

## DARWIN AND THE EVOLUTION OF EVOLUTIONARY THOUGHT

### I. INTRODUCTION

The topic I have selected to review is in a field far removed from any daily activity of mine. Until my research into this paper, it is a topic I have known little about, yet it is one I have been interested in studying for a long time. I took the opportunity this paper presented me to satisfy my curiosity.

Late 20th century America is a society not immune from the affliction of a number of ailments. I would like to briefly dwell on one of them as a roundabout introduction to my paper.

There are many things great about America today, but the problem I want to mention is our society's inability to educate its citizens. The results of the educational system speak for themselves: the USA ranks 18th of 25 industrialized nations in standardized math and science tests. Our country's educational system is strong at producing a handful of superstars, but the bottom 50% coming out of schools do not stand up well in international comparisons. Japan's bottom 50% is the best in the world, and has generated a great deal more per capita wealth than ours in the last 15 years.



Our society has an obsession with the present and little knowledge of the past. Much of today's views of the past are shaped by misleading TV docudramas and bloated mega-celebrations like last year's Statue of Liberty event. Knowledge of man's origins held a great interest for a broad spectrum of people 100 years ago, but what little interest the subject arouses today is wrapped in controversy. We see too many examples of state legislatures and school boards trying to define what scientific knowledge is. Given the state of our educational system, I think they should leave that to the scientists and get on with improving the overall system.

I believe the subject of man's origins is an important subject around which too little knowledge exists in the general public, including myself. Therefore, that is my topic and my paper is titled "Darwin and the Evolution of Evolutionary Thought."

## II. CHARLES DARWIN

We are accustomed to think of ourselves as living in a period of rapid change. In a cultural sense the last half of the 20th century no doubt will be seen as a period of rapid change. But the future intellectual historians will view, I believe, our era as a dull, uninteresting one, in comparison with the massive events of the 19th century. No person made a greater contribution to our understanding of the world in that period than Charles Darwin. My paper has two goals: 1) reviewing Darwin's life and contributions, and 2) presenting a sketch on how evolutionary thinking has evolved to this day.



The conventional view of man's place in the universe in the first half of the 19th century was that the biblical view of creation was accurate. This view held that 1) the earth was very young - a few thousand years old, and 2) species were created separately and were immutable. Darwin developed a comprehensive, fundamentally different viewpoint which shook the conventional wisdom. Darwin's viewpoint gained rapid acceptance and has grown to become the conventional wisdom in today's scientific community.

Darwin was not the prototype revolutionary. He was a reclusive, family man who except for his five-year voyage on the Beagle, only left England once. In fact, he lived 20 miles outside of London, but rarely visited the city. He was independently wealthy, and was able to pursue his own intellectual interests all his life.

Darwin was born in 1809. He at an early age showed great interest in studying nature. This interest was of great concern to his father, who was anxious for him to pursue a medical career. Darwin graduated from Cambridge in 1831 with a concentration in botany and geology. He was uncertain about what direction he wanted to go in when he received an invitation that would forever change his life. Darwin was invited to join the crew of the Beagle as a naturalist for a round-the-world voyage. He jumped at the offer, and at the young age of 22, he set sail from England in September, 1831.

The purpose of the voyage of the Beagle was to survey large sections of the coast of South America. This was a slow process and it enabled



As early as <sup>1838</sup>~~1883~~ Darwin was writing in his notebooks that "the death of a species is a consequence of nonadaptation of circumstances." This was the beginning of the development of Darwin's natural selection theory. Darwin was influenced by his reading of Malthus' views on population growth. One sentence from Malthus that struck him was "Population, when unchecked, goes on doubling itself every 25 years." Population tended to grow geometrically, while subsistence grew arithmetically. This pointed the way to Darwin's notion of the survival of the fittest or, more specifically, nonsurvival of the less fit. Natural selection is based on a number of points: 1) Environments change. One need only be aware of the ebb and flow of ice sheets across North America and Europe to be aware of this. Furthermore, the environment for a particular species includes other species; 2) Within any species, a variety of attributes exist, e.g., big or small legs, keen or poor eyesight, etc.; and 3) Those individual members of species and those species in total which are best suited to the evolving environment will survive and their unique characteristics will tend to predominate.

