

T. H. HUXLEY'S DEFENSE OF CHARLES DARWIN'S

ORIGIN OF SPECIES

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STATEMENT BY AUTHOR

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How does a fine, scientific mind - one that is not without prejudices and skepticism - go to work on a piece of material that shocks the entire world with its information? Thomas Henry Huxley possessed such a mind, and the way his mind reacted to Darwin's Origin of Species is here related.

Huxley was a man who always possessed a love of truth, and he never took at second hand anything for which he vouched in his teachings. He felt the need to verify the facts which other men stated before he accepted them. He contended that it was man's first duty to seek the truth and his second duty to teach it accurately to others.¹ For this reason he felt that he had to verify Darwin's ideas before he could wholly accept them.

Although the main topic of this thesis is Huxley's reactions to Darwin's great publication, some mention needs to be made of the history that was taking place at that particular time before Huxley can be thoroughly discussed.

The nineteenth century was an era in which scientific knowledge influenced the ideas and attitudes of the people toward accepted values more than law, religion, art, and literature did. Science had more influence upon

¹Thomas Henry Huxley, Autobiography and Selected Essays (Boston, New York, Chicago, 1909), pp. xvi - xvii.

literature than literature had upon science. However, the development of experimental science had resulted from several hundred years of intellectual preparation, in which literature had played a great part. Social conditions during the nineteenth century also played a great role in the development of science, for if society had not valued freedom of thought and political liberty so highly, scientific investigations could not have advanced so quickly. Scientists used methods of rational calculation and measurement on which to base their ideas rather than references to the authority, habits, and traditions of past eras. Thus, the science of the nineteenth century reflected the social, economic, and political setting of the day. However, science did not merely reflect the society with its economy and politics, but it made an active contribution of its own to the world. It was able to carry out its investigations without the fear of ridicule of authority, and it did so extensively.¹

The nineteenth century conception of science was primarily that of invention. England had been undergoing a great increase of industrial production due to the improvement of old machinery and the invention of new machinery.

¹E. L. Woodward, The Age of Reform 1815 - 1870 (Oxford, 1938), pp. 543-544.

There was an extensive development in the means of locomotion and intercommunication. Through the development of these commodities the standard of comforts had been raised; famine and disease had been checked to a certain degree; people were bound more closely together through the creation of common interests and education; prejudice was being laid to one side; and the commonwealth was gaining strength against the forces of political and social anarchy.¹

Every mechanical device and chemical substance used in manufacture, and every breed of animal and every group of plants that possessed a variation in its make-up was a part of the new focal point of science. It had helped bring about better conditions in agriculture, economy, sanitation and health, and household comforts and conveniences. Not only had science aided the development of industry, but industry had aided the development of new ideas in physics, chemistry, and biology. People had become as interested in science as they were in industry, and they were aware that advances in science would open new channels for industry. Likewise, they realized that every advance in industry called for experiments and investigations on which the growth of science depended.²

¹T. H. Huxley, "The Advance of Science in the Last Half Century," A Half-century of Science (New York, 1888), p.1.

²Ibid., pp. 4 - 6.

At the beginning of the year 1836, the only concrete sciences that were well-known were astronomy and physics. It had reached the point of "wide general laws and evolutionary aspirations." Geologists had just begun collecting and uniting facts, and very little was known of biology and psychology. As yet there were no sciences of man, his language, his societies, or his religions. "Everywhere science was tentative and invertebrate, feeling its way on earth with hesitating steps...."¹

Everything great that had come about in science had done so because men were seeking for truths.² During this period of history there were more men carefully trained in the scientific method, who were truly interested in science, and who had at their disposal more greatly improved equipment than at any other half-century in history up to that time.³

Huxley felt that this period of history produced some of the most important achievements in physical science. He supported this statement by citing three instances: first, the molecular doctrine which is concerned with the consti-

¹Grant Allen, "The Progress of Science From 1836 to 1886," A Half-century of Science, p. 34.

²T. H. Huxley, "The Advance of Science in the Last Half Century," A Half-century of Science, p. 6.

³Ibid., p. 9.

tution of matter; second, the doctrine of conservation of energy; and third, the doctrine of evolution. Concerning these he said, "The peculiar merit of our epoch is that it has shown how these hypotheses connect a vast number of seemingly independent partial generalizations; that it has given them that precision of expression which is necessary for their exact verification; and that it has practically proved their value as guides to the discovery of new truth. All three doctrines are intimately connected, and each is applicable to the whole physical cosmos. But, as might have been expected from the nature of the case, the first two grew, mainly, out of the consideration of physicochemical phenomena; while the third, in great measure, owes its rehabilitation, if not its origin, to the study of biological phenomena."¹

Vast progress had taken place in the biological sciences since 1837. One of the greatest steps of advancement was Schwann's cell theory in 1839, which included the following points: all living bodies contain protoplasm, which is the basic substance of life; all complex bodies are made up of cells; all the morphological characters of plants and animals are caused by the multiplication, growth, and structural changes of these cells; all the physiological

¹Ibid., p. 10.

activities of plants and animals, i.e., secretion, excretion, motion, etc., are caused by the activities of the cells; the cells of all plants and animals contain the same substance, therefore, there is no absolute line dividing the plant and animal kingdoms; and all higher plants and animals evolved from lower plants and animals.¹

Much work had been done in the field of medicine and hygiene. Cleanliness and common sense had freed England of the plague, which had existed two centuries previously. Doctors had learned how to cope with small-pox and splenic fever, and they had been doing much work to attack hydrophobia, diphtheria, typhoid, and scarlet fever.²

A great advancement took place in comparative anatomy and embryology, and the field of botany was brought to life in gardens and laboratories, especially in France and Germany. When the Origin of Species appeared, the ideas of evolution really started scientists working, and within twenty years the whole world was seemingly converted. Evolution had been primarily an English movement and had as its chief expounders Darwin, Huxley, Spencer, and Wallace.³

¹T. H. Huxley, "The Advance of Science in the Last Half Century," A Half-century of Science, pp. 27-28.

²Ibid., p. 31.

³Allen, "The Progress of Science From 1836 to 1886," A Half-century of Science. p. 37.

Thomas H. Huxley was proud of the great progress that had taken place during this period of history, and in an article entitled "The Advance of Science in the Last Half Century" he expressed himself as follows: "All these gifts of science are aids in the process of leveling up, of removing the ignorant and baneful prejudices of nation against nation, province against province, and class against class; of assuring that social order which is the foundation of progress, which has redeemed Europe from barbarism, and against which one is glad to think that those who, in our time, are employing themselves in fanning the embers of ancient wrong, in setting class against class, and in trying to tear asunder the existing bonds of unity, are undertaking a futile struggle."¹

In speaking of this era, Grant Allen, in his article entitled "The Progress of Science from 1836 to 1886," stated, "Ours has been an age of firm grasp and of wide vision. It has seen the downfall of the anthropocentric fallacy. Cosmos has taken the place of chaos. Isolated facts have been fitted and dove-tailed into their proper niche in the vast mosaic. The particular has slowly merged into the general, the general into still higher and deeper cosmical concepts. We

¹T. H. Huxley, "The Advance of Science in the Last Half Century," A Half-century of Science, p. 25.

live in an epoch of unification, simplification, correlation, and universality. When after-ages look back upon our own, they will recognize that in science its key-note has been the idea of unity."¹

In 1837, biology barely existed, and its separate components, zoology and botany, were concerned primarily with questions of classification. But Charles Darwin had been experimenting with and observing animal and plant life for quite a while.² At this time he began to consider how change affected species, and a year later Malthus's book entitled Essay on the Principle Population provided an answer to his main problem. That answer was that man's success in raising domestic plants and animals was governed by selective breeding. Darwin then wondered how selective breeding could apply to plants and animals that lived without the interference of man. Malthus contended that organisms that possessed favorable characteristics would live and those which did not would be destroyed; thus, new species would result.³

For twenty years Darwin observed and experimented on

¹Allen, "The Progress of Science From 1836 to 1886," A Half-century of Science, p. 33.

²Ibid., p. 37.

