CAN WE BUILD AN EVOLUTIONARY MODEL OF SCIENCE?

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Abstract: *Building an evolutionary model of science requires the development of strict correspondences between the concepts of evolutionary biology and those of the theory of scientific knowledge. In this paper I analyze two difficulties encountered by the evolutionary models of science. The first is related to the fact that is difficult to build an evolutionary model of science without a foundation such as that given, in the biological field, by genetics. I show that an evolutionary model of science can be built without such a foundation. A second difficulty concerns the fact that at the biological level evolution is "blind", not "guided" by a conscious designer, and this does not happen in science. I show that a better understanding of the sense in which evolution is "blind" can help us to overcome this difficulty.*

Keywords: *evolution, science variation, transmission.*

Since the middle of the last century the evolutionary approach crossed the borders of biology and now it is used in many scientific fields such as psychology, linguistics or anthropology. In philosophy, the evolutionary approach is often used in ethics, game theory and epistemology. The idea of evolution has become what Daniel Dennett calls a "universal acid," essentially changing most of the traditional concepts and ideas in many fields of knowledge.[1] In this short paper I will be concerned with the way in which evolutionary theory can be used to take into account the development of scientific knowledge. Those who initiated this project are Karl Popper and Stephen Toulmin, but David Hull's *Science as a Process: An Evolutionary Account of the Social and Conceptual Development of Science*[2] was the book that has aroused significant attention on the use of evolutionary model in philosophy of science.

In most cases, an evolutionary approach to scientific knowledge is achieved by drawing a parallel between the concepts of evolutionary biology and the concepts of the theory of scientific knowledge. In this paper, I will analyze the two criticisms of this type of approach. The paper will have three parts. After, in the first part, I will present the idea of an evolutionary model, in the next two parts I will discuss the two criticisms. The first, discussed in Part Two, refers to the fact that evolutionary model of science is not based, in the same way as evolutionary theory, on a scientific discipline similar to genetics. I will explain why the concept of replicator, characteristic to the model developed by David Hull's model, is not necessary for an evolutionary model. In the last part I will discuss to what extent evolutionary theory, based on the absence of a conscious being who guides the evolution, can be applied to socio-human field.

1. The idea of an evolutionary model of science

In general, developing a model requires drawing a set of correspondences between a set of elements in a domain and another set of elements, belonging to a different domain. In particular, building an evolutionary model implies developing a correspondence between the central concepts of the evolutionary theory and concepts belonging to the

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[1] D. Dennett, *Darwin's Dangerous Idea*, p. 63.

[2] University of Chicago Press, Chicago, Illinois, 1988.

theory of scientific knowledge. Within this approach it is necessary to identify the main concepts of the evolutionary scheme, and then to find the corresponding concepts at the level of scientific knowledge.

Of course, the evolutionary theory in biology contains a number of elements, but not any of them can be automatically translated into science. For this reason, the problem will consist in identifying the relevant elements, which must find their counterpart in the model. This identification will be very important, because if in a model a relevant element finds no counterpart, this will be considered a problem for this model. Donald T. Campbell, one of the authors who founded the evolutionary program of science, identifies three components of an evolutionary model, which can be applied to biology, culture and other areas: variation, selection, and retention.[3,4]

Based on these concepts, a very brief presentation of the evolutionary theory in biology will be the following. Individuals belonging to a population[5] differ in their traits. Some of these traits are advantageous, and individuals who possess them are better adapted to the environment, others are neutral and some of them bad. These traits, or at least some of them, are inheritable. Statistically, individuals who possess advantageous traits will survive longer and have more offsprings. This will make the advantageous traits for survival and reproduction to be selected and to spread within a population and will make the share of individuals of that population that possess these traits increasingly higher.

Modern evolutionary theory is based on genetics. Genetic theory is essential for explaining variation and transmission. The variation is considered the result of some genetic phenomena, among which mutation and recombination have the most important role. Thus, transmission is explained by the replication of genetic information. An important distinction is that between genotype and phenotype. While the genotype is the genetic makeup of an organism, the phenotype represents the observable traits of the individuals, partially determined by the genotype. The adaptability of an individual depends on his phenotypic characteristics.

The correspondence between the three central concepts of evolutionary model and the corresponding concepts in the theory of scientific knowledge can be done in several ways. This will lead to different models. I will refer next to Hull's model, which occasioned the most debate. He starts from the distinction between interactor and replicator. A replicator is an entity that passes on its structure in successive replications" and an interactor is "an entity that interacts as a cohesive whole with the environment in such a way that this interaction causes replication to be differential".[6] Of course, as can be easily spotted, the concept of replicator is a generalization of the concept of gene, while the notion of interactor is a generalization of the one of individual.

