HISTORY OF EVOLUTIONARY THEORY

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Summary

The term "evolution" is linked to the idea of development in the sciences of life, and only subsequently did it acquire the present meaning of diversification and origin of new species. The dominant image of the *scala naturae*, strictly related to the creationist, static and essentialistic positions, was substituted by the image of the tree that characterizes the transformist theories, and that represents the process of transformation over long periods of time.

1. Introduction

"Evolution" is a term rich in suggestions. It penetrates the current lexicon that we are accustomed to use in the most disparate occasions, with meanings that are sometimes very distant from the scientific theory that decreed its success, or that are only vaguely allusive to the Darwinian theory of evolution. The term "evolution" has also historically assumed different meanings in specific studies of life. Darwin, in the *Origin of Species* (1859), never used the word "evolution", although the term already existed and was broadly present in the natural sciences. This is one of the first points that needs to be clarified.

2. Scientific Historiography and the Analysis of the Theoretical Concepts

It often happens, in the development of scientific thought, that some apparently identical terms are used in diverse disciplinary and theoretical circles. These can be quite far from each other, or can go through different phases in the development of a theory. Only a historical analysis can reveal and document the shifts of meaning that have, in fact, deeply transformed the conceptual value of certain terms.

The word "evolution" derives from the Latin *evolutio*. The term originally referred to the unfolding of parchments. In relation to life, it assumed the specific meaning of unfolding, or development, or growth of the organism. The term appears with this meaning in the works of reformist thinkers, such as Albrecht von Haller (1708-1777) and Charles Bonnet (1720-1793), indicating the unfolding of preexisting parts. The ideas of the preformists (who postulated that the primary structure of the organisms can already be found, outlined in the germs that preexisted from the act of creation, so that embryogenesis is simply quantitative growth and the progressive appearance of the organs) was challenged by the epigenetists' ideas. William Harvey (1578-1657) was the first one to use the term epigenesis in the work *De Generatione Animalium* (1651). He wrote that the phenomenon of generation is accomplished through subsequent phases of development from undiversified matter and thanks to "vital forces" of natural character. In the 19th century, an epigenetist like Karl Ernst von Baer (1792-1876) used the Latin term *evolutio* in connection with the German word *Entwicklung*, indicating epigenetic development. Since Darwin, the term evolution indicates instead the differentiation process and the origin of new species (descent with modification) through the mechanisms of casual variation and natural selection. Evolution therefore is a phylogeny, a process that is not prearranged and that is far from linear. Evolution takes place at the level of the species, and is therefore distinct from ontogeny, i.e., different from the development of the single organism from the fertilized egg.

Besides the term "evolution", other important theoretical terms (already existing in the older theories of life, or borrowed for their analogical and metaphoric significance from more or less neighboring theoretical disciplines), ran into remarkable semantic shifts once they were integrated in the new theoretical picture. This happened to the concepts of analogy, homology, struggle for life, selection and even to the concept of species: they were all submitted to the same re-definition process in the context of the new Darwinian theory, that, since its beginning, produced an epochal fracture with the previous representations of life. The Darwinian theory, therefore, has become a symbolic case of scientific revolution. Darwin, in the *Origin*, had anticipated that his ideas would have produced “a considerable revolution in natural history”. If there is a scientific theory that, next to Copernicus' theory, has more recurrently and persistently earned the label of scientific revolution (both in its properly epistemological sense, and in the wider meaning of a turning point and a stirring of a consolidate vision of the world), that is the Darwinian theory of evolution. In this theory, in fact, there were not only radical transformations of the ways to interpret life and the science that studies it, but also important philosophical implications. These implications were so dramatic as to justify the fact that this theory is considered a true watershed. Substitution of a static world with a world in constant change; refusal of creationism; refusal of cosmic teleology; overcoming of anthropocentrism; absolutely materialistic explanation of what

was until then resolved in terms of a "divine project"; and substitution of essentialism and of its rigid and aprioristic classifications with an articulated thought rooted on the concepts of the flux of nature. These are only a few of the fundamental transformations that make it essential to contextualize this theory historically in order to appraise not only its revolutionary significance, but also its explanatory power such that, tightly connected to an elevated degree of acceptance, itis stated that is currently impossible to be biologists without recognizing its validity. Was the Darwinian revolution a true revolution? Or was it instead the result of a linear and continuous development based on the accumulation of facts and new discoveries? Or was it (according to the epistemological interpretation of the growth of scientific knowledge that assumes as its model the Darwinian mechanism of the evolution - the evolutionary epistemology) a modification and differentiation of an idea, as a gradual process of adjustment through trial and error in the attempt to resolve certain problems?

