

DARWIN'S GIFT
TO SCIENCE AND RELIGION

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PREFACE

The message that this book conveys can be simply stated: Science and religious beliefs need not be in contradiction. If they are properly understood, they *cannot* be in contradiction because science and religion concern different matters. Science concerns the processes that account for the natural world: how the planets move, the composition of matter and the atmosphere, the origin and function of organisms. Religion concerns the meaning and purpose of the world and of human life, the proper relation of people to their Creator and to each other, the moral values that inspire and govern people's lives.

The proper relationship between science and religion can be, for people of faith, mutually motivating and inspiring. Science may inspire religious beliefs and religious behavior, as we respond with awe to the immensity of the universe, the wondrous diversity of organisms, and the marvels of the human brain and the human mind. Religion promotes reverence for the creation, for humankind as well as the environment. Religion may be a motivating force and source of inspiration

for scientific research and may move scientists to investigate the marvelous world of the creation and to solve the puzzles with which it confronts us.

Along the way, I will belabor two points primarily addressed to people of faith. The first point is that science is here to stay. No matter what flaws or unknowns religious believers may see in scientific knowledge, science will continue its relentless advance toward solving the puzzles of the world of nature. The condemnation of Galileo by the Catholic Church in the seventeenth century did not bring astronomy to a halt. Rather, we marvel at the immensity of our galaxy and the myriad galaxies beyond. Those who see fault with the theory of evolution may seek to keep it out of the school curriculum or to belittle its accomplishments, but the thousands of scientists who in hundreds of universities and other institutions pursue evolutionary research will persist in their endeavors and continue the advance of knowledge. Universities, foundations, and governments will continue investing millions of dollars in evolutionary research, and thousands of research papers will continue being published yearly in scientific journals.

A second point that I make in this book may come as a surprise to people of faith and scientists alike. I assert that scientific knowledge, the theory of evolution in particular, is consistent with a religious belief in God, whereas Creationism and Intelligent Design are not. This point depends on a particular view of God—shared by many people of faith—as omniscient, omnipotent, and benevolent. This point also depends on our knowledge of the natural world and, particularly, of the living world. The natural world abounds in catastrophes, disasters, imperfections, dysfunctions, suffering, and cruelty. Tsunamis bring destruction and death; volcanic eruptions erased Pompeii and Herculaneum, killing all their citizens; floods and droughts

bring ruin to farmers. The human jaw is poorly designed, lions devour their prey, malaria parasites kill millions of humans every year and make 500 million sick. I do not attribute all this misery, cruelty, and destruction to the specific design of the Creator. About 20 percent of all human pregnancies end in spontaneous abortion during the first two months. That is 20 million natural abortions every year. I shudder in terror at the thought that some people of faith would implicitly attribute this calamity to the Creator's faulty design. I rather see it as a consequence of the clumsy ways of the evolutionary process. The God of revelation and faith is a God of love and mercy, and of wisdom.

Darwin's theory of evolution is a gift to science, and to religion as well. This book gives my reasons. I hope you, the reader, will find them cogent and perhaps be persuaded.

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I

INTRODUCTION

Is God willing to prevent evil, but not able? Then he is impotent. Is he able, but not willing? Then he is malevolent. Is he both able and willing? Whence then evil?

David Hume

Dialogues Concerning Natural Religion, p. 244

The Dominican monastery of San Esteban in Salamanca, Spain, is a complex of buildings dominated by the huge church of San Esteban, a majestic example of late Gothic architecture, designed in the fifteenth century by one of its monks, Juan de Alava. The magnificent Spanish Plateresque façade opens into a severe and uncluttered interior, dominated by the sumptuously ornate and gilded high altar, a 1692 Baroque masterpiece designed by José Churriguera. The main entrance to the monastery is through an Italianate Renaissance portico. Beyond the main Gothic cloister and grand staircase is the *Claustro de Colón*, where in visits during 1491–1492, Columbus discussed with Padre Deza, the scholarly confessor of Queen Isabella, his calculations of Earth’s diameter, seeking Deza’s endorsement to obtain the financial and political support of the Queen for the expedition that a few months later would discover the Americas and initiate a new episode in human history.

This was the setting in which I first encountered the argument from design in the late 1950s. As a student of theology in the Pontifical Faculty of San Esteban, I learned of the five arguments, or ways, for demonstrating God's existence that had been formulated by Thomas Aquinas (1224–1274) in the *Summa Theologiae*. The “fifth way” is an argument from design, based on the designed purposefulness of the universe: “We see that things that lack intelligence act for an end, which is not fortuitous but results from design . . . directed by some being endowed with knowledge and intelligence. . . . Therefore some intelligent being exists by whom all natural things are directed to their end; and this being we call God.” Aquinas's argument was founded on the universe and its parts, all harmoniously fitting together and thus evincing their design.¹

The argument from design for the existence of God based on the complex organization of living things would be formulated much later by William Paley (1743–1805) in his *Natural Theology* (1802). Famously, Paley compared a telescope and the human eye, arguing that both were designed, one by a telescope maker, the other by the same Power who had also created the immense diversity of organisms, with their elaborate contrivances—eyes, wings, gills—all exquisitely designed for effectively accomplishing the functions of life.

