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'Thrilling' TOM HOLLAND

IMPOSSIBLE MONSTERS

Dinosaurs, Darwin and the War
Between Science and Religion



MICHAEL TAYLOR

'The most talented young historian around' SATHNAM SANGHERA

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Impossible Monsters

*Dinosaurs, Darwin and the War
between Science and Religion*



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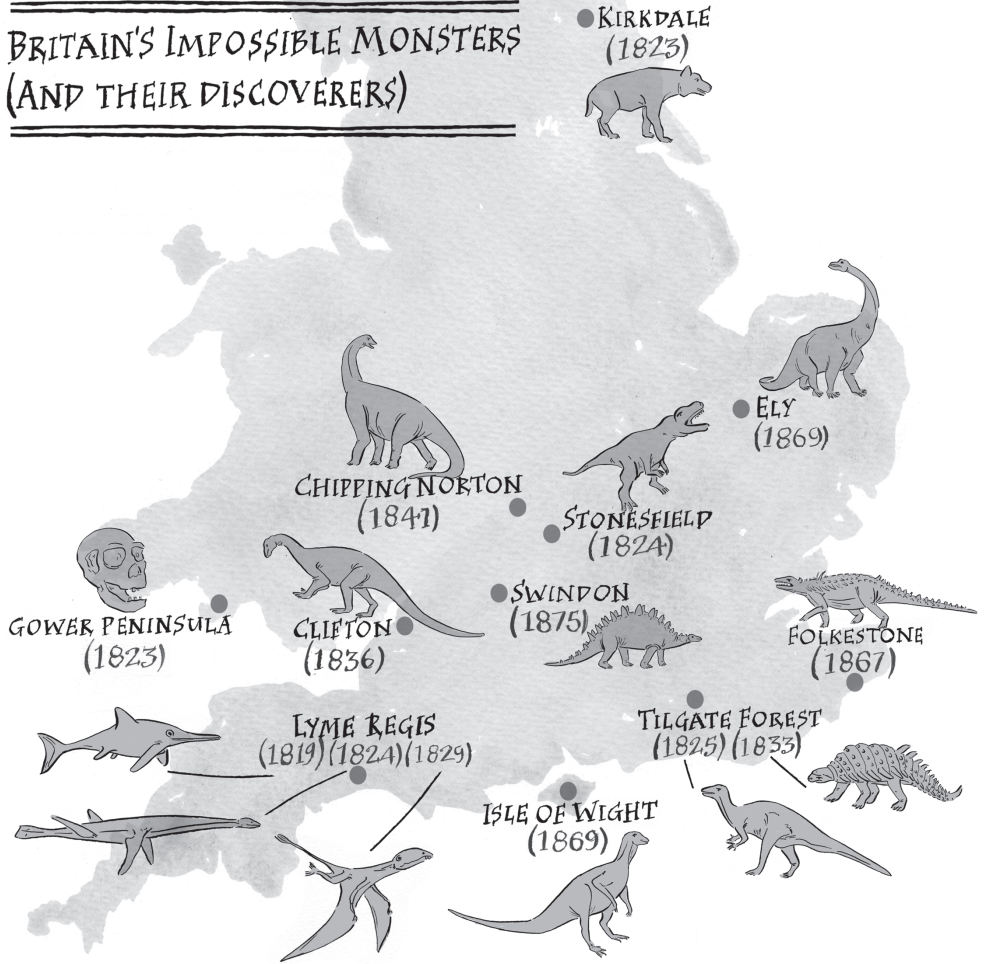
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BRITAIN'S IMPOSSIBLE MONSTERS (AND THEIR DISCOVERERS)



 **Ichthyosaurus**
(Anning/Conybeare/
De la Beche, 1819)


 **Kirkdale Hyena**
(Buckland, 1823)

 **Red Lady of Paviland**
(Davies/Buckland, 1823)

 **Megalosaurus**
(Plot/Buckland, 1824)


 **Plesiosaurus**
(Anning/Conybeare, 1824)


 **Iguanodon**
(Mantell, 1825)

 **Dimorphodon**
(Anning/Buckland, 1829)


 **Hylaeosaurus**
(Mantell, 1833)


 **Thecodontosaurus**
(Riley/Stutchbury, 1836)

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 **Cetiosaurus**
(Kingdon/Owen, 1841)

 **Acanthopholis**
(Griffiths/Huxley, 1867)

 **Gigantosaurus**
(Seeley, 1869)

 **Hypsilophodon**
(Mantell/Huxley, 1869)

 **Dacentrurus**
(Shopland/Owen, 1875)

N.B. Year refers to official
date of announcement

Did not learned men, too, hold, till within the last twenty-five years, that a flying dragon was an impossible monster? And do we not now know that there are hundreds of them found fossil up and down the world? People call them Pterodactyles: but that is only because they are ashamed to call them flying dragons, after denying so long that flying dragons could exist.

Charles Kingsley, *The Water-Babies* (1863)

Preface

Behold now behemoth, which I made with thee;
He eateth grass as an ox.
Lo now, his strength is in his loins,
And his force is in the navel of his belly.
He moveth his tail like a cedar:
The sinews of his stones are wrapped together.
His bones are as strong pieces of brass;
His bones are like bars of iron.
He is the chief of the ways of God.

The Book of Job (40:15–20)

This is a book about the discovery of dinosaurs in the nineteenth century and the consequent revolutions that took place in science, religion, and society. And if all history is to some extent autobiography, I have written this book as a child of the *Jurassic Park* generation. Steven Spielberg's blockbuster was the movie event of 1993 and while I might have been too young to see the film in the cinema, I was the perfect age for the merchandise which accompanied its release. There were lunchboxes, pencil-cases, and schoolbags, and everyone but everyone had to have them; my parents bought me an army of sturdy dinosaur figurines with which I restaged the great battles of the prehistoric world on the living-room floor; and I filled light-blue binders with magazines that described the heroic deeds of fossil-hunters in the American West. In the context of these obsessions, December 1996 was a momentous time for me. Not only did I

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turn a mighty eight years of age, but that month also witnessed the premiere of *Jurassic Park* on terrestrial television. Even now, the scene in which Sam Neill and Laura Dern come across a herd of brachiosaurs fills me with a sense of wonder; less happily, the appearance of the *Tyrannosaurus rex* and its attack on the stricken vehicles still intrude upon the occasional nightmare. Growing up – well, growing up a bit – has done nothing to diminish my fascination with dinosaurs. It remains a matter of puerile pleasure that my favourite guitarist, R.E.M.'s Peter Dinklage, played gigs with an arrangement of model dinosaurs on his amp. As I read books by Steve Brusatte and Michael Benton, or true-crime stories about the clandestine traffic in dinosaur fossils, I become jealous of the lives that palaeontologists have led, hunting for prehistoric treasure in caves and canyons.¹ And I still pay good money to watch the sequels to *Jurassic Park*, movies of such diminishing quality that I can only conclude, to quote the original, that the producers have been so preoccupied with whether they could, they never stopped to think if they should.²

Yet as much as I love dinosaurs for their beauty and brutality, they were the wellspring of another curiosity. At primary school in Northern Ireland, teachers taught me that God had made the world in six days, 6,000 years ago. In the Ulster Bible Belt, it was a matter of regional pride that James Ussher, the seventeenth-century Archbishop of Armagh, had pinned the date of Creation to a Saturday night in October 4004 BC. There was no sense here that the early chapters of Genesis were metaphorical, or that one 'day' of Creation could have represented more than twenty-four hours, and the prominence of creationist theory in the National Trust's displays at the Giant's Causeway was testament to the persistent power and prevalence of these beliefs.³ The conflict between these two great fonts of authority led me, even as an eight-year-old, to ask questions. If the world was only 6,000 years old then what about the dinosaurs, who had lived more than 66 million years ago? If biblical history was accurate and if God had created humankind in his own image, did that mean that the theory of evolution was wrong? Were my ancestors really monkeys? Should I believe the Bible or the scientists?

This book does not attempt to answer those questions, nor is it a polemic against scriptural literalism. Instead, it explores and narrates

the first period in human history where new knowledge of the Earth and its prehistoric inhabitants collided seriously and persistently with Christian belief in the accuracy of the Bible.⁴ It is therefore a history of the geologists, palaeontologists, and biologists who during the nineteenth century discovered dinosaurs, expanded our knowledge of the earliest ages of the Earth, and transformed our understanding of humankind's descent. Equally, it examines the ways in which new scientific knowledge interacted with religious assumptions about Creation, God's role in directing the world, and humankind's relationship to other life on Earth. Accordingly, this book tries to reconstruct the lives and the mindsets of the men and women who made these discoveries, and how their patterns of thought and behaviour changed – or did not – in response to the knowledge they created. How did nineteenth-century Christians, whose belief in the Old Testament was often implacable, react to compelling evidence that the world was probably millions if not billions of years old? Did they reject this evidence, or did they attempt to reconcile it with their religious convictions? If they accepted that the Bible was fallible as history, did they think it could be morally fallible too?

