Chapter 2
God’s Handiwork: The Religious Origins of Science

The heavens declare the glory of God; and the firmament showeth His handiwork.
—Psalm 19

Even children know that in 1492 Christopher Columbus proved that the world is round. They also know that he doggedly pursued backing for his voyage despite years of opposition from the Roman Catholic Church, which ridiculed all dissent from the biblical teaching that the earth is flat. Andrew Dickson White (1832-1918), founder and first president of Cornell University, and author of the single most influential book ever written on the conflict between science and theology, offered this summary:

The warfare of Columbus [with religion] the world knows well: how the Bishop of Ceuta worsted him in Portugal; how sundry wise men of Spain confronted him with the usual quotations from Psalms, from St. Paul, and from St. Augustine; how, even after he was triumphant, and after his voyage had greatly strengthened the theory of the earth’s sphericity . . . the Church by its highest authority solemnly stumbled and persisted in going astray.

The theological barriers to this geographical truth yielded but slowly. Plain as it had become to scholars, they hesitated to declare it to the world at large . . . But in 1519 science gains a crushing victory. Magellan makes his famous voyage. He proves the earth to be round, for his expedition circumnavigates it. . . Yet even this does not end the war. Many conscientious [religious] men oppose the doctrine for two hundred years longer.

Like everyone else, I grew up with this story. It was retold in every account of Columbus’s voyage in my schoolbooks, in many movies, and always on Columbus Day. As for A. D. White’s immense study, A History of the Warfare of Science with Theology in Christendom (in two volumes), when I was young, it was required reading for all budding intellectuals, and I cited it in my second published paper.

Trouble is that almost every word of White’s account of the Columbus story is a lie. Every educated person of the time, including Roman Catholic prelates, knew the earth was round. The Venerable Bede (ca. 673-735) taught that the world was round, as did Bishop Virgilius of Salzburg (ca. 720-784), Hildegard of Bingen (1098-1179), and Thomas Aquinas (ca. 1224-1274), and all four ended up saints. Sphere was the title of the most popular medieval textbook on astronomy. Written by the English Scholastic John of Sacrobosco (ca. 1200-1256), it transmitted the standard view that all heavenly bodies including Earth were spherical. In the same century as Columbus’s voyage, Cardinal Pierre d’Ailly (1350-1420), chancellor of the University of Paris, noted that “although there are mountains and valleys on the earth, for which it is not perfectly round, it approximates very nearly to roundness.”

As for the “sundry wise men of Spain”
who challenged Columbus and advised against funding him, they not only knew the earth was round; they also knew it was far larger than Columbus thought it was. They opposed his plan only on the grounds that he had badly underestimated the circumference of the earth and was counting on much too short a voyage. Expressed in modern measures, Columbus claimed that it was about 2,800 miles from the Canary Islands to Japan, when it is actually about 14,000 miles. Had the Western Hemisphere not existed, and Columbus had no knowledge that it did, he and his crew would have died at sea. In any event, Jeffrey Burton Russell found that it was not true that Christian scholars were benighted fanatics clinging to scriptural claims that the earth was flat; rather, during the first fifteen centuries of the Christian era “nearly unanimous scholarly opinion pronounced the earth spherical, and by the fifteenth century all doubt had disappeared.” Edward Grant, in his monumental study of medieval cosmology, noted that in none of the Scholastic writings was there any mention of a flat earth except for a few asides to refute perceptions of flatness. No contemporary document concerning Columbus, including his own Journal and his son’s History of the Admiral, nor any account of other early voyages including Magellan’s, makes any mention of the shape of the earth. Everyone knew.

So why didn’t we know they knew? Why do only specialists know now? For the same reason that White’s book remains influential despite the fact that modern historians of science dismiss it as nothing but a polemic—White himself admitted that he wrote the book to get even with Christian critics of his plans for Cornell. As will be seen, many of White’s other accounts are as bogus as his report of the flat earth and Columbus. The reason we didn’t know the truth concerning these matters is that the claim of an inevitable and bitter warfare between religion and science has, for more than three centuries, been the primary polemical device used in the atheist attack on faith. From Thomas Hobbes through Carl Sagan and Richard Dawkins, false claims about religion and science have been used as weapons in the battle to “free” the human mind from the “fetters of faith.”

In this chapter, I argue not only that there is no inherent conflict between religion and science, but that Christian theology was essential for the rise of science. In demonstration of this thesis I first summarize much recent historical work to the effect that not only did religion not cause the “Dark Ages”; nothing else did either—the story that after the “fall” of Rome a long dark night of ignorance and superstition settled over Europe is as fictional as the Columbus story. In fact, this was an era of profound and rapid technological progress by the end of which Europe had surpassed the rest of the world. Moreover, the so-called Scientific Revolution of the sixteenth century was the normal result of developments begun by Scholastic scholars starting in the eleventh century. Thus my attention shifts to why the Scholastics were interested in science at all. Why did real science develop in Europe at this time? Why did it not develop anywhere else? I find answers to those questions in unique features of Christian theology.

This leads to examination of the outburst of scientific discovery during the late sixteenth and seventeenth centuries, wherein I explore its connections with Protestantism and conclude that it was Christianity, not Protestantism, that sustained the rise of science. As part of this discussion, I show that the leading scientific figures in the sixteenth and seventeenth centuries overwhelmingly were devout Christians who believed it their duty to comprehend God’s handiwork. Turning to an assessment of the “Enlightenment,” I show it to have been conceived initially as a propaganda ploy by militant atheists and humanists who attempted to claim credit for the rise of science. The falsehood that science required the defeat of religion was proclaimed by such self-appointed cheerleaders as Voltaire, Diderot, and Gibbon, who themselves played no part in the scientific enterprise—a pattern that continues.

Next, I show how the close collaboration between religion and science that characterized much of the nineteenth century was not a “strange interlude.” That particular designation goes to the Darwinian Crusade that dominated most popular twentieth-century discussions of religion and science. I argue that, rather than having been a battle between religion and science, the fracas over evolution was and remains largely a conflict between true believers of both varieties—the strident evolutionists being as unscientific as any fundamentalists.
I conclude by showing that through it all, professional scientists have remained about as religious as most everyone else, and far more religious than their academic colleagues in the arts and social sciences.

A confession is appropriate here. Having begun this chapter, I immersed myself in recent historical studies, only to find that some of my central arguments have already become the conventional wisdom among historians of science. So I have the comfort of learned opinion on my side but no claim to priority. I might have skipped the chapter entirely, but I am painfully aware that most of what it contains is unknown outside narrow scholarly circles. In fact, if asked, most well-informed people would express their absolute certainty that most of this could not possibly be true—early in my career I shared this view. That seemed sufficient reason to write on. But the ultimate justification of this chapter is that, to my knowledge, no one has actually pulled all of the essential themes and findings together to formulate a coherent overall picture of the history of the creative relationship between theology and science.

**What is Science?**

Science is not merely technology. A society does not have science simply because it can build sailing ships, smelt iron, or eat off porcelain dishes. Science is a method utilized in organized efforts to formulate explanations of nature, always subject to modifications and corrections through systematic observations.

Put another way, science consists of two components: theory and research. Theorizing is the explanatory part of science. Scientific theories are abstract statements about why and how some portion of nature (including human social life) fits together and works. However, not all abstract statements, not even all of those offering explanations, qualify as scientific theories; otherwise, theology would be a science. Rather, abstract statements are scientific only if it is possible to deduce from them some definite predictions and prohibitions about what will be observed. And that’s where research comes in. It consists of making those observations that are relevant to the empirical predictions and prohibitions. Clearly, then, science is limited to statements about natural and material reality—about things that are at least in principle observable. Hence there are entire realms of discourse that science is unable to address, including such matters as the existence of God.

By “organized,” I mean to note that science is not random discovery, nor is it achieved in solitude. Granted that some scientists have worked alone, but not in isolation. From earliest days, scientists have constituted networks and have been very communicative.

Consistent with the views of most contemporary historians as well as philosophers of science, this definition of science excludes all efforts through most of human history to explain and control the material world, even those not involving supernatural means. Most of these efforts can be excluded from the category of science because until recent times “technical progress—sometimes considerable—was mere empiricism,” as Marc Bloch put it. That is, progress was the product of observation and of trial and error, but was lacking in explanations—in theorizing. This objection even applies to Nicolaus Copernicus (1473-1543), since his heliocentric conception of the solar system was merely a descriptive claim (almost all of it wrong). He had nothing useful to say about why planets remain in their orbits around the sun, or moons about the planets. Until Newton there was no scientific theory of the solar system. I shall count Copernicus among the founders of modern science only because of his influence on and participation in a network of astronomers whose work soon qualified as truly scientific. But the earlier technical innovations of Greco-Roman times, of Islam, of imperial China, let alone those achieved in prehistoric times, do not constitute science and are better described as lore, skills, wisdom, techniques, crafts, technologies, engineering, learning, or simply knowledge. Thus, for example, even without telescopes the ancients excelled in astronomical observations. But until they were linked to testable theories, these observations remained merely “facts.” Charles Darwin expressed this point vividly:

About thirty years ago there was much talk that geologists ought to observe and theorize; and I well remember someone saying that at that rate a man might as well go into a gravel pit and count the pebbles and describe the
colours. How odd it is that anyone should not see that all observations must be for or against some view if it is to be of any service!11

As for the intellectual achievements of Greek or Eastern philosophers, their empiricism was quite atheoretical, and their theorizing was nonempirical. Consider Aristotle (384-322 B.C.E.). Although praised for his empiricism, he didn’t let it interfere with his theorizing. For example, he taught that the speed at which objects fall to earth is proportionate to their weight—that a stone twice as heavy as another will fall twice as fast.12 A trip to any of the nearby cliffs would have allowed him to falsify this proposition. He also explained in his Physics that the motion of a projectile is due to the push given it by the air closing behind it, paying no heed to the need to open the air in front of it. The superb, and sadly neglected, Scholastic scientist-theologian Jean Buridan (1300-1358) dispatched this Aristotelian proposition by observing that, among other things, when a man runs, he “does not feel the air moving him, but rather feels the air in front strongly resisting him.”13

The same can be said of the rest of the famous Greeks—either their work is entirely empirical, or it does not qualify as science for lack of empiricism, being sets of abstract assertions that disregard or do not imply observable consequences. Thus when Democritus (ca. 460 B.C.E.-ca. 370 B.C.E.) proposed the thesis that all matter is composed of atoms, he did not anticipate scientific atomic theory. His “theory” was mere speculation, having no basis in observation or any empirical implications. That it turned out to be “correct” (and most of it did not) does not make his guess any more significant than that of his contemporary Empedocles (ca. 490 B.C.E.-ca. 430 B.C.E.), who asserted that all matter is composed of fire, air, water, and earth, or Aristotle’s (384 B.C.E.-322 B.C.E.) version a century later, that matter consists of heat, cold, dryness, moistness, and quintessence. Indeed, for all his brilliance and analytical power, Euclid (ca. 300 B.C.E.) was not a scientist, because, in and of itself, geometry lacks substance, having the capacity only to describe reality, not to explain any portion of it.

Of course, these millennia of technological and intellectual progress were vital to the eventual development of science, but it is the consensus among contemporary historians, philosophers, and sociologists of science that real science arose only once: in Europe. In this regard it is instructive that China, Islam, India, and ancient Greece and Rome had a highly developed alchemy. But only in Europe did alchemy develop into chemistry. By the same token, many societies developed elaborate systems of astrology, but only in Europe did astrology lead to astronomy.

In what follows I will examine the connections between religion and the rise of science in Europe, from its medieval beginnings through its flowering in the sixteenth century. Before doing so, however, I must introduce a very important distinction: I am writing about religion and science, not about churches and science.

Institutions and Intellectual Freedom

To say that there was a positive link between religion and science in Western history is surely not to deny that sometimes churches have sought to force conformity to their doctrines. Typically, however, and in almost every instance when blood was shed, these were disputes over theology, not between theology and science.

Consider the execution of Giordano Bruno (1548-1600), often cited as one of the most shameful examples of the religious repression of science. A. D. White claimed that Bruno “should be mentioned with reverence as beginning to develop again that current of Greek thought…[which the] doctors of the Church had interrupted for more than a thousand years.”14 In fact, Bruno was not really a scientist, although he engaged in some speculative astronomy. Rather, he was a renegade monk, a Hermetic sorcerer, and something of a philosopher.15 His troubles had to do entirely with a heretical theology involving the existence of an infinite number of worlds—a work based entirely on imagination and speculation. The same is true of the other equally infamous case, that of Michael Servetus (1511-1553), put to death in Geneva with the acquiescence of John Calvin. Although Servetus did a bit of early work in physiology, he specialized in theology, and it was only for his theological writing that he was condemned.16 Not only did he have such poor judgment that he sent a copy of his Unitarian views about
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God to Calvin, but when these views forced him to flee Italy, he foolishly went to Geneva. Heretical theologies directly threaten the authority of those in control of religious organizations and institutions in a way that science seldom does. Thus even as they pursued heresy, the Spanish inquisitors paid virtually no attention to science per se. In his remarkable recent study, Henry Kamen reported:

Scientific books written by Catholics tended to circulate freely. The 1583 Quiroga Index had a negligible impact on the accessibility of scientific works, and Galileo was never put on the list of forbidden books. The most direct attacks mounted by the Inquisition were against selected works in the area of astrology and alchemy, sciences that were deemed to carry overtones of superstition.17

In contrast, anyone in Spain could have gotten into deep trouble for reading books by Protestants, scientific or not. Even so, most of the books that actually got people in trouble with the inquisitors were not about religion, science, or superstition; they were pornographic.18 The mention of Galileo anticipates a later discussion of that celebrated and much distorted episode. For now, let me merely propose that unless checked by other forces, powerful institutions and organizations tend to suppress dissent and nonconformity, and to impose their views and interests on anyone they can.

Obviously, religious organizations have often demonstrated this principle. But insofar as the suppression of science is concerned, the bloodiest incidents have been recent and have had nothing to do with religion. It was the Nazi Party, not the German Evangelical Church, that tried to eradicate “Jewish” physics, and it was the Communist Party, not the Russian Orthodox Church, that destroyed “bourgeois” genetics and left many other fields of Soviet science in disarray. No one has been prompted by these examples to propose an inherent incompatibility between politics and science. By the same token, that there have been conflicts between churches and science does not justify belief in an incompatibility between religion and science. It is, rather, that autocrats often do not tolerate disagreement. With that in mind, let us now journey back to ancient Rome.

The Mythical “Dark Ages”

In his best-selling The Discoverers (1983), the distinguished Daniel Boorstin, University of Chicago professor, Pulitzer Prize winner and Librarian of Congress, included a chapter entitled “The Prison of Christian Dogma.” In it, Boorstin condemned Christianity for imposing an era of general ignorance and fanaticism upon Europe:

[T]he leaders of orthodox Christendom built a grand barrier against the progress of knowledge . . . After . . . Christianity conquered the Roman Empire and most of Europe. . . we observe a Europe-wide phenomenon of scholarly amnesia, which afflicted the continent from A.D. 300 to at least 1300.19

Like the Columbus tale, this is a story many of us were raised on: Rome fell and with that cataclysm came the “Dark Ages.” Indeed, the second edition of Webster’s Unabridged Dictionary (1934) defined the “Dark Ages” as the “earlier part of [the Middle Ages] because of its intellectual stagnation,” and the college edition of Webster’s New World Dictionary of 1958 defined “Dark Ages” as “1. the period from the fall of the Western Roman Empire (476 A.D.) to the beginning of the modern era (c. 1450). 2. The earlier part of the Middle Ages, to about the end of the 10th century. . . the medieval period in Europe, especially the earlier part, [that] was characterized by widespread ignorance.”

As to the cause of the “Dark Ages,” ever since the start of the eighteenth century historians have proposed that Christianity was the reason, having spread barbarism, superstition, and ignorance across Europe. This interpretation culminated in Edward Gibbon’s (1737-1794) massive indictment of religion in The History of the Decline and Fall of the Roman Empire. In addition to appealing to the French philosophes and other antireligious intellectuals of the day, when more narrowly interpreted as an indictment of Roman Catholicism, Gibbon’s account was immensely popular among Protestant intellectuals as well. Nevertheless, the phrase “Dark Ages” is of recent origins, probably first used by the British historian Henry Thomas Buckle (1821-1862) in his History of Civilization in England (1859). Others soon copied Buckle’s usage, and by the twentieth century the term was in such general use that few knew it wasn’t longstanding. Indeed, some writers seem almost to suggest that people living in, say,
the ninth century described their own time as the Dark Ages.

However, modern historians and archaeologists have completely discredited these views, and there was no excuse for Boorstin to have repeated them. By the time his book appeared, even the popular encyclopedias reflected the revised version. Thus The New Columbia Encyclopedia (1975) suggested that the term “Dark Ages” is no longer used by historians because this era “is no longer thought to have been so dim.” In its entry for the “Dark Ages,” the fifteenth edition of Britannica (1981) reported that this term “is now rarely used by historians because of the unacceptable value judgment it implies,” being a “pejorative” incorrectly denoting this “a period of intellectual darkness and barbarity.”

Spurred by the pioneering work of Henri Pirenne (1862-1935) and Marc Bloch (1886-1944), scholars now realize that Christianity played no role in the defeat of Rome, and that the “Dark Ages” weren’t dark. The decline of Rome had many causes, but the actual “fall” was nothing more (or less) than the culmination of several centuries of a shift in military capacity from the Romans to various Germanic groups, such as the Goths, Huns, Vandals, Burgundians, and Franks. Moreover, when the last battles came, Germans made up the larger proportion of the Roman army as well and in that sense had already supplanted the ethnic Romans. However, as a result of the military defeat of Rome, the political and cultural center of Europe shifted northward. It is this shift that was interpreted as a cultural and intellectual decline by those who, many centuries later, equated civilization with the writings of a tiny group of GrecoRoman intellectuals. In a population lacking familiarity with the classical philosophers and poets, they reasoned, how could there be anything but darkness? Moreover, to them, enlightenment was to be found only in books and abstract ideas, and certainly not in machines or in farming practices. Indeed, the “scorn of men of letters for engineers throughout history has kept them, all too often, oblivious to the technology created by those engineers.”

Thus only recently have historians realized that while Europe’s leading scholars of, say, the eighth century may have written “inferior” Latin, and may not have been well versed in Plato and Aristotle, they were not “barbarians.” They certainly were not barbarians morally: both Plato and Aristotle owned slaves, but during the “Dark Ages,” Europeans rejected slavery (Chapter 4). And they certainly were not barbarians in terms of technology: beginning early in the “Dark Ages” came “one of the great inventive eras of mankind” as machinery was developed and put into use “on a scale no civilization had previously known.” Or, as Lynn White put it, “In technology, at least, the Dark Ages mark a steady and uninterrupted advance over the Roman Empire.” Histories of the technological achievements of medieval times are fascinating reading. For the sake of illustration here I will mention only a few.