³Woodward, The Age of Reform 1815 - 1870, p. 554.

organisms, and finally he converted Malthus's theory of the destruction of countless numbers of living organisms by war, disease and famine into his own leading idea of the struggle for existence.¹

The question of man's place in the scale of life then began to draw particular attention. However, the idea of higher forms of life developing from lower forms was not new. It had been expressed in the 1700's by Buffon, in his Histoire naturelle,² by Monboddo in his two books, Ancient Metaphysics and The Origin of Language,³ and by Erasmus Darwin, in his Zoonomia.⁴ Robert Chambers also had expressed the idea in his Vestiges of Creation in 1844, and Herbert Spencer had furthered the hypothesis in 1854 with his System of Synthetic Philosophy. The geologist Sir Charles Lyell had even used the term evolution in a sense similar to the meaning Darwin was to use a few years later in his Origin of Species.⁵

¹Clarence Ayres, Huxley (New York, 1932), p. 62.

²"George Louis Leclerc Buffon," Encyclopaedia Britannica (1955), IV, pp. 344-345.

³"James Burnett Monboddo," Encyclopaedia Britannica (1955), XV, p. 690.

⁴"Erasmus Darwin," Encyclopaedia Britannica (1955), VII, p. 67.

⁵Woodward, The Age of Reform 1815 - 1870, p. 553.

Charles Darwin's great research began in the following manner. At the advice of scientist friends, he began the study of botany and geology, only to find that the nature and history of species were not perfect in either field; so he became interested in looking into the idea. Books of travel influenced him greatly, and his five-year voyage with the Beagle afforded him the opportunity of studying many tropical regions and of doing original research in the new science of oceanography. Since most naturalists admitted evolution of some form, Darwin's work was not important mainly because it explained the meaning of evolution, but because it was an assimilation of a great amount of evidence which he had collected and carefully examined from every possible region.¹

As Darwin was slowly and patiently working on the Origin of Species in 1858, he received quite a blow which caused him to hurriedly complete his great work. At this time a British naturalist, Alfred Russel Wallace, who like Darwin, had read Malthus's work, formulated in his mind an idea similar to Darwin's concerning the development of species through the struggle for existence. Wallace did not stop to gather and organize evidence to back his ideas, but he quickly wrote a brilliant essay which was to be read to the Linnean Society.

¹Ibid., pp. 553-554.

In June, Darwin received a copy of the essay from Wallace. Upon reading the paper, Darwin must have felt very discouraged, for he had devoted years in gathering information which would back his ideas and in organizing it in his Origin of Species, and here a man appeared who had done very little research and exposed his ideas to the whole world. Darwin was therefore forced to acknowledge the existence of the book on which he was working.¹ He immediately sent an abstract of his work to the Linnean Society.²

On the first of July, 1858, the Linnean Society met, and the Wallace-Darwin papers were presented. Huxley was seemingly greatly interested in Darwin's ideas, for in a letter to Hooker dated September 5, 1858, he wrote, "Wallace's impetus seems to have set Darwin going in earnest, and I am rejoiced to hear we shall learn his views in full, at last. I look forward to a great revolution being effected. Depend upon it, in natural history, as in everything else, when the English mind fully determines to work a thing out, it will do it better than any other."³

¹Ayres, Huxley, p. 62.

²Woodward, The Age of Reform 1815 - 1870, p. 554.

³Leonard Huxley, Life and Letters of Thomas Henry Huxley (New York, 1900), vol. I, p. 171.

Since Huxley was a leading scientist of the day and an out-spoken man, Darwin apparently felt the need of preparing him for the ideas which were to come in the Origin of Species. Darwin did not, however, express his ideas too freely,¹ and perhaps this was a wise move, for if Huxley had disagreed with Darwin's theories, he certainly could have done a great deal of harm in openly criticizing the work even before he had read all of its facts and arguments.

Huxley had never thought much about the "Species" question until after 1850; even though he had read Chamber's Vestiges of Natural Creation in 1846. Before this time his attitude toward the species question had been an agnostic one because he was unable to accept the creational theory. As far as "creation" was concerned he said, "I find no difficulty in conceiving that, at some former period, this universe was not in existence; and that it made its appearance in six days..., in consequence of the volition of some pre-existing Being." He had, however, sought for some cause that was adequate to produce transmutation,² which is the change from one form or species into another.

But Huxley wasn't the only man who was confused and

¹William Irvine, Apes, Angels and Victorians (New York, London, Toronto, 1955), p. 105.

²Leonard Huxley, Life and Letters, vol. I, pp. 178-179.

concerned about the great conflict between the hypotheses of the scientist and the concepts taught by the church. Many other authors wrote on the subject. At first this conflict of ideas did not possess a true reality about it, because many of the writers who favored scientific concepts based their opinions on what they read rather than what they concluded through scientific experiments. They appeared to be more sure of scientific concepts than did those scientists who were actually performing experiments and observations. On the other hand, many people accepted without question a literal and unhistorical interpretation of the Bible.¹

England may have been advanced in many respects, but she was not ready for the Origin of Species. Its subject matter "raised a great outcry in England,"² and it became "a kind of anti-Bible." Since the Bible had been accepted for many years as a biological and geological treatise, the Origin of Species also became "a treatise on religion and ethics."³ Even scientists didn't know whether to speak of it as being in the field of science or of theology; therefore, many of their opinions toward it were extremely contradictory.

Huxley had read Lamarck, Chambers, and Lyell as well

¹Woodward, The Age of Reform 1815 - 1870, p. 529.

²Thomas Henry Huxley, Autobiography and Selected Essays, pp. vii-viii.

³Irvine, Apes, Angels, and Victorians, p. 107.

as Darwin. He finally was willing to give up his belief in creation, but at first, he could not accept the theory of evolution because it did not possess sufficient evidence. There was no theory for him which could adequately explain all the phenomena. He, therefore, took refuge in Goethe's Thätige Skepsis, active doubt, and waited anxiously for some proof that would assure him that evolution was the theory that would satisfy his intellect as well as his feelings.¹

The only biologist whom he met during his years at London who had anything to say in favor of evolution was Dr. Grant of University College and Huxley states, "his advocacy was not calculated to advance the cause."²

On the other hand, Huxley was greatly influenced by Wharton Jones' ideas on evolution. Jones was perhaps the most influential teacher of Huxley's young manhood, and Huxley had the greatest respect and admiration for his views on any subject. Therefore, when he learned that Jones was violently against the theory of evolution, he too felt negative towards it. Jones had always taught him to insist on absolute proof before he accepted any hypothesis so that he would abstain from speculation.³ Since Darwin's

¹ Irvine, Apes, Angels, and Victorians, p. 103.

² Leonard Huxley, Life and Letters, vol. I, p. 180.

³ Irvine, Apes, Angels, and Victorians, p. 104.

hypothesis had not been proven conclusively, Huxley was not free to accept it.

However, shortly before the Origin was published, in a lecture to the Royal Institution, Huxley made a reference to "that hypothesis which supposes that species of living beings living at any time to be the result of the gradual modification of pre-existing species -- a hypothesis which, though unproven and sadly damaged by some of its supporters, is yet the only one to which physiology lends countenance."¹ This statement would certainly make it appear that Huxley was beginning to undergo conversion from his anti-evolutionistic ideas.

Perhaps Huxley was more of an evolutionist than most people realized. At any rate, he had definitely thought a great deal about it, for in June of this same year he had stated in the opening paragraphs of his paper entitled On the Theory of the Vertebrate Skull, which was read to the Royal Society, that "the tyro in comparative anatomy cannot fail to be struck with the resemblances... between the wing of the bird and the fore-limb of the mammal."²

The above-mentioned paper was a harsh attack against

¹ Ayres, Huxley, p. 63.

² Ibid., p. 64.

Sir Richard Owen, who held that the skull was an enlarged and modified vertebra or group of vertebrae. This idea had come from the German zoologist Lorenz Oken, who thought that the entire animal kingdom was one mighty animal and that the various parts corresponded to different animal forms. For example, he said that the lowest animals, like polyps, had only intestine; animals like snails and insects had intestine and skin; and mammals, for example, had intestine, skin and flesh. However, the various portions of each organism had a definite symmetrical relation to each other. For example, arms bore a relationship to legs, mouth to anus, etc.¹

This theory made it impossible to answer the question of how animals that were constructed mainly of intestines could become intestined animals with skin, or how the two ends of the intestine should become so greatly differentiated.

Huxley had grown up with a completely different idea from Owen's in mind. He had learned from Müller the correlation of organic functions. Also he had learned from von Baer that an organism develops from "foundation membranes."² It was this theory that Huxley used to explain the development of the skull. He stated that the fallacy of

¹Ibid., p. 64.

