

## CHAPTER 12

### DARWIN'S HYPOTHESIS

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Darwin's hypothesis consists of two major arguments: That evolution had occurred, and that the mechanism of evolution was natural selection. Neither idea was original, but it was Darwin's linking the hypothesis that animals and plants had evolved to the hypothesis that this evolution was driven by natural selection that provided the logic necessary to interest the scientific community and beyond. Part of the first hypothesis depended severely on acceptance of the evidence that argued that the world was substantially older than 6000 years.

The structure of the world, before the exploration of the New World and the planet, seemed reasonably ordered. It was relatively easy to identify each species and to imagine that one could count all species and completely account for the menagerie on Noah's ark. However, the period of exploration made the definitions less clear. Were the gull of North America, which were lighter in color and had somewhat different markings, the same species as those found in Scandinavia? Questions such as these forced scientists to focus more on the meaning of the variability of species, and even the definition of the term "species" (see Chapter 5, page 68 and chapter 11). Thus the range of variation came under consideration, and with this, acceptance of the idea that, through human choice and control of breeding, one could generate immense variety in the appearance of dogs, chickens, pigeons, horses, cattle, etc. Darwin even devotes an extensive section of the first part of *Origin of the Species* to a discussion of pigeon breeding. Thus, as early as the 18th C, scientist-philosophers such as Buffon and St. Hilaire had hypothesized that species had evolved or changed with time, and anatomists such as the great Cuvier considered that the common features of the skeletons and musculature of all vertebrates derived from a common ancestry. However, based on the assumption that the world was 6000 years old, and observations of the number of generations it took to effect small changes in the appearance of domestic animals, the hypothesis that all varieties of all animals and plants had evolved from a common ancestor was simply absurd. The derivations must have been part of the act of Creation, or the relationships reflected simply God's (or a Designer's) reuse of the same tools and parts.

## HUTTON, LYELL, AND GRADUALISM

However, the search for precious metals, iron, and coal had led to an interest in the structure of the land, as discussed in Chapters 22 and 23. By the end of the 18th C, Hutton had identified various types of soil and rocks, such as old lava and sedimentary accumulations. He had learned to identify different formations—useful for predicting the location of minerals—and realized that they frequently corresponded across all of Europe. Charles Lyell, working on the principle that he promulgated as Gradualism, understood from Steno’s principles (Chapter 2, page 27 and Chapter 3, page 35) that upper layers were younger than deeper layers and, based on his observations of rates of erosion and sedimentation, tried to estimate how long it would take to build such layers. The numbers he came up with by far exceeded Biblical time. He even went to the New World to view its spectacular geography. From estimates of the rate at which Niagara Falls is receding or moving upstream, he calculated that it would take 35,000 years for it to have cut back the seven miles from the original face of the bluff. Using the same sort of estimate, he felt that it would have taken the Mississippi River 60,000 years to produce the delta of precipitated mud where it enters the Gulf of Mexico. It matters little that his calculations were substantially off, based on errors in his estimates of the rate of cutting of the falls and the depth of the delta. The point was that, when he published his *Principles of Geology* in 1830–1833, it had substantial impact. It argued cogently the hypothesis that many others had begun to consider, that the earth was considerably older than the biblical age. Most importantly, Darwin read the book during his voyage on the *Beagle*. Finding, as expected, fossil shellfish high in the mountains of the Canary Islands and Chile, he tried to calculate, using Lyell’s principles, how long it would have taken to lift shoreline to those heights. He came up with figures ranging from the 10’s of thousands to millions of years. His estimates, like Lyell’s, were not that accurate, but they accomplished something very important: they extended the time over which evolution could have occurred and, freeing the outer boundary from the biblical wall of 6000 years, they raised the possibility of much greater extensions of time.

## THE WEIRDNESS OF THE NEW WORLD

So there was time for evolution to have occurred. Was there really evidence that it had?

Exploration raised other questions. For instance, the New World contained strange animals like armadillos, primitive scaly mammals that roll up into a ball when frightened (Fig. 12.1).