In 732, during the very depths of the “Dark Ages,” Charles Martel (grandfather of Charlemagne) led a Frankish army in the Battle of Tours (or Poitiers) wherein they routed the Saracens—Muslim invaders come north from Spain. As with all successful European armies over the past twenty-five hundred years, Martel’s primary force consisted of well-trained infantry formations, and his had better arms and armor than any force fielded by the Romans or the Greeks. Against them the Saracens committed a cloud of cavalry, wearing little or no armor, but superbly mounted and armed with composite bows and the best swords in the world. The Saracen cavalry charged and wheeled and circled, but they could make no dent in the solid ranks of infantry, who inflicted severe casualties upon them with their long pikes. Toward the end of the day the Saracens began to withdraw. It was then that they were slaughtered. Not by the Frankish infantry—men clad in chain-mail armor are ill suited to chase anyone, let alone riders. But at this point came the first-ever appearance on a major battlefield of knights in full armor, who charged at a gallop, putting the full weight of horse and rider behind a long lance. When this wall of force hit the Saracen cavalry, they were routed—their arrows could not penetrate the Frankish armor, and their futile efforts to close and use their swords were forestalled by the long lances of the Frankish knights, and by the irresistible weight of horses charging at full gallop. The difference was stirrups and the Norman saddle. Without stirrups to brace against, a rider attempting to drive home a lance will be thrown off his horse. The ability of a rider to withstand sudden shocks is also greatly enhanced by a saddle with a very high pommel and cantle—the latter being curved to partly enclose the rider’s hips. The Romans had
no stirrups, nor did the Saracens, and both rode with light, almost flat, pad saddles, or even bareback. So they had no heavy cavalry.

Neither did the Romans or the Saracens know how to harness horses effectively. Before Europeans learned better during the “Dark Ages,” horses were harnessed in the same way as oxen. To keep from strangling in such a harness, a horse must keep its head thrown back and can pull only light loads. Fully aware of the problem, Romans responded via legislation! The Theodosian Code decreed severe punishments for anyone “caught harnessing horses to a load in excess of [in modern terms] 500 kilograms.”31 In contrast, during the “Dark Ages” a rigid, well-padded collar was designed that properly places the weight on the horse’s shoulders instead of its neck, enabling the horse to pull as much as the ox and to pull it much faster. Having invented the horse collar, European farmers soon switched from oxen to horses, with an immense gain in productivity—a horse could plow more than twice as much per day as an ox.32

In addition, it was not until well after the fall of Rome that Europeans developed iron shoes nailed to horses’ hooves to protect them from the wear and tear that often causes unshod horses to become lame. The Romans had experimented with various kinds of horse sandals (Nero had some made of silver), but these fell off if the horse even trotted. With iron shoes firmly attached, horses can travel even on hard surfaces without damage.

Unfortunately, although historians had dimly noted the transformation of agriculture involving the use of the horse, for generations they had no idea why this had come about, nor did they have the slightest notion of why the Romans had not excelled in heavy cavalry. In large part this was because historians seldom rode or harnessed horses and rarely knew anyone who did. Thus it was not until 1931 that these revolutionary technological innovations concerning stirrups, saddles, harnesses, and horseshoes came to scholarly attention through the work of a complete outsider, one who knew relatively less about history, but a great deal more about horses—Lefebvre des Noettes, a retired French cavalry officer.33

Since then there has come a flood of books establishing that long before the end of the Middle Ages, before any “Renaissance,” “Enlightenment,” or “Scientific Revolution,” Europe’s technology advanced far beyond anything achieved by the ancients: effective waterwheels, mills, camshafts, mechanical clocks, the compass, and so on.34 Many of these were original inventions. Others came from Asia. But what was most remarkable about the “Dark Ages” was the way in which the full capacities of new technologies were rapidly recognized and widely adopted. Consider gunpowder. The Chinese were the first to use an explosive powder, but it is a misnomer to call their invention gunpowder, since the Chinese did not develop guns and limited its use to fireworks. When knowledge of this Chinese explosive arrived in Europe, probably during the first decade of the fourteenth century, the application to gunnery was immediate—cannon were probably first used in battle during a seige of Metz in 1324.35 What is certain is that by 1325 “cannon existed all over western Europe.”36
The rapid adoption of the compass is another compelling example. The claim that the magnetic compass reached Europe from China through Islam is false. Apparently, it was invented independently in both China and Europe, probably in about the eleventh century. The Chinese were satisfied with a very crude compass, a magnetized needle floating in a liquid. This enabled them to determine the north-south axis, which was primarily of magical concern—the Chinese may not have used this device aboard ships until long after Europeans were doing so. In contrast, soon after discovering the floating-needle compass, medieval Europeans added the compass card and then the sight. This allowed mariners not only to know which way was north but to determine their precise heading, which allowed them to set accurate courses in any direction. The temporal clustering of written reports of this new invention demonstrates that it spread among sailors from Italy to Norway in only a few years.\(^{37}\)

Thus falls forever the first leg of the argument concerning the incompatibility of religion and science. Christianity did not plunge Europe into an era of ignorance and backwardness. Rather, so much technical progress took place during this era that by no later than the thirteenth century, European technology surpassed anything to be found elsewhere in the world.\(^{38}\) This did not occur because of the “rediscovery” of classical knowledge. There is no more misleading account of Western civilization than the one that starts with classical culture and proceeds directly to the “Renaissance,” dismissing the millennium in between as an unfortunate and irrelevant interlude. Western civilization is not the direct descendant of Greco-Roman culture. Instead, it is the product of centuries of interaction between the cultures of the “barbarians” (who, as we have begun to realize, had far more sophisticated cultures than had been acknowledged)\(^{39}\) and Christianity. In fact, it is far less the case that Christianity “Romanized” the Germans than that the latter “Germanized” Christianity. The subsequent addition of Greco-Roman learning was more decorative than fundamental.\(^{40}\) For the fact is that the progress achieved during the “Dark Ages” was not limited to technology. Medieval Europe also excelled in philosophy and science. As Lynn White pointed out, by “the late 13th century Europe had seized global scientific leadership.”\(^{41}\)

**The Scholastic Beginnings of Science**

In many ways the term “Scientific Revolution” is as misleading as “Dark Ages.” Both were coined to discredit the medieval Church. The notion of a “Scientific Revolution” has been used to claim that science suddenly burst forth when a weakened Christianity could no longer prevent it, and as the recovery of classical learning made it possible. Both claims are as false as those concerning Columbus and the flat earth. First of all, classical learning did not provide an appropriate model for science. Second, the rise of science was already far along by the sixteenth century, having been carefully nurtured by devout Scholastics in that most Christian invention, the university. As Alfred W. Crosby pointed out, “in our time the word medieval is often used as a synonym for muddle-headedness, but it can be more accurately used to indicate precise definition and meticulous reasoning, that is to say, clarity” (his emphasis).\(^{42}\) Granted that the era of scientific discovery that occurred in the sixteenth and seventeenth centuries was indeed marvelous, the cultural equivalent of the blossoming of a rose. However, just as roses do not sprout up overnight but must undergo a long period of normal growth before they even bud, so, too, the blossoming of science was the result of centuries of normal intellectual progress, which is why I am unwilling to refer to a “Scientific Revolution” without putting the term in quotation marks. Copernicus provides an unsurpassed example of this point.\(^{43}\)
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The Copernican “Revolution” as Normal Science

All discussions of the “Scientific Revolution” begin with Copernicus, almost as if his use of the word *Revolutions* in the title of his famous work had referred to drastic social changes rather than to celestial orbits. According to popular accounts, Nicolaus Copernicus (1473-1543) was an obscure Catholic canon in far-off Poland, an isolated genius who somehow “discovered” that, contrary to what everyone had always believed, the earth revolves around the sun. As A. D. White told it:

> [A]t length appeared, far from the centers of thought, on the borders of Poland, a plain, simple-minded scholar, who first fairly uttered to the modern world the truth—now so commonplace, then so astounding—that the sun and planets do not revolve around the earth, but the earth and planets revolve about the sun. \(^{44}\)

Then, the popular account continues, the Church made unrelenting efforts to suppress these views, and it was only through the more enlightened auspices of Protestantism that the “truth” survived.

There is far more fiction than fact in this account. First of all, Copernicus received a superb education. He took his first degree at Cracow, one of the greatest universities of that time, and then spent another three and a half years at the University of Bologna, possibly the best university in Europe. Next, he spent about four years at the University in Padua, interrupted by a brief visit to the University of Ferrara, where he received the degree of doctor of canon law. Second, the notion that the earth circles the sun did not come to him out of the blue; rather, Copernicus was taught the essential fundamentals leading to the heliocentric model by his Scholastic professors. That is, the heliocentric model was developed gradually by a succession of then-famous (but now sadly neglected) Scholastic scientists over the previous two centuries, their conclusions about mechanics being so well formulated that “Copernicus could not improve upon them.” \(^{45}\) For all the profundity of his contribution, Copernicus is best understood as having added the implicit next step.

The Greeks believed that vacuums were impossible, and that the universe was a sphere filled with transparent matter. Consequently, because of friction, the continuing motion of the heavenly bodies required the continuous application of force. This was reaffirmed by the Christian scholar (and creator of the first Christian calendar) Dionysius Exiguus (ca. 500-560), who also proposed that the continuing force was provided by angelic beings who pushed each sphere along. Saint Thomas Aquinas (1225-1274) identified God as the Prime Mover but retained the angelic pushers. However William of Ockham (ca. 1295-1349) disputed this view, arguing that a body in motion may not require continuous pushing. This was because he believed space to be a vacuum: once a heavenly body had been set in motion (by the will of God), it encountered no friction and probably would remain in motion. Ockham’s views were discussed and extended by his colleagues at Oxford, most notably by Walter Burley (1275-1357) and Walter Heytesbury (1330-1371), but it was at the University of Paris that Ockham’s ideas had the most impact.

Jean Buridan was rector of the University of Paris and a major figure in Scholastic science. Recall his demolition of Aristotle’s notion that projectiles are propelled by the air closing in behind them. That was but a fragment of his truly impressive work on mechanics, especially on motion and impetus. The following passage displays his skill at disarming theological critics and his understanding of inertia, thus anticipating Newton’s First Law of Motion:

> Also, since the Bible does not state that appropriate intelligences move the celestial bodies, it could be said that it does not appear necessary to posit intelligences of this kind, because it would be answered that God, when He created the world, moved each of the celestial orbs as He pleased, in moving them He impressed upon them impetuses which moved them without His having to move them any more. . . And these impetuses which He impressed in the celestial bodies were not decreased nor corrupted afterwards because there was no inclination of the celestial bodies for other movements. Nor was there resistance which could be corruptive or repressive of that impetus. \(^{46}\)

Buridan also wrote a long discussion on the proposition that the earth turns on its axis, thus creating the appearance that other heavenly bodies such as the sun and moon rise and set. He particularly emphasized that it is more parsimonious to assume that the earth rotates, as this would require far less velocity than would be needed to enable the distant bodies to circle the earth. However, Buridan left his
proposition about the earth’s revolutions as a hypothetical.

Buridan’s successor took impetus theory even further and also extended his discussion of the earth’s rotation, noting that “it seems to me that it is possible to embrace the argument... that the earth turns rather than the heavens.”47 Nicole d’Oresme (1325-1382) was perhaps the most brilliant of all Scholastic scientists, and, after serving as rector of the University of Paris, he completed his career as bishop of Lisieux. His work is remarkably mathematical, thereby setting a high standard for subsequent studies of mechanics and astronomy.48 The idea that the earth turns had, of course, occurred to many observant people over the centuries, but two objections had always made any motion of the earth seem unlikely. First, why wasn’t there a constant and powerful wind from the east, caused by the rotation of the world in that direction? Second, why did an arrow shot straight up into the air not fall well behind (or in front of) the shooter? Since this does not happen, since the arrow comes straight back down, the earth cannot turn. However, building on Buridan’s work, Oresme overcame both of these objections. There is no wind from the east because the motion of the earth is imparted to all objects on the earth or close by, including the atmosphere. That also answers the second objection: arrows shot into the air not only have vertical impetus imposed on them by the bow; they also have horizontal impetus conferred on them by the turning earth.

Oresme was succeeded as rector of the University of Paris by Albert of Saxony (ca. 1316-1390). He also pursued impetus theory and taught an early approximation of Newton’s First Law, noting that this eliminated the need for angelic pushers. “Thus it could be said that the First Cause created the celestial orbs and impressed one such motive quality on each of them, which moves the orb.” This initial impression of force remains sufficient because there is no resistance in space and no other force “toward any opposite motion.”49

As university professors began to teach that sunrise and sunset could be caused by the daily rotation of the earth, it was no longer necessary to assume that the sun circled the earth—the notion of a heliocentric solar system became increasingly plausible and inviting. Then came Nicholas of Cusa (1401-1464), who also became a bishop and also taught that the earth turns as a result of “an impetus conferred upon it at the beginning of time.” Having noted that, “as we see from its shadow in eclipses, the earth is smaller than the sun” but larger than the moon or Mercury, Nicholas went on to observe (as had Buridan and Oresme) that “whether a man is on the earth, or the sun, or some other star, it will always seem to him that the position he occupies is the motionless centre, and that all other things are in motion.”50 It followed that humans need not trust their perception that the earth is stationary; perhaps it isn’t.

All of this prior theorizing was known to Copernicus. Albert of Saxony’s Physics was among the early printed books, the first edition having been published in Padua in 1493, just prior to Copernicus’s becoming a student there.

What, then, did Copernicus contribute? Very little more than to propose a model of the solar system with the sun in the center, circled by the planets. Everything else included in De revolutionibus orbium coelestium was wrong! What made the book more than merely a new concept was that Copernicus “express[ed] himself chiefly in mathematics, the native tongue of science.”51 Thus he fully worked out the geometry of his system, providing a method of calculating future positions—essential for setting the date of Easter, the solstices, and the like. However, his system did not yield results more
accurate than those produced by the earth-centered system created by Ptolemy in the second century, which had guided Europe’s celestial calculations ever since. The Copernican system was no improvement in that respect because he failed to recognize that the planetary orbits are ellipses, not circles. Here he may have been misled by having too much respect for Greek philosophy, which held that the motion of the heavenly bodies must be circular since that is the ideal shape. Consequently, like Ptolemy, Copernicus had to clutter his model with epicycles (loops) in the orbits to obtain reasonably accurate calculations—he ended up with even more loops in his model than had Ptolemy. Indeed, Copernicus failed to progress beyond Ptolemy and the ancient Greeks in that he, too, postulated that the planets did not move through space as such but were encased in “huge rotating spheres” or shells that held them in place. Actually, according to Copernicus it was the spheres that rotated around the sun—the “Celestial Spheres” in his book’s title are not planets, and the circles in his drawings do not designate planetary orbits. Both represent the solid spheres within which he thought the heavenly bodies are embedded.

Thus the “Scientific Revolution” does not begin with Copernicus. As the distinguished I. Bernard Cohen put it, “In short, the idea that a Copernican revolution in science occurred goes counter to the evidence. . . and is an invention of later historians.” Many contemporary historians of science agree. If one does not want to acknowledge that the rise of scientific astronomy was begun by Scholastics, then the beginnings of the field must be moved forward in time to the work of Johannes Kepler (1571-1630), whose elegant model got everything right that Copernicus had gotten wrong. Even so, Kepler fits far better into a historical model of normal scientific progression, in which Copernicus played a significant role, than into a revolutionary model.

One reason history has paid so little attention to the work that prepared the way for Copernicus is that he failed to acknowledge these debts in his famous book (while Kepler’s book gave Copernicus lavish praise). This omission was in no way unusual; it simply was not typical in this era to give much credit to predecessors. Thus for example, Galileo falsely presented the telescope as his own invention, and Newton went to great lengths to erase traces of his debts to Descartes. But the more important reason Copernicus has been presented as a lone genius who revolutionized science is that it suited the ideological agenda of those who were (and remain) determined to impose notions concerning an “Enlightenment” and a “Renaissance” on Western history. Of this, much more later.

Finally, the Protestants did not save the concept of a heliocentric solar system from Catholics bent on suppressing it as a heretical notion. Luther was as appalled by the suggestion that the earth was not the center of the universe as was the pope. The heliocentric model was saved by determined and very devout scholars, both Protestants and Catholics.

**Scholastic Universities**

From Ockham through Copernicus, the development of the heliocentric model of the solar system was the product of the universities, which, as noted in Chapter 1, were a Christian invention. From the start, the medieval university was a place created and run by scholars and devoted entirely to knowledge. I cannot improve on Marcia L. Colish’s description of the Scholastics who founded the university:

They reviewed past authorities and current opinions, giving [their] analysis of them and [their] reasons for rejecting some and accepting others. Altogether, the methodology already in place by the early twelfth century shows the scholastics’ willingness, and readiness, to criticize the foundation documents in their respective fields. More than simply receiving and expanding on the classical and Christian traditions, they set aside ideas from these traditions deemed to have outlived their usefulness. They also freely realigned the authorities they retained to defend positions that these authorities might well have thought strange and novel. [Commentaries] were now rarely mere summaries and explications of their author’s views. Scholastic commentators were much more likely to take issue with their chosen author or to bring to bear on his work ideas from emerging schools of thought or the scholastic’s own opinions.

This intellectual style was encouraged by the governance of the university. Like the trade and craft guilds, the faculty at medieval universities controlled entry to their ranks and set their own standards of
competence and achievement. The autonomy of universities often had to be defended, but it strikes the modern reader as quite amazing just how independent, indeed privileged, these medieval institutions managed to be. In the words of Nathan Schachner:

The University was the darling, the spoiled child of the Papacy and Empire, of king and municipality alike. Privileges were showered on the proud Universities in a continuous golden stream; privileges that had no counterpart, then, before, or since. Not even the sacred hierarchies of the Church had quite the exemptions of the poorest begging scholar who could claim protection of a University. Municipalities competed violently for the honour of housing one within their walls; kings wrote siren letters to entice discontented groups of scholars from the domains of their rivals; Popes intervened with menacing language to compel royalty to respect the inviolability of this favoured institution. Among these privileges was clerical status. Although they need not be ordained or in holy orders (and most were not), students and faculty were accorded the rights of clergy, including the right to be tried only in an ecclesiastical court (where punishments were usually far milder than in civil courts), and physical attacks on them carried the same severe penalties as were imposed on those who attacked priests. Universities also had the acknowledged right to move elsewhere as their faculties saw fit, which resulted in a potent bargaining position for local economic and political advantages (college towns often paid all faculty salaries).

The autonomy of individual faculty members also benefited from their amazingly frequent moves from one university to another, despite the rather primitive means of transportation and communication. Since all instruction was in Latin, scholars were able to move without regard for linguistic boundaries. And because their degrees were mutually recognized, they were qualified to join any faculty. Indeed, it was a time when all the leading scholars knew of one another—many had actually met and all had many mutual acquaintances. And one gained fame and invitations to join faculties elsewhere by innovation. Chapter 1 examined the profound impact of the search for innovations among university theologians, including Wyclif, Hus, Erasmus, Luther, and Calvin. In similar fashion, it was in the universities that Scholastics began the rise of science. As for familiarity with Aristotle, Plato, Euclid, and the other stalwarts of classical learning, it was in the Scholastic universities, not later in the salons of the philosophes or during the Italian “Renaissance,” that the classics were restored to intellectual importance. In part, this depended on the breaking of the “Greek barrier.”

Greek, not Latin, was the intellectual language of classical times. Roman intellectuals actually spoke Greek more often than they did Latin, and therefore the intellectual legacies of Greek learning remained in Greek. Plato, Aristotle, and the like were never really lost or forgotten after the decline of Rome, but they were unreadable in a Europe where only a few scholars knew Greek. This impediment was overcome when, “between 1125 and 1200, a veritable flood of translations into Latin, made Greek . . . [scholarship] available, with more to come in the thirteenth century.” Notice that these translations of classical scholarship were not the work of Humanists rebelling against the “long night” of Christian ignorance. The “rediscovery” was accomplished by exceedingly pious Christian scholars in their newly created universities.

