleontologist George Gaylord Simpson, for example, believed that phyletic gradual evolution (called horotely in his termin

[63] Punctuated equilibrium is often portrayed to oppose the concept of gradualism, when it is actually a form of gradualism.[64] This is because even though evolutionary change appears instantaneous between geological sedimentary layers, change is still occurring incrementally, with no great change from one generation to the next. To this end, Gould later commented that "Most of our paleontological colleagues missed this insight because they had not studied evolutionary theory and either did not know about allopatric speciation or had not considered its translation to geological time. Our evolutionary colleagues also failed to grasp the implication(s), primarily because they did not think at geological scales".[14] Richard Dawkins dedicates a chapter in The Blind Watchmaker to correcting, in his view, the wide confusion regarding rates of change. His first point is to argue that phyletic gradualism—understood in the sense that evolution proceeds at a single uniform speed, called "constant speedism" by Dawkins—is a "caricature of Darwinism"[65] and "does not really exist".[66] His second argument, which follows from the first, is that once the caricature of "constant speedism" is dismissed, we are left with one logical alternative, which Dawkins terms "variable speedism". Variable speedism may also be distinguished one of two ways: "discrete variable speedism" and "continuously variable speedism". Eldredge and Gould, proposing that evolution jumps between stability and relative rapidity, are described as "discrete variable speedists", and "in this respect they are genuinely radical."[67] They assert that evolution generally proceeds in bursts, or not at all. "Continuously variable speedists", on the other hand, advance that "evolutionary rates fluctuate continuously from very fast to very slow and stop, with all intermediates. They see no particular reason to emphasize certain speeds more than others. In particular, stasis, to them, is just an extreme case of ultra-slow evolution. To a punctuationist, there is something very special about stasis."[68] See also: Species problem, Species complex, and Push of the past Richard Dawkins regards the apparent gaps represented in the fossil record as documenting migratory events rather than evolutionary events. According to Dawkins, evolution certainly occurred but "probably gradually" elsewhere.[69] However, the punctuational equilibrium model may still be inferred from both the observation of stasis and examples of rapid and episodic speciation events documented in the fossil record.[70] Dawkins also emphasizes that punctuated equilibrium has been "oversold by some journalists",[71] but partly due to Eldredge and Gould's "later writings".[72] Dawkins contends that the hypothesis "does not deserve a particularly large measure of publicity".[73] It is a "minor gloss," an "interesting but minor wrinkle on the surface of neo-Darwinian theory," and "lies firmly within the neo-Darwinian synthesis".[74] In his book Darwin's Dangerous Idea, philosopher Daniel Dennett is especially critical of Gould's presentation of punctuated equilibrium. Dennett argues that Gould alternated between revolutionary and conservative claims, and that each time Gould made a revolutionary statement—or appeared to do so—he was criticized, and thus retreated to a traditional neo-Darwinian position.[75] Gould responded to Dennett's claims in The New York Review of Books,[76] and in his technical volume The Structure of Evolutionary Theory.[77] English professor Heidi Scott argues that Gould's talent for writing vivid prose, his use of metaphor, and his success in building a popular audience of nonspecialist readers altered the "climate of specialized scientific discourse" favorably in his promotion of punctuated equilibrium.