International Journal of Management, Sciences, Innovation, and Technology IJMSIT

Review Paper

Vol.3, Issue.1, pp.01-11, Jan (2022) **ISSN:** 0000-0000

Introduction to Natural Selection, and the History of the Theory

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Available online at: https://ijmsit.com/volume-3-issue-1/

Received: 03 Jan 2022 Revised: 08 Jan, 2022 Accepted: 22 Jan, 2022

***Abstract*—** Natural selection is the differential survival and reproduction of individuals due to differences in phenotype. It is a major mechanism of evolution, the change in genetic features characteristic of a population through generations. Charles Darwin popularized the term "natural selection", comparing it to artificial selection, which he saw as intentional, when natural selection was not.

***Keywords*—** Natural selection – History – Theory – Darwin – Evolution

I. INTRODUCTION

Diversity exists within all organelle groups. This happens in part because a random mutation originates in the genome of an individual organism, and their offspring can inherit such mutations. Throughout the lives of individuals, their genomes interact with their environments to produce differences in traits. The genomic environment includes the molecular biology of the cell, other cells, other individuals, populations, and species, as well as the abiotic environment. Since individuals with certain variants of the trait tend to survive and reproduce more than individuals with other less successful variants, the population evolves. Other factors affecting reproductive success include sexual selection (often included in natural selection) and fertility selection. Natural selection operates on a phenotype, the characteristics of an organism that actually interact with the environment, but the genetic (heritable) basis for any phenotype that confers that phenotype a reproductive advantage may become more common in a population. Over time, this process can lead to assemblages that specialize in a particular ecological niche (microevolution) and may eventually lead to speciation (the emergence of new species, macroevolution). In other words, natural selection is a fundamental process in the evolution of a population. Natural selection is the cornerstone of modern biology. The concept, published by Darwin and Alfred Russell Wallace in a joint presentation of papers in 1858, was further elaborated in Darwin's influential 1859 book On the Origin of Species by Natural Selection, or the Preservation of

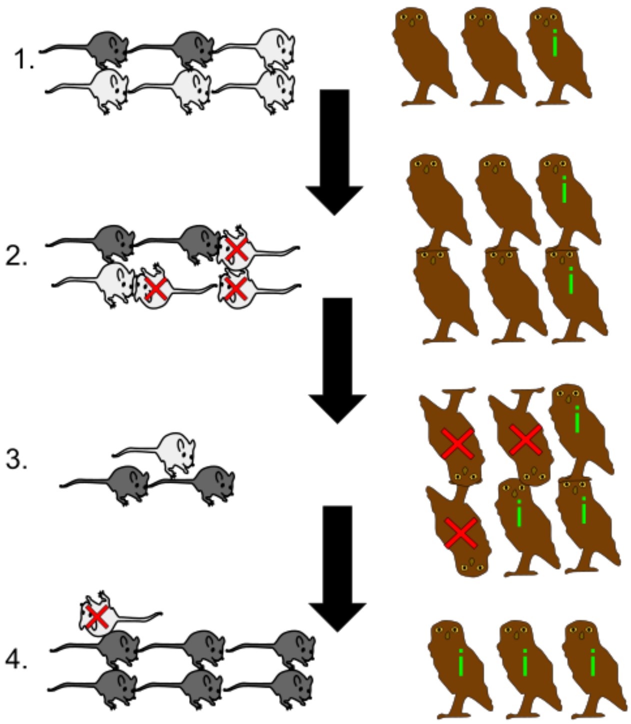
Favorite Lines in the Struggle for Life. He described natural selection as similar to artificial selection, a process by which animals and plants with traits that humans consider desirable are systematically preferred for breeding. The concept of natural selection originally developed in the absence of the correct heredity theory; At the time of Darwin's writing, science had not yet developed modern theories of genetics. The union of Darwinian evolution with later discoveries in classical genetics shaped the modern synthesis in the mid-20th century. The addition of molecular genetics led to evolutionary developmental biology, which explains evolution at the molecular level. While a genotype can be slowly changed by random genetic drift, natural selection remains the primary explanation for adaptive evolution.