Although the Prologue to this book takes place in the seventeenth century, when Archbishop Ussher pronounced that Creation had occurred in 4004 BC, it really begins in 1811 when Mary Anning, the impoverished daughter of a cabinetmaker, found the fossilised skeleton of a bizarre 'fish-lizard', an *Ichthyosaurus*, on the Dorset coastline. To be clear, this was not the first discovery of a dinosaur. For one thing, ichthyosaurs are not dinosaurs; rather, they belong to the category of extinct marine animals known as thunnosaurs. For another, the creatures that we call dinosaurs had long since figured in the classical imagination as gryphons, chimera, and dragons, reports of their fossilised remains having reached the Mediterranean from the Silk Roads of Central Asia.⁵ Even so, the Anning discovery launched the systematic study of these giants in the earth, these 'impossible monsters'; the seventy subsequent years – of scientific breakthroughs and intellectual turmoil, and the attendant transformation of society – are the subject of this book.

The early chapters focus mostly and unapologetically on Britain

because this was a field in which British naturalists took the lead. Although there had been fossils found in North America, Patagonia, and the Low Countries, these had occurred in relative isolation and without sustained analysis. And though Paris was the global centre of zoology, French rocks had not yielded many fossils. In Britain, however, there was not only a critical mass of scholarship but also an industrial interest – in quarries, canals, and mines – in churning the earth that released these ancient bones. As these forces combined to foster the new disciplines of geology and palaeontology, Anning found the *Plesiosaurus* in December 1823; within a few weeks of that discovery, the Oxford clergyman William Buckland had unveiled the first ‘proper’ dinosaur, the *Megalosaurus*; on the very same day, the surgeon Gideon Mantell announced that he had found another, which he later called the *Iguanodon*. At the ancient universities, in the gentlemanly societies of London, and in the capital’s dens of freethinking dissent, Britons of the late Georgian and early Victorian periods contemplated the significance of these new discoveries.

And they were truly significant – quite literally ground-breaking – for even if dinosaurs are now an established feature of both science and popular culture, the earliest discoveries of dinosaur fossils took place in a radically different context. Perhaps most importantly, early nineteenth-century Britain was a deeply and sincerely Christian place: most Britons attended religious services on a weekly basis; the King James Bible occupied a spot on almost every bookshelf; and churchmen enjoyed the prestige and dignity of an exalted social station. This everyday religiosity was reflected in national politics and, for the best part of twenty years, Britain had regarded itself as a Christian bulwark against the infidelity of Revolutionary France. Indeed, there had been violent reaction to Jacobin impiety: ‘Throne and Altar’ rioters had threatened suspected atheists; conservative vigilantes had burned radical literature in public; and by printing heretical works such as Thomas Paine’s *The Age of Reason*, publishers risked prosecution and imprisonment for the crime of ‘seditious libel’. Political rights, moreover, depended on being the right kind of Christian: discriminatory legislation prevented Dissenting Protestants and Roman Catholics – let alone atheists – from sitting in Parliament, holding public office, and graduating from university.

As in form, so in belief. The English Enlightenment had been cautious and conservative, suspicious of the continental radicalism which sought to purge society of superstition, and the Bible remained the supreme authority on moral and intellectual questions. ‘Science’, such as it was, was still the preserve of leisured gentlemen and Oxbridge-educated clergymen who explored the natural world as a means of better understanding the physical works of the Lord. Despite the geologist James Hutton warning that there was ‘no vestige’ of the planet’s beginning, few people questioned biblical history or that the Earth was only a few thousand years old. In the same way, there were no serious grounds for questioning the account of Creation in Genesis, where the Lord had created humankind specially and separately in His own image.

This was why the discoveries of the 1810s and 1820s – the eruption of such impossible monsters from the soils and rocks of southern England – posed such difficult questions. If the Lord made the land and the seas on the third day of the week, and animals on the fifth day, why were fossil-hunters finding the remains of these creatures so deep within the earth? If the Lord had seen fit to save pairs of every animal from the Noachian Flood, meaning that the very notion of extinction was sacrilegious, why had nobody seen an *Ichthyosaurus* or a *Plesiosaurus* in the wild? And if the world had transformed fundamentally since the earliest days of Creation, how had those changes occurred, and how long had they taken? For these reasons, it was the concern of palaeontology’s early pioneers – Buckland, Mantell, and the clergyman William Conybeare – not to disturb or subvert, but to reconcile their new science with existing religious assumptions; they understood perfectly well that accusations of heresy and social disgrace could attend radical thinking. Nonetheless, their discoveries had set in train a process of inquiry that would ultimately revolutionise human understanding of the world and of humankind itself.

By the 1830s, the former barrister Charles Lyell had established himself as the world’s leading geological authority, arguing for a history of the Earth in which change had taken place gradually and consistently and which required much longer than James Ussher’s 6,000 years allowed; it was a potentially perilous theory that found respectability in the personal and political conservatism of its author.

Lyell's travelling companion Roderick Murchison meanwhile sought to harness the power of this blooming science in the service of the British Empire and, in turn, imperial supremacy encouraged scientific exploration.⁶ It was no coincidence that, in these halcyon years of the Pax Britannica, three young men could safely take journeys to the ends of the Earth to satisfy their curiosity. Charles Darwin circled the globe on HMS *Beagle*, observing new species and their peculiar distribution across South America; Thomas Huxley sailed the seaboard of Australia, dissecting jellyfish in a makeshift laboratory on HMS *Rattlesnake*; and Alfred Russel Wallace spent years in the jungles of Brazil and the Dutch East Indies, describing and collecting thousands of varieties of birds, bees, and butterflies.⁷ Building on the work of the previous generation, all three would develop startling ideas about natural life.

As Darwin built up the courage to publicise his dangerous ideas on the variation of species, and as the Great Exhibition of 1851 demonstrated British ascendancy in science and industry, liberal thinkers had begun to question religious orthodoxies. By the mid-century, inspired in part by the 'higher criticism' that was emanating from German universities – and that George Eliot was translating into English – they were challenging the consistency and even the morality of the Bible. George Holyoake would call his preferred approach to ethical matters 'secularism'; years later, Huxley would coin the word 'agnosticism' to describe his own position. In the meantime, more prehistoric creatures had arisen from the earth: Mantell had discovered the armoured *Hylaeosaurus*, Anning the winged *Dimorphodon*, and the anatomist Richard Owen the enormous *Cetiosaurus*. Owen had also coined the term 'dinosauria' to describe the land-dwelling animals among them, but he did not deploy the dinosaurs in the scientific vanguard; instead, he argued that if such massive and complex creatures had been alive at the beginning of time, theories of continuous and progressive development among species simply had to be wrong.

That, of course, was precisely the argument that Darwin sought to refute with his theory of natural selection in *On the Origin of Species* in 1859. Thereafter, Huxley took up the cudgel, making war on the old order, and within a few short years British society would experience a moment of doubt that historians have canonised as the

Victorian crisis of faith. All the while, more fossils were being found, and not just among British rocks. There were strange, human-like skulls from the Rhineland and Gibraltar, the bones of an enormous two-legged dinosaur from New Jersey, and fossilised feathers from Bavaria. These discoveries of the late 1850s and 1860s were the keys to the kingdom. Now, the daring soul could ask: were the feathered *Archaeopteryx* and avian-hipped dinosaurs related to the common bird of the present day? In parallel, was the Neanderthal the ancestor of the human, and did the descent of man involve fraternity with the ape? On a more prosaic level, these fossils were engaging an ever-greater audience. Huxley founded new colleges and encouraged new journals that were independent of the aged Anglican gatekeepers; the Royal Institution sold out scientific lectures for working men; the model dinosaurs at the Crystal Palace were an enduringly popular attraction; and reports of the Bone Wars, where fossil-hunters fought over the bones of the American Badlands, commanded countless column inches. Dinosaurs were no longer the impossible monsters of a fevered imagination, but a simple fact of life.

As intimated in the section above, this book seeks to address and explain changing approaches to three connected issues, and to demonstrate that the discovery of dinosaurs and the developing science of palaeontology played a fundamental role in bringing about those changes.

First, the age of the Earth. In 1811, few people questioned Ussher's calculation that Earth was only a few thousand years old, yet by the 1880s all but the most reactionary had accepted that the age of the planet should be counted not in thousands of years, but tens and maybe hundreds of millions. (The real age of the Earth, 4.4 billion years, is discussed in the Epilogue.) It was a vital correction because Lyell's uniformitarian geology and Darwin's theory of natural selection, each of which worked through incremental and barely noticeable changes, both required ages to take effect. So how did the geologists and palaeontologists of the nineteenth century persuade their contemporaries to dispense with biblical chronology and to embrace this longer timeline?