[78] While Gould is celebrated for the color and energy of his prose, as well as his interdisciplinary knowledge, critics such as Scott, Richard Dawkins, and Daniel Dennett have concerns that the theory has gained undeserved credence among non-scientists because of Gould's rhetorical skills.[78] Philosopher John Lyne and biologist Henry Howe believed punctuated equilibrium's success has much more to do with the nature of the geological record than the nature of Gould's rhetoric. They state, a "re-analysis of existing fossil data has shown, to the increasing satisfaction of the paleontological community, that Eldredge and Gould were correct in identifying periods of evolutionary stasis which are interrupted by much shorter periods of evolutionary change."[79] Evolutionary biologist Robert Trivers accused Gould of being "something of an intellectual fraud" for using claims that were "well known from the time of Darwin" (that evolution displayed "periods of long stasis interspersed with periods of rapid change") to support distinct but more "grandiose" claims regarding species selection, despite the "rate of species turnover [having] nothing to do with the traits within species—only with the relative frequency of species showing these traits".[80] Some critics jokingly referred to the theory of punctuated equilibrium as "evolution by jerks",[81] which reportedly prompted punctuationists to describe phyletic gradualism as "evolution by creeps."[82] The sudden appearance of most species in the geologic record and the lack of evidence of substantial gradual change in most species—from their initial appearance until their extinction—has long been noted, including by Charles Darwin, who appealed to the imperfection of the record as the favored explanation.[83][84] When presenting his ideas against the prevailing influences of catastrophism and progressive creationism, which envisaged species being supernaturally created at intervals, Darwin needed to forcefully stress the gradual nature of evolution in accordance with the gradualism promoted by his friend Charles Lyell. He privately expressed concern, noting in the margin of his 1844 Essay, "Better begin with this: If species really, after catastrophes, created in showers world over, my theory false."[85] It is often incorrectly assumed that he insisted that the rate of change must be constant, or nearly so, but even the first edition of On the Origin of Species states that "Species of different genera and classes have not changed at the same rate, or in the same degree. In the oldest tertiary beds a few living shells may still be found in the midst of a multitude of extinct forms... The Silurian Lingula differs but little from the living species of this genus". Lingula is among the few brachiopods surviving today but also known from fossils over 500 million years old.[86] In the fourth edition (1866) of On the Origin of Species Darwin wrote that "the periods during which species have undergone modification, though long as measured in years, have probably been short in comparison with the periods during which they retain the same form."[87] Thus punctuationism in general is consistent with Darwin's conception of evolution.[85] According to early versions of punctuated equilibrium, "peripheral isolates" are considered to be of critical importance for speciation. However, Darwin wrote, "I can by no means agree ... that immigration and isolation are necessary elements. ... Although isolation is of great importance in the production of new species, on the whole I am inclined to believe that largeness of area is still more important, especially for the production of species which shall prove capable of enduring for a long period, and of spreading widely."