Perhaps it was OK that God decided not to favor Europe with strange animals such as these, but what did it mean that there were fossil giant armadillos (the size of a Volkswagen “beetle”) in South America? If each species was created uniquely, one might expect that, for instance, armadillos once ranged widely in the world and that they now were confined to northern South America through the



*Figure 12.1.* Armadillo. This nocturnal creature is common from Texas southward through South America. Inset: Armadillo rolled into a defensive ball

southwest of the U.S.A. Why were the only fossils of these animals found in the same areas that modern armadillos were found? Was it possible that the modern armadillos were related to the fossils? Was it therefore possible that armadillos had evolved only in the new world, and that the modern small animal was a descendent of the larger fossil animal? If this were the case, why should one conclude that the giant armadillo resulted from an act of special creation, rather than that it too had evolved from something else? Georges Cuvier, at the beginning of the 19th C, had clearly stated that, in the fossil record, the further down one went from the surface of the rocks, the less the fossils looked like present-day life. He had suggested that current animals were not exactly like those at creation. Again and again Darwin encountered this problem, whether with all the fauna in the Cabo Verde Islands or with finches in the Galápagos Islands: unique groups of species, found in one location, with apparent affinity to different species from a nearby location. For instance, each of the finches in the Galápagos Islands is a distinct species, but they are clearly finches, and they have some resemblance to finches along the coast of Ecuador. If each is an act of special creation, why was this little group of special creations confined to one specific region? Would it not be simpler to assume that creation was a continuing process, that each variety of finch had not been individually created during the sixth day of creation, but rather that first there had been one type of finch, and that this type of finch gave rise to other types?

## THE RELATEDNESS OF ANIMALS

This type of reasoning quickly extends backward to some very provocative ideas. For instance, could finches have arisen from other types of birds? Birds are latecomers in the fossil record, and their bone structure is similar to that of some

dinosaurs, while the eggs of birds and dinosaurs are very similar. Could birds be related to reptiles? If this is the case, is it possible that the reptiles themselves came from something else? After all, there was an era in which the skeletons of amphibia (frogs, toads, and salamanders) but not reptiles are found. Etienne Geoffroy St Hilaire had argued that the similarity of vertebrate anatomies meant that they were indeed related, and Jean-Baptiste Lamarck had even suggested that one animal type transformed into another. Lamarck had argued that use or disuse of an organ or limb would determine whether it would grow or atrophy (wither). By the end of the 19th C, this argument of use was disproved and ridiculed, but at the time it made sense—after all, animal structures seem well adapted to the lifestyle of the animal—and Lamarck was, in the last analysis, a topflight and well-respected biologist. Nevertheless, the idea of special creation was so firmly embedded in western (and upper class English) thinking that, as Darwin coped with the implications of this train of thought, he began to realize that to abandon special creation for descent with modification was “like confessing a murder”.

### **SIMPLICITY IN SCIENCE: OCCAM’S RAZOR**

There is another element of scientific logic that was known to Darwin and also applies here. This is called Occam’s Razor. William of Occam (or Ockham) was a 14th C English logician and Franciscan friar, who argued that, if there were several possible alternative explanations of a phenomenon, the one that required the fewest assumptions was most likely the correct one. This principle would apply to the question of why so much of the structure of one animal was similar to that of another animal. For instance, in limbs as different as those of a frog’s foot, a bird wing, a bat wing, the flipper of a seal, a horse hoof, and the hand or foot of a human, the bone structure is very similar (Fig. 12.2) and one can recognize the basis of an original termination in the equivalent of five fingers. By the hypothesis of special creation, it would appear that God reused the basic plan, even though an engineer might have designed more effective support structures for the different uses of the limb. Even worse, one might suggest that the amphibian or reptilian version was a primitive version that was improved for mammals. While it might be flattering to assume that mammalian bone structure is the best possible or perfect one, does it make sense that God would make practice versions? Would the hypothesis of common descent be much simpler? That is, that the tetrapod (four-footed) bone structure appeared once in evolution, and that each of the many types of vertebrates contained a form of that original structure, which had been inherited and modified through the generations (descent with modification)? As Darwin had noted for himself in his notebooks, ‘Once grant that species...pass into each other....& whole [Creationist] fabric totters & falls’?