Some historians have attributed the revival of classical learning to the fall of Constantinople, which, in 1453, caused many Byzantine scholars to flee to Italy, bringing the ancient authors with them. This claim helps to authenticate the Italian “Renaissance,” but it is bad history. Western Scholastics had been reading, translating, citing, and disputing all of the important classical authors for centuries before any émigré Byzantine scholars came west. Indeed, many library catalogs from the twelfth through the fourteenth century have survived and reveal substantial classical holdings—“To take one example, the library of Mont-Saint-Michelin the twelfth century contained texts of Cato, Plato’s Timaeus (in Latin translation), various works by Aristotle and Cicero, extracts from Virgil and Horace.” As for the Italian “Renaissance,” it was not a “rediscovery” of classical learning. Rather, it was a period of cultural emulation during which people of fashion copied the classical style in manners, art, literature, and philosophy—in Florence, each year Lorenzo de’ Medici (1449-1492) gave a banquet to celebrate Plato’s birthday. Out of this passion for their own ancient days of glory, Italians began to claim that Western
history consisted of “two periods of light: antiquity and the Renaissance . . . and between the two . . .
crude centuries and obscure times.” Thus from stylish enthusiasm and ethnic pride was born the notion
of the Dark Ages followed by a dawning of a new enlightenment. But it wasn’t so. Scholastics knew and
understood the work of Plato, Aristotle, and all the rest.

**Scholastic Empiricism**

Nor were these devout scholars intimidated by classical learning. We have already seen how
Scholastics such as Jean Buridan and Nicole d’Oresme rejected many major claims made by classical
writers. The case of Albertus Magnus (1205-1280) is also exemplary. Probably no one else did nearly so
much to “put Western Christendom in touch with the Aristotelian tradition.” But Albertus was not
content simply to expound Aristotle. Rather, he supplemented and corrected Aristotle to the best of his
ability. Consequently, he attempted to subject Aristotle’s empirical claims (and those of others as well)
to observational testing when possible, frequently finding them to be in error. Along the way Albertus
Magnus became “perhaps the best field botanist of the entire Middle Ages,” instituting a tradition of
research leading directly to the breakthroughs in biology and physiology made during the sixteenth and
seventeenth centuries.

Albertus was not alone in his commitment to careful empiricism. Consider developments in the study
of human physiology. It was the Scholastics, not the Greeks, Romans, Muslims, or Chinese, who based
their studies on human dissection. Just as everyone has been taught the falsehood about Columbus and
the flat earth, hardly anyone knows the truth about dissection and the medieval Church, and for the same
reasons.

Human dissection was not permitted in the classical world, which is why Greco-Roman works on
anatomy are so faulty. Aristotle’s studies were limited entirely to animal dissections, as were those of
Celsius and Galen. Celsius claimed that three centuries before his time, several Greek physicians in
Alexandria may have dissected a few slaves and criminals. Otherwise “in the classical period the dignity
of the human body forbade dissection.” Human dissection was also prohibited in Islam. Then came the
Christian universities and with them a new outlook on dissection. The starting assumption was that what
is unique to humans is a soul, not a physiology. Dissections of the human body, therefore, are not
different from studies of animal bodies and have no theological implications. From this assumption two
additional justifications of dissection were advanced. The first was forensic. Too many murderers
escaped detection because the bodies of their victims were not subjected to a careful postmortem. The
second concerned human welfare—that no adequate medical knowledge could be acquired without
direct observation of human anatomy.

Thus, in the thirteenth century, local officials (especially in Italian university towns) began to
authorize a postmortem in instances when the cause of death was uncertain. Then, late in the century,
Mondino de’ Luzzi (ca. 1270-1326) wrote a textbook on dissection, based on his study of two female
cadavers. Subsequently, in about 1315, he performed a human dissection in front of an audience of
students and faculty at the University of Bologna. From there, human dissection spread quite rapidly
throughout the Italian universities. Public dissections began in Spain in 1391, and the first one in Vienna
was conducted in 1404. Nor were these rare occurrences—dissection became a customary part
of anatomy classes. In about 1504, Copernicus took part in human dissections during his brief enrollment
in medical courses at the University of Padua. The “introduction [of human dissectioni into the Latin
west, made without serious objection from the Church, was a momentous occurrence.”

Nevertheless, A. D. White wrote indignantly about how the great physiologist Andreas Vesalius
(1514-1564) “risked the most terrible dangers, and especially the charge of sacrilege, founded upon the
teachings of the Church” by conducting human dissections. White went on to claim that anyone who
dissected a human body at this time risked “excommunication,” but that the heroic Vesalius “broke
without fear” from “this sacred conventionalism” and proceeded “despite ecclesiastical censure . . . No
peril daunted him.” All this was alleged to have taken place two centuries after human dissection
began at the universities where Vesalius learned and then practiced his anatomical craft! This is not a
fact only recently brought to light. Writing in the early 1920s, Charles Singer, one of the first historians of medicine, thought it so well known as to need no documentation that “although Vesalius profoundly altered the attitude towards biological phenomena, he yet prosecuted his researches undisturbed by the ecclesiastical authorities.”

White also failed to convey the immense fame and recognition Vesalius’s work received immediately upon publication. Nor did White deign to report that Charles V, the Holy Roman Emperor, responded to Vesalius’s “sacrilege” by ennobling him as a count and awarding him a lifetime pension. Thereafter, the young anatomist took up residence at the court of Phillip II in Spain, and this during the most active period of heresy-hunting by the local inquisitors! As for Vesalius’s religious views, he died while returning from a pilgrimage to the Holy Land. Thus we uncover another of White’s bogus accounts of the unrelenting religious opposition to science. And, like the tale about Columbus, it has had a deep and twisted effect on our intellectual culture.

The commitment to empiricism was vital to the rise of Western science. Thus, continuing in this tradition, Johannes Kepler produced the first accurate model of the solar system. Long and careful observations prompted Kepler to conceive of the planetary orbits as elliptical, not circular, whereupon entirely accurate orbital calculations could be made quite simply, without a need to assume epicycles. Kepler’s breakthrough also made it possible for the first time to accurately explain the seasons, as earth’s elliptical orbit placed it at different distances from the sun during the course of the year. Fully scientific astronomy had been achieved.

However the focus thus far on universities, on innovation, and on empiricism has neglected the truly important question: why were the Scholastics and later Europeans interested in science at all? At first glance, that would seem a foolish question. Isn’t the rise of science a normal aspect of cultural progress, of the rise of civilizations? Not at all. Many quite sophisticated societies did not generate communities of scientists or produce a body of systematic theory and empirical observations that qualify as science. Although China was quite civilized during many centuries when Europeans were still rude savages, the Chinese failed to develop science. Similarly, although in full possession of the whole corpus of Greco-Roman scholarship, and having made some impressive advances in mathematics, Islamic scholars did not become scientists. Once they had mastered the classic texts, Muslim scholars were content with the role of exegetes and added little or nothing of their own. Nor did science arise in ancient India or Egypt. And while classical Greece had considerable learning, it did not have science.
As noted, science consists of an organized (that is, sustained and systematic) and empirically oriented effort to explain natural phenomena—a cumulative process of theory construction and theory testing. This enterprise arose only once. As the historian Edward Grant explained, “it is indisputable that modern science emerged in the seventeenth century in Western Europe and nowhere else.” Other leading historians and sociologists of science may date the rise of science somewhat earlier, but all of them agree that it was a development unique to Europe.  

The crucial question is: Why?  

The Christian Difference  

My answer to this question is as brief as it is unoriginal: Christianity depicted God as a rational, responsive, dependable, and omnipotent being and the universe as his personal creation, thus having a rational, lawful, stable structure, awaiting human comprehension.  

As Nicole Oresme put it, God’s creation “is much like that of a man making a clock and letting it run and continue its own motion by itself.” Or, in the words of Psalm 119:89—90: “For ever, O Lord, thy word is settled in heaven. Thy faithfulness is unto all generations: thou hast established the earth, and it abideth.” Among the scriptural passages most frequently quoted by medieval scholars is the line from the Wisdom of Solomon (11:20) “[T]hou hast ordered all things in measure and number and weight.”  

In contrast with the dominant religious and philosophical doctrines in the non-Christian world, Christians developed science because they believed it could be done, and should be done. As Alfred North Whitehead (1861-1947) put it during one of his Lowell Lectures at Harvard in 1925, science arose in Europe because of the widespread “faith in the possibility of science . . . derivative from medieval theology.” Whitehead’s pronouncement shocked not only his distinguished audience but Western intellectuals in general once his lectures had been published. How could this great philosopher and mathematician, coauthor with Bertrand Russell of the landmark *Principia Mathematica* (1910-1913), make such an outlandish claim? Did he not know that religion is the mortal enemy of scientific inquiry?  

Whitehead knew better. He had grasped that Christian theology was essential for the rise of science in the West, just as surely as non-Christian theologies had stifled the scientific quest everywhere else. As he explained:  

I do not think, however, that I have even yet brought out the greatest contribution of medievalism to the formation of the scientific movement. I mean the inexpugnable belief that every detailed occurrence can be correlated with its antecedents in a perfectly definite manner, exemplifying general principles. Without this belief the incredible labours of scientists would be without hope. It is this instinctive conviction, vividly poised before the imagination, which is the motive power of research:—that there is a secret, a secret which can be unveiled. How has this conviction been so vividly implanted in the European mind? When we compare this tone of thought in Europe with the attitude of other civilisations when left to themselves, there seems but one source of its origin. It must come from the medieval insistence on the rationality of God, conceived as with the personal energy of Jehovah and with the rationality of a Greek philosopher. Every detail was supervised and ordered: the search into nature could only result in the vindication of the faith in rationality. Remember that I am not talking of the explicit beliefs of a few individuals. What I mean is the impress on the European mind arising from the unquestioned faith of centuries. By this I mean the instinctive tone of thought and not a mere creed of words.  

Whitehead ended with the remark that the images of Gods found in other religions, especially in Asia, are too impersonal or too irrational to have sustained science. Any particular “occurrence might be due to the fiat of an irrational despot” God, or might be produced by “some impersonal, incalculable origin of things. There is not the same confidence as in the intelligible rationality of a personal being.” Indeed, most non-Christian religions do not posit a creation at all: the universe is eternal and, while it may pursue cycles, it is without beginning or purpose, and, most important of all, having never been created, it has no Creator. Consequently, the universe is thought to be a supreme mystery, inconsistent, unpredictable, and arbitrary. For those holding these religious premises, the path to wisdom is through meditation and mystical insights, and there is no occasion to celebrate reason.  

In contrast, many central aspects of Christian theology were produced by reasoning. Thus did Tertullian (ca. 160-225), one of the earliest Christian theologians, instruct that “reason is a thing of God,
inasmuch as there is nothing which God the Maker of all has not provided, disposed, ordained by reason—nothing which He has not willed should be handled and understood by reason.” Several centuries later Saint Augustine (354-430) held that reason was indispensable to faith: “Heaven forbid that God should hate in us that by which he made us superior to the animals! Heaven forbid that we should believe in such a way as not to accept or seek reasons, since we could not even believe if we did not possess rational souls.” Of course, Christian theologians accepted that God’s word must be believed even if the reasons were not apparent. Again Augustine: “[I]n certain matters pertaining to the doctrine of salvation that we cannot yet grasp by reason—though one day we shall be able to do so—faith must precede reason and purify the heart and make it fit to receive and endure the great light of reason.” Then he added that although it is necessary “for faith to precede reason in certain matters of great moment that cannot yet be grasped, surely the very small portion of reason that persuades us of this must precede faith.”

Perhaps the most remarkable aspect of these passages from Augustine is the optimism that one day reason will triumph. In addition to regarding it as the duty of theologians to seek to understand God’s will, the weight of opinion in the early and medieval Church was that there was also a duty to understand, the better to marvel at, God’s handiwork. As Saint Bonaventure (1221—1274) explained, it is the purpose of science that “God may be honored.”

Saint Thomas Aquinas (Ca. 1225—1274) attempted to fulfill Augustine’s optimism that some of these “matters of great importance” could be grasped by reason in his monumental Summa Theologiae, which remains the definitive explanation of many points of Catholic doctrine. Aquinas argued that because humans lack sufficient intellect to see directly into the essence of things, it is necessary for them to reason their way to knowledge, step-by-step. Thus although Aquinas regarded theology as the highest of the sciences since it deals directly with divine revelations, he advocated the use of the tools of philosophy, especially the principles of logic, in the endeavor to construct theology.

The critical point in all of this is methodological. Centuries of meditation will produce no empirical knowledge, let alone science. But to the extent that religion inspires efforts to comprehend God’s handiwork, knowledge will be forthcoming, and science arises as “the handmaiden” of theology. And that’s precisely how not only the Scholastic scientists but also those who took part in the great achievements of the sixteenth and seventeenth centuries saw themselves—as in pursuit of the secrets of the Creation. Charles Webster has summed up the consensus among recent historians of science:

Any truly historical account. . . must pay due attention to the deep interpretation of scientific and religious ideas. It would seem perverse to deny religious motivation in the numerous cases where this was made explicit by the scientists themselves, often with painful emphasis. No direction of energy toward science was undertaken without the assurance of Christian conscience.

The Negative Cases

Before ending this discussion, however, I must demonstrate the negative—that the critical religious ideas were lacking in societies that seem otherwise to have had the potential to develop science but did not. Keep in mind that I am arguing only that a particular conception of a Creator was necessary for the rise of science, not that it was a sufficient cause. Were a Stone Age culture fully converted to Christianity, one still would not anticipate that they would evolve science anytime soon. Many other cultural and social developments were necessary for the rise of science. Hence negative cases are those in which, if religion is ignored, one might have expected them to become scientific. In my estimation there are three such cases: China, Greece, and Islam.

China

Only three years before his coauthor Alfred North Whitehead proposed that Christianity provided the psychological basis for the pursuit of science, Bertrand Russell found the lack of Chinese science rather baffling. From the perspective of his militant atheism, China should have had science long before Europe. As he explained, “Although Chinese civilization has hitherto been deficient in science, it never
contained anything hostile to science, and therefore the spread of scientific knowledge encounters no such obstacles as the Church put in its way in Europe.  

But despite Russell’s confidence that since it was not afflicted by the Church, China would soon far surpass Western science, he failed to see that it was precisely religious obstacles that had prevented Chinese science. Although through the centuries the common people of China have worshiped an elaborate array of Gods, each of small scope and often rather lacking in character, the intellectuals have prided themselves on following “Godless” religions, wherein the supernatural is conceived of as an essence or principle governing life, but which is impersonal, remote, and definitely not a being. The Tao is an example of an essence; yin and yang represent a principle. Just as small Gods do not create a universe, neither do impersonal essences or principles—indeed, they seem unable to do anything. Thus as conceived by Chinese philosophers, the universe simply is and always was. There is no reason to suppose that it functions according to rational laws, or that it could be comprehended in physical rather than mystical terms. Consequently, through the millennia Chinese intellectuals pursued “enlightenment,” not explanations. This is precisely the conclusion reached by the Marxist historian Joseph Needham, who devoted most of his career and many volumes to the history of Chinese technology. Having exhausted attempts to discover a materialist explanation, Needham concluded that the failure of the Chinese to develop science was due to their religion, to the inability of Chinese intellectuals to believe in the existence of laws of nature, because “the conception of a divine celestial lawgiver imposing ordinances on non-human Nature never developed.” Needham continued: “It was not that there was no order in Nature for the Chinese, but rather that it was not an order ordained by a rational personal being, and hence there was no conviction that rational personal beings would be able to spell out in their lesser earthly languages the divine code of laws which he had decreed aforetime. The Taoists, indeed, would have scorned such an idea as being too naïve for the subtlety and complexity of the universe as they intuited it.” Exactly.

Several years ago my friend Graeme Lang dismissed the notion that the influence of Confucianism and Taoism on Chinese intellectuals was the reason that science failed to develop in China; his grounds were that all culture is flexible, and that “if scholars in China had wanted to do science, philosophy alone would not have been a serious impediment.” Perhaps. But Lang missed the more basic question: why didn’t Chinese scholars want to do science? And, with Whitehead and Needham (and many others), I agree that it didn’t occur to the Chinese that science was possible. Fundamental theological and philosophical assumptions determine whether anyone will attempt to do science.

**Greece**

For centuries the ancient Greeks seemed on the verge of achieving science. They were interested in explaining the natural world with suitably abstract, general principles. Some of them were careful, systematic observers of nature—although Socrates considered empiricism such as astronomical observations a “waste of time,” and Plato agreed, advising his students to approach astronomy through philosophy and to “leave the starry heavens alone.” And, like the Scholastics, the Greeks formed coordinated scholarly networks—the famous “schools.” But in the end all they achieved were nonempirical, even antiempirical, speculative philosophies, atheoretical collections of facts, and isolated crafts and technologies—they never broke through to real science.

Three factors prevented the Greeks from achieving science. First, their conceptions of the Gods were inadequate to permit them to imagine a conscious Creator. Second, they conceived of the universe not only as eternal and uncreated, but as locked into endless cycles of progress and decay. Third, prompted by their religious conceptions, they transformed inanimate objects into living creatures capable of aims, emotions, and desires—thus short-circuiting the search for physical theories.

To begin with their conception of the Gods—none of the numerous divinities in the Greek pantheon was a suitable creator of a lawful universe, not even Zeus. As were humans, the Gods were subject to the inexorable workings of the natural cycles of all things. Some Greek scholars, including Aristotle (384-322 B.C.E.), did posit a “God” of infinite scope having charge of the universe, but they conceived of this
“God” as essentially an essence much like the Tao. Such a “God” lent a certain spiritual aura to a cyclical universe and its ideal, abstract properties, but being an essence, “God” did nothing and never had. Plato (ca. 427-347 B.C.E.) posited a sort of Godly being called the Demiurge who was the personification of reason. The Demiurge attempted to construct a cosmos that would fully achieve the ideals of the good, the true, and the beautiful, but insofar as this “being” had to work with already existing materials having properties (especially defects) over which the Demiurge had no control, the results fell far short of the intended ideal.

Many scholars doubt that Plato really meant for the existence of the Demiurge to be taken literally. But whether meant as the depiction of a real creator God or as a metaphor, Plato’s Demiurge pales in contrast with a God who is not only the master but the Creator of all materials, having made the universe out of nothing. Moreover, Plato proposed that the universe had been created, not in accord with firm operating principles, but in accord with ideals. These consisted primarily of ideal shapes. Thus the universe must be a sphere because that is the symmetrical and perfect shape, and heavenly bodies must rotate in a circle because that is the motion that is most perfect. Composed of a priori assumptions, Platonic idealism was a severe impediment to discovery. For example, the unshakable belief in ideal shapes prevented Copernicus from entertaining the thought that planetary orbits might not be circular.

In many ways it is strange that the Greeks sought knowledge and technology at all, having rejected the idea of progress in favor of a never-ending cycle of being. Plato at least proposed that the universe had been created, but most Greek scholars assumed that the universe was uncreated and eternal. Aristotle condemned the idea “that the universe came into being at some point in time . . . as unthinkable.” Although the Greeks saw the universe as eternal and unchanging, they did concede the obvious fact that history and culture are everchanging, but only within the strict confines of endless repetition. In On the Heavens, Aristotle noted that “the same ideas recur to men not once or twice but over and over again,” and in his Politics he pointed out that everything has “been invented several times over in the course of ages, or rather times without number”; since he was living in a Golden Age, current levels of technology were at the maximum attainable level. As for inventions, so, too, for individuals the same persons would be born again and again as the blind cycles of the universe rolled along. According to Chrysippus (280—207 B.C.E.) in his now lost On the Cosmos, the Stoics taught that the “difference between former and actual existences of the same people will be only extrinsic and accidental; such differences do not produce another man as contrasted with his counterpart from a previous world-age.” As for the universe itself, according to Parmenides (born 515 B.C.E.) all perceptions of change are illusions, for the universe is in a static state of perfection, “uncreated and indestructible; for it is complete, immovable, and without end.” Other influential Greeks, such as the Ionians, taught that although the universe is infinite and eternal, it is also subject to endless cycles of succession. Plato saw things a bit differently, but he, too, firmly believed in cycles: that eternal laws caused each Golden Age to be followed by chaos and collapse.

