

MR. DARWIN AND HIS ORIGINS

An article in the Fresno Bee on August 31 of this year regards a surgery conducted by the Pew Forum on Religion and Public Life and the Pew Research Center for the People and the Press. It states that nearly two thirds of Americans say that creationism should be taught alongside evolution in public schools. Forty-two percent hold strict creationist views agreeing that “Living things have existed in their present form since the beginning of time.” Forty-eight percent said humans have evolved over time but of these 18% said that evolution was guided by a Supreme Being and 26% said that evolution occurred through natural selection. Overall, 64% said that they were opened to the teachings of creationism in addition to evolution while 38% favored displacing evolution with creationism.

A recent gallop poll, cited in the New Yorker editorial of August 22, 2005, stated that evolution is subscribed to by only one-third of the population.

Charles Darwin in 1859, almost a century and a half ago, published a book on what we now call evolution. The controversy has been continuing since that time.

This paper is about that eponymous author and that pivotal book. I will focus on the setting of Victorian science in those years, what we knew and didn't know about geology and biology, the accepted conceptions or paradigms of the period, the underlying principles of science at the time, and the historical events leading up to the publication.

I will then discuss the book itself, the details of publication, the facts and arguments presented, and the essential conclusions it contained. I will discuss the public and scientific community's reaction to the appearance of that book and the later events of Darwin's life, his own evolution of views, and the publication of his other seminal book Descent of Man as well as his later life and his death and burial at Westminster Abby near the grave of Sir Isaac Newton.

I will then briefly touch on the subsequent significant developments in evolutionary biology, including the rediscovery of genetics in 1900, the discovery of DNA as the genetic code in 1956, and very briefly the discovery and authentication of man's remote relatives as well as what is called Neodarwinism and the Darwinian synthesis now held as a standard template for modern scientific thought. I will not have time to discuss the evolution of subsequent reactions to Darwinian natural selection

including the 1925 Scopes monkey trial in Dayton, Tennessee, depicted in the movie “Inherit the Wind” where Clarence Daryl and William Jennings Bryan clashed. Later, the development of “Creation Science”, the Supreme Court decision against creationism in 1987, and the contemporary “Intelligent Design” synthesis currently proposed as a rival to Mr. Darwin’s theory. I trust that there will be time for some of that in the discussion period if I have sufficiently peaked your interest.

The Victorian Period

The Victorian period is commonly considered to be coincident with the reign of Queen Victoria of Great Britain (ADD THE YEARS OF HER REIGN). Many consider it extending to the eve of War World I. Certainly, Barbara Tuckman, the popular historian and author of the book, Guns of August, ends the Victorian era with the death of King Edward VII, Victoria’s son in May 1910, when nine kings, five heir apparents and a multitude of ministers of Europe, North America, and Asia marched in a funeral procession in London.

Victorian science had benefited from the “Giants” who had gone before. Roger Bacon and the British Empirists established the methods of observation and experimentation and indeed the validity of inductive reasoning to arrive at scientific truth.

Sir Isaac Newton who co-invented calculus and established the basic principles of gravity and the physics of planetary motion, was a national hero widely read and sometimes even understood by the British population.

There were basic principles in Victorian science. These were that science was thought to be universal, that is, the principles discovered applied everywhere on the planet and perhaps everywhere in the universe. The principles were thought to be simplistic, that is, that nature in its immense complexity could be reduced to more or less basic principles and that these principles could often be stated as “laws.” An example was Schwann’s Law, the German biologist who stated, after extensive microscopic study, that all life was based on “cells.” There certainly had been laws of physics elucidated by Newton, followed up by laws of chemistry, geology, and eventually laws of biology or natural science.

Let's say a word about in whose hands scientific progress was made and scientific power resided. Victorian science in England was a small group of men, of independent means and independent opinions who constructed what was then the world of science. There was no proper world for the scientists. Biologists, zoologists and geographers, pursued their bent as amateurs and out of pure curiosity. The world for a young Englishman was wide open. The great exploratory adventure was in the agenda of all young Englishmen.

Scientists discussed and debated their ideas, discussions, and theories in societies like the Royal Academy of Science, the Geographic Society, the Linnean Society (named after the great classifier of living organisms), and the British Association of Science. Also, in facilities like the Royal Botanical Gardens at Kew and the Hunter Museum or the British Museum.

Books, papers, and lectures (always recorded) were the main ways of transmitting information but correspondence played an extremely important role also. The British worldwide postal system was efficient, swift, reliable, and reasonable, consequently, extensively used.