Darwin added to the *Origin*, beginning with the third edition of 1861, *An Historical Sketch of the Progress of the Opinion on the Origin of Species*, a brief historical introduction in which he replied to the accusations of not having recognized his debts to those who, before him, had anticipated the idea of evolution. In a footnote, Darwin quotes Aristotle who, in his *Physicae Auscultationes*, could have anticipated the principle of natural selection, i.e., the most original and characteristic concept pertaining to the Darwinian explanatory scheme. Darwin himself, however, points out immediately that it appears evident “how little Aristotle fully comprehended the principle”. This observation reminds us of the need for the maximum caution in the intricate play of the historical overcoming and anticipations. The complexity of this issue can be a dangerous trap for the historian of science. On one hand, the search for a line of continuity in the development of scientific knowledge could induce the historian to express judgments on the theories of the past in terms of values, in relationship to their contribution or to their theoretical distance from the currently accepted theories. Ernst Mayr, one of the main representatives of the modern evolutionary biology and one of the fathers of the synthetic theory of the evolution (the theoretical nucleus of contemporary Darwinism), but also one of the most engaged scholars in the reconstruction of the history of biological thought and in the analysis of the concepts, warns us to distance ourselves from the so-called "wiggish" historiography that appraises the work of a scientist, not in the terms of the intellectual ambit in which he or she was active, but in the perspective of his/her strict relationship with the present conceptions. The result of this approach is the underestimation of the role of theories that were subsequently revealed to be wrong and the theoretical motives that justified their formulation. Mayr reminds us that "the path of science is never straight" and of the danger represented by the historiographic category of "overcoming", that reconstructs the history of a discipline as a continuous and linear progress, an accumulation of discoveries and new facts, a kind of triumphal march toward the present day. There is also the symmetrical danger of the research, at any cost, of the precursors, i.e., the search for anticipations and precognitions in illustrious authors of the past (the farther the better). The result of this type of research is a kind of "contraction" of history, in which everything has already been said and discovered.

Concerning in particular the development of evolutionary biology, Mayr has underlined that, even if discoveries and acquisitions of new facts are fundamental elements in the

progress of scientific knowledge, the most important advancements were achieved with the introduction of new concepts or with the refinement of already existing concepts. Concepts such as evolution, common descent, geographical speciation, isolation mechanisms, natural selection, adaptation, would have, in fact, led to a drastic reorientation in an area of biology that was previously confused and to the creation of new theories and of innumerable new researches. This fact confirms the thesis that scientific progress consists mainly of the progress of the scientific concepts.

3. The Definition of "Species"

The historical and theoretical analysis of biology, and above all of evolutionary biology, clearly shows that the introduction of the temporal dimension in nature, that is the carrying axis of a properly conceived evolutionary theory, was once much of a problem. This problem was not only scientific, but philosophical, inevitably involving the representation of the world itself, as it had been conceived for centuries. For centuries the search for explanations on nature, and life in particular, had been built on beliefs and presuppositions that were deep-rooted in a mythological (and therefore prescientific) perspective. In the frame of the ancient cosmogonies and of myths of Creation, we find the first classifications of the natural world, the first attempts to individuate an order in the multiplicity of reality. It is not surprising that the first phases of the natural sciences appear to be, above all, attempts to describe and arrange the diversity, and a search for analogies and similarities that could allow the organization in homogeneous groups (therefore more functional to knowledge) of the many components of the created world. The epistemologist David Hull has noticed that: "From the beginning, one of the chief goals of science has been to discover classes of phenomena that are lawfully related - classes commonly termed natural kinds".

