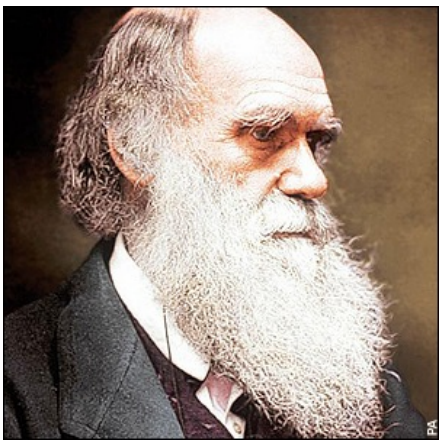
THE ORIGIN OF SPECIES

by Charles Darwin



THE AUTHOR

Charles Darwin (1809-1882) was born in Shropshire, England, on the same day that Abraham Lincoln was born in a log cabin in Kentucky. His father was a wealthy doctor, and his grandfather, Erasmus Darwin, was a naturalist and poet whose work included an early theory of evolution and the interconnection of all life. Charles was baptized into the Anglican Church, but his family attended Unitarian worship and would broadly be characterized as freethinkers. After studying medicine at the University of Edinburgh with little enthusiasm, he was sent by his father to Cambridge to study for the Anglican ministry. Initially, Darwin again did not apply himself, but gradually became more diligent, especially in the study of natural philosophy (ironically, one of the works that impressed him most was William Paley's *Evidences of Christianity*).

After graduation, Darwin was offered a position as naturalist on a voyage around South America planned by the *H.M.S. Beagle*. He accepted over his father's objections, and embarked on a five-year trip that would change his life. He spent most of him time on land during the voyage, collecting specimens and filling notebooks with observations. He had been influenced by Lyell's uniformitarian theories of geology, and began to develop his own ideas about the transformation of one species into another, especially since the boundaries between varieties and species were so difficult to define. One of the most startling discoveries of his voyage involved fossil remains of the *Megatherium*, a large armadillo-like creature, in a cave in South America. His time in the Galapagos Islands also generated certain ideas about how species change.

By the time he returned to England, he was famous, and was readily accepted into the circle of geologists and naturalists in London. Here he was influenced by Thomas Malthus' ideas on population. A perfectionist, Darwin buried himself in his work, preparing numerous books at the same time while continuing his research. As a result, his health suffered, and for the rest of his life he experienced stomach and heart problems, largely due to stress from overwork. In January 1839 he married his cousin Emma Wedgwood, days after being elected a Fellow of the Royal Society. The years that followed included researches focusing on animal husbandry, barnacles, and pigeon breeding, along with numerous publications. He also interacted with other

naturalists, some of whom had been developing their own theories of evolution, though none had gone as far as Darwin, who already was convinced that man, too, was a product of the process, nor had they formulated a convincing mechanism to explain evolutionary changes. His work increasingly focused on natural selection as that explanatory mechanism, but he was reluctant to publish his ideas until he had compiled sufficient supporting evidence. While engaged in these researches, he suffered a staggering blow when his ten-year-old daughter Annie died in 1851.

The Origin of Species (1859) was forced into publication prematurely when a contemporary presented a very similar theory, and stirred immediate controversy (these notes are based on the revised sixth and last edition, published in 1872). Rejected by some on either scientific or theological grounds, it was accepted by others who saw in it support for some form of theistic evolution, while others rejoiced that it could be used to undermine religion. Most vocal among the latter was Thomas Henry Huxley, later called "Darwin's Bulldog," whose famous debate with Anglican Bishop Samuel Wilberforce in 1860 gained much popular support for a theory of evolution that included man. Darwin later supported these ideas with the publication in 1871 of *The Descent of Man*. When Darwin died in 1882, he was buried in Westminster Abbey, near the grave of Isaac Newton. Rumors of a deathbed conversion have been shown to be fabricated.

His ideas of natural selection were picked up, expanded, and applied to human society in a movement called Social Darwinism, associated largely with the work of Herbert Spencer. Social Darwinists used the survival of the fittest to justify everything from laissez-faire capitalism to the English Poor Laws to European imperialism. Despite Darwin's insistence that human beings were all one species, others used natural selection to support theories of racial supremacy (Hitler being the most notorious example of this), while Friedrich Nietzsche used it to argue his nihilistic views, advocating the Will to Power over traditional (Christian) morality. Darwin thus became one of the most influential thinkers of the nineteenth century, and perhaps in all of human history.

SUMMARY

Historical Sketch

Darwin begins his book with a brief historical overview of evolutionary thought prior to the publication of the present volume, focusing on writings that promoted the malleability of species. He includes a brief reference to Aristotle, then speaks of Lamarck and his belief in the evolution of all species, including man, and notes that he advocated such ideas as the inheritance of acquired characteristics, the disappearance of organs through disuse, and the spontaneous generation of simpler organisms. Geoffroy St. Hilaire believed that changes in organisms were caused by the environment, but that such changes no longer occurred today. W.C. Wells proposed a theory of natural selection to explain certain human characteristics such as skin color, using selective breeding in animals as an analogy. Rev. W. Herbert had argued that God had created one species of each genus, which had then evolved into the presently-existing varieties. He continues to mention other works, including the anonymous *Vestiges of Creation*, which appears to have promoted a theistic version of what today would be called Punctuated Equilibrium. Herbert Spencer, later the chief proponent of Social Darwinism, had by this time already argued for the modification of species, including the evidence of embryology among his supporting ideas.

Dr. Schaaffhausen argued that the absence of intermediate forms is due to extinction, so that existing organisms evolved from those that have since become extinct, while T.H. Huxley argued against what is now called Progressive Creation, noting that it lacked any foundation in either science or revelation.

Introduction

In the Introduction, Darwin notes that the thinking that led to the publication of this work was stimulated by his observations while serving as a volunteer naturalist on the voyage of H.M.S. *Beagle* around the coast of South America 22 years earlier. He also credits Charles Lyell and Dr. Hooker for encouraging him to publish his conclusions, and notes that the present work is a mere abstract, lacking the scholarly apparatus that a full work would require. Before summarizing the content of the book, he notes that, while naturalists before him had recognized the mutability of species, they had failed to provide an adequate explanation for the observed changes – a problem he hoped to remedy with his theory of natural selection. He does acknowledge that much supporting evidence is yet to be gathered, but is confident that when such evidence has been compiled, his theory will be firmly established.

Chapter I - Variation Under Domestication

Darwin begins the first chapter with the observation that variation in domesticated plants and animals is greater than exists in nature, and argues that differences in conditions of life must cause this variability. He also notes that variability does not diminish over time, as cultivated plants continue to vary no matter how much variation has already occurred. Variations depend both on the nature of the organism and on the conditions in which it lives, with the former seeming to be of greater importance in definite variations, which affect all members of the species, while the latter is more important in indefinite variations, which affect only individual organisms. He notes that the reproductive system is particularly susceptible to environmental influences, since domesticated animals reproduce freely in captivity, while wild animals cannot easily be bred under the same circumstances.

He then argues for the inheritance of acquired characteristics, citing as examples the thicker wing bones of wild ducks and the larger udders of domesticated cattle. He also notes the peculiar fact that certain seemingly-unrelated variations almost always occur together, such as long limbs and long heads or pink bones and black skin in pigs. While he argues that almost all traits are inheritable, he admits that traits that cannot be inherited are of no interest in the context of his theory. Lack of knowledge of the laws of inheritance he considers to be a serious drawback (the science of genetics was unknown in 1859), but he speculates that the appearance of inherited characteristics at the same stage of development in the child as in the parent supports the evidence of embryology as an indicator of evolutionary development. He then responds to those who would argue that acquired and thereafter inherited characteristics are lost through the process of reversion when domesticated species are turned out into the wild by noting that any reversion that may occur is due to changes in environment, so that reversion could only be an effective argument if it occurred while the species continued under domestication.

Darwin then notes the difficulty of distinguishing between varieties and species among domesticated animals and plants; scientists disagree about what constitutes a species, and such

distinctions are largely empirical in nature. He then goes on to argue that the enormous variety among domesticated creatures exists despite the fact that they all are variations on a single wild species, though there may be some exceptions (he admits that dog breeds may descend from several species rather than just one). But if significant variation can occur among the domesticated descendants of a single species, why should wild species not be capable of the same degree of variation? Furthermore, cross-breeding is incapable of producing the observable variations in a way that allows them to be transmitted to offspring, as the author has demonstrated with the breeding of pigeons. He goes on to give examples of widely-divergent variations in domesticated pigeons (so great that, were they to be observed in the wild, they would be labeled as distinct species), then argues that all varieties must descend from a single wild species, the rock pigeon, since to argue the contrary would lead to the conclusion that primitive societies had domesticated eight different species of pigeon, all of which have now become extinct, which is highly improbable. He further argues that, because cross-breeding often produces characteristics not possessed by either parent, and because all breeds of pigeon can easily be cross-bred to produce fertile offspring, all must come from a common wild antecedent. He admits, however, that breeders of animals, birds, and plants in his day would almost universally believe that the differences they observe indicate distinct rather than single sources for the creatures with which they are so familiar.

He then argues that domestic races are produced, not by natural variation due to environment or habit (acquired characteristics) alone, but by the purposeful accumulation of minute changes by human breeders. He notes that such purposeful breeding to perpetuate certain characteristics has a long history, even citing Jacob's efforts in this direction in Genesis 30:31-43. Even breeders who only wish to breed the best animals of whatever kind eventually wind up altering the species over the long term. Unconscious selection also occurs through the greater survival rates of better individuals, which then reproduce and pass on their traits; this unconscious selection is evidenced by the superior quality of domestic plants to their wild forebears. He also notes that, because beneficial variations are relatively rare, large numbers of organisms are more likely to allow planned improvement of the species, especially when breeders pay close attent6ion to small variations and prevent accidental cross-breeding. He also notes that, while limits probably exist with regard to certain characteristics (e.g., speed and size), infinite variety is possible with regard to the number of characteristics that may be altered.

Chapter II - Variation Under Nature

Darwin begins his chapter on variation in nature by attempting to distinguish between the use of the term *species*, which is generally understood to be "an unknown element of a distant act of creation," and *variety*, which implies community of descent, though such connections cannot be proved. He also speaks of *monstrosities* (what today are called mutations), noting that they are generally harmful to the organism and are rarely inheritable, though he continues to argue for the inheritability of at least some acquired characteristics.