Several years would pass after my theology studies in Salamanca before I learned about Paley's work. This was in 1961, at Columbia University, in New York City, where I began doctoral studies in genetics and evolution. It was an unexpected turn of events for me, coming from conservative Spain, to discover that there was in the United States a strong creationist current that saw Darwin and the theory of evolution as contrary to religious beliefs. In Salamanca, in my theological studies, evolution had been perceived as a friend, not an

enemy, of the Christian faith. Evolution, I learned in my theology classes, had provided theologians with the “missing link” in the explanation of evil in the world or, in theological parlance, evolution had solved the “theodicy” problem. A dictionary definition of theodicy is “defense of God’s goodness and omnipotence in view of the existence of evil.”

Setting the Stage

The problem of evil has been succinctly stated in the Christian tradition as a dilemma: “If God cannot prevent evil, God is not omnipotent; if God can prevent evil but does not, God is not benevolent. But evil exists—how come?” If the reasoning is valid, it would follow that God is not all-powerful or all-good. Christian theology accepts that evil exists, but denies the validity of the argument.²

Traditional theology distinguishes three kinds of evil: (1) moral evil or sin, the evil originated by human beings; (2) pain and suffering as experienced by human beings; (3) physical evil, such as floods, tornados, earthquakes, and the imperfections of all creatures.

Theology has a ready answer for the first two kinds of evil. Sin is a consequence of free will; the flip side of sin is virtue, also a consequence of free will. Christian theologians have expounded that if humans are to enter into a genuinely personal relationship with their maker, they must first experience some degree of freedom and autonomy. A virtuous life *earns* the eternal reward of heaven. Christian theology also provides a good accounting of human pain and suffering. To the extent that pain and suffering are caused by war, injustice, and other forms of human wrongdoing, they are also a consequence of free will; people choose to inflict harm on one another. On

the flip side are good deeds by which people choose to alleviate human suffering.

What about earthquakes, storms, floods, droughts, and other physical catastrophes? Enter modern science into the theologian's reasoning. Physical events are built into the structure of the world itself. Since the seventeenth century, humans have known that the processes by which galaxies and stars come into existence, the planets are formed, the continents move, the weather and the change of seasons, and floods and earthquakes occur are natural processes, not events specifically designed by God for punishing or rewarding humans. The extreme violence of supernova explosions and the chaotic frenzy at galactic centers are outcomes of the laws of physics, not the design of a fearsome deity. Alas, theodicy still encountered a seemingly insurmountable difficulty. If God is the designer of life, whence the lion's cruelty, the snake's poison, and the parasites that secure their existence only by destroying their hosts?

I first heard about evolution in the Catholic grammar school and high school I attended in Madrid. My first science class, in sixth grade, was taught by Father Pedro, a gentle soul, who would catch fire when explaining science. Evolution was also taught at length in the biology course I attended at the University of Madrid. That the theory of evolution might conflict with the teachings of the Catholic Church, which pervaded life in Spain during the 1940s and 1950s, was never mentioned, as far as I can remember, except perhaps as a whimsical conceit or as a timid concern of intellectual conservatives. Surely, the 1950 encyclical *Humani generis* by Pope Pius XII had put the matter to rest. Biological evolution, the Pope wrote, is compatible with the Christian faith.

Later, when I was studying theology in Salamanca, Darwin was a much-welcomed friend. The theory of evolution pro-

vided the solution to the remaining component of the problem of evil. As floods and drought were a necessary consequence of the fabric of the physical world, predators and parasites, dysfunctions and diseases were a consequence of the evolution of life. They were *not* a result of deficient or malevolent design: the features of organisms were not *designed* by the Creator.

Evolution by natural selection is Darwin's answer to Paley. It is also the solution to the last prong of the problem of evil. Theology professors in Salamanca saw in the theory of evolution a significant, even definitive, contribution to theodicy. I was, therefore, much surprised when I became aware of the creationist movement in the United States and the pervasive reservations against the theory of evolution.