Second, the means of Creation. In the early nineteenth century, the

prevailing theory on humankind's origins was known as 'monogenesis', according to which there had been a single creation as described in Genesis. However, Lyell's geology allowed for a much longer history of the world, Darwin's theory suggested that species had changed over time, and the fossilised remains of the Neanderthal and *Archaeopteryx* appeared to be proof of that theory. And if new sciences could articulate natural mechanisms for the development of species beyond the supervision of Providence, what were the implications for 'Creation' itself? Was humankind really the superior manufacture of the Lord? Had He been involved in Creation at all?

Third, and directly contingent on the second issue, was humankind's relationship to other species. Were humans truly and innately superior or were they merely the most advanced among myriad forms of life? Did it matter that other species – orangutans, cats, and dogs among them – shared in human emotions such as fear, anger, happiness, and affection? During a period when radicals, abolitionists, feminists, and Chartists were striving to eradicate the formal boundaries that society had erected *within* humanity, this was a biological question with profound political implications: if nothing but evolution separated humankind from brute animals, what was there naturally to separate the ruling classes from the masses?

All three issues feed into one of the defining questions of social, cultural, and intellectual history: secularisation. Although some scholars have argued that British society was not 'secular' before the inter-war period or even before the cultural revolution of the 1960s, many others have identified the commencement of that process in the nineteenth-century conflict between science and religion.⁸ So, did science liberate itself from the strictures of religious conformity? Did science evolve from the leisurely pursuit of moneyed amateurs into a regimented profession? Did scientific evidence at last surpass the scripture as the ultimate font of knowledge? And if so, when? This book suggests that several key moments in 1881–82 may symbolise religion's concession of supremacy: the near-simultaneous foundations of Richard Owen's Natural History Museum and of Thomas Huxley's Normal School of Science; the re-election as MP for Northampton of the atheist Charles Bradlaugh in defiance of the religious requirements of the House of Commons; and the interment in

Westminster Abbey of Charles Darwin, the author of the devil's gospel. This is not to say that most Britons had become atheist or even agnostic, nor does it suggest that science had 'defeated' religion. Rather, it was now clear that, regardless of private feeling, Christianity no longer commanded the public sphere; conversely, by offering secular explanations of natural processes that eliminated divine agency as a consequential force, science had claimed an intellectual authority that it would never relinquish. As one historian has put it, Britons of the late nineteenth century now lived in 'a new[ly] secularized civil polity'.⁹

The aim of this book is to explain how and why these changes had occurred, and how the discovery of dinosaurs and the development of geology and palaeontology were essential to these developments. It is not, therefore, a straightforward history of 'science' or 'religion', if either can be described in such monolithic terms; instead, I have tried to write a history of the interaction between science and religion within the wider context of society. And while the scholarly and popular literatures on these subjects are vast, this is I think the first history of the whole century to bring together the biographies of the leading figures of Victorian science, the social and intellectual contexts in which they lived, and the essential role that the discovery of dinosaurs played in transforming the way that people thought about the world. It is also primarily – despite detours to France, Germany, and especially the United States in later chapters – a history of Britain. This is not just because the pioneers of palaeontology were British or because the most influential scientific theorists of the day were British too; it is also a reflection of the simple fact that, at the Victorian height of British power, British opinion often mattered more.

The term 'war', which appears in this book's subtitle, may require explanation. Although the idea of a conflict between science and religion has been popular since the 1870s, tinged with an anti-Catholicism that harked back to the persecution of Galileo, historians have long sought to present a more nuanced assessment of the subject, with one recent volume regretting this 'conflict thesis' as an idea that will not 'die'.¹⁰ Perhaps this is fair comment: just as the eighteenth-century divine William Paley had presented 'natural theology' as a means of unveiling God's wisdom through the study of nature, it was possible

even after the florescence of Darwinian theory for science and religion to cohabit.¹¹ Even so, the sincere Christianity of some scientists and the scientific inquiries of some clergymen did not preclude tension between religious belief and scientific evidence; indeed, the very process of reconciling one to the other presupposes an inherent conflict. Moreover, as these pages will show, latent tension flared repeatedly into open hostility. Scriptural geologists denounced the heresies of colleagues who doubted the biblical age of the Earth; radical secularists condemned all priestcraft as delusion and bigotry; Huxley prosecuted his 'gorilla war' against the conservative Richard Owen before becoming 'Darwin's bulldog'; and by campaigning for scientific freedom from religious interference, the nine men of the X Club were self-appointed generals in a battle against the old order.¹² Science and religion were not implacable enemies, but the nineteenth century still played host to a culture war between the guardians of orthodoxy and the agents of change; there was conflict enough.

Prologue:

The House of Ussher

The World, which his hand made, is aged: but of what age,
who can justly tell? The Sacred Writ is the best Register:
Therein its Age possibly may be found.¹

William Greenhill, 9 June 1658

A twentieth-century generation of Mankind . . . would have revolted . . . against any seriously intended suggestion that a six-thousand-years' plan was being imposed on them by a dictatorial Deity. The grotesque precision with which the term of this alleged sentence of penal servitude on Mankind had been dated by the pedantry of an archbishop, who had constituted himself the self-appointed clerk of God's court, would have been the last straw on a twentieth-century camel's back if this human beast of burden had any longer taken Ussher's calculations seriously.²

Arnold J. Toynbee, *A Study of History* (1954)

Frail and cold, sitting on his horse in the winds of the Welsh autumn, James Ussher, the elderly Archbishop of Armagh, rode slowly along the rough, wet paths that led west into the Vale of Glamorgan. He had been safe in Cardiff, under the roof that he had shared with 'many persons of good Quality' and even, briefly, with the king himself.³ It was September 1645 and civil war had engulfed the British Isles.

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Earlier that summer, Parliament's New Model Army had inflicted a shattering defeat on Charles I at Naseby, and the royalist campaign was in disarray: 'All the foot [officers and soldiers]', recorded one royal aide, 'remained prisoners'.⁴ Since that fateful day, the king had ridden more than 1,200 miles across Britain, trying desperately to rally troops to his banner, but this errand had failed in south Wales. The so-called Peaceable Army, representing Welshmen who were 'much insulted and harassed by the rapacious insolence' of Charles's officers, would not bow to royal authority.⁵ By August, local support for the king had collapsed. So, when Charles decided to leave Cardiff for the north, taking the castle's garrison with him, Archbishop Ussher had been forced to seek sanctuary elsewhere.⁶

At first he considered going abroad but, with Parliament's navy patrolling the coastline, preventing escape by sea, Ussher looked instead to St Donat's Castle, the ancestral home of the royalist Stradling family. Gathering his possessions, including reams of scholarly material, he set out in the company of his daughter and 'other Ladies' who required shelter. The way was far from clear. As many as 10,000 rebels were thought to be roaming the Welsh countryside and, in seeking to avoid their attention, Ussher and his companions would move carefully 'by some private ways near the Mountains'.⁷ It would not keep them safe. In a place where 'it was Crime enough that they were English', or simply not Welsh, they came upon a 'Party that were scouting thereabouts'. Seized and delivered up to the main body of bandits, Ussher and his daughter were 'barbarously used' and 'treated with great cruelty'.⁸ Thrown from their horses, they watched as their captors plundered their baggage, ransacking Ussher's chests of books. In an instant, they dispersed his papers 'into too many hands to be retrieved'.⁹

There is no record of how Ussher and his daughter recovered from this distress, but in time they reached St Donat's, where the archbishop began to grieve: a friend remarked that he never saw him 'so much troubled in my life'. In conversation with his daughter, Ussher saw 'God's hand' in events and regarded himself as the victim of divine displeasure: 'I am touched in a very tender place', he lamented, for 'He has thought fit to take from me at once all that I have been gathering together, above these twenty years, and which I intended to publish for the advancement of Learning, and the good of the

Church'.¹⁰ This was the cause of Ussher's pain: not the crisis of royal power, nor being thrown from his horse, but the loss of his books and papers. Yet when local grandees rallied around to restore much of Ussher's library, donating precious volumes from their own collections, they allowed him to resume the work of a lifetime: a chronology of the Earth from the moment of Creation.