[88] The importance of isolation in forming species had played a significant part in Darwin's early thinking, as shown in his Essay of 1844. But by the time he wrote the Origin he had downplayed its importance.[85] He explained the reasons for his revised view as follows: Throughout a great and open area, not only will there be a greater chance of favourable variations, arising from the large number of individuals of the same species there supported, but the conditions of life are much more complex from the large number of already existing species; and if some of these species become modified and improved, others will have to be improved in a corresponding degree, or they will be exterminated. Each new form, also, as soon as it has been improved, will be able to spread over the open and continuous area, and will thus come into competition with many other forms ... the new forms produced on large areas, which have already been victorious over many competitors, will be those that will spread most widely, and will give rise to the greatest number of new varieties and species. They will thus play a more important role in the changing history of the organic world.[89] Thus punctuated equilibrium is incongruous with some of Darwin's ideas regarding the specific mechanisms of evolution, but generally accords with Darwin's theory of evolution by natural selection.[85][90] See also: Rapid modes of evolution Recent work in developmental biology has identified dynamical and physical mechanisms of tissue morphogenesis that may underlie abrupt morphological transitions during evolution. Consequently, consideration of mechanisms of phylogenetic change that have been found in reality to be non-gradual is increasingly common in the field of evolutionary developmental biology, particularly in studies of the origin of morphological novelty. A description of such mechanisms can be found in the multi-authored volume Origination of Organismal Form (MIT Press; 2003). See also: Language change In linguistics, R. M. W. Dixon has proposed a punctuated equilibrium model for language histories,[91] with reference particularly to the prehistory of the indigenous languages of Australia and his objections to the proposed Pama–Nyungan language family there. Although his model has raised considerable interest, it does not command majority support within linguistics.[92] Separately, recent work using computational phylogenetic methods claims to show that punctuational bursts play an important factor when languages split from one another, accounting for anywhere from 10 to 33% of the total divergence in vocabulary.[93] Punctuational evolution has been argued to explain changes in folktales and mythology over time.[94] Speciation Adaptive radiation Catastrophe theory Convergent evolution Court Jester Hypothesis Critical juncture theory Evolutionary capacitance Gene orders Koinophilia Punctuated equilibrium in social theory Punctuated gradualism ^ a b c d Eldredge, Niles; Gould, S.J. (1972). "Punctuated equilibria: An alternative to phyletic gradualism". In Schopf, T.J.M. (ed.). Models in Paleobiology. San Francisco, CA: Freeman Cooper. pp. 82–115. Reprinted in Eldredge, N., ed. (1985). Time Frames (PDF). Princeton, NJ: Princeton University Press. pp. 193–223. Archived from the original (PDF) on 2020-01-13. Retrieved 2018-01-27. Eldredge, Niles (1972). "2nd draft (unpublished)". doi:10.5531/sd.paleo.4. hdl:2246/6564. {{cite journal}}: Cite journal requires |journal= (help) Eldredge, Niles; Gould, Stephen Jay (1972). "3rd draft (final, published)". doi:10.5531/sd.paleo.7. hdl:2246/6567. {{cite journal}}: Cite journal requires |journal= (help) ^ a b Gould, S.J. (15 April 1982). "Punctuated equilibrium — a different way of seeing". New Scientist. Vol. 94. pp. 137–139 – via Google Books.