The classificatory activity represents the beginning and the foundation of the scientific knowledge and constantly accompanies its developments, as is particularly evident in biology, where it marks its diverse phases, and even the great turning points that are often identifiable through the direction of the dominant thought in systematics and the never-ending disputes that stemmed from them. The activity of classification can be found in the dominion (for a long time unchallenged) of the essentialistic thought, with its rigid taxonomic schemes; it can be found in the controversy on the *universalia* that, in the framework of biological systematics, took the shape of a debate on the reality or arbitrariness of the concept of species; it can be found in the attempt to overcome the essentialist and typological positions and nominalistic and conventionalistic positions, represented by evolutionism and its interpretation of the biological species conceived as the result of a historical process of gradual differentiation that connects, through descent with modification, all the living beings in the branching of phylogeny.

It was a very long journey in which the approach to the study of life has been deeply transformed. The passage from natural history to a properly named biology has required, in fact, a breakup of extremely powerful conceptual schemes. These schemes stemmed from Aristotle and from his general theory on the nature of the universe, but above all, from the determination of the classical method of definition. The knowledge of nature was organized around this axis.

The epistemologist David Hull has expressly said that the Aristotelian essentialism produced "two thousand years of stasis" in the progress of the scientific disciplines; this effect was particularly relevant in taxonomy. According to Hull, at the origin of the problem of the species there is "the biologically irrelevant but logically crucial notion, of definition", that was responsible for the incapability of taxonomists to define appropriately the species, since, according to this doctrine, it is impossible to define what is subject to constant change. The species is an emblematic case of the doctrine of the definition, and the definition is achieved through the next kind and the specific difference, i.e., pointing out the immediately broader concept and the further characterizing notation of the concept to be defined. In the context of classical thought, the species appears as the concept that translates in itself the essence and the procedure of the definition. Therefore it requires the identification (above and below the contingent) of the first substance. The use of notions that have the characters of permanence and of stability is necessary in order to introduce order to the mutability and to the diversity of the experience. According to Aristotle, as well as to Plato, science must concern itself only with the universal, with what is necessary and constant, i.e., with the formal-essential level of things. Objects that are totally submitted to the causality are not subject to scientific analysis. Aristotle's approach, though differing form Plato's, according to whom species are transcendent external ideas independent from the material world, states that the universal is immanent to the empirical world and to the individual to which the fullness of being is recognized; but it is the *eidos* (i.e., the form-species) that is the irreducible nucleus of the empirical world. The *eidos* represents, and in fact is, existing more than the single thing. This is the way to pursue the resolution of the aporia between universal essence and individual substance, and to obtain the conciliation of empirical realism with the epistemological demand of universality. This criterion of the immanence of the universal finds in biology its ideal application, since, through the reproductive process, the species enjoys the eternal permanence that is denied to the individual and that can be contemporarily recognized as an object of the scientific discourse (since it has all the epistemological requisites) and as a privileged level of reality. What Aristotle achieved was not a simple classification in accordance with arbitrary criterions and founded on simple dichotomies, but rather a hierarchy, that is an arrangement in which some groups are subordinate to some higher groups. This goal is achieved through an evaluation of the discriminating characters selected for the classification, and in which the increasing complexity of the world in a strict finalist scheme (where there are no chances neither for gaps nor for jumps and where there is no room either for evolution nor for change, nor for a modification that is not the actualization of what is already contained in the form) is clearly individualized and considered.

The sclerotization and the dogmatization of this attitude, filtered through scholasticism, determined the situation denounced by Hull and by Mayr, according to whom, still today, in those cases where essentialism is traceable in the most remote forms or as an unconscious philosophy at the workplace of systematics, many scholars, even though admitting evolution, would stick to a static concept of species.

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Biographical Sketch

Barbara Continenza is a researcher in philosophy and history of science at the University of Rome "Tor Vergata". Her major research interests are in theoretical and methodological problems of biology, and in the history of evolutionary biology and the behavioral sciences.