CHAPTER 4

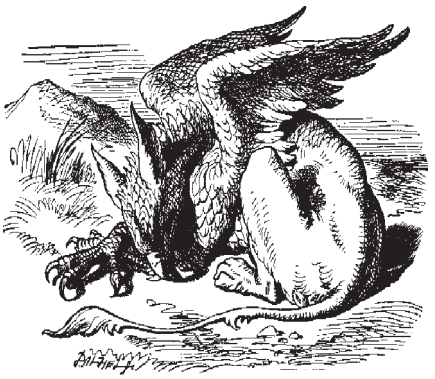
WERE KANGAROOS ON NOAH'S ARK?

EXPLORATION OF THE WORLD AND ITS EFFECT ON IMAGES OF THE STRUCTURE AND FATE OF THE WORLD

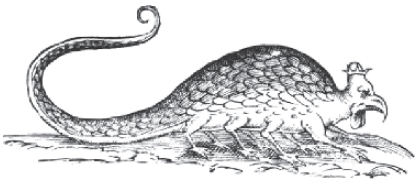
The Age of Exploration, or the Age of Discovery, seriously upset the Western European view of the world. As in other relatively confined societies, the primary theory of creation (the Judaic Genesis, accepted by Christians and Moslems) was reasonably consistent and unchallenged. There were contradictions and inconsistencies as well as earlier pagan legends that were similar enough to be considered ancestral, as is discussed in Chapter 2, page 21, but overall the story of the formation of the earth, night and day, plants, animals, and finally Adam and Eve, coupled with the Garden of Eden, Noah's flood, and sequence of the patriarchs did not seriously defy logic. The existence of marine fossils such as shellfish on mountaintops was known and, although Aristotle had correctly surmised that they indicated the lifting of land from the ocean floor, for the most part fossils were regarded as evidence of the Flood, indication of how life could be generated out of rock, or tricks of the devil. That some fossils were very different from modern animals and plants was not troubling. After all, few Europeans had seen an elephant or a giraffe, and these animals seemed no more-or-less fantastic than basilisks, manticores, or gryphons (Fig. 4.1).

There was one other issue, best explained by discussing a bit of biology from the standpoint of one of the great modern evolutionists. This is the apparently static nature of biology and the earth from a single vantage point.

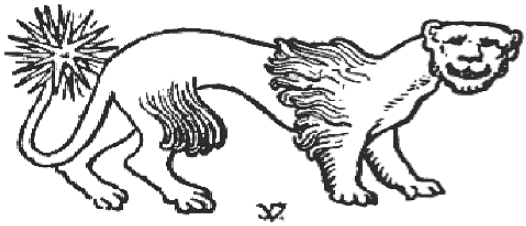
To a single human living in a specific location, the earth is quite stable. Muddy water might run down a hillside or mountainside, but the hill does not disappear; a river may overflow its banks and cut a new channel, but the river pretty much follows its primary course. Singularities in weather, such as major storms, droughts, floods, or earthquakes soon become legends and even myths. Ernst Mayr, who gave us the basis of our current understanding of the relationship among evolution, species formation, and genetics, emphasized that the same was true for our understanding of animals and plants. A given species might be more abundant in one year than in another, but overall the species was always there. As Jared Diamond has argued, even extinction usually passes unnoticed. The human generation in which a species has become extinct has known the species only as very rare, and has heard of its abundance only from ancestral tales. Thus Diamond, as a young man and expert



Gryphon



Basilisk



Manticora. From ancient Bestiaria.

Figure 4.1. Mythical creatures from medieval and early renaissance times. With limited ability to travel and otherwise explore the world, most literate people saw no important differences between creatures such as these and other fantastic animals such as the rhinoceros, the giraffe, or the crocodile. Credits: Gryphon - Gryphon illustration by Sir John Tenniel for Lewis Carroll's Alice in Wonderland (Wikipedia) Basilisk - Source: Ulisse Aldrovandi, "Monstrorum historia", 1642, Austrian National Library, Signature BE.4.G.23 (Wikipedia) Manticore - A manticore from an ancient bestiary (Wikipedia)