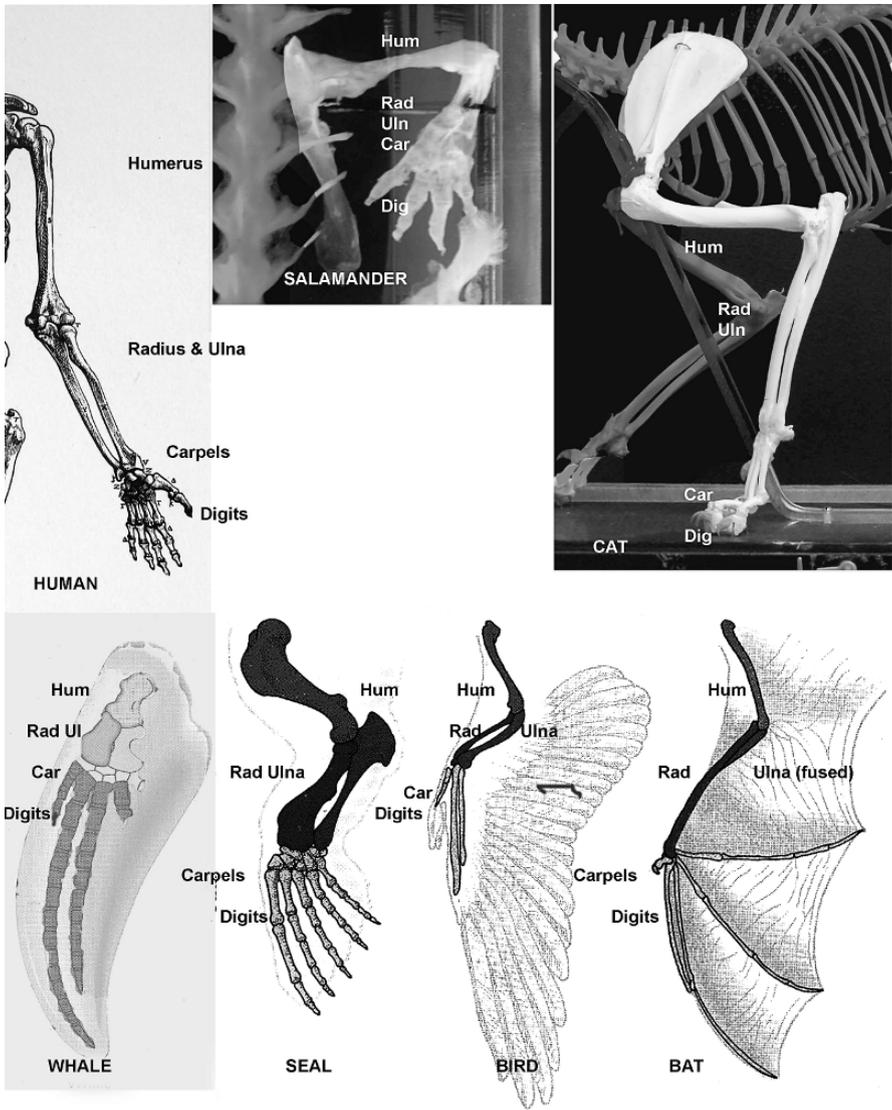


Figure 12.2. Limbs of various vertebrates (human, salamander, cat, whale, seal, bird, and bat). Although they serve different purposes (grasping, walking, swimming, flying) or have evolved independently to serve the same function (seal vs whale; bird vs bat), they all have the same bone structure. Credits: Modified from Gilbert S F, *Developmental Biology*, 8th Ed, Sinauer Press, Boston

## PUNCTUATED EQUILIBRIUM

By the time that Darwin published *Origin of the Species* he had accumulated sufficient evidence—and the logic of Malthus as well as the evidence from geology and physics was sufficiently convincing—that the hypothesis of natural selection was well received by the scientific community. There were of course many questions left unanswered. The mechanism for heredity was unknown (see Chapter 13), leaving a substantial gap in the total logic, and some who were uncomfortable with the hypothesis, including Lord Kelvin, argued against it, but by-and-large by the end of the century there was near-universal acceptance among scientists.

