THE EVOLUTIONARY VIEW OF SCIENTIFIC PROGRESS

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***Abstract*:** *In this article I have examined how Kuhn uses the evolutionary analogy to analyze the problem of scientific progress. In the first part I have presented the standard view of progress in evolutionary biology, based on the distinction between absolute and relative progress. I have concluded that progress should be seen in a relative way, as a relationship between two individuals or two species that have actually compete for resources. However, the evolution of species is not characterized by a coherent trend of improvement. In the second part I have shown that Thomas Kuhn successfully uses this distinction in its approach to scientific progress. In the last part, I have discussed whether scientific specialization can be construed in terms of the evolutionary analogy. I have shown that the metaphor of niche restriction, which Kuhn uses, is not inadequate to explain scientific progress.*

Keywords: *evolutionism, absolute progress, relative progress, specialization, ecological niche.*

Kuhn's view of science is characterized by a novel conception of scientific progress. When referring to this concept, one element is often overlooked: the evolutionary analogy that Kuhn uses to explain how science progresses. Probably, this omission is explained by two facts. First, Kuhn devotes to this theme a relatively low number of pages. Secondly, Kuhn does not realize a complete correspondence between the scientific domain and the biological one, as David Hull, for instance, does, in his work *Science as a Process. An Evolutionary Account of the Social and Conceptual Development of Science*. Despite this, the evolutionary analogy has a central role in the Kuhnian account.

In this paper, I will focus on how Kuhn uses the evolutionary analogy to elucidate the sense in which science is a progressive activity.[1] My work will have three parts. In the first of them, I will present the standard evolutionary view of progress, which has as its heart the distinction between relative and absolute progress. The next part will discuss how these two concepts can be found in Kuhn's work, while in the last part I will analyze one element that plays an important role in Kuhn's evolutionary approach of progress: specialization of scientific knowledge.

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[1] In this paper I will use the term "evolution" in the usual sense in biology, lacking any value connotation. The term "progress" will have such a connotation.

1. Relative and absolute progress in evolutionary biology

When trying to build a coherent vision of progress in the biological world, scientists must explain an apparent tension. On the one hand, natural selection eliminates individuals less fitted to the environment in favor of the better adapted ones. This leads to the idea of a certain kind of progress in the world of animals and plants. On the other hand, when we follow in a historical perspective the long-term evolution of plants and animals, we cannot find a characteristic or a set of characteristics indicating the sense in which we can talk about an overall progress. This apparent tension makes necessary a distinction between two types of progress. On the one hand, there is a comparative, relative or local sense of progress, referring to the competition between two individuals or two species. On the other hand, it is a global, or absolute, sense of progress, which refers to a general trend of improvement that would be present in the overall evolution of the animal or plant world.

Biological individuals compete for a limited amount of resources (food, water, air). If in such a competition, in a certain environment, individuals of a given species tend to replace those from another species, we can talk about the superiority of the first ones upon the latter ones. In the absence of such a direct competition, the superiority relation cannot be defined. This is the evolutionary view of progress since the creation of this theory by Charles Darwin.[2]

The biological characteristics advantageous for some species can be neutral or even harmful for others, living in different environments. For example, homeothermy (the characteristic of some animals to maintain constant internal body temperature regardless of external conditions) that characterize mammals was an important adaptation by which they filled a series of niches previously filled by reptiles.[3] This adaptation is an important evolutionary advantage in certain environmental conditions, for example those in which there is a significant difference between night time and day time temperatures. But this feature is less important for species living in other environmental conditions, for instance for reptiles, and they can have another advantage over mammals. The notion of superiority of one species upon another applies, therefore, only to organisms or species successively occupying the same environment.[4]

However, evolutionary biologists address the problem in a different perspective, trying to provide an absolute sense of progress, too. In this approach the focus is not on the relation of superiority or inferiority in direct comparison between two species, but on the general analysis of the history of species. Generally, in a process we can talk about progress only if two conditions are met[5]: 1) the process can be seen in a directional way, as a gradual change (increase or decrease) from the point of view of some relevant characteristics; 2) this change is an improvement from a relevant point of view. In particular, there is an absolute

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[2] See the section *„On the state of development of ancient compared with living forms"*, of the chapter X of Darwin, *Origins of Species*, pp. 247-249.