Finally, the Greeks insisted on turning the cosmos, and inanimate objects more generally, into living things. Entirely in keeping with the animism that anthropologists of religion associate with “primitive” cultures, Plato taught that the Demiurge had created the cosmos as a living thing—writing in Timaeus that the world is “a single visible living creature.” Hence the world has a soul, and although “solitary,” it is “able by reason of its excellence to bear itself company, needing no other acquaintance or friend but sufficient to itself.” Indeed, as David C. Lindberg pointed out, “Plato assigned divinity to the world soul and considered the planets and fixed stars to be a host of celestial gods.”

But if mineral objects are animate, one heads in the wrong direction in attempting to explain natural phenomena—the causes of the motion of objects, for example, will be ascribed to motives, not to natural forces. The Stoics, particularly Zeno (490-430 B.C.E.), may have originated the idea of explaining the operations of the cosmos on the basis of its conscious purposes, but this soon became the universal view. Thus, according to Aristotle, celestial bodies move in circles because of their affection for this action. Stanley L. Jaki pointed out that it was only by rejecting Greek, and especially Aristotelian, physics that
Scholastic science could progress, by “achieving a depersonalized outlook on nature in which stones were not claimed to fall because of their innate love for the centre of the world.”

It is very significant that Greek learning stagnated of its own inner logic. After Plato and Aristotle, very little happened beyond some extensions of geometry. When Rome incorporated the Greek world, it fully embraced and celebrated Greek learning—Greek scholars flourished under the Republic as well as during the reign of the Caesars. But possession of Greek learning did not prompt significant intellectual progress by Romans. The decline of Rome did not interrupt the expansion of human knowledge any more than the “recovery” of Greek learning enabled this process to resume. To the contrary, as will be seen, Greek learning was a barrier to the rise of science! It did not lead to science among the Greeks or the Romans, and it stifled intellectual progress in Islam.

Islam

It would seem that Islam has the appropriate God to underwrite the rise of science. But that’s not so. Allah is not presented as a lawful creator but has been conceived of as an extremely active God who intrudes on the world as he deems it appropriate. Consequently, there soon arose a major theological bloc within Islam that condemned all efforts to formulate natural laws as blasphemy insofar as they denied Allah’s freedom to act. That is, Islam did not fully embrace the notion that the universe ran along on fundamental principles laid down by God at the Creation, but assumed that the world was sustained by his will on a continuing basis. This was justified by a statement in the Qur’an: “Verily, God will cause to err whom he pleaseth, and will direct whom he pleaseth.” Although the line refers to God’s determination of the fate of individuals, it I been interpreted broadly to apply to all things.

If God does as he pleases, and what he pleases is variable, then the universe may not be lawful. Contrast this with the Christian conception of God as stated by the early French scientific genius René Descartes (1596—1650), who justified his search for natural “laws” on grounds that such laws must exist because God is perfect and therefore “acts in a manner as constant and immutable as possible,” except for the rare occurrence of miracles.

Whenever the subject of Islamic science and learning is raised, most historians emphasize that throughout the centuries when Christian Europe knew virtually nothing of Greek learning, that learning was alive and deeply appreciated in Islam. That is certainly true. It is even true that some classical manuscripts reached Christian Europe through Islam, especially as Christian and Muslim intellectuals had contact in Spain. But it is also true that possession of all of this “enlightenment” did not prompt much intellectual progress within Islam, let alone eventuate in Islamic science. Instead, as the devout Muslim historian Caesar E. Farah explained:

The early Muslim thinkers took up philosophy where the Greeks left off. Thus in Aristotle Muslim thinkers found the great guide; to them he became the “first teacher.”

Having accepted this a priori, Muslim philosophy as it evolved in subsequent centuries merely chose to continue in this vein and to enlarge Aristotle rather than to innovate. It chose the course of eclecticism, seeking to assimilate rather than to generate, with a conscious striving to adapt the results of Greek thinking to Muslim philosophical conceptions, but with much greater comprehensiveness than was achieved by early Christian dogmatics.

The result was to freeze Islamic learning and stifle all possibility of the rise of an Islamic science, and for the same reasons that Greek learning stagnated of itself: fundamental assumptions antithetical to science. It is very significant that the Rasa’il, the great encyclopedia of knowledge produced by early Muslim scholars, fully embraced the Greek conception of the world as a huge, conscious living organism having both intellect and soul. Indeed, according to Jaki, the “Muslim notion of the Creator was not adequately rational to inspire an effective distaste for various types of pantheistic, cyclic, animistic, and magical world pictures which freely made their way into the Rasa’il.” Nor were outlooks more conducive to science achieved by Ibn Rushd, known to the West as Averroës (1126-1198), and his followers, despite their efforts to exclude all Muslim theology from their work, in direct
conflict with those who sustained the Rasa’il. Instead, Averroës and his followers became intransigent and doctrinaire Aristotelians—proclaiming that his physics was complete and infallible, and if an observation were inconsistent with one of Aristotle’s views, the observation was certainly incorrect or an illusion.

As a result of all this, Islamic scholars achieved significant progress only in terms of specific knowledge, such as certain aspects of astronomy and medicine, that did not necessitate any general theoretical basis. And, as time passed, even this sort of progress ceased.

Clearly, then, and contrary to the received wisdom, the “recovery” of Greek learning did not put Europe back on the track to science. Judging from the impact of this learning on the Greeks, the Romans, and the Muslims, it would seem to have been vital that Greek learning was not generally available until after Christian scholars had established an independent intellectual base of their own. Consequently, when they first encountered the works of Aristotle, Plato, and the rest, medieval scholars were willing and able to dispute them! As I have tried to make clear, it was in explicit opposition to Aristotle and other classical writers that the Scholastics such as Albertus, Ockham, Buridan, and Oresme advanced toward science. To the extent that he clung to Greek concepts, Copernicus fell far short of founding scientific astronomy. Because medieval scholars outside the sciences (especially those in the arts and in speculative philosophy) had become such ardent admirers of the Greco-Roman “classics,” many of the great scientists of the sixteenth and seventeenth centuries often paid lip service to their “debts” to Aristotle and others, but their actual work negated almost everything the Greeks had said about how the world works.

I surely do not mean to minimize the impact of Greek learning on European intellectual life. It had an enormous influence, not only on Scholastic thought, but on many subsequent generations. However, the most antiscientific elements of Greek thought were withstood or, at worst, sequestered in the humanities, while the sciences marched on. For example, the Greek notion that the universe was eternal proved very attractive to many Scholastics. But from the start it was heatedly opposed—Saint Bonaventure ridiculed the notion on logical grounds, and it was included among the condemned propositions in the famous edict issued by the bishop of Paris in 1277. Moreover, not even the most ardent Scholastic supporters of an eternal universe claimed that it was uncreated. Rather, the debate involved very subtle points of theology that affirmed the ability of God to create an eternal universe. No Scholastic Platonists ever proposed a God as limited as the Demiurge. Nor did the idea that the earth and planets were conscious beings gain much credence, let alone such notions as that they went in circles from the joy of doing so. Moreover, even long before Greco-Roman learning was confined to classics departments, it was not the philosophy of scientists. While it is true (and constantly cited by classicists) that Newton remarked in a letter to Robert Hooke in 1675, “If I have seen further (than you and Descartes), it is by standing on the shoulders of giants,” such high regard for “the ancients” is not expressed or reflected in his work or in his usual presentations of self. Indeed, just as Newton and his peers achieved their breakthroughs in obvious opposition to the Greek “giants,” their contemporaries in theology mounted their own assault on Greek learning. For example, Guillaume Budé (1467-1540), founder of the Bibliothèque Nationale in Paris, condemned Plato and Aristotle for so often writing about things they knew nothing about. Luther took a similar view: “[M]y advice would be that Aristotle’s Physics . . . should be altogether discarded, together with all the rest of his books which boast of treating things of nature . . . [for] nothing can be learned from them . . . I venture to say that any potter has more knowledge of nature than is written in these books.” Others, including Pierre De La Ramée (1515-1572), launched an organized repudiation of the famous Greeks as “fallible individuals, prone to human error, apparently guilty of plagiarisms on many counts,” until the “old giants began to look more like modern dwarfs.” What the great figures involved in the sixteenth—and seventeenth-century blossoming of science—including Descartes, Galileo, Newton, and Kepler—did confess was their absolute faith in a Creator God, whose work incorporated rational rules awaiting discovery.

To sum up: the rise of science was not an extension of classical learning. It was the natural outgrowth
of Christian doctrine: Nature exists because it was created by God. To love and honor God, one must fully appreciate the wonders of his handiwork. Moreover, because God is perfect, his handiwork functions in accord with immutable principles. By the full use of our God-given powers of reason and observation, we ought to be able to discover these principles.

These were the crucial ideas, and that’s why the rise of science occurred in Christian Europe, not somewhere else.

However, some scholars have argued that not all brands of Christian theology were equally conducive to the rise of science—that it was Protestantism, especially its Puritan variety, that led to the rise of science.

**Puritans and the Rise of Science**

In 1938 Robert K. Merton’s doctoral thesis in sociology at Harvard, submitted in 1935, was published in *Osiris*. In “Science, Technology and Society in Seventeenth Century England,” Merton rejected the Marxist and secularist orthodoxies of the day that science was the triumph of irreligion, by proposing that Puritanism had given rise to the “Scientific Revolution.” According to Merton, this occurred because the Puritans reasoned (and, presumably, they were the first Christians to do so) that as the world was God’s handiwork, it was their duty to study and understand this handiwork as a means of glorifying God. Thus, Merton argued, among Puritan intellectuals in England during the seventeenth century, science was defined as a religious calling. Merton’s argument was, of course, an extension of Max Weber’s claims about the role of the Protestant ethic in the rise of capitalism and, as will be seen, equally untenable. To support his thesis, Merton combed the writings of Puritan participants in the “Scientific Revolution,” finding they gave overwhelming emphasis to the principle that science consists of the study of God’s handiwork for the purpose of more fully appreciating the glory of God. For example, in his last will and testament, Robert Boyle (1627-1691) addressed his fellow members of the Royal Society of London, wishing them all success in “their laudable attempts, to discover the true Nature of the Works of God” and “praying that they and all other Searchers into Physical Truths” may thereby add “to the Glory of the Great Author of Nature, and to the Comfort of Mankind.” Indeed, since Puritans believed that work was a calling from God, these early scientists were at pains to “justify the ways of science to God.”

By assembling many such quotations from seventeenth-century English scientists, Merton made it entirely clear that, far from being a rejection of religion, at least in England the “Scientific Revolution” was made from religious motivations by deeply religious people. Anticipating critics who would propose that these remarks about God by early scientists were no more than the literary conventions of the times or even “calculating hypocrisy,” Merton noted how many of these scientists manifested their piety in quite unambiguous actions. Boyle, for example, expended a considerable portion of his limited funds to have the Bible translated into various languages. John Ray left Cambridge because, upon the Restoration, he was unwilling on religious grounds to take the required oaths of loyalty to Charles II. Indeed, Merton dismissed all suspicions of false piety as an “unwarranted extrapolation of twentieth-century beliefs and attitudes to seventeenth-century society.” Then, with uncharacteristic candor he remarked, “Though it always serves to inflate the ego of the iconoclast…..,’debunking’ can supplant truth with error.”

In addition to an analysis of Puritan theology and its implications for the study of God’s handiwork, Merton presented quantitative data on the early membership of the Royal Society of London, which he interpreted in support of his claim that Puritans dominated that body, composed of the prominent English scientists of the seventeenth century.

Through the years, Merton’s study has received a great deal of attention. As he knew they would, various iconoclasts have indeed suggested that since real scientists know better than to embrace religion,
all signs of their piety must be fake. Fortunately, these claims have mainly been ignored by historians and sociologists of science, who have, instead, correctly concentrated on the serious flaws and inferior history of Merton’s study.

Scholars now recognize that Merton’s claims were much too narrow. The rise of science was neither limited to the efforts of the English nor to Protestants, let alone to Puritans. Thus H. E. Kearney sketched the remarkable intellectual circle centered on Friar Mann Mersenne (1588-1646), who, from his convent in Paris, established a correspondence network linking the leading scientists of the day, irrespective of religion or nationality. It connected Descartes in Holland, Gassendi and Peiresc in Provence, Shickard in Tübingen, Nortensius in Leyden, Galileo in Florence and van Helmont in Brussels. Mersenne’s correspondence in fact symbolizes the European nature of science. The intellectual Europe of the age of Galileo took no account of later national boundaries. Nor, curiously enough, do religious differences seem relevant, despite the shadow of the Thirty Years’ War.

Of course, this internationalism reflected the European scholarly network that had existed since the rise of universities. Much has been made of the importance of “social networks” for generating and sustaining intellectual innovations, culminating in the extraordinary work on intellectual networks by Randall Collins. There have been many studies of scientific networks, a number of which have followed Merton in examining the Royal Society of London. But, as has been seen, scientific networks had existed in Europe for centuries.

An equally fatal flaw in Merton’s thesis is that there was nothing new or Protestant about the belief that science was possible and worthy. As has been established, science was well along before there were any Protestants, and Catholics continued to play a vital role in the scientific blossoming of the sixteenth and seventeenth centuries. Finally, it has been established that Merton’s analysis is based on such a broad definition of “Puritan” that essentially no one was excluded—possibly not even Catholics. In Barbara J. Shapiro’s pithy summation, “what [Merton] is essentially saying is that Englishmen contributed to English science.

However, not even Merton’s most severe critics claim an incompatibility between religion and science. Thus it will be useful to move closer to the individuals who led the rise of science.

Scientific Stars: 1543-1680

Merton analyzed the religious orientation of members of the Royal Society of London in an attempt to support his thesis concerning the role of Puritanism. Subsequently, these data have been reworked a number of times with various results. But, to the best of my knowledge, no one has undertaken anything similar for the full set of scientific stars of this era. Consequently, I created a data set consisting of individual scientists.

How should one define the appropriate population of scientific stars? That is, how shall one decide when and whom? Historians typically define the era of the “Scientific Revolution” as stretching from the publication in 1543 of Copernicus’s De revolutionibus to the end of the seventeenth century. Therefore, I selected Copernicus as my first case and included all appropriate cases, beginning with Copernicus’s contemporaries and stopping with scientists born after 1680. The “whom” was a bit more difficult. First of all, I limited the set to active scientists, thus excluding some well-known philosophers and supporters of science such as Francis Bacon, Joseph Scaliger, and Diego de Zuniga. Second, I tried to pick only those who made significant contributions. To select the cases, I searched books and articles on the history of science, and I also consulted a number of specialized encyclopedias and biographical dictionaries, among which I must mention the several editions of Isaac Asimov’s Biographical Encyclopedia of Science and Technology for its completeness and lack of obvious biases. Having developed a list of 52 scientists, I then consulted various sources, including individual biographies, to determine the facts that I wished to code for each case. The first fact I coded was nationality and the results are as follows:
Clearly, the English did furnish far more than their share of significant early scientists. However, they made up too small a percentage of the total to justify Merton’s attribution of the rise of science to the English, let alone to English Puritans.

The second fact I coded was denomination. Was this primarily a Protestant revolution?

Table 2.1 permits examination of the distribution of three other facts I coded, and of cross-tabulations allowing comparisons of Catholics and Protestants. The data show that these 52 early scientists were fairly evenly spread across four fields, but Catholics were a bit more likely to have pursued biological-physiological studies than were Protestants. Slightly over one-fourth (15) of the 52 had ecclesiastical careers as priests, ministers, monks, canons, and the like. Catholics were more than twice as likely as Protestants to have had such a vocation.

The most challenging task was to assess personal piety. It would not do to equate piety with conformity to the prevailing orthodoxy, else one would be forced to argue that Martin Luther and John Calvin were lacking in piety.
To code someone as devout, I searched for clear signs of especially deep religious concerns. The label of “conventionally religious” was applied to those whose biography offers no evidence of skepticism, but whose piety does not stand out as other than entirely satisfactory to their religious associates. An example is Marcello Malpighi, whose observation of the growth of a chick’s heart is regarded as one of the most remarkable achievements of seventeenth-century biology. Malpighi’s biography offers no direct evidence of concerns about God of an intensity similar to Boyle’s or Newton’s. On the other hand, he did retire to Rome to serve as the personal physician of Pope Innocent XII, a very pious Counter-Reformation pontiff, who probably expected a similar level of piety of those around him. If anything, then, I have underrated Malpighi’s level of personal piety; similar underestimates may be the real basis for the modest differences shown in Table 2.1 between Catholics and Protestants.

Finally, I reserved the category “skeptical” for anyone about whom we may infer a lack of belief that the world was the work of a conscious, responsive God—virtually any French *philosophe* would be so coded.

The most important finding in Table 2.1 is that those who made the “Scientific Revolution” included an unusually large number of devout Christians—more than 60 percent qualified as devout and only two, Edmund Halley and Paracelsus, qualified as skeptics. Given Paracelsus’s general exhibitionism, it is difficult to know what he actually did or didn’t believe about God. We know he did profess faith in astrology and in the Hermetic form of ritual magic (see Chapter 3). As for Halley, it is likely that he was an atheist. In any event, the proportion of devout is especially striking since, contrary to popular belief, even during the Middle Ages Europeans were not more devout than they are today. Were there any remaining doubt about it, these data make it entirely clear that religion played a substantial role in the rise of science. (The complete list of cases and the code for each on piety is provided in Appendix 2.1.)

**Galileo**

But what about Galileo? The story of the persecution of Galileo Galilei (1564-1642) is nearly as famous as the one about Columbus and the flat earth, although in this instance the conventional version is somewhat more truthful. He was in fact one of the greatest figures in the history of science, and, in his old age, he did run afoul of the Catholic Church, was forced to recant his belief that the earth moves around the sun, and was sentenced to live in seclusion for the last nine years of his life. But there is far more to the story than this, and these overlooked or ignored facts put things in a somewhat different light: that Galileo’s troubles stemmed as much from his arrogance as from his scientific views. It happened this way.

Long before he ascended the throne of Peter, when he was still Cardinal Matteo Barberini, Pope Urban VIII (1623 to 1644) knew and liked Galileo. When Galileo published his Assayer in 1623, he dedicated it to Barberini, who is reported to have greatly enjoyed the nasty insults it directed at various Jesuit scholars. Indeed, Barberini was prompted to write an adulatory poem on the glory of astronomy. So what went wrong?

Keep in mind that this whole affair took place at a time when the Reformation stood defiant in northern Europe, the Thirty Years’ War raged, and the Counter-Reformation was well underway. In these circumstances, the Catholic hierarchy became increasingly sensitive to Protestant attacks that Catholics were unfaithful to the Bible; for many Churchmen, acceptance of the Copernican conception of the solar system was a manifestation of this infidelity. However, the primary issue was Church authority, and as the Counter-Reformation proceeded, the limits of orthodox theology were defined far more narrowly than they had been (Chapter 1). However, most Church leaders, including the pope, were not ready to condemn science and impose an unflinching orthodoxy. Rather, they proposed ways for scientists to sidestep theological conflict. For example, Friar Mann Mersenne advised his network of correspondents that God was free to place the earth anywhere he liked, and it was the duty of scientists to find out where he had put it. Other influential Catholics were more circumspect, noting that there were no theological objections to proposing hypothetical or mathematical conclusions.
In this spirit the pope reassured Galileo that he had nothing to fear as long as he made it clear that he spoke as a mathematician, not a theologian. Specifically, Pope Urban instructed Galileo to acknowledge in his publications that “definitive conclusions could not be reached in the natural sciences. God in his omnipotence could produce a natural phenomenon in any number of ways and it was therefore presumptuous for any philosopher to claim that he had determined a unique solution.” It seems a simple enough dodge, akin to the “hypothetical” modifier that the Scholastics had frequently appended to their scientific works. Moreover, for a man who often made false claims to actually have performed research that was at best “hypothetical” (such as dropping weights from the Leaning Tower of Pisa), this surely did not stretch his ethical standards.