At the level of cultural evolution, the replicator corresponds to the notion of meme, which was introduced by Richard Dawkins, in his 1982 book *The Extended Phenotype*, and which is used very often in works that deal with culture in an evolutionary manner. At the level of science, the replicator corresponds to the constitutive elements of science, which can take very different forms: scientific concepts, experimental designs, methods, etc.[7] The scientist plays the role of the interactor, and the transmission of these elements will depend on his success as a scientist. The success of a scientist will correspond, within the model, to the adaptability of the biological individual.

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3 Donald T. Campbell, *„Unjustified Variation and Selective Retention in Scientific Discovery"*, p. 143.

4 In the following, I will use the term *„transmission"*, not *„retention"*, in order to focus on the way in which, within a population, some traits are passed to the next generation.

5 It should be noticed that the population, not the species, is the basic unit of evolution.

6 D. Hull, *Science as a Process: An Evolutionary Account of the Social and Conceptual Development of Science*, p. 408.

7 *Ibidem*, p. 434.

A distinction that is rarely taken into account when developing the evolutionary models of science is that between individual and population.[8] However, the distinction is crucial within the model. The transmission of advantageous traits is made from one individual to another within a population and therefore it should be clear who play these roles in the model. As shown, according to Hull, the individual corresponds to the scientist. Normally, the population would correspond to a scientific community working in a scientific discipline. This is relevant because it shows that the transmission of scientific elements is made within the scientific community in a certain discipline, not at the general level of scientists.

2. An evolutionary model without replicators

As noted, the modern theory of evolution is based on genetics. This leads to the idea that an evolutionary model of science will be based, in the same way, on a scientific discipline similar to genetics. Failure to do so would lead to a significant criticism of evolutionary models of science. In this part, I will try to show that an evolutionary model of science can be developed even in the absence of a theory based on the concept of replicator, similar to the genetic theory.

The concept of meme can help us to reconstruct at the cultural level the mechanisms of mutation and recombination, relevant for explaining variation and transmission. However, and this is the first problem, memetics, the field that tries to show that this concept can help us to understand cultural phenomena, has not yet a true scientific status. For this reason, we are still far away from talking about an equivalent in culture in general and in science in particular of the concepts of mutation and recombination.

A second reason why the concept of meme proves not to be useful in the evolutionary model of science is the fact that, similar to gene, meme must represent the smallest unit of information that can be transmitted. But in the case of science is difficult, however, to talk about "the smallest part". We have already shown that transmission does not need to consider whole theories, but can also refer to smaller units, such as concepts. But concepts are not necessarily the smallest units, because a certain manner to develop or to operationalize a concept can be transmitted from one theory to another. But these smaller units cannot be defined with sufficient precision and, also, cannot be listed in full.

There is also a third reason why the concepts of replicator and interactor do not contribute significantly to an evolutionary model of science. An important role of these concepts would be to help us to rebuild the distinction between genotype and phenotype. At the biological level, these two can be characterized totally independently. Genotype is characterized by genetic information encoded in DNA, while the phenotype by the observable characteristics of individuals (color, size, etc.), among which some explain why some individuals are better adapted than others. Genotype does not influence itself the adaptedness of individuals, but through phenotypical characteristics that is determined by genotype. If we are trying to make the same distinction in Hull's model, we will encounter a difficulty. The genotype is determined by scientific elements that create the theory that is supported by the scientist. Phenotype has to be a set of characteristics determined by these scientific elements, but conceptually distinct from them. These must explain why we have scientists with different levels of success. David Hull does not show the features that play this role within his model.

In the last three paragraphs, I have shown that the model based on the distinction between replicator and interactor can not be successfully applied to science. Next, I will show that this does not make impossible to develop an evolutionary model. Such an evolutionary

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[8] For instance, D. Shrader affirms that this distinction is not necessary for an evolutionary model of science. See *„The Evolutionary Development of Science"*, p. 274 (condition vi).

model should not be based on the distinction between genotype and phenotype or on a scientific discipline similar to genetics.

Of the three central concepts of evolutionary theory, variation and transmission are those that are explained by genetic theory. I will argue that the use of these concepts necessarily imply a similar genetic theory. I will start with the concept of variation. Just as individuals differ in terms of biological traits, so scientists differ among themselves. In an evolutionary model of science, the relevant differences are these between scientific ideas used in scientific explanations. Differences between individuals are sufficient for an evolutionary model, and variation should not be seen as genetic variation.

Similarly, the concept of transmission does not entail the concept of replication, characteristic to biological phenomena. The only thing necessary to be able to talk about an evolutionary model of science is an explanation of the way in which the characteristics of a scientific theory are transmitted. In a sense, this is easier than in biological evolutionism. While evolutionary theory had to wait the development of genetics to explain how the traits are transmitted from a biological individual to its offsprings, at the level of scientific theory transmission is a simple thing to explain. Professional prestige won by adepts of a scientific theory will bring new adherents to it. Some of these are young, and in this case the basic mechanism is learning. In other cases, the new supporters are experienced scientists, who hitherto were supporters of a rival theory.