It is true universities were repositories of learning but this was seldom scientific learning. Much of the curriculum at a university was language, history, literature, law, and theology. For example, two thirds of all Oxford dons in 1850 had taken holy orders.

Scientific knowledge was progressing with startling findings and in the context of this paper I will discuss four of these developing principles. They include:

1. The great age of the earth.
2. The evolving concept of species.
3. Similarities of animal and human structure.
4. The Malthusian struggle for survival.

Throughout Western history, the age of the earth was clearly depicted in the Bible. Creation took six days and there were about 2,000 years of Old Testament. The length of time since the birth of Christ was debated and changed several times but was almost always equal with the current year. The age of the earth was calculated to be about 4,000 years, but geologic knowledge was increasing from information gathered in huge public work's projects that included excavation, the building of bridges, and canals.

Information about strata or layers and distinct fossils in different layers was being gathered.

Sir Charles Lyell, author of The Principles of Geology, was a Scotchman and an aristocrat. Later he became an associate of Darwin. By looking at the different layers and the fossils they contained, he began to believe that the earth was many more thousands if not millions of years older than the Biblical account. The worldwide discovery of similar layers with similar fossil content defined this.

I have a brief slide here about the geologic time scale expanding from the Cambrian period about 600 million years ago when at least at that time we knew life was first present. Later we understood that the pre-Cambrian showed the first signs of life, at least algae and primitive bacteria. Then came the Paleozoic, Mesozoic and Cenozoic eras. You will note the Cretaceous period is the age of dinosaurs. The end of the Cretaceous, so called the upper Cretaceous, was beginning of primitive mammals approximately 60 millions years ago.

We now know that the earth is about 4½ billion years old and that life (the blue-green algae mats and the first bacteria) existed 2 to 3 billion years ago. In Darwin's time,

not a single pre-Cambrian fossil had been found and the Cambrian explosion of complex invertebrates in the sea provided the earliest evidence for any life on earth.

A few words about biological classification, that is, the Linnean System
(EXPLAIN THE SLIDE HERE REGARDING LINNEAN SYSTEM AS WELL AS
CLASSIFICATION OF MAN).

The second developing principle in the Victorian era was the concept of species and its change.

From the time of Aristotle, species were considered immutable. The account of creation in Genesis certainly accords species as individual creations by God. Since species were immutable and the Creator in a special creation provided each of the species on the earth, Saint Thomas Aquinas in the high middle days asserts there could not be changes of species nor species mutating from one to another. There certainly could be variation within a species, that is, my dog and your dog may look different but they are both dogs.

Actually, this is one of the key points to be later discussed that “species” were not immutable and, in fact, may change overtime with some going extinct and new species arising.

Another principle of Victorian science was the similarities between humans and animals.

Traditionally, man was not related to the animal kingdom. Man is considered separate and “above” the animals as in the Biblical statement. Anatomic data was showing that there were basic “plans” universal to all life (for example, the Schwann’s law) and that very similar plans existed within classes such as mammals but mankind was still considered “the citadel,” that is, similar to but not related to animals and must not be compared with animals. He was the product of special creation with a spirit and intellect and an entity called a soul not possessed by animals. Even the science developing at that time of comparative anatomy which looked at (for example) the brains of humans and hominids such as chimpanzees and apes, and came to the conclusion that the brain of man which by that point was understood to be at least the locus of intelligence if not the soul was essentially different from animals. This was the position of Richard Owens, the

director of the Hunter Museum, and later the British Museum who became a life long opponent of Darwin.

A fourth evolving train of thought at the time of Darwin's publications was the work of Thomas Malthus who had published in early 1800's a number of books on population and society. He noted that people produced many more offspring than actually survived. And, in fact, if they did survive, we would have overpopulation. He defined wars, famine, and disease as the great limiters of population. But those that survived such events, were superior to those that did not survive and were eliminated, that is, the survivors had qualities that allowed survival. You can see the seeds of racism in this kind of thinking and indeed it flourished as exactly that in the British Empire. Western mankind was superior, so they flourished. People began to apply this kind of thinking to animals and later to the plant population as a struggle for survival and a "survival of the fittest."

Next, I want to talk about the historical events leading to the publication of The Origin of Species.