²Ibid., pp. 64-65.

the vertebral theory of the skull was precisely like "that which, before von Baer, infested our notions of the relations between fishes and mammals. The mammal was imagined to be a modified fish, whereas in truth fish and mammal start from a common point."¹ He went ahead to say that the same is true concerning the skull. While it may be true "that there is a primitive identity between the spinal or vertebral column and the skull, it is no more true that the adult skull is a modified vertebral column than it would be to affirm that the vertebral column is a modified skull."² Vertebrates have possessed skulls as long as they have spines. On this point Huxley was correct and he therefore won his argument with Sir Richard Owen.³

Before the Origin came out, Huxley began discussing ideas and concepts about the theory of evolution to try to pave the way for Darwin's great work. One of the questions that he brought before the public was this: "How is it that if evolution is ever progressive, progress is not universal?" Two years later Darwin was to answer this by stating that not all forms advance; but for the meantime, this question was definitely a means to get people thinking about the idea of

¹Ibid., p. 65.

²Ibid., p. 65.

³Ibid., p. 65.

evolution. Huxley called attention to the fact that there were in existence many types of organisms that had not progressed appreciably during geological time. This fact showed that no other hypothesis besides Darwin's could explain such a phenomenon.¹

Sir Charles Lyell, a veteran geologist and Darwin's confidant, through his proof of geological uniformity had helped pave the way for the theory of evolution, but he had not been able to accept Darwin's theory of the descent of man because it was "repugnant to his feelings." However, he did not allow his sentiment to stand in the way of truth. He "declared himself a Darwinian, though not without putting in a serious caveat."

On June 25, 1859, Huxley wrote Lyell telling him that he would like to hear his objections to the Darwinian theory and explaining his own ideas on the subject. He stated that he did not see the force of Lyell's argument that there must be an intermediate form between monkeys and men whose fossils must be somewhere in the rocks. At the close of his letter Huxley stated that he did not feel that the transmutation hypothesis had been proven, but he felt that it was a powerful instrument of research.²

¹Leonard Huxley, Life and Letters, vol. I, pp. 183-184.

²Ibid., pp. 185-187.

Although Huxley was still somewhat skeptical about the concept of evolution because of lack of evidence, he soon began to apply the doctrines to his own subjects of Development and Vertebrate Anatomy and to the question of the origin of mankind, which was, at that time, the most heated question, in the lecture room of his classes at the Government School of Mines, Jermyn Street.¹

Huxley realized that anyone who accepted Darwin's ideas would be exposed to ridicule and misrepresentation, but this did not keep him from expressing his views to his classes. After all, whether the public liked it or not, the structural likenesses between the apes and man had previously been shown. Huxley was positive of this because in 1857, a paper entitled "On the Characters, Principles of Division and Primary Groups of the Class Mammalia" had caused him to reinvestigate the subject. This paper, which was read before the Linnaean Society, stated that certain features of the brain were found only in the genus "Homo" and were therefore evidence to place man in a division "Archencephala," apart from and superior to other genera of mammals. Huxley certainly did not agree with this statement, so he went to work and soon was convinced that the brain structures in question "were not peculiar to Man, but

¹Irvine, Apes, Angels, and Victorians, p. 106.

were shared by him with all the higher and many of the lower apes."¹ Having satisfied himself, he exposed his students to this knowledge.

In November, 1859, the Origin of Species was published and Huxley's interests were centered on the subject.² He read the book with great enthusiasm, and on November 23 he wrote Darwin saying that no work on Natural History Science had made such an impression upon him since he had read von Baer's essays nine years previously. He stated that the tone of the book was excellent, and that it certainly was impressive to people who were interested in the subject. He thanked Darwin for giving him such a great wealth of new ideas, but he also explained that there were a couple of points that he would not accept until he looked into all sides of the question.

The great objections that Huxley had were two in number. First, he did not understand why Darwin had accepted Natura non facit saltum without some restrictions; and second, he did not understand why variation should occur at all if continual physical conditions were of as little importance as Darwin thought.³

¹Leonard Huxley, Life and Letters, vol. I, p. 192.

²Ibid., p. 178.

³Ibid., p. 189.

He continued by stating, "I trust you will not allow yourself to be in any way disgusted or annoyed by the considerable abuse and misrepresentation which, unless I greatly mistake, is in store for you. Depend upon it, you have earned the lasting gratitude of all thoughtful men." And toward the end of his epistle he added, "I am sharpening up my claws and beak in readiness."¹ This last statement would indicate that Huxley believed enough in Darwin's ideas to stand behind him at all cost. Huxley was a man who always searched for truth, and he did not accept ideas unless he sincerely felt that they were true. Even though Huxley felt that Darwin did not have enough evidence to back some of his statements, he agreed with the main ideas and promised Darwin that he would not pick the Origin to pieces until he had reread it two or three more times.²

Darwin must have been greatly relieved to receive this letter, for he did not know exactly what effect the book would have upon his friend. Before the book was published, the two men had conversed many times about their ideas, and Darwin realized that he did not have Huxley completely converted. When he first began to write the Origin, he felt that if he could get Lyell, Hooker, and

¹Ibid., pp. 188-189.

²Ibid., p. 189.

Huxley to agree, at least in part, with his ideas, the subject was safe. As time advanced he grew certain that he had converted Lyell and Hooker, but in a statement written on November 13, 1859, he said, "If I can convert Huxley I shall be content."¹

With the exception of the above mentioned objections, much to Darwin's pleasure, Huxley did accept the Origin as a working hypothesis which explained problems otherwise inexplicable.²

Some time during the year 1859, Huxley wrote an essay entitled "The Darwinian Hypothesis"³ in which he attempted to bring to view some of Darwin's ideas. One of the first things that Huxley brings up is that it is impossible for a person to study the distinct species as they occur in nature -- study their relations to the surrounding conditions, their structural likenesses and differences, and the union of their present and past histories -- without finding himself completely devoid of a plan. He certainly cannot start with the idea that every organ of a creature serves a special function in the life of that individual, for it had been shown that the gums of a young calf and a

¹Ibid., p. 179.

²Ibid., p. 179.

³T. H. Huxley, Darwiniana (New York, 1896), pp. 1-21.

foetal whale contained rudimentary teeth which were never used; some insects that never bite had rudimental jaws, and some that never fly had rudimental wings; and many blind creatures possessed rudimental eyes. With this in mind Huxley states that every plant and animal starts from the same given point, develops along the same path until it reaches the point where its characteristics differ from those of its neighboring creatures, and then it turns down its own specific path of development. For example, "man in his development runs for a little while parallel with, though never passing through, the form of the meanest worm, then travels for a space beside the fish, then journeys along with the bird and the reptile for his fellow travellers; and only at last, after a brief companionship with the highest of the four-footed and four-handed world, rises into the dignity of pure manhood."¹

Huxley then refutes the principle of adaptation in helping us to understand how specific creatures exist in certain regions and not in others by showing that many plants and animals of the Northern Hemisphere are better adapted to live in the Southern Hemisphere than the ones that exist there. Therefore, the living organisms of a country are not necessarily the best adapted organisms for that climate.

¹Ibid., pp. 5-6.

Also, many times the organisms of an island will be a distinct species which is different from all other species, but they will resemble the plants and animals of the nearest mainland. On the Isthmus of Panama there is hardly a species that is common to both sides of the narrow strip of land. No matter where a person looks, there appear to be insolvable questions which arise in nature -- that is, if he goes by only what he sees at the time. He must not stop here, but must delve into the strata of the earth and study the fossils of the plants and animals that existed in the area at various times. Through a complete study of these fossils he will discover a "regular succession of living beings, each younger set, being in a very broad and general sense, somewhat more like those which now live."¹

Huxley contrasts these ideas with those of the writer of the Pentateuch, who believed that each species was the "product of a creative fiat" and was therefore "out of the domain of science altogether."²

Huxley delves further into the problem by studying Lamarck's findings. Lamarck believed that all living beings were related to each other through their resemblance in the whole plan of structure; therefore, "the highest creature

¹Ibid., p. 9.

²Ibid., p. 10.

grades by multitudinous steps into the lowest." He also believed that "an organ may be developed in particular directions by exerting itself in particular ways, and that modifications once induced may be transmitted and become hereditary." For example, if an animal was placed in a new circumstance, its needs would change; these needs would cause new desires, and the desire to satisfy such needs would bring about a modification of the organ exerted.¹

Huxley then suggests that perhaps the idea never occurred to Lamarck that the animal might change his habits before the continual exertion had a chance to modify the organ. Since the time of Lamarck, most naturalists have left the question of the origin of species to such people as the writer of the "Vestiges."

