EARTH'S DEEP HISTORY

How It Was Discovered and Why It Matters

MARTIN J. S. RUDWICK

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INTRODUCTION

Sigmund Freud once claimed that three great revolutions had transformed our human sense of our place in nature. The first had removed our Earth from the center of the universe, turning it into one planet among several others, orbiting one ordinary star among a vast multitude of others. The second revolution had embedded our species in the rest of the animal world, by supposedly demoting us from being the objects of God's unique concern and turning us into mere naked apes. And the third revolution had undermined any sense of ourselves as rational beings, by disclosing the depths of our unconscious fantasies. These major changes in our conception of ourselves have subsequently been labeled with celebrated names, respectively those of Copernicus, Darwin, and Freud himself.

However, as my friend the late Stephen Jay Gould pointed out long ago, Freud's list omitted a fourth revolution that certainly deserves a place in the same league, although it lacks the convenience of being associated with any single well-known individual. One striking feature of this fourth great change—the second in historical order—was that it vastly enlarged the timescale of our Earth and by implication that of the universe, just as the first or Copernican revolution had vastly enlarged

its spatial scale. In earlier times, most people in the West had taken it for granted that the world had started, if not precisely in 4004 BC, then at some such point in time, only a few millennia ago. After this revolution it became equally commonplace to accept that the Earth's timescale runs at least into millions of years, if not billions. Geologists now work routinely with mind-boggling amounts of "deep time," just as their colleagues the astronomers and cosmologists work with literally inconceivable magnitudes of cosmic "deep space" (and time too).

This much is now well known, far beyond scientific circles. But an overwhelming emphasis on the enlargement of the timescale has obscured two other features of this great revolution, which, taken together, are much more significant. The first of these was a radical change in the place of humanity itself. The "young Earth" of the traditional picture was also an almost wholly human Earth. Apart from a brief opening scene or prelude—putting the props on stage, as it were—it was a human drama from start to finish, from Adam through to some future Apocalypse at the end of the world. In contrast, the "ancient Earth" first discovered and reconstructed by early geologists was largely non-human because it was almost completely pre-human: our species seemed to have made a very late appearance on the world stage. Most of this newly discovered deep time was therefore as devoid of any human presence as the vastnesses of deep space.

At the same time, the distinction between a relatively brief human period and a far more lengthy pre-human one was a sign of a second and even more radical consequence of this great revolution in our conception of nature. The simple sequence of a non-human period followed by a human period was enough in itself to give our planet a basically *historical* character; and the vast expanses of pre-human deep time, even on their own, turned out to have been filled with a history just as eventful and dramatic in its own way as human history. In short, it turned out that *nature has had a history of its own*.

So this book offers a brief account, not primarily of the discovery of deep time, but rather of the reconstruction of *Earth's deep history* and our human place within it. The story of this fourth great revolution has been neglected, particularly in books and TV programs designed for the general public. There are two distinct reasons for this. First, it has been shrunk into nothing more than a prelude to the supposedly more exciting story of Darwin's theory of evolution. It is true that the

recognition of the Earth's deep history was a necessary precondition for any satisfactory explanation of the diversity of living organisms, and particularly of the origin of our own species. But the story summarized in this book has had a career of its own, independent of Darwin's or any other theory of evolution, because it concerns the history of *everything* on Earth: not only plants and animals, but also rocks and minerals; mountains, volcanoes, and earthquakes; continents, oceans, and atmosphere. So the recognition that the Earth has had a history of its own, and that it was possible to reconstruct it reliably and often in detail, amounted to a major revolution in human thought. It is a story that deserves to be told in its own terms and for its own sake.

The second reason for this story's neglect is that it has been shrunk into just one episode in the triumphant march of Science in its struggle against Religion. The notorious 4004 BC date already mentioned has been widely taken to typify the repressive obscurantism of The Church in resisting the progress of Enlightened Reason. But this use of labels such as Science and Religion, Church and Reason (usually in the singular and often with initial capitals), should make us suspicious. Real history is never so abstract or so tidy. In fact, this stereotype of a perennial conflict between Science and Religion has long been abandoned by historians who have studied any of its alleged episodes at all closely. It makes shoddy history, though of course it provides stirring rhetoric for modern atheistic fundamentalists. In this book, in contrast, I try to show how an emerging sense of the Earth's deep history was related to earlier conceptions of a much briefer kind of history in far more interesting and important ways than this tired stereotype allows. The surprising revival of "young Earth" ideas by some modern religious fundamentalists, and the even more surprising political power of such ideas in certain parts of the world, should not distract us from tracing the main story. I deal briefly with the modern creationists at the very end of this book, but in such a way that I hope it will be clear that they are a bizarre sideshow, not the climax of the narrative.

I argue in fact that the discredited stereotype of perennial conflict between Science and Religion should, at least in this case, be turned upside down. Once we recognize that the core of this great revolution in human thought lay in the realization that nature has had a history of its own, the merely quantitative enlargement of its timescale becomes a secondary issue. What is much more important is to under-

stand the origins of this new sense of the historicalness or *historicity* of nature. It should be no surprise that its source lay in the contemporary understanding of *human* history, which was deliberately and knowingly transposed into the world of nature. Human history, not physics or astronomy, became the model for tracing the history of nature. The rise and fall of empires, for example, was utterly unpredictable even in retrospect, unlike the predictable movements of the planets. Human history was recognized as being deeply *contingent*: at every point things could well have turned out differently (this alone makes it possible, and often fascinating, to ask counter-factual or "what if . . .?" questions about the past). This was the sense of historicity that was transferred from culture into nature, generating a new understanding of nature, and specifically of the Earth, as similarly historical. If this transfer does seem surprising, it is probably because it entails accepting that the sciences of nature have here been decisively enriched by an input from the sciences of human history, right across the supposed gulf between the so-called Two Cultures, between Science and the humanities. People outside the English-speaking world don't experience the same difficulty, because they have the good sense to call *all* these bodies of disciplined knowledge "sciences," in place of our peculiar Anglophone use of a singular "Science" for just some of them.

In view of the character of Western culture during the relevant centuries (roughly, seventeenth through nineteenth), it should also be no surprise that one major source—even arguably *the* major source—for this new vision of nature as historical was the strong sense of history embodied in the Judeo-Christian scriptures, with their dynamic narrative thrust from primal Creation through pivotal Incarnation towards an ultimate City of God. These culturally foundational texts, far from obstructing the discovery of the Earth's deep history, positively facilitated it. To borrow a metaphor from biology, they *pre-adapted* their readers to find it easy and congenial to think in similarly historical terms about the *natural* world that formed the context of human action and, so believers claimed, of divine initiative. Of course this suggestion is neutral with respect to the validity of the religious perspective embodied in the texts: it does not amount to evidence in favor of these religious beliefs or against them, and my purpose in making the connection is historical, not apologetic.

Does the discovery of the Earth's deep history matter? Certainly it

is a fascinating story in its own right, and one that deserves to be far more widely known: contrast its low profile with the huge attention that was rightly given to Darwin's evolutionary theory in his bicentennial year. Beyond its intrinsic interest, I believe it matters profoundly, because it disclosed something about our world that has wide-ranging implications and was quite unexpected. Those who in earlier times made it their business or their vocation to study the world of nature—the people who have come to be called scientists—widely assumed that with further study it would become more and more *predictable*. They aimed to uncover the "laws" of nature, which by definition were taken to be the same yesterday, today, and forever. The better the laws of nature were understood, the more effectively human individuals and societies would be able to control or change the world of nature in the service of human goals and purposes. Sciences such as physics and astronomy were therefore taken as models. The more the underlying laws of nature were quantified and given mathematical expression, the more precisely the timing of an eclipse, for example, could be predicted.