Throughout the 1840s and 1850s Darwin refined his thesis. He published his views first in his 1859 book Origin of Species only because another Englishman, Alfred Wallace, was about to publish his independently arrived at views on natural selection. The Origin of Species made four major claims: 1) The living world is dynamic, not static. Species today are different from those in the past; 2) Species evolved based on the accumulation of small, almost imperceptible changes; 3) All living organisms evolved from a single source; and 4) Natural selection based on variation and survival was the driving force of the change process.



mounting evidence caused a dramatic change in a short period of time in how 19th century man viewed his origins.

Darwin's next publication to generate widespread interest was the Descent of Man published in 1871. The Descent of Man brought man into the evolutionary sphere. The Origin of Species had little to say about man, although there were clear implications. Naturally further controversy ensued. However, Darwin continued to spend the majority of his time on what would appear to be minutiae. In 1862 he wrote On the Various Contrivances by Which British and Foreign Orchids are Fertilized by Insects. In 1876 he published The Effects of Cross and Self-Fertilization in the Vegetable Kingdom. However, these and many other of his books were all aimed at showing how natural selection worked throughout the plant and animal world.

Darwin died an agnostic, yet he was far from being anti-Christian. His wife was a devout Christian and he was very concerned how his theories would impact his Christian friends. Darwin died in 1882. As a sign of the widespread support within the British establishment for Darwin at the time of his death, Parliament moved that he be buried at Westminster Abbey, next to Newton.

Darwin's contributions have stood the test of time. Much of what occurs in the natural sciences today takes place within the overall framework established by Darwin. Prior to Darwin, various individuals had speculated about various ideas that Darwin ultimately used in his overall theory. But no one had come close to carrying out the extensive

practical and theoretical homework that Darwin had. For that Darwin has earned an eternal spot as a major contributor to man's understanding of himself. But what has happened since Darwin's death? That is the topic of the next section.

### III. THE EVOLUTION OF EVOLUTIONARY THOUGHT

The most significant developments in our understanding of evolutionary biology over the last 100 years has occurred in the area of genetics. Starting with the rediscovery in 1900 of Mendel's studies on inheritance, extending through Watson and Crick's unraveling the structure of DNA in the early 1950s, and up to today, expanded knowledge of genetics has given biologists a much better understanding of how variations occur within species. Analysis of the DNA structure has also helped determine how far back various species have split off from each other. The molecular record is now felt to be more important to determine species branching than the fossil record.

I'd like to now focus in on three key areas surrounding evolution today. They are: 1) The rate of change in evolution; 2) Man's ancestors over the last 4,000,000 years; and 3) The current state of the science/religion relationship.

#### A. Rate of Change Controversy

Darwin had emphasized that species changed in very slow, gradual ways as opposed to making sudden jumps from one condition to another. Within the overall parameters of Darwinian theory, a controversy has erupted in the last 15 years concerning the rate of



change of species evolution. Stephen Gould, a highly regarded professor of paleontology at Harvard, believes that the fossil record supports a view that species go through long periods of stability marked by short periods of rapid change. Gould is by far the most well known evolutionary theorist in the USA today. Gould has a monthly column in the Natural History magazine, and those articles have been regularly collected into books such as After Darwin, The Panda's Thumb, and The Flamingo's Smile.

Paleontologists have had two concerns. First of all the fossil record is very sketchy. Species suddenly appear and then disappear. New species show up which appear to be descendants of the first species, but there are no intermediate species to be found. While intermediate species, such as the horses in Nebraska, have been found, there have not been many of them. These missing links have been a source of concern. As an aside, it is very fortunate for our understanding of the past that any fossils have survived and been found. Nevertheless, one person has commented that more paleontologists exist than there are bones that have been found.

Gould's theory has been aptly called "punctuated equilibrium." Before further describing it, it will be useful to review the primary way that all evolutionary theorists believe new species evolve. New species evolve at the periphery of a species population. It is believed that periodically small subgroups of a species population become cut off from the main species group. This could be due to a number of reasons, such as the formation of a

river, desert, or mountain range. This geographical separation prevents interbreeding. Once separated, each population group begins to uniquely adapt to its own distinct environment. Over a long period of time the two groups could no longer interbreed if they were to come back together, and now two species exist where there had been one.

Gould's unique insight has been that a large species group has a high level of inertia to evolution. It is difficult for small, individual variations to impact a large species population. However, a small group at the periphery of a large group, and once cut off is able to change much more quickly. Thus, missing links would be created in the small peripheral groups where evolution was occurring relatively rapidly, e.g., in the tens of thousands of years instead of over millions of years. Thus relatively small numbers of "missing links" would ever have existed. This, coupled with the fact that the overall fossil record is limited, helps explain why so few "missing links" have ever been found.