Study had consumed James Ussher ever since his childhood in Dublin in the 1580s. Taught to read and write by two blind aunts who had learned 'much of the Bible by heart', he was among the first students to enrol at the city's new Trinity College, which had been founded as a finishing school for aspiring Protestant churchmen.¹¹ After graduating as the star of his class aged only sixteen, Ussher rose quickly in both academic and clerical circles, even forsaking his inheritance to avoid the distractions of running the family estate. Appointed professor of divinity at Dublin in 1607, he entered the senior ranks of the Church of Ireland when he became Bishop of Meath in 1620. Five years later, having curried the favour of King James I by preaching zealously against Catholicism – he had long thought that Rome was 'the principall seat of Antichrist' – Ussher secured the highest office in the Irish Church, the archbishopric of Armagh.¹²

All the while, he pursued his interests in chronology, in early Celtic Christianity, and the founding fathers of the Church. This was often at the expense of Ussher's episcopal duties: as one contemporary put it, he had 'too gentle a soul for the rough work of reforming' and was 'not made for the governing part of his Function'.¹³ Nor was Ussher much interested in society. 'It is a sad thing', he once lamented, 'to be forced to put one's foot under another's Table, and . . . to be obliged to bear their follies'.¹⁴ A man 'indifferent tall and well shaped', whose once-brown hair escaped in grey wisps from his clerical skullcap, Ussher preferred to eat 'wholesome Meat without Sauce', to avoid sitting 'long at Table', and to relax only by walking alone on riverbanks.¹⁵ He therefore lived in a large measure 'the life of a recluse, his vision . . . bounded by the walls of his splendid library'.¹⁶

As Ussher developed his 'rich magazine of solid learning', he became a prominent figure in the network of theologians, antiquarians, and philosophers who populated the European republic of letters.¹⁷

Friendly relations with bibliophiles in France, the Low Countries, and the patchwork quilts of the German and Italian states meant that, if Ussher ever needed a copy of a rare book, he usually got it. There was no doubt of Ussher's renown, and Cardinal Richelieu, the *éminence grise* at the court of Louis XIII, was a noted admirer; the Frenchman sent a gold medal and his compliments in 'a very respectful letter' to Ussher, who in reply presented Richelieu with a gift of several Irish greyhounds 'and other rarities of the country'.¹⁸

In 1641, having spent forty years flitting between his archdiocese and English libraries, Ussher was in London when rebellion convulsed Ireland. His properties did not escape the fury of the insurgents: 'In a very few days', reported one of his colleagues, they 'plundered his houses in the country, seized on his rents, quite ruined or destroyed his tenements, killed or drove away his numerous flocks and herds of cattle . . . and left him [nothing] but his library and some furniture'.¹⁹ Even the survival of the library was a close-run thing, for Ussher's steward reported that the rebels 'made no question of devouring us' and 'talked much of . . . burning [the library] and me by the flame of books'.²⁰ Thus was the archbishop stranded in London as tensions rose between Charles I and Parliament, and though he shared many Calvinist beliefs with parliamentary leaders, his sympathies lay with the king: 'he made it his business,' recalled one colleague, 'as well by preaching as writing, to exhort [MPs] to Loyalty, and Obedience to their Prince'. When war broke out in 1642, Ussher left London for the royalist stronghold of Oxford, where in the aftermath of the Battle of Edgehill he preached against the 'Rebellious Proceedings' in the presence of the king himself.²¹ He stayed there for the best part of three years, burying himself in his work, but when rumours spread of a parliamentary assault on the city, he found himself moving further west, first to Cardiff and then – as we have seen – to St Donat's Castle.

As Ussher convalesced under the Stradlings' roof, the royalist plight grew 'every day more desperate'. If Wales fell, where else could Ussher go? Once again, he toyed with going 'beyond the Seas'. He even procured the early-modern equivalent of a passport, but this document held no sway with Richard Moulton, the roundhead admiral who commanded the Bristol Channel. Asked by Ussher's allies whether the archbishop could depart, Moulton 'returned a rude and threatening

answer, absolutely refusing'.²² It was only the charity of the Countess of Peterborough that rescued Ussher and, late in 1646, he travelled to London to lodge with her near Charing Cross. Safe in the capital, Ussher resumed work on his chronology, breaking only to preach at Lincoln's Inn and occasionally to the king, who by now was a prisoner of Parliament.

The one great event which punctuated this twilight life of study and prayer was the execution of Charles I in January 1649. Standing on the leaden roof of Lady Peterborough's house, Ussher could see down Whitehall to the scaffold outside Banqueting House. As Charles spoke his last words, the archbishop 'stood still and said nothing but sighed, lifting up his hands and eyes (full of tears) towards Heaven'. When the time came for the king to remove his cloak and doublet, and as 'the villains in vizards' pulled up his hair to clear a path for the executioner's blade, Ussher could not bear to watch. Possessed by grief and horror, he grew pale and fainted. Carried down to his bedroom, he spent the rest of the day in tearful contemplation; he would fast on the anniversary of Charles's death 'so long as he lived'.²³

By 1650 James Ussher was sixty-nine and in failing health. Having lost many of his teeth and no longer able to speak in public, he had retired from preaching. Increasingly short of sight as well, he now spent his days chasing the sunlight from east to west, from window to window, that he still might read. Despite these infirmities, Ussher at last realised more than five decades of ambition when, at several presses around London, the publisher James Flesher printed the first volume of his chronology, *Annales Veteris Testamenti*. By 1654, when the second volume arrived, Ussher had produced almost 2,000 pages of densely written, exhaustively researched history, all in Latin.²⁴ The central conclusion of this chronology, which had used the biblical record to reach back to the moment of Creation, would have profound influence on the human understanding of the Earth – and life on Earth – for more than 200 years.

Readers of the twenty-first century might scoff at 'chronology', at the very idea that analysing the Bible could reveal hidden, precise truths about the history of the Earth. Yet in the early modern period, in a world where God's hand was thought to be the key force in

driving human events, chronology represented a sincere and sophisticated attempt to understand the history of mankind and the Lord's own works. As one historian has explained, 'If world history was to be related to a divinely ordered plan, it was essential to begin by establishing the order of events, even in the remotest ages.'²⁵ Numerous scholars had already tried to do this. As early as the second century AD, Theophilus of Antioch had argued that the world had existed for 5,698 years; the Spanish orientalist Benito Arias Montano had suggested that Genesis began in 4084 BC; and the Cambridgeshire parson John Swan believed that 3,997 years had elapsed between Creation and Christ. By far the most revered chronologist was Joseph Justus Scaliger, the French Calvinist who had posited 3950 BC as the date of Creation within a framework of time that he called the Julian Period. But in terms of influence and longevity, Ussher would outdo them all.

Although he had begun his investigations at a young age, getting as far as the Books of Kings by the age of fifteen, it was only when Ussher ascended to the episcopacy (and its revenues) that he commenced his great work in earnest, and he did so by collecting materials from across Europe and the Near East. He 'looked particularly for assistance in his Biblical researches' to the chaplain of the Levant Company in Aleppo, who obliged by procuring precious copies of the Syriac Old Testament and – better still – a copy of the recently discovered Samaritan Pentateuch.²⁶ One linguist in Berlin was paid an annual retainer of £24 (some £7,000 in today's money) to source more than 300 manuscripts; from John Bainbridge, the Savilian professor of astronomy at Oxford, he acquired evidence on ancient astronomical cycles; and in his pursuit of biblical knowledge Ussher even deigned to use Catholic sources, seeking out a copy of a chronology issued at Rome.²⁷ Inevitably, 'his expences were much in Books'.²⁸

Understanding Ussher's chronology demands working backwards in time. And though the most recent event that he describes is the destruction of the Temple at Jerusalem in AD 70, the first truly significant date is 4 BC, the birth of Christ. Of course, identifying any year 'BC' as the date of the Nativity appears paradoxical, but this was the obvious choice for two reasons. First, the 'Anno Domini' dating system assumed that Christ was born during the twenty-eighth year of the reign of Caesar Augustus, but even if Augustus was technically

proclaimed emperor in 27 BC (which would have given a Nativity of AD 1), he had really reigned since the Battle of Actium in 31 BC, meaning that Christ had been born in 4 BC. The second reason was Matthew 2:1, which states that ‘Jesus was born in Bethlehem in Judea, during the time of King Herod’. Yet if Christ was born in AD 1, Matthew 2:1 could not have been correct, since Herod was known to have died no later than 4 BC. By deciding on the earlier date, Ussher sought to settle the matter.²⁹

Attaching the Nativity to a precise date, however, was a simple task when compared to reconstructing the period between 4 BC and – moving backwards – the end of the Old Testament, which had concluded in historical terms with the books of Ezra, Nehemiah, and Esther in the fifth century BC. Where the Bible was silent, Ussher called upon ancient and classical history, and more than three-quarters of his chronology concerns the intertwined histories of the Greeks, Romans, Persians, and Babylonians. It was only by pegging certain events to certain dates, such as Alexander the Great’s victory at Gaugamela in 331 BC, that Ussher inched his way backwards into the ‘historical’ Old Testament. He established the death of Nebuchadnezzar the Great, who had carried into exile all Jerusalem, at 563 BC; after this, he fixed the accession of Nabonassar in Babylon to 747 BC. Making further progress towards Creation required sifting through the morass of regencies, interregna, and overlapping reigns which characterised the history of the kingdom of Judah. Ussher also had to bear in mind several remarkable events such as Joshua commanding the sun to stand still over Gibeon, and Hezekiah turning back the sundial of King Ahaz, both of which affected the progress of time and therefore his calculations.³⁰