ornithologist (one who studies birds), counted all the birds he could identify on one island in New Guinea. Like Ernst Mayr who had preceded him, he asked the pre-literate tribesmen how many types of birds there were, and came up with essentially one-to-one correspondence. (Diamond recognized differences between two extremely similar species of moderate interest to the native population; the native people considered the two to be the same species. In at least one instance the New Guineans were more perceptive in distinguishing species than he was.) Diamond did not conclude that all his education and training had led to no greater sophistication than a pre-literate hunter. He concluded instead that, in a limited territory such as an island, species were quite distinct and easily discriminated. It was only when a zoologist ranged over larger territories and found geographical a zoologist variation—for instance, a frog from western North America might be bigger and fatter, with a slightly different coloring pattern, than a frog from the

East Coast—that it became difficult to tell where, in terms of shape or color, one species ended and another began. Such were the very disturbing observations of the explorers, conquistadors, and missionaries. The European world view was forced to change markedly. But first, let's take a brief look at this European world view.

CLASSIFYING THE SPECIES—IS THE WORLD FULLY KNOWABLE?

Noah took onto the Ark two of every species[3]; and these species came off the ark and repopulated the world. Despite the curiosity, which must have existed in medieval Europe, as to how lions and lambs got along, or plague locusts and wheat, or the jokes that also must have existed about why Noah bothered to take mosquitoes or rats along, it was perfectly within reason to assume that there was a finite number of animals and plants on earth. It would be laudable and even holy to compile a complete list of these organisms. Thus, motivated by theological as well as scientific reasons, Carl Linnaeus (sometimes referred to as Carl von Linné or Carolus Linnaeus), the Swedish father of taxonomy or system of classification, in 1735 (almost 250 years after Columbus' first voyage, and 41 years before the American Revolution) published his first effort to systematize the assorted botanical and zoological information of the period, and to compile a complete compendium of all living creatures. The system of classification was one we still use today, with what one amounts to as a family name and a given name. The equivalent to the family name ("Smith") is the genus name and would include, for instance dogs and wolves (Canis) or leopards and tigers (Panthera) while the equivalent to the given name would define the species itself (the common one, familaris). The name for a dog would therefore be *Canis familaris* (the genus is listed first and is capitalized, like an Asian family name, and the species name is listed second and both are italicized. Following the traditions of Linnaeus' time, all scientists use Latin, and the name simply translates from Latin as the common or familiar dog. We will discuss the problem of classification in greater detail in Chapter 5, page 55.

Linnaeus' self-imposed task was indeed Herculean, but he considered it to be finite—that is, there was an end to the project. It would be possible to identify

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[3] [Genesis 7, Revised standard Version] And Noah and his sons and his wife and his sons' wives with him went into the ark, to escape the waters of the flood. [8] Of clean animals, and of animals that are not clean, and of birds, and of everything that creeps on the ground, [9] two and two, male and female, went into the ark with Noah, as God had commanded Noah. [10] And after seven days the waters of the flood came upon the earth. [11] In the six hundredth year of Noah's life, in the second month, on the seventeenth day of the month, on that day all the fountains of the great deep burst forth, and the windows of the heavens were opened. [12] And rain fell upon the earth forty days and forty nights. [13] On the very same day Noah and his sons, Shem and Ham and Japheth, and Noah's wife and the three wives of his sons with them entered the ark, [14] they and every beast according to its kind, and all the cattle according to their kinds, and every creeping thing that creeps on the earth according to its kind, and every bird according to its kind, every bird of every sort. [15] They went into the ark with Noah, two and two of all flesh in which there was the breath of life. [16] And they that entered, male and female of all flesh, went in as God had commanded him; and the LORD shut him in. [17]

and classify all living things. Remember that he was working approximately 250 years after Columbus first reached the Americas. It seemed necessary to undertake this classification, because explorers were bringing back plants and animals that had not been known in Europe, and the list of known creatures was beginning to expand. The project, however, still seemed reasonable. However, clouds were beginning to appear on the horizon. We can describe it as the problem of the kangaroo.