Charles Darwin was born in 1809, his father was a physician. His uncle was Josiah Wedgewood, a manufacturer of china. He was a member of the landed and wealthy gentry. As a young man, he studied medicine at Glasgow Scotland, which was then the pinnacle of Victorian science, though few other universities were at the time. He was there for two years but dropped out because of disinterest. He had been interested in the study of beetles as a youngster and had an extensive collection, hence, an interest in natural science but certainly not medical science. He then studied and took a degree at Cambridge in theology and planned to become a country parson.

In December of 1831 at the suggestion of his uncle and his father, he signed on to the HMS Beagle, a survey ship which was making a five-year voyage to South America. His status on the Beagle was uncertain. He was basically to be a gentleman companion to the captain and to the ship's physician. He was not actually a naturalist at that point but had some interest in natural science. This trip was basically to "see the world." Such a basic formative trip was often in the plans of proper British gentlemen. During the voyage, he collected numerous biological specimens, continuing his boyhood interest as a collector of beetles. He also viewed volcanoes and saw sedimentary layers of fossils

which were available to him in his travels. Formatively, he also read Sir Charles Lyell's "Principles of Geology," which was mentioned earlier, and wrote a journal which was published after his return.

He returned to England in 1836 and became a fellow of the Royal Society of Geology and Zoology. He met Sir Charles Lyell, the author he had studied, and became a lifelong friend. He married Emma Wedgwood, his cousin, moved to London, and then to Kent in the Village of Downe where with his father's help built an estate which he called Downe House where he remained basically for the rest of his life, seldom leaving because of ill health.

He published a number of books and journal articles from his time on the Beagle. These included "Geological Observations in Volcanic Islands" in 1842, and then the results of additional studies as well as his early studies on barnacles which were mostly morphologic classifications.

During this time, he pondered and brooded about evolution. His pondering took a long time. He suspected the social implications of his theories and thought it would be unsettling and as he called it in his correspondence an "astounding heresy."

During this time, he became friends with Joseph Hooker who was a botanist at the Royal Botanical Gardens at Kew. He discussed with him his thoughts that species were not immutable and that extinction implied evolution, that is, if all living creatures (species) eventually go extinct as the fossil records suggest, there must be evolution. He discussed this with Charles Lyell also who in his second addition of the Principles of Geology spoke of such changes in species in the fossil record.

During this time, he also studied domestic breeders of pigeons and dogs, and corresponded widely as well as keeping his own pigeons and dogs and learned extensively how breeders of domestic species could “artificially select” for specific characteristics and see these characteristics appear in the progeny. He wrote a book on this artificial selection in 1844 and in 1854 another monogram on barnacles.

Thomas Henry Huxley, probably his most famous associate, was a physician and a scientist. He had taken his great journey on the HMS Rattlesnake (1847 to 1852) which explored and charted Australia and New Guinea. He was also an avid reader of Lyell. Based on a paper he published, he became a fellow of the Royal Society and associated with the great scientists of the age. He officially and vociferously broke with Richard

Owens in 1856 over skulls and bones in the comparison of man and apes. He became an associate and personal friend of Darwin anticipating the great debate that origins would create. He held various positions and professorships and published and lectured widely.

Darwin met Alfred Russell Wallace after review of one of his publications in the Annals and Magazine of Natural History in 1855, which was regarding the mutability of species. Wallace believed that geography (place) was an important determiner of species and structure as Darwin himself was believing, and thus they became fast correspondents.

Wallace wrote a paper in February of 1858 from Indonesia clearly outlining his theory.

He sent this via the British Post to Darwin and asked him to show it to Sir Charles Lyell who, as noted previously, had in his second edition spoken of the variability of the fossil records in the various geologic layers.

Darwin recognized that his theory regarding mutability of species and change in structure with succeeding generations dependent on selection was in jeopardy of being “anticipated.” Since he had not put his thoughts formally onto paper in the proper literature, he was concerned. He met with Hooker and Lyell and decided on the plan to document “descent with variation” with his co-discoverer. He wrote to Wallace saying

that he liked the paper greatly and he had indeed showed it to Sir Charles Lyell. After discussion with Lyell, he decided to co-present Wallace's paper in absentia with his own as co-discoverers of descent with variation as evolution was called at that time.

He quickly then wrote a paper outlining his theories and Lyell and Hooker presented these two papers, that is, his and Wallace's, at the Linnean Society in London on July 1, 1858. Darwin himself did not present the paper nor was he present, citing illness. Thereafter, Darwin set to work in an earnest frenzy to bring his "Origin of Species" his great work into publication over the next year and one half.