Since the 1970s I have been much involved in seeking a solution to the perceived conflict between evolution and religion. I was an expert witness in the Little Rock, Arkansas, trial decided by Federal District Judge William R. Overton in 1982 (*McLean v. Arkansas*) and I participated in the preparation of an Amicus Brief submitted to the Supreme Court of the United States by the National Academy of Sciences and the American Association for the Advancement of Science (*Edwards v. Aguilar*, 1987). These two decisions declare that teaching "creation science" in public schools is contrary to the Constitution of the United States. Over the past thirty years, I have published editorials, critiques, and articles and have delivered innumerable public lectures at civic and religious gatherings of various Christian denominations and at colleges and universities. The message has always been twofold: (1) evolution is good science and (2) there need not be contradiction between evolution and religious beliefs.

I have sought over the years to persuade my readers and listeners that evolution is here to stay, as a well-corroborated

scientific theory, but that Christians need not see evolution as a threat to their beliefs. My conviction is that the theory of evolution is theology's disguised friend, not its enemy. This also is the message of this book: There need not be conflict between religion and science. Apparent contradictions only emerge when either the science or the religious beliefs, or very often both, are misinterpreted. So, please read on; hear me out. I'll seek to persuade you. If I fail, you'll have the satisfaction of having listened to my reasons and, perhaps, you may reinforce or clarify the grounds for your objections.

Making the Case

In his *Natural Theology* of 1802, William Paley made the strongest possible case for intelligent design, based on extensive and accurate biological knowledge, as extensive and accurate as was available at the time. Paley made well the case that the human eye is as complex a contrivance as a watch or a telescope, with several parts all required to fit precisely for achieving vision. I'll introduce Paley's persuasive arguments in Chapter 2. He explored the diversity of organs and limbs in all sorts of organisms, precisely designed to accomplish their function. Paley saw that the relationship between mates of the same species, between animals of different species, and between organisms and their environments appeared to have been precisely designed by an omnipotent Creator. In the first half of the nineteenth century, other scientists (such as Sir Charles Bell in *The Hand, Its Mechanisms and Vital Endowments as Evincing Design*) would explore scientific evidence of intelligent design, but the argument from intelligent design has never been made, either before or afterward, as extensively or as forcefully as it was made by Paley.

Paley's and Bell's evidence for design was persuasive and, indeed, definitive based on the scientific knowledge available in the first half of the nineteenth century, but their arguments crumbled after Charles Darwin's discovery of natural selection and the publication of his *The Origin of Species* (hereafter abbreviated as simply *The Origin*) in 1859. Darwin is deservedly credited for accumulating convincing evidence from paleontology and biology that demonstrated life's evolution. In Chapter 3, I make the point that, important as that demonstration was, it was not Darwin's primary concern. Darwin was, first and foremost, motivated to show that his discovery of natural selection provided a scientific explanation of the design of organisms. Darwin's account of biological design implied, as a necessary consequence, that organisms would have evolved through time and diversified in different habitats. Therefore, Darwin collected evidence of biological evolution in order to corroborate his explanation of design by natural selection. I point out in Chapter 3 that Darwin's discovery of natural selection is one of the most significant events in intellectual history, because it completed the Copernican Revolution. The scientific advances of the sixteenth and seventeenth centuries had brought the phenomena of inanimate matter—the motions of the planets in the heavens and of physical objects on Earth—to the domain of science: explanation by natural laws. Natural selection similarly provided a scientific account for the design and diversity of organisms, which had been left out by the Copernican Revolution. With Darwin, all natural processes, inanimate and living, became subject to scientific investigation.

Accounts of natural selection, scholarly or popular, often short-change Alfred Russel Wallace, its independent co-discoverer. I suggest that this neglect is not misplaced. Wallace

saw natural selection as promoting evolution, which he saw as progressive, not as the explanation of design, which is its ultimate significance.

Chapter 4 is an attempt to explain natural selection briefly to nonbiologists. I provide a simple definition, well aware that a proper explanation of the process calls for an extensive treatise. That working definition allows me to highlight important features of the process of natural selection: it is grounded on genetic change; depends on spontaneous mutations; is opportunistic, that is, modulated by the past history of organisms and the demands of the environment; and is “creative,” so that it gives rise to genuine novelty, organisms and features that are designed for specific ways of life but would never have come to be without natural selection. I provide a simple example, using bacteria, to show how events each of extremely improbable occurrence—suitable mutations—combine and become actuated in organisms. The fauna and flora of the Hawaiian Islands illustrate some dominant features of natural selection: opportunism, adaptation, and prevalence of some kinds of organisms and absence of others well suited for Hawaiian habitats.