[permanent dead link] ^ a b c d Mayr, Ernst (1954). "Change of genetic environment and evolution". In Huxley, J.; Hardy, A.C.; Ford, E.B. (eds.). Evolution as a Process. London, UK: Allen and Unwin. pp. 157–180 – via Blackwell Publishing. ^ Lerner, I.M. (1954). Genetic Homeostasis. New York, NY: John Wiley. ^ a b Eldredge, Niles (1971). "The allopatric model and phylogeny in Paleozoic invertebrates". Evolution. 25 (1): 156–167. doi:10.2307/2406508. hdl:2246/6568. JSTOR 2406508. PMID 28562952. ^ Gould, S.J. (1969). "An evolutionary microcosm: Pleistocene and recent history of the land snail P. (Poecilozonites) in Bermuda". Bull. Mus. Comp. Zool. 138: 407–532. ^ Rhodes, F.H.T. (1983). "Gradualism, punctuated equilibrium and the Origin of Species". Nature. 305 (5932): 269–272. Bibcode:1983Natur.305..269R. doi:10.1038/305269a0. PMID 6353241. S2CID 32953263. ^ a b c d Mayr, Ernst (1992). "Speciational Evolution or Punctuated Equilibria." In Albert Somit and Steven Peterson The Dynamics of Evolution. New York: Cornell University Press, pp. 21-48. ^ Shermer, Michael (2001). The Borderlands of Science. New York: Oxford University Press, pp. 97-116.[permanent dead link] ^ Geary, Dana (2008). "The Legacy of Punctuated equilibrium." In Warren D. Allmon et al. Stephen Jay Gould: Reflections on His View of Life. Oxford: Oxford University Press, pp. 127-145. ^ Prothero, D. (2007). "Punk eek, Transitional Formsand Quote Miners." In Evolution: what the fossils say and why it matters. New York: Columbia University Press, pp. 78–85. ^ Schindewolf, Otto (1936). Paldontologie, Entwicklungslehre und Genetik. Berlin: Borntraeger. ^ Gould, S. J. (2002). The Structure of Evolutionary Theory. Cambridge, Massachusetts: The Belknap Press of Harvard University Press. p. 775. ISBN 978-0-674-00613-3. ^ a b S. J. Gould (1991). "Opus 200" Natural History 100 (August): 12-18. ^ Eldredge, Niles (1985) Time Frames: The evolution of punctuated equilibria. Princeton: Princeton University Press, p. 120. ^ Wilkins, John S.; Nelson, G. J. (2008). "Trémaux on species: A theory of allopatric speciation (and punctuated equilibrium) before Wagner" (PDF). History and Philosophy of the Life Sciences. 30 (2): 179–206. PMID 19203015. ^ a b Benton, Michael and David Harper (2009) Introduction to Paleobiology and the Fossil Record New York: John Wiley & Sons, pp. 123-124. ^ a b Futuyma, Douglas (2005). Evolution. Sunderland, MA: Sinauer Associates, p. 86. ^ Erwin, D. H. and R. L. Anstey (1995) New approaches to speciation in the fossil record. New York : Columbia University Press. ^ S. J. Gould 2002. The Structure of Evolutionary Theory. Cambridge MA: Harvard University Press, p. 875. ^ Wake, David B.; Roth, G.; Wake, M. H. (1983). "On the problem of stasis in organismal evolution". Journal of Theoretical Biology. 101 (2): 212. Bibcode:1983JThBi.101..211W. doi:10.1016/0022-5193(83)90335-1. ^ Simpson, G. G. (1944). Tempo and Mode in Evolution. Columbia University Press. New York, p. 203. ^ Campbell, N.A. (1990) Biology p. 450–451, 487–490, 499–501. Redwood City CA: Benjamin Cummings Publishing Company. ^ a b S. J. Gould, & Eldredge, Niles (1977). "Punctuated equilibria: the tempo and mode of evolution reconsidered." Archived 2018-05-08 at the Wayback Machine Paleobiology 3 (2): 115-151. (p.145) ^ McCarthy, T. & Rubridge, B. (2005) The Story of Earth and Life. Cape Town: Struik Publishers. ISBN 1-77007-148-2. ^ de Brito Neto, S. G.; Fernando Alves, E.; Cavalcante e Almeida Sá, Mariana (2017). "Speciation in real time and historical-archaeological and its absence in geological time". Academia Journal of Scientific Research. doi:10.15413/ajsr.2017.0413 (inactive 1 November 2024). ISSN 2315-7712.