Next, let's talk about the facts of publication. This book was actually published November 24, 1859. The publisher was Murray's who had published a number of Darwin's previous books and had contracted with him for this particular book. The full title was on "The Origin of the Species by Means of Natural Selection as the Preservation of Favored Races in the Struggle for Life." 502 pages long, only 1,250 copies were printed, 12 were given free to the author. It cost 14 shillings. By contrast, on the same day, the first edition of A Tale of Two Cities by Charles Dickens cost 5 shillings. The number of a print run of A Tale of Two Cities is not something I know but suffice it to

say it is probably quite a bit more than 1,250. Darwin wrote this book in a conversational, readable, logical, and highly illustrative style. He has used lots of analogies. One thing that was a feature of scientific articles and books at that time was that they were generally readable to the average educated person. This is in contrast to the general unreadability of scientific articles except to those directly in the field.

The print run of 1,250 was sold out on the first day. This is not unusual in that pre-orders were taken. In fact, a circulating library ordered 200 copies anticipating that it would be popular. It underwent eight editions in Darwin's lifetime allowing him to revise and reflect on his theory. The editions were revised nearly every two or three years at first and then every five or so years thereafter. New ideas and concepts, refutations, new arguments and in some cases deletions of arguments occurred without any real significant change in the theory proposed.

The edition available now and commonly read is that eighth or last edition that actually was written by Darwin himself.

The book is divided into 25 chapters and starts out with an extensive description of domesticated animals, primarily pigeons. He actually made a fairly sophisticated

study of pigeons and was a pigeon fancier. He names a number of varieties of pigeons and characteristics of each of these “breeds.” He corresponded with a number of pigeon breeders and discovered that there were general “rules” of varying or changing by selective breeding. He concluded that there were many variations of a single species.

These variations were extremely broad.

Next, he goes into variations found in a species in nature. He came up with some general rules of variation, the foremost of which was that species under domestication varied more extensively in body structure, function, lifetime, and reproduction than did species in nature. Part of this might have been, however, that although we can tell differences easily in our domesticated dogs, one usually doesn’t have the opportunity to spot perhaps even significant variations in wild species.

The next part of the book dealt with the struggle for existence and noted that most species produced many more young than actually survived and that survival was a struggle competing with predators, climate, and availability of prey or nutrition. He took the analogy of variation under domestication and applied it to nature in general and

believed that the struggle for survival brought about natural selection or as he later called it simply “survival of the fittest.” I will talk more about this concept.

In the next chapter, he enumerates the laws of variation and in a remarkably reflective chapter talked about the difficulties one might have with his theory of natural selection in attempts to address each of those difficulties. He has a chapter on instinct and hybridism.

There is a chapter on the geologic record. He notes that much of the understanding of the immense age of the earth and the appearance and disappearance of various species is based on the fossil record and explains this in detail. He has several chapters on geographic distribution and comes to the conclusion from his studies in the Galapagos Islands of the now called “Darwin Finch” that adaptation seemed to evolve as a result of the availability of food. He illustrates the beak of the Darwin Finch having approximately 12 variations depending on whether the diet of the bird consisted primarily of worms, flying insects, nectar, burrowing insects, bark insects, etc.

He has a chapter on comparative anatomy, that is, analogous structures existing in a number of different species which can be explained as the presence of common

ancestors. He also delves into a poorly understood subject at the time, embryology, or the development of living creatures from single cells to eventually the adult stage.

As a good teacher, he includes the final chapter of recapitulation and conclusion, a glossary and an index. He concludes with this famous passage, “Thus, from the war of nature from famine and death, the most exalted object which we are capable of conceiving namely the production of higher animals directly follows. There is grandeur in this view of life with its several powers having been originally breathed by the Creator into a few forms or into one and that while this planet has gone cycling on according to the fixed laws of gravity from so simple a beginning endless forms most beautiful and most wonderful have been and are being evolved.”

This last phrase is in the eight edition and not found in the first few editions and represents several concepts which Darwin added later on, that of a Creator and the actual use of the word evolution.

