

NEO-DARWINIAN EVOLUTION BY NATURAL SELECTION

A Summary by Jay E. Gould

Charles Darwin made a number of observations while sailing around the world on the HMS Beagle in the 1830's, which led to his *theory of evolution by natural selection* (published in 1859), and which can be summarized as follows:

1. The *reproductive potential* of animal species is staggering;
2. However, *populations* typically remain *relatively stable*;
3. Therefore, there is a *struggle for existence*, and most of the young animals die without reproducing;
4. *Variation* exists in the traits of the members of most species;
5. Some of the variation among individuals is *heritable*;
6. Because of their *inherited attributes*, some individuals are likely to cope better with predators, parasites, climatic pressures, and competition for food and/or mates.
7. As a result, these individuals will tend to *survive longer* and *leave more offspring*--with their *adaptive characteristics*--than will others of their species that have different and less successful inherited traits. This is called *differential reproduction*.

NATURAL SELECTION is the difference in the number of *surviving, reproducing offspring* produced by individuals that is caused by *variation* in their anatomy, physiology, behavior, and cognition, etcetera.

EVOLUTIONARY CHANGE within a reproducing group will occur as the *heritable characteristics* of those that survive and reproduce best--the most *successful* individuals--spread throughout the *population* over succeeding generations. In contrast, the traits associated with reproductive failure, in the less successful individuals, will be eliminated.

Hence, organisms will *evolve traits* that promote *individual reproductive success* (including survivability), as measured by the number of offspring that live to reproduce themselves.

The *intensity of natural selection*, and hence *evolution*, is greater under *changing environmental conditions* than under constant conditions.

Importantly, the *speciation* that occurs through *evolution* has the appearance, when diagramed, of a *tree or bush*, rather than that of a ladder--i.e., there is *adaptive radiation/divergence* rather than simply the replacement of one species by another.

Evolution by natural selection is recognized as *one of the most important ideas* of Western culture. This is because of its simplicity, its predictive value, and its vast scope of application to biological matters. It is a *logical inevitability*, and it serves as a *major organizing principle* for all of biology, and should be for psychology as well.

Modern Evolutionary Theory

Darwin's theory was developed before the discovery of the *role of genes in heredity*:

1. *Genes* are present in the *nuclear chromosomes* (and elsewhere, e.g., mitochondria) of all living things, and are made up of sequences of 4 varieties of *DNA (or RNA) nucleotides*, which when transcribed in triplets (known as codons) contain the coded information for *protein synthesis* from sequences of 20 different *amino acids*;
2. Many genes occur in two or more alternative forms known as *alleles*, which results in the production of slightly different forms of a given protein (which is either structural or functional, most being enzymes--catalysts of biochemical reactions);
3. Gene alleles are *heritable*, i.e., transmitted reproductively from parent to offspring;
4. If one allele produces effects, through its variant protein, that routinely causes its bearers to *reproduce* its alleles more often than *other individuals* with *different alleles*, then the "successful" allele will become more common in the *population*;
5. *Selective pressure* will favor alleles that are unusually good at promoting the *survival and propagation* of these same alleles.

It can be concluded that, biologically, *individuals* are first and foremost "machines" for promoting the *survival and propagation* of their *gene alleles*. A human and an ant are each primarily a gene's way of making more copies of itself!

We now know that *evolution* occurs by *natural selection* acting on *chance mutations* of genes (e.g., due to replication error and radiation) and *recombinations* that produce new alleles and combinations, respectively, only some of which are advantageous, i.e., *adaptive for survival and reproductive success*.

Natural selection thus *complements* mutation and recombination as primary factors of evolution--hence *evolution is more than just a random process of chance!*

Process of evolution by natural selection of gene alleles can be *summarized* as follows:

1. Modification of the *proportion/prevalence of different traits* in a *species population* over *successive generations*;
2. As a function of the *differential transmission* of copies of *alternative gene alleles* for *characteristics* to the next and succeeding generations;
3. Due to differences in the number of *surviving, reproducing offspring* produced by *individuals*, i.e., due to *differential reproductive success*;
4. As a result of *heritable genetic variation* (due to gene mutations and recombinations) for anatomy, physiology, behavior, and cognition;
5. Where such variation is fairly consistently associated with *differential adaptiveness* with respect to, e.g., coping with predators, parasites, and climatic conditions, as well as competing for food and/or mates.