Ussher emerged at length into the genealogies of the Old Testament, into those dreary verses where the patriarchs ‘begat’ each other. Although he departed from Scaliger on exactly when – and to which mother – Abraham was born, and though he ignored some discrepancies between versions of the Torah, these genealogies constituted the final stretch of his chronology. With the Bible giving the age of each patriarch at the birth of his first son, it required only simple addition to reach back, past the Flood and the Exodus in Egypt, to the birth of Adam and the week of Creation.³¹ And in which year did Ussher find

himself? 4004 BC. Rather conveniently, this allowed him to reconcile his chronology with an established Christian belief that there had been 2,000 years of ‘nature’ and 2,000 years of ‘law’ under the Torah before the birth of Christ. Even more precisely, Ussher held that ‘the beginning of time . . . fell upon the entrance of the night preceding the twenty third day of October in the year [4004 BC]’.³²

But why the night of 22–23 October? First, Ussher assumed that Creation had occurred on a Sunday, given that Saturday was the Jewish Sabbath on which the Lord would have rested. Why the autumn? Well, the Jewish New Year is determined by the autumnal equinox, and this led Ussher – guided by astronomical calendars – to the night of 21–22 September. And the jump to 22–23 October? This was because of a discrepancy between the Julian and Gregorian calendars. In the former, every year divisible by 100 had been a leap year; in the latter, it is only where such years are also divisible by 400 (that is, 400, 800, 1,200, and so on) that an extra day is added to the year, which we still do on 29 February. This meant that between the beginning of time and the adoption of the Gregorian calendar in 1582, there had been roughly thirty ‘too many’ days, and so the archbishop needed to move the date of Creation by a month. And this was why, according to Ussher, the world began on the night of 22–23 October in 4004 BC.³³

When Ussher died in 1656, succumbing to pleurisy, London mourned. The clergymen of the city escorted his hearse from Somerset House to Westminster Abbey, where they interred the archbishop in the chapel of St Erasmus. Despite political differences with the deceased, Oliver Cromwell contributed £200 to Ussher’s burial. As Cardinal Mazarin and the King of Denmark fought over the remains of his Irish library, which at one stage had consisted of ‘10,000 Volumes, Prints, and Manuscripts’, Ussher and his chronology only grew in stature.³⁴ When writers of the 1690s dared to dissent from its conclusions, one clergyman roared back in defence of ‘that great ornament of his Age, See and Country, the incomparable Arch-Bishop Usher’ [*sic*].³⁵ By the 1770s, Samuel Johnson would tell James Boswell that Ussher was ‘the great luminary of the Irish church; and a greater . . . no church could boast of, at least in modern times’.³⁶ His chronology influenced great historians too: for Edward Gibbon, ‘the Annals of Ussher distinguished the

connection of events, and engraved the multitude of names and dates, in a clear and indelible series'.³⁷

But why did Ussher's chronology – and not the work of, say, the French genius Scaliger – dictate the assumptions of so many people? It was not down to language, since both men wrote in Latin. Nor was there any sectarian motive, since Scaliger too was Protestant. Rather, it seems that Ussher's predominance is owed to John Fell, who as Bishop of Oxford in the 1670s proposed 'an Edition of the H. Scriptures . . . to which will be added . . . Chronological observations'.³⁸ The first such Bible appeared in 1679 and the fashion for biblical dates took root. When Ussher's dates were added to a new version of the King James Bible in 1701, 'the idea that the world was created roughly 4,000 years before Christ became fixed in popular consciousness in the English-speaking world'.³⁹ Generation after generation of Protestants would now open their Bibles and see the date of 4004 BC beside the first verse of Genesis, and 'for more than a century thereafter it was considered heretical to assume more than 6,000 years for the formation of the earth'.⁴⁰

Of course, this is not to say that Ussher's theory prevailed universally, or that other scholars did not contemplate a longer history of the Earth. As long ago as the eleventh century, one Chinese philosopher had suggested 'that geological and astronomical evidence pointed to an immensely long history of the world'.⁴¹ Moreover, as Enlightenment naturalists began to examine the world around them, and especially the ground beneath their feet, the notion developed – albeit within limited intellectual circles – that the six 'days' of Creation could have been metaphorical. Upon examining the Alpine landscape in the 1770s, the Genevan scholar Horace Bénédict de Saussure assumed that major changes in the Earth's structure had occupied 'a long succession of ages'; and by assessing how long it took for molten balls of lead to cool and harden, the French naturalist the Comte de Buffon estimated that the Earth had formed almost 75,000 years ago.⁴² The Scottish traveller Patrick Brydone meanwhile related the embarrassment of a Sicilian bishop who realised that Etna's lava was truly ancient: 'Moses hangs like a dead weight upon him,' he wrote, 'and blunts his zeal for inquiry . . . he has not the conscience to make his mountain so young as that prophet makes the world'.⁴³

Most importantly, at least for what became the science of geology, James Hutton would formulate a theory that the earliest ages of the Earth could be explained only by reference to geological processes that were *ongoing*. A Scotsman who had abandoned careers in both law and medicine, Hutton had studied in Edinburgh, Paris, and Leiden before making a fortune through the manufacture of ammonium chloride. Using this wealth to purchase extensive farmland, he took a close interest in the earth underlying his crops. Living off the rentals yielded by his estates, Hutton spent decades – often in the company of great Enlightenment figures such as Adam Smith and James Watt – discussing and exploring the Earth and its composition.⁴⁴ He rode through England, Wales, and much of Scotland, lamenting of his enthusiasms: ‘Lord pity the arse that’s clagged to a head that will hunt stones.’ One critical excursion took place in 1785 in the Cairngorms, where he found ‘branching veins of granite’ piercing deep into layers of another metamorphic rock known as schist; it was a phenomenon that he could explain only if the granite were much younger than the schist. Three years later, at Siccar Point north of Berwick, he found sandstone lying horizontally across vertical strata of schist, an ‘unconformity’ that, in his view, suggested that the churning force of the ocean had been forming, folding, raising up, and setting down these layers of rock over an immeasurably long period of time.⁴⁵

In a paper before the Royal Society of Edinburgh, Hutton proposed that ‘the land on which we rest is not simple and original, but . . . a composition, and had been formed by the operation of second[ary] causes’ other than the Creation and the Deluge.⁴⁶ When his theory appeared in print, he claimed that the natural history of the Earth even evinced ‘a succession of worlds’. More distressing still for scriptural literalists, Hutton stated that examining ‘the system of nature’ led directly to this conclusion about the age of the Earth: ‘We find no vestige of a beginning, no prospect of an end.’⁴⁷ It was a daring rebuke of biblical chronology and of the belief that only divine agency had shaped the physical world. Yet if this concept of what has been called ‘deep time’ shocked the readers of the 1790s, and even if it contradicted James Ussher’s calculations, it would pale in comparison to a series of astounding discoveries which began, in 1811, with two teenagers finding something strange in a beachside cliff on the south coast of England.⁴⁸

PART ONE

Giants in the Earth

DRAMATIS PERSONAE

Mary Anning, fossil-hunter, Lyme Regis
Henry De la Beche, geologist, Lyme Regis and Jamaica
William Buckland, clergyman and geologist, Oxford
William Conybeare, clergyman and geologist, Bristol
Georges Cuvier, naturalist, Paris
Charles Lyell, lawyer and geologist, London
Gideon Mantell, surgeon and geologist, Lewes
Roderick Murchison, soldier and geologist, London

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I

Shells by the Shore

The remarkable situation of the town, the principal street almost hurrying into the water, the walk to the Cobb, skirting around the pleasant little bay, which, in the Season, is animated with bathing machines and company, [and] the Cobb itself, its old wonders and improvements, with the very beautiful line of cliffs stretching out to the east of the town, are what the stranger's eye will seek; and a very strange stranger it must be, who does not see charms in the immediate environs of Lyme, to make him wish to know it better.¹

Jane Austen, *Persuasion* (1817)

There were many good reasons to visit Lyme Regis. The small Dorset town, which lay some twenty miles to the west of Weymouth, had a storied history: patronised by Edward I in the 1280s, it had sent ships to defeat the Spanish Armada and, almost a hundred years later, it was where the Earl of Monmouth landed his troops during the ill-starred rebellion against James II. There was the seaside too, and when the doctor Richard Russell popularised saltwater as a cure 'for the affections of the glands' in the 1750s, 'a residence at Lyme [was] rendered highly favourable . . . to invalids who require to bathe'.² There was also the Cobb, the medieval harbour wall of boulders and pebbles which curled an arm around the town: 'There is not any one like it in the world,' declared one observer, 'for no stone that lies there was ever touched with a tool'.³ But Lyme's real treasure lay in the grey-blue cliffs that rose up around it. Deep within that stone, and shaken loose onto the beach by storms and landslides, was one of the

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richest collections of fossils in the world. Every summer – then, as now – Lyme played host to ‘a race of perambulators that, swallow-like, set out [to] ramble along the shore’, to sift through the sand and the rocks of the coastline, and to collect ‘specimens of sea-weed and shells’.⁴ In hosting these seasonal ‘fossilists’, as fossil-hunters were called, Lyme stole a march on its neighbour Charmouth, which, as ‘a very genteel village, inhabited by persons of small fortunes . . . would not condescend to . . . take in boarders’.⁵

For the people who lived the year round in Lyme, many of them working in mills on the River Lym, finding fossils and selling them to wealthy visitors was a vital means of boosting meagre wages. They hawked the ancient shells of ammonite molluscs, which they promised would cure blindness and impotence; the remains of the long, pointed squids known as belemnites were thought to confer similar benefits on horses. Besides these precious fossils, they sold fragments of ancient ‘crocodile’ backbones as ‘verteberries’, and romanticised other shells as ‘John Dory’s fingers’ after the sailor of folklore.⁶ As this cottage industry bloomed, visiting collectors learned which locals to trust. The Irish doctor James Johnson advised one friend to call upon ‘a confounded rogue’ by the name of Lock and to buy him ‘a Grog or Pint’, a gesture of friendship that Lock would reward with first choice of ‘all the crocodiles he may meet with’.⁷ It was good advice: Lock’s ability to divine curiosities had earned him the nickname ‘Captain Cury’.