In contrast, the discoveries outlined in this book showed that the Earth's deep history—and therefore its future—could not be reduced to any such simple and predictable form. The Earth had not been programmed, as it were, in such a way that its past and future course was fully determined, given certain initial conditions and the unchanging laws of nature. Of course the component parts of terrestrial nature were assumed to be acting indeed according to unchanging laws: the power of crashing waves to erode a coastal cliff, for example, was taken to have been underlain in the deep past by the same laws of physics as at the present day. But the past history and likely future of *this* continent and *this* ocean could not be deduced from any such nonhistorical laws, still less the past and future of the Earth as a whole. All such histories had to be reconstructed from surviving evidence of what *in fact* had happened, just as the past history of the people inhabiting the land and trading across the sea had to be reconstructed from the surviving documents and artifacts of their history. In other words, the Earth's deep history could not be reconstructed by applying the laws of nature "top down," but only by piecing together the historical evidence "bottom up." The Earth's deep history turned out to have shared the messy unpredictable contingency of human history, rather

than the astonishingly precise predictability of, say, the motions of the Moon and planets in relation to the Sun. That this unpredictable contingency *matters*—not least in current controversies about our human role in the near future of our home planet—should need no further emphasis.

In the course of human history, the science of geology was the first to develop this new sense of nature itself as intrinsically historical, but it was not the last or the only such science. Just as geologists came to recognize that, say, the present form of the Alps cannot be understood without unraveling the long and complex *history* of those mountains, so biologists—and notably Darwin who, significantly, began his career as a geologist—later showed that the present forms and habits of plants and animals likewise embody their own evolutionary histories and cannot be fully understood without taking those histories into account. And the same kind of historicity was eventually adopted even in the largest-scale science of all: cosmologists now deal routinely with the reconstruction of the *histories* of stars and galaxies—and even the history of the entire universe from its conjectural Big Bang onwards—in ways that are closely parallel to those first developed by geologists for the Earth's deep history. So the story I summarize in this book has an importance that goes far beyond the particular science on which it is focused.

In conclusion, I must emphasize that this book is based, as any such work should be, not only on my own historical research but also on research by many other historians of many nationalities, most of it published in recent decades and in several languages. This needs to be emphasized, because all this modern research by historians of the sciences is too often blithely ignored, or at best under-utilized—with a few honorable exceptions—by the authors of popular science books, by the makers of TV science programs, and, most seriously, by scientists who pronounce on the history of their own sciences. They all seem to prefer to stay in a cozy comfort zone of recycled myths about the past, often myths with an unattractively chauvinistic (and sexist) flavor, singling out "The Father" of this or that.

In view of the sheer mass of reliable historical research that is available, the writing of this short book has demanded a drastic pruning of detail, and a sharpening of focus, in order to highlight what I see as the main features of the story. In particular, I have concentrated

this account on the arguments and activities of those who came to call themselves scientists, rather than the ideas that were prevalent among wider social groups or in society as a whole. I have touched only lightly on the broader cultural implications of what these people claimed to have discovered. And it is a matter of human history that most of the basic ideas about our planet's deep history, which now underlie the work of Earth scientists worldwide, were first developed in Europe and not elsewhere. So most of my story is focused on the European cultural sphere rather than those other parts of the world that play an increasingly important role in the sciences of the 21st century. (If the story is also largely one of male activities, that is because it reflects earlier historical realities; a more detailed history of the last few decades would show that, at least in this kind of science, gender has become increasingly irrelevant.)

I hope this book will help not only to make a great revolution in human thought more widely known and understood, but also to blow away the cobwebs of some outdated ideas: not least the pervasive myth of perennial conflict between "Science" and "Religion," two beasts as mythical in every sense as those traditional symbols of good and evil, St. George and the Dragon.

1

Making History a Science

THE SCIENCE OF CHRONOLOGY

"Time we may comprehend: 'tis but five days elder than ourselves." So the 17th-century English writer Sir Thomas Browne summarized, almost casually, the profound question of the ultimate origin of our world, our species and time itself. In the age of scientific giants such as Galileo and Newton, most people in the Western world, whether religious or not, took it for granted that humanity is of almost the same age as the Earth. They also assumed that not just the Earth, but the whole universe or cosmos, and even time itself, are scarcely any older than human life.

The opening chapter of Genesis, and of the Bible, set out a brief narrative in which Adam ("The Man") had been formed on the sixth day of creative action, after five days of preparation and before God completed a primal week by resting on its Sabbath day. Browne and his contemporaries did not need a repressive Church to bully them into accepting this as a reliable account of the most distant past (and anyway, in a Christendom fractured by the Reformation and Counter-Reformation, there was no single all-powerful body capable of enforcing any such belief). It seemed obvious *common sense* to them that the world

must always have been a *human* world, apart from a brief prelude in which the props necessary for human life had been put on stage: Sun and Moon, day and night, land and sea, plants and animals. A world without human beings would have struck them as utterly pointless, except as a brief setting of the scene for the human drama to come. So they took it for granted that Genesis gave them an authentic account of the world's earliest origins. It came, they believed, from the hand of Moses, the only ancient historian to have recorded the earliest ages of the world; and the very first phase of that history—before any human being had been there to witness and remember it—could only have been disclosed to Moses (or to Adam before him) by the Creator himself. To cap it all, nothing in the world around them seemed obviously to suggest that its history had been otherwise.

Browne and most of his contemporaries, educated and uneducated alike, took it for granted that the history of humanity was of almost the same length as the history of the natural world. But far from thinking these histories were very short, and the Earth very young, they regarded both as extremely long, relative to brief human lives of, at best, some "three score years and ten." History was plotted on a scale of the "Years of the Lord" (*Anni Domini*, AD) that had elapsed since Jesus's birth, which was treated as the uniquely pivotal moment of divine Incarnation. Since that point in time and the time, some thirty years later, when the Roman official Pontius Pilate had ordered Jesus's execution, more than sixteen centuries had passed into history. This was a very long span of time by any human standard; the study of the Romans and their highly respected Latin literature fully deserved its title of "*Ancient* History." Yet the scale of "Years Before Christ" (BC) stretched even further back, past the ancient Greeks and their equally admired literature, to the obscure earliest ages for which the only surviving records were widely believed to be those in the Bible. Most historians reckoned that the primal Creation itself must be nearly three times as distant from the Incarnation as the Incarnation was distant from their own day. In total this amounted to an almost inconceivably lengthy history of the world. Some fifty or sixty *centuries* seemed more than enough time for the unfolding of the whole of known human history and also therefore for the natural world, the stage on which it had been played out. The world's beginnings put even the "Ancient History" of the Greeks and Romans into the shade.

When one of these 17th-century historians calculated that the week of Creation had started on a specific day during the year 4004 BC, the date could be questioned, and was, but the precision aimed at was not. Nor was the order of magnitude thought to be an underestimate. This particular figure was published by James Ussher, an Irish historian whose powerful patron and great admirer had been King James I of England (James VI of Scotland). Shortly before that monarch's death, he appointed Ussher to be Archbishop of Armagh and head of the established Protestant church in Ireland, though as it happened the scholar spent most of his later life in England.