I review evolutionary history in Chapters 5, 6, and 7, where I introduce the evidence for evolution with a statement (accompanied by a supporting illustration) that is sure to surprise most readers: gaps in the reconstruction of evolutionary history from all living organisms back to their common ancestor no longer exist. The evidence comes from the recent revolution in molecular biology. Chapter 5 is mostly dedicated to the kind of evidence that was available to Darwin, although made current: the fossil record of organisms that lived long before the present, such as a primitive horse that lived 50 million years ago; comparative anatomy, showing that the forelimbs of humans, dogs, whales, and birds are

modifications of ancestral (reptile) forelimbs; comparative embryology and vestigial organs, such as the human vermiform appendix and our minitail; and biogeography, the peculiar distribution of plants and animals that tells us so much about the history, not only of organisms but also of continents and islands. In that chapter, you will find unfamiliar names such as *Archaeopteryx* and *Tiktaalik*. *Archaeopteryx* fossils have feathers and a skeleton intermediate between birds and their dinosaur ancestors. *Tiktaalik* is the whimsical name for several specimens, described in early 2006, of an animal intermediate between fish and tetrapods (amphibians).

Darwin extended the theory of evolution by natural selection to humans in *The Descent of Man*, which he published in 1871, twelve years after *The Origin*. Intermediate fossils between humans and apes were yet to be discovered—the “missing links” alleged by Darwin’s critics. As I explain in Chapter 6, the missing links are no longer missing. Thousands of intermediate fossil remains (known as “hominids”) have been discovered since Darwin’s time, and the rate of discovery is accelerating. The earliest hominids are about 6 million years old: *Sahelanthropus* from Chad, *Orrorin* from Kenya, and *Ardipithecus* from Ethiopia. Several fossil specimens of *Australopithecus afarensis* have been discovered in the Afar region of Ethiopia; these are likely ancestors of ours that lived about 4 million years ago, were bipedal, but had small brains, about one pound in weight, one-third the brain size of modern humans. *Homo habilis*, our ancestors of 2 million years ago, had one-and-a-half-pound brains. Their descendants, *Homo erectus*, who spread from Africa to Asia and Europe, had two-pound-plus brains; they and their relatives lived for several hundred thousand years. Our species, *Homo sapiens*, evolved in Africa about 150,000 years ago and then spread through the world’s continents.

Two major puzzles of human evolution remain. One puzzle is the genetic basis of the ape-to-human transformation. The human genome and the chimpanzee genome have been deciphered. Each consists of about 3 billion letters—the linearly arranged nucleotides of four kinds that make up the DNA. The human and chimp genomes differ by little more than 1 percent and yet we are so different in important ways: much larger brain, language, technology, art, ethics, and religion. The other puzzle is the brain-to-mind transformation. We know that the 30 billion neurons in our brains communicate between themselves and with other nerve cells by chemical and electric signals. How do these signals become transformed into perceptions, feelings, ideas, critical arguments, aesthetic emotions, and ethical and religious values? And how, out of this diversity of experiences, does a unitary reality emerge, the mind or self? The soul created by God, you might say, accounts for both transformations: ape to human and brain to mind. This religious answer may be satisfactory for believers, but it is not *scientifically* satisfactory. I still want to know how the anatomical and behavioral traits that differentiate us from apes emerge out of our genetic differences; I also want to know the biological correlates that account for mental experiences.

Molecular biology emerged as a discipline 100 years after Darwin, following the 1953 discovery of the double-helix structure of DNA, the hereditary chemical. Molecular biology provides the strongest evidence of biological evolution and makes it possible to reconstruct evolutionary history with as much detail and precision as anyone might want (Chapter 7). The chemical components of life and their proportions, DNA, the genetic code that conveys the genetic information from the nucleus to the cell, the twenty amino acid components of proteins and enzymes—they are all the same in all organisms from

bacteria and protozoa to plants and animals. This uniformity makes sense only if it is due to a common origin. For reconstructing evolutionary history it is all-important that genetic information is stored in the linear array of letters (nucleotides) that make up the DNA. The DNA sequences from different organisms can be aligned. The number of letters that are different between organisms reflect the time elapsed since their last common ancestor. One reason why molecular evolutionary biology is so powerful is that it allows us to compare the most diverse kinds of organisms, something not possible for comparative anatomy or the fossil record. DNA sequences of humans, flies, trees, and bacteria can be aligned with one another and with all sorts of other organisms in order to ascertain their evolutionary history.

Another reason why molecular biology is powerful is multiplicity. There are thousands of genes in each organism. If the results of one study are not as precise or as detailed as the investigator desires, he can study more and more genes until he reaches the desired accuracy and detail. There is virtually no limit.