The theory of transmutation then crept into the minds of men, and the question arose whether it were possible that living things could be mutually connected by some law with the inorganic elements of the world, since living things act and react upon it.

Questions of this nature have arisen frequently, but they might have gone unexpressed for a long time if it had not been for Darwin's great publication. The author had won scientific acclaim years before when he had published a

¹Ibid., p. 11.

series of researches. His generalizations had been confirmed and were perhaps the most influential theories in the progress of biology. Recently this well-known scientist had turned his attention to minute anatomy. After twenty years of investigation, he had compiled his findings into a great work, which certainly deserves the right to be read, even if not agreed with.

Then Huxley explains that the Baker Street Bazaar had been exhibiting oxen, sheep, pigs, poultry, etc., which certainly were not similar to the wild members of those species. Upon very careful study, it is found that these, like many other artificial breeds of plants and animals, are produced by the following method. The breeder notices a slight difference in a few of his stock, so wishing to perpetuate this difference, he breeds a female and a male possessing this characteristic. Their offspring are examined, and if the characteristic is found, they are bred with other individuals of their kind. The operation of selective breeding is repeated until the individuals show a marked divergence from their primitive stock.

In the above situations the breeder is a human being who selects the characteristics that he wishes to perpetuate in a particular species. Darwin states that there is a "natural selection" in Nature which will perform practically the same duty.

Through the struggle for existence every plant and animal is constantly at war with every other. Every plant fights for air, light and water, and only the strongest survives. Year after year as many animals are killed by natural causes as are born; therefore, "those only escape which happen to be a little better fitted to resist destruction than those which die." This is where Darwin's natural selection comes into play. If some individuals of a species accidentally take on a variation which will suit them better than their neighbors for the struggle for existence, they will more than likely be the ones to survive and produce offspring, which will tend to have this predominating variation. The tendency of these individuals to persist will grow through successive generations, and a new species possessing these variational characteristics will arise.¹

Huxley concludes that this natural selection, the hypothesis of Darwin, seems to be the best answer to the question of why specific irregularities in species exist and have existed in time and space. However, Huxley states that whether or not this is the absolute truth is not known at the present stage of investigation. He suggests that the students of species stick to Goethe's aphorism which is

¹Ibid., p. 18.

called "Thätigie Skepsis" meaning active doubt, because "it is doubt which so loves truth that it neither dares rest in doubting, nor extinguish itself by unjustified belief." Perhaps after another twenty years of study, Darwin's hypothesis will be proven true. One thing in his favor is the fact that Darwin dislikes speculation; therefore, all of his statements are based on observation and experimentation. So Huxley advises men to look carefully into Darwin's great work.¹

Even though Huxley is not absolutely convinced that all Darwin's statements are correct, he feels that they are at least ideas to be considered.

In December 1859, Mr. Lucas, a writer on the staff of the Times, was to have written an article on the Origin, which had been sent to him in the usual course of business. Since he knew nothing about science, he asked Huxley to help him out of this difficulty. He explained that he would have to adopt whatever Huxley wrote by prefacing it with a few of his own paragraphs. Huxley was so anxious to give "the book a fair chance with the multitudinous readers of the Times" that he did not care about the conditions.² It made no difference to him whether or not the public knew who wrote

¹Ibid., p. 20.

²Leonard Huxley, Life and Letters, vol I, pp. 189-190.

the article, which appeared December 26.

In a letter to Hooker on December 31, 1859, in speaking of the article, he wrote, "... as a scientific review the thing is worth nothing, but I earnestly hope it may have made some of the educated mob, who derive their ideas from the Times, reflect. And whatever they do, they shall respect Darwin."¹

After the Origin came out, Huxley realized that Darwin's statements supported the conclusions that he himself had reached in regard to the structural likenesses between men and apes, so he decided to further the cause of evolution by choosing the subject "The Relations of Man to the Lower Animals" for his six lectures to workingmen in 1860.²

Just previous to the opening of the Oxford Meeting of the British Association, the July issue of the Quarterly Review, just released from the press, carried a very sarcastic anonymous review of the Origin. From its frequent references to "that great comparative anatomist, Professor Owen" and its remark about turnips turning into men, Huxley and Darwin were both certain that it had been written by Bishop Wilberforce.³

¹Ibid., p. 190.

²Ibid., p. 192.

³Ayres, Huxley, p. 52.

Huxley had not planned to attend the Oxford Meeting of the British Association of 1860, but rather to join his wife at her sister's country house near Reading. On Friday afternoon he ran into Robert Chambers, the author of Vestiges of Creation, who asked him not to desert them in their great battle, for they knew that Bishop Wilberforce was going to ridicule Darwin's theory. But Huxley thought that the Bishop's speech would be "merely an appeal to prejudice in a mixed audience." However, when Chambers spoke of his deserting them, he promised to remain in town and attend the meeting.¹

This meeting played an important role in Huxley's career. Six months had passed since the Origin of Species had been published and, as Darwinism was a topic in everyone's mind, it was brought up at this gathering. Huxley was given the opportunity to help give evolution a fair hearing and also to make himself known "as a dangerous adversary in debate -- a personal force in the world of science which could not be neglected."²

On June 28, Dr. Daubeny of Oxford gave a report entitled "On the final causes of the sexuality of plants, with particular reference to Mr. Darwin's work on the Origin of Species." After the report Huxley was called on to speak.

¹Leonard Huxley, Life and Letters, vol. I, p. 193.

²Ibid., pp. 192-193.

He tried extremely hard to avoid a discussion because he felt that such a discussion should not be carried on before the public where sentiment might play a great part.

Sir Richard Owen, the most outstanding comparative anatomist of his time,¹ did not heed this consideration. He arose and stated that he had some facts to give that would help the public come to a conclusion about the truthfulness of Darwin's theory. He pointed out in his paper that the gorilla's brain "presented more differences, as compared with the brain of man, than it did when compared with the brains of the very lowest and most problematical of the Quadrumana."²

Since Huxley had studied this point very carefully for two years previously, he had come to different conclusions; but he was not prepared with a paper to refute Owen's statements. He, therefore, asked that his "direct and unqualified contradiction" be placed on record and he pledged himself to gather the proof that would demonstrate the falseness of Owen's conclusions. This he accomplished, and in 1861 his proof appeared in the *Natural History Review*.³

On Saturday, June 30, at the British Association,

¹Irvine, Apes, Angels, and Victorians, p. 4.

²Leonard Huxley, Life and Letters, vol. I, p. 194.

³Ibid., p. 194.

Dr. Draper of New York read a paper entitled "Intellectual Development of Europe considered with reference to the views of Mr. Darwin."¹ Upon completion of the paper, an hour or more after the introduction, a discussion was begun, and the president asked for no one to speak unless he had a valid argument for either one side or the other.

Three men spoke briefly, but the crowd shouted them down. Then Bishop Wilberforce was called upon, but he in turn asked his friend Professor Beale to speak first. Beale stated that he thought "the new theory ought to meet with fair discussion," but he added that he did not have sufficient knowledge of the subject to discuss it adequately.²

The Bishop then rose and began his speech. He stated that he did not have any firsthand information, but had only read about the subject. He ridiculed both Darwin and Huxley severely. He spoke for half an hour, assuring the people that there was absolutely nothing in the idea of evolution. At the completion of his speech, he turned to Huxley and begged to know whether he claimed descent from a monkey through his grandmother or his grandfather.³

Huxley rose slowly and spoke deliberately. The writer

¹Ibid., p. 195.

²Ibid., vol. I, p. 196.

³Ayres, Huxley, pp. 50-51.

in Macmillan's Magazine stated that no one remembered exactly what Huxley's words were, but they meant that "he was not 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."¹

One person seated in the audience stated that Huxley first explained that "the suggestion was a descent through thousands of generations from a common ancestor."²

In his text, Leonard Huxley states that "the Athenaeum reports him [Huxley] as saying that Darwin's theory was an explanation of phenomena in Natural History, as the undulatory theory was of the phenomena of light. No one objected to that theory because an undulation of light had never been arrested and measured. Darwin's theory was an explanation of facts, and his book was full of new facts, all bearing on his theory. Without asserting that every part of that theory had been confirmed, he maintained that it was the best explanation of the origin of species which had yet been offered."³

The audience admitted that the Bishop had used very bad taste and bad manners in his speech. When Huxley had arisen to begin his speech, he was received coldly, and his

¹ Leonard Huxley, Life and Letters, vol. I, p. 198.