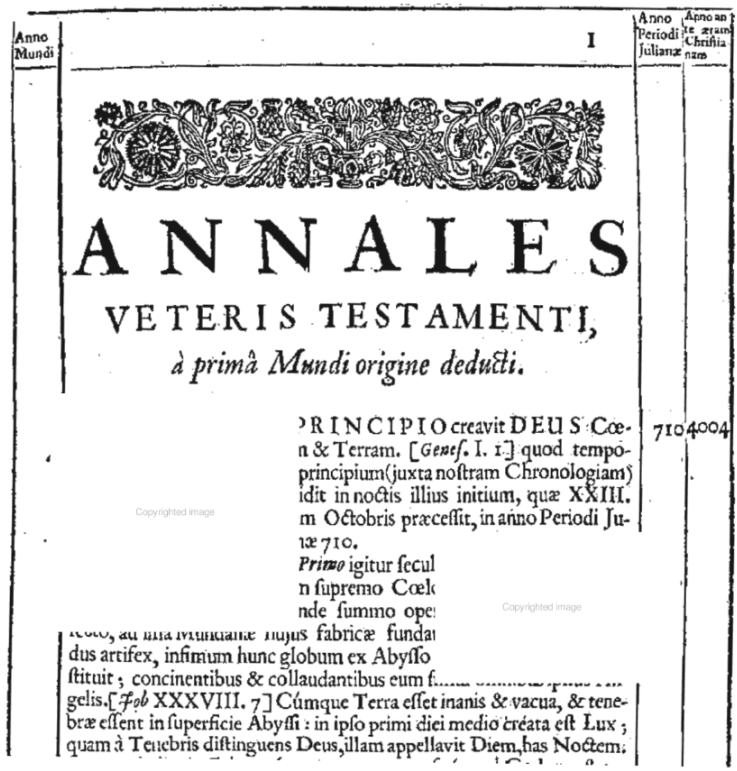
In modern times, Ussher and his date of 4004 BC have been much scorned and ridiculed. But Ussher was not a religious fundamentalist in the modern mold. He was a public intellectual in the mainstream of the cultural life of his time. His work doesn't deserve to be treated as a joke like those in *1066 And All That*, the classic spoof history in which the English national story is studded with unmistakeable Good Kings and Bad Kings, Good Things and Bad Things. Ussher's 4004 BC was not, in its time, a Bad Thing. On the contrary, what it represented was in some important respects a thoroughly Good Thing. Ussher's view of world history may seem so far removed from the modern scientific picture of the Earth's deep history that there can be no possible link between them, except as irreconcilable alternatives (which, in the eyes of modern fundamentalists, both religious and atheistic, is just what they are). In fact, however, what 17th-century historians such as Ussher were doing is connected without a break with what Earth scientists are doing in the modern world. Ussher is therefore a good starting point for understanding the origins of our modern conception of the Earth's deep history. Moreover, once Ussher's ideas are understood in the context of his own time, their superficial similarity to modern creationist ideas of a "Young Earth" is transformed into a stark contrast. The creationists, unlike Ussher, are out on a limb, and a precarious one at that.

In the 17th century Ussher was just one of the many scholars, scattered across Europe, who were engaged in the kind of historical research that was called "*chronology*." This was an attempt to construct a detailed and accurate timeline of world history, compiled from all available textual records, both sacred and secular, including records of striking natural events such as eclipses, comets, and "new stars"

(supernovae). Other chronologists criticized or rejected many specific details in Ussher's timeline, but most of them shared his broader aims, and his compilation illustrates very well what they were all trying to do.

Ussher published his *Annals of the Old Covenant* (*Annales Veteris Testamenti*, 1650–54) near the end of a long and highly productive scholarly life. He wrote it in Latin, which ensured that it could be read by other scholars elsewhere: Latin was the common international language of educated people throughout Europe, just as English is today around the world. Ussher's two massive volumes were entitled *Annals* because they summarized year by year what was known of events in world history; or at least he assigned each event to what he judged to be its correct year, and described them all in strict temporal order. So his book began with Creation at 4004 BC. But it extended forwards right through the BC/AD divide and the years of Jesus's life, as far as the immediate aftermath of the Romans' utter destruction of the great Jewish Temple in Jerusalem in AD 70. From Ussher's Christian perspective, this marked the decisive end of the "Old Covenant" linking God specifically with the Jewish people. So his chronology traced the course of world history as far as the first few years of God's "New Covenant" with the new people of God—in principle global and multiethnic—represented by the Christian Church.

Ussher's world history embodied the best scholarly practice of his time. Chronology fully deserved its status as a historical *science* (using that word in its original sense, which is still current except in the Anglophone or English-speaking world). It was based on a rigorous analysis of all the ancient textual records known to him. These were mostly derived from sources in Latin, Greek, and Hebrew. Half a century earlier, the French scholar Joseph Scaliger, the greatest and most erudite chronologist of them all, had also used those in several other relevant languages such as Syriac and Arabic. But even Scaliger knew only a little about sources further afield, for example from China or India, and the ancient Egyptian hieroglyphs had not yet been deciphered. Nonetheless, chronologists had available to them a massive body of multicultural and multilingual evidence. From all these varied records they extracted dates such as those of major political changes, the reigns of ancient monarchs, and memorable astronomical events. They then tried to match them up, often across different ancient


Anno Mundi

I

Anno Periodi Julianæ

Anno ante æram Christianam

ANNALES

VETERIS TESTAMENTI,

à primâ Mundi origine deducti.

PRINCIPIO creavit DEUS Cœ- 710 4004
n & Terram. [*Genes.* I. 1.] quod tempo-
principium (juxta noſtram Chronologiam)
idit in noctis illius initium, quæ XXIII.
m Octobris præceſſit, in anno Periodi Ju-
næ 710.
Primo igitur ſecul
n ſupremo Cœl
nde ſummo ope
dus artifex, infimum hunc globum ex Abyſſo
ſtituit; concinentibus & collaudantibus eum f...
gelis. [*Job* XXXVIII. 7.] Cúmque Terra eſſet inanis & vacua, & tene-
bræ eſſent in ſuperficie Abyſſi: in ipſo primi diei medio creata eſt Lux;
quam à Tenebris diſtinguens Deus, illam appellavit Diem, has Noctem:

FIG. 1.1 How Ussher's "4004 BC" first appeared in print: part of the opening page of his *Annals of the Old Covenant* (1650–54), with his dating system in three marginal columns. On the left, the "Year of the World" [*Anno Mundi*] starts at 1, with Creation itself. On the right, the "Year before the Christian Era" [*Anno ante æram Christianam*] starts at 4004, and will decline as the chronology proceeds, but the "Year of the Julian Period" [*Anno Periodi Julianæ*]—a kind of reference timeline independent of any real history—is already at 710. In the opening sentence of his text, Ussher dates the initial act of Creation, including the beginning of real time, at the start of the night preceding 23 October in the year 710 Julian, so that still earlier Julian years were in a kind of "virtual" time. Chronology was not a science for the simple-minded! Ussher's Latin title refers to the theological concept of a divine "old *covenant*" with the Jewish people, not to the Jewish scriptures or "Old *Testament*"; his chronology also covers the period to which the New Testament or Christian scriptures refer.

cultures, and to link them together in a continuous chain of dated events. (The science of chronology is not extinct: the results of modern chronological research are on display in our museums, wherever artifacts from ancient China or Egypt, for example, are labeled with dates BC or BCE; all such dates are derived from similar correlations between the histories of different cultures.)

By far the greater part of Ussher's evidence, like that of other chronologists, came not from the Bible but from ancient *secular* records. Not surprisingly, his sources were most abundant for the more recent centuries BC, and tailed off rapidly as he penetrated into the more remote past. For the very earliest times they were extremely scanty and almost confined to the bare record in Genesis of "who begat whom" in the earliest generations of human life. This makes it clear that Ussher's main objective was indeed to compile a detailed history of the world, and not primarily to establish the date of Creation or to bolster the authority of the Bible in general. Ussher treated the Bible as one historical source among many, even if it was also, from his perspective, the most valuable and reliable of all.