Individual differences, however – traits that differentiate offspring from the same parents – are inheritable, and thus form the basis for natural selection. Darwin argues that such variations can sometimes be significant, involving important body parts, and accuses those who deny that such differences are ever important of circular argumentation, since they define important body parts as those that never vary within a species. In fact, some species show such a large degree of

variation that they are sometimes thought to be several species rather than one. He believes that these variants can be shown to be connected though continuous gradation, and that all exist simultaneously because they neither contribute to nor detract from the survival of the species. Darwin goes on to note that so much disagreement exists between different naturalists' identifications of species as distinct from varieties that the difference becomes a mere matter of opinion with no firm scientific foundation. He argues instead that tremendous continuity can be seen from individual differences to varieties to sub-species to species that one might conclude that he is observing a continuous process; rather than species being specially created and then branching out into a limited range of varieties, one should conclude that individual differences have the potential to become varieties, varieties to become sub-species, and sub-species to become species, though of course not all do so. Such conclusions are also supported by the fact that the greatest variations are seen in species that have been the most frequently studied and are the most numerous and wide-ranging. Dominant varieties, or those which become incipient species, appear to have a competitive advantage over similar varieties of the same organism, and thus become more numerous in the struggle for survival (here Darwin introduces a concept that he will develop later). Organisms that become dominant also exist in environments conducive to their growth and success. Furthermore, though species formation is a slow process, one may conclude that the process is ongoing. While the existence of intermediate forms has usually led naturalists to identify all as part of one species, the absence of such forms has not prevented such an identification if the differences between organisms are small enough. Darwin then says that he will explain why smaller differences between varieties develop into larger differences between species of the same genus.

Chapter III - Struggle for Existence

Darwin now embarks on the task of explaining how minor differences between organisms, whether they be described as variations, sub-species, or species, develop into greater and more distinct differences. This leads him to comment on the struggle for existence, in which competition for scarce resources leads those organisms with characteristics better suited to survival to outdistance their weaker rivals, and thus reproduce and pass on their advantageous qualities. This he refers to as Natural Selection, or Survival of the Fittest. The competition he describes is not often carried out by direct battles between organisms of the same or different species, but rather involves acquiring the resources, such as food and water, that are needed for survival, by whatever means necessary. This struggle for existence is inevitable because each organism produces far more offspring than can possibly survive (he relies on the theory of Thomas Malthus concerning the geometric growth of population here); in fact, the number of offspring depends on the survival rate, so that organisms where the offspring have a high mortality rate must produce numerous progeny in order to sustain their numbers.

What checks the growth of any species? Growth is checked, not only by the scarcity of food and water and climatic conditions, but also by being preyed on by other organisms. Darwin gives several examples of the interdependence of organisms in an ecosystem, noting, for instance, that the number of clover plants depends on the number of bumblebees, which vary according to the number of mice, which will decrease in the presence of numerous feral cats, so that the number of cats can influence the kinds of flowers that grow in the meadow outside a town. If the competition between predator and prey influences the numbers of any given species, how much

more so will the varieties of a single species competing for the same sustenance? Surely those with the competitive advantage will soon drive out those with inferior qualities. Furthermore, the structure of organisms is closely related to the ecosystem in which they live, though we would be hard-pressed to imagine the kinds of changes that would suit each creature to thrive in a different environment.

Chapter IV - Natural Selection; or the Survival of the Fittest

This chapter is really the heart of Darwin's work, because in it he describes the mechanism by which change in the natural world occurs. He begins by defining Natural Selection, then responds to critics who think the term denotes some purposeful intelligence by insisting that he means no such thing, and is saying no more by the phrase than a physicist would say when he speaks of the law of gravity ruling planetary movements. Differences occur, for whatever reason, and the most beneficial variants survive long enough to reproduce because of the competitive advantage they obtain from their differences. While such changes should be more easily observable in an isolated ecosystem such as an island, they can even without isolation produce changes even greater than those resulting from selective breeding of plants and animals by man because of the much larger time frame within which Nature operates. He notes as well that sexual selection plays a role in differentiation, since males with characteristics that lead to more frequent mating - strength and ferocity in carnivores, brilliant plumage or striking songs in birds - will pass those characteristics to their offspring; he even argues that most differences between males and females of any given organism can be explained by this process. Furthermore, he argues that, because sexual differentiation is advantageous to plants, situations such as that found in the holly tree, where some plants are male and some female, would have been produced gradually by natural selection. In fact, the great changes wrought by the perpetuation and accumulation of small ones correspond to phenomena observed in geology, where a slow and gradual process of erosion produces deep valleys and steep cliffs. He finishes the subsection by arguing that natural selection eliminates both Progressive Creation [one version of modern theistic evolution] and Punctuated Equilibrium [Stephen Jay Gould's view, often dubbed the "Hopeful Monster Theory" by critics], though without using those contemporary terms in doing so.

Darwin then notes that with most organisms reproduction occurs by the union of a pair of individuals, though most plants are hermaphrodites. He then argues that, because union with organisms of other varieties produces strength in a species and close interbreeding weakens a strain, no organism can continue for many generations to fertilize itself; even hermaphrodites must at least occasionally join with other individuals in reproduction. Thus plants that are able to fertilize themselves occasionally are fertilized by others when insects carry pollen from a flower on one plant to one nearby. At this point Darwin notes that, while pollen from a variety of the same species is present, it takes precedence over pollen from the same flower, but pollen from another species yields to home-grown pollen. As far as animals are concerned, land animals never fertilize themselves, and, though aquatic creatures are often hermaphrodites, the flow of water clearly allows for cross-fertilization.

The author then asserts that variability in a species is advantageous to survival because the production of more varieties enhances the chance of the appearance of a beneficial one. On the other hand, an organism that fails to adapt will die out, driven to extinction by stronger competitors. He further argues that variations tend to become dominant in a restricted area, while

other varieties will dominate elsewhere because of different prevailing conditions. Among organisms that travel between the two regions, intermediate varieties will undoubtedly appear, but these will over time be eliminated by one or both dominant variations. These dominant variations will thus distinguish themselves more and more from neighboring varieties so that they will eventually become distinct species. Furthermore, varieties that differ the most from one another have the greatest chance of survival because they will not be competing for the same resources. While isolation can assist the production of a new species, it is by no means essential; in fact, largeness of area is far more important - continents produce far more new species than islands. On the contrary, isolated regions tend to preserve old species that have been driven to extinction in regions containing more variety of life. In fact, the entire process of natural selection makes the extinction of less-favorable forms as inevitable as the production of new species.

Darwin then speculates on the effects of natural selection on the descendants of a single ancestor. He presents a chart showing how variations of a single organism can, over time, produce more significant variants, and eventually distinguishable species - as many as eight over a period of more than *fourteen thousand* generations [Young Earth advocates clearly need not apply, though modern evolutionists would find Darwin's numbers here remarkably conservative!]. He then notes that the diagram is an oversimplification: intermediate forms may survive for long periods and some varieties may continue without change for a significant amount of time. Not only will a number of new species be produced from a single organism, but an organism of the same species will over time be equally prolific, producing many related species; thus two species from the same genus will produce two new genera. Furthermore, another originally-related species may continue unchanged, and thus appear to be an intermediate form between the two new genera. This is not the case; instead, the organisms share a common descent. Extrapolating this concept over *millions* of generations produces a history of life on earth corresponding closely to the geologic strata visible in the earth's crust.

Natural selection thus leads to the improvement of organisms and the progress of the organization of life as a whole. Darwin here admits, however, that the concept of "improvement" is hard to define, since naturalists differ on what they consider to be the "highest" kinds of fish and plants, though all agree that, among animals, those closest to man in structure and intelligence must be the highest. Darwin then argues that specialization of organs is the clearest measure of advancement and that natural selection tends to produce it, though he admits that progress sometimes renders some organs superfluous, thus leading to a decrease in specialization as an organism evolves. He then addresses the obvious question raised against his theory: If natural selection produces advancement while rendering less-developed variations extinct, why do simple forms of life still exist? His answer is that ecosystems have plenty of room for the survival of simple organisms, so that for them greater organization is not an advantage; thus they do not evolve. Besides, even lower forms of life are marvelously complex [Intelligent Design advocates would clearly agree here . . .]. Darwin then extrapolates backward, noting that natural selection could in fact explain the emergence of all the organisms presently in existence from unicellular organisms in the dim and distant past [He doesn't include man yet, though that is the obvious conclusion of his argument; *The Descent of Man* was published eleven years after *The Origin of Species*]. He then concludes the chapter by responding to two frequently-raised questions: Couldn't natural selection as easily produce convergence of traits as divergence? Wouldn't his system lead to an almost infinite number of species on earth? His answer is that convergence is impossible because it would produce similar organisms competing for the same resources, both

of which could not survive, and that the number of species must be limited, both by the characteristics of any given physical environment, and by the fact that successful species tend to drive out and destroy unsuccessful ones. Furthermore, species extinction requires far less time than species creation. He then notes in closing that the apparent hierarchy of organisms, allowing them to be divided into classes, orders, families, genera, and species according to their similarities to and differences from one another, could not possibly be explained by independent works of creation, but can easily be explained by the working of natural selection. Finally, he speaks of the great Tree of Life as illustrating the hierarchy of all living things, starting from a unitary beginning, branching into great variety, with new branches forming from small twigs and other branches falling off over time.

Chapter V - Laws of Variation

Here Darwin notes that the cause of variations, though it may be spoken of as a matter of chance, may more adequately be ascribed to unknown forces. Such forces are probably more related to the reproductive system of the organism than to the environment, though the latter obviously plays a part. He then argues that use or disuse of a body part also influences its growth and retention. Flightless birds, for example, have lost the need to fly in order to obtain food or escape predators, so their legs have become stronger and their wings weaker. These changes he ascribes both to natural selection and to the inheritance of acquired characteristics. He also argues that climate must be a factor, since different species of the same genus exist in very different climatic conditions and these must have descended from a common ancestor. On the other hand, organisms have often been successfully transplanted from one climate to another, so that competition with other organisms must be a more powerful factor than climate alone in the survival of a species. In fact, the ability to adapt to different climates must be a widespread quality of organic life.

The author then moves on to speak of correlated variations – differences in one organ that seem in some way to correspond to differences in another. While these are sometimes related (larger pelvic region and larger kidneys), often they are not; why, for instance, are blue-eyed white cats often deaf? Often these correlations are unrelated to utility, and thus impervious to natural selection. Darwin goes on to argue that such connections can be explained by the economy of nature – if more energy and nutrition are used to develop one part of the body, some other part must naturally be deprived. Perhaps, in fact, natural selection is a process of economy in which the organism seeks the most efficient use of resources, though one need not necessarily conclude that the development of one part will always accompany the degeneration of another, or vice versa.

