Comparative Analysis of Charles Darwin and James Watson

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"*Credo quia incredibile*," as stated by Charles Darwin in his autobiography, I believe it because it is incredible. It is the incredibly large and complex question of 'what is life' that has mesmerized and even terrorized the minds of mankind for centuries. It is the question that led the great minds of two very different people, Charles Darwin and James Watson, to incredible conclusions that have left similar lasting impacts on science and spirituality. Their discoveries of natural selection and the structure of the double helix alluded to the simplicity and elegance of life despite its seeming complexity. Darwin was able to view the world and the interactions of its inhabitants and see the subtle differences between populations of a species. He saw like no one else before him how nature and competition acted upon the fitness and variability of individuals, leading to descent with modification by evolution, and in many cases for the unfit, to the extinction of a species. A century later, James Watson, with his partner Francis Crick, revealed the molecule at the epicenter of the force unearthed by Darwin. Together, Watson and Crick gave shape to the genetic code that determines fitness and the whole constitution of an individual. With determination, luck, and a molecular model kit, Watson and Crick were able to deduce from the collective knowledge of science the structure of the double helix.

In many ways, both Darwin and Watson proved that science, by the use of observation, experimentation, and the power of believing in the impossible, was capable of making sense of life's greatest mysteries. These two great scientists, a century apart,

are unequivocally linked in the history of science forever as the men who helped mankind understand life itself. In order to understand the impact Darwin and Watson have made in science, it is important to understand these two men at the individual level in order to understand how they came to their revolutionary ideas. Darwin and Watson used both similar and different approaches to answering their questions, faced competition amongst their scientific peers, and sought to revolutionize the study of life with their groundbreaking and long-lasting theories, which despite putting them in the ranks of the great fathers of biology, received very different receptions within their scientific communities.

As James Watson implied in *The Double Helix*, there is no perfect scientist, that they are all very human and have individually unique approaches to science. This is very true of both Charles Darwin and James Watson, two people at polar ends of the wide spectrum of humanity. Charles Darwin, great naturalist of the 19th century, was a gentleman in every way. Modest, respectful, adoring husband and father, he lived a quiet life despite the loudness of *The Origin of Species*, first published in 1859. Observation was central to his science and the framework of his mind is clear to his readers in passages of *The Voyage of the Beagle: Galapagos Archipelago (1845)*. One of his most famous examples of observation is that of the finches of the Galapagos Islands. Darwin pondered the varying beaks and wrote, "The most curious fact is the perfect gradation in the size of the beaks in different species of Geospiza, from one as large as that of a hawfinch to that of a chaffinch…Seeing this gradation and diversity of structure in one small, intimately related group of birds, one might really fancy that from an original paucity of birds in this archipelago, one species had been taken and modified for different

ends."[1] This one example of Darwin's ability to come to valid conclusions from pure observation and curiosity is representative of how he conducted science as a whole. He observed, questioned, hypothesized, and organized vast amounts of information into credible ideas.

Darwin took great interest in recording extensive details of the animals he encountered, from their behavior to appearance and habitat choices. According to Editor Joseph Carroll it was this unique ability of Darwin's mind to piece ideas together that made natural selection theory possible. Carroll wrote in the foreword of *On the Origin of Species* that, "Darwin's insight into the phylogenetic basis of systematic order is a true insight- an insight that peers into the reality of things. Consequently, once he has in possession this one central clue to the organization of life, he can use it as a guide to every other aspect of natural history. It becomes his golden thread through the mazes of anatomy, development, reproductive interactions, ecology, paleontology, and the geographical distribution of living things."[2] Books were central to Darwin's great insight into natural order. He also took delight in corresponding with other naturalists of the time. From the knowledge he gained from books Darwin built from past ideas, tweaked ideas of great minds such as Thomas Malthus, Charles Lyell, and Alexander Von Humboldt, to name only a few, and added to his own observations while traveling on the H.M.S Beagle, 1831-1836. The branching of his mind, every which way, much like the diagram he drew of the tree of life, put together the great puzzle that is natural selection. As seen in his *Origin of Species,* the book that debuted Darwin's theory on natural selection and evolution, he was exceedingly careful to give credit to everyone he