II. HISTORICAL DEVELOPMENT

Pre-Darwin's theory

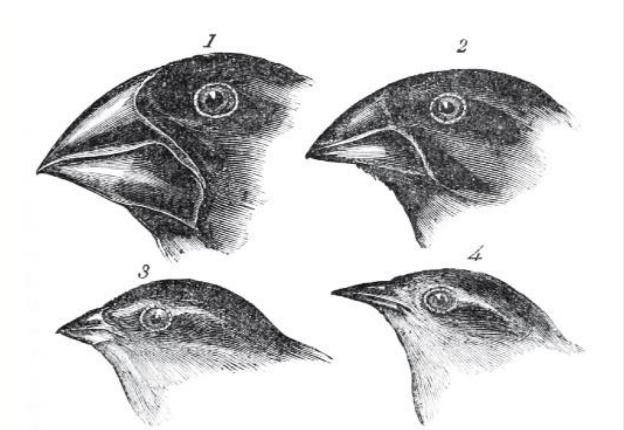
Aristotle considered whether it was possible for various forms to appear, but that only useful forms survived.

Several classical philosophers, including Empedocles and his intellectual successor, the Roman poet Lucerchus, expressed the idea that nature produces a great variety of creatures, at random, and that only those creatures that have been able to sustain themselves and reproduce successfully survive. Aristotle criticized Empedocles' idea that living things arose entirely through the accidental actions of such causes as heat and cold in Book Two of Physics. He postulated teleology in its natural place, and believed that form was fulfilled for a purpose, citing the regularity of inheritance in species as evidence. [5] However, he acknowledged in his biology that a new species of animal, mutants (τερας), can occur very rarely (Generation of Animals, Book IV). As stated in Darwin's 1872 edition of On the Origin of Species, Aristotle considered whether various forms (such as teeth) had appeared by chance, but only useful forms had survived.



Darwin's theory

In 1859, Charles Darwin elaborated his theory of evolution by natural selection as an explanation for adaptation and speciation. He defined natural selection as "the principle by which every slight variation [of a trait] is preserved, if advantageous". The concept was simple but powerful: individuals who are more adapted to their environments are more likely to survive and reproduce. As long as there is some difference between them and that difference is heritable, there will be an inevitable selection of individuals with the most beneficial differences. If the differences are heritable, then differential reproductive success leads to the evolution of certain populations of a species, and populations that evolve to be sufficiently different eventually become different species.



Finches from Galapagos Archipelago

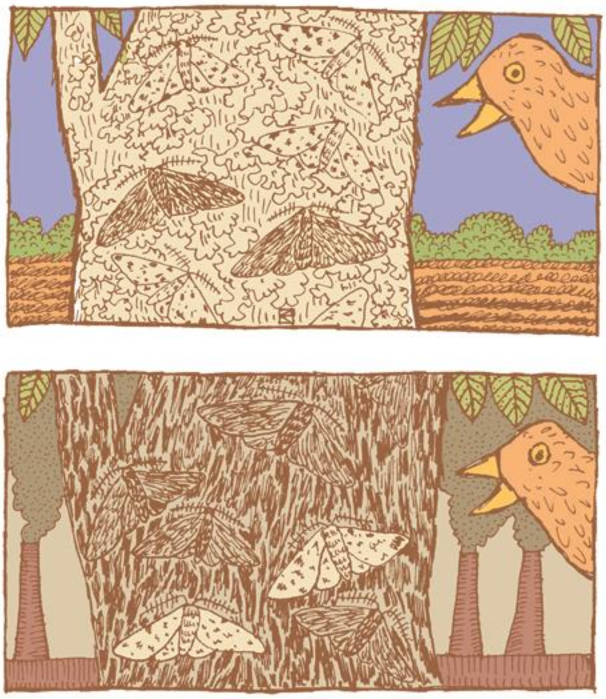
Darwin's ideas were inspired by observations he made on the second voyage of HMS Beagle (1831-1836), and from the work of the political economist, Thomas Robert Malthus, in An Essay on the Principle of Population (1798), noting that population (if not specified) increases exponentially doubled, while the food supply only grows arithmetically; Thus, the inevitable resource constraints will have demographic effects, leading to a "struggle for survival". When Darwin read Malthus in 1838, he had already prepared for his work as a naturalist to appreciate the "struggle for existence" in nature. It struck him that as the population grows more than the resources, “favorable variations tend to be preserved, and unfavorable changes are destroyed. The result of this will be the formation of new species.”