{{cite journal}}: CS1 maint: DOI inactive as of November 2024 (link) ^ Erwin, D. H. and Anstey, R. L (1995). "Speciation in the fossil record." Archived 2019-03-23 at the Wayback Machine In Erwin, D. H. & Anstey, R. L. (eds). New Approaches to Speciation in the Fossil Record. Columbia University Press, New York, pp. 11–39. ^ Bomfleur, B.; McLoughlin, S.; Vajda, V. (March 2014). "Fossilized nuclei and chromosomes reveal 180 million years of genomic stasis in royal ferns". Science. 343 (6177): 1376–1377. Bibcode:2014Sci...343.1376B. doi:10.1126/science.1249884. PMID 24653037. S2CID 38248823. ^ a b Mayr, Ernst (1963). Animal Species and Evolution. Cambridge, MA: Harvard University Press. ^ Eldredge, Niles and S. J. Gould (1997). "On punctuated equilibria (letter)." Science 276 (5311): 337-341. ^ Nichol, S.T, Joan Rowe, and Walter M. Fitch (1993). "Punctuated equilibrium and positive Darwinian evolution in vesicular stomatitis virus." Proceedings of the National Academy of Sciences 90 (Nov.): 10424-28. ^ Elena S.F., V.S. Cooper, and R. Lenski (1996). "Punctuated Evolution Caused by Selection of Rare Beneficial Mutations." Science 272 (June 21): 1802-1804. ^ Futuyma, Douglas (1987). "On the role of species in anagenesis". American Naturalist. 130 (3): 465–473. Bibcode:1987ANat..130..465F. doi:10.1086/284724. S2CID 83546424. ^ S. J. Gould 2002. The Structure of Evolutionary Theory. Cambridge, Massachusetts: Harvard University Press, p. 39. ^ Eldredge, Niles; Gould, S. J. (1974). "Morphological Transformation, the Fossil Record, and the Mechanisms of Evolution: A Debate". Evolutionary Biology. Vol. 7. pp. 305–306. doi:10.1007/978-1-4615-6944-2_8. ISBN 978-1-4615-6946-6. ^ Niles Eldredge (1989). Time Frames. Princeton University Press, pp. 139-141. ^ a b Lieberman, B. S.; Dudgeon, S. (1996). "An evaluation of stabilizing selection as a mechanism for stasis". Palaeogeogr. Palaeoclimatol. Palaeoecol. 127 (1–4): 229–238. Bibcode:1996PPP...127..229L. doi:10.1016/S0031-0182(96)00097-1. ^ Stenseth, N. C.; Maynard Smith, John (1984). "Coevolution in ecosystems: Red Queen evolution or stasis?". Evolution. 38 (4): 870–880. doi:10.2307/2408397. JSTOR 2408397. PMID 28555824. ^ Williams, G. C. (1992). Natural Selection: Domains, Levels and Challenges. New York: Oxford University Press, p. 132. ^ Koeslag, J. H. (1990). "Koinophilia groups sexual creatures into species, promotes stasis, and stabilizes social behaviour". Journal of Theoretical Biology. 144 (1): 15–35. Bibcode:1990JThBi.144...15K. doi:10.1016/s0022-5193(05)80297-8. PMID 2200930. ^ Koeslag, J.H. (1995). On the engine of speciation. J. theor. Biol. 177, 401-409 ^ Maynard Smith, John (1989). Did Darwin Get it Right?. New York: Chapman and Hall. p. 126. ^ Gemmell, Michael R.; Trewick, Steven A.; Hills, Simon F. K.; Morgan-Richards, Mary (2019). "Phylogenetic topology and timing of New Zealand olive shells are consistent with punctuated equilibrium". Journal of Zoological Systematics and Evolutionary Research. 58 (1): 209–220. doi:10.1111/jzs.12342. S2CID 213493738. ^ Michaux, B. (1989). "Morphological variation of species through time". Biological Journal of the Linnean Society. 38 (3): 239–255. doi:10.1111/j.1095-8312.1989.tb01577.x. ^ S. J. Gould 2002. The Structure of Evolutionary Theory. Cambridge MA: Harvard University Press, p. 872. ^ Sterelny, Kim (2007). Dawkins vs. Gould: Survival of the Fittest. Cambridge, U.K.: Icon Books, p. 96. ^ Brett, Carlton E.; Ivany, Linda C.; Schopf, Kenneth M. (1996). "Coordinated stasis: An overview". Palaeogeography, Palaeoclimatology, Palaeoecology. 127 (1–4): 1–20. Bibcode:1996PPP...127....1B. doi:10.1016/S0031-0182(96)00085-5. ^ S. J. Gould (1992) "Punctuated equilibrium in fact and theory." Archived 2018-01-26 at the Wayback Machine In Albert Somit and Steven Peterson The Dynamics of Evolution. New York: Cornell University Press. pp. 54–84. ^ Gould, S.J. (June–July 1976). "The return of hopeful monsters". Natural History. Vol. 86. pp. 22–30. ^ Mayr, Ernst (1982). Growth of Biological Thought (PDF). Harvard University Press. p. 617. Archived from the original (PDF) on 2016-06-23. ^ Maynard Smith, J. (1983). "The genetics of stasis and punctuations" (PDF). Annual Review of Genetics. 