DATING WORLD HISTORY

Like other chronologists, Ussher adopted the sophisticated dating system that had been devised by Scaliger. The Frenchman had constructed a deliberately artificial "*Julian*" timescale from astronomical and calendrical elements. It provided a neutral dimension of time, as it were, on which rival chronologies could be set out and compared. It was not just a convenient device; it also highlighted the crucial distinction between *time* and *history*. Time itself was just an abstract dimension measured in years; history was all the real events that had happened in the course of time. What any chronologist claimed as real history could be plotted, on a baseline of the Julian scale, as "years of the world" (*Anni Mundi*, AM) counting forwards from Creation, or as "years before Christ" (BC) counting backwards from the Incarnation, from which the "Years of the Lord" (AD) were counted forwards. Research on chronology was powered by an intellectual craving for quantitative precision. This was characteristic of the age, and not confined to projects such as chronology. It was even more prominent in the natural sciences, for example in the contemporary work of astronomers such as Tycho Brahe and Johannes Kepler. In both kinds of investigation, quantitative precision was valued more highly than ever before.

Like cosmology, however, chronology was a highly controversial kind of research. Producing a dated timeline of events was fraught with problems of incomplete, ambiguous, or incompatible records. At one point after another, chronologists had to use their scholarly

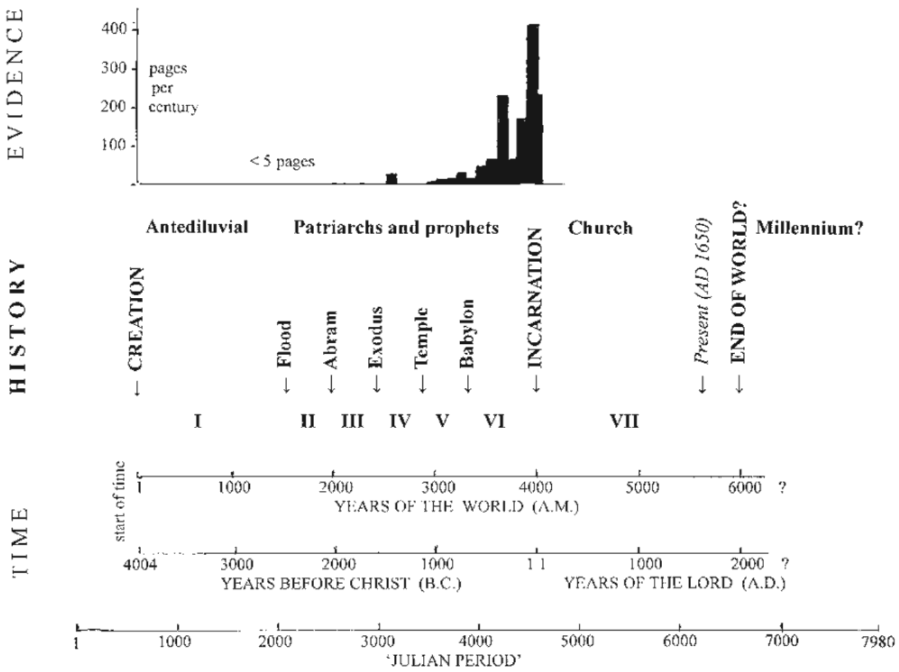


FIG. 1.2 How chronologists dated their world histories. In this diagram, drawn in modern style, time flows from left to right. The "Julian period" was a deliberately artificial timeline, on which each of 7980 years, past and future, could be defined uniquely by a combination of astronomical and calendrical factors. It served as a reference scale of *time*, on which chronologists could plot the dates in *history* that they calculated for Creation, Noah's Flood, the birth of Christ, and other decisive events or "epochs," expressed either in years BC and AD, or in "Years of the World" (*Anni Mundi*, AM) from Creation. These events then defined seven "Ages" (I to VII) for the whole of world history, as seen of course from a Judeo-Christian perspective. This diagram is based on the figures in Ussher's *Annals*, but those calculated by other chronologists were not (on this scale) substantially different. The bulk of relevant historical records declined rapidly as chronologists penetrated back in time: the histogram shows the amount of text devoted, in Ussher's work, to successive centuries: his *Annals* started at 4004 BC and ended at AD 73.

judgment to decide which records were the most reliable, and how they could most plausibly be linked together in an unbroken timeline. Consequently, there were almost as many rival dates for each important event as there were chronologists proposing them. This was particularly true for the date of Creation itself. Ussher's 4004 BC was just one proposal in a crowded field ranging (according to one survey) from 4103 BC to 3928 BC. Scaliger, for example, had decided on 3949 BC, and Isaac Newton—a keen chronologist among many other

things—later settled for 3988 BC. Ussher, like some other chronologists though not all, claimed a very precise date indeed, namely the start (at nightfall, according to Jewish timekeeping) of the first day of the first week after the autumn equinox; this marked the Jewish New Year equivalent to the Christian year 4004 BC. At the time, complex calendrical and historical reasoning made this kind of precision a perfectly respectable ambition, however bizarre it may seem to us.

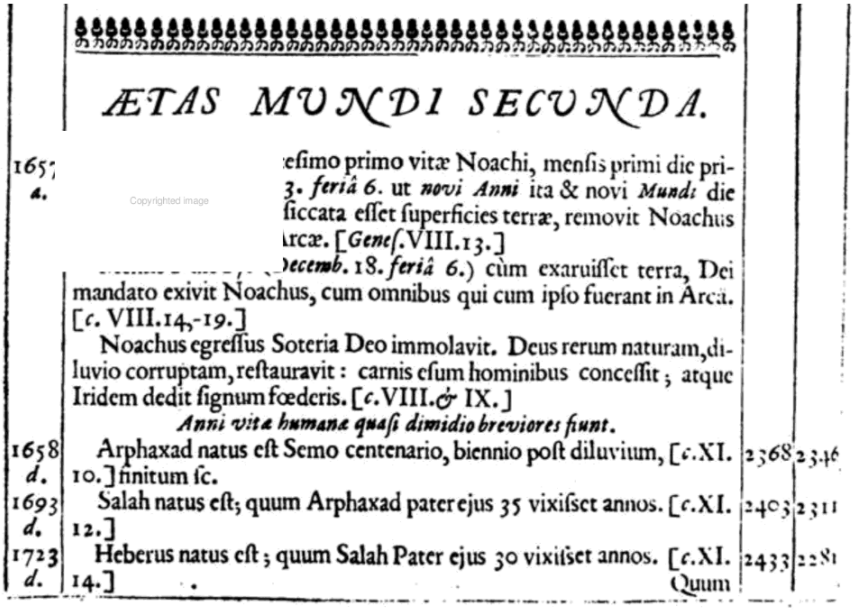
It is only by historical accident that Ussher's 4004 BC has become the best known of all such dates and now the most notorious, at least in the English-speaking world. Almost half a century after Ussher's death

FIG. 1.3 How Ussher's "4004 BC" first appeared in the Bible itself: part of the opening page of William Lloyd's edition (1701) of the "Authorized" [King James] translation in English, with the first or *hexameral* (six-day) Creation story at the start of the book Genesis. This page shows inconspicuously (top right) the Creation dated at 4004 Before Christ, 0710 on the Julian scale, 0001 for the world itself, and other calendrical data. In the same marginal column, and also on the left, are the first of many hundreds of editorial cross-references to other parts of the Bible, and notes on the Greek and Hebrew texts on which the translation was based. This should have have made it clear to readers—but often didn't—that the dates in the margins were likewise editorial notes, not a part of the sacred text itself. The little picture decorating the first letter of the text is of Adam and Eve in the Garden of Eden, the second Creation story in Genesis.

