# IN PRAISE OF PREDATORS AND STUPID QUESTIONS

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## 1. The Cambrian Explosion

After Charles Darwin developed his theory of natural selection in 1859 to explain the evolution of living creatures, a few problems appeared for his theory. One of these problems was to explain why the fossil record started suddenly, around 600 million years ago, in the beginning of the Cambrian period, with no fossils being known before that time. Wouldn't that "Cambrian explosion" of complex invertebrates indicate God's initial decision to populate the earth, and not the gradual evolution of creatures from lower to more complex forms?

Pre-Cambrian fossils ended up being found, and consisted mostly of bacteria end blue-green algae. Evolutionary theory was vindicated, but the problem remained: why was there such a steep rise in diversity during the first 20 million years of the Cambrian period? A plausible explanation was given in 1973 (see GOULD, 1973, pp. 119-25), within the perspective of ecological theory. Life acquired such complexity and variety of forms because of the appearance of the first predator or "cropper"! One might expect that the introduction of a cropper in a community where there is one hegemonic species and little diversity would reduce even more the diversity, but what occurs is the opposite: many different species evolve, each specializing in an alternative way to escape the predator, each with a relatively small number of individuals.

## 2. In Order to Evolve, Ask Stupid Questions!

The evolution of life is in many ways similar to the evolution of science, and to the evolution of knowledge for each individual. The school in philosophy of science that studies knowledge as an evolutionary process is called "evolutionary epistemology" (see HULL, 1988).

Within this current, the explanation for the Cambrian explosion brings out an important consequence for our acquisition of knowledge, and for the scientific method. It suggests that the best way for our knowledge to grow is to have some sort of "cognitive predator" that would constantly try to destroy our views of the world. In that way, we would have to constantly generate new ways of thinking that could escape such "predators", and our conception of the world would evolve, instead of stagnating.

In the classroom, the upshot of this is that we should always put forward our doubts, always ask questions, without feeling ashamed of falling in error or saying something stupid. That doesn't mean that we should say things without some previous reflection; if you have a doubt, think at least a minute to see if you can't solve the problem by yourself. But if you are not sure of an answer, you must ask, even if you imagine that your friends might think less of you: whatever they think of you, they will surely be learning with your stupid question!

Another point can be made, considering the evolutionary metaphor. Our society, which can also be thought of as an ecological system, is composed of individuals which are different from one another, each has developed particular skills, desire different things, think differently. Diversity within society is vital for its strength. In view of this, it is desirable that we stick hard to our ways of thinking and to our doubts, not accepting answers to our questions that are not completely convincing. In that way we can maintain our originality! But of course one should not be hard-headed and refuse changing opinions: there is a fragile balance between dogma and doubt that each of us should maintain, with the help of certain methods for selecting views,... in order to constantly evolve!

Asking questions and receiving answers from the teacher constitutes a simple "methodology" for acquiring knowledge, and making our personal world-view evolve. In college and university, such a method still works well, but sooner or later one finds out that teachers cannot in general answer your questions, or if they do answer your questions, you don't believe them any more! That is the time you will have to develop your own private predators, ways of discovering your own errors without the direct help of others.

## 3. Aspects of Scientific Methodology

We have argued that each individual should develop a method for falling in error, if he wishes to have his world-view evolve through life. There is no set of rules for doing this, each individual must find his own way, but one thing that helps is to lose the embarrassment of stating stupid opinions or asking stupid questions in class. Knowledge arises from error.

Things become more clear when we look at the methods that science has developed for progressing. Most philosophers of science tend to agree that there is one basic methodology that underlies science, but they have a hard time agreeing on what is that basic methodology! In the 17th century, the discussion was whether knowledge arises mostly from observation (empiricism) or mostly from pure or mathematical thought (rationalism) (see OLDROYD, 1986). As is usually the case, both traditions were relevant to science, but in the 18th century the differences between both traditions developed into the rift between science, which studied empirical facts, and philosophy, which studied knowledge unattainable by observation.