17: 12. Archived from the original (PDF) on 2010-12-06. ^ Ruse, Michael (1985). Sociobiology, Sense or Nonsense?. New York, NY: Springer. p. 216. ^ For reply see: Gould, S.J. (2002). Structure. pp. 765, 778, 1001, 1005, 1009. Dawkins, R. (1996). The Blind Watchmaker. W. W. Norton & Company. pp. 230-236. ISBN 9780393315707 – via Google Books. Dennett, D. (1996). Darwin's Dangerous Idea. Simon and Schuster. pp. 288–289. ISBN 9780684824710 – via Google Books. ^ Hanegraaff, H. (1998). The Face that Demonstrates the Farce of Evolution. Nashville, TN: Word Publishing. pp. 40-45. ISBN 9781418515096 – via Google Books. ^ Gould, S.J. (May 1981). "Evolution as fact and theory". Discover. Vol. 2. pp. 34–37. ^ Ayala, F. (2005). "The structure of evolutionary theory" (PDF). Theology and Science. 3 (1): 104. doi:10.1080/14746700500039800. S2CID 4293004. Archived from the original (PDF) on 2018-09-23. Retrieved 2007-04-22. ^ S. J. Gould (2007) Punctuated equilibrium. Cambridge MA: Harvard University Press, p. 26. ^ a b Simpson, G. G. (1944). Tempo and Mode in Evolution. New York: Columbia Univ. Press, p. 206 ^ Fitch, W. J. and F. J. Ayala (1995) Tempo and mode in evolution: genetics and paleontology 50 years after Simpson. Washington, D.C.: National Academy Press. ^ Simpson, G. G. (1953). The Major Features of Evolution Archived 2019-04-21 at the Wayback Machine. New York: Columbia Univ. Press, p. 390. ^ Simpson, G. G. (1944). Tempo and Mode in Evolution. New York: Columbia Univ. Press, pp. 205-206. ^ Wright, Sewall (1982). "Character change, speciation, and the higher taxa" (PDF). Evolution. 56 (3): 427–443. doi:10.2307/2408092. JSTOR 2408092. PMID 28568042. Archived from the original (PDF) on 2011-08-28. ^ Simpson, G. G. (1984) Tempo and Mode in Evolution. Reprint. Columbia University Press, p. xxv. ^ Dawkins, Richard (1996). The Blind Watchmaker. New York: W. W. Norton & Co., Chapter 9. (p. 224-252) ^ Dawkins, Richard (1996). The Blind Watchmaker. New York: W. W. Norton & Co., p. 227. ^ Dawkins, Richard (1996). The Blind Watchmaker, p. 228. Dawkins' exception to this rule is the non-adaptive evolution observed in molecular evolution. ^ Dawkins, Richard (1996) The Blind Watchmaker, p. 245. ^ Dawkins, Richard (1996). The Blind Watchmaker, p. 245-246. ^ Dawkins, Richard (1996). The Blind Watchmaker, p. 240. ^ Cheetham, Alan; Jackson, Jeremy; Hayek, Lee-Ann (1994). "Quantitative genetics of bryozoan phenotypic evolution". Evolution. 48 (2): 360–375. doi:10.2307/2410098. JSTOR 2410098. ^ Dawkins, Richard (1996). The Blind Watchmaker, p. 250-251. ^ Dawkins, Richard (1996). The Blind Watchmaker, p. 241. ^ Dawkins, Richard (1996). The Blind Watchmaker, p. 250. ^ Dawkins, Richard (1996). The Blind Watchmaker, p. 251. ^ Dennett, Daniel (1995). Darwin's Dangerous Idea. New York: Simon & Schuster, pp. 282-299. ^ Gould, S. J. (1997). "Darwinian Fundamentalism" The New York Review of Books, June 12, pp. 34-37; and "Evolution: The Pleasures of Pluralism" The New York Review of Books, June 26, pp. 47-52. ^ "Stephen Jay Gould, "Punctuated Equilibrium's Threefold History," 2002". 2019-10-19. Archived from the original on 19 October 2019. Retrieved 2022-02-16. ^ a b Scott, Heidi (2007). "Stephen Jay Gould and the Rhetoric of Evolutionary Theory". Rhetoric Review. 26 (2): 120–141. doi:10.1080/07350190709336705. S2CID 144947503. ^ Lyne, John; Howe, Henry F. (1986). ""Punctuated equilibria": Rhetorical dynamics of a scientific controversy". Quarterly Journal of Speech. 