What Is Biological Evolution?

by Lenny Flank

The word "evolution" actually means two quite distinct and separate things (and it is a favorite creationist tactic to attempt to blur the distinction between the two). On the one hand, "evolution" means simply that organisms have changed over time, that some organisms have disappeared from the planet and have been replaced by other organisms that did not exist before. In this sense, "evolution" is not a scientific theory or hypothesis; it is an observable fact, in the same way that the life cycle of a frog is an observable fact. The fossil record is very clear in indicating that organisms once existed which no longer exist (dinosaurs, trilobites, pterodactyls, mastodons), and that organisms exist now which did not exist in earlier geological eras (humans, chimps, white-tailed deer, viperine snakes).

On the other hand, "evolution" is also the word used to indicate the scientific theory of how this process of organism replacing organism occurred. In this sense, "evolution" is not an observable fact; it is a scientific model (more later on the definition of a "model") which purports to explain the fact of evolution (changes in species through time).

Most of the time, when a scientist speaks of "evolution", he or she is talking about the currently accepted model of the process through which organisms have changed over time, not about the actual existence or nonexistence of such change itself. The creationists, on the other hand, like to interpret various scientific criticisms of some aspects of the evolutionary model as an attack on the existence of evolution itself. It is important to recognize that this argument is spurious, since the two spheres are quite separate and distinct.

The currently-accepted scientific model of evolution was first laid out in Darwin's book On The Origin of Species Through Natural Selection. The Darwinian theory of evolution can be summed up in a number of simple postulates:

(1) The members of any particular biological population will differ from each other in minor ways, and will have slightly differing characteristics of construction and behavior. This is the principle of "variation".

(2) These variations can be passed from one generation to the next, and the offspring of those possessing a particular type of variation will also tend to have that same variation. This is the principle of "heritability".

(3) Certain of these variations will give their possessor an advantage in life (or avoid some disadvantage), allowing that organism to obtain more food, escape predators more efficiently, etc. Thus, those organisms that possess such a useful variation will tend to survive longer and produce more offspring than other members of that population. These offspring, through the principle of heritability, will also tend to possess this advantageous variation, and this will have the affect of increasing, over a number of generations, the proportion of organisms in the population which possess this variation. This is the principle of "natural selection".

These principles are combined to form the core of the evolutionary model. The traditional Darwinian outlook holds that small incremental changes in structure and behavior, brought about by the natural selection of variations, produce, after a long period of time, organisms that differ so greatly from their ancestors that they are no longer the same organism, and must be classified as a separate species. This process of speciation, repeated over the 3.5 billion year span of time since life first appeared on earth, explains the gradual production of all of life's diversity.

In recent years, two new theories have been widely accepted which complement the traditional Darwinian theory of evolution. The first of these is "punctuated equilibria", a theory set forth by Stephen Gould and Niles Eldredge in the early 1970's. The original Darwinian theory holds that the incremental changes which produce a new species occur throughout the entire population of the "parent" species, and that the entire population gradually becomes replaced by the new species, a scenario known technically as "sympatric speciation" (sympatric means "same place"). In 1972, Gould and Eldredge proposed that the majority of speciations take place not in the entire population of the parent species, but within a small, geographically isolated portion of it. After this isolated transition to a new species has taken place, the new species moves outward from the area of its birth to replace the older species throughout its range. This scenario is known

as "allopatric speciation", from the words for "different place".

Gould and Eldredge pointed out that an allopatric mode of speciation, in which the evolutionary transition from one species into another takes place only in an isolated geographic area and over a relatively short period of time, would necessarily limit the number of such transitional fossils that would be found by paleontologists, since these transitional populations would be extremely limited in both space and time, and would not be found unless they were preserved as fossils (itself a rare occurence) and also unless a fossil hunter happened to stumble onto the specific area where such a transition had taken place (Gould and Eldredge did manage to describe one such area--a single small quarry in New York which illustrated the transition from one Phacops species of trilobite to another; the lower levels contained the parent species of trilobites, the upper levels contained the new species, and in between were a series of transitions leading from one to the other).

Another theory of evolution is called "genetic drift", "neutralism" or "nonadaptive evolution". In the Darwinian view, all of an organism's traits are the result of natural selection, which continuously weeds out unsuitable variations and selects suitable ones to be retained in the next generation. However, in at least some instances, the presence of a particular genetic trait may be solely the result of chance. In a small population in which a portion of the members possessed one trait and a portion possessed another, it is possible for an accidental set of circumstances such as a disease or natural disaster to wipe out all of those possessing one of these traits, leaving only one trait left. Thus, this trait would be retained not through natural selection, but solely because of fortuitous circumstances. This is often referred to as "survival of the luckiest".

There also seem to be a large number of traits which are equal in their "fitness"; none has any selection advantage over the others. In this manner, these traits are said to be "neutral"--they are neither selected for nor selected against, and the proportion of one trait to another in a population can change haphazardly through purely statistical methods.

Neither the punctuated equilibria theory nor the neutralist theory replaces the Darwinian theory of gradualist natural selection, nor does either consider the Darwinian theory to be "wrong". Rather, both processes are complementary to the Darwinian viewpoint, while at the same time completely separate from it. Thus, it cannot really be said that there is a single "theory of evolution"--there are in fact several. Although much scientific debate today centers around the relative frequency and importance of each of these modes of speciation, none of this debate concerns the actual existence or nonexistence of evolutionary change (although creationists are very fond of citing selected quotations from evolutionary theorists criticizing this or that aspect of evolutionary mechanism theory, in an attempt to cast doubt on the entire model).

It is also important to note here that evolution as a scientific model is completely silent on the ultimate origin of life on earth; although the evolution model asserts that all life is descended from some common source (which may have been a single original organism, or may have been a number of different organisms which appeared at more or less the same time), the model itself has nothing to say about the process through which this original organism or organisms appeared on earth--evolutionary mechanism theory is only concerned with the question of how life can be transformed into new forms of life. There is no evolutionary theory concerning the original development of life from non-living chemicals, since this topic falls outside of the framework of the evolutionary model. The question of origins belongs to an entirely separate biological discipline known as "abiogenesis", which is the province of bio-chemists rather than of evolutionary biologists. In the same vein, the evolution model has nothing whatsoever to do with astronomy or cosmology, and is completely silent about the original formation of the universe (big bang, steady state, closed or open universe, etc).

And, like any other scientific model (gravity, relativity, quantum physics, molecular chemistry), the evolution model presents no moral, ideological, economic or political agenda. Evolution theory does not posit any way that humans "should" act, or any assertions about how society "should" be organized, any more than does the theory of relativity or the theory of quantum electrodynamics. Likewise, evolutionary theory does not assert that history (either human or biological) is inevitably "progressive", moving inexorably from "good" to "better"; neither does history move from "less complex" to "more complex". The process of evolution is totally ad hoc and nondirectional.

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