Modern versions of the argument from design, “intelligent design” (ID) as it has been currently named, are considered in Chapter 8. As you read this chapter, you will discover that, although I tried, I couldn’t find many saving graces in ID. The one saving grace is the proponents’ motivation: proponents of ID want to discover God and faith in science. I, on the contrary, hold that religious beliefs should seek justification on the solid rocks of faith and revelation, not on scientific knowledge—which by its very nature is never definitive or forever valid. ID proponents say that evolution is “only” a theory. But “theory” is a term used by scientists to refer to well-established knowledge, such as the molecular theory of matter, the helio-

centric theory of planet revolutions, or relativity theory. Each of these scientific theories, like the theory of evolution, is not a guess or hunch as might be the case when “theory” is used in ordinary language. (Actually, scientists refer to conjectures as “hypotheses.”) ID is bad science or not science at all. It is not supported by experiments, observations, or results published in peer-reviewed scientific journals. I further argue that ID is bad religion, bad theology, because it implies that the designer has undesirable attributes that we don’t want to predicate about God. I hope you find the points I make in this respect convincing. ID proponents argue that the theory of evolution is incompatible with religious beliefs. Curiously, they share this conviction with materialistic scientists. I argue that both—IDers as well as materialists—are wrong: science and religion are compatible because they concern different realms of knowledge.

The last point is further developed in Chapter 9. Science is a way of knowing, but it is not the only way. Common experience, imaginative literature, art, and history provide valid knowledge about the world. The significance and purpose of the world and human life, as well as matters concerning moral or religious value, transcend science. Yet these matters are important; for most of us, they are at least as important as scientific knowledge *per se*.

In Chapter 10, I address a historical and epistemological question. I argue, particularly in Chapter 3, that Darwin considered natural selection, not evolution as such, his theory. I also argue that the theory of natural selection, not the evidence for evolution, is Darwin’s most transcending contribution to science. The question arises, why is it that Darwin has been credited by history with the theory of evolution, more so than with the theory of natural selection? I explain that this historical mishap arises from the philosophical theory, known as empiri-

cism, which prevailed, particularly in Britain, in the nineteenth century. Gregor Mendel, the founder of genetics, has suffered the same misattribution: He is credited with the discovery of the “laws” of inheritance, seen as generalizations derived from his experiments, rather than the discovery of the fundamental components of the “theory” of biological heredity, for which he deserves to be. Readers keen on understanding how evolution and religion are compatible may skip this chapter without missing a single beat of my argument. Readers lured by the history of ideas may find my explanations interesting and, perhaps, convincing.

I hope the arguments, explanations, and facts presented in the chapters that follow will help you comprehend why Darwin’s theory of natural selection is a gift, not only to science, but to religion as well.

2

INTELLIGENT DESIGN: THE ORIGINAL VERSION

I know no better method of introducing so large a subject, than that of comparing a single thing with a single thing: an eye, for example, with a telescope. As far as the examination of the instrument goes, there is precisely the same proof that the eye was made for vision, as there is that the telescope was made for assisting it.

William Paley, *Natural Theology*, chap. III, p. 20

The English clergyman William Paley was intensely committed to the abolition of the slave trade and by the 1780s had become a much sought-after public speaker against slavery. Paley was also an influential writer of works on Christian philosophy, ethics, and theology. *The Principles of Moral and Political Philosophy* (1785) and *A View of the Evidence of Christianity* (1794) earned him prestige and well-endowed ecclesiastical benefices, which allowed him a comfortable life. In 1800, Paley gave up his public-speaking career for reasons of health, providing him ample time to study science, particularly biology, and to write *Natural Theology; or, Evidences of the Existence and Attributes of the Deity* (1802), the book by which he has become best known to posterity and which would greatly influence Darwin. With *Natural Theology*, Paley sought to update John Ray's *Wisdom of God Manifested in the Works of the Creation* (1691), taking advantage of one century of additional scientific knowledge.

Paley's keystone claim is that "There cannot be design without a designer; contrivance, without a contriver; order, without choice; . . . means suitable to an end, and executing their office in accomplishing that end, without the end ever having been contemplated"¹

Natural Theology is a sustained argument for the existence of God based on the obvious design of humans and their organs, as well as the design of all sorts of organisms, considered by themselves, as well as in their relations to one another and to their environment. The argument has two parts: first, that organisms give evidence of being designed; second, that only an omnipotent God could account for the perfection, multitude, and diversity of the designs.

There are chapters dedicated to the complex design of the human eye; to the human frame, which displays a precise mechanical arrangement of bones, cartilage, and joints; to the circulation of the blood and the disposition of blood vessels; to the comparative anatomy of humans and animals; to the digestive tract, kidneys, urethras, and bladder; to the wings of birds and the fins of fish; and much more. For 352 pages, *Natural Theology* conveys Paley's expertise: extensive and accurate biological knowledge, as detailed and precise as was available in the year 1802. After detailing the precise organization and exquisite functionality of each biological entity, relationship, or process, Paley draws again and again the same conclusion, that only an omniscient and omnipotent Deity could account for these marvels of mechanical perfection, purpose, and functionality, and for the enormous diversity of inventions that they entail.