a scholarly English bishop included a long string of Ussher's dates among his own editorial notes in the margins of his new edition of the "Authorized" or "King James" translation of the Bible into English, which had originally been published with the authority of Ussher's royal patron back in 1611. Ussher's dates remained there, by custom or inertia, in successive editions of the Bible in English, right through the 18th century and most of the 19th, although they were never formally authorized by either church or state. Darwin and his English contemporaries, for example, would have grown up seeing 4004 BC printed on the very first page of their family Bibles. Many young or uneducated readers, not understanding the role of an editor, assumed that the date was an integral part of the sacred text, and they respected or even revered it accordingly. Only in 1885 were all Ussher's dates—by then long obsolete, in historical as well as scientific terms—omitted from the margins of the new "Revised Version" of the Bible. This was the first complete English translation to incorporate the greatly improved linguistic and historical understanding of the texts that was the fruit of biblical research by Jewish and Christian scholars since the time of Ussher (and King James). Readers of the Bibles placed by the Gideons in hotel bedrooms had to wait even longer, until the late 20th century, to be relieved of the implications of 4004 BC. In contrast, marginal dates did not usually feature in Bibles in other languages, so people outside the English-speaking world were generally spared this disastrous misapprehension that the exact date of primal Creation had been fixed by divine, or at least ecclesiastical, authority.

PERIODS OF WORLD HISTORY

To return, however, to Ussher's century: his and other chronologists' efforts to compile rigorously precise "annals" of world history were a means to what most of them regarded as a more important end. Quantitative precision was intended to help yield qualitative meaning. Chronologists wanted to give precision to what they saw as the overall shape of human history, by dividing it into a meaningful sequence of periods. The primary division represented by the traditional dating system of years BC and AD was just such a distinction, for it separated the old human world before the Incarnation from the radically new human world which—from a Christian perspective—that unique



ÆTAS MUNDI SECUNDA.

1657 a. eſimo primo vitæ Noachi, menſis primi die pri-
3. feriâ 6. ut *novi Anni* ita & novi *Mundi* die
ſiccata eſſet ſuperficies terræ, removit Noachus
tegumentum Arcæ. [*Geneſ.* VIII. 13.]
(*Decemb.* 18. *feriâ* 6.) cùm exaruiſſet terra, Dei
mandato exivit Noachus, cum omnibus qui cum ipſo fuerant in Arca.
[*c.* VIII. 14.-19.]
Noachus egreſſus Soteria Deo immolavit. Deus rerum naturam, diluvio corruptam, reſtauravit: carnis eſum hominibus conceſſit; atque
Iridem dedit ſignum fœderis. [*c.* VIII. & IX.]
Anni vitæ humanæ quaſi dimidio breviores fiunt.

1658 d. Arphaxad natus eſt Semo centenario, biennio poſt diluvium, [*c.* XI. 10.] finitum ſc. — 2368 — 2346

1693 d. Salah natus eſt; quum Arphaxad pater ejus 35 vixiſſet annos. [*c.* XI. 12.] — 2403 — 2311

1723 d. Heberus natus eſt; quum Salah Pater ejus 30 vixiſſet annos. [*c.* XI. 14.] — 2433 — 2281

Quum

FIG. 1.4 The very early part of Ussher's *Annals* that covers Noah's Flood, with references to the Genesis text, which he believed was the only reliable source available at this remote point in world history. The Flood is dated at Years-of-the-World 1657 (marginal column on left, as in Fig. 1.1); the first postdiluvial generations are then recorded with, in addition, Julian and BC dates (in columns on right, again as in Fig. 1.1). For Ussher and other chronologists it was also of great importance that the Flood marked the start of the world's "Second Age" [*Aetas Mundi Secunda*]. Apart from the initial six "days" of Creation, the Flood was the event in scriptural history that most obviously involved the natural world as well as the human. This made it the focus of much subsequent debate about how early human history might be related to the Earth's own history.

event had first brought into being. But Ussher, like other chronologists, also subdivided the millennia of BC history, by defining a sequence of decisive events or "*epochs*," which in turn marked out a sequence of distinctive "*ages*," "*eras*," or periods. Ussher identified five significant turning-points between the mega-events of the Creation and the Incarnation. These ranged in time from Noah's Flood to the ancient Jews' deportation into exile in Babylon. Adding the period since the Incarnation, world history could then be divided into a sequence of seven ages. These were often taken to match, or echo symbolically, the sequence of seven "days" in the week of Creation itself. So the whole shape of world history was deeply imbued with Christian meaning.

In the 17th century, then, world history was pictured qualitatively

as a sequence of distinctive periods bounded by particularly significant events, each of which chronologists tried to date accurately on a quantitative timescale. All this history was taken to be, most importantly, one of cumulative divine self-disclosure or "*revelation*," but it was also largely *human* history. The non-human world of nature was treated for the most part just as a setting for the human drama, an almost unchanging background or context for human action and divine initiative. Only occasionally did events in the natural world feature prominently in accounts of human history, either sacred or secular. In the sacred story, for example, the waters of the Red Sea had retreated temporarily, enabling the Jewish people under Moses' leadership to make their Exodus from Egypt and gain their freedom. Equally conveniently, or providentially, the Sun "stood still" for an embattled Joshua (though what exactly that meant was much debated); later still, Jesus's birth and death were said to have been marked by, respectively, a new star and an earthquake.

Only at two points did the natural world feature still more prominently, right in the foreground of the sacred story. These two points were the Creation itself, and Noah's Flood. In the 17th century, each was the focus of a distinctive kind of historical commentary, which to a limited extent enlarged the scholarly study of texts with materials drawn from nature.

The first kind of commentary was on the six "days" or phases of Creation. The brief narrative in Genesis was often used as a framework for reviewing what was currently known about the structure and functions of the cosmos, the Earth, and plants and animals, all of which jointly constituted the environment of human life. These commentaries (known as "*hexahemeral*" or "*hexameral*," from the Greek for "six days") followed what was taken to be the primary meaning of the biblical text. They treated the origins of the major features of the natural world as a coherent sequence of historical events in real time. The narrative was taken to be describing the sequence in which the props had been placed on stage, as it were, before the human drama could begin. So any such review of the environment of human life was not only a kind of *natural history*—an inventory or systematic *description* of nature—but also an account of origins that claimed to be nature's true *history* (in the modern sense of that word). However brief the time-span of Creation was thought to have been, the story did

ascribe to the natural world its own history, divided into a sequence of distinctive periods (the six "days" of the narrative) culminating in the appearance of human beings. It should be clear enough that this conception of world history was—despite the obvious huge contrast in the kind of timescale envisaged—closely *analogous* to the modern view of the Earth's deep history, with its similar succession of major events and new forms of life. To point this out is not to claim that the Genesis account anticipated the truth of the scientific account, but just that the way it was interpreted in the 17th century was *structurally* similar to modern ideas about the Earth's history. The Genesis narrative therefore *pre-adapted* European culture to find it easy and congenial to think about the Earth and its life in a similarly *historical* way.

NOAH'S FLOOD AS HISTORY

Noah's Flood or Deluge (described later in the book of Genesis) was treated even more clearly as a real historical event: on the chronologists' calculations, it could be dated to more than a millennium and a half after the start of the human drama. Unlike the Creation story, its details did not depend on direct divine revelation. They could have reached Moses—who was believed to be the author of Genesis—through an unbroken line of records or memories stretching back to Noah and his family, who had been on board the Ark and had witnessed the Flood at first hand. So the story of the Flood was subjected to detailed analysis by scholars, who tried to work out what exactly had happened and how. They tried to reconstruct the "*antediluvial*" ("before the Deluge") human world that the Flood had destroyed; how Noah's family had survived the catastrophe in his Ark; and how the "*postdiluvial*" ("after the Deluge") human world had recovered from it. They also conjectured how it might have been caused and how it had affected the Earth itself and its animal inhabitants and other non-human features. All this was based on the biblical text, mainly because Genesis was believed to contain the sole authentic historical record of the event (similar non-biblical stories, such as Deucalion's flood in the Greek records, were generally thought to be second-hand accounts derived from the earlier biblical one, or else accounts of later and more local events).