Why therefore is there still controversy? Much of course depends on the beliefs or preferences of individuals, but the argument focuses on two major issues. The first is a misunderstanding of the use of the word “theory” in science (see page 11), but the second is that “scientists still disagree about the theory of evolution”.

This latter point deserves some attention. Scientists, and especially biologists and geologists, do not “disagree about the theory of evolution”. In essence, everyone agrees that the earth is very old, that species have evolved from other species, and that among the important forces driving evolution is the fact that all species are capable of overbreeding. There is also no doubt that individuals of a species vary in ways that can affect their ability to survive and reproduce, and that much of this variation can be inherited. We will continue to explore the evidence linking species in subsequent chapters, but at this point we can concede that the essence of the theory of natural selection is widely if not universally accepted. Where evolutionists differ is over the relative importance of sexual selection (the means by which one sexual partner chooses its mate), the necessity of species to be separated into two groups (such as on an island and the mainland) for evolution to proceed, the relative importance of predators, as opposed to disease or random mutations, to force selection, whether or not natural selection can operate at the level of genes (a gene can be selected for even if the net effect is bad for the individual), whether or not there is competition such that there is selection for male genes that are disadvantageous to females and vice versa, and other such factors. These are essentially arguments over the mechanics of how evolution works, and they do not challenge the basic premise. Perhaps the most important of the disputes is over the concept of “punctuated equilibrium,” as presented by Stephen Jay Gould and Niles Eldridge. These authors, major theorists in evolution, argue that rapid bursts of change interspersed with long periods of stability are the norm rather than the exception. They argue that, for instance in the case of the trilobites, a major shift in environmental conditions—to some extent hypothetical, but backed by substantial general evidence—caused a rapid evolution of the group that produced the trilobites. Once they had appeared, they remained stable, with relatively little change, over the course of their 300,000,000 year history. Gould and Eldridge argue that this is the primary driving force of evolution: a major change in conditions on the earth creates a very difficult time for some or all creatures. Some of the most extreme variants can cope with the new conditions, and selection and evolution occur very rapidly in evolutionary terms (over a few million or tens of millions of years).

Once the tumult is over and the new variants have established themselves, they persist with extremely modest change until the next upheaval. This interpretation has substantial implications as we consider issues such as those of global warming, but it does not fundamentally challenge the theory of natural selection. It merely generates a new hypothesis as to the dominant forces for natural selection. As a scientific hypothesis, it is a good one, since it carries implicitly the appropriate tests to evaluate, such as verification that the evolutionary history of many more species is punctuated, but it does not challenge the evidence that evolution has occurred.

The concept of evolution is distinct from that of natural selection. There is essentially no doubt that evolution has occurred. The theory of natural selection is the best—and an extremely well substantiated—hypothesis describing the mechanism by which varieties that we see today were created. What is under discussion today is the details of the mechanism. As in all good science, one question leads to another, and we continue to burrow deeper into the meaning of the question. This issue is discussed further in Chapter 14, page 191.

## REFERENCES

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## STUDY QUESTIONS

1. Restate Darwin's hypothesis in your own words. Which elements are essential?
2. Make a prediction based on Darwin's hypothesis as you have phrased it in question 1. What would you expect to find?
3. What elements from earlier science were essential to Darwin's hypothesis? Explain.
4. Argue an alternative hypothesis as to why, for instance, fossils of armadillos are found only where armadillos survive today.
5. How was it possible for early geologists to argue for an older earth? What might have caused them to come up with numbers that today we consider to be incorrect?
6. What are some of the primary issues today in evolutionary theory? Argue for AND against the statement "Scientists still disagree about the theory of evolution". Do you think that your arguments are valid, even if you are not a trained scientist? Why or why not?