The theory of punctuated equilibrium has been well received within the biological and paleontological community. However, how much of an advancement from Darwin's thinking it is, is still debatable. In the fourth and later editions of the Origin of Species Darwin stated "Many species once formed never undergo any further change . . .; and the periods, during which species have undergone modification, though long as measured by years, have probably been



short in comparison with the periods during which they retain the same form." Thus Darwin gave a very good definition of what Gould calls today "punctuated equilibrium." Nevertheless, Gould is emphasizing an important aspect of the evolutionary process that many others have overlooked. This is just one example of the very creative thinking going on in this area today.

#### B. Man's Ancestors

The longer that species have been separated in evolutionary terms, the more differences there are in their respective DNA. Changes in DNA occur from time to time by chance - the accident of mutation - it takes time for those changes to accumulate. For example, species that have been apart for 25,000,000 years such as the dog and the racoon have accumulated differences equivalent to about 12% of their DNA. Man, the chimpanzee, and the gorilla share 99% of their DNA. This molecular fact and the fossil record indicate that man, the chimp, and the gorilla went their separate ways about 4,000,000 years ago.

While a few things appear clear concerning what has transpired in the last 4,000,000 years, there are far more unanswered questions than there are answers. Our understanding of man's ancestors has changed steadily over the last 50 years, and there is every reason to believe that our current views will be subject to substantial modification over the next 50 years.



It is now generally believed that the first species in the unique chain leading to man was the Australopithecus. Fossils of this species were first discovered in Africa in 1925. Australopithecus had a flat skull, protruding jawbones, and a small brain case. The next species leading to man is called Homo Habilis and has also been found only in Africa. It is estimated that this species existed 1,500,000 - 3,000,000 years ago. Richard Leakey uncovered the best fossils of this species in the early 1970s. The next in line is Homo Erectus and many fossil samples of this species have been found in Asia and Africa. Java and Peking man are examples of this species and it is estimated that this species existed 500,000 - 1,500,000 years ago. Homo Erectus was a cave dweller, a fire user, a deer hunter, a seed gatherer, and a maker of specialized tools. It is estimated that early versions of our species, Homo Sapiens (this species had a larger brain case than its predecessors), appeared approximately 400,000 years ago. The predominant view today is that Homo Sapiens spread out from East Africa. An alternative view has ancestors of today's Australian aborigine as being the first Homo Sapiens. This view is based on an esoteric analysis of DNA differences between various groups of people today. In this view Homo Sapiens spread out from Australia.

Mankind today has four major subgroupings: Black, White, Australian, and Asian. The predominant view has the Black, White, and Asian subgroupings forming and diverging from each other approximately 100,000 years ago. At about the same time another interesting branching was taking place. This time a new group



branched off from Homo Sapiens and that was Homo Sapiens Neanderthalensis or Neanderthal man. It is viewed that this group evolved in a way as to be more suited to the advancing Ice Age. Neanderthal man was certainly intelligent - he had tools, painted pictures in caves, and even buried his dead with ritual. The Neanderthal's skeletons were much more robust than ours, and their muscle attachments to the bone indicate they were much stronger than we. Yet the Ice Age didn't last and neither did Neanderthal man. However, it is likely that they did not disappear, but instead merged into the mainstream Homo Sapiens population, as they probably had not branched off long enough to prevent interbreeding.

Anthropologists and archaeologists have carried out extensive digs in the past 40 years and have greatly increased our understanding of the growth and diversity of human culture over the last 30,000 years. The Scientific American regularly publishes review articles in this field. A May, 1984 article reviewed how humans had occupied a cave in western Pennsylvania from about 19,000 BC to 1000 AD. The March, 1987 issue described the sophisticated culture uncovered in a Danish settlement which had been occupied over 7000 years ago.

Over the last 100 years there has been a dramatic increase in our understanding of man's origins. Much more is known than most people realize. This knowledge has expanded within the overall framework established by Darwin. Nevertheless many questions remain concerning man's evolution and early culture and unfortunately many



of those questions may remain unanswered forever due to the limited nature of the material scholars are left to work with.