The Australian kangaroo is a marsupial, meaning that although it is warm-blooded and fur-bearing, its young are born extremely immature and promptly migrate to a pouch, where they physically attach to a milk-producing gland that is not quite the same as the nipple of a true mammal. There are a few other differences that separate kangaroos, opossums, and their relatives from most other mammals. Using the kangaroo as an example is somewhat misleading, since the first kangaroos were not known to Europeans until 1770, but they illustrate the problem introduced by the raccoons, skunks, and opossums of the new world: How did they get from Noah's Ark to North and South America without being seen, either alive or as fossils, in Europe or the Middle East? One could adjust to the idea that, for instance, lions were seen in northern Africa or the Middle East but not in Europe because, after all, Europe was colder. It was theoretically possible for lions to be in Europe, walking across the land links of the Eastern Mediterranean. Lions simply did not like to be in Europe. However, the climate of North America was not that different from that of Europe, and there was no obvious reason why a raccoon or opossum or skunk could not live in Europe. The same could be said for the true cacti, the spiny flat, branched, or ball-like plants native to the New World deserts. Contrary to old cowboy films and popular images, they did not exist in European, African, or Asian deserts. The world could live without poison ivy (though for a brief period the English considered it to be an attractive houseplant), but creatures of considerable benefit to humans, such as corn, tomatoes, and potatoes, sugar cane, sunflowers, and chocolate, were quite popular among the natives of the New World, as was tobacco, but were unknown in the Old World. Why had God not given Europeans the benefits of tomatoes, potatoes, and corn? Surely the Ark was not a holy Greyhound bus, dropping off passengers on different continents.

Even the explorers were confused. The great explorers were courageous but also extremely knowledgeable people. They had to orient themselves on the ocean so that they would return, for instance, to Spain rather than going too far north and running into England or too far south and running into Africa; they had to be able to locate fresh water and to successfully hunt for food whenever they reached land; they had to locate trees suitable for repairing and waterproofing their boats (pitch pines, named for the waterproof sap they exuded); they had to be able to defend themselves or, preferably, barter and trade with people whose language they had never encountered. The translators, the physicians, the naturalists on these boats were very important members of the crew. Thus it was that Columbus, reaching Hispaniola (Haiti/Dominican Republic) knew that he had landed on an

island because there were no large mammals there—an astute observation that would be understood centuries later but nevertheless left the lingering question as to God's logic in not distributing large mammals onto islands. More perturbing, and even specifically noted by Columbus, was the silent or barkless dogs of the Caribbean.

The European view of the world (or, as we might say today, the environment) came very much out of Genesis 1:26.[4] All living things served mankind. Other cultures, in Asia, the Americas, and Africa, had different views, but Europeans understood that, though sometimes the value of something like a flea might be difficult to discern, in one way or another all creatures existed in the reflection of humans at the center of creation. And scholars had set about enumerating the "uses" of all creatures. For instance, the function of a dog was to protect the property of its master, by barking at and if necessary biting an intruder. What then was the "use" of a dog that didn't bark?

Then there was Cuvier. Between 1795 and 1832 Georges Cuvier was professor of animal anatomy at the Musée National d'Histoire Naturelle in Paris. He had recognized the relationship between form and function in an animal, and more importantly had recognized how everything was linked. For instance, a carnivore would most likely have good binocular vision to judge distance, sharp tearing teeth, strong jaws, sharp and strong claws together with strong limbs, and the short digestive tract of a meat-eater. Based on this understanding, Cuvier was considered, probably correctly, to be able to reconstruct a skeleton from a single bone. Since he was so erudite, his opinions were widely respected. His importance in the story of evolution is the following: He could also reconstruct the skeletons of fossils. These buried bones were being found more and more frequently. Cuvier could easily distinguish mammals from reptiles and birds, carnivores from herbivores, and so forth. Fossils were often incomplete, but he could reconstruct from a fragment of the animal its probable size and appearance. And what he found was deeply perturbing. He found that the reconstructions often led to probable animals that could be classified, or grouped into specific categories, but that the animals in these categories were distinctly different from living animals in the same categories. We now recognize this as part of the story of evolution, but in the sense of Noah's Ark, the focus of his argument was a bit different: the species he reconstructed from bones no longer existed. They had become extinct. How did extinction relate to Genesis? Were these creatures from before the Flood (ante-Diluvian)? Had they been carried on the Ark and later been abandoned by God? And how long ago did they disappear? Why would God have put creatures on this earth only to take them away?