Darwin then observes that structures that appear on an organism multiple times tend to vary more than structures that appear few times (vertebrae in snakes vary, while legs in primates do not), unspecialized organs vary more than specialized ones, and simple organisms vary more than complex ones. Furthermore, when extraordinary characteristics appear in an organism, those characteristics tend to be highly variable. Over time, natural selection fixes those qualities that are most advantageous, but while change is still rapid, wide variations continue to appear. Evidence for this is seen in the fact that specific characteristics (those relating to one species) are more variable than generic ones (those relating to an entire genus). Furthermore, the appearance in one species of qualities belonging to another of the same genus is evidence of common descent,

leading one to suspect that the reappearing quality has remained somehow latent in the species that does not normally possess it. He cites as evidence the presence of faint zebra-like stripes in some specimens of donkeys and horses, especially in the young. In response to those who would argue that God had created distinct species with the capacity to display characteristics of similar species over time, Darwin argues that this would be to charge God with the same kind of deception associated with those who argue that fossils never lived, but were created already embedded in the earth at its beginning.

Chapter VI - Difficulties of the Theory

Darwin now addresses what he perceives to be difficulties in the theory he has proposed. The first is the lack of transitional forms – organisms exist in well-defined species rather than a continuum as one would expect. Secondly, how can one explain an organism gradually evolving from another whose habits and structure are widely different? A third objection has to do with behavior rather than structure: How can natural selection be thought to produce instinctive behavior? A fourth problem relates to fertility – varieties can cross-breed without hindrance, but different species produce sterile offspring when crossed. He then goes on to address the first two of these objections in the present chapter.

His response to the first problem is that superior forms tend to crowd out their inferior progenitors and force them into extinction, thus explaining the lack of transitional forms. If one were to object that the fossil record ought to contain evidence of these transitional forms, the author would point out the paucity of fossil evidence, which cannot be assumed to contain a complete record of life on earth. But what of closely-related species that exist now in contiguous regions? Why are not living transitional forms observable today? He proposes continental drift as one possible explanation, but recognizes that such a theory still does not address present conditions. Instead he argues that transitional forms tend to exist in narrow geographical regions and in relatively small numbers, and furthermore exist only for a short period of time before being exterminated.

As far as unique habits and structures are concerned, Darwin admits that a creature such as the bat poses peculiar difficulties. How does "an insectivorous quadruped" evolve into a flying bat, and how could transitional forms have ever survived long enough to evolve at all? He here admits that supporting evidence for such changes is sparse indeed (flying squirrels and lemurs?), and that only a long list of examples would suffice to give people confidence in his explanation. As far as habits are concerned, he argues that diverse habits may be observed among the members of a single species, and gives the example of woodpeckers. Furthermore, like some web-footed geese that rarely go near water, habits change without corresponding changes in structure.

He then admits that imagining that complex structures like the eye could arise by natural selection is indeed difficult [he here is responding to the teleological argument proposed some fifty years earlier by William Paley]. Gradations do exist, however, and though he can explain how nerves become sensitive to light no more than he can explain the origin of life itself, he nonetheless is convinced that natural selection is the mechanism by which even complex structures were produced. He even gives an encomium to the Creator as he marvels at the beauty and complexity of natural selection and its works. Further support is then adduced from the fact that similar structures can alter functions in transition from one organism to another. Thus, versatile organs in simple organisms could acquire specialization over time. He sees evidence of this in the presence of vestigial structures in the developmental stages of embryos.

The author then addresses special problems, such as the existence of neuter insects incapable of reproduction and strange creatures like fish with electrical properties, especially since such fish are not closely related to one another, nor are their electrical capacities structurally or functionally similar. Darwin argues that, since common descent is unthinkable, each species must have evolved electrical properties separately. A similar problem arises with luminescent insects. In any case, nature produces a wide variety of structures for obtaining similar results or performing similar functions, though he admits that real innovation is almost never observable. Why, he asks, should such variety of means for performing similar functions exist if each species was an independent creation?

Darwin then addresses the problem of unimportant structures, and notes that our knowledge of the functions of different parts of organic beings is so limited that we should hesitate to describe any structure as nonessential. Cannot even the tail of a giraffe, which functions as nothing more than a flyswatter, enable organisms that have a large one to retain their strength more readily by driving off pests? Furthermore, characteristics can take on greater importance when further perfected in subsequent generations. In the end, however, we must plead ignorance concerning the uses of many structures that we observe in the creatures around us.

But what of beauty? Must all structures be utilitarian, or can they exist simply to delight God and man? Darwin's theory requires that all structures must have served, at least at some time in the past, some utilitarian purpose. Mere beauty for the sake of beauty, it seems, is fatal to his theory. Beauty, after all, is in the eye of the beholder, and is neither innate nor inalterable. If beauty had been created for the benefit of man, one must conclude that beauty did not exist in the vast geological ages before man appeared on the scene [note the circular argument here]. Besides, beauty aids in reproduction of both plants and animals.

Chapter VII - Miscellaneous Objections to the Theory of Natural Selection

In this chapter, Darwin deals briefly with miscellaneous objections to his theory. These include the following:

- Some argue that since longevity is a clear benefit to any organism, one would expect alterations to show increasingly long lifespans [contra. biblical genealogies, for example]. He responds that as much benefit could be accomplished by perpetuation of seed or offspring in short-lived organisms.
- Others object that Egyptian monuments show little change in animals from that region over thousands of years. Darwin's response is that some organisms have changed little from one glacial age to the next, but that this means only that no more beneficial variations have arisen in that time.
- How can a variety coexist with its parent species? This can be explained by slight differences in environment.
- Varieties differ from one another in many particulars. How can these changes have been produced simultaneously by natural selection? Darwin argues that the alterations need not be simultaneous.
- Some characteristics seem to be of no inherent benefit to the organisms that possess them. How can these have come about through natural selection? The response is that we should not quickly conclude that structures are of no benefit, either now or in the past, and that changes in certain characteristics can produce corresponding changes in others.

- Some argue that natural selection is unable to explain incipient forms of structures that will become useful at later stages of development [note that Intelligent Design advocates make this same argument in connection with cellular structures]. Using the example of the giraffe's neck, Darwin answers that gradual change would have allowed those with the longest necks to survive while shorter-necked variants would have died out [This begs the question, and certainly cannot address the issue on a cellular level]. Darwin himself then admits that he knows of no reason why long-necked quadrupeds have not evolved in regions other than Africa if the ability to reach high branches is so valuable for survival. The same problem arises when considering that life on some islands has never produced land-dwelling mammals, even though aquatic and flying mammals (e.g., seals and bats) are common, though Darwin suggests that such mammals would gain no advantage by restricting themselves to life on land.
- Another objection to natural selection is that, since highly-developed mental powers are obviously advantageous, why have more organisms not developed them? Why, in fact, have apes not developed the mental capacity of human beings? Darwin here refuses to speculate, noting that the same could be asked of the varying mental capacities of different races of man.
- How can natural selection explain the close resemblance of some insects to the plants on which they conceal themselves? The author suggests that accidental similarities, leading to longer survival, have tended to be perpetuated and augmented.
- How would baleen, the bony structures in whales used to filter out tiny organisms, have first appeared? Darwin proposes that perhaps such structures developed from the kind of sifting mechanisms found in the beaks of certain ducks, which are used to filter edibles from muddy lake bottoms.
- What of fish with both eyes on one side of their heads? How could such a structure have evolved, especially since in its early stages such visual imbalance must have been deleterious? The response is that such fish are symmetrical in early life, but are unable to remain upright and fall to the sea bottom, then twist their bodies to be able to see with both eyes, in the process moving the lower eye slightly toward the upper side in the cartilaginous head [he again depends on the inheritance of acquired characteristics here]. And what of prehensile tails? They, too, come to be inherited as a result of development through the habit of grasping.
- What of mammary glands? Darwin's explanation is that mammals evolved from marsupials, which have mammary glands inside their pouches; these gradually became external in mammals. Earlier, these evolved from cutaneous glands in fish, by what means he is unable to explain.
- What about the snapping function of the arms of a starfish? The motion is so complex that one cannot imagine any small part or seminal form of it being of sufficient value to be retained by natural selection. Darwin's response is that such structures are but modified spines, such as are found on sea urchins.
- The beak of the tarantula provides another problem; here Darwin admits that no transitional forms exist, but insists that such must have occurred nonetheless, since intermediate forms can be observed for the pincers of crustaceans, which perform a similar function.

- What about climbing plants? Darwin argues that the ability to rotate slightly and the quality of sensitivity to touch can be found occasionally in non-climbing species, and that such could be the foundation for natural selection to produce climbing varieties. He notes, however, that climbing plants differ so much from one another that they could not have evolved from a single source, but must have developed independently within the ancestry of each species.
- Why have so many species not developed organs that would be of such obvious advantage to them? Darwin's response is that we do not know enough of the developmental progress of any organism to answer such a question, given the complexity of minute changes involved in any adaptation.

The critic named St. George Mivart who raised most of the objections addressed in this chapter, which was added to the final (1872) edition of Darwin's work, apparently did so in order to promote a theory of sudden drastic change in opposition to natural selection [ironically, such a view has perforce been espoused by some modern evolutionists in light of the paucity of evidence that Darwin so confidently asserted would eventually surface]. Darwin rejects this as preposterous because it would require that several individuals of the newly-emerged species should appear in the same place at the same time. He admits, however, that the geological record appears to support such sudden emergences, though at the same time arguing for the severely incomplete nature of extant fossil remains. He then turns to embryology to support his theory, arguing that dramatic and sudden changes could not have occurred without leaving their mark on the embryo, which clearly has not occurred. Such assertions, in fact, smack more of miracle than of science.

Chapter VIII - Instinct

The chapter begins with a disclaimer: that the author has no intention of dealing with the origin of instincts and other mental powers, but only addressing the way they vary in related organisms. [This gap is only less significant than the failure to explain the origin of life itself, about which Darwin is also notably silent.] He also makes no attempt to define what he means by *instinct*, noting that the word can be used to describe varying unconnected behaviors, but is willing to assume a general common understanding of the term among his readers. He also distinguishes between instincts and habits, noting that, while the latter can on occasion be inherited by descendants, many instincts show no signs of having been acquired through practice at all. The main point of the chapter, however, is that instincts vary, though often very slightly, and as such may be presumed to be subject to the power of natural selection in their alteration over time. Such diversity can be shown to exist, though Darwin admits the disadvantage of not being able to know anything of the instincts of extinct species, thus being limited in tracing possible gradations.