[1] Charles Darwin. *On the Origin of Species*, edited by Joseph Carroll. (Peterborough, Ont.: Broadview Press, 2003), 457.
[2] Darwin, *The Origin of Species*, 13.

borrowed from. Charles Lyell, geologist, advocate of uniformitarianism, and author of the *Principles of Geology*, was of great importance to Darwin. According to Carroll, "In the Origin, Darwin speaks of the Principles of Geology as a work that the future historian will recognize as having produced a revolution in natural science and his own work was influenced by."[3] Charles Darwin is the epitome of a humble, morally sound, and formidable scientist. He did not seek fame, but rather he sought to better science with a theory that he devoted his life to.

James Watson can only be compared characteristically to Darwin in that his mind came to conclusions in the same branching fashion and his work also opened doors for future scientific discoveries. Watson, zoologist turned geneticist, was a much less humble man, with no qualms of banishing fair-play from science, and commonly known for his large and sometimes controversial ego. According to Jazilah Bte Othman, reviewer of the Double Helix, "A PhD before his 23rd birthday had perhaps given Watson a certain cockiness in his manner and attitude. He declares that many scientists are 'cantankerous fools who unfailingly backed the wrong horses', and are 'not only narrow-minded but also just stupid.'"[4] Interestingly, Watson's ego was crucial to his discovery of the double helix in 1953. Without his ruthless competitive streak and drive to be famous, he may have been beaten to the finish line by Linus Pauling, chemistry genius of the era. In order to win the so-called "race," as Watson named it, he relied heavily on networking with his fellow scientists at Cambridge, Kings University, and connections overseas, and was thus able to take advantage of the collective knowledge of the

[3] Darwin. *On the Origin of Species*, 21
[4] Othman, Jazilah. "What reading the Double Helix and The Dark Lady of DNA can teach students about science," *Teaching Science- The Journal of Australian Science Teachers Association* 1, no. 54 (2003), 50-51.

scientific community. As Watson noted in *The Double Helix*, he probably would have been stuck on the wrong stereochemistry without the pure circumstance of working in the same area as chemist Jerry Donahue, who pointed out that Watson was incorrectly using the keto forms of his nucleotides rather than the enol forms.[5]

Of the greatest controversy to Watson's discovery was his use of borrowing, which some would call stealing, from Rosalind Franklin. Franklin, x-ray crystallographer, and assistant of fellow DNA researcher Maurice Wilkins, had developed two x-rays of the A and B forms of DNA which, without her knowledge, were central to the model process that Watson employed. Furthermore, her firm belief that the sugar phosphate backbone was on the exterior side of the molecule was used by Watson as well. Throughout *The Double Helix* he not only periodically insulted Franklin, but also completely disregarded her work as being the turning point for the discovery. According to biographer of Rosalind Franklin, *The Dark Lady of DNA*, Brenda Maddox writes that it wasn't until 46 years after the discovery that Watson finally admitted that the 'Franklin photograph was the key event.'[6]

With the pieces of information Watson stole from Franklin, borrowed from men like Maurice and Chargraff, or were given by his peers at Cambridge, Watson came to his grand conclusion. "The scientific model is clearly demonstrated in Double Helix – how Watson and Crick used hypothesis, inference, and experimental data to revise earlier hypothesis, and so on, to finally arrive at the solution."[7] This is the key difference between Watson and Darwin, besides the obvious personality differences. Where Darwin was a genius of observation and hypothesizing, Watson was a genius of experimentation

[5] Watson, James. *The Double Helix*. (New York: Nortan and Company, 1980), 110-112.
[6] Maddox, Brenda. *The Dark Lady of DNA*. (New York: HarperCollins, 2002), 316.
[7] Othman, "What reading the Double Helix & The Dark Lady of DNA can teach students about science," 2.

and quantitative deductions. These differences would eventually greatly affect the receptions of their ideas.

