# Charles Darwin's theory of evolution and his concept of species

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*In the beginning of nineteenth century, when the modern biology was initiated, the first clear recognition and demonstration of the fact of evolution was made by the French naturalist Lamarck who proposed his theory of organic evolution in Philosophie Zoologique discussing brilliantly that all life is the product of evolutionary change. His theory is known as inheritance of acquired characters or theory of use and disuse. However, his theory could not stand up scientific tests so it was not accepted and is of historical importance. Charles Darwin proposed his theory to explain the mechanism of evolution. His theory is based on observations and deductions which was published in his book in 1859 'Origin of species by means of natural selection'. His theory had great impact on scientific and intellectual worlds and was acceptable by most biologists. His theory has two components: (i) descent with modification-all species have descended from pre existing species and (ii) natural selection acts as a causative agent of evolutionary change. It is considered as the most important contribution in the history of science which was suggested by Darwin that all the organic beings which have ever lived on this planet have descended from some one primordial form. The theory of evolution proposed by Charles Darwin and the concepts of species followed by him which has been severely commented and debated are briefly described.*

For more than a century, evolution has become the cornerstone of biology. Dobzhansky, considered twentieth-century Darwin[1], remarked, 'Nothing in biology makes sense except in the light of evolution.' Futuyma[2] remarked, 'It is one of the most breathtaking ideas in the history of science, which was suggested by Darwin that all the organic beings which have ever lived on this planet have descended from the pre-existing form.' From this concept, it implies that every trait of every species is an outcome of evolutionary history. Thus evolutionary perspective illuminates every field in biology. It has been commented that 'Evolution is the unifying theory of biology.'[3]

The idea of evolution is very old. The essence of the idea of organic evolution appears in Greek writings (600 BC). And it occurred to many throughout the history of man, but it was vague and unacceptable. People thought of special creation by God. For many centuries nothing was added to the idea of evolution. It is worth mentioning an important idea given by Aristotle (384–322 BC), a well-known philosopher, biologist, evolutionist and father of biological classification: the ladder of life, a series in which organisms could be arranged in order of increasing complexity. It pertains to evolution, defined as 'the development of an entity through a gradual sequence of changes from simple to more complex in the course of time'. In the medieval period, the idea of evolution was revived: by Bacon, Bonnet, Kent, Oken and others. It is worth mentioning that there were significant contributions made by Linnaeus, Buffon, and Erasmus Darwin in shaping the idea of evolution.

When modern biology started at the beginning of the nineteenth century, the first theory of evolution recognizing and demonstrating the concept of evolution was put forward by Jean Baptiste Lamarck from France, who explained his theory in his book *Zoologique Philosophie* in 1809 (ref. 4). In a simple manner, the evolution of long-necked giraffe could be explained because of stretching the neck, again and again, to get the leaves from higher plants: there was the evolution of long-necked giraffe. So the theory of use and disuse works here, which led to the inheritance of acquired characters which was the basis of Lamarckism. There are other examples of this kind. Cutting the tails of mice in every generation does not lead to the generation of tailless mice. So straight away, the Lamarckian concept was not accepted, and it has become a concept of historical importance. Recently, a few references have been available in the literature, demonstrating the importance of Lamarckism. Handel and Ramagopalan[5] remarked, 'Is Lamarckian evolution relevant to medicine?' Lamarckian concepts which were not given any relevance to modern evolutionary theory, are now enjoying a resurgence with the increasing complexity of epigenetic theories of inheritance. Evidence has been presented for epigenetic alterations, including DNA methylation and histone modifications transmitted transgenerationally. This provides a potential mechanism for environmental influences to be passed from parents to offspring showing Lamarckian evolution. There are a few examples of experimental evidence for Lamarckism (see Handel and Ramagopalan[5]). These authors have also commented that Epigenetics permits the peaceful co-existence of Darwinism and Lamarckism. However, the importance given by a few authors in favour of Lamarckism does not affect the importance of Darwinism, which is based on observations and deductions. The most important contribution of Darwin is that whatever species exist or have existed in the past on earth are derived from pre-existing forms (descent with modifications). It was also mentioned that species not only evolve, but also divide or fragment. From this, it also implies that every characteristic of every species is an outcome of evolutionary history. The concept of natural selection as a causative force of evolution is also an important dynamic evolutionary force which has been explained by population geneticists in terms of statistics in how it brings about evolutionary changes in natural and experimental populations[6,7]. Thus natural selection is an important factor in evolution. The Modern Synthesis, as Huxley[8] has called it, owes more to Charles Darwin than any other evolutionist and is built around the essential concept of natural selection proposed by Charles Darwin in his book *Origin of Species by means of Natural Selection*. However, it incorporates much that is post-Darwinian. It is an important contribution of Charles Darwin to biology, though he lacked the knowledge of Mendelian Genetics, which is a drawback. In 1866, Mendel's

laws of inheritance were published and remained unnoticed for about 40 years and were re-discovered in 1900 by Correns, de Vries and Tschermak. Thus, the importance of Darwinism was quite apparent when his idea of natural selection was integrated with Mendelian genetics and the theory was named by Huxley[8] as Modern Synthesis, although it was born in 1937 (ref. 9) as a generally accepted way of approaching the problems of evolutionary biology with the publication of Dobzhansky's book *Genetics and the Origin of Species*. That is why it has been commented by Singh[10] that Dobzhansky integrated Genetics with Evolution: two books (Darwin: *Origin of Species* and Dobzhansky: *Genetics and the Origin of Species*).