Among the many 17th-century historians who analyzed and com-

mented on the Flood story in this way, the German Jesuit scholar Athanasius Kircher is a good example (just as Ussher has been taken here as a representative chronologist). Kircher was a highly erudite scholar who published on a wide range of topics of interest to his educated readers around Europe; like Ussher he wrote in Latin, making his work accessible to them all. His massive illustrated book on the *The Subterranean World* (*Mundus Subterraneus*, 1668), based on a wide knowledge of the natural sciences of his time, described the physical Earth as a complex system, dynamic but not in any sense a product of history. For example, he speculated how its visible surface features such as volcanoes might be related to its unseen internal structure (he had traveled in Italy and had first-hand knowledge of Vesuvius and

FIG. 1.5 Kircher's view of the Flood as it subsided, leaving the Ark stranded on the summit of Ararat (right). A matching engraving showed the Flood at its earlier and greatest height, with the Ark floating above the Caucasus (left center), the highest mountain range Kircher knew. These reconstructions combined his interpretation of the textual evidence of the story in Genesis with the natural evidence of what he knew about the Earth's physical geography. (He was well aware that the Ark was not drawn here to scale: like many modern scientific illustrations, this was a *diagram*, albeit in Baroque style.)

Etna). But he did so in rather the same way that the surgeons and physicians among his contemporaries were working out how the visible features of the human body were related to the unseen organs within. Kircher described the Earth's anatomy and physiology, as it were, but he did not describe it as having had any significant major changes or *history* since its initial creation.

The Flood, however, was the great exception. In another massive

FIG. 1.6 Kircher's "Conjectural Geography"of the world before and after the Flood. This half of his world map marks, conjecturally, "antediluvial" land areas that in the "postdiluvial" world are submerged (*olim Terra modo Oceanus*)—among them the lost land of Atlantis, here placed west of Spain—and, conversely, areas that were formerly under the sea but are now dry land (*olim Oceanus modo Terra*). This illustrated Kircher's claim that the Earth's geography had changed significantly as a result of the Flood. The Earth therefore had a true physical *history*, at least in this respect. His map (in Mercator projection), based on those in contemporary atlases, shows the still barely known Australia as a part of a much larger Antarctica or "unknown southern land" (*Terra australis incognita*), and a similar unknown landmass in the Arctic.

volume, *Noah's Ark* (*Arca Noë*, 1675), Kircher analyzed the Flood historically, using his impressive multilingual skills to exploit all the known ancient versions of the biblical text. He worked out how Noah had built the Ark and embarked with its cargo of varied livestock; how the rising Flood had floated the Ark away and eventually dumped it on the summit of Ararat as the waters subsided; and how the human world had started up again in the postdiluvial period. From the data given in Genesis, he reconstructed, and illustrated in detail, the likely form and size of the Ark. He tried to work out how it could have accommodated even a single pair of every known animal. This gave him a reason to embellish his account with pictures of a wide range of these living animals (in effect, giving his readers a "natural history"). Since the Flood was said to have been worldwide, he also calculated how much extra water would have been needed to raise sea level globally, enough to cover the tops of the highest known mountains; and he speculated about where it might have come from and gone to, unless, implausibly, it was created and then eliminated specially for the occasion.

What is most significant in the present context is that Kircher, like some other scholars, also conjectured that the distribution of land and sea before the Flood might have differed from the form of the continents and oceans after that great event. The Flood might have changed the physical Earth substantially, in no less real a sense than it had changed the human world. At least at this point he was claiming, in effect, that the Earth had a true physical *history* to parallel its human history. However, as the title of his book implied, his erudite analysis was focused primarily on Noah and his Ark, and only secondarily on the physical effects of the Flood itself. His work belonged, in the main, to the same world of thought as that of scholarly chronologists such as Ussher: history was primarily a *human* story, and by modern standards a brief one.

THE FINITE COSMOS

One practical advantage of the artificial Julian timescale, as chronologists saw it, was that it spanned a total period long enough to accommodate any plausible calculation of the date of Creation at one end, and any anticipated date of the ultimate completion of world history at the other end, leaving plenty of virtual time to spare, as it were, at both

ends. It was this that made it convenient as a dimension on which rival chronologies could be plotted and compared. But it also highlights what is, to modern eyes, surely the most unfamiliar feature of Ussher's (and Scaliger's) kind of chronology. This was not that it was very short by our modern scientific standards (though extremely long in human terms), but that it outlined a world history that had *finite limits, both past and future*. In this it was strikingly similar to the "closed world" of the traditional *spatial* picture of the cosmos—with the Earth at its center and all the stars around its periphery—which had been equally taken for granted until astronomers such as Copernicus, Kepler, and Galileo began to open it out into a spatially infinite universe. However, Kircher and many other scholars in his time remained sceptical about that new picture of the cosmos, which they felt had yet to prove itself.

Ussher and most of his contemporaries believed that they were living in the world's seventh and last age. Its final End was widely thought to be imminent, or at least it was expected in the foreseeable future. One common opinion was that the world might end with the completion of exactly six millennia from the Creation (that is, on Ussher's figures, in 1996!). This matched Ussher's calculation that the pivotal point of the Incarnation had been precisely four millennia after the Creation (it had long been recognized that the traditional scale was not quite correct on the real date of Christ's birth, which was put at 4 BC). Such precision, heavily laden with symbolic meaning, made Ussher's figure of 4004 BC particularly attractive to many of his contemporaries; he was not the first or the only chronologist to propose it.

Ussher emphasized and was proud of his achievement, yet he was well aware that his claim was controversial. As already mentioned, many different dates for the Creation were proposed, but not all chronologists were convinced that *any* such date could be fixed. Ever since the early centuries of the Christian (or Common) era, some scholars had pointed out that the Sun, the apparent movement of which defines ordinary days, had not been created until the fourth "day" of the Genesis story. So it had often been suggested that the seven "days" of Creation might not denote periods of twenty-four hours at all. Instead they might represent divinely significant moments, rather like the future "day of the Lord" in the recorded sayings of the Jewish prophets (our use of phrases such as "in Darwin's day" is indefinite in rather the same way). If so, the "week" of Creation might have been of indeter-

minate duration, and its starting and ending dates might be even more uncertain. In other words, this biblical text, like others, was seen to require interpretation. Its meaning could not simply be read off unambiguously, as if the plain or "literal" meaning was self-evident and beyond argument. This recognition that scholarly judgment was needed, to interpret the meaning of texts, led chronologists and other historians to develop methods of *textual criticism* that continue to underlie historical (including biblical) research to the present day; "criticism" was of course used here in the same sense as in artistic, musical, or literary criticism, without any necessarily negative connotations.

The interpretations of 17th-century scholars may strike us now as extremely literal in character, but this is partly because they were taking the biblical texts seriously as *historical* documents. However, the strongly marked "*literalism*" of their approach to the Bible, far from being an ancient tradition, was a quite recent innovation. In earlier centuries many other layers of meaning—which might be termed symbolic, metaphorical, allegorical, poetic, and so on—had been prominent and generally more highly valued than the literal. But they had sometimes been elaborated so fancifully that, particularly in the Protestant world in the wake of the Reformation, they were downplayed or stripped away altogether, leaving the supposedly simpler "literal" meaning supreme. Yet Protestant scholars, no less than Catholics, conceded and indeed emphasized that their interpretations of biblical texts were intended primarily to elucidate practical *meaning* based on theological understanding, not to impart knowledge of nature.