² Ibid., p. 199.

³ Ibid., p. 198.

friends were the only ones who cheered him; but as he stated facts and made his points, the applause grew. When he completed his speech, he received almost as much applause and cheering as Bishop Wilberforce had. Through the great force of his speech he was able to carry his unwilling audience along with him.¹

Huxley's facts were strengthened when, after his concluding statements, Hooker was called on to give his view of Darwin's theory from the botanical viewpoint. He showed through demonstration that the Bishop did not understand the principles of the Origin of Species, and that he knew nothing about botanical science.²

With this last statement by Hooker, the meeting adjourned without a comment from Bishop Wilberforce.

In 1860 Huxley published an essay entitled "The Origin of Species,"³ in which he attempted to give an account of the established facts concerning species, and to show the relationship of Darwin's explanations of those facts to the explanations of Darwin's contemporaries and predecessors, and to the requirements of scientific logic.

¹Ibid., pp. 203-204.

²Ibid., p. 200.

³Thomas H. Huxley, "The Origin of Species," Darwiniana (New York, 1896), pp. 22-79.

One of Huxley's first statements is that Darwin was well-versed in his field. He had done a great deal of work in zoology, anatomy, and geology; and his knowledge of geography was not gotten wholly from books and maps, but also from long voyages and observations. After having observed, studied, and experimented with material for many years, he had registered his findings in a great work entitled the Origin of Species.

Huxley then attempted to define the word species for his reader. A species may be a group of plants or animals that possess "some common peculiarity of form or structure," or it may be a group of plants or animals that possess "some common functional character." The aspect of species that has to do with form and structure is the morphological aspect and the one that has to do with function is the physiological aspect.¹

Usually the members of a species will reproduce offspring that resemble very closely the parents, but occasionally parents will produce an offspring that differs quite considerably from them. This offspring is known as a Variety. The origin of only a few of these varieties have been accurately recorded. Two, however, are rather well-known. The first was the appearance of a male lamb known

¹Ibid., p. 26.

as the Ancon sheep in the year 1791. This lamb differed from his parents in that he possessed a long body and short bandy legs, which prevented him from jumping the fences and getting into neighboring pastures. His owner was so pleased with this characteristic that he decided to try to reproduce it in all his lambs. He replaced the older ram with this Ancon ram, and to this delight, nearly all of the young lambs that were produced were either pure Ancons or pure ordinary sheep; and when enough Ancons were produced to interbreed with one another, the offspring were always Ancons.

It was noted that this new race of sheep always kept together when herded with other sheep. Therefore, it is believed that this race would exist today if another variation had not come along which proved to possess wool and meat superior to that of the Ancons. This illustration shows how a race may breed true at once and show no mixed forms, even when crossed with a different breed.¹

The second case is a Maltese man named Gratio Kelleia, who possessed six fingers on each hand and six toes on each foot. He married a woman with the normal number of fingers and toes, and they had four children. One son had six fingers and toes like his father; two had five fingers and toes on each hand and foot, though one's hands and feet were

¹Ibid., pp. 39-40.

slightly deformed; and a daughter had five fingers and toes, but thumbs that were slightly deformed. These children matured and married mates with the normal number of fingers and toes. The children which they produced are as follows: the first son had three children like himself with six fingers and toes on each hand and foot, and one child with five of each; the daughter gave birth to one child with six toes, and three normally formed children; the next son, who possessed slightly deformed hands and feet, had two children with six fingers and toes, one child with five fingers and toes, and one with six fingers on each hand, six toes on one foot, and five toes on the other; and the last son, who was normally formed, had several children, all of whom possessed the normal number of fingers and toes. When these offspring matured, they all married normally formed mates; and after a few generations, the varied characteristic disappeared.¹

It is not known why varieties come into existence, but the important fact is that these varieties follow the fundamental law of reproduction, which is the tendency of an animal possessing certain characteristics to produce offspring with these same or similar characteristics. It is seen that a new race of Ancon sheep was produced for a few generations because of selective breeding. That is, the parents for the

¹ Ibid., pp. 37-38.

new offspring were selected because they both exemplified the desired characteristics. On the other hand, there was no new race produced in the case of the Maltese family because the children did not select mates who possessed the same characteristics which some of them possessed. Consequently, the varied characteristics soon became extinct.

Any organ in the body of an animal may occasionally vary from the normal type. Since this variation may be transmitted to an offspring, if the variation is selectively transmitted, the foundation of a new race may occur.

A question then arises as to how to distinguish two true species from two varieties within a certain species. Physiologists state that "if a male and a female, selected from each group, produce offspring, and that offspring is fertile with others produced in the same way, the groups are races and not species. If, on the other hand, no result ensues, or if the offspring are infertile with others produced in the same way, they are true physiological species." This would be an admirable test, if it were always possible to apply it and if its results could always be definitely interpreted. Unfortunately, this test is usually not applicable. For example, when many male wild animals are kept in confinement, they refuse to breed even with their own females; therefore, negative results gathered from these crosses would have no value. Also, wild animals usually

have such a dislike for different species and tame members of their own species, that they will usually not breed with any of them. If offspring should appear from the above mentioned animals, the offspring for many generations need to be studied carefully in order for the observer to come to definite conclusions.¹

Darwin cited cases where plants were more fertile with pollen from another species than from their own. He also cited a case where the pollen of one plant fertilized the ovule of another species, but the male of the latter species did not fertilize the ovule of the first. If physiologists would cross the two species in one way, a true species would seem to develop, because no union would take place; but if they would cross them in the opposite way, a race would appear to develop.

Even though the fact of fertility or sterility may have little value in the testing for species, it should be remembered that there are groups of plants and animals whose members cannot successfully breed with the members of other groups, and that there are hybrids which cannot successfully breed with other hybrids.

Concerning the essential properties of species, the following passage appears to be correct: "Living beings,

¹Ibid., p. 45.

whether animals or plants, are divisible into multitudes of distinctly definable kinds, which are morphological species. They are also divisible into groups of individuals, which breed freely together, tending to reproduce their like, and are physiological species. Normally resembling their parents, the offspring of members of these species are still liable to vary; and the variation may be perpetuated by selection, as a race, which race, in many cases, presents all the characteristics of a morphological species. But it is not as yet proved that a race ever exhibits, when crossed with another race of the same species, those phaenomena of hybridisation which are exhibited by many species when crossed with other species. On the other hand, not only is it not proved that all species give rise to hybrids infertile inter se, but there is much reason to believe that, in crossing, species exhibit every gradation from perfect sterility to perfect fertility."¹

In his essay Huxley then states that there are two kinds of hypotheses concerning the origin of species. The first is the "special creation" hypothesis, which states that every species was produced by a supernatural creative act. No species arose as the result of a variation of any other living organism.

¹Ibid., p. 50.

The second is the "transmutation" hypothesis, which states that all species are produced by the modification of species which existed previously. "It is probable, though not a necessary consequence of this hypothesis, that all living beings have arisen from a single stock." The origin of species is not necessarily concerned with the origin of this original stock. "The transmutation hypothesis... is perfectly consistent either with the conception of a special creation of the primitive germ, or with the supposition of its having arisen, as a modification of inorganic matter, by natural causes."¹

People who favor the doctrine of special creation, which originated with the Hebrew cosmogony, believe that there are different species on the two sides of the Isthmus of Panama because it pleased the Creator to make them different. Likewise, rudimentary organs in animals exist because the plan pleased the Creator. "Man is more like a gorilla than a gorilla is like a lemur" because the Creator favored that plan of organization.²

Huxley felt that one day scientists would look back on such ideas as this and regard them as evidences of a low state of intelligence that existed in the nineteenth century.

¹Ibid., p. 54.

²Ibid., p. 61.

Geological investigations show that it is impossible to divide the large number of extinct animals and plants into distinct separate groups. There is no definite break between the appearance of water plants and animals and the appearance of land plants and animals. The transition appears to have taken place extremely gradually.

In "The Origin of Species" Huxley then stated that people who were interested in the species question were forced either to believe one of the two hypotheses concerning the origin of species or else possess a feeling of uneasy scepticism. It appeared that under the circumstances the latter condition was the most justifiable state of mind. Huxley therefore stated that it was no wonder that so many naturalists were present at the meeting of the Linnaean Society on July 1, 1858, to hear the papers of Wallace and Darwin read. It was rather a surprising coincidence that both men, living on opposite sides of the globe and working independently, should come up with the same solutions to the questions concerning species.