The eras that Darwin and Watson respectively lived in, a century apart, were very different, but the rivalry of scientific minds and the competitive nature of discovery was very much the same. Darwin lived in Victorian England and a culture of high society that would be coming to its end when, years later, Watson would be working in Cambridge, London. In the 19th century, natural history was the work of adventurous and wealthy gentleman and was, thanks to innovative advances in publication techniques, accessible to the general public thus becoming a cultural interest. Scientific methods were being developed and employed by men like Alexander Von Humboldt who stressed the importance of quantitative measurements and the development of scientific instruments. Ideas were being thrown every which way as naturalists sought to explain the vast information of collected knowledge on organisms and how life and earth came to be.

According to Joseph Carroll, "The middle of the nineteenth century was the right time for the formulation of the theory of natural selection because this whole network of naturalistic research had finally produced all the elements that were necessary to it."[8] In many ways, it was a time of scientific revolution, where science was going head to head with religion, and the competing ideas of the time were creation versus non-creation, the age of the earth, and whether species go extinct. Radical ideas that went against the Genesis caused great distress and often resulted in repercussions. It was when Robert Chamber's *Vestiges of Creation*, 1844, created a huge public outcry that Darwin became very aware of the sensitivity of the topic of mankind's origin. Chambers addressed the

[8] Darwin, *On the Origin of Species*, 24.

origin of man and received harsh criticism. Darwin, witness to the effect of the book, knew that he could not make the same mistake, therefore completely excluded any discussion of the origin of mankind in his book in order to be taken seriously. Meticulous in nature, Darwin labored at great efforts to come up with a vast quantity of examples to support his theories and in doing so publication was delayed for approximately twenty years. When Alfred Russel Wallace came to similar conclusions on descent with modification as Darwin did from reading Malthus, Darwin was prompted to hastily publish *Origin of Species*. In respect of Wallace's achievement and in order to be fair they published simultaneously. Not even the secluded and quiet life of Darwin was totally free from the competitive world of science, constantly brimming with new ideas.

James Watson faced similar competition, albeit in a completely different England of the 20th century. Due to the advances that Darwin created with *The Origin of Species*, science had developed out of its roots of natural history into the wide spectrum of chemistry, geology, physics, biology, and many other branches. Darwin broke down the barriers, many of which were religious, that were keeping science from advancing. Watson lived in a much more open-minded scientific community where he was free to leave religious beliefs outside of the laboratory. In many ways, thanks to the work of his scientific predecessors, much was understood of life when Watson was researching, perhaps an unfair advantage over Darwin in terms of ease of access to quality information. Without a doubt DNA was one of the last missing links to understanding the great question of 'what is life.' To Watson's advantage, structures of the pieces of DNA were already known, what wasn't known was how the pieces fit together. How the sugar

phosphate backbone, nucleic acids, and bonding interacted was a mystery and a huge prize to the man or woman who figured it out. In 1952, when Hershey and Chase proved with their virus experiments that DNA, not protein, was the genetic material, the race was on. Linus Pauling was the greatest chemist of the day, and after his achievements with protein structure proved his worth he began to pursue the problem of DNA structure. With a strong sense of competition in the air and a desire to make a name for himself, Watson's motives were not as neutral as Darwin's. Unlike Darwin, Watson was quick to announce any advances he made; prematurely announcing he had discovered the structure when in fact he was quite wrong at first. Watson also did not have to fear the reception of the scientific community of his day. He had enough quantitative evidence to prove it, and a community willing to accept provable ideas, so he didn't need to hold back. Reserve was not in his nature.