Once he had his theory, Darwin was meticulous in gathering and refining the evidence before making his idea public. He was in the process of writing his "Big Book" to present his research when the naturalist Alfred Russell Wallace independently conceived and described the principle in an essay he sent to Darwin to send to Charles Lyell. Lyell and Joseph Dalton Hooker decided to present his essay with unpublished writings sent by Darwin to his fellow naturalists, and read in the direction of species to form varieties; and the substantiation of varieties and species by natural means of selection on the Linnian Society of London announcing the joint discovery of the principle in July 1858. Darwin published a detailed account of his evidence and conclusions in On the Origin of Species in 1859. In the third edition of 1861, Darwin acknowledged that others - such as William Charles Wells in 1813, and Patrick Matthew in 1831—Suggested similar ideas, but neither developed them nor presented them in eminent scholarly publications.

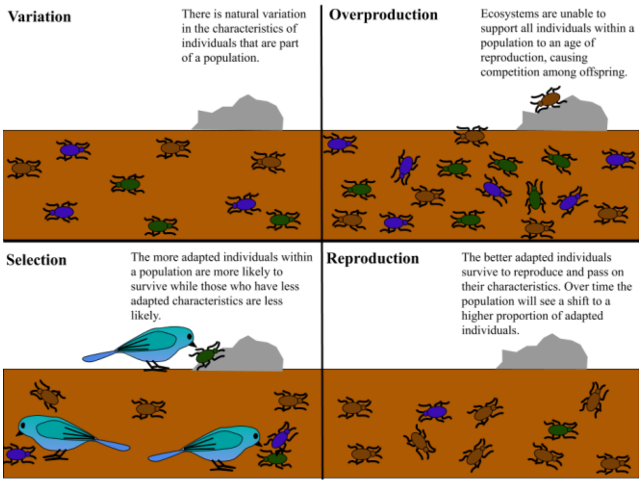
Darwin thought of natural selection by analogy with how farmers choose crops or livestock for breeding, which he called "artificial selection"; In his early manuscripts he referred to "nature" who would make a choice. At the time, other mechanisms of evolution, such as evolution by genetic drift, had not yet been explicitly formulated, and Darwin believed that selection was likely only part of the story: "I am convinced that natural selection was the principal but not the exclusive means of modification . . . " In a letter to Charles Lyell in September 1860, Darwin lamented the use of the term 'natural selection', preferring the term 'natural conservation'.

For Darwin and his contemporaries, natural selection was in essence synonymous with evolution by natural selection. After the publication of On the Origin of Species, learners generally accepted that evolution had occurred in some form. However, natural selection has remained controversial as a mechanism, partly because it was seen as too weak to explain the range of observed characteristics of organisms, and partly because even evolutionists rejected its "undirected" and non-progressive nature, a response that has been described as the most significant handicap. Before accepting the idea. However, some thinkers have enthusiastically embraced natural selection. After reading Darwin, Herbert Spencer introduced the phrase survival of the fittest, which became a popular summary of the theory. The fifth edition of On the Origin of Species published in 1869 included Spencer's phrase as an alternative to natural selection, noting credit: "But the expression often used by Mr. Herbert Spencer of the Survival of the Fittest is more accurate, and sometimes equally apt". Although non-biologists still use the phrase quite often, modern biologists avoid it because it is a filler if the word "fittest" is read to mean "higher functional" and is applied to individuals rather than as an average quantity over a population.