The Eye and the Telescope

Paley's first model example in *Natural Theology* is the human eye; it appears in Chapter III, "Application of the Argument." I quote him, for there is no better way to display Paley's knowledge of the anatomy of the eye or his skill of argumentation.

Early in the chapter, Paley points out that the eye and the telescope "are made upon the same principles; both being adjusted to the laws by which the transmission and refraction of rays of light are regulated."² Specifically, there is a precise resemblance between the lenses of a telescope and "the humors of the eye" in their figure, their position, and the ability of converging the rays of light at a precise distance from the lens—on the retina in the case of the eye.

Paley makes two remarkable observations, which enhance the complex and precise design of the eye. The first observation is that rays of light should be refracted by a more convex surface when transmitted through water than when passing out of air into the eye. Accordingly, "the eye of a fish, in that part of it called the crystalline lens, is much rounder than the eye of terrestrial animals. What plainer manifestation of design can there be than this difference? What could a mathematical instrument maker have done more to show his knowledge of [t]his principle . . . ?"³

The second remarkable observation made by Paley that supports his argument is dioptric distortion.

Pencils of light, in passing through glass lenses, are separated into different colors, thereby tinging the object, especially the edges of it, as if it were viewed through a prism. To correct this inconvenience has been long a desideratum in the art. At last it came into the mind of a sagacious optician, to inquire how this matter was managed in the eye, in which there was exactly the same difficulty to contend with as in

the telescope. His observation taught him that in the eye the evil was cured by combining lenses composed of different substances, that is, of substances which possessed different refracting powers.⁴

The telescope maker accordingly corrected the dioptric distortion “by imitating, in glasses made from different materials, the effects of the different humors through which the rays of light pass before they reach the bottom of the eye. Could this be in the eye without purpose, which suggested to the optician the only effectual means of attaining that purpose?”⁵

Argument Against Chance

Paley summarizes his argument by stating the complex functional anatomy of the eye: The eye consists, “first, of a series of transparent lenses—very different, by the by, even in their substance, from the opaque materials of which the rest of the body is, in general at least, composed.”⁶ Second, the eye has the retina, which as Paley points out is the only membrane in the body that is black, spread out behind the lenses, so as to receive the image formed by pencils of light transmitted through them, and “placed at the precise geometrical distance at which, and at which alone, a distinct image could be formed, namely, at the concurrence of the refracted rays.”⁷ Third, he writes, the eye possesses “a large nerve communicating between this membrane [the retina] and the brain; without which, the action of light upon the membrane, however modified by the organ, would be lost to the purposes of sensation.”⁸

Could the eye have come about without design or preconceived purpose, as a result of chance? Paley had set the argument against chance, in the very first paragraph of *Natural Theology*, reasoning rhetorically by analogy:

In crossing a heath, suppose I pitched my foot against a *stone*, and were asked how the stone came to be there, I might possibly answer, that for any thing I knew to the contrary it had lain there for ever; nor would it, perhaps, be very easy to show the absurdity of this answer. But suppose I had found a *watch* upon the ground, and it should be inquired how the watch happened to be in that place, I should hardly think of the answer which I had before given, that for any thing I knew the watch might have always been there. Yet why should not this answer serve for the watch as well as for the stone; why is it not as admissible in the second case as in the first? For this reason, and for no other, namely, that when we come to inspect the watch, we perceive—what we could not discover in the stone—that its several parts are framed and put together for a purpose, *e.g.* that they are so formed and adjusted as to produce motion, and that motion so regulated as to point out the hour of the day; that if the different parts had been differently shaped from what they are, or placed after any other manner or in any other order than that in which they are placed, either no motion at all would have been carried on in the machine, or none which would have answered the use that is now served by it.⁹

In other words, the watch's mechanism is so complicated it could not have arisen by chance.

Relation or Irreducible Complexity

The strength of the argument against chance derives, Paley tells us, from what he names “relation,” a notion akin to what some contemporary authors have named “irreducible complexity.”¹⁰ This is how Paley formulates the argument. “When several different parts contribute to one effect, or, which is the same thing, when an effect is produced by the joint action of different instruments, the fitness of such parts or instruments to one another for the purpose of producing, by their united action,

the effect, is what I call *relation*; and wherever this is observed in the works of nature or of man, it appears to me to carry along with it decisive evidence of understanding, intention, art.”¹¹

The outcomes of chance do not exhibit relation among the parts or, as we might say, they do not display organized complexity. He writes that “a wen, a wart, a mole, a pimple” could come about by chance, but never an eye; “a clod, a pebble, a liquid drop might be,” but never a watch or a telescope.