The empiricist methodology favoured by scientists emphasised that new knowledge arises basically from careful observation and experimentation, while mathematical theorizing served to organize such experiences. The basic method of science might be summarised as follows: discover new phenomena by observation, perform systematic experimentation to obtain (by "induction") new hypotheses, test such hypotheses in different experimental situations in order to confirm them, thus obtaining new laws. The more theoretical and mathematical part of science would work on top of the empirical laws, trying to unify them in more general laws and theories, obtaining perhaps new empirical predictions, which might or might not be confirmed.

In the second half of the 19th century, much discussion was dedicated to the status of the theoretical abstractions of scientific theories. Should unobserved entities of theories be considered "real", or are they nothing but "abstractions"? This important discussion is nowadays part of what is called the problem of "scientific realism", and the view that theoretical entities cannot be held to be real unless they are observed is usually called "positivism". Are scientific theories merely instruments for obtaining predictions, or do they reveal the structure of unobserved reality? (see HACKING, 1983).

Parallel to these more general discussions, certain ideas of the old rationalist tradition were adopted by some scientists in the beginning of the 19th century into what is now called "hypothetico-deductive method". The difference with respect to the "inductivist" methodology described above is that new hypotheses were seen not as arising from the observation of nature, but as free human creations. The important part of science would be testing, and not so much observation: a scientist could invent any sort of crazy hypothesis, as long as he described how his hypothesis could be experimentally tested, and someone in fact tried to perform such experiments.

## 4. Good Scientific Theories must be Falsifiable

After World War I, the positivist tradition was fortified by considerations from formal logic. The so-called Vienna Circle developed the school of "logical positivism", which diffused throughout the world after World War II, resulting (after the slow rejection of certain radical positions) in the "received view" of philosophy of science, which only started to be systematically attacked (due to its overemphasis of logic and neglect of the history of science) in the 60's.

One of the early critics of this inductivist tradition was KARL POPPER (1935), who defended a hypothetico-deductive methodology of science. Science strives for general statements about the world, but it is impossible to verify that a general law of nature is true, since we cannot observe all of its instances, in order to be sure that it is true. For instance, to verify that "all swans are white", we would have to check all the swans in the world. Positivists argued that by induction one could acquire a certain degree of confidence about the truth of a law, thus confirming it (in a probabilistic sense).

Popper's solution was ingenious. Instead of worrying about the confirmation of laws and theories, it would be better to worry about its falsification! It is easy to falsify the statement "all swans are white", by simply observing a black swan (which in fact exists!). Popper then proposed that scientific theories should aim at being capable of being falsified, and that science only progresses when in fact a theory or hypothesis has been falsified.

Popper's methodology was quite influential in the 50's and 60's, especially within certain fields of biological sciences. In psychology and social sciences, it is common for a theory to explain phenomena in an overarching and sophisticated way, but in such a manner that almost any observation can be explained by the theory. If such theories cannot be falsified, they can't be scientific.

Popper's falsifiability criterion for characterizing science serves as a demarcation criterion between science and non-scientific world views, especially religion and metaphysics. There is no way to show that a religious belief is false, unless it asserted something like: "The world will end in 1984". The fact that there is no way of falsifying a religious doctrine explains why religious traditions are so old; religions however do evolve, but the criteria of selection are not related to truth, but to how well the doctrine adapts to the economical and cultural aspects of a specific society at a specific time, or how efficiently it answers to the fears and concerns of the faithful.

## 5. Conclusion

It was argued here that error is essential for the evolution of biological species, for the improvement of one's knowledge and world view, and for the progress of science. In biology, one criterion for "error" is established by the predator that appears in an environment formerly dominated by a hegemonic species. In our personal lives, our knowledge can only improve if we are not embarrassed about constantly exposing our views to criticism. If we however are, then we should develop methods, especially later on in life, for continuously exposing our views to an abstract "predator", and for keeping our world view evolving, or the knowledge in a specific field progressing. Finally, in science, theories can only be tested if they make clear predictions that could turn out to be falsified. If such predictions are verified, or if they are shown to be in error, then science progresses.

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