The term natural selection is often defined to operate on genetic traits, because they are directly involved in evolution. However, natural selection is "blind" in the sense that changes in the phenotype can confer a reproductive advantage regardless of whether the trait is heritable or not. Following Darwin's primary usage, the term is used to refer both to the evolutionary consequence of blind selection and to its mechanisms. It is sometimes useful to distinguish clearly between the mechanics of election and its effects; When this distinction is important, scientists specifically define "natural selection (phenotype)" as "those mechanisms that contribute to the selection of individuals that reproduce", regardless of whether the basis for selection is heritable. It is said that the traits that cause an organism to have greater reproductive success are chosen for it, while traits that reduce success are chosen against it.



Natural variation occurs between individuals of any group of organisms. Some differences may improve an individual's chances of surviving and reproducing so that the reproductive rate increases throughout his life, which means he leaves more offspring. If the traits that give these individuals a reproductive advantage are also heritable, i.e. passed down from father to offspring, there will be differential reproduction, i.e. a slightly higher proportion of fast rabbits or efficient algae in the next generation. Even if the reproductive advantage is minimal, any beneficial genetic trait becomes dominant over several generations. In this way, the organism's natural environment selects "traits" that confer a reproductive advantage, causing evolutionary change, as Darwin described. This gives the appearance of a target, but in natural selection there is no intentional choice. [a] Artificial selection is purposive where natural selection is not, although biologists often use teleological language to describe it.



The light and dark peppered moth is found in Great Britain, but during the Industrial Revolution, many of the trees on which the moths settled became black with soot, with the dark color giving the colorful moths an advantage in hiding from predators. This gave the dark-colored butterflies a better chance of surviving to produce dark-coloured offspring, and within just fifty years of the first dark-colored moths captured, all moths in industrial Manchester were dark-coloured. The balance was reversed by the effect of the 1956 Clean Air Act, and the dark moth became rare again, attesting to the influence of natural selection on the evolution of the peppered moth. A recent study, using image analysis and bird vision models, shows that paler mites match lichen backgrounds more than dark morphs, and for the first time identifies mites' camouflage for predation risk.

The concept of physical fitness is central to natural selection. In general terms, the more "fit" individuals have a better potential for survival, as in the well-known phrase "survival of the fittest", but the precise meaning of the term is more precise. Modern evolutionary theory does not define viability by how long an organism lives, but by how well it reproduces. If an organism lives half as long as others of its kind, but has twice as many offspring that live to adulthood, its genes become more common in the adult population of the next generation. Although natural selection acts on individuals, the effects of chance mean that physical fitness can only be determined 'on average' for individuals within a population. The suitability of a particular genotype corresponds to the average effect of all individuals with that genotype. A distinction must be made between the concept of "survival of the fittest" and "improving viability". "Survival of the fittest" does not give an "improvement in validity", it merely represents the removal of less valid variants from the population. A mathematical example of "survival of the fittest" was given by Haldane in his research paper "The Cost of Natural Selection". Haldane called this process "substitution" or, more commonly, in biology, the term "fixation". This is properly described by the differential and reproductive survival of individuals due to differences in phenotype. On the other hand, the 'improvement in viability' does not depend on the differential survival and reproduction of individuals due to differences in phenotype, but rather on the absolute survival of the particular variant. The probability of a beneficial mutation occurring in some members of a population depends on the total number of multiples of that variant. Kleinman described the mathematics of "improvement in viability". The Kishoni mega plate experiment gave an empirical example of "validity optimization". In this experiment, the 'improvement in viability' depends on the number of times a given variant is repeated in order for a new variant to appear capable of growing in the next region of higher drug concentration. Installation or replacement is not required for this "validity improvement" operation. On the other hand, an "improvement in viability" can occur in an environment where "survival of the fittest" is also effective. Richard Lenski's classic long-term E. coli evolution experiment is an example of adaptation in a competitive environment, ("improving viability" during "survival of the fittest"). Competition slows down the potential for beneficial mutation to occur in some pedigrees to give improved viability. A candidate variant for a useful mutation in this limited carrying capacity environment must first compete for the "less favorable" variants in order to accumulate the required number of replicates so that there is a reasonable probability of that beneficial mutation occurring.