[3] Michael Ruse, *"Evolution and Progress"*, p. 55.

[4] T. Shanahan, *The Evolution of Darwinism*, p. 181.

[5] These two conditions can be found, in similar formulations, in many places. Seee, for instance, Ayala, *"The concept of Biological Progress"*, pp. 341-342.

progress in the biological life on earth only if in all lineages, or at least in the most of them, there is a change in terms of a biologically relevant feature and it can be shown that this change is advantageous for the survival of the organisms. In most lineages, evolution can be seen as a directional change, advantageous for individuals, in terms of certain features. The question is whether progressive changes in different parts of lineages are modifications of the same biological characteristics in the same direction.

The evolutionary biologists bring a number of criticisms regarding the concept of absolute progress and I will present two of them. First, there are some features that are justified to the same degree to play the role of the absolute criterion of progress: adaptability, degree of specialization, complexity, ability to survive in different environmental conditions, etc.[6] There is a trade-off between these criteria, and species superior from a certain point of view are inferior from another point of view. Given this fact, these criteria do not lead to the same hierarchy, and a choice between them is necessary. But such a choice can only be subjective.[7]

Secondly, researchers show that no biological trait offers an evolutionary advantage in any environment. For example, Cope's rule states that in a lineage of populations the body size of individuals tends to increase. There are also good grounds to believe that this development represents an improvement. For example, the members of the larger predatory species will have an advantage on the prey. Cope's rule is confirmed in many lineages, but in some parts of lineages the sizes of individuals tend to decrease, which is also an evolutionary advantage in their environment. For example, from a certain size, it will be difficult for the animals to find the necessary food, which will provide an evolutionary advantage for individuals with small body size.

Therefore, the trend of increasing body size is not a universal feature of animal evolution and does not provide an evolutionary advantage to all species. If body size is not an adequate feature to characterize the absolute progress, is it not possible to find another feature to play this role? Most evolutionists argue that no biological property can help us in defining the absolute progress. As a conclusion of this section, the evolution of species is characterized by progress in a relative, comparative sense, but not in an absolute one.

2. Kuhn on scientific progress seen in an evolutionary perspective

In a critical article regarding the Kuhnian evolutionary model, Barabara Gabriela Renzi tries to show that Thomas Kuhn does not make clear the distinction between absolute and relative progress, about which I discussed in previous section.[8] (The author uses the syntagms *global progress* and *relative progress*). As shown, this distinction is central to the evolutionary conception of progress and therefore the Renzi's criticism is serious. I will show that this criticism is not entirely justified. Kuhn presents his evolutionary view of scientific

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[6] For a more comprehensive list of criteria, see Shanahan, *op. cit.*, p. 204.

[7] Shanahan, *op. cit.*, p. 242.

[8] G. Renzi, *„Kuhn's Evolutionary Epistemology and its Being Undermined by Inadequate Biological Concepts"*, pp. 150-153.

progress especially in three works: *The Structure of Scientific Revolutions*, ***"****Road Since Structure"* and *"The Trouble with Historical Philosophy of Science"*.

In *The Structure of Scientific Revolutions*, Kuhn shows that an evolutionary approach can help us understand how science progresses. In the same way as in the biological evolution, scientific progress should not be conceived as a process of evolution toward an end. Kuhn wants to reject the conception that the successive theories from different research traditions are getting closer to the truth. The truth**,** classically defined as the correspondence between statement and reality, is not a very useful concept for understanding the evolution of scientific knowledge, because science should not be seen as a "confrontation" between a set of statements and a permanent reality.