### C. Science and Religion

Darwin's theory and its quick acceptance in the scientific community came as a shock to religious leaders. But even in Darwin's time many religious leaders began to rethink their views of creation and how to interpret the Bible. Gradually many religious leaders accepted much of evolutionary theory, but still described key roles that God played in the process along the way. In the Roman Catholic Church Pope Pius XII issued an encyclical in 1950 that presented a cautious, but not negative, view of evolution. The encyclical included such statements as "In any discussion of evolution the Catholic must take for granted the spiritual soul of man . . . discussion of evolution is left for experts in science and theology, and reasons for and against must be gravely weighed." The Catholic Church had learned earlier lessons about the problems of digging its heels in against progress in scientific knowledge.

Yet certain religious fringe groups have carried out a determined battle against the teaching of evolution. Their determination has helped them gain influence far beyond what would be expected from their actual numbers. Their basic belief is that all species including man were made by direct acts of God during the creation week described in Genesis. Furthermore, whatever changes that have occurred since then were changes within an existing species.



The Tennessee law banning the teaching of evolution and the Scopes trial was a highlight of their efforts in the 1920s. Their efforts in the 1960s and 1970s received consistent setbacks in the courts which took a clear position banning the teaching of religious viewpoints in public schools. More recently the creationists have countered by developing a doctrine of scientific creationism which essentially tries to find fault with Darwinian theory. They've pushed for equal time in public schools, but have met with little success. However, their efforts have made a lot of school boards nervous, and even Ronald Reagan, in his efforts to court the religious right, has lent some support. In the 1980 campaign Reagan said "Well, evolution is a theory, a scientific theory only, and it has in recent years been challenged in the world of science, and it is not yet believed in the scientific community to be as infallible as it once was believed." Now Reagan's knowledge of evolution is likely no more extensive than his knowledge of the actions of many of his subordinates in recent years, and his statement is simply false. There is absolutely no trend towards lost confidence in evolutionary theory in the scientific community. As in any healthy science, heated differences of opinion exist, but they occur within an overall evolutionary framework.

The gap between science and creationists, not science and religion, will continue to be wide. The success of the creationists will be a function of how effectively scientists communicate their viewpoint and how interested the general public is in the pursuit of knowledge.



#### IV. CLOSING

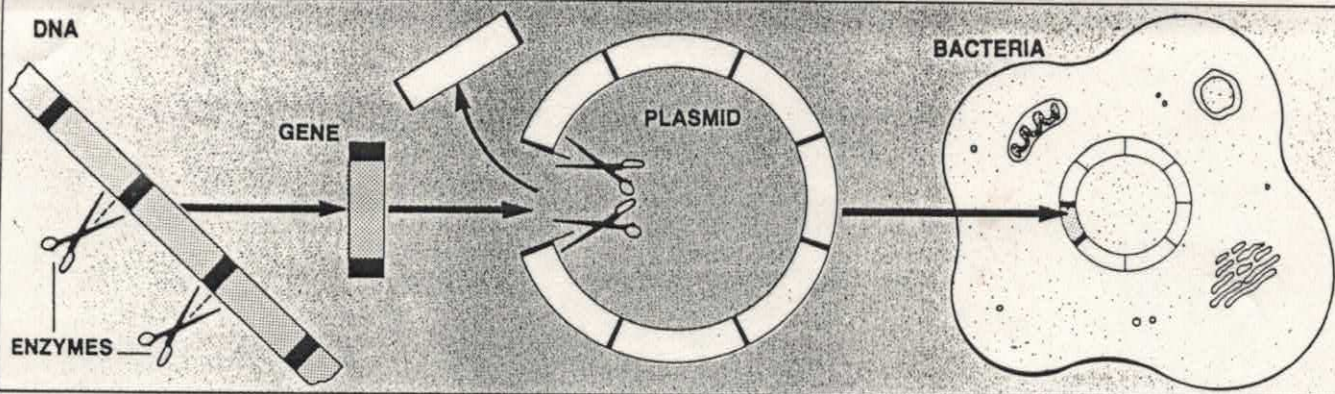
I believe knowledge of evolution is important for all educated people. I became hooked on the subject and found fascinating the history and current activity in the area. Unfortunately, too much of the general populace continues to find the notion of evolution distasteful. An extreme version of this distaste was voiced recently by a Georgia Court of Appeals Judge who stated, "This monkey mythology of Darwin is the cause of permissiveness, promiscuity, pills, prophylactics, perversions, pregnancies, pornography, pollution, poisoning, and proliferation of crimes of all types." These strong and emotional viewpoints do influence people. A recent survey of readers of a magazine aimed at teenagers found over half believing Darwin's theory to be false.