In the case of the Creation story, for example, what was thought to be of ultimate importance was not its exact date, or the duration of its "days." Far more significant for human lives was its assurance, in effect, that all things had been freely created by the one and only God, who had pronounced them all to be intrinsically "good"; that the sequence of creative actions had not been arbitrary but underlain by the consistent purposes of a caring God; and that no created *thing*—not even angels or other heavenly powers, let alone the Sun or Moon or other natural entities—should be treated as ultimate in value or deserving of worship. Themes such as these had been the stuff of both popular sermons and scholarly commentaries on Genesis, ever since the early Christian centuries. The theological *meaning* of the texts, and their application in the practice of Christian faith, had been emphasized

endlessly, taking priority over any use they might have as sources of factual knowledge about the world's origins. (The historically recent rise of literalism, and the continuing primacy of theological meaning in biblical interpretation, are often overlooked or ignored by modern fundamentalists, religious and atheistic alike.)

The exact date of Creation was not the only unresolved problem lurking behind the chronologists' confident dating of world history. Although Egyptian hieroglyphic inscriptions could not be deciphered, there were ancient Greek reports of what had been known at that time. According to these, Egypt's early dynasties stretched back many centuries before the generally favored dates for the Creation. The two sources of alleged evidence—Egyptian and biblical—could not both be correct, so chronologists had to choose between them. Once again, scholarly judgment was needed. It is hardly surprising that the biblical record was treated as the more reliable. The Egyptian record of allegedly pre-Creation history was generally dismissed as political spin, as a fiction devised long ago to bolster the legitimacy or prestige of Egypt's ancient rulers. Equally unsettling, however, were some of the early Chinese records, when research by Jesuit scholars living in China first made them known to other Europeans. These records too suggested a much longer ancient human history than the chronologists' calculations allowed. And ancient Greek reports of Babylonian records, though generally dismissed as fictitious, claimed even greater antiquity for human civilizations.

Most unsettling of all, perhaps, were the conjectures contained in a small book published just after Ussher's huge *Annals*. The author of the anonymous *Men Before Adam* (*Prae-Adamitae*, 1655), which soon became widely known and indeed notorious, used a subtle interpretation of a specific New Testament text to argue that the biblical story of Adam was originally intended to refer to the first Jew, not the first human being. This put a big question mark against all chronologies based on Adam as the starting point for human history. The conjecture had the advantage that it could explain how the human races around the world might have had time to become so widespread and diverse. The sheer variety of humanity had not been fully appreciated by Europeans until, little more than a century earlier, their great exploratory voyages had first taken them around Africa to Asia and across the Atlantic to the Americas. Conversely, however, the conjec-

ture had the disadvantage that it seemed to deny the unity of humankind in the Christian drama of salvation. For example, it appeared to exclude the indigenous peoples of the Americas from that drama, and thereby denied them fully human status. The claim that there had been "Pre-Adamite" human beings got its author—whose identity had been disclosed as the French scholar Isaac La Peyrère—into trouble with the Catholic authorities, though after renouncing such speculations, at least nominally, he lived to a peaceful old age.

THE THREAT OF ETERNALISM

In the present context, however, the importance of Pre-Adamite ideas is that they added to the impact of the allegedly ancient Egyptian, Chinese, and Babylonian records. They all implied that the totality of human history might be far longer than any conventional Western chronology allowed, stretching back not five or six millennia but perhaps more than ten, or even—if the Babylonian records were to be believed—many tens of millennia. All this was disturbing to conventional thinking: not primarily because it put the dating of Creation or the authority of the Bible in doubt, but far more because it seemed to open the door to a much more radical kind of speculation. It suggested that ancient Greek philosophers such as Aristotle and Plato, whose ideas on other topics had long been revered in Europe, might have been right in this: they were taken to have claimed that the universe, and with it the Earth and human life, are not just extremely ancient but literally *eternal*, without any created beginning or final end. This was profoundly disturbing, because to deny that human beings are in some sense *created*, and therefore morally answerable to their transcendent Creator, seemed equivalent to denying that they have any ultimate responsibility for their actions and behavior. It seemed to threaten the very foundations of morality and society.

At first glance, this "*eternalism*" (as it has since been named) might seem to anticipate the modern picture of a history of the Earth and the cosmos measured in billions of years, in sharp contrast to the chronologists' short and finite story measured in mere thousands. But the apparent modernity of eternalism is deceptive and deeply misleading. In fact, a "young Earth" and an eternal one, which were the only two alternatives considered in the 17th century, were *equally un-modern*.

Both assumed that human beings have always been and will always be essential to the universe. Although the chronologists' short and finite history of the Earth (and of the cosmos) included a very brief pre-human setting of the scene, it was otherwise wholly a human drama from start to finish. But the eternalists' picture, likewise, was of an Earth (and a cosmos) that had never in the past been without human beings, or at least some rational Pre-Adamites, and never would be in the future. Those who argued for the authenticity of extremely early human records from Egypt, China, or Babylon, way back beyond the usual range of plausible dates for Creation, assumed that even these were just the most ancient that had happened to survive. They took it for granted that there must have been a long or even infinite sequence of still earlier human cultures, of which all traces had been lost in the mists of time.

So the *infinitely* ancient Earth (and universe) of eternalism did not anticipate the modern scientific picture of an immensely lengthy but *finite* history of the Earth (and of the universe). Yet at the time, in the 17th century and even later, eternalism did offer a radical alternative to what was then the culturally dominant picture of a probably brief and certainly finite universe. Eternalism was widely regarded as subversive, socially and politically as well as religiously. So it generally remained, as it were, underground: it was most often visible when it was attacked by its orthodox critics, rather than being expressed openly by its unorthodox proponents. What was perceived as the radical threat to human society posed by eternalism goes a long way to account for the dogged defense, in some circles though not all, of the "young Earth" derived from a very literal interpretation of the Creation story in Genesis. Conversely, however, eternalists often had their own—religiously sceptical or even atheistic—agenda to promote. So this was certainly not a straightforward struggle of enlightened Reason against religious Dogma. There were strong "ideological" issues at stake on *both* sides of the argument.

On a global scale, however, the idea of an indefinite or even endless sequence of human lives, as implied by eternalism, had been the norm rather than the exception. Most pre-modern societies around the world embodied in their cultures an assumption that time—or rather, the *history* that unfolds in time—is repetitive or in some sense cyclic, not arrow-like or uniquely and irreversibly directional. Underlying

this assumption, and making it seem common sense, was the universal experience of the cycle of individual lives from birth through maturity to death, repeated from one generation to the next. This was powerfully reinforced by the annual cycle of the seasons, which in most premodern societies was an extremely powerful determinant of human lives. Together they fostered a similarly cyclic or "*steady-state*" view of human cultures, of the Earth, and of the universe as a whole. Against this background, the idea that the world has had a unique starting point and a linear and irreversibly directional *history*—an idea that first emerged in Judaism and was extended in Christianity (and later in Islam too)—stands out as a striking anomaly. Each of the Abrahamic faiths condensed its directional view of history into an annual cycle of fasts and festivals (Passover, Easter, etc.), which replicated the cosmic picture in miniature on the more accessible scale of ordinary human lives. But the larger-scale picture remained paramount, namely that humanity, the Earth, and the universe have jointly had a true *history*, with an irreversible arrow-like direction to it.