When he published his famous *Dialogue concerning the Two Chief World Systems* (in 1632), Galileo did include this formula, but he put it in the mouth of Simplicio, the dullard who voiced all of the “errors,” the correction of which was the main thrust of the book. Moreover, he deceived the pope about when the book would appear, so that it came out unexpectedly, touching off a storm of controversy that required response. Understandably, the pope felt betrayed. But Galileo seems never to have understood this and was inclined to blame all his troubles on the Jesuits (who probably played no important role, despite his insults) and on true believers in Aristotle, especially professors (who had also suffered as a group from his acidic humor). Despite all this, the pope did thwart efforts to impose more serious consequences on Galileo. Even so, the scandal caused by Galileo helped to stimulate a general crackdown by the Church on intellectual freedom—albeit too late to prevent Catholic participation in the rise of science.

Although constantly offered as a prime exhibit in the case against religion, what does the Galileo affair actually reveal? It most certainly demonstrates that powerful organizations often do abuse their power. But it also shows that Galileo was not just an innocent victim; not only did he needlessly tempt fate, but he thoughtlessly placed the whole scientific enterprise itself in jeopardy. Beyond that, the case fails to show what most of the opponents of religion hope to gain from their frequent retellings. For the fact is that, despite everything, Galileo had no doubts about God and always regarded himself as a good Catholic. As William Shea noted, “Had Galileo been less devout, he could have refused to go to Rome [when summoned by the Holy Office]; Venice offered him asylum.” Thus there is no reason whatever to question his sincerity when he wrote that “the book of nature is a book written by the hand of God in the language of mathematics.” Hence the most important lesson here is to recognize that while Pope Urban VIII’s religious views may have caused Galileo to suffer for his scientific views, Galileo’s science did not suffer because of his own religious views.

Keep in mind that to accept, as I do, that science was the legitimate offspring of Christian theology is not to suppose that such dependency long remained. Once properly launched, science was able to stand on its own and soon developed its own motives and momentum. But, as I plan to show, these are not incompatible with religion. Moreover, when science and religion do appear to collide, questions should usually be raised about the actual scientific and/or religious standing of the matters at issue. The “Enlightenment” offers a revealing case in point.

**The “Enlightenment”**

The identification of the era beginning in about 1600 as the “Enlightenment” is as inappropriate as the identification of the millennium before it as the “Dark Ages.” And both imputations were made by the same people—intellectuals who wished to discredit religion and especially the Roman Catholic Church, and who therefore associated faith with darkness and secular humanism with light. To these ends they sought credit for the “Scientific Revolution” (another of their concepts), even though none of them had played any significant part in the scientific enterprise.

One of the first steps in this effort was to designate their own era as the “Enlightenment,” and to claim it was a sudden and complete disjunction with the past. To this end, the “Dark Ages” were invented. Among the very first ever to do so, Voltaire (1694-1778) described medieval Europe as hopelessly mired in “decay and degeneracy.” This became the universal theme. Jean-Jacques
Rousseau (1712-1778) wrote of previous centuries: “Europe had relapsed into the barbarism of the earliest ages. The peoples of this part of the world, so enlightened today, lived some centuries ago in a condition worse than ignorance.” A century later, when Jacob Burckhardt (1818-1897) popularized the idea of the “Renaissance,” the “Dark Ages” were a historical certitude, not to be shaken until late in the twentieth century. Moreover, it was not enough to blame the “Dark Ages” on Christianity; religion must also be denied any credit for the rise of science. Hence it was necessary to discredit the achievements of the Scholastic era. In keeping with this aim, John Locke (1632-1704) denounced the Scholastics as hopelessly lost in a maze of trivial concerns, as “the great mintmasters” of useless terms as an “expedient to cover their ignorance.” In similar fashion, one after another of the philosophes condemned Catholic scholarship until the word “scholastic” became an epithet—defined as “pedantic and dogmatic” according to any edition of Webster.

With the past out of the way, the central aspect of the campaign by the likes of David Hume, Voltaire, and their associates consisted of wrapping themselves in the achievements of science to authenticate their condemnation of religion in general, and Catholicism very specifically. Franklin L. Baumer noted that “the Enlightenment was a great Age of Faith.” Then he asked, rhetorically, “But faith in what?” Not religion, but “belief in man’s power.” And the proof of this power was science, which, to paraphrase Laplace, made God an unneeded hypothesis. Never mind that the actual discoveries had been made by “serious and often devout Christians.” What mattered was that, in the words of Peter Gay, “science could give the deists and atheists great comfort and supply them with what they wanted—Newton’s physics without Newton’s God.” Indeed, although Voltaire and his circle were careful to acknowledge Newton’s commitment to a Creator (albeit only to a remote and impersonal Prime Mover), subsequent generations of “Enlightenment” ideologues took great pains to further minimize Newton’s faith.

Newton Deified and Falsified

One of the first actions of those who proclaimed the “Enlightenment” was the “deification of Newton.” Voltaire set the example by calling him the greatest man who ever lived. Thus began an unexcelled outpouring of worshipful prose and extravagant poetry. David Hume wrote that Newton was “the greatest and rarest genius that ever rose for the ornament and instruction of the species.” As Gay noted, “the adjectives ‘divine’ and ‘immortal’ became practically compulsory.” For example, in his Panegyric on the Newtonian Philosophy (1750) Benjamin Martin rhapsodized, “Mystery that has been hid from Ages, and from Generations; but is now made manifest to all Nations, by the divine Writings of the immortal Sir Isaac Newton.” In 1802 the French philosophes Claude-Henri de Saint-Simon (1760—1825) founded a Godless religion to be led by scientist-priests and called it the Religion of Newton (his pupil Auguste Comte renamed it “sociology”).

However, as the “Enlightenment” became more outspokenly atheistic and more determined to establish the incompatibility of science and religion, a pressing matter arose: what was to be done about Newton’s religion? Trouble was that Newton’s religious views were not a matter of hearsay or repute. He had, after all, in 1713 added a concluding section to the second edition of his monumental Principia, the “General Schohum” (or proposition), which was devoted entirely to his ideas about God. In it, Newton undertook to demonstrate the existence of God, concluding that:

…the true God is a living, intelligent, powerful Being.
…the he governs all things, and knows all things that are done or can be done.
…He endures forever, and is everywhere present.
…As a blind man has no idea of colors, so have we no idea of the manner by which the all-wise God perceives and understands all things.

Worse yet, Newton had written four letters during 1692-1693 explaining his theology to Richard Bentley. In the “Bentley Letters” Newton ridiculed the idea that the world could be explained in impersonal, mechanical terms. Above all, having discovered the elegant lawfulness of things, Newton
believed he had, once and for all, demonstrated the certainty that behind all existence there is an intelligent, aware, omnipotent God. Any other assumption is “inconsistent with my system.” Finally, Newton left behind a huge collection of unpublished manuscripts, some of them rewritten several times, which he clearly intended for posthumous release. As we shall see, while these were troubling to those wishing to affirm Newton’s absolutely orthodox Anglicanism, they were devastating to those who wished to claim him as the hero of secular rationality. Before we consider the contents of these manuscripts, it will be useful to see how each interest group falsified Newton to history.

The first falsifiers were devout Christians seeking to suppress Newton’s mildly heretical views of the Trinity. He did not believe that Jesus was born the actual Son of God. Instead, Newton believed that at the Resurrection Jesus was changed from mortal to immortal, thus becoming the Son. Moreover, as will be seen, Newton absolutely believed in the Second Coming. Thus although on purely technical grounds it might be argued that Newton was a non-Trinitarian, he certainly was not a “Unitarian,” nor was he any sort of deist—his God was no remote and unconscious “First Cause.” Nevertheless, many of Newton’s peers thought it best to gloss over and deny even his minor departures from orthodoxy. In doing so, however, they provided an opportunity for those who wished to claim that all of Newton’s expressions of faith were insincere.

When Newton died, the Royal Society of London appointed a committee to examine his papers, and they decided, “in view of the theological character of the greater part, that they should not be printed.” However, the committee left it to one of their members, Thomas Pellett, to make a fuller assessment and to select items for publication. He found the manuscripts to consist of eighty-two different works, some extremely extensive, adding up to more than four million words. From this trove, Pellett selected only two very brief works for publication, scrawling “Not Fit to be Printed” on the first page of most of the rest. Control of these papers then passed to Newton’s niece Catherine Conduitt (who had lived with him for many years). She decided that most of her uncle’s work should be published, but, having ordered that “the papers must be carefully kept,” and that nothing could be copied or printed until they had been further examined by the Reverend Arthur Ashley Sykes (1684-1756), Mrs. Conduitt died. The manuscripts were inherited by her uncle, the earl of Portsmouth, whereupon they came to be known as the Portsmouth Collection. When Charles Hutton examined the Collection in the 1790s, he remarked on their extent, noting “there being upwards of four thousand sheets, in folio, besides the bound books etc.” But he revealed nothing of their contents. Nor did Samuel Horsley when he produced an edition of Newton’s works—“being more anxious to suppress than to make public Newton’s heresies.” Thus did the greater part of Newton’s writings remain locked away, all the while being misrepresented by the privileged few who gained access to them. Newton’s first biography, written in the 1720s by his friend William Stukeley, portrayed him as almost divine and without any taint of heresy. Nor was his next major biographer, David Brewster, willing to acknowledge Newton’s theological excursions, although he was given access to the Collection.

Misrepresentations also came from the atheist side, only these were concerned with Newton’s published writings on religion. As noted, one tactic was to dismiss his various statements about God as insincere, being no more than mere conformity undertaken to avoid trouble with religious authorities and in hopes of preferment. It was asserted, for example, that Newton added the General Scholium only “to allay the suspicion of atheism.” Moreover, much was made of the fact that he did this only in 1713 when he was past seventy, and that he should not be judged for actions taken in his dotage. The conformity excuse would not, of course, account for Newton’s expressions of faith in the “Bentley Letters,” as these had been private communications to a devoted follower. To overcome this problem, although without any legitimate grounds to do so, various writers redated the letters as written subsequent to 1713, rather than in 1692, and dismissed them, too, as the work of a man of diminished intellectual acuity. Indeed, Jean-Baptiste Biot (1774-1862) dismissed everything written by Newton after age forty-five as the fantasies of an aging man who had lost his intellectual powers, also claiming that all of Newton’s religious writings and interests were subsequent to his mental decline. Or as the
philosopher Baron d’Holbach (1723-1789) put it, “the sublime Newton is no more than an infant, when he quits physics and evidence to lose himself in the imaginary regions of theology.”

Thus despite clear evidence to the contrary, it came to be the received wisdom in “enlightened circles” that during his vigorous days as a scientist, Newton was at the very most a deist in the mode of Hume, Voltaire, and the philosophers. Friedrich Engels (1820-1895) claimed that although “Newton still allowed Him the ‘first impulse’ [he] forbade Him any further interference in his solar system.” E. T. Bell wrote in his still popular *Men of Mathematics*, “Newton however did permit his rational science to influence his beliefs to the extent of making him what would now be called a Unitarian.” Or as Gerald R. Cragg explained, Newton was “a deist” because he “ignored the claims of revelation.”

Meanwhile, Newton’s sequestered works ticked on. In 1872 the Portsmouths asked archivists from Cambridge University to catalog the Collection and to keep any papers of scientific value. After categorizing the manuscripts, the archivists found that there was virtually nothing “scientific” among them; hence nearly the entire Collection was returned to the earl of Portsmouth under the terms of the original agreement. Six decades later, an American biographer of Newton consulted the brief inventory that had been drawn up at Cambridge, finding evidence of Newton’s enormous theological output, but the actual content of these works remained unknown. Finally, in 1936, faced with confiscatory British inheritance taxes, the current earl of Portsmouth consigned the Collection to Sotheby and Company, the famous London auction house. The Newton manuscripts and papers were offered in 329 lots, making it likely that they would be hopelessly scattered among an international group of dealers. At the time, some Newton scholars assumed that was in fact what happened. But it did not, thanks to a Cambridge economist who used his own funds and careful study of the auction catalog to keep the most important manuscripts together.

John Maynard Keynes (1883-1946) was probably the most famous and influential economist of the twentieth century, and the most dedicated collector of Newtonia. According to A.N.L. Munby, the Cambridge librarian and Keynes’s biographer, the great economist began his collection in 1905 when he bought a rare first edition of Newton’s *Principia* from a Cambridge bookseller for “four shillings, a staggering bargain even in those days.” When he learned that the Portsmouth Collection was to be auctioned, Keynes “with characteristic energy and public spirit took upon himself the burden of assembling as much of the material as he could in his own library.” Since Newton had carefully recopied the major manuscripts, there were two or more copies of each. Thus Keynes could pick his spots, being careful not to “forfeit the goodwill of the booksellers” who made up the bulk of the other bidders, as he planned to buy many manuscripts from them later. During the sale, which grossed a total of less than £10,000, Keynes bought 38 of the 329 lots offered. Within the next two months he bought 92 more lots. According to Munby, altogether Keynes spent £3,000, or about $15,000—a substantial sum for a professor in those days, but a pittance in terms of value. While Keynes worked to buy the most important of Newton’s unpublished works, he corresponded with A. S. Yahuda, a Yale professor who was acquiring Newton’s theological manuscripts purchased by American dealers—mainly duplicates of those gathered by Keynes. In his will Keynes bequeathed his entire collection of Newtonia to his college (King’s) at Cambridge. The collection assembled by Yahuda is now in the Hebrew National and University Library in Jerusalem.

Because the Sotheby catalog was “a model of learned . . . presentation and must always remain a standard reference book on the shelves of Newtonian scholars,” Keynes knew a great deal about what he was buying. Nevertheless, he was astonished by the content of the manuscripts. They revealed that even during his prime years of scientific achievement, Newton was as interested in theology and Bible prophecy as in physics—he left more than a million words on these topics. For example, in a work on Bible prophecy, begun in the 1670s and with additions and revisions introduced until the month of his death in 1727, Newton calculated, among many other things, that the Second Coming of Christ would occur in 1948, four years after the “end of the great tribulation of the Jews.” The documents also revealed that Newton had been deeply involved in astrology and had devoted many years of intensive
effort to alchemy, leaving another million words on that topic.\footnote{169}

Keynes recognized the historical importance of these papers at once and planned to write about them at length. His first installment was an essay, “Newton, the Man,” written for the Royal Society of London’s tercentenary celebration of Newton’s birth in 1946 (which had been delayed by four years owing to World War II). Unfortunately, Keynes died unexpectedly several months before the event, so his essay was read to the society by his brother Geoffrey. It was Keynes at his eloquent best:

In the eighteenth century and since, Newton came to be thought of as the first and greatest of the modern age of scientists, a rationalist, one who taught us to think on the lines of cold and untinctured reason. I do not see him in this light. I do not think that any one who has pored over the contents of [these manuscripts] can see him like that. Newton . . . looked on the whole universe and all that is in it as a riddle, as a secret which could be read by applying pure thought to certain evidence, certain mystic clues which God had laid about the world to allow a sort of philosopher’s treasure hunt... He believed that these clues were to be found partly in the evidence of the heavens and in the constitution of elements . . . but also partly in certain papers and traditions handed down., in an unbroken chain back to the original cryptic revelation in Babylonia. He regarded the universe as a cryptogram set by the Almighty.

So now we know. The real Isaac Newton was the quintessential student of God’s handiwork, believing not only in the existence of physical laws but that similar divine laws governed history as well.\footnote{170} Two centuries of efforts to depict Isaac Newton as having been much too sophisticated to believe in God were motivated by precisely the same reasons that underlay the false stories about Columbus, about Vesalius, about the “Dark Ages,” about the “Enlightenment” and about the Scholastics. To wit: science stands in opposition to religion. No important scientific work can be achieved or even fully understood by minds dominated by “superstition.” The “Scientific Revolution” was made by “enlightened men,” who thereby enlightened us, making it impossible for an intelligent person to be religious. These are the slogans of one of the longest-running and most effective polemical campaigns in Western history. But while the campaign has had a very significant impact on the intellectual world in general, as evidenced even in dictionaries, strangely enough it seems not to have made much difference to scientists. Not only were those who made the “Scientific Revolution” notable for their piety; that tradition has continued. For example, through most of the nineteenth century, science remained as much a religious as a secular calling—efforts to unravel God’s handiwork continued.

**“Handiwork” And Nineteenth-Century Science**

Perhaps only during the Scholastic era was there such a close and creative relationship between theology and science as obtained during the nineteenth century. Indeed, while early science may have been stimulated by theology, now theology was stimulated by the latest scientific discoveries, finding in them overwhelming proof of basic religious tenets—an approach that was known as “Natural Theology.” Its proponents dismissed mere speculation in favor of careful observations of nature. Indeed, “the natural theologian had to be a scientist . . . [it] was a discipline in which Christian philosophy and empirical science merged.”\footnote{171} Thus where once religion had encouraged the assumption that immutable natural laws existed, now the precision of these laws was used to prove the existence of God. This came to be known as the Design Argument: to discover in the complexity of the world the necessity of a Creator.

No one did more to popularize the Design Argument than did the English Churchman William Paley (1743-1805). In his immensely influential Natural Theology, Paley considered the implications of finding a stone lying on the ground. If one were asked how the stone came to be there, it might be adequate to answer that perhaps “it had lain there forever.” In contrast, “suppose I had found a watch upon the ground.” It will not do to suppose that a watch had lain there forever, for, as one examines a watch, any suggestion that it may have come into existence through happenstance becomes absurd—any watch reveals itself as a creation. Compared even to the finest watch, the least complex biological organism is a far more sophisticated “machine” and impels us to assume a Creator.\footnote{172} In the remainder of his book, Paley explored the complexities of a variety of different biological machines. For, although this may surprise most readers, the fossil evidence of progressive development from simple to complex
life-forms, of animals existing long before humans, or evidence of the stars being far older than the earth, did not unsettle most Christian theologians! Indeed, there is an immense library of now unread books of Natural Theology that outlined the latest scientific knowledge—particularly in biology, geology, astronomy—and reconciled it with Christian theology. This was not a defensive literature but is more properly described as an enthusiastic celebration of God’s handiwork: Paley’s image of God as the Divine Watchmaker truly captured the spirit of the times. We will meet Paley again in Chapter 4 because long before he wrote about Natural Theology, he was a vigorous opponent of slavery as utterly incompatible with true Christianity.

During the nineteenth century, astronomical observatories were built in many cities across the United States by public fund-raising campaigns. In nearly every instance these campaigns were organized by and drew mainly upon devout Christians who wished to make it possible for people to observe the wonders of God’s handiwork. Leading astronomers were particularly popular lecturers in religious as well as scientific circles—if, in fact, it is possible to distinguish two such circles at this time. The rapidly growing system of American higher education, wherein most scientists were based, was itself almost entirely a religious creation, inspired by denominational competition. Moreover it was not only theologians who were eager to unite religion and science; similar efforts were typical of the leading scientists of the day. For example, Louis Agassiz (1807-1873), among the most important geologists of the nineteenth century and the first to hold an appointment at Harvard, combined the results of his brilliant fieldwork (including pioneering research on the Ice Age) with elegant expressions of the Design Argument. Indeed, in his monumental Contributions to the Natural History of the United States (1857-1862), Agassiz argued that attempts to construct biological classification systems were an effort not to impose human understanding on the natural world but to discover the classification system that existed “in the mind of the Creator.” In his review of the first volume of Agassiz’s Contributions James Dwight Dana wrote in The American Journal of Science that it had “borne science to a higher level than it had before attained.” Dana’s own expression of the “harmony” between theology and science, in an essay entitled “Thoughts on Species,” was considered so important that it was published simultaneously in both the leading theology journal and the leading science journal of the day.