Darwin's hypothesis was simple and can be stated in a few words: "all species have been produced by the development of varieties from common stocks; by the conversion of these, first into permanent races and then into new species, by the process of natural selection, which process is essentially identical with that artificial selection by which

man has originated the races of domestic animals -- the struggle for existence taking the place of man, and exerting, in the case of natural selection, that selective action which he performs in artificial selection."¹

Darwin supports his hypothesis by three kinds of evidence. He attempts to prove first that "species may be originated by selection," second that "natural causes are competent to exert selection," and third that the strange phenomena "exhibited by the distribution, development, and mutual relations of species, can be shown to be deducible from the general doctrine of their origin, which...combined with the known facts of geological change."²

Huxley then states that this hypothesis is certainly in accord with the canons of scientific logic and appears to be the only adequate method.

Mathematicians felt that Darwin's method was not inductive enough. In Darwin's defence Huxley states that Darwin, through experiment and observation, tried to determine facts inductively, then he studied the data, and lastly, he tested the validity of his findings by comparing his deductions with the facts of Nature. "Inductively, Mr. Darwin endeavours to prove that species arise in a given

¹Ibid., p. 71.

²Ibid., p. 72.

way. Deductively, he desires to show that, if they arise in that way, the facts of distribution, development, classification, etc., may be accounted for, i.e., may be deduced from their mode of origin, combined with admitted changes in physical geography and climate, during an indefinite period."¹

Huxley felt that there was no fault to be found in Darwin's method, but that it had not been proved whether or not species can originate by selection, or whether or not natural selection exists. If these facts could be proved, Darwin's hypothesis would be a proved theory. Since these have not been proved, his ideas are only hypotheses, but they are the most logical scientific hypotheses that exist.

Darwin was aware of the following weak point in his hypothesis. He knew that many groups which possessed the morphological characteristics of species had been produced many times, but, at the time, there was no positive evidence that a group of animals had, "by variation and selective breeding, given rise to another group which was... infertile with the first."²

One of the most valuable parts of Darwin's work is his proof of the fact that "the frequent absence of

¹Ibid., p. 73.

²Ibid., pp. 74-75.

transitions is a necessary consequence of his doctrine, and that the stock whence two or more species have sprung, need in no respect be intermediate between these species." It is believed that Nature makes jumps every now and then in creating species.¹

In concluding, Huxley states that even though the Origin of Species does not satisfy all of the requirements of scientific logic yet, it is the most superior hypothesis which has been brought forward. Even if Darwin's ideas should be disproved immediately, "the book would still be the best of its kind--the most compendious statement of well-sifted facts bearing the doctrine of species that has ever appeared."²

In the autumn of 1860, Huxley began an extensive study on the structural similarities of the hands, feet, and brains between men and apes, and he became so interested in this theme that he decided to lecture on "The Relation of Man to the Rest of the Animal Kingdom" to the working men in the spring of 1861. Judging by a letter that he wrote to his wife on March 22, these lectures were extremely successful. In this letter he stated, "My working men stick by me wonderfully, the house being fuller than ever last night.

¹Ibid., pp. 76-77.

²Ibid., p. 78.

By next Friday evening they will all be convinced that they are monkeys...."¹

The above lectures were publicly displayed in the Natural History Review, and immediately following their publication, another controversy between Huxley and Owen began.

In the midst of this conflict, Huxley was invited by the Philosophical Institute of Edinburgh to deliver two lectures on the "Relation of Man to the Lower Animals" on January 4 and 7, 1862. He gladly accepted this proposition, for he felt it would give him an opportunity to strengthen his defence of Darwin by showing the similarities in the structures of men and apes. He also showed that the differences which existed between man and the higher apes were not greater than those which existed between the higher and lower apes. He stated that if Darwin's hypothesis of evolution explained the common ancestry of the apes, then there should be no difficulty for the anatomist to see the origin of man, so far as the gap between man and the higher apes was concerned. He admitted that he felt this idea was close to the truth, but he could not be absolutely positive.²

In letters to Darwin and Hooker on January 13 and

¹Leonard Huxley, Life and Letters, vol. I. p. 205.

²Ibid., pp. 207-208.

January 16 respectively, he related how pleased and surprised he was to receive great applause from the audience when he stated that he felt almost certain that man and ape had originated from the same stock.¹

It was not the scientific issue that caused Huxley to be so interested in the Origin of Species, but it was the popular issue. Actually Darwin hardly mentioned man or apes in his work, and he said nothing about their evolutionary relations, but the implication was very obvious. The public grasped the idea that man originated from the anthropoids and this became the chief point of controversy.² It was Huxley who, through his extensive study on the structural similarities of the hands, feet, and brains between men and apes, really created "the theory of human descent from anthropoid stock."³

In a letter to Darwin on January 20, 1862, Huxley stated how pleased he was that his lectures at the Philosophical Institute of Edinburgh had been so well received by his audiences. He made it clear to Darwin that he had spoken much more favorably toward Darwin's doctrines than leading reports had stated. Judging by the following

¹Ibid., pp. 209-210.

²Ibid., p. 75.

³Ibid., p. 235.

quotation, it is quite plain that Huxley had not easily accepted the Darwinian theory without doing a great deal of experimenting and investigating himself, but once he did accept it, he intended to expand the idea. He wrote, "I am constitutionally slow of adopting any theory that I must needs stick by when I have once gone in for it; but for these two years I have been gravitating towards your doctrines.... By about this time next year I expect to have shot past you, and to find you pitching into me for being more Darwinian than yourself. However, you have set me going, and must just take the consequences, for I warn you I will stop at no point so long as clear reasoning will carry me further."¹

About this time Sir Charles Lyell was in the process of writing his book entitled Antiquity of Man. Since he needed some information concerning the ape question, he asked Huxley to supply the answers. Also, a short time later he asked Huxley to draw for him a diagram of the comparison and the differences between the newly discovered Neanderthal skull and other skulls. Before beginning his preparatory investigations, Huxley explained to Lyell that there was almost one hundred per cent range in cranial capacity between the highest and the lowest members of any race. With this

¹Leonard Huxley, Life and Letters, vol. I, pp. 210-211.

Huxley began his study at the College of Surgeons. He measured skulls and found that the Neanderthal skull could be a "slightly exaggerated modification of one of the two types...of Australian skulls." He related this information to Lyell and explained to him that he wished he had six months to work on the subject, because he felt he would eventually come to "a new ethnological method, new modes of measurement, a new datum line, and new methods of registration."¹

Probably the most important thing about the above intensive study was that it caused Huxley to become seriously interested in the study of Ethnology,² i.e., the study of conditions from which customs and laws develop. It is the study of social life, physical conditions, and stages of culture to try to discover basic laws of social development.

While Huxley was working on the anthropological questions of the theory of evolution, he made two important contributions to the general question of evolution. The first was his delivery of the anniversary address to the Geological Society on February 21. His speech was a great critical discourse on what palaeontology had and had not

¹Ibid., pp. 212-213.

²Ibid., p. 213.

done, and he related how little men knew about the beginning of life upon the earth. He also presented a sketch showing the comparison between the past and present of nearly every class in zoology and a few classes in botany. In speaking of this discourse, Sir Charles Lyell stated that he never remembered any address being listened to with such applause, in spite of the fact that a number of people in the audience did not agree with some of Huxley's opinions.¹

The second contribution that Huxley made to the question of evolution was his Working Men's Lectures for 1862. He wrote Darwin telling him that he could think of nothing to lecture about except the Origin of Species. These six lectures were grouped under the general title "On Our Knowledge of the Causes of the Phenomena of Organic Nature." They concluded with "a critical examination of the portion of Mr. Darwin's work On the Origin of Species, in relation to the complete theory of the causes of organic nature."²

These lectures were as much admired by experts as they were by workingmen, and Darwin, above all, was extremely pleased with their success. He stated in a letter to Huxley that he had been well abused at times, but through Huxley's

¹Leonard Huxley, Life and Letters, vol. I, pp. 220-221.