Natural selection can act on any inherited phenotypic trait, and selective pressure can be produced by any aspect of the environment, including sexual selection and competition with individuals of the same or other species. However, this does not mean that natural selection is always directional and results in adaptive evolution; Natural selection often maintains the status quo by eliminating less favorable variants.

Selection can be categorized in many different ways, such as its effect on a trait, on genetic diversity, by the stage of the life cycle in which it operates, by unit selection, or by a competing resource.

Selection has different effects on traits. Stabilizing selection keeps a trait at a constant optimum level, and in the simplest case all deviations from this optimum option are selectively unfavorable. Directional selection favors the maximal values of the trait. Uncommon disruptive selection also works during transitions when the current situation is suboptimal, but changes the trait in more than one direction. In particular, if the trait is quantitative and univariate, both higher and lower trait levels are preferred. Disabled selection can be a precursor to speciation.

Influence on genetic diversity

Alternatively, selection can be broken down according to its effect on genetic diversity. Negative selection removes genetic variation from a population (opposed to by a de novo mutation, which introduces new diversity. In contrast, balanced selection preserves genetic diversity in a population, even in the absence of two de novo mutations, through selection based on Frequency One mechanism for this is heterozygous advantage, whereby individuals with two different alleles have a selective advantage over individuals with only one.The polymorphism at the ABO locus is explained in this way.

Through the life cycle stage

Another option is to classify the selection by the stage of the life cycle in which it operates. Some biologists recognize only two types: viability and growth (or survival, which increases the likelihood of an organism's survival), and fecundity selection (or fertility or childbearing), which increases the rate of reproduction, given survival. Others have further divided the life cycle into selection components.Thus, viability and survival selection can be determined separately and respectively as improving the likelihood of survival before and after reproductive age, while fertility selection can be broken down into components Additional subtypes including sexual selection, gametophyte selection, gamete survival and compatibility selection, and zygote formation.

According to the selection unit

Selection can also be categorized by level or unit selection. Individual choice acts on the individual, in the sense that adaptations "for" the individual, result from the choice between individuals. Genetic selection works directly at the gene level. In kinship selection and conflict within the genome, selection at the gene level provides a more appropriate explanation for the underlying process. Group selection, if it occurs, works on groups of organisms, assuming that groups reproduce and mutate in a manner similar to genes and individuals. There is an ongoing debate about the degree to which group selection occurs in nature.

III. EVOLUTION BY NATURAL SELECTION

A prerequisite for natural selection to lead to adaptive evolution, new traits and speciation is the presence of genetic variation that results in differences in fitness. Genetic variation is the result of mutations, genetic recombination and changes in karyotyping (the number, shape, size, and internal arrangement of a chromosome). Any of these changes could have a very beneficial or extremely harmful effect, but significant effects are rare. In the past, most changes in genetic material were considered neutral or close to neutral because they occurred in non-coding DNA or resulted in tandem substitution. However, many mutations in non-coding DNA have adverse effects. Although mutation rates and the fitness effects of mutations depend on the organism, the majority of mutations in humans are slightly harmful.