He then gives examples of acquired habits or differentiated instincts being inherited by offspring - some cats chase mice while others chase birds, pointers point and shepherds herd, and furthermore, such characteristics continue to appear even in cross-breeding: a dog whose grandfather was a wolf refuses to come in a straight line when its master calls. Darwin then speaks extensively of three striking examples - the cuckoo laying its eggs in the nests of other birds, red ants making slaves of black ants, and bees building geometrically-complex hives. In his discussion of the cuckoo and other parasitic birds, he argues for the inheritance of acquired characteristics and notes favorably the imperfect parasitism of some varieties as evidence of

transition. Similarly, he argues that slave-making behavior could have been developed and then inherited, and again notes variations in relationships and division of labor between master ants and their slaves of different species. With regard to the bees, Darwin comments on the gradations observable from the simple rough cylinders of bumblebee hives to the hexagonal prisms of the hive bee, with many variants in between.

The author next addresses objections to his explanation of the evolution of instinctive behavior. To those who would argue that multiple instinctive adjustments would have to be made at the same time to have any benefit, he responds that such would not be necessary if changes were gradual rather than abrupt, and we recall that behavioral changes would perforce accompany structural ones. After passing over objections similar to those addressed in the last chapter, he focuses on one particularly difficult example: that of sterile insects, neuter forms that do not reproduce, yet are essential to the life and health of the colony. With regard to worker ants and bees, the neuter organisms differ significantly in structure and instinctive behavior from the fertile males and females. How can such characteristics be transmitted if those that possess them are sterile? Darwin's answer is that natural selection is applicable to the community as well as to individuals within it. As supporting evidence, he cites plants that produce flowers, some of which are sterile and some of which are not, on the same stalk. He proposes a similar argument even when neuter insects show considerable variety of structure and function among themselves, even to the point of being readily divisible into distinct castes, citing an example of observable gradations between two castes of workers in a particular species of ant. After listing a few other extraordinary instincts that he believes can also be explained by natural selection, he concludes with a summary law applying to all living beings: "Multiply, vary, let the strongest live and the weakest die."

Chapter IX - Hybridism

Darwin now turns to the problem of hybridism, noting that the offspring of most cross-bred organisms are sterile, and that such sterility cannot possibly have resulted from natural selection, since it in no way contributes to the perpetuation of the organism. In fact, it seems to perpetuate the purity of any given species by working against corruption or change. The author first notes that the question of whether species are able to produce offspring at all through cross-breeding is different from that of the sterility of offspring that are so produced. This distinction he sees as important because so many use it as a means of distinguishing between varieties and species – a distinction that he earlier argued was very difficult to make.

He begins by observing that the line between fertility and sterility is not absolute, but shows varying gradations; so much so that leading authorities arrive at contradictory conclusions when attempting to distinguish between species and varieties on this basis. He goes on to argue that sterility among hybrids could be caused by too close interbreeding rather than by too great differences. In fact, some species are more fertile when crossed with other species than when fertilized by one of their own, and some hybrids are notoriously fecund [note that all of his examples so far in this chapter have been taken from hothouse horticulture]. Much less evidence exists for animals, though Darwin notes that both the ability of animals to cross-breed and the sterility of the offspring appear to be much higher than in plants. He argues, however, that domestication appears to increase the fertility of hybrids, since domestic animals such as dogs and cattle can cross-breed freely and produce fertile offspring, though they must be descended from several distinct wild species in the distant past.

Some have argued that success in cross-breeding depends on the systemic affinity of the species, but Darwin argues that such is not always the case, since some widely different species can be crossed successfully, while some with apparently great affinity have never produced hybrids. On the other hand, affinity clearly fails as an absolute indicator because some organisms cross very well between the male of one species and the female of the other, but when a reciprocal cross is attempted (female of the first with a male of the second), the experiment has always failed. Furthermore, hybrids that closely resemble one of the parent organisms are more likely to be sterile than those with intermediate characteristics. Grafting follows many of the same rules. Darwin thus concludes that the ability to cross-breed organisms and the fertility of the resulting hybrids is due to incidental characteristics of the reproductive systems of the organisms rather than to something innate in organisms that is intended to keep them distinct and prevent confusion of species.

What might these incidental characteristics be? Darwin suggests three possibilities capable of explaining failure to cross-breed: the male and female members are physically incompatible, the male member is incapable of fertilizing the female member despite making contact (for reasons unknown), and the embryo, once formed, is unable to survive. Hybrids, on the other hand, are often sterile because their sex organs are underdeveloped, though no one can explain why some hybrids suffer from such deformities while others thrive and reproduce without difficulty. This explanation does not suffice for reciprocal crosses or hybrids closely resembling one parent, however. While acknowledging that he has no explanation for why some hybrids thrive and others do not, he insists that widespread evidence shows that crosses between organisms that differ slightly promote the health of the species, while crosses between those too closely related weaken the offspring. He then adds that the fertility of different forms of dimorphic and trimorphic plants is fully parallel to the behavior of crosses and hybrids, thus demonstrating that sterility is not caused by differences in the organisms, but by differences in their reproductive members.

Continuing to argue against the validity of using fertility as a means of distinguishing separate species from varieties, Darwin agrees that varieties of the same species are generally fertile when crossed, but notes that, when crosses of similar organisms turn out to be sterile, they are immediately defined as separate species, which significantly undermines the power of the distinction. Nevertheless, some examples of varieties incapable of cross-fertilization can still be cited, which Darwin then does. He thus concludes that sterility of crosses and hybrids cannot be used to distinguish between varieties and species, but that such phenomena must be due to changes in the reproductive systems of the organisms that cannot at the present time be explained.

Chapter X - On the Imperfection of the Geological Record

Darwin now tackles what he acknowledges to be the most serious argument against his theory - the fact that intermediate forms do not exist throughout the geological record. He believes that the cause of this paucity of evidence is the imperfection of the geological record itself. Before addressing specific issues, however, he comments on the sort of evidence one should expect to find. Instead of searching for intermediate links between two present species, one should look for a common ancestor with intermediate links to both. These common ancestors will almost always have become extinct, having been beaten out by their better-adapted offspring. The intermediate forms, however, surely must have existed in the past.

He turns first to the problem of the vast amounts of time required for such huge changes to occur very slowly and gradually. Citing Lyell's *Principles of Geology*, he notes that the slowness with which erosion and sedimentation occur gives us some idea of the extreme age of the earth, surely totaling millions of years. He then notes that selective breeding can produce significant changes in domestic animals in a century; how much more could nature have produced in more than ten thousand times the span?

Nonetheless, the fact remains that fossil evidence is paltry at best. Some species are known only by tiny fragments, while for others our knowledge is based on a few samples collected from a single location. Darwin reminds the reader that organisms composed of soft matter only cannot be preserved, while organisms under water will soon decay apart from sedimentation. Furthermore, fossils exposed to wind and rain will deteriorate. Also, for some unknown reason, some very old and thick sedimentary beds contain no fossil remains at all. One possible explanation is that large time intervals elapsed between the formation of consecutive layers of sediment, so that organisms that lived during the time when no sediment was being deposited would have decayed rather than being preserved. He then argues that most fossils must have been formed under shallow seas where the rate of sedimentation approximately equaled the rate of subsidence.

Why, then, do single formations not show the gradations one would expect in a given location from the forms existing at the bottom to those found at the top, even where samples of the same species can be seen throughout? Darwin rejects the idea that species change so slowly that rock strata would not record the changes. Instead, he argues that changes in climate and migration can more readily account for gaps in the fossil record and the appearance and disappearance of certain species in any given formation. In fact, in order for a single formation to record the gradual evolution of a given species, that species would have had to have inhabited the region throughout the time when the formation was being constructed, and the process of sedimentation must have been going on continually throughout the entire time - a most unlikely prospect. Furthermore, paleontologists have a tendency to identify as separate species any organisms, however, similar, that are found in different strata of the same formation unless connective links are also present, which, for the reasons enumerated above, is not likely to occur.

The author next addresses the oft-remarked phenomenon of large numbers of related organisms suddenly appearing in one stratum of a formation that did not appear in the ones below it. He admits that, had these all appeared at the same time rather than evolving from a common ancestor, such fossil evidence would be fatal to his theory. He responds, however, that the imperfection of the fossil record requires that we not assume that, just because given organisms left no remains in previous strata, they did not exist during the time periods represented by those strata. Here he also objects to his opponents arguing from negative evidence ("if no evidence of an organism exists in a given stratum, it must not have existed at that time"), though he himself does exactly the same thing ("if no evidence of an organism exists in a given stratum, it must have existed during the interval between deposits or have existed in a different locality").

The final problem he addresses in the chapter is the existence of fossil remains from many different parts of the animal kingdom in the lowest strata of rock deposits [this is what evolutionists today refer to as the Cambrian Explosion]. If his theory is correct, life on earth must have existed for at least 140 million years before the Cambrian period and left no record in the process. Yet this hardly seems to be sufficient time for the evolution of all the species found in Cambrian rock. He suspects, however, that because the early earth was subject to much more

rapid and violent changes than is the case today, changes in living organisms must have been correspondingly accelerated. He has no explanation, however, for the fact that such early organisms left no fossil remains. [Darwin believed the Cambrian period existed 60 million years ago; modern evolutionists have multiplied that number by ten, placing it nearly 600 million years ago, but still have not found fossil remains prior to that time with the exception of bacteria].

Chapter XI - On the Geological Succession of Organic Beings

Having disposed of the arguments against his theory from the fossil record, Darwin now turns to ways in which the geological evidence supports natural selection. As more fossil beds are discovered, evidence accumulates to support the slow and gradual changes in species. Some species change faster than others, and some appear to have changed little, if at all, but most show observable alterations. Furthermore, once a species becomes extinct, it never reappears; Darwin explains apparent exceptions as cases of migration from another location. The same rules apply to genera and families of organisms.

With regard to the extinction of species, he remarks that catastrophism has generally been rejected, even by those geologists whose views would lead them to seek it as an explanation for extinction. Explaining extinction is another matter. Why one species becomes extinct and others do not is a mystery, aside from the general observation that something in the environment must have been unpropitious to its survival, and thus it was crowded out by a more successful competitor. The fact that species become rare before they become extinct, however, clearly argues against catastrophism. Evidence that appears to indicate the rapid extermination of a species, such as trilobites, is again explained away by noting the sparse and seemingly random nature of the fossil record.

Darwin now turns to the observation that changes in life forms throughout the world seem to have occurred simultaneously. Though species differ, organisms from the same families appear in the fossil record in the same order and for approximately the same duration (geologically speaking) in different geographical areas, though in some cases living organisms in America are barely distinguishable from fossil remains in Europe. This is true of sea creatures; at this point insufficient information is available to ascertain whether the same is true of land-dwelling or freshwater organisms. The inevitable conclusion is that the observed changes cannot be ascribed to alterations in local conditions, but must be due to some overarching law governing all organisms. That law is the law of natural selection.