This strong sense of history gave the Judeo-Christian tradition an underlying structure that is closely analogous to the modern view of the Earth's deep history (and cosmic history) as similarly *finite and directional*. More specifically, the science of scholarly chronology, as a way of plotting human history with quantitative accuracy and of dividing it into a qualitatively significant sequence of eras and periods, was closely analogous to the modern science of "*geochronology*," which tries to give a similar kind of precision and structure to the Earth's deep history, dividing it in the same way into eras and periods. Whether these are "mere" analogies, or something much more, is a question that the rest of this book will explore.

To summarize: the history of the universe, the Earth, and human life itself was traditionally conceived in the West as having been very brief in comparison with the modern picture. But this is a relatively trivial difference: the quantitative contrast is less significant than the qualitative similarity. What is not trivial is that the scholarly history represented by chronologists such as Ussher was almost exclusively based on *textual* evidence (the astronomical evidence of past eclipses, comets, etc. also came from textual records). Even in the historical analysis of Noah's Flood by scholars such as Kircher the textual evidence was dominant and the use of natural evidence was marginal.

At much the same time, however, and still in the 17th century, other scholars were beginning to bring the natural evidence much more substantially into debates about the Earth's own history, yet without seeing any obvious need to extend the timescale on which it had played out. This is the subject of the next chapter.

2

Nature's Own Antiquities

HISTORIANS AND ANTIQUARIES

In retrospect it might seem obvious that evidence from the natural world—such as rocks and fossils, mountains and volcanoes—ought to have undermined the idea of a "young Earth" from the start. But in fact the significance of such features was far from obvious, and for some very good reasons. Among these was the sheer novelty of the idea that nature might have had any real history, after its chief components had been put on stage during the "week" (literal or not) of Creation. Apart from the much later and unique mega-event of the Flood, the natural world was taken to have been a stable backdrop throughout the ongoing drama of human history. That nature might have had its own dramatic action began to seem plausible only when the ideas and methods of historians were *transposed* into the natural world, from culture into nature. History—human history—was a flourishing field of scholarship in the 17th century, and its variety and high standards provided fertile ground for this crucial transfer.

James Ussher's 4004 BC was not the only date calculated by chronologists for the week of primal Creation. But nor were chronologists the only people doing historical work in the 17th

century. Chronology was just one rather specialized kind of history. It was multilingual and multicultural in its sources; it interpreted world history in terms of the Christian narrative of cumulative divine self-disclosure or "revelation"; and generally it set out its results in the form of "annals," or chronicles of events arranged in a year-by-year sequence with as much precision as chronologists could muster. Other scholars wrote histories of other kinds, often more secular in character and taking ancient Greek and Latin writers as their models. These were histories of particular places or peoples, or of specific periods or episodes in the past, or of the lives and influence of individuals of outstanding importance. Like the chronologists, other historians often divided the past into periods of distinctive character, or they adopted periods already in general use. Periods could be useful for descriptive purposes, even if their dates were not defined precisely. For example, the "Middle" ages or mediaeval period filled the centuries between the decline of the "Ancient" or Classical world of Greece and Rome and the Renaissance or rebirth that marked the start of the "Modern" world.

Documents and books, stored in archives and libraries, were essential in almost all kinds of historical work. Like the chronologists, other historians adopted rising standards of scholarly rigor and an increasingly critical evaluation of the reliability (or otherwise) of their sources. Secular textual records, no less than scriptural ones, required critical scrutiny. Records contemporary with the events themselves were most highly valued, and historians learned how to detect telltale signs of anachronism: the documents might be later forgeries, which in turn might have significant political implications. Conversely, many historians believed that valuable clues about the earliest periods of human history, back before the relatively well-documented ages of Greece and Rome, might be preserved in the apparently unpromising form of myths, legends, and fables. Stories of gods and superhuman heroes might in reality be garbled accounts of great ancient rulers and exceptional natural events. These stories might seem at first sight incoherent or implausible, but with suitable demythologizing—a method termed "*euhemerist*" after its much earlier exponent the ancient Greek author Euhemerus—they might throw light on the very earliest "fabulous" or "mythical" stages of human history.

However, historians also made increasing use of other kinds of evi-

dence. Textual documents could be supplemented with other records of what had happened in the past. For the Classical past of Greece and Rome, for example, there were the inscriptions found on ancient buildings, or dug up in their ruins: no less textual than conventional documents, but often supplementing them by providing important new information about distant past events. Then there were the coins found on ancient sites, which often helped with dating because they preserved bits of text combined with portraits of ancient rulers and other significant images. Other artifacts, even without any text attached, provided further evidence about great events or ordinary everyday life in these much admired ancient cultures. They ranged, for

FIG. 2.1 The "cabinet of curiosities" assembled by the Danish savant Ole Worm of Copenhagen. It included a wide variety of interesting or puzzling objects of all kinds, natural and human, all carefully classified. Most of his fossils, for example, would have been stored on the lower shelves, and classed as *Lapides* ["Stones"]. This engraving (here greatly reduced in size) formed the spectacular frontispiece or visual summary of the book describing and illustrating Worm's collection (*Museum Wormianum*, 1655); being in Latin, it was accessible to educated people throughout Europe.

example, from Greek vases and Roman sculptures to "*monuments*" such as Greek temples and Roman theaters. All such artifacts, which together supplemented documentary sources, were known as "*antiquities*." The smaller and more collectable kinds (in modern terms, just "antiques") often featured prominently—alongside an amazing variety of other rare, curious, or puzzling objects, both natural and human—in the "cabinets of curiosities" or private museums assembled by scholars, particularly those who called themselves antiquarians or "*antiquaries*."

There was no reason why antiquities could not be used as historical evidence, even in the total absence of textual sources. For most of Europe, evidence for the times before the Romans arrived with their literate culture was confined to undateable artifacts such as stone tools or weapons found lying on the ground, or bronze objects and pottery dug up from ancient tombs, or striking but enigmatic monuments such as the huge stone circle of Stonehenge in the south of England. It seemed possible that some of these artifacts might date from the same centuries as early literate cultures elsewhere, such as the Classical Greek world around the Mediterranean. But it was conceivable that some other artifacts were older than any textual evidence anywhere (apart from the very sparse early biblical records, and the early myths preserved by other cultures, all of which were controversial). So the artifacts studied by antiquaries, even if undateable, might help to throw light on the earliest periods of human history, back before the times from which *any* reliable textual documents survived. In effect, they might replace, and not merely supplement, the more traditional sources of historical evidence.

NATURAL ANTIQUITIES

There was also no reason why these antiquities could not be supplemented in turn, or even replaced, by other ancient material objects, which were not artifacts because they were not human but natural in origin. Nature might, metaphorically, have its own antiquities. The most striking objects of this kind were the sea shells that in some regions could be picked up on the ground, far from the sea and sometimes high above it. These "*natural antiquities*" had already been noticed and commented on, back in Classical times. In the 17th century

FIG. 2.2 Fossil shells (and a piece of coral) found in Calabria in the south of Italy. These were among the many engravings published by Agostino Scilla in *La Vana Speculazione* (1670). They supported his claim that such objects were the remains of shellfish and other creatures that had once been truly alive. They were so similar to the shells of molluscs, sea-urchins, corals, etc. in the nearby Mediterranean that any other explanation of them was, he claimed, no better than a "vain speculation." (The shells are fitted economically into the space available on the expensive copper plate from which the engraving was printed.)

many scholars, like their forerunners in the ancient world, believed these shells showed that in the distant past the seas had extended far beyond their present limits. For example, the Sicilian scholar (and professional painter) Agostino Scilla published an account of those he had collected on his native island and in adjacent parts of Italy. He claimed that his first-hand observations showed clearly that they were the shells