Although Natural Theology is associated with the nineteenth century, it rested upon a very old tradition of scriptural interpretation. As far back as the first century, Clement I (considered to have been the third pope) taught that the Bible is not only or always to be understood literally; rather some passages are allegories. Saint Augustine considered this the only acceptable approach to scripture “since divers things may be understood under these words which yet are all true.” In fact, Augustine frankly admitted that it is possible for a later reader— with God’s help, to grasp a scriptural meaning even though the person who first wrote down the scripture “understood not this.” Thus, he continued, it is necessary to “enquire. . . what Moses, that excellent minister of Thy faith, would have his reader understand by those words. . . let us approach together unto the words of Thy book, and seek in them Thy meaning, through the meaning of Thy servant, by whose pen Thou hast dispensed them.” Moreover, since God is incapable of either error or falsehood, if the Bible seems to contradict knowledge, that is because of a lack of understanding on the part of the “servant” who recorded God’s words.

The Catholic Church has always taught that the meaning of scripture lot invariably literal and is thus subject to interpretation by the Church. In fact, it was by claiming the exclusive right to interpret scripture that Church placed itself in opposition, not only to those committed to literalism, but also to its own theologians and, in some eras, to science. Moreover, by asserting its interpretive infallibility, the Church made reformations inevitable.

The need to interpret the Bible was central to the entire Protestant undertaking, even leading some to assert that people must be their own theologians. But even Protestants committed to a more authoritarian church rejected scriptural literalism. For example, John Calvin clearly asserted the legitimate basis for Natural Theology when he taught that God accommodates his revelations to the limits of human understanding—that “revelation is an act of divine condescension.” For example, Calvin explained
that the author of Genesis “was ordained to be a teacher of the unlearned and primitive, as well as the learned; so could not achieve his goal without descending to such crude means of instruction.” Thus Calvin dismissed such notions as the six days of Creation as not indicative of the actual time involved.\textsuperscript{176}

In his Sermons on the Ten Commandments, Calvin explained:

Because we are not yet participants in the glory of God, thus we cannot approach him; rather, it is necessary for him to reveal himself to us according to our rudeness and infirmity. The fact remains that since the beginning of the world when God appeared to mortal men, it was not in order to reveal himself as he was, but according to men’s ability to support him. We must always keep this in mind: that God was not known by the fathers. And today he does not appear to us in his essence. Rather he accommodates himself to us. That being the case, it is necessary for him to descend according to our capacity in order to make us sense his presence with us.\textsuperscript{177}

From the Catholic side, this view was ratified by the Carmelite friar Paolo Antonio Foscarini in his 1615 work on Copernicus: “Scripture speaks according to our mode of understanding.”\textsuperscript{178}

Hence the rise of science did not catch Christian theologians with their verses down. The only thing new about Natural Theology was the name—indeed, Calvin also wrote at length on the Design Argument. The willingness of scientists to acknowledge a Creator and the equal willingness of theologians to adjust their doctrines to the latest scientific discoveries drove the militant heirs of the “Enlightenment” nearly to distraction. Despite the achievements of the “divine” Newton, the forces of “superstition” not only persisted; they had not even been driven out of the universities. Something had to be done. And it was.

**Evolution and Religion**

Charles Darwin (1809-1882) would be among the most prominent biologists in history even had he not published The Origin of Species (1859). But he would not have been deified, nor would he have been substituted for Newton in the campaign to “enlighten” humanity. As will be seen, the battle over evolution is not an example of how “heroic” scientists have withstood the relentless persecution of religious “fanatics.” Rather, from the very start it has primarily been an attack on religion by militant atheists who wrap themselves in the mantle of science in an effort to refute all religious claims concerning a Creator—an effort that has also often attempted to suppress all scientific criticism of Darwin’s work.

Although it has recently become remarkably lively, I would prefer not to participate in the current debate over the logical and empirical status of the theory of evolution. Unfortunately, to adequately understand the real basis of the long-standing conflict over evolution, we must see that the aggressive public certitude of Darwinians has been in almost direct proportion to the shortcomings of the theory. Problems that were obvious even to Darwin have not been overcome after more than 150 years of effort. My reluctance to pursue these matters is based on my experience that nothing causes greater panic among many of my colleagues than any criticism of evolution.\textsuperscript{179} They seem to fear that someone might mistake them for Creationists if they even remain in the same room while such talk is going on. As will be seen, that is precisely how “Darwin’s Bulldog,” Thomas Henry Huxley (1825-1895), hoped intellectuals would react when he first adopted the tactic of claiming that the only choice is between Darwin and biblical literalism. Indeed, Richard Dawkins, who holds a chair at Oxford devoted to the public understanding of science, has frankly asserted that “even if there were no actual evidence in favor of Darwinian theory . . . we should still be justified in preferring it over all rival theories,” carefully limiting the latter to the crudest possible Creationism and to antique Lamarckian genetics.\textsuperscript{180}

However, just as one can doubt Max Weber’s Protestant ethic thesis without thereby declaring for Marxism, so, too, one may note the serious shortcomings of Darwinian and neo-Darwinian theory without opting for six-day Creation or indeed for any rival theory—modern physics provides a model of how science benefits from being willing to live with open questions rather than embrace obviously flawed theories. I certainly do not claim that room must be left for a Creator in any adequate theory of biological origins—perhaps a far more adequate and entirely materialistic theory will appear tomorrow. What I am saying is that Darwin’s theory, on with all of the subsequent revisions, falls noticeably short
of explaining the origin of species. Even so, I raise this issue only because it is needed to demonstrate the thoroughly ideological basis of the Darwinian Crusade, and to thereby show that it does not indicate a basic incompatibility between religion and science. There is, of course, an inherent conflict between “scientific atheism” and religion, which is what is illustrated here.

When a militant Darwinist such as Richard Dawkins claims, “The theory is about as much in doubt as the earth goes round the sun,”\(^1\) he does not state a fact but merely aims to discredit a priori anyone who dares to express reservations about evolution. Indeed, Dawkins has written, “It is absolutely safe to say that, if you meet somebody who claims not to believe in evolution, that person is ignorant, stupid, or insane.”\(^2\) Eric Hoffer would have treasured these statements had they been available when he wrote The True Believer (1951). Worse yet, Dawkins knows the many serious problems that beset a purely materialistic evolutionary theory, but asserts that no one except true believers in evolution can be allowed into the discussion, which must be held in secret. Thus he chastises Niles Eldredge and Stephen Jay Gould, two distinguished fellow Darwinians, for giving “spurious aid and comfort to modern creationists.”\(^3\) Dawkins believes that, regardless of his or her good intentions, “if a reputable scholar breathes so much as a hint of criticism of some detail of Darwinian Theory, that fact is seized upon and blown up out of proportion.” Dawkins’s views have been widely shared. Consequently, while acknowledging that “the extreme rarity of transitional forms in the fossil record” is a major embarrassment for Darwinism, Gould confided that this has been held as a “trade secret of paleontology,” and acknowledged that the evolutionary diagrams “that adorn our textbooks” are based on “inference, ... not the evidence of fossils.”\(^4\) Indeed, according to Steven Stanley, another distinguished evolutionist, doubts raised by this problem with the fossil record were “suppressed” for years.\(^5\) Stanley noted that this, too, was a tactic begun by Huxley, who was always careful not to reveal his own serious misgivings in public. As Eldredge summed up, “We paleontologists have said that the history of life supports [the principle of gradual transformations of species], all the while really knowing that it does not.”\(^6\) This is not how science is conducted; it is how ideological crusades are run.

**Darwinian Theory**

To give the greatest possible reassurance to readers, I have been careful to draw my statements about deficiencies of the theory of evolution only from well-known, enthusiastic Darwinians.

By Darwin’s day it had long been recognized that the fossil evidence showed that, over an immense period of time, there had been a progression in the biological complexity of organisms. In the oldest strata, only simple organisms are observed. In more recent strata, more complex organisms appear. Moreover, following the work of Carolus Linnaeus (1707-1778), the biological world has been classified into a set of nested categories. Thus within each genus (mammals, reptiles, etc.) are species (dogs, horses, elephants, etc.), and within each species are many specific varieties, or breeds (Great Dane, poodle, beagle, etc.). The boundaries between species are distinct and firm—one species does not simply trail off into another by degrees. For example, interbreeding is possible among varieties within a species (between, say, poodles and beagles), but not across species (dogs cannot breed with cats). Hence there will be no mixed breeds across species (no dog/cats or horse/cows). What that means is that new species cannot be created by crossbreeding.\(^7\)

These facts were of considerable interest to Natural Theologians and to biologists alike, and everyone realized that they posed two primary questions. The first is about variation within species. How is it that there are so many different breeds of dogs, for example? The second question asks about variation across species. As more complex creatures appear in the fossil record, where did they come from? That is, how do new species come into existence?

It was well known that selective breeding could create variations within species. The immense array of breeds of dogs is the result of centuries of selective breeding wherein humans have picked out dogs showing the greatest amount of the desired trait (short tail, shaggy coat, long legs) and then have bred them until, after many generations of selective breeding, one had Great Danes or Standard Poodles. But how did selective breeding happen in nature without human direction? Here Darwin made a very clever
and lasting contribution: the principle of natural selection. Just as human breeders select on the basis of desired traits, nature does the same, albeit unwittingly. Three elements are involved. First, organisms within any species vary slightly in many different ways that are inheritable. Second, organisms are subject to a struggle for survival, and those having traits more conducive to survival will be more likely to reproduce. Hence organisms will change by becoming better suited (adapted) to survive. Third, if the conditions governing survival differ from one place (or ecological niche) to another, the result will be different breeds of the same species. This was the easy one.

It would seem impossible for natural selection within existing species to create new species. As Darwin acknowledged, breeding experiments reveal clear limits to selective breeding beyond which no additional changes can be produced. For example, dogs can be bred to be only so big and no bigger, let alone be selectively bred until they are cats. Hence the question of where species come from was the real challenge, and, despite the title of his famous book and more than a century of hoopla and celebration, Darwin essentially left it unanswered.

After many years spent searching for an adequate explanation of the origin of species, in the end Darwin fell back on natural selection, claiming that it could create new creatures, too, if given immense periods of time. That is, organisms respond to their environmental circumstances by slowly changing (evolving) in the direction of traits beneficial to survival until, eventually, they are sufficiently changed as to constitute a new species. Hence new species originate very slowly, one tiny change after another and eventually this can result in a whole chain of new species, as from lemurs to humans via many intervening species.

Darwin fully recognized that a major weakness of this account of the origin of species involved what he, and others, referred to as the principle of “gradualism in nature.” Darwin explicitly rejected the idea that a whole cluster of favorable changes could occur simultaneously, thus producing a new species at one sudden bound. “To admit [such a possibility],” he wrote in The Origin, “is, as it seems to me, to enter into the realms of miracle, and to leave those of Science.” Linnaeus had pronounced that “nature makes no leaps,” and this was the equivalent of Holy Writ for Darwin and his followers. And as Howard Gruber explained, this “posed an alternative of terrible import: nature makes no jumps, but God does.” To show that something is of natural, not divine, origins, one must show that it followed an extremely gradual and clear progression from prior forms. And that was the rub. The fossil record was utterly inconsistent with gradualism. As Darwin acknowledged:

[Why, if species have descended from other species by fine gradations, do we not everywhere see innumerable transitional forms? Why is not all nature in confusion instead of the species being, as we see them, well defined?]

Darwin offered two solutions. Transitional types are quickly replaced and hence would mainly be observable only in the fossil record. As for the lack of transitional types among the fossils, that was, Darwin admitted, “the most obvious and serious objection which can be urged against the theory.” Darwin dealt with this problem by blaming “the extreme imperfection of the geological record.” “Only a small portion of the surface of the earth has been geologically explored, and no part with sufficient care.” But just wait, Darwin promised, the missing transitions will be found in the expected proportion when more research has been done. Thus began an intensive search for what the popular press soon called the “missing links.”

Today, the fossil record is enormous compared to what it was in Darwin’s day, but the facts are unchanged. The links are still missing; species appear suddenly and then remain relatively unchanged. As Steven Stanley reported, “The known fossil record…offers no evidence that the gradualistic model can be valid.” Indeed, the evidence has grown even more contrary since Darwin’s day. As the former curator of historical geology at the American Museum of Natural History noted, “Many of the discontinuities [in the fossil record] tend to be more and more emphasized with increased collecting.”

As Stephen Jay Gould summarized:

The history of most fossil species includes two features particularly inconsistent with gradualism:
1. **Stasis.** Most species exhibit no directional change during their tenure on earth. They appear in the fossil record looking much the same as when they disappear; morphological change is usually limited and directionless.

2. **Sudden appearance.** In any local area, a species does not arise gradually by the steady transformation of its ancestors; it appears all at once and “fully formed.”

These are precisely the objections raised by many biologists and geologists in Darwin’s time—it was not merely that Darwin’s claim that species arise eons of natural selection was offered without supporting evidence, but that the available evidence was overwhelmingly contrary. Unfortunately, rather than concluding that a theory of the origin of species was yet to be accomplished, many scientists urged that Darwin’s claims must be embraced, no matter what. As one of Europe’s leading paleontologists, François Jules Pictet, remarked in his 1860 review of *The Origin*:

> We are presented with a theory which on the one hand seems to be impossible because it is inconsistent with observed facts and on the other hand appears to be the best explanation [available].

Ever since, there has been an urgent, if often circumspect, search for a plausible alternative. Ironically, while Thomas Henry Huxley used to regale his audiences with stories of a species springing into existence “without anything to precede it” as proof of the absurdity of Creationism, in private he searched for a biological mechanism by which such leaps could be explained. Huxley was in fact “convinced that new forms came into being not through modification of the details of their morphology but through abrupt, large-scale reorganization of entire anatomical systems.” But he couldn’t discover a convincing explanation and thus continued his unwavering public condemnations of all criticisms of Darwin’s theory. Darwin himself had searched for such a mechanism for many years, and I think it obvious that he fell back on gradualism and natural selection to account for the origin of species only because, finding it necessary to publish to prevent Alfred Russell Wallace from gaining sole credit for the theory of evolution, he had nothing better to offer.

In any event, during the late nineteenth and early twentieth centuries, increasing numbers of biologists attempted to find an evolutionary mechanism capable of fitting the fossil evidence that evolution occurs by sudden leaps. As was Darwin’s own work, the earliest of these efforts were based on Jean-Baptiste Lamarck’s (1744-1829) theory that acquired characteristics can be inherited—that modifications of an organism by its environment are passed along to its offspring. Indeed, Darwin not only knew that it is possible to create a breed of dogs with short tails by selective breeding; he also believed, with Lamarck, that if one surgically shortens the tails of dogs, this will result in a short-tailed breed of dogs—eventually. However, this did not solve the problem. Even by assuming that acquired characteristics are inherited (which was soon rejected by biologists), one ends up with a *gradual* model of evolution by tiny increments, incompatible with a fossil record of new species appearing as if out of nowhere. Then came the rediscovery of the genetic principles of Gregor Mendel (1822-1884), and it seemed as if the mechanism for the origin of species had been found.

Darwin knew nothing about genes, let alone about genetic mutations. He agreed with Lamarck that the features of both parents blend to form their offspring. But Mendel showed that genes do not blend. When applied to evolution, this means that gradual changes via natural selection cannot account for new species. Thus at the turn of the century the most prominent biologists, including Hugo de Vries, William Bateson, and Thomas Hunt Morgan, completely (if rather circumspectly vis-à-vis the public) rejected Darwin’s theory and searched for a plausible genetic basis for evolution. They thought they found it in the phenomenon of genetic mutations.

A mutation is a change that occurs within a gene of a given organism and which can, therefore, be passed on to that organism’s offspring. That is, an actual physical change takes place in a specific gene, thus altering the organism and its genetic potential. In most neo-Darwinian accounts of evolution, mutations are assumed to occur randomly. Many of these minor random mutations will be irrelevant to survival and therefore may or may not persist. Many (perhaps most) will be unfavorable and will disappear as creatures having this trait will die out. But some traits will be favorable and will persist and spread through a species on the basis of superior rates of survival. But how does this result in a new
species? How do slight random mutations change a reptile into a bird or indeed, a tiny lemur into a human? In keeping with Darwin’s views, evolutionists have often explained new species as the result of the accumulation of tiny, favorable random mutations over an immense span of time. But this answer remains inconsistent with the fossil record, wherein creatures appear “as Athena did from the head of Zeus—full-blown and raring to go.”

Consequently, for most of the past century, biologists and geneticists have tried to discover how a huge number of favorable mutations can occur at one time so that a new species would appear without intermediate types.

In 1940 Richard Goldschmidt proposed the “hopeful monster” solution—“A monstrosity appearing in a single genetic step might…produce a new type.” He acknowledged that most multiple mutations result in a “hopeless monster,” in that the changes are harmful or retrograde. But sometimes new features might be an improvement, hence a “hopeful monster.” What Goldschmidt was really up to was inferring a genetic cause from an empirical result. New species pop into view. Since that must be the result of evolution, we can only assume that a truly massive, multiple mutation has taken place. In fact, it must happen twice in the same time and place if the monster is to secure a mate. The hopeful monster still stalks the fringes of neo-Darwinism, but it has been dismissed by most biologists as it would have been by Darwin. As the eminent and committed Darwinist Ernst Mayr explained:

The occurrence of genetic monstrosities by mutation…is well substantiated, but they are such evident freaks that these monsters can only be designated as “hopeless.” They are so utterly unbalanced that they would not have the slightest chance of escaping elimination through selection. Giving a thrush the wings of a falcon does not make it a better flyer. Indeed, having all of the other equipment of a thrush, it would probably hardly be able to fly at all…To believe that such a drastic mutation would produce a viable new type, capable of occupying a new adaptive zone, is equivalent to believing in miracles.

Which is what Darwin said.

A more recent effort to account for the sudden appearance of new species in the fossil record has been suggested by Niles Eldredge and Stephen Jay Gould. This is known as punctuated equilibrium. It has never been entirely clear what this principle is, a problem made worse by the fact that the authors, especially Gould, have often changed their minds about what they do mean. In some incarnations it appeared to be a new version of the “hopeful monster”—indeed, Gould published an essay entitled “Return to the Hopeful Monster.” The initial version of “punctuated equilibrium” merely asserts that Darwin was wrong to suppose that evolution occurs via a slow accumulation of tiny steps. Since the fossil record shows sudden leaps, that’s how evolution occurs—from time to time the equilibrium of an unchanging species is punctuated by a sudden change. Since Darwin’s theory can’t handle this, Gould concluded that a new evolutionary principle is needed. But no such principle was suggested. Indeed, Gould was able to write at length about how “punctuated equilibrium theory” reconciles Darwinism with the fossil record, at the same time denying that this theory proposes any “violent mechanism” by which the sudden appearance of a new species occurs. But in not proposing a mechanism, Gould and Eldredge made no progress in solving the problem of the origin of species. In the end, what they argued is that however it happens, new species arise in a very local area and do not spread until they have passed through the intermediate stages. That solves the problem of the “missing links”—they exist in only one small place, and it would take an immense stroke of luck to find them (presumably more luck than is needed to produce the new species itself). But we still don’t know why or how such leaps occur. Moreover, even by discussing the urgency of the need for a solution, Gould and Eldredge have stirred up antagonism among peers who realize that any such mechanism is very likely to reopen the door to miracles, just as Darwin feared. In fact, another prominent Darwinian, Daniel C. Dennett, has accused Gould of having such intentions—“my diagnosis, however, is that he [Gould] has all along been hoping for skyhooks to lift evolution along.”