72 (2): 132–147 [135]. doi:10.1080/00335638609383764. ^ Trivers, Robert (October 4, 2012). "Fraud in the Imputation of Fraud". Psychology Today. Retrieved 2023-02-26. ^ Turner, John (1984). "Why we need evolution by jerks". New Scientist. Vol. 101, no. Feb. 9. pp. 34–35. ^ Gould, S. J. and Steven Rose, ed. (2007). The Richness of Life: The Essential Stephen Jay Gould. New York: W. W. Norton & Co., p. 6. ^ Darwin, Charles (1859). On the Origin of Species. London: John Murray, p. 301. ^ Darwin, Charles (1871). The Origin of Species. London: John Murray, p. 119-120. ^ a b c d Eldredge, Niles (2006) "Confessions of a Darwinist." Archived 2013-12-24 at the Wayback Machine The Virginia Quarterly Review 82 (Spring): 32-53. ^ Darwin, Charles (1859). On the Origin of Species. London: John Murray. p. 313. ^ Darwin, Charles (1869). The Origin of Species. London: John Murray. 5th edition, p. 551. ^ Darwin, Charles (1869). The Origin of Species. London: John Murray. 5th edition, pp. 120-121. ^ Darwin, Charles (1869). The Origin of Species. London: John Murray. 5th edition, pp. 121-122. ^ Gould, Stephen Jay; Eldredge, Niles (1993), "Punctuated equilibrium comes of age", Nature, 366 (6452): 223–227, Bibcode:1993Natur.366..223G, doi:10.1038/366223a0, PMID 8232582, S2CID 4253816 ^ Dixon, R.M.W. (1997). The rise and fall of languages Cambridge: Cambridge University Press. ^ Bowern, Claire; Koch, Harold, eds. (2004-03-18). Australian Languages. Current Issues in Linguistic Theory. Vol. 249. John Benjamins Publishing Company. doi:10.1075/cilt.249. ISBN 9789027295118. ^ Atkinson, Quentin D.; Meade, Andrew; Venditti, Chris; Greenhill, Simon J.; Pagel, Mark (2008). "Languages Evolve in Punctuational Bursts". Science. 319 (5863): 588. doi:10.1126/science.1149683. hdl:1885/33371. PMID 18239118. S2CID 29740420.; Dan Dediu mail, Stephen C. Levinson, Abstract Profiles of Structural Stability Point to Universal Tendencies, Family-Specific Factors, and Ancient Connections between Languages, PLoS ONE,7(9), 2012, e45198012. ^ Julien d'Huy, A Cosmic Hunt in the Berber sky : a phylogenetic reconstruction of Palaeolithic mythology. Les Cahiers de l'AARS, 15, 2012; Polyphemus (Aa. Th. 1137) A phylogenetic reconstruction of a prehistoric tale. Nouvelle Mythologie Comparée / New Comparative Mythology 1, 2013; Les mythes évolueraient par ponctuations Archived 2020-05-28 at the Wayback Machine. Mythologie française, 252, 2013, 8-12. Wikimedia Commons has media related to Punctuated equilibrium. Punctuated Equilibrium - by Stephen Jay Gould Punctuated Equilibrium at Twenty - by Donald R. Prothero Punctuated Equilibria? - by Wesley Elsberry, TalkOrigins Archive Scholarpedia: Punctuated equilibria - by Bruce Lieberman and Niles Eldredge All you need to know about Punctuated Equilibrium (almost) - by Douglas Theobald Enigmas of Evolution - by Jerry Adler and John Carey, Newsweek Retrieved from " Gradualism and punctuated equilibrium are two ways in which the evolution of a species can occur. A species can evolve by only one of these, or by both. Scientists think that species with a shorter evolution evolved mostly by punctuated equilibrium, and those with a longer evolution evolved mostly by gradualism.Gradualism is selection and variation that happens more gradually. Over a short period of time it is hard to notice. Small variations that fit an organism slightly better to its environment are selected for: a few more individuals with more of the helpful trait survive, and a few more with less of the helpful trait die. Very gradually, over a long time, the population changes. Change is slow, constant, and consistent.In punctuated equilibrium, change comes in spurts. There is a period of very little change, and then one or a few huge changes occur, often through mutations in the genes of a few individuals. Mutations are random changes in the DNA that are not inherited from the previous generation, but are passed on to generations that follow. Though mutations are often harmful, the mutations that result in punctuated equilibrium are very helpful to the individuals