So far I have shown that evolutionary models of science should not be based on concepts like those of replicator and interactor. So, the fact that such concepts cannot be successfully used is not a criticism of the attempt to formulate such models. There is, however, a general criticism against the attempt to develop an evolutionary model of science.

3. Blind evolution?

In biology, natural evolution is not guided by a conscious being.[9] This is not a secondary feature of the evolutionary theory, but it is precisely the one that made it attractive for scientists. Evolutionary biology has shown that the perfect structure of animals and plants should not be explained by the existence of a being that creates them based on a design. But in science and generally in culture, decisions are made by rational beings. If correct, this argument affects the application of evolutionary model in all fields of culture, whereas in none of these we can ignore the human subject.

The argument above addresses very easily, in a negative sense, the problem of the evolutionary pattern of any field of science and culture. This fact may raise questions, because, as I said, the evolutionary model has been applied successfully in many social and humanistic disciplines. Is it possible that these applications may not take into account the intentional nature of human choices? I will argue that this is not true.

We must distinguish between the intentional nature of the specific decisions made by scientists and the fact that these decisions follow a unique direction and have a final end. Even if every scientific change is justified rationally, the overall development of science is not in any way antecedently determined. The overall evolution of a scientific discipline has no single direction and no unique purpose and is, in this respect, undirected. However, other areas may not meet this requirement.

In general, when we analyze this criticism, and other similar ones, to the evolutionary models of science, we are between two dangers. The first one would be that the evolutionary model can not be appropriate for any field of knowledge, and the second one would be that this model can apply in all areas. Such a general application would

[9] In a remarkable way, this feature of evolution is captured by the Dawkins syntagm “blind watchmaker", which gives the title of one of his most famous works.

empty of content the evolutionary model. Therefore, it is useful to show that the evolutionary model does not apply indistinctively to all fields.

There is a more determined sense, and still related with the first one, in which biological evolution is blind. At the biological level, variation is not in any way "guided" by a conscious subject, but it is the result of accident. It is natural selection, not mutations, that has the main role in explaining the adaptation to the environment of individuals. In contrast, at the level of scientific knowledge, rational beings propose new solutions to scientific problems and their activity is intentional. This observation, largely unquestioned, it seems sufficient to reject the project of an evolutionary approach to science. In the same time, this argument would apply with equal justification in any other field of culture. However, some authors argue that this observation is not sufficient.

There are two senses in which, in evolutionary biology, variation is not random. First, the range of possible variations is severely limited by a number of conditions imposed by the genetic material. Although individuals of the same species differ significantly, they cannot have any trait. This is relevant for the way in which the natural selection acts, because a too high rate of variation would make difficult the fixation of traits that are advantageous for a certain population.

Secondly, there are a number of genetic laws, which make certain mutations more likely than others. Consequently, the fact that the variation is random does not mean that any mutation is equally likely or that all mutations are possible.[10] Similarly, the randomness of the variation in the scientific solutions does not mean that scientists can develop any solution to a scientific problem. For a particular scientific idea to be a solution to a scientific question, it must already comply with some conditions.

The relevant sense of the word "random" it is that only the chance sometimes makes variation lead to a advantageous trait for a population, which will subsequently be maintained. Variation and selection are two completely independent processes, which mean that the probability of a mutation does not depend on the mutations that previously proved advantageous or adverse. The term which usually described this feature is "undirected".[11] Biological variation is undirected, in the sense that, within a population, mutations don’t have direction, a trend of increasing probability of being advantageous. In contrast, at the level of science, previously tested solutions, successfully or not, influence the solutions to be tested by scientists in the future.

Broadly, there are two strategies of defense against this argument. The first is to show that the development of new scientific ideas, or at least some of them, is analogous to blind mutations, and do not depend on previously selected solutions. This solution emphasizes, in the manner of Feyerabend, the role of scientific hypotheses anarchically generated without any restriction.[12]

The second strategy is to show that an evolutionary model of science does not imply that the processes of variation and selection are independent. This second response is given by Toulmin. According to him, we can make a distinction between "coupled" evolution, in which the processes of variation and selection are not independent, and ”uncoupled” evolution, in which the two processes are independent.[13] I will not develop these two possible responses, but they can give us an answer to the argument of blind evolution.

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[10] *Ibidem*, p. 148.

[11] See Mark Ridley, *Evolution*, pp. 88-89.

[12] See Donald T. Campbell, *op. cit.*, pp. 153-158.

[13] Stephen Toulmin, *Human Understanding*, vol. I: *The Collective Use and Development of Concepts*, pp. 337-338.

4. Conclusion

In this paper I discuss two arguments that question the possibility of developing an evolutionary model of science. I tried to show that they can find an answer. In any case, developing an evolutionary model of science is not the only solution to use biological evolutionism in order to understand scientific knowledge. Even in the absence of a strict correlation between the field of biological evolution and that of science, biological evolutionism can help to understand science, through its types of argument and its approach.

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