The author now points out the similarities that exist between extinct and living organisms. All extinct organisms fit either into or between contemporary classifications, and thus serve as missing links between existing genera. He then cites examples of fossil creatures bridging gaps between pig and camel, whales and aquatic carnivores, and notes that certain dinosaurs bridge the gap between reptiles and birds. Natural selection readily explains these similarities, since it would argue that the “missing link” is the common progenitor of the organisms with which it shares some common characteristics, or at least that it appeared earlier on the evolutionary branch from which these organisms developed. As noted previously, we should not expect to find anything close to a complete record of these changes, given the spotty character of the geological evidence. On the other hand, the existing evidence of affinities between extinct organisms and contemporary ones is inexplicable by means of any other theory.

Darwin now argues that the increased specialization and complexity of contemporary organisms in relation to their fossil forebears supports the theory of natural selection. In response to the objection that some organisms show no change at all over eons of time, Darwin notes that they are ideally suited for their environments, thus have no need to change. After all, natural selection does not *require* alteration. As to the broader question of whether or not the overall organization of life on earth has advanced, he pleads ignorance because of the sparsity of the geological record. Besides, the judgment as to what forms of life are "more advanced" is somewhat arbitrary; even organization and specialization must take a back seat to the ultimate decisive factor - victory in the struggle for survival, which may at times be won by less-advanced organisms [So the cockroaches might conquer the earth after all!]. The outcomes of such struggles are ultimately unpredictable; no one would have been able to predict by examining structure and organization that the plants of the British Isles would succeed in driving out many of the native plants of New Zealand when transported there, for instance, while the converse may not be observed at all. He ends the section with an approving reference to the theory that embryos of modern creatures resemble extinct organisms of the same class, thus serving to trace the evolutionary history of the species - a topic to which he intends to return in a later chapter.

The relationship between extinct and living organisms is even stronger when one confines his attention to a single geographical area. This can be seen when comparing Australian fossil remains to marsupials or South American plated fossils to armadillos. He then notes that such similarities cannot be explained by the continuity of environmental conditions, nor can differences be explained by diverse environments. What unusual environmental conditions in Australia could possibly explain the fact that marsupials appeared there and nowhere else? In fact, marsupials did once inhabit Europe. As usual, natural selection provides the explanation for these observations, so that isolated populations become increasingly distinct from one another over time.

Chapter XII - Geographical Distribution

In dealing with the subject of geographical dispersion of organisms, Darwin begins by noting that neither the similarities nor the differences among organisms may be entirely explained by climate and physical environment. He uses the Americas as an example, remarking that great diversity of climate and physical conditions may be found there, that this diversity is parallel to conditions in the Eastern Hemisphere, yet the creatures found in the New World differ markedly from those in the Old that live in similar environments. Consequently, one might argue that barriers to migration serve as more important dividing lines separating distinct organisms than climatic differences. The obvious conclusion to this reasoning is that different species originated in different places on the earth. To argue that all species originated in the same place would require belief in miracles, according to Darwin. Instead, if explanations can be given for members of the same or similar species existing in widely-separated regions, the principle that each species began in one geographical location and then spread to neighboring regions by migration should be considered to be proved.

What factors, then, influence migration? Certainly climate changes and alterations in elevation of land masses, connections between islands and continents forming and breaking, and continental drift are all factors that can explain migratory patterns. He admits, however, that this joining and separating of land masses must have occurred in the distant past, before the existence of present species. He even argues that the distribution of species could form the foundation for speculation concerning the former alignment of land masses.

Not all migration occurs as a result of conjoined land masses, however. The author notes that plant seeds may migrate by floating on the sea, being transported on driftwood or icebergs, in the crops of dead birds or carried by live ones, or by migratory insects like locusts. Such explanations, however, must be limited to migrations of hundreds, rather than thousands, of miles. He further argues that the similarities of species found in widely-separated mountaintop environments may be explained by glacial ages during which such species were widespread, but survived only in alpine regions when the glaciers receded. But what of similar organisms that do not live in cold climates? Darwin explains these by noting that a tropical climate must have preceded the Ice Age, and that during this time, organisms that inhabit more moderate regions would have lived further north, and could have migrated between the hemispheres over the land bridge that at one time connected Alaska with Siberia.

Lastly, Darwin argues that glacial eras in the Northern Hemisphere appear to have alternated with those in the South. He suggests that these alternations could have been caused by slight changes in the inclination of the earth's axis, leading to changes in ocean currents, and then to climate changes in the two hemispheres. He notes that such patterns of climate change would explain the existence of similar organisms in the temperate climes, both north and south, and on the mountain peaks in tropical regions.

Chapter XIII - Geographical Distribution, continued

Darwin continues his discussion of geographical distribution by considering the problem of freshwater organisms. How do they spread over either land or ocean? They obviously have done so, for the same species exist in widely-separated geographical regions. Darwin proposes several mechanisms, including long-ago tropical ages when species could spread readily from the Antarctic throughout the Southern Hemisphere, tornadoes that carry fish from one body of water to another, floods that temporarily link bodies of fresh water, and principally birds, which carry seeds or fish eggs from one place to another in the mud on their feet or in their crops.

The author then turns to the problem of the inhabitants of oceanic islands. He notes that such islands contain far fewer species of organisms than do nearby continents, and that an unusually high percentage of these organisms are unique to the island environment. He explains similarities by migration (e.g., sea birds) and uniqueness by long periods of evolution in isolation from parent species. On the other hand, frogs, toads, and newts do not inhabit oceanic islands, which Darwin explains by noting that salt water kills them immediately, making migration impossible. He then asks why, if species were created separately, these should *not* exist in such environments? Furthermore, no terrestrial mammals (other than domesticated varieties) live on islands more than 300 miles from a continent. Flying mammals such as bats do inhabit these islands, however, which Darwin sees as clearly supporting migration as the means by which oceanic islands were stocked. In addition, islands separated by shallow waters have similar flora and fauna, while those separated by deep channels show far less similarity in their native life forms. Darwin explains this by suggesting that those separated by shallow waters must have been linked much more recently, and notes that such patterns of distribution are unintelligible on the basis of distinct creation of species. He also disputes the idea that former connection of oceanic islands to the nearest continents can explain these observations, for if such connections existed, the severing of the connections must have occurred long before the emergence of the species under consideration. And why should the inhabitants of oceanic islands resemble so closely those of

nearby continents, despite differences in climate, soil, and geography? The geography of the Galapagos Islands is very similar to that of the Cape Verde Islands, but their inhabitants are very different from one another, yet closely related to those of South America on the one hand and Africa on the other. Creation cannot explain such phenomena, but migration surely can.

Chapter XIV - Mutual Affinity of Organic Beings: Morphology: Embryology: Rudimentary Organs

Darwin begins this chapter by reiterating the idea that living organisms fall into natural groupings on the basis of certain common characteristics, and that this phenomenon can be explained readily by common descent. Previous attempts to argue that classification systems illustrated a divine plan or that they simply serve as a means of describing common characteristics fall short of providing a scientific explanation for *why* these things should be so. He then begins to make some observations about the peculiarities of classification. For instance, important functional characteristics, being common among many organisms, are not of great value for classification purposes, while vestigial organs, which have little or no functional value, are very helpful for classification, as are characteristics of embryos. Furthermore, classification has tended to be very flexible, with genera, for instance, being reclassified as families or sub-families when other similar organisms are discovered. All of this can be explained through descent with modification rather than by some unknown creative design. The arrangement of groups in any classification system is therefore ultimately genealogical. He uses the illustration of human languages and their interrelationships, arguing that a complete table of human languages would mirror genealogical relationships among the races of man.

The author then argues that some common features are analogical, and best explained by adaptation to similar environments, but are useless for classification purposes because they have nothing to do with common descent. For example, the fins of whales and fish are analogical, having nothing to do with common descent, but the shapes of the fins of different varieties of whales can be useful in tracing ancestry. An even more extreme example can be found in butterflies from widely-divergent species (or even genera or families) that mimic one another in appearance while living in the same environment; the similarities are analogical rather than reflecting common descent, yet natural selection explains the perpetuation of the mimicking varieties, since they are able to survive better than the ones of their kind that stand out. He closes the section by commending the work of Ernst Haeckel in connecting embryonic development to phylogeny.

Darwin then turns to morphology – the commonalities of structure that exist in related organisms. He notes that such commonalities can be easily explained by common descent, but that adaptation and divine design cannot explain, for instance, why the arms of all mammals have a similar skeletal structure. Numerous minute variations over time, however, would explain the similar structures of arm, fin, and wing. Furthermore, similarities among structures in given individuals indicate variation over time, such as the apparent similarities between the bones of the skull and the vertebrae of advanced vertebrates or the jaws and legs of crustaceans. This suggests that multiple similar structures in simple organisms diversify to form varied parts retaining evidence of similar structure in more advanced ones.

Darwin then turns to embryology, describing it as “one of the most important subjects in the whole round of history.” He observes that, in early developmental stages, many organisms

look surprisingly alike despite the differences that will later emerge, while most look quite unlike the mature organism. Furthermore, embryos increase in the complexity of their organization as they mature, especially as they are required to act for their own survival. Add to these observations the fact that variations tend to occur later in life and that these variations appear in offspring at the same time they appeared in their parents, and an explanation for the similarities of embryos becomes apparent. Clearly organisms descended from the same stock are differentiated from one another only as they mature. The obvious conclusion is that the similarities of embryos of widely-divergent species provide evidence of a common origin. Because of these things, naturalists value examination of the embryo for purpose of classification more than examination of the adult organism. As far as organisms that undergo little or no metamorphosis are concerned, they clearly found it advantageous to acquire adult characteristics as early in life as possible in order to compete successfully in their environments. Darwin also admits that the paucity of geological evidence may forever prevent proof of the connection for which he argues.

The author now turns to the existence of vestigial organs, which he asserts are very common. Male mammals have rudimentary mammary glands, birds have false wings that contribute nothing to their flight, and fetal whales have teeth that never appear in the adult. Such useless appendages clearly could not have resulted from natural selection, for they contribute nothing to the organism's survival. They must, therefore, be surviving remnants of an earlier stage of evolutionary development. [Interestingly enough, Darwin refuses to recognize that *new* organs must in the early stages of development have been useless, in which case natural selection would have eliminated them; he instead argues that no evidence exists of such nascent organs because they would have been supplanted by more fully-developed ones]. Darwin then argues that rudimentary organs have shriveled due to disuse, then been inherited in this condition by offspring. Furthermore, organs that have become useless are unlikely to be further reduced in size by natural selection. Thus rudimentary [vestigial] organs are of great value in tracing the descent of organisms. According to Darwin, evolution can explain the existence of such organs, while creation cannot.