Domestic animals were another puzzle. Dogs were dogs, but if an alien arrived on earth, would this alien really consider a Chihuahua or a dachshund to be the same as a St. Bernard or a greyhound or a poodle? Domestication is defined as

[4] Then God said, "Let us make man in our image, after our likeness; and let them have dominion over the fish of the sea, and over the birds of the air, and over the cattle, and over all the earth, and over every creeping thing that creeps upon the earth."

human control of breeding, and it was very clear that horses, cattle, goats, sheep, birds, and (in China) fish could be markedly altered by human choice of breeding partners. It was less obvious but at least intuitively understood that domestic crops could be improved and changed markedly from their wild ancestors by selective breeding. So, did Noah take on board a German shepherd or a poodle? By 1809 Jean-Baptiste Lamarck was arguing on this basis as well as that of Cuvier's fossils, that Linnaeus was wrong, that species were not fixed but could change over time. Lamarck proposed that animals and plants changed in response to their environment. He is subject to some ridicule today because we now know that he misinterpreted the causal relationships (see Chapter 12, pages 167–168) but in fact he was a highly intelligent, perceptive scientist who heavily influenced the theory of his time and led to later advances.

Thus the biology of the herbals and zoological books was becoming less and less certain. These concerns were joined with a similar growth of concerns regarding the physical world that had begun to grow in Eastern Europe. The Pole Nikolai Kopernik, better known by the Latin form of his name, Nicolaus Copernicus, in 1514, about 25 years after Columbus' voyage, proposed that the sun, not the earth, was the center of the solar system. Copernicus' ideas were not readily accepted, both for ideological reasons and for reasons having to do with the ELF rule: His evidence was not very good. Copernicus described perfectly circular orbits, but with the calculations of perfectly circular orbits the match to the actual paths of the planets was not exact. The great astronomer Tycho Brahe, who believed in epicycles (wheels spinning on the edges of other spinning wheels, Fig. 4.2) calculated epicycles that came far closer to matching the actual positions of the planets. Copernicus argued on the basis of Logic, similar to that of William of Occam, who argued that the simpler hypothesis was the one to be believed (Occam's Razor), that epicycles were an affectation. However, Brahe's Evidence was stronger. It was not until Johannes Kepler demonstrated that the

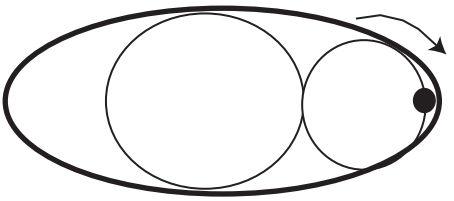

Figure 4.2. Epicycles. If one circle (or sphere) rolls along another, depending on the relative sizes of the two spheres, a single spot on the external sphere will appear to trace an ellipse through space or even go backwards. Since the trajectories of the planets as viewed from the earth follow such patterns, elaborate mathematical schemes based on the position of the spot were devised. Calculations such as those of Tycho Brahe predicted quite well the positions of the planets, but the theory was abandoned when Copernicus and later Kepler argued that there was no physical reason for epicycles and that a simpler model was orbits around the sun. As the concept of gravity developed, it became possible for Kepler to calculate elliptical paths based on the laws of motion and gravity. These proved more accurate than the calculations of Brahe

orbits of the planets were elliptical, that logic and evidence merged. The result of epicyclical movement would be an ellipse, but the hypothesis of an ellipse around the sun was much simpler than the hypothesis of epicycles around the earth. This argument continued to build for almost 100 years, until in 1609 Galileo received a telescope, which had recently been invented, and used it to demonstrate that the heavens were not constructed as had been believed. By 1612 Galileo was convinced that the earth revolved around the sun, leading to the well-known trial of 1616.