Paley notices the “relation” not only among the component parts of an organ, such as the eye, the kidney, or the bladder, but also among the different parts, limbs and organs that collectively make up an animal and adapt it to its distinctive way of life: “In the *swan*, the web-foot, the spoon bill, the long neck, the thick down, the graminivorous stomach, bear all a relation to one another. . . . The feet of the mole are made for digging; the neck, nose, eyes, ears, and skin, are peculiarly adapted to an underground life. [In a word,] this is what I call relation.”¹²

I am filled with amazement and respect for Paley’s extensive and profound biological knowledge. He discusses the fish’s air bladder, the viper’s fang, the heron’s claw, the camel’s stomach, the woodpecker’s tongue, the elephant’s proboscis, the bat’s wing hook, the spider’s web, insects’ compound eyes and metamorphosis, the glowworm, univalve and bivalve mollusks, seed dispersal, and on and on, with accuracy and as much detail as known to the best biologists of his time.

The organized complexity and purposeful function reveal, in each case, an intelligent designer, and the diversity, richness, and pervasiveness of the designs show that only the omnipotent Creator could be this Intelligent Designer.

Nature's Imperfections

Paley's natural theology flounders, however, when trying to explain how the imperfections, defects, pain, and cruelty of organisms could be consistent with his notion of the Creator. Chapter XXIII of *Natural Theology* is entitled "Of the Personality of the Deity" and it would surprise many by its well-meaning, if naïve, arrogance, as Paley seems convinced that he can determine that God is a person, God's "personality," and what his attributes are.

Paley wants, first, to establish that "contrivances," such as the eye or the kidney, cannot come about by natural principles or processes, such as Newton's laws of mechanics, which explain, for example, the motions of the planets. This is how the chapter starts: "Contrivance, if established, appears to me to prove . . . the *personality* [Paley's emphasis] of the Deity, as distinguished from what is sometimes called nature, sometimes called a principle. . . . Now, that which can contrive, which can design, must be a person. These capacities constitute personality, for they imply consciousness and thought. . . . The acts of a mind prove the existence of a mind; and in whatever a mind resides, is a person. The seat of intellect is a person"¹³

Paley then proceeds to set "the natural attributes of the Deity," namely, omnipotence, omniscience, omnipresence, eternity, self-existence, necessary existence, and spirituality—all these Paley infers from the observation of natural processes! But Paley is an honest writer who knows he has to face the difficult questions of (1) organs or parts seemingly unnecessary or superfluous and (2) imperfect and dysfunctional organs.

About seemingly superfluous organs, Paley considers two possible states of affairs: "in some instances the operation, in others the use, is unknown."¹⁴ In some cases, we are ignorant

of the function of the organ, even if we know it to be necessary for survival; in other cases, we ignore whether the organ is at all necessary. Examples of the first kind include the lungs of animals, which Paley knew to be necessary for survival, although he was not “acquainted with the action of the air upon the blood, or in what manner that action is communicated by the lungs.” He cites the lymphatic system as a second example of an organ that is necessary for survival, even though how it functions was unknown. Instances “may be numerous; for they will be so in proportion to our ignorance. . . . Every improvement of knowledge diminishes their number.”¹⁵

Examples of organs that might be unnecessary for an animal's survival include the spleen, which seems not to be necessary for “it has been extracted from dogs without any sensible injury to their vital functions.”¹⁶ However, it may well be the case that the organ serves some unknown function, even though it may not be necessary for survival in the short run.

About nature's imperfections, this is Paley's general explanation: “Irregularities and imperfections are of little or no weight, . . . but they are to be taken in conjunction with the unexceptionable evidences which we possess of skill, power, and benevolence displayed in other instances.”¹⁷

But this account is unconvincing. If functional design manifests an Intelligent Designer, why should not deficiencies indicate that the Designer is less than omniscient, or less than omnipotent? Paley cannot have it both ways. Moreover, we know that some deficiencies are not just imperfections, but are outright dysfunctional, jeopardizing the very function the organ or part is supposed to serve. In the human eye, the optic nerve forms inside the eye cavity and creates a blind spot as it crosses the retina. This defect does not occur in the eye of squids, which is otherwise as complex as the human eye. In

addition to imperfections of design, oddities, seeming cruelties, and even sadism pervade the design of the living world. Carnivorous predators behave in ways that by human standards would be judged cruel; parasites seem designed with a sadistic purpose, since they exist by harming other organisms. The mating interactions between male and female in some insects, spiders, and other organisms would be judged cruel and even sadistic by human standards. (This is a matter to which I return in Chapter 8.)

Paley is honest enough to acknowledge these difficulties as he knew them, but his explanation is inconsistent with his overall argument. Even if the dysfunctions, cruelties, and sadism of the living world were rare, which they are not, they would still need to be attributed to the Designer if the Designer had designed the living world.