Once published, Darwin's *Origin of Species* and Watson's structure of the double helical nature of DNA received extremely different receptions. When Darwin released his book, the scientific community was split. While Darwin did have his supporters amongst the names of Huxley, Wallace, and Hooker, to name a few, his critics were very harsh. Of great concern to many people was the implication of mankind's evolution from apes and a non-Genesis creation. Thomas F. Glick, author of *The Comparative Reception of Darwin,* writes that Sir Richard Owen, leading comparative anatomist of the time, was amongst the strongest critics and Owen claimed that, "an 'impassable gulf' existed between man and the ape in that man's brain contained a posterior lobe that was lacking in the apes."[9] Educated men had difficulty accepting the idea of descent from primates,

[9] Glick, Thomas F. *The Comparative Reception of Darwin*.. (Chicago: The University of Chicago Press, 1988), 36-37.

thus keeping them from believing in the credibility of Darwin altogether. Furthermore, the lack of fossil evidence to prove this seemingly bizarre theory added to their poor reception of Darwin's evolution. Without the intermediate fossil links there was no proof. Darwin defended this by saying that the fossil records were incomplete and that with more time many more transitional fossils would be found, thus proving his theory of descent with modification.

The *Origin of Species* is famous for being one long argument, but because of its lack of quantitative evidence it was called purely speculative and hypothetical by its criticizers. Evolution takes place beyond the lifespan of humans and is impossible to view on the macro-scale. People could not see it happening, so it was hard for them to believe without proof. In addition, the age of the earth was a hot topic, deeply entangled with religious views and physics. Darwin knew that for his theory to work the earth must be very old. Sir William Thomson, later known as Lord Kelvin, leading physicist of the day "calculated that the earth as a cooling body could not, on the principles of thermodynamics, have supported life for the many millions of years that the uniformitarian geologists and evolutionists required if their theories were to stand up."[10] In a later edition of the Origin, Darwin admitted that Kelvin's calculations were the most serious objections that evolution and natural selection faced. Only with Marie Curie's discovery of radium could Kelvin be disproved.

After years of searching for more evidence for his theory with the help of his supporters, Darwin was slowly able to gain members of the scientific community, and he wrote in 1867, "The belief in descent theory is slowly spreading in England, even amongst those who can give no reason for their belief. No body of men were at first so

[10] Glick, *The Comparative Reception of Darwin,* 45-46.

much opposed to my views as the members of the London Entomological Society, but now I am assured that, with the exception of two or three old men, all the members concur with me to a certain extent."[11] As he gained the support of science, he could do little to gain the religious community. Creationism and Intelligent design are just two ideas that have tried to take Darwin out of science textbooks. They oppose Darwin's lack of a creator, young earth, and the cruelty of natural selection, ironic, since as beautifully stated by Edward J. Larson, author of *Summer for the Gods,* "If nature reflected the character of its creator, then the God of a Darwinian world acted randomly and cruelly."[12] Though Darwin is acknowledged by the majority of the scientific community as a revolutionary thinker and founder of modern biology, the title came slowly and difficultly. Darwin's ideas remain deep in controversy and the story of its reception will not be concluded for a very long time.

James Watson had a much easier time with the release of his and Crick's DNA model. In fact, the scientific community rejoiced at the discovery and quickly used its collective power to prove its validity. So quickly was it accepted, that only nine years after their discovery Watson and Crick were awarded the 1962 Nobel Prize in Physiology. Immediately it was realized by the scientific community that the knowledge of the structure of DNA could advance the research of genetics, biochemistry, biology, and all other sciences of life. It was a perfect merging of scientific ideas. The only great criticism it received was in the method of how it was discovered. According to Othman, teachers worried that Watson's *The Double Helix* would set a bad example for science students. Othman accused Watson of completely throwing all regards of the scientific

[11] Glick, *The Comparative Reception of Darwin*, 60.
[12] Larson, Edward J. *Summer for the Gods: The Scopes Trial and America's Continuing Debate Over Science and Religion.* (New York: Basic Books, 1997), 17.

method out the window, of advocating winning as the most important aspect of science, and morals being obstacles in the pathway of science.[13] Indeed, Watson did stain the ethics of his discovery with his refusal to acknowledge Franklin and by purposefully insulting many of the people that contributed to the discovery. Nonetheless, *The Double Helix* was a uniquely revealing novel into the inner-workings of great discoveries and continues to deserve its place in the classroom.

