Comments on the Logical Foundations of Darwinian Evolution

This document is a draft and does not even have a conclusion.

There is an argument that has been around for at least fifty years that says that the Darwinian theory of evolution is an empty shell. The argument goes roughly as follows:

> The theory of evolution (Darwin's theory of evolution) says that evolution occurs and that the guiding principle is *survival of the fittest*. However, which animals are the fittest? Aren't they merely the individuals that survive better than do their brethren? Darwin has merely recognized a tautology: a principle that implies its own truth and which is in fact trivial.

This argument is sometimes followed by the drop of a second shoe:

> Darwinian evolution cannot be falsified. Therefore (following Karl Popper) it is not a scientific theory.

It is obligatory (and irrelevant) to point out that Darwin did not use the phrase "survival of the fittest" in the first edition of *Origin of the Species*. Along similar lines, an interesting question is, has anyone who has read *The Origin of Species* made the above argument?

I intend to show that there is a tautological crux in Darwinian evolution, but there are aspects that are not tautologies, that a tautology can qualify as a scientific discovery, and paradoxically a tautology may be falsifiable.

Tautologies

A tautology is a statement that is necessarily true. In logic a statement is a tautology if it is true regardless of how truth and falsity are ascribed to the components of the statement. For example, the statement *(p and q) imply p* is true regardless of whether p is true or false and whether q is true or false (the parentheses are there to distinguish that statement from *p and (q implies p)*). The term tautology is not used terribly often or well outside of logic. It is implicit in many arguments of the type we are investigating here that a tautology is necessarily trivial. A standard example of a tautology is a statement such as *the red chair is red*. Many people seem to

believe that this is representative of all tautologies. However, tautologies may be as profound as any statements in logic.

The Evolution Statement

In order to aid a look at the logical foundations of Darwinian evolution the principal theses can be stated as follows:

1. Species change over time: species become extinct, new species arise, and extant species change.
2. If a species has genetic variation, and if the characteristics governed by this variation effect survival, the genetic makeup of the species will change. Furthermore, the genetic change while randomly driven, can be seen as adaptation to the environment.
3. All evolution can be accounted for under rule 2.

Statement 1 was not original with Darwin, but it was not widely accepted. When *The Origin of Species* was published the fossil record was minuscule compared with today, and most people were ignorant of it. Today, statement 1 can be considered an established scientific fact. Even many creationist accept it. But they object to statement 2 and far more to statement 3. Statement 3 bears the brunt of the creationist attack.

The Tautology

Statement 2, can be viewed as a tautology. It can be restated in many forms many of which are clearly tautological. Most briefly we can say: the distribution of genetic material in a species changes over time as a consequence of environmental factors. (This of course assumes that there is genetic variation.)

Again, it is easy to argue that statement 2 is a tautology and that it is unfalsifiable, and is therefore not a scientific statement. I would say it qualifies as a scientific statement for the following reasons:

1. However obvious statement 2 seems after one understands it, if it was stated prior to Darwin, it was not appreciated. There are enough subtleties that even today many academics misunderstand it. Hence it certainly is not a trivial statement. In fact it has clearly changed the way that many, perhaps most, scientists view the world. It has even led to such new views in this century, for example sociobiology.
2. Statement 2 has important consequences. It leads to its own classification of species.- Also, the idea occurs, that perhaps the evolutionary process may be practically applied elsewhere, for example "genetic algorithms" in computer science.
3. Statement 2 leads to statement 3 which is not a tautology and is a very enticing hypothesis: natural selection as the principle guiding the creation of all species.

Note that this list of reasons is not complete; other arguments can be made that statement 2 is scientific.

Falsification

The requirement that a scientific statement be falsifiable is tantamount to requiring that it can be tested. Obviously, any test that can only give one answer, because for instance that the statement is a tautology and is not falsifiable, is a meaningless test. Of course, I have argued here that statement 2 should be considered a scientific statement even if it is not considered falsifiable. It is statement 3 that clearly needs testing. It can be argued (again following arguments of Karl Popper) that statement 3 can not be proven true; that it can only be proven false. Creationists often argue that natural selection will not lead to any really new species, that is, they argue that statement 3 is not only wrong, that it is very wrong.

One problem with statement 2 is that too many people fail to understand it. Thus testing it, whether it is falsifiable or not, can serve the purpose of illustrating it. The fact is that both statements 2 and 3 can be tested by various experiments and fascinating new experiments have been popping up recently. By new experiments, I mean new types of experiments. Every time fossils are discovered that constitutes a new experiment and it has the potential of falsifying statement 3. This is why creationists are so intent on showing dinosaurs and humans coexisted.

Many of the arguments to the effect that natural selection is not testable boil down to the fact that we cannot do any experiment we want to. It is argued that we can't go back and visit the dinosaurs etc. However every field has this type of problem to some extent, otherwise no experimentalist would ever get the Nobel prize in physics. The experimental difficulties of astronomy are at least as bad as paleontology; it is interesting to note that telescopic observations in the former have an analogous role to fossil hunting in the latter.

What is desirable in evolution as far as testing goes is to show that it has predictive power. Given an ecology can we predict how it will evolve? There are indications that the answer is yes if the ecology is very simple, or if we are studying a specific facet of the ecology that has some independence from the rest. However, will it ever be possible to predict the evolution of a complex ecosystem? And if the answer is no, as I am quite sure it is, what does that say?

Let us consider a much simpler prediction problem than the problem of predicting the course of a complex ecosystem. Every year major league baseball has a "season." When the season starts it is already known where and when all the regular season games will played (with a few exceptions due to rain etc.). It is known what the personnel are far each of the teams. It is even known who the best prospects are in the minor leagues. The rules of the game are codified and known (and are finite). The playing fields are all known. In short predicting the course of the baseball season is a problem infinitely easier that projecting the course of evolution for a complex ecosystem. Yet who can, or for that matter who ever will at the beginning of the season predict with confidence what two teams will play in the world series and the number of games in the series and their scores? Note that the nature of the schedule with a finite number of games with a finite number of elements and clear finite rules, makes it infinitely easier to simulate by computer the baseball season. Nonetheless, the best simulation would not give reliable answers to the above questions.

Here we run into a little problem. There are people who believe that you could simulate the baseball season with great accuracy if you had enough data. What is meant by "enough data" is massive amounts of data: all possible environmental and psychological data to such a point that (having simulated the evolution of all viruses and the weather) we know which player will get what flu and when. This amount of detail of course is beyond absurd and the ability to do

such simulation with meaningful accuracy would contradict recent results in chaos theory. There are many other reasons (for example the tenets of quantum physics) to doubt whether given massive data an accurate simulation could be done. However, it is sufficient to observe that such an experiment would never be practical.

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