Johnson also recommended ‘a person who collects for sale by the name of Anning, a cabinet maker’, who enjoyed an equally solid reputation.⁸ This was Richard Anning, a bearded giant of a man who had moved to Lyme from the nearby village of Colyton, and who lived with his wife Molly and their children in a terraced house on Bridge Street beside Lyme’s jailhouse. Theirs was not an easy life. Besides the want, disease, and deprivation which blighted the lives of most British workers, Richard, as a self-employed artisan, was vulnerable to the caprices of his clients. In 1805, he lost the business of an especially notable customer when Jane Austen, who was seeking to repair a broken box in her holiday home, scorned his quote of five shillings as ‘beyond the value of all the furniture in the room together’.⁹ Life was precarious in other ways. Living on the river, close to the seafront, the

Annings woke one morning to find that the ground floor of their home had been ‘washed away . . . [by] an exceptionally rough sea’.¹⁰ Tragedy touched the family too: in December 1798, the four-year-old Mary had been ‘left by the mother for about five minutes . . . in a room where there were some [wood] shavings’ and an open fire. In a scene of horror, ‘the girl’s clothes caught fire and she was so dreadfully burnt as to cause her death’.¹¹

Always hopeful that fresh finds among the rocks might keep his family in bread, Richard Anning continued to hunt for fossils along Lyme’s beachfront, often taking his son Joseph and another daughter, also called Mary, on his missions. It was a matter of luck that *this* Mary Anning had lived long enough to join her father in the hunt. In the summer of 1800, when only fourteen months of age, she had been taken by her nurse to a field outside Lyme to see a performance by a travelling band of horsemen. Having given ‘an extraordinary display of vaulting’ on the previous evening, the equestrians had attracted a sizeable crowd. But as the people of Lyme gathered in the late afternoon the weather became ‘intensely hot and sultry’ and, just before five o’clock, a storm rolled in.¹² According to one eyewitness, ‘it thundered and lightnined [*sic*] at such a degree as not remembered by the oldest person then in the town, also accompanied [*sic*] with heavy rain’. While some spectators fled home, others kept dry under the lincays where the cattle slept; others still ‘sought shelter under cover of some lofty elms’, and Mary’s nurse was among them. It was a fatal mistake. One historian records that after ‘a vivid discharge of electric fluid’ a cry went up, and three people lay motionless under the elms. All three were dead, including the nurse: her husband recalled that ‘on the right side my wifes [*sic*] hair cap and handkerchief [were] much burnt and the flesh wounded’.¹³ Mary was thought to have perished as well, but when taken home and dunked in a warm bath, she revived. The local doctor proclaimed the miracle of her resurrection to an anxious crowd and, from this moment, a legend took root: supposedly ‘a very dull girl’ before the lightning strike, Mary ‘now grew up lively and intelligent’.¹⁴

Although Richard Anning’s wife was ‘wont to ridicule’ his beachfront excursions, not least when he risked social censure by setting out on Sundays, there was a steady turnover of fossils: ‘If [he] found

anything worth purchasing, it was usually exposed in front of his shop . . . on a little table.¹⁵ Molly Anning might also have worried for her family's safety, for hunting fossils was a dangerous business. The seafront at Lyme was prey to the cold, quick tide of the Channel; moreover, because the best material was wrested from the rocks by stormy weather, fossiling meant standing beneath an unstable cliff-face. The Swiss naturalist Jean-André Deluc, who visited Lyme frequently in the 1800s, narrated one of Anning's close escapes: 'One day,' he recorded, 'as he was walking along [a] path [on a cliff-top], he felt the ground give way under him, and at the same time he saw a section of the part which still remained firm, rising, as it were, above his level . . . He threw himself with a spring on the upper ground, and ran immediately back towards the town.'¹⁶ But Richard Anning's luck did not hold.

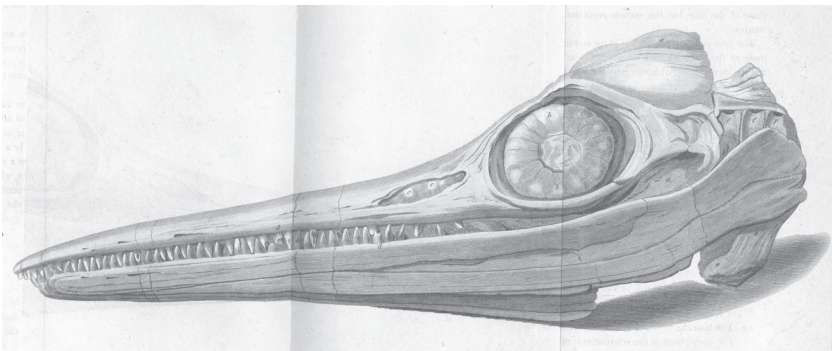
On a winter's night in 1809, having arranged to sell his recent discoveries to the patrons of the Pilot Boat Inn at Charmouth, Anning was walking over the Black Ven cliff when he 'diverged from the path in a field on the summit of the hill'.¹⁷ The sources do not record whether Anning was the worse for drink or if he simply could not see under dark skies, but he lost his footing and plunged onto the rocks below. It was a measure of Anning's strength that, despite being knocked out and seriously hurting his back, he picked himself up and returned to Lyme on foot, taking to bed with only a hot water bottle. But this fall from Black Ven had broken him. Over the next twelve months, Anning fell prone to violent coughing fits; when he started spitting blood, it was clear that he was too weak to fight the consumptive disease that was endemic at the time. He died in November 1810, leaving debts of £120 (some £10,000 today) and a family who soon relied upon parish relief for survival. While Joseph found an apprenticeship in upholstery, eleven-year-old Mary was left to her own devices because 'her mother, being in great distress, did not attend to her'. Lost and alone, Mary took solace in Lyme's beaches, 'wander[ing] along the seashore' until she 'picked up a fossil' for which a passing lady gave her half a crown.¹⁸ This was not much, about £10 in today's money, but for a family living close to destitution it was enough. Mary and her brother would keep hunting for fossils.

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In 1811, Joseph Anning found the most magnificent ‘cury’ on the beach between Lyme and Charmouth. Buried two feet deep in the sand, it had clearly fallen from the cliff-face and it was, he thought, the fossilised skull of a crocodile. This was a reasonable assumption. After all, bits and pieces of crocodiles had long been found on the Dorset coast, but this specimen was different. It was much longer than usual and it was terrifying: from a deep, powerful skull with cavernous eye-sockets, a long, curved snout extended some four feet in length, hosting close to a hundred sharp, conical teeth. It was extraordinary, but where was the rest of it? Before returning to work, Joseph took his young sister, the twelve-year-old Mary, to the spot where he made the discovery and charged her with tracking down the rest of the skeleton. It would take almost a year, but Mary Anning would find the larger part of the creature. Disinterring the fossil, however, was another matter, for while the skull had fallen to the beach, the body was lodged in the rocks above the strand; its removal would require the labour of three strong men and a great deal of care.

Today, when palaeontologists find something in the field, they use a meticulous procedure that has been refined ever since its development in the late nineteenth century. First, they strengthen exposed bones with a varnish to prevent them from shattering; next, they use hammers and chisels to dig a trench both around and then underneath the fossil, which sits like a mushroom on a pedestal of rock. After this, they apply a jacket of plaster and hessian cloth to the top of the



The skull of the marine reptile, discovered by the Annings in 1811–12, that Everard Home would christen the ‘*Proteosaurus*’

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mushroom, which is flipped over so they can repeat the process on the underside. The palaeontologists then move this ‘fossil jacket’ to their laboratory, where they whittle away the rock that surrounds the bones using fine drills and brushes, at last releasing the fossils.¹⁹ The Annings, of course, had none of these methods, nor modern equipment. Instead, they carved out the bones as best they could: where the rock was soft, they could lift them out individually; where it was hard, they chiselled out larger slabs and lugged them home along the beach. Either way, reassembling these ancient skeletons was a laborious, complicated affair.