In opposition, Gunther S. Stent wrote *A Review of the Reviews*, and harshly criticized the reviewers of the book who condemned the morality of the discovery and pronounced it as a false representation of 'scientific creativity.' Stent goes on to say that, "Other more sophisticated reviewers, however, recognized that Watson had made a major contribution to dispelling the myth that scientific research represents the movement of disembodied intellects toward discovery by inexorable logical steps, motivated only by the aim to advance knowledge."[14] Science is a tool of the human mind and is conducted in the manner of the individual. It is up to the scientist to decide how to do their science. Watson conducted science differently from Wilkins, Franklin, and even Darwin. No single approach is the right way. Watson ignored fair-play, sought fame in the scientific community, and spent as much time thinking about girls as he did thinking about DNA, with the result of bettering science. Darwin actually sought to better science, not only for the personal satisfaction, but to break free of the old paradigms and open people's minds to the gestalt shift that he could see. In both ways, Darwin and Watson contributed to science, just in very different ways and with extremely different receptions. It is unfortunate that an honest man like Darwin, who played fair and gave humble credit,

[13] Othman, "What reading the Double Helix & The Dark Lady of DNA can teach students about science," 2.
[14] Watson, *The Double Helix*, 161.

would receive the harshest of criticisms. Watson, not the most respectable of men, ironically was more accepted by the scientific community. Darwin is definitely to thank for Watson's ability to release his ideas to a community that was ready to accept modern ideas. Darwin did the heavy work of aiding in the transition to the modern era where genetics was not just an idea, but an accepted fact of life.

Charles Darwin's theories of natural selection and evolution go hand in hand with James Watson's double helix, together opening the door for modern day genetics and proving their lasting relevancy. The unanswered questions of Darwin's *Origin of Species* on how variability is transferred from parent to offspring could finally be understood by the discovery of DNA's structure and the mechanism of replication. Of key importance, genetics was added to Darwin's original four postulates and the revised postulates are now known as the modern synthesis and in summary state that, "mutations create new alleles, and segregation and independent assortment shuffle alleles into new combinations. Individuals within a population are variable and pass their alleles to their offspring. The individuals that survive and reproduce are those with the alleles and allelic combinations that best adapt them to their environment."[15] The modern synthesis allowed Darwin's theories to be relevant to modern day science and deeper ingrained in the biological sciences. Scientists interested in proving evolution can use the modern synthesis and its postulates as tools to follow the allele frequencies of populations and prove that nature non-randomly selects the traits most suitable to that environment.

Genetics not only clarified natural selection, but it added the experimental and quantitative aspects that Darwin's original postulates lacked and were subsequently harangued for. Perhaps the most important aspect of the modern synthesis is its ability to

[15] Freeman & Herron. *Evolutionary Analysis*. (San Francisco: Pearson Education, 2007), 96.

aid in the understanding of the evolution of dangerous organisms to mankind. Antibiotic resistance is becoming a serious and growing threat that is capable of being understood and battled with knowledge of genetics and evolution. Horizontal gene transfer is believed to be the leading cause of this resistance and according to David Haussler, a genome scientist, "I am struck with the fact daily that the more information we accumulate, the more validation we find of Darwin's theory. Once new material has nestled into a host's genome via horizontal transfer, the genetic material is as subject to natural selection as ever."[16] Bacteria that inherit the antibiotic resistant gene then reproduce and pass the trait on to their offspring. Even if new antibiotics are developed, eventually there will be a variant form that is able to resist it, survive, and propagate. It is a genetic arms race eloquently described by Leigh Von Valen in his Red Queen metaphor, stated as, "In this place it takes all the running you can do, to keep in the same place: For an evolutionary system, continuing development is needed just in order to maintain its fitness relative to the systems it is co-evolving with."[17] Recombination, crossing over, mutations, transduction, the list goes on of the many elegant ways that alleles are shuffled, rearranged, and paired. Survival of the fittest decides who lives and dies, while the red queen race never ends. Constantly evolving, constantly being selected for, the combination possibilities are limitless.