I believe it is unfortunate so many people remain out of touch with important, mainstream thought in the scientific community. Such a condition is part of the overall problem with our educational system that I mentioned at the beginning of this paper. I hope that this paper sparks your interest in the subject as it has mine.

Thank you.

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JDG40/FC1





**Genetic engineering** consists basically of three steps. First, gene splicers use special enzymes to scissor a gene from a string of DNA (left). Then, that gene is implanted into a plasmid (center),

which is a ring of bacterial DNA. Finally, the plasmid is reinserted (right) into a bacterium. The organism duplicates all the proteins called for by the plasmid's DNA, including that of the new gene.

cal products, some of which currently sell for millions of dollars a pint.

So far, no gene-splicing firm is producing industrial quantities of any product. But no expert doubts that their ability to coax valuable substances from bacteria in the laboratory can be translated into large-scale factory production. For example, take the bacterial production of insulin.

Right now, insulin—a hormone needed for the ten million diabetics in this country alone—comes from pancreatic glands of slaughtered an-

a chemical molecule known as *deoxyribonucleic acid*, or DNA. Each of our cells holds a strand of DNA which, if unbound, would stretch 2 yards or more. This DNA strand contains segments called genes. Each gene—and there are about a million or so genes along one strand of human DNA—holds the blueprint for one kind of protein. Collectively, it is this string of genes, and the proteins they produce, that decide you are a human being instead of a corn stalk.

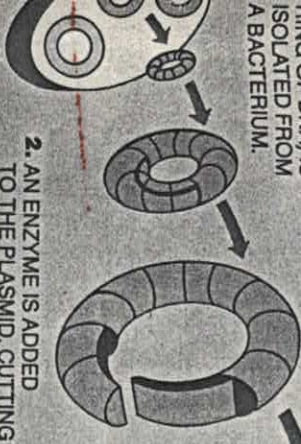
Genetic engineering involves taking a gene from one organism and

ment is complicated, the process delicate, the cost enormous. Bacteria do it all for free. What's more, they can do things in one cell that would take millions of dollars in equipment to match, even if we knew how."

A rare biological substance called interferon offers a good example of how bacterial factories now accomplish with ease what biologists have attempted to do for decades. Interferon is a natural antiviral substance, the only one known. It is so chemically complicated that biologists are unable to untangle its mo-

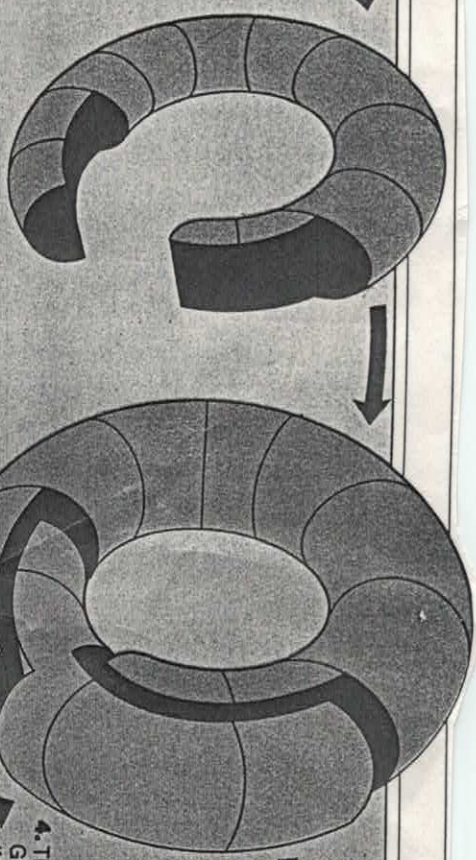


A PLASMID (A RING OF DNA) IS ISOLATED FROM A BACTERIUM.



2. AN ENZYME IS ADDED TO THE PLASMID, CUTTING THE DNA AT SPECIFIC SITES AND ALLOWING IT TO OPEN.

### HOW RECOMBINANT DNA WORKS



3. A GENE FOR PROTEIN, SUCH AS INSULIN, IS TAKEN FROM ANOTHER CELL AND CUT WITH THE SAME ENZYME USED ON THE PLASMID.

4. THE SECOND GENE IS INSERTED INTO THE OPENED PLASMID, WHERE IT FITS EXACTLY AND FORMS RECOMBINANT DNA.

5. THE RECOMBINANT PLASMID IS BACK INTO BACTERIUM. THE BACTERIUM DIVIDES AND COPIES IT, CREATING MORE RECOMBINANT PLASMIDS.