News of the beast which emerged from the Dorset limestone spread quickly. On Thursday, 12 November 1812, the *Bath Chronicle* reported that ‘the complete petrification of a crocodile, 17 feet in length’ had been wrested from the cliffs.²⁰ Over the following weekend, the *Statesman*, the *General Evening Post*, and *Bell’s Weekly Messenger* reprinted the same report in London.²¹ By the next year, news of the Annings’ discovery had reached even the *Madras Courier* in India.²² It also caught the attention of Henry Hoste Henley, the proprietor of Colway Manor near Lyme – and of Sandringham House in Norfolk – who paid £23, almost £2,000 today, for the fossilised skeleton; it was a finders’ fee that would let the Annings eat well for months.

Buying the ‘Lyme crocodile’ did not mean that Hoste Henley would take possession of it. Rather, the privilege of presenting the specimen to the world belonged to William Bullock, the proprietor of the Egyptian Hall museum at Piccadilly. As London’s learned men came to inspect the creature, there was one burning question: just what *was* it? At the December 1814 meeting of the zoological Linnean Society, James Johnson – who had once recommended the services of Richard Anning – argued that the ‘crocodile’ was no such thing: ‘The bones in question’, he declared, were in fact ‘the bones of a new and unknown species of amphibious animal’.²³ Over the course of four papers before the Royal Society, the most prestigious scientific institution in the English-speaking world, Sir Everard Home went further. The dominant figure at the Royal College of Surgeons and George III’s personal physician, Home agreed that the Lyme creature was no crocodile: the spine and the teeth were too distinct. Nor was ‘this very extraordinary

animal' a fish or whale, since neither the ribs nor the shoulder blades conformed to type.²⁴ Instead, Home came to the conclusion that 'among the animals destroyed by the catastrophes of some remote antiquity [that is, the Flood], there had been some at least that differ so intirely [*sic*] in their structure from any which now exist, as to make it impossible to arrange their fossil remains with any known class of animals'.²⁵ Deciding that the creature most closely resembled the small, cave-dwelling salamander known as the proteus, he proposed the name of *Proteosaurus*.²⁶ Joseph and Mary Anning, two destitute teenagers from Lyme Regis, had not just discovered an animal that was unknown to British science; they had discovered an animal which no longer existed.

Home's conclusion was alarming, for the very idea of extinction was thought to verge on blasphemy. According to the book of Genesis, Noah had taken seven pairs of every 'clean' animal, two pairs of every 'unclean' animal, and seven pairs of every bird onto the Ark, thereby ensuring that every land species had survived the Flood. It was also widely assumed that when 'the fountains of the great deep burst forth', marine creatures would not have been unduly affected. Most British naturalists therefore shared the view of one Irish doctor that 'no real Species of Living Creatures is so utterly extinct, as to be lost entirely out of the World, since it was first Created'.²⁷ But if the Lyme specimen belonged to an extant species that had survived the Flood, where were the rest of them? Some observers took comfort in Robert Hooke's suggestion that there could be 'divers parts of the World' or of the deep sea, 'such as have been [. . .] not yet discovered by the *Europeans*', where these creatures would be 'frequent and plentiful enough'.²⁸

Even so, the idea that proteosaurs could have survived in some remote part of the world could not explain the *depth* at which the Annings made their discovery, since they had found the Lyme creature 'about 100 feet below the surface of the earth'.²⁹ The problem here was the order of Creation laid down in Genesis: the land and the sea had come into being on the third day of Creation, yet God had created marine creatures – and Home believed that the *Proteosaurus*'s 'constant residence [was] in the water' – on the fifth day of the week.³⁰ So, if the Lyme creature had been created *after* the land, how could the

Annings have found it *beneath* one hundred feet of rock? Moreover, even if the biblical Flood had swept this particular animal over land and marooned it to die in south Dorset when the waters receded, why had it not been found on the surface of the earth? The logical inconsistency between biblical history and the new fossil record was painfully obvious, even to children. When the six-year-old Frank Rawlins was drawn to ‘a fine display of fossils’ at Lyme, he would ask his father ‘why all these creatures should have burrowed their way down so deep into the rocks until they were smothered by them’.³¹ From the perspective of the twenty-first century, the obvious solution is to disregard Genesis as an accurate account of the world’s origins. Yet for many Britons of the 1810s, this was not an option.

It may be tempting to think that the Enlightenment, that awesome intellectual movement of reason and rationalism, had discredited biblical literalism during the long eighteenth century, thus opening worlds of inquiry that were unbenighted by religious dogma. Yet except among the most radical philosophers, this did not happen. The English Enlightenment had been immersed in Christianity, with Isaac Newton declaring that the very purpose of scientific investigation was ‘to discourse of God’.³² It followed that William van Mildert, who became Bishop of Durham in the early nineteenth century, took inexhaustible pride in the fact that Newton, Francis Bacon, and Robert Boyle were ‘*Christians*: these were Believers in *Revelation*, and were not led by Philosophy only’.³³ There had also been a British counter-Enlightenment, where the forces of conservatism sought to repress and expunge the most dangerous elements of new philosophy. Infamously, the British courts had sentenced the elderly schoolmaster Peter Annet to the pillory and a fatal year of hard labour for translating Voltaire into English;³⁴ and for fear that he was a member of the Illuminati, the Bavarian society which had promoted secular egalitarianism, British conservatives had condemned the Prussian philosopher Immanuel Kant.³⁵ The world in which the Annings discovered the Lyme creature was therefore deeply religious. One historian of the period has written that ‘religious feeling and biblical terminology so permeated *all* aspects of thought . . . that it is hard to dismiss them’,³⁶

and another that ‘Protestant literalism still prevailed and Englishmen read both Old and New Testaments as a miraculously unified whole’.³⁷

Early British forays into geology encountered this fervour directly. The Dublin chemist Richard Kirwan, a noted eccentric who removed his door knocker at seven o’clock each evening to prevent the intrusion of callers, decried James Hutton’s geological theory of ‘deep time’ as contrary to ‘reason and the tenor of the Mosaic history, thus leading to an abyss’.³⁸ James Parkinson, the doctor who described the eponymous palsy, was also a celebrated geologist and his *Organic Remains of a Former World* (1804–11) was an avowedly Christian attempt ‘to find out the ways of God in forming, destroying, and reforming the Earth’. For Parkinson, the Bible provided irrefutable proof that ‘after the complete formation and peopling of this globe, it was subjected to the destructive action of an immense deluge of water’.³⁹ As for Mary Anning, one of the few volumes that she is known to have possessed as a teenager was the 1801 edition of *The Theological Magazine*, which insisted on a literal, six-day interpretation of Creation.⁴⁰

This enduring intellectual commitment to Christian values and biblical teaching pertained in British society more widely. Although the Church of England suffered badly from inept administration, meaning there were nowhere near enough ministers or churches to serve its parishioners, it claimed the nominal affiliation of almost ninety per cent of the English population, with one clergyman in Hampshire estimating that eighty-one per cent of his flock attended church at least ‘occasionally’.⁴¹ Beyond the Anglican supremacy, Dissenting Protestants – such as the Annings – constituted the most vibrant religious community in Britain: despite laws which prevented Baptists, Methodists, and other sects from graduating from the ancient universities and holding public office, Dissenting congregations more than doubled in size between 1800 and 1820.⁴²

British reading habits were deeply religious too, thanks in part to the Bristolian writer Hannah More. Living alone but in comfort thanks to annual payments from a former fiancé, More had become concerned with the publication of irreligious works in the late eighteenth century: ‘Vulgar and indecent penny books were always

common,' she explained to an ally, 'but speculative infidelity brought down to the pockets and capacity of the poor forms a new era in our history'. It was an ungodly sensation that required 'strong counteraction'.⁴³ From 1795 to 1798, therefore, More had churned out 114 *Cheap Repository Tracts* which urged Britons to embrace piety and deference: she advised readers to be more like her character Mr Johnson of Wiltshire, who was content to go about life placidly 'that he might have leisure to admire God in the works of His creation'.⁴⁴ In the first year of publication alone, the *Tracts* sold two million copies.