Here is a brief description of Lamarckism (first theory of evolution as far as modern biology is concerned) and Darwinism, an important theory of evolution emphasizing descent with modifications and the role of natural selection as a causative agent.

There are two titles in Darwin's book[11]: On the Origin of Species by means of natural selection or the preservation of favoured races in the struggle for life. Species means 'kind', and it is a Latin word. It is a basic unit of biological classification and a taxonomic rank. Aristotle has been called the father of biological classification. He has also stressed that all the attributes of animals, behaviour and body parts should be considered while classifying the animals. As far as species is concerned, he believed in the typological species concept, also known as essentialism. Linnaeus, believed in the morphological, typological or essentialist concept of species. He also suggested binomial nomenclature. In the literature, more than 20 species concepts have been described[12–15]. Under each concept, a species is defined differently. To name a few species concepts which are frequently used: morphological or typological, nominalistic, phenetic, cohesion, phylogenetic, ecological, physiological, genetic, genic, evolutionary, biological, etc. Darwin did not use the noun 'evolution' to describe his theory of the origin of species, but he used the word 'evolved' once in his book. Evolution entered the English language as a synonym for descent with modifications through the idea of Herbert Spencer, a non-biologist called the father of social Darwinism. Darwin has frequently used the terms species and varieties in his book. Regarding the concepts of species, there is much debate and comments on the concepts he followed in his book. Evidence for the central role of species is provided by two important books, highlighting the species through reference to Darwin's book: Dobzhansky's *Genetics and the Origin of Species*[9] and Mayr's *Systematics and the Origin of Species*[16]. Darwin did not define species, but he appeared to have a morphological concept of species central to his theory of natural selection[17]. In Darwin's opinion, the term species is arbitrary and is used for convenience to a group of individuals which resemble closely with each other, and it does not differ from 'variety', which is assigned to more fluctuating and less distinct forms. According to Darwin, the concept of species is unnecessary because gradual evolutionary changes may account for the diversity of life on this planet[15]. On the other hand, Kottler[18] writes, 'there is definite evidence from his transmutation notebooks that Charles Darwin did believe in some sort of biological species concept accepting the reality of species in some sense'. Darwin was fully aware of cladogenesis (speciation – the splitting of species) and recognized the role of isolation in the process of speciation. Mayr[19] in his most recent statement on Charles Darwin, reached a similar conclusion that Darwin believed in geographic speciation, which was consistent with the earlier concept of species as reproductively isolated populations. Kottler[18] states that in his transmutation notebooks, Darwin realized the reality of species, based on the criterion of non-interbreeding, identification of acquisition of reproductive isolation, as the mark of completion of the transition from permanent variety to the status of good species. Darwin also subscribed to Buffon's cross-sterility species criterion, supporting his concept that when individuals are crossed, they do not produce offspring or produce sterile progeny that belongs to different species. In the notebook, the non-interbreeding species criterion was explicitly adopted by Darwin. According to Darwin, species did not differ essentially from varieties within the species but could be distinguished in that they had developed gaps in formerly continuous morphological variations[20]. De Queiroz[21] suggested that all contemporary definitions describe variations of the general concept of the species as evolutionary lineages, which was adopted by Darwin in the passages where he clearly described the origin of species. Aldhebiani[22] has commented that Darwin and Wallace[23] considered species as fundamental units of evolutionary change and initiated a new era of species definition. They have explained that species could be produced rapidly if conditions were favourable, and in the absence of such conditions, species might remain unchanged for a longer period. There is an interesting observation by Hausdorf[24] in which he suggested that there is a differential fitness species concept which differs from the biological species concept in respect of the exchange of the species-specific features, which may not only be restricted by reproductive isolating mechanisms but also by divergent selective processes. In this regard, the differential fitness species concept is closer to Darwin's understanding of species than the biological species concept[24]. Mallet[25] has emphasized what Darwin meant by species, and the conception of species in Origin is now generally recognized by philosophers and historians as useful for his purpose, which is to demonstrate the evidence for their transmutations[18]. Based on Darwin's definition, which is simple and it allows multiple species to originate from a single ancestral species. Darwin has written in his book, 'We shall be compelled to acknowledge that the only distinction between species and well-marked varieties is that the latter are known or believed to be connected at the present day by intermediate gradations, whereas species were formerly thus connected'[11]. Huxley[26] has suggested that Darwin's use of the term species was useful but based on morphology. Huxley suggested the term physiological species, which are unable to interbreed successfully. Physiological species became an important term in the field of evolutionary biology[25].

In conclusion, a number of several evolutionists, taxonomists, naturalists and biologists have given much importance to the theory of evolution proposed by Charles Darwin and the concepts of species followed by him. Since Darwin believed in reproductive isolation, geographic speciation, interspecific hybrid sterility and transformation of varieties to the status of good species, it is rightly suggested by several evolutionists, biologists and naturalists that he followed the biological species concept, which is the most widely accepted concept of species although it has certain difficulties in its application[15]. Here it may be mentioned that the biological species concept has been criticized by suggesting that it is time to abandon the biological species concept by Wang *et al.*[27], who believe in the genic concept of species. On the other hand, Butlin and Stankowski[28] have replied to the remark of Wang *et al.*[27] by stating that it is not the time to abandon the biological species concept. In fact, they have argued that there is

actually no difference between the genic concept and BSC unless the BSC is tied to the allopatric accumulation of reproductive isolation, and the genic view is not.


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