²Ibid., p. 222.

lectures he had been greatly praised.¹ He continued by saying, "I have read No. IV. and V. They are simply perfect. They ought to be largely advertised; but it is very good in me to say so, for I threw down No. IV with this reflection, 'What is the good of my writing a thundering big book when everything is in this little green book so despicable for its size?' In the name of all that is good and bad I may as well shut up shop altogether."²

Darwin was so much impressed with this work of Huxley that for the first time he expressed a doubt whether Huxley's future really lay in research. He felt perhaps that he should write a new textbook on zoology, which was greatly needed and would have an immense influence; but Huxley did not favor this suggestion.³

At this time Huxley was working on his first book which was to be published under the title Evidences as to Man's Place in Nature. He had become interested in man "as a physical mechanism, as an anthropoid ape, as a social unit and a citizen, as a delicate machine for the discovery of scientific truth, but never to any appreciable extent in man as a personality and a human being. With all his splendid

¹Irvine, Apes, Angels, and Victorians, p. 136.

²Leonard Huxley, Life and Letters, vol. I, p. 223.

³Irvine, Apes, Angels, and Victorians, p. 137.

talents for friendship and affection, he remained, from the psychological point of view, largely indifferent to people. He was not even interested in himself.... For him, writing was an instrument, never an end. It meant the art of clarity, of controversy, which he cultivated for the purposes of the scientist and the philosopher."¹

On May 5, he wrote a letter to Sir Charles Lyell inclosing a copy of the proof of his book which he wanted Lyell to check and criticize. Evidently Lyell did not agree with all of Huxley's ideas and he must have aired his disagreement, for on August 17, Huxley wrote him a rather harsh letter in which he expressed his displeasure in some of Lyell's comments. Lyell evidently suggested that Huxley check Lamarck's theories, because Huxley stated, "I will look at Lamarck again. But I doubt if I shall improve my estimate of the latter. The notion of common descent was not his." He then continued by saying, "If Darwin is right about natural-selection--the discovery of this vera causa sets him to my mind in a different region altogether from all his predecessors...." With this he remarked that he did not feel that Darwin's doctrine was a modification of Lamarck's. "If he is only right Darwin will, I think, take his place with such men as Harvey, and even if he is wrong

¹Ibid., pp. 12-13.

his sobriety and accuracy of thought will put him on a far different level from Lamarck. I want to make this clear to people."¹

The ape-man controversy, which was begun at the meeting at Oxford in 1860, came to a conclusion at the meeting of the British Association held at Cambridge in 1862. At this assembly Professor W. H. Flower presented a public demonstration which showed the presence "in apes of the cerebral characters said to be peculiar to man."²

Huxley underwent a period of transition and culmination between the years 1859 to 1863. It was a period of transition because he began to do many things in life that could lead to interests in fields other than scientific research. It was a period of culmination in that he seemingly found his great mission in life, he developed literary characteristics, and he won many of his most notable victories; but with all of this, his scientific work did not suffer. He even managed to combine all his activities and to achieve all his destinies in his book, Evidence of Man's Place in Nature, which was perhaps his greatest scientific achievement.³ This book was published in 1862, as the

¹ Leonard Huxley, Life and Letters, vol. I, pp. 214-216.

² Ibid., p. 213.

³ Irvine, Apes, Angels, and Victorians, p. 135.

results of Huxley's findings on the Neanderthal skull and on the comparison of structures in man and ape. The book was immediately a success and by February of 1863, sales had reached the second thousand in England, and in July it was republished in America.¹

In a letter to Kingsley on April 30, 1863, Huxley spoke about the one great weak point in Darwin's doctrine. He explained that Darwin had shown that "selective breeding is a vera causa for morphological species; he has not yet shown it a vera causa for physiological species." For example, in speaking of two kinds of pigeons, if they were physiological species equivalent to the horse and ass, then their progeny should be sterile; but contrary to expectations, their progeny are perfectly fertile.² The answer to the cause of this was not known, but nevertheless, it existed.

In speaking of differences between men and apes, Kingsley had suggested the possibility that the great difference was that men had souls and apes did not. In response to this Huxley wrote, "If you tell me that an Ape differs from a Man because the latter has a soul and the ape has not, I can only say it may be so; but I should uncommonly like to know how either that the ape has not one or that the man has."³

¹ Leonard Huxley, Life and Letters, vol. I, p. 217.

² Ibid., p. 257.

³ Ibid., p. 262.

During 1863, Huxley became very friendly with Professor Ernst Haeckel, a German biologist. Haeckel had been brought up with a religious background, but he had lost his faith in 1848. He continued to be against religious doctrines until Darwinism appeared and provided him with a new faith and mission. In 1863 he greatly aided the cause of evolution in Germany at the scientific congress by giving a lecture on the Origin of Species.¹

Huxley and Haeckel, working together, were able to introduce the "man of science as a cultural type" into broader circles of European civilization. A great warfare between evolution and orthodoxy arose and Huxley seized this magnificent opportunity to get his scientific ideas before the public through his Workingmen's Lectures of 1862 and 1863. By lecturing in defence of the Origin at this time, "he delivered an eloquent indictment against the Divine Will as a natural cause."²

In 1864, Huxley published an essay entitled "Criticisms on the Origin of Species," in which he attempted to straighten out some misconceptions that Professor Kölliker in his critical essay "Upon the Darwinian Theory" had drawn concerning Darwin's doctrine. The essay also ridiculed the

¹Irvine, Apes, Angels, and Victorians, p. 116.

²Ibid., p. 117.

conclusions that M. Flourens had stated concerning the same general subject.

The main item on which Huxley disagreed with Kölliker was the statement that Darwin was a Teleologist because he had said that every organ in the structure of an animal was created for the benefit of the animal. In speaking of this Kölliker said:

Varieties arise irrespectively of the notion of purposes, or of utility, according to general laws of Nature, and may be either useful, or hurtful, or indifferent.

The assumption that an organism exists only on account of some definite end in view, and represents something more than the incorporation of a general idea, or law, implies a one-sided conception of the universe. Assuredly, every organ has, and every organism fulfils, its end, but its purpose is not the condition of existence. Every organism is also sufficiently perfect for the purpose it serves, and in that, at least, it is useless to seek for a cause of its improvement.

Huxley then explained the teleological argument. It stated that "an organ or organism (A) is precisely fitted to perform a function or purpose (B); therefore it was specially constructed to perform that function."²

Huxley attempted to clarify Darwin's ideas for Professor Kölliker. Darwin had said that organisms vary greatly;

¹Thomas H. Huxley, "Criticisms on the 'Origin of Species'," Darwiniana, p. 82.

²Ibid., pp. 82-83.

of these variations a few are better adapted to their surroundings and they thrive; but many are not well-suited to their surroundings, so they cease to thrive.

"According to Teleology, each organism is like a rifle bullet fired straight at a mark; according to Darwin, organisms are like grapeshot of which one hits something and the rest fall wide." Huxley continued by saying, "For the teleologist an organism exists because it was made for the conditions in which it is found; for the Darwinian an organism exists because, out of many of its kind, it is the only one which has been able to persist in the conditions in which it is found." Huxley further stated that teleology implied that "the organs of every organism are perfect and cannot be improved; the Darwinian theory simply affirms that they work well enough to enable the organism to hold its own against such competitors as it has met with; but admits the possibility of indefinite improvement."¹

For an example Huxley cited the following. Teleology stated that cats catch mice very well because they are expressly constructed to do so. Darwin stated that they caught mice well because through many variations in the Feline stock from one generation to another the cats that were best suited for catching mice were the ones which persisted and the cats that could not catch mice well did

¹Ibid., pp. 84-85.

not persist. Darwin felt that cats existed because they could catch mice well and that they did not exist in order to catch mice well.¹

Huxley then corrected Kölliker on another point. Darwin had not affirmed that "every detail in the structure of an animal has been created for its benefit." What he had said was this: "The foregoing remarks lead me to say a few words on the protest lately made by some naturalists against the utilitarian doctrine that every detail of structure has been produced for the good of its possessor. They believe that very many structures have been created for beauty in the eyes of man, or for mere variety. This doctrine, if true, would be absolutely fatal to my theory--yet I fully admit that many structures are of no direct use to their possessor."² Darwin then listed several illustrations to back his statement and concluded by saying, "Hence every detail of structure in every living creature (making some little allowance for the direct action of physical conditions) may be viewed either as having been of special use to some ancestral form, or as being now of special use to the descendants of this form--either directly, or indirectly, through the complex law of growth."³

¹Ibid., p. 85.

²Ibid., pp. 86-87.

³Ibid., p. 87.