Indeed, the word “miracle” crops up again and again in mathematical assessments of the possibility that even very simple biochemical chains, let alone living organisms, can occur by a process of random trial and error. For generations, Darwinians have regaled their students with the story of the monkey and
the typewriter, noting that given an infinite period of time, the monkey sooner or later is bound to produce Macbeth (or all of Shakespeare or the Bible) purely by chance. The moral being that infinite time can perform miracles. However, the “monkey” of random evolution does not have infinite time. Even if one makes the wild assumption that life came here from a much older faraway planet, the progression from simple to complex life-forms on Earth took place within a quite limited time.²¹¹ Even more telling is the fact that when competent mathematicians considered the matter they quickly calculated that even if the monkey’s task were reduced to coming up with only a few lines of Macbeth, let alone Shakespeare’s entire play, the probability is far, far beyond any possibility.²¹² The odds of creating even the simplest organism at random are even more remote—Fred Hoyle and Chandra Wickramasinghe²¹³ calculated the odds as 1 in 1040000 (consider that all of the atoms in the known universe are estimated to number no more than 1080). In this sense, then, Darwinian Theory does rest on truly miraculous assumptions.

Perhaps the most amazing aspect of the current situation is that while Darwin is treated as a sacred saint in the popular media, and the “theory” of evolution is regarded as the invincible challenge to all religious claims, it is taken for granted among the leading biological scientists that the origin of species has yet to be explained. Writing in Nature in 1999, Eors Szathmairy began his review of Jeffrey Schwartz’s effort to construct such a theory:

The origin of species has long fascinated biologists. Although Darwin’s major work bears it as a title, it does not provide a solution to the problem. Does Jeffrey Schwartz give one? I am afraid that, in general, he does not.²¹⁴

When Julian Huxley claimed that “Darwin’s theory is…no longer a theory but a fact,” he surely knew better.²¹⁵ But just like his grandfather, Thomas Henry Huxley, he knew that his lie served the greater good of “enlightenment.”

The Darwinian Crusade

When The Origin of Species was published, it aroused immense interest, but initially it did not provoke antagonism on religious grounds. Darwin’s scientific reputation ensured that reviewers took the book seriously and treated its author respectfully. Although many criticized his lack of evidence, none raised religious objections, as even Stephen Jay Gould has acknowledged.²¹⁶ Instead, the initial response from those involved in Natural Theology was extremely favorable. Asa Gray (1810—1888), the distinguished Harvard botanist, hailed Darwin for having solved the most difficult problem confronting the Design Argument—the many imperfections and failures revealed in the fossil record. Acknowledging that Darwin himself “rejects the idea of design,” Gray congratulated him for “bringing out the neatest illustrations of it.”²¹⁷ Gray interpreted Darwin’s work as showing that God has created a few original forms and then let evolution proceed within the framework of divine “laws”—hence the occasional wrong turnings and “errors.” Darwin and his immediate supporters found this intolerable—it was precisely in opposition to the Design Argument that his theory was aimed.

Thus when religious antagonism came, it was generated by a social movement which—by constantly proclaiming that, together, Newton and Darwin had evicted God from the cosmos—forced religious leaders to respond. For the heirs of the “Enlightenment,” evolution seemed finally to supply the weapon needed to destroy religion. As Richard Dawkins confided, “Darwin made it possible to be an intellectually fulfilled atheist.”²¹⁸

The Darwinian Crusade was launched by a group of men led and typified by Thomas Henry Huxley.²¹⁹ Like Huxley, some of these crusaders were scientists. But, also like Huxley, since long before the publication of Darwin’s theory, they had been activists on behalf of socialism and atheism.²²⁰

The earliest and most militant proponents of Darwinism made up a virtual Who’s Who of socialism.²²¹ When she wasn’t singing hymns praising evolution with George Bernard Shaw at Fabian Society meetings, Annie Besant was distributing her pamphlet Why I Am a Socialist, in which she gave the answer “because I am a believer in Evolution.” Alfred Russell Wallace, who is credited as Darwin’s co-discoverer of the theory of evolution, was a prominent socialist whose reading of the evolutionary
future of humanity led him to be the first to proclaim the coming of that biological paragon of selflessness, “socialist man.” Indeed, still to be found in Darwin’s library is a first edition of *Das Kapital*, inscribed to “Mr. Charles Darwin. On the part of his sincere admirer, Karl Marx, London 16 June 1873.” More than a decade before, when he read *The Origin*, Marx wrote to Engels that Darwin had provided the necessary biological basis for socialism. When he spoke at Marx’s burial service, Engels equated the two: “Just as Darwin discovered the law of development of organic nature, so Marx discovered the law of development of human nature.” The way was now clear for the revolution and for “scientific atheism.”

Indeed, atheism was central to the agenda of the Darwinians. Darwin himself once wrote that he could not understand how anyone could even wish that Christianity were true, noting that the doctrine of damnation was itself damnable. As for Huxley, he expressed his hostility toward religion often and clearly, writing in 1859:

My screed was meant as a protest against Theology & Parsondom. . . both of which are in my mind the natural & irreconcilable enemies of Science. Few see it but I believe we are on the Eve of a new Reformation and if I have a wish to live thirty years, it is to see the foot of Science on the necks of her Enemies.

As the Oxford historian J. R. Lucas summed up:

[Huxley] had no love of ecclesiastics and was sure that science must be at odds with religion. Later in his life he [was] still remarkably resistant to the idea that there were clergymen who accepted evolution, even when actually faced with them.

Quite simply, there could be no compromises with faith. For as John Tyndall (1820-1893) told the British Association in his 1874 presidential address:

[T]he basis of the doctrine of evolution consists . . . in its general harmony with scientific thought . . . We claim and we shall wrest from theology, the entire domain of cosmological theory.

That same year, the leading Darwinian in Germany, Ernst Haeckel (1834—1919), acknowledged:

On one side spiritual freedom and truth, reason and culture, evolution and progress stand under the bright banner of science; on the other side, under the black flag of hierarchy, stand spiritual slavery and falsehood, irrationality, barbarism, superstition and retrogression. . . Evolution is the heavy artillery in the struggle for truth. Whole ranks of . . . sophistries fall together under the chain shot of this . . . artillery, and the proud and mighty structure the Roman hierarchy, that powerful stronghold of infallible dogmatisms like a house of cards.

Is it really surprising that religious people, scientists as well as clerics, began to respond in the face of unrelenting challenges issued to them in the name of evolution? It was not as if they were merely asked to accept life had evolved—Natural Theologians had long taken that for granted and continued to do so. Instead, what the Darwinians demanded was that religionists agree to the untrue and unscientific claim at Darwin had proved that God played no role in the process. Nor were these Darwinian challenges limited to radical circles and peripheral publications. The actual author of the *Times*’s huge review of *The Origin* was none other than Thomas Henry Huxley, who praised the book to the heavens, while denying they existed. How could there not have been religious rejoinders? Indeed, Huxley built his lectures on evolution into a popular touring stage show wherein he challenged various potential religious opponents by name.

Of course, persons of faith felt it necessary to respond. And Huxley was very clever (and lucky) about which ones to emphasize. The most famous among those drawn to respond was William Gladstone (1809-1898), four-time prime minister of Britain. Gladstone was a gifted writer and sincere Christian, but he was not a scientist and thereby provided Huxley with an ideal opponent. Even so, Huxley responded to Gladstone mainly with abuse, rather than with science—even he admitted, “I really cannot use respectful language about this intrusion of an utter ignoramus into scientific questions.”

In an early draft of this chapter, I assumed that another of Huxley’s “victims” was the bishop of Oxford, Samuel Wilberforce (1805-1873), who is said to have made an ass of himself in a debate with Huxley during the 1860 meeting of the British Association at Oxford. The original account of this
confrontation reported:

I was happy enough to be present on the memorable occasion at Oxford when Mr. Huxley bearded Bishop Wilberforce. . . The Bishop arose and in a light scoffing tone, florid and fluent, he assured us that there was nothing in the idea of evolution. . . Then turning to his antagonist with a smiling insolence, he begged to know, was it through his grandfather or his grandmother that he claimed descent from a monkey? On this Mr. Huxley... arose and spoke these tremendous words. . . He was not ashamed to have a monkey for an ancestor; but he would be ashamed to be connected with a man who used his great gifts to obscure the truth. No one doubted his meaning and the effect was tremendous.232

This anecdote has appeared in every distinguished biography of Darwin and of Huxley, as well as in every popular history of the theory of evolution.233 In his celebrated Apes, Angels and Victorians, William Irvine used this tale to disparage the bishop’s snobbery.234 In his prizewinning study, H. James Brix went much further; describing Wilberforce as “naive and pompous,” a man whose “faulty opinions” were those of a “fundamentalist creationist,” and who provided Huxley with the opportunity to give evolution “its first major victory over dogmatism and duplicity.”235 Every writer tells how the audience gave Huxley an ovation, and nearly everyone has taken pains to identify the bishop as “Soapy Sam.”

Trouble is, it didn’t happen. The quotation above was the only “firsthand” report of this story, and it appeared in an article entitled “A Grandmother’s Tales” written by a non-scholar in a popular magazine thirty-eight years after the alleged encounter! No other account of these meetings, and there were many written at the time, mentioned remarks concerning Huxley’s monkey ancestors or claimed that he made a fool of the bishop. To the contrary, many thought the bishop had the better of it, and even many of the committed Darwinians thought it at most a draw.237 Moreover; as all of the scholars present at Oxford knew, prior to the meeting Bishop Wilberforce had published a review of The Origin in which he fully acknowledged the principle of natural selection as the source of variations within species. However; he rejected Darwin’s claims concerning the origin of species, and some of these criticisms were sufficiently compelling that Darwin immediately wrote his friend the botanist J. D. Hooker (1817—1911) that the review “is uncommonly clever; it picks out with skill all the most conjectural parts, and brings forward well all the difficulties. It quizzes me quite splendidly.”238 In a subsequent letter to the geologist Charles Lyell (1797—1875), Darwin complained that Wilberforce’s review “is full of errors,” but then acknowledged, “By the way, Bishop makes a very telling case against me.”239 Indeed, several of Wilberforce’s comments caused Darwin to make modifications in a later revision of the book.240 These were the issues that Wilberforce summarized for the British Association and to which Huxley responded.

Even though the account of Huxley’s triumph over the supposedly fatuous and snobbish bishop was exposed as fictional more than twenty years by J. R. Lucas,241 this fact has been given so little attention that I almost repeated the fiction—it lives on in Desmond’s 1997 biography of Huxley. Yet, judging from their citations, all of the biographers and historians who reported it as fact had read Francis Darwin’s collection of father’s correspondence and ought to have wondered why Darwin himself saw merit in “Soapy Sam’s” foolishness. Furthermore, Wilberforce’s sophisticated review of The Origin remains easily accessible in The Quarterly Review for July—October 1860. Nevertheless, the tale of the bishop’s comeuppance continues to thrive as a revealing “truth” about the incompatibility of religion and science. It’s as though Samuel Wilberforce (who took a particularly distinguished first in mathematics at Oxford) must have been wrong and a fool because he was a bishop. Indeed, Lucas has suggested that the “most important reason why the legend grew” is that “it is a point of professional pride” for “academics… to know nothing outside their own special subject..,” They firmly believe that outsiders are necessarily ignorant; hence Huxley “must have succeeded on that occasion.” Moreover; “the quarrel between religion and science came not because of what Wilberforce said, but because it was what Huxley wanted; and as Darwin’s theory gained supporters, they book over his view of the incident.”242
The episodes involving Gladstone and Wilberforce reveal several methods frequently used by the Darwinian Crusade to overwhelm its opponents. When possible, focus all attention on the most unqualified and most vulnerable opponents, and when no easy targets present themselves, invent them—as Huxley’s celebrated biographer Adrian Desmond admitted, he “made straw men of the ‘Creationists.’”

Thus even today it is a rare textbook on general biology or on evolution, to say nothing of popular treatments of evolution and religion, that does not reduce “Creationism” to Bishop Ussher’s calculations concerning the age of the earth and to William Jennings Bryan’s antics during the so-called Scopes Monkey Trial.

James Ussher (1581-1656) was a fellow of Trinity College, Dublin, and later served as bishop of Armagh. A Protestant of Calvinist tendencies, Ussher has been credited with calculating that the Creation took place in 4004 B.C.E. In fact, he did not originate this figure, which was only one of many circulating at that time—indeed, Isaac Newton devoted considerable attention to this same matter and reached quite similar conclusions. More to the point, by the time of the Darwinian Crusade, Ussher’s date was largely forgotten, and the prevailing view among theologians as well as geologists was that the earth was very old. It was the evolutionists who claimed that Ussher’s date was the representative Christian view, the better to discredit their opponents. In fact, serious opposition to evolutionary theory of the truly fundamentalist kind did not arise until more than sixty years after the publication of *The Origin*.

H. James Brix’s snide identification of Bishop Wilberforce as a “fundamentalist creationist” was quite incorrect both theologically and linguistically. It was wrong theologically because the bishop did not interpret scripture literally (in his review of *The Origin* Wilberforce specifically condemned all objections to science based on scripture), and it was wrong linguistically because the term “fundamentalist” had not yet been coined. Most people probably assume that fundamentalism is the oldest form of Christianity that “Old Time Religion” celebrated by the popular revitalist hymn. In fact, the Fundamentalist Movement was born in about 1910 in the United States. In response to the “new criticism” in biblical studies holding sway in the prominent seminaries (Harvard Divinity School had been openly Unitarian for a century), a group of conservative Christian pastors committed themselves to the proposition that everything in the Bible is true as interpreted literally—thus breaking with nearly two thousand years of Christian interpretive tradition. They published their views in twelve booklets called *The Fundamentals*, hence the name.

The Fundamentalist Movement proved to be quite popular and quickly became a major cultural and political factor in American life. Having decided to oppose the teaching of evolution in the schools, the movement succeeded in having laws prohibiting such teaching passed in five southern states including Tennessee. As anyone who has seen the play or movie *Inherit the Wind* knows, as a result of this law, fundamentalist public officials persecuted teachers dedicated to teaching real science. In fact, no prosecutor in Tennessee or anywhere else made any effort to enforce the law, and it would seem that none ever intended to do so. What actually happened was that in 1925 the American Civil Liberties Union ran newspaper ads seeking a volunteer to test the law and managed to recruit John Thomas Scopes, a coach and sometime substitute biology teacher; who was willing to admit to having taught evolution (although he is unlikely have actually done so) and to force the local prosecutor to act. The ACLU also arranged to have Scopes defended by Clarence Darrow (1857-1938), “the most prominent defense attorney of the time and author of many atheist tracts. Then came an extraordinary stroke of good luck for he evolutionists. William Jennings Bryan (1860—1925), three-time losing democratic candidate for president, managed to get himself appointed to ead the prosecution. Bryan hoped to parlay the national publicity attracted by the trial into a fourth run for the presidency. Of course, he knew little science, had no particular theological qualifications, and made fool of himself and thereby of fundamentalism—aided and abetted by an extremely biased press.

The legacy of the “Scopes Monkey Trial” remains so potent that whenever Christians ask that evolution be presented in public schools as “only a theory,” they are ridiculed in the press as
fundamentalists and Creationists. Julian Huxley and many other Darwinian ideologues claim that, unlike the theories of physics, chemistry, or even sociology, evolution is “fact,” not theory. This is philosophical nonsense. All scientific theories remain subject to the possibility of future disconfirmation. Indeed, when the great philosopher of science Karl Popper suggested that the standard version of evolution even falls short of being a scientific theory, being instead an untestable tautology, he was subjected to public condemnations and much personal abuse.

Popper’s tribulations illustrate another basis for the victory of Darwinism: a successful appeal for a united front on the part of scientists to counter religious opposition has had the consequence of silencing dissent within the scientific community. I have already noted that problems with evolutionary theory have often been “hushed up.” But it is worth quoting this remarkably frank admission by the very eminent Everett C. Olson that there is “a generally silent group” of biological scientists “who tend to disagree with much of the current thought” about evolution, but who remain silent, many of them because they “are so strongly in disagreement that it seems futile to express dissent. He acknowledged that it is “difficult to judge the size and composition of this silent segment,” but their “numbers are not inconsiderable” and their “existence is important and cannot be ignored.”

Recently the number of such dissenters has become known; Olson’s concerns were more than justified. A survey of biologists who are so distinguished as to be listed in American Men and Women of Science found that 45 percent acknowledged that the process of evolution is guided by God. A survey of all biologists would undoubtedly show that “Evolutionary Creationists” were in the majority! Indeed, the religiousness of modern scientists is not as it is typically portrayed.

The Religiousness of Modern Scientists

Probably the first ever survey of scientists was conducted by Francis Gal-ton (1822-1911), who, in 1872, mailed questionnaires to about 190 “English men of science.” Galton was Charles Darwin’s cousin and one of the founders of quantitative psychology, who had gained fame for his studies of hereditary genius. Galton’s survey of scientists is based on one of the most naive and biased questionnaires ever written, nearly as dreadful as the one distributed to English workingmen later in that same decade by Karl Marx. Galton had previously claimed that scientific interest was hereditary, but in this study he wanted to make room for environmental factors as well, having been convinced through correspondence with a Swiss biologist that both nature and nurture were involved. To find out, Galton asked questions such as:

- Measurement round inside rim of your hat?
- How far do your scientific tastes appear to have been innate?
- Has the religion taught in your youth had any deterrent effect on the freedom of your researches?

When Charles Darwin filled out the questionnaire, he wrote “Certainly innate” in answer to the second of the above questions. To the third, he simply responded “No.” That answer greatly surprised Galton. Being a militant atheist, Galton expected that not only Darwin but nearly everyone else would answer “Yes.” He knew science and religion were incompatible. But not only did his cousin reject the opportunity to say so; more than 90 of the 100 who filled out the questionnaire did likewise—Galton seems never to have recognized the ambiguity of the question. He was also badly surprised to discover that nearly every respondent claimed a church affiliation. It is perhaps indicative that although Galton provided exact figures in reporting most of his results (for example, only 13 had a head size under 22 inches and 8 exceeded 24 inches), he was much less forthcoming about his religion results, and the numbers I reported above needed some reconstruction. Moreover, while Galton admitted that many respondents expressed strong religious views, he stressed that “many of those who describe themselves as religiously inclined. . . seem singularly careless of dogma and exempt from mysterious terror.” In any event, these findings were so unwelcome that when the pioneering statistician Karl Pearson (1857-1936) wrote Galton’s biography in three volumes, he was careful to explain the methodological reasons
why these data should not be interpreted on behalf of the obviously “erroneous” belief that science and religion are compatible. Nevertheless, when better studies came along, the results were the same.

In 1914 the American psychologist James Leuba sent questionnaires to a random sample of persons listed in American Men of Science. Each was asked to select one of the following statements “concerning belief in God” (all italics in the original):

1. I believe in a God to whom one may pray in the expectation of receiving an answer. By “answer,” I mean more than the subjective, psychological effect of prayer.
2. I do not believe in God as defined above.
3. I have no definite belief regarding this question.

Leuba’s standard for belief in God is so stringent it would exclude a substantial portion of “mainline” clergy, and that was obviously intentional on his part. He wanted to show that men of science were religious. To his dismay, Leuba found that 41.8 percent of his sample of prominent scientists selected option one, thereby taking a position many would regard as “fundamentalist.” Another 41.5 percent (many of whom, as Leuba acknowledged, no doubt believed in a somewhat less active deity) selected the second option, and 16.7 percent took the indefinite alternative.