Predecessors and Epigones (Pre-Darwinian)

The argument from design had been already proposed by some Fathers of the Church in the early centuries of the Christian era on the basis of the overall harmony and perfection of the universe. Augustine (354–430) affirms that “The world itself, by the perfect order of its changes and motions and by the great beauty of all things visible, proclaims . . . that it has been created, and also that it could not have been made other than by a God ineffable and invisible in greatness, and . . . in beauty.”¹⁸

In the Middle Ages, Aquinas formulated the argument from design as the fifth way to demonstrate the existence of God. Aquinas distinguished between truths, such as the Incarnation and the Trinity, that can be known only by divine revelation, and truths accessible by human reason, which include God’s existence. In his *Summa Theologiae*, Aquinas advances five ways

to demonstrate, by natural reason, that God exists. The fifth way derives from the orderliness and designed purposefulness of the universe, which evince that it has been created by a Supreme Intelligence. "Some intelligent being exists by which all natural things are directed to their end; and this being we call God."¹⁹

Natural theology was disfavored by the Reformation. Martin Luther and John Calvin denied that human nature, corrupted after the Fall, would have the power, without Revelation, to acquire knowledge of God and his attributes.

The most forceful and elaborate formulation of the argument from design, before Paley, was *The Wisdom of God Manifested in the Works of Creation* (1691) by John Ray (1627–1705), an English clergyman and naturalist. Ray regarded as incontrovertible evidence of God's wisdom that all components of the universe—the stars and the planets as well as all organisms—are so wisely contrived from the beginning and perfect in their operation. The "most convincing argument of the Existence of a Deity," writes Ray, "is the admirable Art and Wisdom that discovers itself in the Make of the Constitution, the Order and Disposition, the Ends and uses of all the parts and members of this stately fabric of Heaven and Earth."²⁰

On the Continent, Voltaire (1694–1778), like other philosophers of the Enlightenment, accepted the argument from design. Voltaire asserted that in the same way as the existence of a watch proves the existence of a watchmaker, the design and purpose evident in nature prove that the universe was created by a Supreme Intelligence.²¹

William Paley was not the only proponent of the argument from design in Britain in the first half of the nineteenth century. A few years after the publication of *Natural Theology*, the eighth Earl of Bridgewater endowed the publication of treatises that

would set forth “the Power, Wisdom and Goodness of God as manifested in the Creation.” Eight treatises were published during 1833–1840, several of which artfully incorporate the best science of the time and had considerable influence on the public and among scientists. William Buckland, professor of geology at Oxford University, notes in *Geology and Mineralogy* (1836) the world distribution of coal and mineral ores and proceeds to point out that they had been deposited in a remote part, yet obviously with the forethought of serving the larger human populations that would come about much later. This attribution to the Creator is particularly noteworthy because Buckland in two earlier treatises, *Vindiciae Geologicae* (1820) and *Reliquiae Diluvianae* (1823), had explained sedimentation, fossil deposits, and rock formation as natural processes, without invoking the direct intervention of God.²² Later, another geologist, Hugh Miller in *The Testimony of the Rocks* (1858), would formulate what I call the “argument from beauty,” which allows that it is not only the perfection of design but also the beauty of natural structures found in rock formations and in mountains and rivers that manifests the intervention of the Creator.

One of the Bridgewater Treatises, *The Hand, Its Mechanisms and Vital Endowments as Evincing Design*, was written by Sir Charles Bell, a distinguished anatomist and surgeon, famous for his neurological discoveries, who became professor of surgery in 1836 at the University of Edinburgh. Bell follows Paley’s manner of argument, examining in considerable detail the wondrously useful design of the human hand, but also the perfection of design of the forelimb used for different purposes in different animals, serving in each case the particular needs and habits of its owner: the human’s arm for handling objects, the dog’s leg for running, and the bird’s wing for flying. “It must now be apparent,” he concluded, “that nothing less than

the Power, which originally created, is equal to the effecting of those changes on animals, which are to adapt them to their conditions: that their organization is predetermined, and not consequent on the conditions of the earth or the surrounding elements.”²³

Charles Darwin, while he was an undergraduate student at the University of Cambridge between 1827 and 1831, read Paley’s *Natural Theology*, which was part of the University’s canon for nearly half a century after Paley’s death. Darwin writes in his *Autobiography* of the “much delight” and profit that he derived from reading Paley: “In order to pass the B.A. examination, it was also necessary to get up Paley’s *Evidences of Christianity*, and his *Moral Philosophy*. . . . The logic of . . . his *Natural Theology* gave me as much delight as did Euclid. . . . I did not at that time trouble myself about Paley’s premises; and taking these on trust, I was charmed and convinced by the long line of argumentation.”²⁴

Later, however, after he returned from his five-year voyage around the world in the HMS *Beagle*, Darwin would discover a scientific explanation for the design of organisms. Science, thereby, made a quantum leap. This is the subject to which I now turn.