Some mutations occur in the set of tools or regulatory genes. Changes in these often have significant effects on an individual's phenotype because they regulate the function of many other genes. Most, but not all, mutations in regulatory genes result in non-viable fetuses. Certain non-lethal regulatory mutations occur in the sculpting genes in humans, which can lead to cervical rib or polydactyly, an increase in the number of fingers or toes. When these mutations lead to higher fitness, natural selection favors these phenotypes and the new trait spreads in the population. Static attributes are not static; Traits that have a high fitness in one environmental context may be less favorable if the environmental conditions change. In the absence of natural selection to preserve this trait, it becomes more diverse and deteriorates over time, which may give rise to an archaeal member of the trait, also called evolutionary bags. In many cases, an apparent archaeal organ may retain a limited function, or it may be selected for other useful traits in a phenomenon known as preadaptation. One famous example of a vestigial organ, the eye of a blind mole rat, is thought to retain a function in photoperiod perception.

Speciation

Speciation requires a degree of reproductive isolation—that is, reduced gene flow. However, intrinsic to the concept of the species against which the hybrid is selected is to oppose the evolution of reproductive isolation, a problem recognized by Darwin. The problem does not occur in heterozygous speciation with geographically separate populations, which can diverge with different combinations of mutations. Edward Bagnall Bolton realized in 1903 that reproductive isolation can develop through divergence, if each strain acquires a different, incompatible allele of the same gene. Selection versus heterozygous advantage will directly create reproductive isolation, leading to the Bateson-Dobzhansky-Müller model, which was further developed by H. Allen Orr and Sergei Gavrilets. With reinforcement, however, natural selection can lead to increased pre-isolation. The zygote, which affects the process of speciation directly.

Genetic basis

Natural selection works on an organism's phenotype or physical characteristics. The phenotype is determined by the genetic makeup of the organism (genotype) and the environment in which the organism lives. When different organisms in a population have different copies of the gene for a particular trait, each of these versions is known as an allele. It is this genetic difference that underlies the differences in phenotype. An example is the ABO blood group antigens in humans, where three alleles control the phenotype.

Some traits are governed by only one gene, but most traits are affected by the interactions of many genes. A difference in one of the many genes that contribute to a trait may have only a small effect on the phenotype; Together, these genes can produce a continuum of potential phenotypic values.

Directivity of election

When some components of a trait are heritable, selection changes the frequencies of different alleles, or gene variants that produce the trait variants. Selection can be divided into three categories, based on its effect on allele frequencies: directional, fixative, and disruptive selection. Directional selection occurs when an allele has greater fitness than the others, so that its frequency increases, and it acquires an increasing share in the population. This process can continue until the allele is stable and the entire population shares the most appropriate phenotype. The most common is selective selection, which reduces the frequency of alleles that have a detrimental effect on the phenotype—that is, the production of less favorable organisms. This process can continue until the allele is eliminated from the population. Stabilization selection preserves functional genetic traits, such as protein-coding genes or regulatory sequences, over time by selective pressure against deleterious variants. Disruptive (or variegated) selection is the selection that favors extreme trait values over intermediate trait values. Rupture selection may cause homozygous speciation through specialized stratification.

IV. SELECTION, GENETIC VARIATION, AND DRIFT

A portion of all genetic variations are functionally neutral, resulting in no phenotypic effect or significant difference in fitness. Moto Kimura's genetic drift neutral theory of molecular evolution suggests that this difference accounts for a large part of the observed genetic diversity. Neutral events can drastically reduce genetic variance through a population bottleneck. Which among other things can cause founder effect in small groups at first. When genetic variation does not result in differences in fitness, selection cannot directly affect the frequency of that variation. As a result, genetic variation at these loci is higher than at the loci where variation affects fitness. However, after a period of no new mutations, genetic variation at these loci is eliminated due to genetic drift. Natural selection reduces genetic variation by eliminating non-adapted individuals, and thus mutations that cause maladaptation. At the same time, new mutations occur, resulting in a balance between selection and mutation. The exact outcome of the two processes depends both on the rate at which new mutations occur and on the strength of natural selection, which is a function of the unsuitability of the mutation.