Chapter XV – Recapitulation and Conclusion

Darwin begins his final chapter by reviewing the major objections to his theory and summarizing his responses, then recapitulating the arguments in favor of the theory. He affirms that natural selection, though not the sole means of variation in organisms, explains so many observations that it could not possibly be false [ironically, he uses the wave theory of light as a supporting example – a theory that was seriously brought into question less than a generation later by Einstein's work with the photoelectric effect]. The author also argues that the inability of his theory to explain the origin of life [modern evolutionists have not been quite so reserved on this subject] is no drawback, since physicists are unable to explain the essence of gravity, yet no one doubts its veracity. He dismisses religious objections, noting that gravity, too, had its detractors on religious grounds (e.g., Leibniz). He is convinced that the major reasons why people are unwilling to admit the mutability of species are because of the large amounts of time required to support such a theory and the paucity of evidence connecting the purported changes. He then goes on to reject the idea that limited variations could have been caused by natural selection, but that larger ones could not have been; after all, where may one draw the line? He rejects as absurd the

miraculous introduction of new living organisms at widely-separated times in history, wonders whether such special creations involved one organism or many, infants or adults, and questions the credibility of full-grown organisms being created with evidence of maternal nourishment in the womb. Surely the philosophical doctrine of simplicity would favor the initial creation of few organisms rather than many. Darwin then notes that between the publication of the first edition of the book and the present [I'm using the sixth and final edition, published in 1872, thirteen years after the original], universal skepticism has been replaced by almost universal acceptance of some form of evolutionary development. He also argues against those who would affirm that "species have given birth, through quite unexplained means, to new and totally different forms" [what is today called Punctuated Equilibrium and is advocated by some evolutionists], noting that evidence is lacking, and that such an assertion has little advantage over a belief in special creation.

Darwin then addresses the question of how far his theory is to be extended. Though he has no definitive answer, he believes that descent with variation goes very far indeed, so that the entire animal kingdom and the entire plant kingdom may have arisen from a small handful of progenitors, and that, by analogy, animals and plants may have a common ancestor (after all, some simple organisms cannot with certainty be classified as plant or animal), so that all life on earth descended from a single primordial form.

He sees his theory as having the advantage of simplifying and reorienting biological classification issues and giving greater insight into human history and psychology. He argues that evolution accords better with what we know of the Creator, since death and extinction would then be due to secondary causes, thus ennobling the earliest forms of life on the planet. He is clearly optimistic about the future of life on earth, seeing evolution as progressing toward the perfection of man. The ending of the book is highly poetic, ascribing to the Creator and the laws by which life on earth has evolved the enormous variety of beauty with which the earth is filled.

NOTABLE QUOTATIONS

"I am well aware that scarcely a single point is discussed in this volume on which facts cannot be adduced, often apparently leading to conclusions directly opposite to those at which I have arrived. A fair result can be obtained only by fully stating and balancing the facts and arguments on both sides of the question; and this is here impossible." (Introduction, p.24)

"Although much remains obscure, and will long remain obscure, I can entertain no doubt, after the most deliberate study and dispassionate judgment of which I am capable, that the view which most naturalists until recently entertained, and which I formerly entertained – namely, that each species has been independently created – is erroneous." (Introduction, p.26)

"Changed habits produce an inherited effect." (ch.1, p.31)

"The laws governing inheritance are for the most part unknown." (ch.1, p.33)

"The key is man's power of accumulative selection: nature gives successive variations; man adds them up in certain directions useful to him." (ch.1, p.46)

"A well-marked variety may therefore be called an incipient species." (ch.2, p.66)

"I look at the term species as one arbitrarily given, for the sake of convenience, to a set of individuals closely resembling each other, and that it does not essentially differ from the term variety, which is given to less distinct and more fluctuating forms." (ch.2, p.66-67)

"But by steps hereafter to be explained, the larger genera also tend to break up into smaller genera. And thus, the forms of life throughout the universe become divided into groups subordinate to groups." (ch.2, p.72)

"Owing to this struggle, variations, however slight and from whatever cause proceeding, if they be in any degree profitable to the individuals of a species, in their infinitely complex relations to other organic being and to their physical conditions of life, will tend to the preservation of such individuals, and will generally be inherited by the offspring." (ch.3, p.74)

"Every single organic being may be said to be striving to the utmost to increase in numbers, [and] heavy destruction inevitably falls either on the young or the old, during each generation or at recurrent intervals." (ch.3, p.78)

"So profound is our ignorance, and so high our presumption, that we marvel when we hear of the extinction of an organic being; and as we do not see the cause, we invoke cataclysms to desolate the world, or invent laws on the duration of the forms of life!" (ch.3, p.82)

"The structure of every organic being is related, in the most essential yet often hidden manner, to that of all the other organic beings, with which it comes into competition for food or residence, or from which it has to escape, or on which it preys." (ch.3, p.85)

"This ought to convince us of our ignorance of the mutual relations of all organic beings; a conviction as necessary, as it is difficult to acquire." (ch.3, p.87)

"Can it, then, be thought improbable, seeing that variations useful to man have undoubtedly occurred, that other variations useful in some way to each being in the great and complex battle of life, should occur in the course of many successive generations. If such do occur, can we doubt (remembering that many more individuals are born than can possibly survive) that individuals having any advantage, however slight, over others, would have the best chance of surviving and of procreating their kind? On the other hand, we may feel sure that any variation in the least degree injurious would be rigidly destroyed. This preservation of favourable individual differences and variations, and the destruction of those which are injurious, I have called Natural Selection, or the Survival of the Fittest." (ch.4, p.89)

"Nature, if I may be allowed to personify the natural preservation or survival of the fittest, cares nothing for appearances, except in so far as they are useful to any being. She can act on every internal organ, on every shade of constitutional difference, on the whole machinery of life. Man selects only for his own good: Nature only for that of the being which she tends." (ch.4, p.91)

"What natural selection cannot do, is to modify the structure of one species, without giving it any advantage, for the good of another species." (ch.4, p.94)

"We are far from having any reason to suppose that many species ever undergo modification and improvement at the same time in the same area." (ch.4, p.95)

"Natural selection acts only by the preservation and accumulation of small inherited modifications, each profitable to the preserved being; and as modern geology has almost banished such views as the excavation of a great valley by a single diluvial wave, so will natural selection banish the belief of the continued creation of new organic beings, or of any great and sudden modification in their structure." (ch.4, p.102)

"The mere lapse of time by itself does nothing, either for or against natural selection. I state this because it has been erroneously asserted that the element of time has been assumed by me to play an all-important part in modifying species, as if all the forms of life were necessarily undergoing change through some innate law. Lapse of time is only so far important, and its importance in this respect is great, that it gives a better chance of beneficial variations arising and of their being selected, accumulated, and fixed." (ch.4, p.109)

"I do believe that natural selection will generally act very slowly, only at long intervals of time, and only on a few of the inhabitants of the same region. I further believe that these slow, intermittent results accord well with what geology tells us of the rate and manner at which the inhabitants of the world have changed." (ch.4, p.112)

"If species had been independently created, no explanation would have been possible of this kind of classification; but it is explained through inheritance and the complex action of natural selection." (ch.4, p.134)

"I have hitherto sometimes spoken as if the variations – so common and multiform with organic beings under domestication and in a lesser degree with those under nature – were due to chance. This, of course, is a wholly incorrect expression, but it serves to acknowledge plainly our ignorance of the cause of each particular variation." (ch.5, p.136)

"Adaptation to any special climate may be looked at as a quality readily grafted on an innate wide flexibility of constitution, common to most animals." (ch.5, p.143)

"If under changed conditions of life a structure, before useful, becomes less useful, its diminution will be favoured, for it will profit the individual not to have its nutriment wasted in building up an useless structure." (ch.5, p.148)

"There is a *tendency* in the young of each successive generation to produce the long-lost character, and that this tendency, from unknown causes, sometimes prevails." (ch.5, p.161)

"The crust of the earth is a vast museum; but the natural collections have been imperfectly made, and only at long intervals of time." (ch.6, p.166)

"To suppose that the eye with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I freely confess, absurd in the highest degree." (ch.6, p.176)

"How a nerve comes to be sensitive to light, hardly concerns us more than how life itself originated." (ch.6, p.176)

"Let this process go on for millions of years; and during each year on millions of individuals of many kinds; and may we not believe that a living optical instrument might thus be formed as superior to one of glass, as the works of the Creator are to those of man?" (ch.6, p.179)

"If it could be demonstrated that any complex organ existed, which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down. But I can find out no such case." (ch.6, p.179)

"As two men have sometimes independently hit on the same invention, so in the several foregoing cases it appears that natural selection, working for the good of each being, and taking advantage of all favorable variations, has produced similar organs, as far as function is concerned, in distinct organic beings, which owe none of their structure in common to inheritance from a common progenitor." (ch.6, p.185)

"It is a common rule throughout nature that the same end should be gained, even sometimes in the case of closely-related beings, by the most diversified means." (ch.6, p.187)

"Some authors maintain that organic beings have been formed in many ways for the sake of mere variety, almost like toys in a shop, but such a view of nature is incredible." (ch.6, p.187)

"It certainly is true, that new organs appearing as if created for some special purpose, rarely or never appear in any being." (ch.6, p.189)

"They believe that many structures have been created for the sake of beauty, to delight man or the Creator (but this latter point is beyond the scope of scientific discussion), or for the sake of mere variety, a view already discussed. Such doctrines, if true, would be absolutely fatal to my theory." (ch.6, p.193)

"If it could be proved that any part of the structure of any one species had been formed for the exclusive good of another species, it would annihilate my theory, for such could not have been produced through natural selection." (ch.6, p.196)

"Maternal love or maternal hatred [e.g., in bees], though the latter fortunately is most rare, is all the same to the inexorable principle of natural selection." (ch.6, p.198)

"This conclusion [sudden large modifications], which implies great breaks or discontinuity in the series, appears to me improbable in the highest degree." (ch.7, p.237)

"One class of facts, however, namely, the sudden appearance of new and distinct forms of life in our geological formations supports at first sight the belief in abrupt development. But the value of this evidence depends entirely on the perfection of the geological record, in relation to periods remote in the history of the world. If the record is as fragmentary as many geologists strenuously assert, there is nothing strange in new forms appearing as if suddenly developed." (ch.7, p.239)