in their environments. Because these mutations are so different and so helpful to the survival of those that have them, the proportion of individuals in the population who have the mutation/trait and those who don't changes a lot over a very short period of time. The species changes very rapidly over a few generations, then settles down again to a period of little change.This explanation talks about punctuated equilibrium as the result of one or a few mutations that cause large change. However, punctuated equilibrium is any sudden, rapid change in a species and can also be the result of other causes, such as huge and sudden changes in the environment that result in more rapid changes in the organisms through harsher selection.How did the tiger get its stripes: gradualism or punctuated equilibrium? We don't know whether the tiger got its stripes through gradualism or punctuated equilibrium, but in order to explain both concepts, here is how it could have happened through each. Let's assume that stripes are helpful because they help the tiger to camouflage, blend in with the tall grasses where it lives, so that it can sneak up on its prey (what it eats) and not be noticed.Gradualism: A long time ago, there were a lot of tiger-like animals, but without stripes. Most of them were unmarked, but a few had light markings and color variation in their fur. These few blended in with the tall grasses a little bit better, so they were generally able to catch more food, and fewer of the marked than unmarked ones died of hunger, so more of them were able to reproduce. In the next generation, more animals were marked than in the previous generation. Of those that were marked, some had more, some less, and some the same amount of marks than in the previous generation. Also, the marks were more, less, or the same amount clearly defined. Again, the ones with marks did better than the ones without, and the ones with more, clearly defined marks did better than the ones with fewer or fainter marks. Very gradually, over many, many generations, stripes over the tigers' whole bodies formed and appeared in the whole population, because the tigers that survived in each generation were those whose marks were most clear and contrasted most with the rest of the fur, and those that covered the most area on the bodies of the tigers.Punctuated equilibrium: A long time ago, there were a lot of tiger-like animals, but without stripes. One time, a mutation occurred in a few of the animals, causing a huge change: they were born with stripes! This was so helpful to survival that out of the whole population, none or almost none of those with stripes died of hunger. They lived to reproduce, and their striped offspring also did very well. Over only a few generations, the whole population was born striped.A combination: Here is one idea of how tigers could have gotten their stripes by both gradualism and punctuated equilibrium: A mutation had a huge affect, causing distinct, stripe-like markings. These were then gradually "polished up" into stripes.The idea of punctuated equilibrium originated long after the idea of gradualism. Darwin saw evolution as being "steady, slow, and continuous". Later, scientists were studying fossils and they found that some species have their evolution almost "mapped out" in fossils. For others they found a few, very different species along the evolutionary course, but very few or no fossils of "in between" organisms. Also, when dating the fossils, scientists saw that in some species change was very slow, but in others, it must have occurred rapidly to be able to produce such change over such a short amount of time. The scientists reasoned that there had to be another way that evolution could have happened that was quicker and had fewer intermediate species, so the idea of punctuated equilibrium was formed.