Kölliker believed that there was no known transitional forms between existing species, and also that known varieties did not vary so greatly that they ever established a new species. He felt that Darwin's ideas were weakened by the fact that no transitional forms existed in fossils. He stated also that the weakest point in Darwin's theory was the "conception of the imperfection of organisms and the necessity of their becoming perfected," for Kölliker felt that each organism was perfect in itself and needed no further development.¹

Huxley then explained Darwin's idea that all organisms vary. The offspring may vary from its parents and if it is better suited to the surroundings, it will persist; but if it is worse suited to its surroundings than its parents are, it will be extinguished and the characteristics of the parents will persist. If the new variety should persist, it would probably continue to do so until another variety would be produced that would be even better suited to the surroundings than it was.²

M. Flourens had felt that Darwin had greatly personified Nature and that he had only imagined a natural selection. Flourens did not see how any such phenomena could exist;

¹Ibid., pp. 88-89.

²Ibid., p. 90.

therefore, Huxley tried to show how changes in conditions and variations in animals cause animals which are most alike to breed with each other because they are the ones that survive, while animals that did not possess these characteristics ceased to exist.¹

The early 1870's showed a turn in the scientific course in England and also in Huxley's career as a scientist. After his publication of The Descent of Man, evolution became the dominant question in the scientific field.² But even though the drift was toward evolution there were still many objectors who continued to criticize the idea and Huxley continued to defend Darwin's hypothesis. Darwin was a shy man and was averse to controversy; therefore, he gave Huxley the "power of attorney" to deal with critics in any manner that he felt best. From all of this Huxley became known as Darwin's bull-dog.³

On February 18, 1870, as retiring president of the Royal Geological Society, Huxley delivered his farewell speech. It was a revision of the one he had made eight years before and he "pointed out the growth of evidence in favour of the evolution theory, and in particular traced the

¹Ibid., pp. 99-104.

²Ayres, Huxley, p. 132.

³Ibid., p. 86.

paleontological history of the horse."¹

During 1871, Huxley continued his literary warfare in defence of Darwin. He tried to defend Darwin against biologists, the field of biology against the clergy, and "state education against those who scarcely believed either in the state or in education."²

By a little more than a decade after the publication of the Origin of Species, a change had come over Darwin's critics. The majority of the articles that were now being written were not abusive attacks upon Darwin, but rather they were to a large extent intelligent and appreciative. The author of an article that appeared in the Quarterly Review for July, 1871, admitted "the certainty of the action of natural selection..." and further stated that there was an "a priori probability in favor of the evolution of man from some lower animal form...."³

Wallace and Mivart, two of Darwin's greatest critics, believed in evolution as strongly as Darwin did; but "Mr. Wallace denies that man can have been evolved from a lower animal by that process of natural selection which he, with

¹Leonard Huxley, Life and Letters, vol. I, pp. 351-352.

²Irvine, Apes, Angels, and Victorians, p. 275.

³Thomas H. Huxley, More Criticisms on Darwin and Administrative Nihilism (New York, 1890), pp. 5-6.

Mr. Darwin, holds to have been sufficient for the evolution of all animals below man; while Mr. Mivart, admitting that Natural selection has been one of the conditions of the evolution of the animals below man, maintains that natural selection must, even in their case, have been supplemented by 'some other cause' -- of the nature of which, unfortunately, he does not give us any idea. Thus Mr. Mivart is less of a Darwinian than Mr. Wallace, for he has less faith in the power of natural selection. But he is more of an evolutionist than Mr. Wallace, because Mr. Wallace thinks it necessary to call in an intelligent agent... to produce even the animal frame of man; while Mr. Mivart requires no Divine assistance till he comes to man's soul."¹

By 1873, there was no longer any need for Huxley to be Darwin's bull-dog, because the evolution controversy was over, and Darwin's hypothesis had become an accepted fact in science.²

In November 1877, the honorary degree of LL.D. was conferred upon Charles Darwin at Cambridge. On the evening after the public ceremony, a dinner of the Philosophical Club was held at which time Huxley spoke in praise of Darwin's services to science. During the speech Huxley

¹Ibid., pp. 6-7.

²Ayres, Huxley, p. 93.

stated, "Most people know Mr. Darwin only as the author of this work [speaking of the Origin of Species], and of the form of evolutionary doctrine which it advocates. I desire to say nothing about that doctrine. My friend Dr. Humphry has said that the University has by to-day's proceedings committed itself to the doctrine of evolution. I can only say 'I am very glad to hear it.' But whether that doctrine be true or whether it be false, I wish to express the deliberate opinion, that from Aristotle's great summary of the Biological knowledge of his time down to the present day, there is nothing comparable to the Origin of Species, as a connected survey of the phenomena of life permeated and vivified by a central idea. In remote ages the historian of science will dwell upon it as the starting-point of the Biology of his present and our future."¹

Not until 1880, when Darwin's classic had attained its place in the minds of men, did Huxley again have very much to say about the Origin of Species. During that year Huxley was asked to give a lecture at the Royal Institution on the "Coming of Age" of the Origin of Species. At this time he reviewed the great controversy in the past tense.²

Six years after the death of Darwin in 1882, Huxley

¹Leonard Huxley, Life and Letters, vol. I, pp. 515-516.

²Ayres, Huxley, p. 93.

undertook the job of writing Darwin's obituary for the Royal Society. In a letter to Hooker on March 23, 1888, he stated that he was rereading the Origin for the sixth or seventh time in preparation for the notice, and that in his opinion "it is one of the most difficult books to exhaust that ever was written." And he concluded by saying, "I have a notion of writing out the argument of the Origin in systematic shape as a sort of primer of Darwinism."¹ Huxley felt that one reason why people at first could not accept Darwin's ideas was that his book was so difficult to understand. This obituary notice was the last big tribute that Huxley could give to Darwin, so he wanted to clear up any misunderstood statements and ideas and to make this an account of Darwin's intellectual progress.²

In 1894, Lord Kelvin, President of the Royal Society, awarded Huxley the Darwin Medal. At this time Kelvin remarked that Darwinism would not have met with such great acceptance and would not have gained such power, if it had not been for the brilliant advocacy with which it was exposed to all classes of men in its early days.³ Kelvin was, of course, referring to the manner in which Huxley defended

¹ Leonard Huxley, Life and Letters, vol. II, p. 205.

² Ibid., vol. II, p. 204.

³ Ibid., vol. I, p. 224.

Darwin's Origin of Species through his lectures, his articles and essays, and his public and private controversies with opponents.

The awarding of the Darwin Medal to Huxley was a delayed tribute to the growth of a mind, which was not without either the prejudices or the skepticism of the day, which went to work on Darwin's shocking information that all forms of life have evolved from pre-existing forms.

Although Huxley was not able at first to accept all of Darwin's ideas because of lack of evidence, he became very conscious of them and began public discussion of the theory of evolution to try to pave the way for The Origin of Species.

Even though he was still somewhat skeptical about the concept of evolution, Huxley soon began to apply the doctrines to the courses in vertebrate anatomy that he instructed at the Government School of Mines, Jermyn Street. He realized that any person who accepted Darwin's ideas would be exposed to ridicule and misrepresentation, but this did not keep him from expressing his views to his classes, for he contended that it was man's first duty to seek the truth and his second duty to teach it accurately to others.

Huxley was assured more than ever that Darwin's theory concerning evolution was correct when he realized that Darwin's statements supported the conclusions that he himself had

reached two years previously in regard to the structural likenesses between men and apes. So for his 1860 lectures to workingmen, Huxley chose the topic "The Relation of Man to the Lower Animals."

During that same year Huxley, in his essay entitled "The Origin of Species," stated that, even though he was still skeptical about some statements of Darwin's hypothesis because they did not yet satisfy all the requirements of scientific logic, he felt that this was the best hypothesis that had been brought forward.

After an extensive study on the structural similarities of the hands, feet, and brains between men and apes, Huxley, not Darwin, created the theory that man descended from the anthropoid stock. Darwin had made this fact fairly obvious, but he had not stated it as such.

Huxley had kept his mind so free that he could give up any hypothesis as soon as facts were shown to be opposed to it. His love of truth had enabled him to abandon or to modify his own ideas when they ceased to be supported by observations. It was only after extensive experimentation and observation that he was convinced that Darwin's hypothesis was the most logical one that had been propounded. After he had arrived at this conviction, he did all in his power to further the idea and help convert the world through his workingmen's lectures, his published articles and essays, and his controversies with opponents.

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