He called evolution in his original book *Descent with Variation*. The word evolution at that point meant basically embryology, that is, a development of an adult organism or at least a born organism from single cells. The word evolution comes from

the Latin *evolvere* which basically means to unroll. As time went on, it became a popular word and thus was included in his concluding statement in the book. Another interesting thing is the mention of the word “Creator,” in other words, understood as God. This is the only mention of God and, in fact, none of the editions of *Origin of the Species* directly confront religion and a religion interpretation of the existence or changes in life. It’s also noticeable that the whole book *Origin of the Species* in its multiple editions during Darwin’s life doesn’t mention mankind’s origin nor is there any discussion of the ultimate or first origin of life. It’s also important to realize that he had no understanding of the genetic mechanism at that time. Although Mendel was writing papers on the evolving science of genetics, these papers were basically undistributed and thus undiscovered until approximately 1900.

The basic principles in *Origin of the Species* include the analogy, as stated before, between artificial selection and natural selection. Also, that existence is a struggle not a kind, gentle world. He talked about how variability within species works but not its cause. He also explained how natural selection works. He basically stated and maintained throughout his life, as do biologists at this point, that natural selection is the

only, that is, the necessary and sufficient mechanism for evolution to occur. Natural selection has “evolved” to include not only mutation, selection for positive variation, but also sexual selection (that is, the development of a long colorful broad tail in a peacock which really doesn’t help him fly very well but apparently is popular with the women).

In a nutshell, natural selection means that all evolution can be traced to the presence of variation (for several reasons) which are then selected positively by the environment in an individual animal’s life leading up to and through reproduction and the rearing of young to independence. Slight variations that give an individual animal a competitive advantage in any of these spheres will overtime be selected for and appear to be a general characteristic of a species. The concept of natural selection also implies that this is not an intelligent process, that is, that all evolution did not lead to a particular species or a particular body form, it’s rather an individual process.

Then, finally, a basic principle of his work is that species are a mutable category, that is, they are not fixed by God as many believed at the time or at least fixed by nature and that, as seen in the fossil record, species have come and gone throughout time and that the present species and individuals came from ancestral individuals and species.

The immediate response to Origin of the Species was tremendous. His original paper read at the Linnean Society presented with Wallace drew little or no response from the scientific community but this one was a blockbuster. The reaction focused immediately on mankind which he had not mentioned at all in Origin of Species, that is, the relationship of man to the primate. And particularly the origin of man's intellect.

A debate occurred approximately six months later, that is, June 30, 1880, between Thomas Huxley, a physician and biologist, versus Bishop Wilberforce who was a Divine, that is, a theologian and writer and Bishop of Oxford. This occurred at the meeting of the British Association of Science and basically ended with Huxley winning, although there were various interpretations. Wilberforce used theology to explain that man could not have evolved and relied on innuendo by asking Huxley exactly which side, that is, was it his grandmother or his grandfather side that he was related to an ape. Huxley's reply, though he was known by his coloric and excitable character, stated that he was only there in the interest of science, that he had heard nothing to prejudice Mr. Darwin's case and that this theory was much more than a hypothesis, it was the best explanation of species yet advanced. He touched on the Bishop's obvious ignorance of the science

involved and explained clearly and briefly Darwin's leading ideas and then in tones even more grave and quiet said that he would not be ashamed to have a monkey for his ancestor but he would be ashamed to be connected with a man who used great gifts to obscure the truth.

Within approximately 15 to 20 years, evolution, at least natural selection, was accepted by all leading scientists, though during that 20 years there were a number of significant battles.

Darwin stayed at Downe House, his home estate, basically for the rest of his life. There were no great exploratory journeys. He did not give many public lectures and seldom traveled except short distances for vacations or for spa cures. He published many books over the remainder of his life on orchids, earth worms, beetles, and additional articles on barnacles. Since the public debate focused so hotly on the origin of man, he felt it would be necessary to clarify his theories regarding that issue and published in 1871 a book called *The Descent of Man*. It was actually two thick volumes and asserted that humans were incontrovertibly members of the animal kingdom. He also raised the issue of sexual selection. This is a process by which survival is defined in broader terms

than simply escaping predators, finding food, and adapting to the environment successfully. It also involved finding a mate, mating, and raising the young to independence. He gave many illustrations in *Descent of Man* about the differences between male and female animals and in humans and notes that these represent evolution via sexual selection in many cases. He used extensively the literature that was becoming available and discussed in detail the nature of faculties that were understood to make humans fully human like language, reasoning ability, morality, self-consciousness, memory, and imagination and explained at least theoretically how these could evolve from higher animals.

In some other books he discussed genealogy and the very acceptable practice of marrying cousins, after all he himself had married a cousin. He also wrote a book on human emotions as they appear in facial expressions and made use of the then growing technique of photography to capture people in various moods and facial expressions making universal comparisons. This was in November 1872.