In the same time**,** Kuhn rejects any absolute concept of progress. There are a number of features relevant for the comparative evaluation of scientific theories**,** of which Kuhn lists five in *"****Objectivity, Value Judgment*** *and Choice Theory"*: consistency, accuracy, scope, simplicity**,** fruitfulness**.** A scientific theory can be superior to another from one point of view and inferior from another point of view. So, in a way parallel to the first argument from the first section against absolute progress in evolutionary biology, these criteria, in the same degree justified, can lead to different hierarchies.

If progress can not be defined in an absolute manner, what other solution do we have? In *"****The Trouble with Historical Philosophy of Science"***, Kuhn provides an answer by developing a historical perspective, characteristic both to his approach to science and evolutionary biology. This historical perspective described by Kuhn is characterized by two central features characteristic both to the scientific and biological evolution. First, explanations in both areas concerns changes rather than states.[9] For, example, when biologists explain the evolution of birds, they show how they developed their specific organs, such wings, from the organs of an ancestor species. The explanation is based on a set of previous data regarding the body structure of the ancestors of birds and refers to how this structure has changed to adapt to a new environment, the air. Similarly, the explanation of the development of scientific theories is based on the structure of previous scientific theories and show how it changed in order to give a better solution to the problems relevant in that moment for the scientific community. Secondly, in both explanations the covering-law model of explanation, specific to natural science, is not appropriate, and must be replaced with a historical explanation.[10]

What does it result from the things above about the scientific progress? Regarding the biological term of comparison, the appearance of wings is an improvement in terms of survival in the aerial environment. The evolutionary explanation, which shows how the appearance of wings is an adaptation to this

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[9] See Robert J. O'Hara, *"Homage to Clio, or, Toward an Historical Philosophy for Evolutionary Biology"*.

[10] The absence (or at least the lack of importance) of natural laws in biology is supported by evolutionary contingency thesis, paradigmatically illustrated by Stephen Jay Gould in his *Wonderful Life* by the metaphor of a tape that, rewinded many times from exactly the same point, lead to different results.

environment, leads to this conclusion. If individuals of a species in the struggle for survival gain over those of other species, they are necessarily, in a sense, superior to them.[11] However, this sense is limited to the context in which the competition actually took place. In the same time, it is not assumed in any way that the wings of birds, in their actual structure, would be the only solution, or the best, for the adaptation to the new environment, but only that it is the best solution under certain circumstances.

Similarly, Kuhn repeatedly emphasizes that replacement of a tradition of scientific research, as a result of a scientific revolution, is a progress. This is guaranteed by the mere fact that the decision of the scientific community was to choose the new tradition against the previous one and there is no other better criterion. [12] Simply, the new tradition offered a solution to the problems considered more important by the scientific community. Philosophers of science can only give a *post factum* explanation of the choice of the scientists, but they can not offer normative judgments. Therefore, in the comparative sense indicated in the first section, the superiority of the new theories on those replaced it is a necessary conclusion, which follows from the way in which the words are used. However, progress should be seen only in this comparative way.

Despite the conclusion that he seems to support according to which the scientific progress can be defined only in a comparative way, Kuhn tries to give an overall view of the general progress of scientific knowledge. In some parts of the *Structure* and *"Road Since Structure"*, Kuhn addresses this theme, based on the idea of the specialization of scientific knowledge. This is the point in which his not too intentions are clear and offer a partial justification for Renzi's criticism.

3. The specialization of scientific knowledge and the progress of science

Kuhn believes that the specialization of scientific knowledge plays an important role in explaining the progress of science, and this affirmation is not counterintuitive. He tries to introduce this idea in his evolutionary view we talked about before. How is this possible?

Kuhn makes a parallel between the scientific revolutions and the events of speciation, which lead to the formation of two species by splitting of a population. Scientific revolutions are, in several ways, a good correspondent of speciation. [13] First, from a sociological point of view, scientific revolutions lead to the creation of new scientific communities. This is shown by the emergence of scientific journals dealing with the problems of the new discipline, by delimitation of a group of scientists trying to solve these problems, mutually knowing their scientific articles and often referring to them. Finally, as an advanced phase of development of the

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[11] In the fragment referred also to footnote 2, Darwin says: "In a more general sense the more recent forms must, on my theory, be higher than the more ancient; for each new species is formed by having had some advantage in the struggle for life over other and preceding forms." (*Origins of Species*, p. 248).