"The embryo is thus left almost unaffected, and serves as a record of the past condition of the species." (ch.7, p.239)

"Many instincts are so wonderful that their development will probably appear to the reader a difficulty sufficient to overthrow my whole theory. I may here premise that I have nothing to do with the origin of the mental powers, any more than I have with that of life itself." (ch.8, p.241)

"The general sterility of crossed species may safely be looked at, not as a special acquirement or endowment, but as incidental on changes of an unknown nature in their sexual elements." (ch.9, p.298)

"Independent of the question of fertility and sterility, in all other respects there seems to be a general and close similarity in the offspring of crossed species, and of crossed varieties. If we look at species as having been specially created, and at varieties as having been produced by secondary laws, this similarity would be an astonishing fact. But it harmonises perfectly with the view that there is no essential distinction between species and varieties." (ch.9, p.301)

"What geological research has not revealed, is the former existence of infinitely numerous gradations, as fine as existing varieties, connecting together nearly all existing and extinct species. But this ought not to be expected; yet this has been repeatedly advanced as a most serious objection against my views." (ch.10, p.321)

"If numerous species, belonging to the same genera or families, have really started into life at once, the fact would be fatal to the theory of evolution through natural selection." (ch.10, p.323)

"To feel no surprise at the rarity of a species, and yet to marvel greatly when the species ceases to exist, is much the same as to admit that sickness in the individual is the forerunner of death - to feel no surprise at sickness, but, when the sick man dies, to wonder and to suspect that he died by some deed of violence." (ch.11, p.338)

"The geological record, at all times imperfect, does not extend far enough back to show with unmistakable clearness that within the known history of the world organisation has largely advanced." (ch.11, p.351)

"The geological succession of extinct forms is nearly parallel with the embryological development of existing forms." (ch.11, p.353)

"He who admits the doctrine of the creation of each separate species, will have to admit that a sufficient number of the best adapted plants and animals were not created for oceanic islands; for man has unintentionally stocked them far more fully and perfectly than did nature." (ch.13, p.393)

"Extinction has only defined the groups: it has by no means made them; for if every form which has ever lived on this earth were suddenly to reappear, though it would be quite impossible to give definitions by which each group could be distinguished, still a natural classification, or at least a natural arrangement, would be possible." (ch.14, p.427)

"On the ordinary view of the independent creation of each being, we can only say that so it is; - that it has pleased the Creator to construct all the animals and plants in each great class on a uniform plan; but this is not a scientific explanation." (ch.14, p.430)

"It is highly probable that with many animals the embryonic or larval stages show us, more or less completely, the condition of the progenitor of the whole group in its adult state." (ch.14, p.442)

"We learn from the study of our domestic productions that the disuse of parts leads to their reduced size; and that the result is inherited." (ch.14, p.448)

"Nothing at first can appear more difficult to believe than that the more complex organs and instincts have been perfected, not by means superior to, though analogous with, human reason, but by the accumulation of innumerable slight variations, each good for the individual possessor. Nevertheless, this difficulty, though appearing to our imagination insuperably great, cannot be considered real if we admit the following propositions, namely, that all parts of the organization and instincts offer, at least, individual differences – that there is a struggle for existence leading to the preservation of profitable deviations of structure or instinct – and, lastly, that gradations in the state of perfection of each organ may have existed, each good of its kind. The truth of these propositions cannot, I think, be disputed." (ch.15, p.452)

"Nature may be said to have taken pains to reveal her scheme of modification, by means of rudimentary organs, of embryological and homologous structures, but we are too blind to understand her meaning." (ch.15, p.469)

"I see no good reason why the views given in this volume should shock the religious feelings of anyone." (ch.15, p.470)

"Any one whose disposition leads him to attach more weight to unexplained difficulties than to the explanation of a certain number of facts will certainly reject the theory." (ch.15, p.471)

"Little advantage is gained by believing that new forms are suddenly developed in an inexplicable manner from old and widely different forms, over the old belief in the creation of species from the dust of the earth." (ch.15, p.473)

"I cannot doubt that the theory of descent with modification embraces all the members of the same great class or kingdom. I believe that animals are descended from at most only four or five progenitors, and plants from an equal or lesser number." (ch.15, p.473)

"The crust of the earth with its imbedded remains must not be looked at as a well-filled museum, but as a poor collection made at hazard and at rare intervals." (ch.15, p.476)

"In the future I see open fields for far more important researches. Psychology will be securely based on the foundation already well laid by Mr. Herbert Spencer, that of the necessary acquirement of each mental power and capacity by gradation. Much light will be thrown on the origin of man and his history." (ch.15, p.477)

"As all the living forms of life are the lineal descendants of those which lived long before the Cambrian epoch, we may feel certain that the ordinary succession by generation has never once been broken, and that no cataclysm has desolated the whole world. Hence we may look with some confidence to a secure future of great length. And as natural selection works solely by and for the good of each being, all corporeal and mental endowments will tend to progress toward perfection." (ch.15, p.477)

"Thus, from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows. There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved." (ch.15, p.478)

ESSAY QUESTIONS

Discuss the following in a five-paragraph essay:

1. Charles Darwin was clearly a theistic evolutionist. What evidence can be found in *The Origin of Species* to support this claim? Why do modern evolutionists so vehemently reject any hint of belief in a Creator?

2. Many attempts have been made in recent years to modify Darwin's theory of evolution, including theistic variants such as Progressive Creation and Intelligent Design and non-theistic ideas like Punctuated Equilibrium. Interestingly enough, Darwin addresses different aspects of these in *The Origin of Species*. How does he respond to these ideas, and to what extent are his criticisms valid in today's scientific environment?

3. In Charles Darwin's *The Origin of Species*, he often expresses hope that evidence presently lacking in support of his theory will be forthcoming in the years ahead. This is particularly true with regard to geology and the fossil record. To what extent has his optimism been justified? How convincing are his explanations for the paucity of supporting evidence?

4. In Charles Darwin's *The Origin of Species*, the author often makes comparisons between domesticated animals and wild species, particularly in reference to the selective breeding of domestic varieties and its implications for changes that occur in nature. To what extent is the analogy between domestic and wild organisms appropriate? Evaluate the arguments he builds on this connection.

5. A number of the central arguments that appear in Charles Darwin's *The Origin of Species* have since been rejected by modern biologists, including the inheritance of acquired characteristics, the evolutionary significance of embryology, and the value of vestigial organs in tracing evolutionary development. To what extent does the failure of these arguments bring into question the entire theory, or should we conclude, as modern evolutionists contend, that the evidence for the theory is strong enough to uphold it even if these supporting arguments are no longer accepted?

6. How severely was Charles Darwin's *The Origin of Species* handicapped by the author's lack of knowledge of genetics? Does present knowledge of the subject strengthen or weaken Darwin's arguments? Why?

7. An important aspect of the central argument in Charles Darwin's *The Origin of Species* is the impossibility of clearly drawing a line distinguishing one species from another. How does the existence of flexible and indefinable boundaries between species help his argument? How would an opponent of evolutionary theory respond to Darwin's assertion on this subject?

8. In chapter two of Charles Darwin's *The Origin of Species*, he argues against the use of mutations (what he calls "monstrosities") as a useful explanation for changes that occur in species. On what basis does he reject this argument, so common among contemporary evolutionists? How valid is his argument as a response to supporters of his theory today?

9. Discuss the extent to which the competition for scarce resources is a vital part of the theory promulgated in Charles Darwin's *The Origin of Species*. Be sure to incorporate related ideas such as natural selection, the survival of the fittest, and the overproduction of offspring in your discussion.

10. To what extent does Charles Darwin's *The Origin of Species* depend on the views of nature found in the works of Thomas Hobbes, Thomas Malthus, and Charles Lyell? In what ways does the validity of their views of the state of nature, reproduction, and geology affect the validity of Darwin's famous theory?

11. In Charles Darwin's *The Origin of Species*, the author clearly has no respect for Catastrophism as an explanation for geological or biological phenomena. Why not? Assess the arguments he uses, which clearly are directed against the biblical teaching of a universal flood among other things.

12. To what extent is the argumentation in Charles Darwin's *The Origin of Species* dependent upon vast amounts of time? The chronological speculations of Darwin have been dwarfed by his contemporary followers, of course. To what extent is this dependence on undefined eons one of the causes of the prevalence of Young Earth teaching among Christians?

13. In Charles Darwin's *The Origin of Species*, the author often cites evidence that he believes can readily be explained by natural selection but is incapable of explanation by special creation. Choose three such pieces of evidence and evaluate Darwin's argument. What does he reveal about his understanding of special creation in the way these arguments are formulated?

14. Charles Darwin's theory of evolution has often been criticized as implying a chance universe. Darwin at times used the language of chance, but in *The Origin of Species* he repudiates the idea, insisting that he used the language as a sort of shorthand for unknown causes. Do you find his argument convincing? Why or why not? To what extent, if at all, does Darwinian evolution depend on chance?

15. In chapter five of Charles Darwin's *The Origin of Species*, he criticizes the idea of created age as a deception unworthy of Almighty God. Respond to this accusation and the way Darwin uses it. What assumptions underlie his evaluation of this common Christian argument?

16. In chapter six of Charles Darwin's *The Origin of Species*, he addresses some major objections to his theory. Choose three of these objections and evaluate his answers. How satisfactory are they? To what extent are they logically coherent and scientifically convincing?

17. At the end of chapter six of Charles Darwin's *The Origin of Species*, the author speaks of beauty, and notes that natural selection leaves no room for beauty unless it has utilitarian value. Yet, at the end of his famous book, Darwin praises the beauty and variety of living creatures on earth. How would you respond biblically to this most unscientific of human experiences?

18. In chapter six of Charles Darwin's *The Origin of Species*, he argues that the complexity of the human eye renders explanation by means of natural selection impossible. Later he says, "If it could be demonstrated that any complex organ existed, which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down. But I can find out no such case." To what extent does the Teleological Argument of William Paley cause Darwinian evolution to "ultimately break down"? What about the Intelligent Design concept of irreducible complexity?

19. In chapter six of Charles Darwin's *The Origin of Species*, he refers on several occasions to kinds of evidence that would utterly destroy his theory. Does such evidence exist? How, in this sense, is Darwin more honest than many of his contemporary disciples?

20. In chapter six of Charles Darwin's *The Origin of Species*, the author argues that natural selection makes no distinction between maternal love and maternal hatred, i.e., between good and evil. To what extent does such an assertion support the criticisms often raised against Darwinism of undermining the very foundations of morality? What evidence can you give from contemporary society of the validity of such charges?