The stability of the earth was also less certain, and again the Age of Exploration had some impact. First, mapmakers had been making maps for a few hundred years. Although the outlines of the continents were rather imprecise, coastlines were important to sailors, and especially the locations of small islands and shoals that were hazards to the ships. It was beginning to become apparent that in these details river mouths could change over the years as silt accumulated in some areas and erosion opened others. By 1795, James Hutton from Scotland was suggesting that the features of the earth were not permanent but were gradually changed over time by erosion, sedimentation, and similar processes. His theory was called **gradualism.** And the exploration of the New World was raising other questions. For instance, the Grand Canyon was first reported by Garcia Lopez de Cardenas of Spain in 1540. Though scientists did not really try to understand its construction until 1870, it was clear that the Colorado River had cut it, and any reasonable estimate of how fast a river cuts a channel made one wonder about the age of the earth. In 1650 the Irish Bishop James Ussher had published the first part of a monumental work, in which he had assiduously counted all the dates and ages backward through the Bible, compared some dates with Greek records, and made an assumption or two. Using these calculations, he came to the conclusion that the world had been created on October 23, 4004 B.C. This calculation seemed in line with previous assumptions, based on estimates of the Bible; it was hailed as an achievement, and accepted without excessive circumspection for almost 200 years. However, geological formations like the Grand Canyon made one wonder: was approximately 6000 years enough to cut such a canyon?

Between the 16th and the 19th centuries, many of the apparently solid beliefs on which the interpretation of Genesis was based were increasingly in difficulty. The increasing confusion as to exactly what a species was made it difficult to understand whether Noah would, for instance, have brought on board a pair of eastern bullfrogs and a pair of western bullfrogs, or just one pair of bullfrogs, and it made no sense that the Ark had specific drop-off points or stops on route. God seemed to have made some species only to let them die out. Barkless dogs did not serve humans in the way that Europeans understood. The Bible gave a maximum age for the earth of 6000 years, less if one assumed that the 800+ years of the patriarchs of Genesis were allegorical, but there was indication that some features of the earth would take longer to form. And why were there seashells in the mountains? Several of the changes that came about are described in Fig. 4.3. This figure should be used in reference to the several Chapters 3–8.

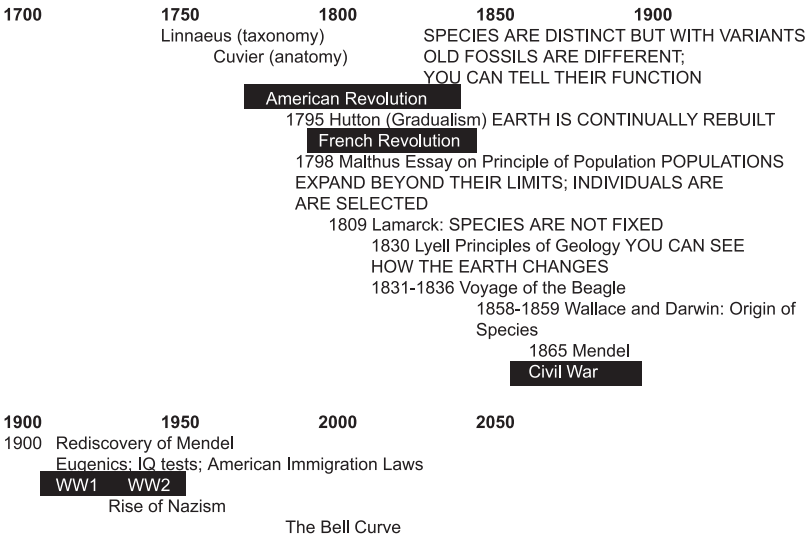

Figure 4.3. The historical context in which the story of evolution was born

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STUDY QUESTIONS

1. Look at any type of organism that you commonly encounter: sparrows, pigeons, dandelions, tropical fish, maple trees. Do you have any difficulty identifying it as a member of a specific species or type? How much variation is there among individuals? How does this variation compare to that of domestic organisms such as cats or dogs?
2. Describe any animal or plant of which you have heard but which you have never seen. In what characteristics does it differ from animals or plants that you know? Do these characteristics match any animal or plant that you consider to be fictitious? How do you know which are real and which are fictitious?
3. Look at a riverbank, a lakeshore, a river delta, a mountain range, a fault that has generated earthquakes, or any geological structure near you that may have changed over the history of the earth. Is there any way that you can estimate the

rate that it is changing or has changed, and from this the time that this feature has been present?

4. What criteria would you use to decide if specific animal or plant species are related to each other, and how closely they might be related? For instance, you might ask what is the closest relative to a raccoon, a skunk, or a bat. Defend the criteria that you choose.