He eventually became the elder statesman of science internationally and Darwinism was propelled out of the arcane realm of learned societies and literary magazines into the ordinary world of humor, newspapers and popular demotic literature.

Since at least the original ideas for evolution and natural selection came from Malthus talking about human populations and political structures, it was obvious and natural that analogies would be made between Darwinism and political movements. Thus, social Darwinism arose. He actually never ascribed to applying the principles of natural selection or evolution to political society. He came to the attention of Karl Marks who actually sent him a signed copy of Das Capital in 1873. Darwin wrote him a polite thank you note but there is no evidence that there is any further correspondence or meetings between Karl Marks and Charles Darwin.

He did, however, continue to correspond extensively both in preparation of his research studies and with the growing devotees and components of what was beginning to be called in his later life Darwinism. He had many visits to Downe House with cultural leaders. His close associate was Thomas Huxley, the leading biologist of the era,

and Tindell, the leading physicist, as well as Joseph Hooker, the president of the Royal Society, a botanist.

The fad of spiritualism was very popular in the 1870s but apparently never attracted Darwin's interest.

In 1875, Charles Lyell, one of the original inspirers of Darwin's biologic thinking and a noted geologist, expired. Hooker who then was president of the Royal Society arranged for him to be buried at Westminster Abbey in the Nave where Sir Isaac Newton was also buried.

Later that year, Darwin wrote an autobiography that he intended just to be for the family. It was published posthumously. It helped to explain how Charles Darwin who early on was a man of faith (the Anglican Church), someone who took a degree in theology and eventually wanted to be a country parson, came to terms with his loss of faith blaming his increasing doubt on the absence of any rational proof for God's existence. He never denied the existence of a God standing behind the scene, just that such as a Creator was unprovable, thus he died an agnostic.

In 1877, he published a study on different forms of flowers and plants of the same species and coined the term polymorphism, that is, several forms of basically the same creature based on environments. In the autumn of his life, he returned to his favorite study of earthworms and produced several more books.

He received an honorary degree from Cambridge, that is, a doctorate of law. Cambridge was where he had studied. There was talk of an honorary degree from Oxford but this never came to fruition. In 1880, he published a book on the mechanism of movement of plants.

There were rumors that he was offered a knighthood and declined it. Apparently what actually happened is Gladstone, the Prime Minister, offered him a trusteeship of the British Museum which he declined because of ill health. As far as we know, he never was offered knighthood.

The final book he wrote in 1881 was called Formation of Vegetable Mold Through the Action of Earthworms. This actually was a very popular book which is a little hard to understand at this point but sold quite well.

On April 19, 1882, he died at Downe House. He had been in ostensibly poor health all of his life with digestive problems. Some of these may have been simply a reclusive nature claiming health problems as a way of avoiding public events and lectures. He intended to be buried at the Downe Church yard but Joseph Hooker intervened and had him buried at Westminster Abby. Twenty members of Parliament signed the petition, Gladstone, the prime minister, gave consent as did Dr. Bradley, the dean of Westminster Abby. The funeral was a week later, April 26. It was a huge affair, dignitaries attended. Gladstone and the Archbishop of Canterbury both declined to appear. His grave is in the nave near Herschel and Sir Isaac Newton.

After his death, in the 1890s, there began to be a decline in interest in natural selection as the main or only mechanism of evolution. The rediscovery in 1900 of Mendelian Genetics helped deal with this issue. Neodarwinism, Social Darwinism and the Darwinian Synthesis are various movements which have occurred throughout the 20th century. Various popularizers of Darwinian thinking such as Steven J. Gould, a paleontology professor at Harvard, who has published extensively both scientific and popular articles on Darwin on paleontology and discovered significant additions to the

basic theory of natural selection. Additionally, Richard Dawkins, a British biologist, has sharpened Darwinian theory with a number of books such as The Selfish Gene, The Blind Watchmaker, and Climbing Mount Improbable where he applies population genetics and mathematics to natural selection. Richard Dennet is a Yale philosophy of science professor who has written among other books Darwin's Dangerous Ideas, giving a philosophical sense to Darwinism.

The theory of evolution by natural selection once Origin of Species was published, has drawn immense criticism and controversy with the basic issue of being who speaks better for the origins of men, science or religion. One hundred and fifty years later Darwinism remains embroiled in a more sophisticated but basically similar broil of controversy.