Clearly, these results were not what Leuba had expected and hoped for. So he gave great emphasis to the fact that, as measured, believers were not in the majority, and went on to express his faith in the future, claiming that these data demonstrated a rejection of “fundamental dogmas—a rejection apparently destined to extend parallel with the diffusion of knowledge.” However when Leuba’s study was exactly repeated in 1996, the results were unchanged. Thus over an eighty-two-year period, there was no decline in a very literal belief in God among scientists.

Table 2.2

Religiousness by Scholarly Field

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<tr>
<th></th>
<th>% Religious Person</th>
<th>% Regular Attend</th>
<th>% Never Attend</th>
<th>% Religious Conservative</th>
<th>%No Religion</th>
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<td>35</td>
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*Source: Calculated from the Carnegie Commission Survey of 60,028 American Academics, 1969*
tepids—40 percent of faculty in mathematics and statistics characterized themselves as “religiously conservative,” as did 34 percent of physical scientists and 36 percent of those in the life sciences. Moreover, scientists attend church at the same level of regularity as the general population—47 percent of mathematicians and statisticians reported attending two or three months or more, as did 43 percent of physical scientists and 42 in the life sciences. The 1973 General Social Survey (which is only four years later than the faculty survey) found that 44 percent of Americans attended at least two or three times a month. Scientists are, however, a bit more likely than the general population to report that they never attend church—about a third in most areas and about half of social scientists, compared with 21 percent in the 1973 GSS. And scientists surpass the general population in the percentage stating their religious preference as “none.” Nevertheless, outside the social sciences, only about one gave this response.

But perhaps the most striking finding is that on each of these measures, faculty in the “hard” sciences turn out to be far more likely to be religious are their counterparts in the “softer” social sciences: they attend church more regularly, are more likely to describe themselves as “deeply” or “moderately” religious and to say they are “religiously conservative,” are far more likely to claim religious affiliation. These patterns are evident not only in the simple cross-tabulations shown here but in complex regressions: differences between the social and the natural and physical sciences are extremely robust and withstand controls for individual bases such as age, gender, race, or religious upbringing. Moreover, these differences across scientific areas have been replicated in other samples of college professors, and even in samples of graduate and undergraduate students. In addition, Steven Bird found that high school students with “fundamentalist” affiliations were no less likely than anyone to declare scientific majors in college. Furthermore, longitudinal data show that professors and students do not become less religious as they progress through their scientific training; instead, those enrolling in social sciences are less religious than the general population before entering college and graduate school.

Table 2.2 also breaks down the social sciences into specific fields. Here we see an additional feature: it is above all faculty in psychology and anthropology who stand as towers of unbelief. The other social sciences are relatively religious, but these two fields are true outliers. Compared to faculty in the physical sciences, psychologists and anthropologists are almost twice as likely to not attend church, to not describe themselves as religious persons, and to say they have no religion. These differences are of such magnitude that one can scarcely imagine their not influencing the tone of conversation, instruction, and research in these two fields. Indeed, this sheds a great deal of light on why it is so widely believed that religion and science are incompatible—nearly everything written on the topic during the twentieth century was written by nonscientists or by social scientists. It would be difficult to imagine the following quotation in an undergraduate physics or chemistry textbook:

> The evolutionary future of religion is extinction . . . Belief in supernatural powers is doomed to die out, all over the world, as the result of the increasing adequacy and diffusion of scientific knowledge.

But no eyebrows were raised when it appeared in an undergraduate textbook by the very prominent anthropologist Anthony E C. Wallace.

This contrast between the social and the physical sciences is well illustrated by the following anecdote. In 1940 A. S. Yahuda, the Yale professor who acquired the collection of Newton’s manuscripts now in Jerusalem, offered to show Newton’s theological works to George Sarton. The eminent Harvard historian declined rather ungraciously on grounds that he was exclusively interested in science. But when Yahuda showed the manuscripts to Albert Einstein, he found them fascinating and wrote a letter in which he expressed his delight in examining Newton’s “spiritual workshop.” Einstein was also quite given to “God talk.” In 1911 Einstein told the Jewish philosopher Martin Buber, “What we [physicists] strive for is just to draw His lines after Him.” In 1921, he told a young physicist, “I want to know how God created this world ... I want to know His thoughts, the rest are details.” Moreover, two remarks he frequently made about God became famous: “God is subtle, but he is not malicious,” and “God does not play dice with the world.” Although some of Einstein’s biographers deny that his use of the word “God” had any religious implications, there is no need for me to become involved in that
issue. My point is simply that such expressions did not, and do not, raise any eyebrows in the world of the physical and natural sciences, but any social scientist who talked that way would be stigmatized among her or his peers. That’s probably why sociologists of science continue to follow Sarton’s example. Not only are they not interested in Newton’s or Einstein’s God talk; they have shown little or no interest in the immense revival of such talk in scientific circles.

On July 20, 1998, the cover of *Newsweek* proclaimed, “Science Finds God.” Given the assumptions that have governed intellectual opinions about science and religion for most of the century, the discovery that many sophisticated scientists think a Creator offers the most parsimonious explanation of how it all came to be is news of cover-story magnitude. Yet it was hardly an overnight development. A landmark in the resumption of serious dialogue between science and theology was Ian Barbour’s *Issues in Science and Religion* (1966). Ever since, reputable efforts (mostly by scientists) to wed religion and science, such as *God and the New Physics,* 270 have been attracting a large readership. Moreover, these developments could be interpreted as a return to the traditional relationship between theology and science. The brilliant new works by theologians such as John Polkinghorne, 271 who is the only ordained member of the Royal Society of London, are in the tradition of Natural Theology—as Polkinghorne fully acknowledges. By the same token, efforts by scientists such as the Nobel laureate in physics Charles Townes 272 to demonstrate that God is a necessary element in any comprehensive explanation of the universe are entirely in keeping with a long tradition, one that the Darwinian Crusade sought to terminate. It might even be legitimate to say that this renewed relationship is a return to “normal” if Albert Einstein was right when he counseled that “[s]cience without religion is lame. Religion without science is blind.” 273

It is not my claim that scientists should include God within their cosmologies, or, indeed, that nonbelievers can’t do good science—at least not once the system is in place. I do argue that religion and science are compatible, and that the origins of science lay in theology.

**Conclusion**

Despite its length, this chapter consists of only two major points. First, science arose only once in history—in medieval Europe. Second, science could only arise in a culture dominated by belief in a conscious, rational, all-powerful Creator. Thus it could be said that the rise of science required an Eleventh Commandment: “Know thou my handiwork.”

**Appendix 2.1**

**Roster of Scientific Stars**

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Birth—Death</th>
<th>Personal Piety</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bayer, Johann</td>
<td>1572—1625</td>
<td>Devout</td>
</tr>
<tr>
<td>2</td>
<td>Borelli, Giovanni</td>
<td>1608—1679</td>
<td>Conventional</td>
</tr>
<tr>
<td>3</td>
<td>Boyle, Robert</td>
<td>1627—1691</td>
<td>Devout</td>
</tr>
<tr>
<td>4</td>
<td>Brahe, Tycho</td>
<td>1546—1601</td>
<td>Conventional</td>
</tr>
<tr>
<td>5</td>
<td>Briggs, Henry</td>
<td>1561—1630</td>
<td>Devout</td>
</tr>
<tr>
<td>6</td>
<td>Cassini, Giovanni</td>
<td>1625—1712</td>
<td>Conventional</td>
</tr>
<tr>
<td>7</td>
<td>Copernicus, Nicolaus</td>
<td>1473—1543*</td>
<td>Conventional</td>
</tr>
<tr>
<td>8</td>
<td>Descartes, René</td>
<td>1596—1650</td>
<td>Devout</td>
</tr>
<tr>
<td>9</td>
<td>Fabricius, David</td>
<td>1564—1617*</td>
<td>Devout</td>
</tr>
<tr>
<td>10</td>
<td>Fallopius, Gabriel</td>
<td>1523—1562</td>
<td>Devout</td>
</tr>
<tr>
<td>11</td>
<td>Fermat, Pierre</td>
<td>1601—1665</td>
<td>Conventional</td>
</tr>
<tr>
<td>12</td>
<td>Flamsteed, John</td>
<td>1646—1719</td>
<td>Devout</td>
</tr>
<tr>
<td>13</td>
<td>Galilei, Galileo</td>
<td>1564—1642</td>
<td>Conventional</td>
</tr>
<tr>
<td>14</td>
<td>Gassendi, Pierre</td>
<td>1592—1655*</td>
<td>Devout</td>
</tr>
<tr>
<td>15</td>
<td>Gellibrand, Henry</td>
<td>1597—1663</td>
<td>Devout</td>
</tr>
<tr>
<td>16</td>
<td>Gilbert, William</td>
<td>1540—1603</td>
<td>Conventional</td>
</tr>
<tr>
<td>17</td>
<td>Graaf, Regnier de</td>
<td>1641—1673</td>
<td>Conventional</td>
</tr>
</tbody>
</table>
18. Grew, Nehemiah (1641—1712) Devout
19. Grimaldi, Francesco (1618_1663)* Devout
20. Guericke, Otto (1602—1686) Conventional
21. Halley, Edmund (1656—1742) Skeptic
22. Harvey, William (1578—1657) Conventional
23. Helmont, Jan Baptista van (1577—1644) Devout
24. Hevelius, Johannes (1611—1687) Conventional
25. Hooke, Robert (1635—1703) Devout
26. Horrocks, Jeremiah (1619_1641)* Devout
27. Huygens, Christiaan (1629—1695) Devout
28. Kepler, Johannes (1571—1630) Devout
29. Kircher, Athanasius (1601_1680)* Devout
30. Leeuwenhoek, Anton (1632—1723) Conventional
31. Leibniz, Gottfried (1646—1716) Devout
32. Malpighi, Marcello (1628—1694) Conventional
33. Mariotte, Edme (1620—1684)* Devout
34. Mersenne, Mann (1588_1648)* Devout
35. Napier, John (1550—1617) Devout
36. Newton, Isaac (1642—1727) Devout
37. Oughtred, William (1575_1660)* Devout
38. Papi, Denis (1647—1712) Devout
39. Paracelsus (1493—1541) Skeptic
40. Pascal, Blaise (1623_1662)* Devout
41. Picard, Jean (1620—1682) Devout
42. Ray, John (1628_1705)* Devout
43. Riccioli, Giovanni (1598—1671) Devout
44. Roemer, Olaus (1644—1710) Conventional
45. Scheiner Christoph (1575_1560)* Devout
46. Snell, Willebrord (1591—1626) Conventional
47. Steno, Nicolaus (1638—1686) Devout
48. Stevius, Simon (1548—1620) Conventional
49. Torricelli, Evangelista (1606—1647) Conventional
50. Vesalius, Andreas (1514—1564) Devout
51. Vieta, Franciscus (1540—1603) Conventional
52. Wallis, John (1616_1703)* Devout

*Ecclesiastic (priest, monk, friar, minister canon, etc) Italic type indicates a Protestant..

Chapter 2: God’s Handiwork: The Religious Origins of Science
2. It also provides the opening line of that great standard by George and Ira Gershwin, “They All Laughed” (1936): “They all laughed at Christopher Columbus, when he said the world was round.”
9. Albeit a small, very vocal minority of religion-baiters persists.
14. White, 1896, 1:57
16. As Theodore K. Rabb (1975:274) put it, “The Servetus case seems irrelevant to a discussion of Protestant opposition to science, because surely nobody has questioned that both Calvin and those who led the outcry... were interested only in the punishment of doctrinal heresy. To suggest another issue is to raise straw man.”

20. In its fiftieth anniversary issue, published in September 1998, Archaeology ran a lengthy article entitled “The Not-So-Dark Ages,” summarizing the findings of an immense number of excavations which demonstrate that this era was far more “civilized” than had been admitted in previous generations, and confirmed the historical reassessment crediting this era with having laid the “foundations of modern European culture” (Hodges, 1998:61).

25. Ibid.:vii, 1.
39. I was taught that when Julius Caesar conquered Britain, the natives were semisavages who painted themselves blue. Yet Caesar’s own account reveals that to fight and win a long and closely contested naval battle to cross the Channel. People possessed of a navy able to challenge the Romans could hardly
44. White, 1896:121.
47. In Grant, 1994:642.
52. Cohen, 1985a; Gingerich, 1975; Neugebauer, 1975.
58. Colish, 1997:266.
59. Schachner 1938:3.
60. Grant, 1996:23.
64. Ibid.
70. Grant, 1996:205.
71. White, 1896, 2:50.
74. Movies and stories concerning “body snatchers” often suggest that their nefarious activities were necessary because of prohibitions on dissection. In fact, body snatching did take place in various times and places—not, however, because human dissection was forbidden, but because of a lack of bodies: families were reluctant to offer their loved ones to disrespectful treatment, or to forgo the comfort of visits to a grave site.


80. Ibid.:12.


82. On Repentance 1.


84. De reductione artium ac theologiam.

85. Grant, 1996; Meyer, 1944.

86. Webster, 1986:213.


88. The quotation from Russell continues, “I have no doubt that if the Chinese get a stable government and sufficient funds, they would, within the next thirty years, begin to produce remarkable work in science. It is quite likely that they might outstrip us…”


92. Grant, 1994, 1996; Jaki, 1986; Lindberg, 1992; Mason, 1962, as well as the cited original sources.


100. Lindberg, 1992; Mason, 1962.


102. Oeuvres 8:61.


111. Given Merton’s obsession with matters of priority, I find it very peculiar that he was never forthcoming about the extent of his debt to Dorothy Stimson’s prior publication of a relationship between Puritanism and the rise of science. It may be that he wrote his thesis without knowledge of her prior work. But, for all the reasons he advanced in his own writings about priority, he should have clearly stated the facts when he published in 1938, and he certainly needed to do so in later republications of the key excerpt of his thesis. A very tardy discussion of the matter by Bernard Cohen, one of Merton’s greatest admirers, in Clark, Modgil, and Modgil (1990) was not very enlightening. Some historians now attribute the thesis jointly to Merton and Stimson, also without mention of priority (cf. Hunter, 1982; Shapiro, 1968). However, since these same historians reject the thesis, this may have become as insignificant as a dispute about the first claim concerning the existence of phlogiston.


113. Ibid.,445.

114. Merton’s thesis strongly appealed to the anti-Catholic biases of the time. It was an era of very open anti-Catholicism. Indeed, it has been said that in those days anti-Catholicism was the anti-Semitism of liberal intellectuals. Remarkably strident anti-Catholicism was common in the respectable magazines and journals of the 1930s—indeed, until the 1960s.


122. In contrast, the Random House Webster’s Dictionary of Scientists, in addition to displaying every sin of political correctness, trivializes the word “scientist” by the inclusion of a flock of entries such as “Fixx, James 1932—1984. US popularizer of jogging.”

123. Cheetham, 1983.

124. Some historians have attempted to identify Pierre Gassendi as a skeptic despite his having been a Catholic priest. This seems entirely unfounded, as Sylvia Murr (1993) has demonstrated convincing.
128. Ironically, part of Galileo’s troubles stemmed from renewed efforts to crack down on astrologers, whose claims to predict the future had long been denounced as dangerous superstition (see Chapter 3). Some Churchmen mistakenly equated the claim that the earth moved with doctrines that fate was ruled by the motion of heavenly bodies.
130. Ibid.:110.
133. Works 1:23.
135. Burkhardt was also the first to claim that Constantine’s conversion was insincere, a mere pose assumed out of his lust for power. Fortunately, later historians have dismissed this claim, but they have yet to fully detect the similar biases at work in his study of the Renaissance.
140. Ibid.:130.
146. Cajori’s translation: Newton, 1934:543—47.
148. Before his death, Newton destroyed a vast collection of papers. Many of the manuscripts he carefully saved he also recopied, as authors did in those days to provide a clean manuscript for the printer.
149. McLachlan, 1941:165.
150. Christianson, 1984; More, 1934.
152. Ibid.
153. Brewster, 1855, 1871.
159. Bell, 1937:96.
163. Hall, 1992; Munby, 1952.
165. Ibid.:41.
166. In addition, there is a very major collection of Newton’s scientific manuscripts at Oxford and another in the Babson College Archives, in Wellesley, Massachusetts.
170. Over the past four decades, Newton’s theological, alchemical, astrological, and other esoteric manuscripts and notes have been studied with great care, and much has been published—although there remains more to come (cf. Castillejo, 1981; Dobbs, 1975, 1991; Hall and Hall, 1962; McLachlan, 1950).
173. Dana, 1858:341.
175. McGrath, 1999:11.
176. In ibid.
179. I was advised by several colleagues that to criticize evolutionary theory would damage my “career.” This merely hardened my resolve to suffer no more of this arrogant occultism.
182. Dawkins, 1989:34.
187. Some might claim that there are rare exceptions such as when a horse and an ass are bred to produce a mule. But, as in the case of
mules, the offspring such crossbreeding are sterile hybrids.
188. Here I am giving orthodox and neo-orthodox Darwinians a break, s they have not been able to define fitness as other than a relatively
higher rate reproduction, hence making the theory tautological: those that reproduce a higher rate will reproduce at a higher rate.
192. Ibid.:406.
193. Ibid.:414.
199. Schwartz, 1999:3.
202. This term (“neo” means new) is applied to all evolutionary studies based on Mendelian genetics.
204. Goldschmidt, 1940:390.
209. A skyhook is a magical device, a hook attached to a cable that reaches the sky and is able to raise and lower loads despite not being
hooked to a or other mechanical device. When I was in the army, the term was in common usage, and a sergeant might say, “Unless the
chaplain can pray us down a ok, we ain’t never going to lift that sucker.”
211. Indicative of the unscientific character of the Darwinian Crusade, Carl Segan (1975:82) responded to the fact that “the time available
for the origin of ms to have been short, a few hundred million years at most,” as proof that on must be much faster and statistically
much more probable than we had thought.
212. Dawkins (1986) “solves” this problem by introducing an unidentified editor who lets the monkey know each time it has a correct letter
in the correct space, thus providing for a quite rapid accomplishment of the lines. I find this remarkable in someone who essentially
makes his living from atheism, since any educated Creationist would gladly embrace this version of “directed” evolution.
228. Tyndall, 1874:44.
230. A survey of students at five leading American Protestant divinity schools, conducted in the late 1 920s, found that 94 percent agreed
“[t]hat the idea of evolution is consistent with belief in God as Creator,” and only 5 percent agreed “[t]hat the creation of the world
occurred in the manner and time recorded in Genesis” (Betts, 1929).
232. Sidgwick, 1898:433—34.
236. Macmillan’s Magazine, October 1898.
239. Ibid., 124—25.
242. Ibid., 329—30.
245. That it was remembered at all was due to its being included in a marginal note in some editions of the King James Version of the Bible.
249. Ibid.
257. A cross-sectional sample of Protestant ministers in Chicago in the late 1920s revealed that, while all expressed their belief “that God exists,” only 64 percent agreed “that prayer has the power to change conditions in nature.” The same study also surveyed students at five theological schools, of whom only 21 percent agreed with the item on prayer (Bettis, 1929). In a 1968 sample of Protestant clergy in California, only 45 percent of pastors of the United Church of Christ could agree to the statement “I know God really exists and I have no doubts about it” (Stark et al., 1971). Of Methodist clergy, 52 percent agreed. Notice that this item is much less stringent than the one used by Leuba, since clergy were free to define God as they wished. Given that the majority of these same clergy doubted the divinity of Jesus, one must suppose that many of them asserted their beliefs in a rather remote and vague conception of God, not one who hears and answers prayers.
265. This is not surprising, for Sarton remained a staunch supporter of A. D. White and his claim that religion is the natural enemy of science (see Sarton, 1955).
266. Manuel, 1974:27.
270. Davies, 1983.