[12] Kuhn, *The Structure of Scientific Revolutions*, p. 170.

[13] The following reconstruction starts from *The Structure of Scientific Revolutions*, p. 170 and *"Road Since Structure"*, pp. 97-98.

new disciplines, new scientific societies will be established, aiming at standardizing the scientific language and organizing the new body of knowledge. The organization of congresses and gradual increase in the number of the members of scientific societies will confirm the formation of a new discipline.

Secondly, from the point of view of scientific language, revolutions often lead to the formation of two scientific disciplines characterized by distinct conceptual structures. The phenomenon referred by Kuhn is the following one. A scientific discipline is characterized by a conceptual structure. At one point, this structure may prove insufficient to explain newly discovered phenomena. A new rival conceptual structure could arise, trying to deal with the new phenomena. In many cases, the difficulties affect only a fragment of the old conceptual structure and, therefore, the conceptual change does not affect in the same degree all the central terms of a discipline, but focuses only on some of them. A fragment of the old conceptual structure survives, while the rest of it is modified and also detailed. Thus, the new tradition will appear as a deeper analysis of a portion of the previous conceptual structure and the subject matter of the new disciplines will be narrower than that of the previous one. As long as a fragment of the previous conceptual structure will be adequate for some phenomena that it tries to explain, this fragment will survive. Thus, two different scientific disciplines will emerge, characterized by two distinct conceptual structures.

The question is whether the mechanism described above leads to progress. At the level of science, Kuhn shows that the increasing specialization of scientific knowledge leads to a deeper, more detailed and more precise description of the subject of a scientific discipline, which becomes more determined, more delimited. Every scientific discipline develops in depth rather than breadth. However, scientific knowledge as a whole advance also in breadth, as more areas become subject of scientific knowledge. The progress of scientific knowledge is thus characterized by two phenomena: subject of each scientific discipline becomes deeper and science as a whole becomes broader.

In order to analyze the phenomenon of scientific specialization, Kuhn uses the concept of ecological niche. In the perspective relevant for the analogy with scientific knowledge, an ecological niche consists in all conditions (physical, biological, etc.) which make possible the existence of a species that will fill that niche. Similarly, in a preliminary form, a niche will be a fragment of reality that makes possible the existence of a scientific discipline, which deal with that fragment. An ecological niche will be, therefore, the subject of a scientific discipline, which will fill that niche. At the biological level, the phenomenon of specialization has as a correspondent the phenomenon of niche restriction.[14]

Unfortunately, the evolutionary analogy does not work very well, as long as the phenomenon of niche restriction does not have an important role in explaining progress, relative or absolute. First, biologists do not identify niche restriction as a long-term trend of the evolution of species. Secondly, the phenomenon of niche restriction does not represent an improvement. One of the main reasons is that a very limited niche creates difficulties when a change in

[14] Kuhn, *"Road Since Structure",* p. 102.

environmental conditions occurs. Such a change is impossible for scientific knowledge, where reality which scientific theories should **"fit to"** is constant.[15] In conclusion, the phenomenon of niche restriction is not a good analogue of the scientific specialization in terms of progress.

In this article I discussed the evolutionary analogy that Kuhn uses for the analysis of scientific progress. We have shown that the evolutionary distinction between relative progress and absolute progress is useful to understand how science progresses in Kuhn's conception. However, the evolutionary analogy does not help us understand the specialization of scientific knowledge, which has an important role in Kuhn's view of scientific progress.

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[15] The distinction between the variability of the environment to which the biological individuals should fit and the constancy of the „environment" to which the scientific theories should fit is an important distinction between the two fields.