21. In chapter seven of Charles Darwin's *The Origin of Species*, the author responds to miscellaneous arguments raised against his theory, mostly by an advocate of what today would be called Punctuated Equilibrium named St, George Mivart. Choose three of the issues Darwin addresses and evaluate the effectiveness of his arguments. To what extent do his coherent valid arguments undermine the contemporary theorizing of Harvard biologist Steven Jay Gould? To what extent do his weak arguments tend to undermine his own theory?

22. Charles Darwin, in his work *The Origin of Species*, makes no attempt to explain either the origin of life or the origin of consciousness and mental activity. How serious are these gaps with regard to the credibility of his theory? To what extent do these gaps continue to undermine the theory in its modern form?

23. In chapter eight of Charles Darwin's *The Origin of Species*, he deals with instinctive behavior. How critical is the fact that he must rely on the inheritance of acquired characteristics to explain the evolution of instincts? To what extent does this reliance undermine his entire theory?

24. In chapter eight of Charles Darwin's *The Origin of Species*, he attempts to explain the perpetuation of neuter organisms by hypothesizing the operation of natural selection on the level of the community rather than just the individual. How credible is this? To what extent does such an argument pave the way for Social Darwinism and its defenses of racial supremacy and imperialism?

25. Discuss the extent to which Charles Darwin in his work *The Origin of Species* depends on speculation and extrapolation to cross the boundary between microevolution and macroevolution. Choose three examples of arguments in which he does this and evaluate the validity of the leap in logic thus represented.

26. Evaluate Darwin's argument explaining the gaps in the fossil record in chapter ten of *The Origin of Species*. Pay special attention to his use of the concept of burden of proof. Is his use of this trick of logic valid? Why or why not?

27. Evaluate Darwin's explanation of the Cambrian Explosion in chapter ten of *The Origin of Species*. How convincing is his argument? Analyze the logic of the argument he presents for the absence of fossils before this time and the evidence of a great variety of complex organisms with no apparent forebears?

28. Evaluate the explanations of geographical distribution of organisms in chapters twelve and thirteen of Charles Darwin's *The Origin of Species*. Note that he immediately eliminates the possibility of all living things being created in the same place because this would require a miracle. He then argues for a combination of migration and natural selection to explain the observable phenomena. Might not the miracle of divine creation in one location plus migration *better* explain the conditions with which he seemingly struggles?

29. Discuss Darwin's treatment of morphology in chapter fourteen of *The Origin of Species*. Is he correct in affirming that creation cannot account for morphological similarities among diverse organisms? Why or why not? To what extent does his theory remedy this perceived defect?

30. In Charles Darwin's *The Origin of Species*, what assumptions does he make about science? What do we learn about his mindset when he repeatedly rejects Creationist explanations because they are not scientifically verifiable? Give and evaluate specific examples of his use of this form of argumentation.

31. Charles Darwin was optimistic about the future of the human race, even arguing at the end of *The Origin of Species* for ultimate perfectibility. Does his theory support such optimism? Why or why not? Is that optimism shared by modern evolutionists?

32. In the final chapter of Charles Darwin's *The Origin of Species*, he says, "I see no good reason why the views given in this volume should shock the religious feelings of anyone." What does this statement reveal about Darwin's understanding of religion in general and Christianity in particular? How are his religious sensibilities evident throughout the volume? Be sure to cite specific examples in your discussion.

33. Contemporaries of Darwin such as American botanist Asa Gray, biologist Louis Agassiz, and physicist William Thomson (Lord Kelvin) criticized *The Origin of Species* on theistic grounds. In what ways did their arguments differ? How effective were they in challenging Darwin's conclusions?

34. Asa Gray, in his review of Charles Darwin's *The Origin of Species*, argues that the burden of proof must lie on the shoulders of those who favor the transformation of species, and that "thus far the burden has been more than they could bear." Why must the burden of proof rest on the shoulders of evolutionists? Why have they failed to deal effectively with that burden? Why do contemporary evolutionists insist that the burden of proof instead must rest on the shoulders of those who argue in favor of divine creation and the relative fixity of species?

35. Asa Gray, in his review of Charles Darwin's *The Origin of Species*, argues that creationism, by its very nature, is not subject to scientific proof. Do you agree? Why or why not? To what extent does this explain the dissatisfaction of scientists, Darwin included, with creationist explanations for the forms of life that exist on earth?

36. Asa Gray, in his review of Charles Darwin's *The Origin of Species*, argues that the author's extrapolations weaken his argument. Gray says, "To command assent we naturally require decreasing probability to be overbalanced by an increasing weight of evidence. An opponent might plausibly, and perhaps quite fairly, urge that the links in the chain of argument are weakest just where the greatest stress falls upon them." Give examples from Darwin's work to support Gray's criticism. Where does he place the greatest emphasis on arguments for which direct evidence is notably lacking?

37. Asa Gray, in his review of Charles Darwin's *The Origin of Species*, argues that atheistic evolution is incapable of belief: "We cannot think the Cosmos a series which began with chaos and ends with mind, or of which mind is a result: that if by successive origination of species and organs through natural agencies, the author means a series of events which succeed each other irrespective of a continued directing intelligence, - events which mind does not order and shape to destined ends, - then he has not established that doctrine, nor advanced toward its establishment, but has accumulated improbabilities beyond all belief." Why did Gray argue that Darwin, who had made no attempt to portray a universe without God, had failed to demonstrate a universe without continually-operating divine intelligence? Flesh out Gray's objection with details from Darwin's influential work.

38. One critic of Charles Darwin's *The Origin of Species* argued that the theistic aspect of the author's theory was nothing but mere pretense. After all, Darwin saw the need for an intelligent Creator only to explain the origin of life, but after that relied on an impersonal law called Natural Selection. How long, then, until another scientist arises to give a naturalistic explanation for the origin of life itself, completely eliminating any need for God at all? The critic thus argued that Darwin's theory was inherently atheistic. Do you agree? Why or why not? Use examples of the theistic aspects of Darwin's seminal work to support your conclusions.

39. Shortly after the publication of Charles Darwin's *The Origin of Species*, the author, concerned about the negative reaction to the work among Christians, wrote to Rev. Charles Kingsley to solicit his opinion. Kingsley responded, "It's just as noble a conception of God to think that he created animals and plants that then evolved, that were capable of self-development, as it is to think that God has to constantly create new life forms and fill in the gaps that he's left in his own creation." What does Kingsley's response show about his understanding of evolution? of the Scriptures?

40. Richard Dawkins, and outspoken contemporary supporter of Charles Darwin's *The Origin of Species*, has called evolution by natural selection "arguably the most powerful idea ever." He explains the basic concept of evolution as follows: "Given sufficient time, the non-random survival of hereditary entities will generate complexity, diversity, beauty, and an illusion of design so persuasive that it is almost impossible to distinguish from deliberate intelligent design." Evaluate Dawkins' summary. Is it a faithful encapsulation of Darwin's theory? What does it indicate about the real direction in which the evidence of the natural world points, and thus about the weakness of evolution by natural selection?

41. Samuel Wilberforce, an Anglican bishop and critic of Darwin's *The Origin of Species*, argued that evolution by natural selection was incompatible with Scripture: "Man's derived supremacy over the earth; man's power of articulate speech; man's gift of reason; man's free will and responsibility; man's fall and man's redemption; the incarnation of the Eternal Son; the indwelling of the Eternal Spirit – all are equally and utterly irreconcilable with the degrading notion of the brute origin of him who was created in the image of God, and redeemed by the Eternal Son assuming to Himself his nature." Is Wilberforce's criticism valid? What about Darwinism, especially in its application to man, would lead to these conclusions?

42. Critic Ian Johnston recently asserted that "no single event in the history of our culture has had such a devastating effect on our political, intellectual, religious, and moral life as has the development of the modern understanding of the world given to us by biologists." He was referring, of course, to Charles Darwin's *The Origin of Species*. To what extent is this extreme statement justified? Consider the impact of Darwinism on the areas of life Professor Johnston enumerates.

43. Liberal Studies professor Ian Johnston, in his comments on Charles Darwin's *The Origin of Species*, noted that an amazingly large percentage of the population continues to find the foundational idea of modern biology untenable. He notes, "One might observe that there is a Darwinian explanation for the refusal to accept Darwinism. Given the very pessimistic conclusions about moral purpose to which his theory drives us, and given the importance of a sense of moral purpose in helping us cope with life, a refusal to believe Darwin's theory may have important survival value." Analyze Johnston's ironic observation and discuss what it reveals about the essence of evolutionary theory and the persistence of its critics.

44. Richard Owen, a contemporary of Darwin and the paleontologist who coined the word *dinosaur*, was very critical of Darwin's explanation for changes in species in *The Origin of Species*. One argument he proposed against the infinite malleability of organisms is that obvious advantages, like physical size and number of antlers on a buck, do not increase without limit, but stay within a certain range. How, then, he asks, can one be expected to believe that organisms change enough to develop from one species into another? Assess Owen's argument. How might Darwin respond to it? What evidence would he give? Is his evidence convincing? Why or why not?

45. Gordon R. Taylor, Chief Science Advisor to BBC Television, has argued that the title of Charles Darwin's *The Origin of Species* is misleading, since Darwin neither explains the origin of life itself, nor does he give direct evidence for the origin of a single species among the huge volume of examples he provides in his seminal tome. Is this a valid criticism? Why or why not? To what extent is Darwin's evidence based on suppositions and extrapolation? Support your conclusion with specific citations from Darwin's work.

46. In a letter to Christian botanist Asa Gray, Charles Darwin wrote the following: "With respect to the theological view of the question, this is always painful to me. I am bewildered. I had no intention to write atheistically. But I own that I cannot see as plainly as others do, and as I should wish to do, evidence of design and beneficence on all sides of us. There seems to me too much misery in the world." He then goes on to speak of wasps that lay their eggs so that the larvae feed on the living bodies of caterpillars and cats playing with mice. In other words, the problem of evil plagued Darwin as it has so many others through the ages. Does this denial of design thus make him a "deistic evolutionist" rather than a theistic one? Cite evidence from *The Origin of Species* to support your argument about how Darwin understands God's role in the world.

47. In 1872, the Zoological Section of the French Institute refused membership to Charles Darwin on the following grounds: "*The Origin of Species*, and still more *The Descent of Man*, is not science but a mass of assertions and absolutely gratuitous hypotheses, often evidently fallacious. This kind of publication and these theories are a bad example, which a body that respects itself cannot encourage." Evaluate the criteria given by this prestigious scientific association. What evidence do you find in *The Origin of Species* that would justify characterizing it as "a mass of assertions and absolutely gratuitous hypotheses"?