Genetic linkage occurs when two alleles are located in close proximity to the chromosome. During gamete formation, recombination reconstitutes alleles. The chance of such a modification occurring between two alleles is inversely related to the distance between them. Selective sweeps occur when an allele becomes more common in a population as a result of positive selection. As the prevalence of a single allele increases, closely related alleles can also become more common through "genetic association", whether neutral or slightly deleterious. Strong selective scanning results in a region of the genome where the positively selected haplotype (the allele and its neighbors) in Its essence is the only one that exists in the community. Selective scans can be detected by measuring correlational disequilibrium, or whether a particular haplotype is over-represented in a population. Since selective scanning also leads to selection for neighboring alleles, a mass of strong linkage disequilibrium may indicate a 'recent' selective sweep near the center of mass.

Background selection is the opposite of selective scanning. If a particular locus suffers from strong and persistent purifying selection, the associated variance tends to be eliminated, resulting in a region in the genome with low overall variability. Because background selection is caused by deleterious novel mutations, which can occur randomly in any haplotype, it does not produce clear blocks of linkage disequilibrium, although with low recombination, it can still result in slightly negative disequilibrium. in general.

The influence

Darwin's ideas, along with those of Adam Smith and Karl Marx, had a profound influence on nineteenth century thought, including his radical claim that "elaborately constructed forms, quite different from one another, and dependent on each other in a very complex way" arose of the simplest forms of life through a few simple principles. This inspired some of Darwin's most ardent supporters - and provoked his strongest opposition. According to Stephen Jay Gould, natural selection had the ability to "dispose of some of the deepest and most traditional comforts of Western thought", such as the belief that humans have a special place in the world.

In the words of the philosopher Daniel Dennett, Darwin's "dangerous idea" of evolution by natural selection is a "universal acid", which cannot be confined to any vessel or vessel, because it soon seeps up, making its way into an ever-wider ocean? Thus, in the past decades, the concept of natural selection has spread from evolutionary biology to other disciplines, including evolutionary computation, quantum Darwinism, evolutionary economics, evolutionary epistemology, evolutionary psychology, and cosmological natural selection. This infinite application has been called Universal Darwinism.

V. CONCLUSION

The social implications of the theory of evolution by natural selection have become a source of ongoing debate. Friedrich Engels, a German political philosopher and co-creator of the ideology of communism, wrote in 1872 that "Darwin did not know what bitter satire he had written on mankind, and especially on his fellow countrymen, when he showed that the free competition, the struggle for existence, which the economists celebrate As the highest historical achievement, it is the natural state of the animal kingdom." Herbert Spencer and eugenics advocate Francis Galton's interpretation of natural selection as necessarily progressive, leading to supposed advances in intelligence and civilization, and becoming a justification for colonialism, eugenics, and social Darwinism. For example, in 1940 Konrad Lorenz, in his later disavowed writings, used the theory as a justification for Nazi state policies. He wrote, "...the choice of toughness, heroism, and social utility ... must be chosen by some human institution, if humanity, in the absence of selective factors, should be destroyed by domestication brought about by dissolution. The racist idea as the basis of our state has already been realized So much in that regard." Others have developed ideas that human societies and culture evolve through mechanisms similar to those that apply to the evolution of species.

More recently, work between anthropologists and psychologists has led to the development of social psychology and later evolutionary psychology, a field that attempts to explain features of human psychology in terms of adaptation to an ancestral environment. The most notable example of evolutionary psychology, particularly in the early work of Noam Chomsky and later by Steven Pinker, is the hypothesis that the human brain has adapted to acquire the grammar of a natural language. It has been hypothesized that other aspects of human behavior and social structures, from specific cultural norms such as the avoidance of incest to broader patterns such as the role of gender, have similar origins for adaptation to the early environment in which modern humans evolved. By analogy with the action of natural selection on genes, the concept of meme - 'cultural transfer units', or culture equivalents for genes that undergo selection and recombination - arose, was first described in this model by Richard Dawkins in 1976 and later expanded by philosophers such as Daniel Dennett as explanations of activities complex cultural, including consciousness.

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