Without a doubt, Darwin would be awed by the advances that have been made since he first came to the great conclusions that were the result of his voyage on the H.M.S Beagle. Heredity was a puzzle he could not solve. If only he had read the transcript that Mendel had sent to him he may have had a quantitative process to back up

[16] Hayden, Thomas. "What Darwin Didn't Know" *Smithsonian* 39.11 (2009): 40-48.
[17] Freeman & Herron, *Evolutionary Analysis*, 53.

his observations. History doesn't always take the easy road, but Darwin's and Watson's ideas mesh together seamlessly. Genetics and natural selection continue to be important to modern day science and will continue to be used together to further understand life.

Charles Darwin and James Watson revolutionized science as we know it today. Though they lived in different eras and approached science and life differently, they experienced the same thrill and love of science that led them to their respective places in the history of science. More than they ever could have imagined, their achievements are central to biology and how the question of life is approached. Darwin carried science from the Victorian era of natural history into a modern era open-minded to scientific revolutions almost devoid of religious connections. He fought criticism and mockery in order to reveal natural selection to the world, all while staying true to his beliefs and acceptant of new ideas. With *The Origin of Species* he forced people to view the world in a different way and see the connections that he had made. For those who saw the gestalt shift first, suddenly it made sense why variation occurs within species. It is a hereditary mechanism to insure the survival of the fittest and the demise of the unfit; nature is always changing and the only way to keep up with it is to be variable. The Darwinian paradigm shift paved the way for future scientists.

James Watson is not a father of biology like Darwin, but he is a product of the revolution that Darwin commenced. Watson's achievements are without a doubt great and worthy of respect and honor, but not in such a large scale as Darwin. Watson had all of the pieces to the puzzle in his hands before building his groundbreaking model. Much was already known of DNA, he just had to put the pieces together. Darwin had to first find the pieces to his puzzle amidst all the chaos of information and lack thereof, and then

figure out how to put them together. Where Watson made his discovery in two years, Darwin spent his life working on natural selection.

Darwin and Watson's stories of discovery are among the most detailed accounts of human thought and scientific method; the blending of individuality with the pursuit of a question is revealed as a unique experience with the fluidity of science. In many ways their achievements not only opened doors for science, but also opened doors to questioning what is right or wrong science. Fair-play, ethics, competition; the question is where the line is drawn in the pursuit of science. The history of science shows many examples of where the blurred line is passed and Watson is an example. He took advantage of information that he did not have permission to use in order to solve a question that would seal his importance in the scientific community forever. History is made up of cheaters, liars, and on occasion, men like Darwin, the epitome of a good guy scientist. It is unfortunate sometimes, but history needs the variety of scientists, good guys and bad guys, in order to advance. Just like natural selection works on populations, variety increases the diversity and richness of science. The differences between Darwin and Watson made their achievements possible. Darwin had all the ingredients within him to see natural selection at work: curiosity, impeccable skills of observation, and determination. Watson had all the makings to enable him to see the double helix: trial by error skills, a competitive streak, and a hunger for importance. In *The Dark Lady of DNA,* Maddox questions, "What should be one's purpose in the pursuit of science?"[18] This is a difficult question to answer. Some would say that it should be to better mankind as a whole, or to further understand the unknown. When it comes down to it, there really is no right answer. The purpose is what the scientist wants it to be and the value of the

[18] Maddox, *The Dark Lady of DNA, 316.*

discovery is completely dependent on the society, the culture, and the individuals behind the science. A scientific achievement is only as great as these factors allow it to be.

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