The French Revolution only galvanised hostility towards unbelief. Although many Britons were at first sympathetic to the enemies of the Bourbon monarchy – Edmund Burke, who railed against 'this new conquering empire of light and reason', was an isolated voice of warning – opinion hardened quickly.⁴⁵ In 1791, the 'Throne and Altar' rioters of Birmingham marked the second anniversary of the storming of the Bastille by razing several Dissenting chapels and destroying the laboratory of the radical chemist Joseph Priestley. Following France's declaration of ideological warfare upon Europe in 1792, and especially after the National Convention's execution of Louis XVI in January 1793, William Pitt's conservative administration embarked upon an extensive programme of political and intellectual repression. When, for example, the radicals Thomas Hardy, John Horne Tooke, and John Thelwall denounced the government's suspension of habeas corpus, they were tried for sedition. And when the London Corresponding Society sought to promote fraternity with its French comrades, the government put its weight behind the conservative Reeves Associations, which restricted membership to 'persons well affected to the government of these realms'. In seeking to disarm 'the wicked and senseless reformers of the present time', these Associations attained a fearsome influence. At Leeds, one loyalist claimed that 'sedition is crushed to death'; at Richmond outside London, they forced a liberal vicar into the public recantation of reformist views; in Somerset, one bookseller so feared retribution that he gave up his entire stock of seditious literature for burning by the local Association.⁴⁶

There was an explicitly religious dimension to British reaction too, for the political revolution in France had unfolded alongside the 'de-Christianisation' of the country and especially Paris.⁴⁷ As early as

October 1789, the National Constituent Assembly had seized and sold the properties of the Catholic Church, whose clergy were now answerable to the French government, not the Pope. By 1793, many French churches, whether Catholic or Protestant, had become temples of the 'Cult of Reason', a civic religion which made no room for God or Christ. The Cult of the Supreme Being, which Robespierre decreed as the state religion, might then have proclaimed belief in the divinity of nature and 'the immortality of the soul', but for many in Britain it looked like the French had lapsed into infidelity.⁴⁸ Even when Napoleon restored the Catholic Church to its privileges, British suspicion endured: the third edition of the *Encyclopaedia Britannica* fumed against French philosophy for having 'disseminated, far and wide, the seeds of Anarchy and Atheism'.⁴⁹ It followed that if France was the enemy, and if French revolutionaries were deists or atheists, 'true Britons' were bound to defend the Church and the scriptures. For the British men and women who were exploring the history of the Earth, the religious implications of their work carried serious social and political risk. How could they communicate their theories and findings without provoking the wrath of either the Church or the government? In the 1810s, nobody would feel these pressures more keenly than the Anglican minister and reader in mineralogy at the University of Oxford, William Buckland.

2

Undergroundology

He, who with the pocket hammer smites the edge
Of every luckless rock or stone that stands
Before his sight, by weather-stains disguised,
Or crusted o'er with vegetation thin,
Nature's first growth, detaching by the stroke
A chip, or splinter, – to resolve his doubts;
And, with that ready answer satisfied,
Doth to the substance give some barbarous name.¹

William Wordsworth, *The Excursion* (1814)

William Buckland, like Mary Anning, was a child of south-west England. The son of an Anglican clergyman, he was born in 1784 in Axminster, only five miles north-west of Lyme, and he spent his childhood exploring a landscape of pits and fossils, hunting ammonites with his father. He ‘could not take a stroll in the neighbouring fields’, a friend related, ‘without stumbling . . . on lias quarries’. In this way, in learning where the treasures of the earth abounded, ‘all the circumstances of his early life were calculated to impress on him that character of mind which so peculiarly qualified him’ to study geology. Wherever he went, the countryside remained his laboratory. At school at Winchester, he collected fossilised sponges from the chalk of the South Downs; later, he spoke fondly of Bristol as another ‘geological school’ where the rocks appeared to speak to him: ‘They wooed me, and caressed me, saying at every turn, “Pray, pray be a geologist!”’²

Buckland would not study geology formally, for nobody did.

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Instead, as the senior scholar for Devonshire at Corpus Christi College, Oxford – an honour secured by his uncle, who was a fellow there – Buckland studied Classics and theology, graduating in 1805 before joining the fellowship at Corpus Christi and entering the Anglican clergy. It was an easy and well-trodden path, for in the eighteenth and early nineteenth centuries Oxford, as Gibbon had famously lamented, was an incurious place, saturated in port: the master of Balliol College, John Parsons, was not alone in succumbing to ‘suppressed gout’.³ The lack of intellectual vigour was so manifest that in 1785 the university authorities had felt the need to enact a statute ‘for putting down [the] unacademical expenses’ which had served to distract ‘the younger members’ of the colleges. Henceforth, the dons forbade their students from keeping horses or dogs, and from indulging their ‘unbridled and ruinous fondness for games wherein there is a monied stake’.⁴ It was not until 1800 that Oxford introduced a common system of examination.

A few enterprising scholars were kicking against the pricks, and one of them was the London-born doctor John Kidd who, in 1803, at the age of only twenty-seven, became Oxford’s first Aldrichian professor of chemistry. Later described as a ‘sensible, homely man’ who conducted his medical rounds in unfashionable, ‘obsolete’ coats, Kidd was commissioned to deliver lectures in the ‘Medicinal and Philosophic’ aspects of chemistry; at the same time, it was implied that he should steer clear of the radicalism which had forced the Bristolian physician Thomas Beddoes from a previous chair in the subject.⁵ Kidd therefore did not seek to overturn the traditional dominance of theology, mathematics, and Classics; rather, he presented chemistry ‘in the same light as the supernumerary war-horses of Homer’s chariots, which were destined to assist, but not to regulate, the progress of their nobler fellow-coursers’.⁶ But as the author of an extensive syllabus of lectures on chemical attraction, compounds, and analysis, Kidd bridled at suggestions that Oxford science was moribund: ‘The Physical and Experimental Sciences’, he protested, ‘are not neglected in this place’.⁷ Besides chemistry, Kidd also gave voluntary lectures in mineralogy, often in the dark rooms beneath the Ashmolean Museum, and in his audience were two firm friends: the Classics student William Conybeare, and William Buckland.

Though his fellowship was tied to theology and the classics, Buckland used whatever time he could find for geological research. Confined to the British Isles by the war in Europe, he rode alone through Berkshire and Wiltshire in 1808; over the next couple of years, he inspected the granite of Dartmoor and the gravel of the Midlands. It was all good training for his horse, an old black mare who became 'so accustomed to the work that she invariably came to a full stop at a stone quarry'. Buckland also took in Lyme Regis, where the fossil-hunters attended him at breakfast. On his table were 'beefsteaks and belemnites, tea and terebratula, muffins and madrepores, toast and trilobites'; sprayed across the room were 'fossils whole and fragmentary, large and small, with rocks, earths, clays, and heaps of books and papers'.⁸

By 1814, during Napoleon's exile to Elba, Buckland and Conybeare began to consider going 'to Paris, to see Kings and Emperors, and . . . Crocodiles'. This grand tour took place in 1816, when the pair undertook 'five months of intense labour . . . in seeing every collection and professor that could be heard of'. They met Goethe at Weimar and geological pioneers at Freiburg; they descended into Hungarian gold-mines, walked through Viennese museums, and scaled extinct volcanoes in northern Italy. They revelled in this expedition as if heroes of a scientific epic: Conybeare thought of himself as Don Quixote; Buckland was dubbed 'Sir Ammon Knight'. By the time that Buckland had shipped home the fossils that took his fancy, his rooms at Corpus Christi resembled a prehistoric warehouse. An academic colleague recalled climbing a narrow staircase and entering a long, corridor-like room 'filled with rocks, skulls, and bones in dire confusion'. Buckland himself reposed 'in a sort of sanctum at the end . . . in his black gown, looking like a necromancer, sitting on one rickety chair . . . and cleaning out a fossil bone from [its] matrix'.⁹

Now in his late twenties, and often seen ranging the fields of southern England with a bright blue bag in which he stored his specimens, Buckland was the coming man. By 1813 he had succeeded John Kidd as Oxford's reader in mineralogy, and he soon ascended to membership of the Geological Society of London. Established over dinner in Covent Garden in 1807, the Society was less a vehicle for disruptive science than a club for like-minded gentlemen. It followed a 'routine of breakfasts and dinners, punch and beef-steaks', and it kept the quality of its

membership under review.¹⁰ In 1809, its secretary expressed grave concern that ‘we are thought to be going on too rapidly in the admission of members, and are not sufficiently discriminate’.¹¹ Membership of the ‘JollSoc’, as it was known, bestowed valuable social cachet.

Yet Buckland was not content. He was also poor, at least by the standards of gentlemanly science. ‘I am Lecturer in Mineralogy’, he told his father, and ‘for that I receive £100 per annum’, which is less than £7,000 in today’s money. Besides this, Buckland received a stipend from Corpus Christi and earned a little more through informal tutoring, but it was not enough. Indeed, his relative penury was a major obstacle to social advancement and, more painfully, his prospects of marriage. Buckland knew what he needed, or at least what he wanted. ‘I crave to be Lecturer in Geology’, he wrote, and ‘for that I ask £100 for my lectures’. If ever appointed to such a lectureship, Buckland figured that he would need another £100 to curate Oxford’s geological collections and for ‘exchanging specimens with foreigners of all countrys’ [*sic*]. However, at a time when fiscal retrenchment and paying down the post-war debt were the essential government policies, funding for new scientific ventures was limited. This meant that Buckland needed to apply to the Prince Regent, the future George IV, for the money.¹²

This petition entailed the kind of torturous application that has become an eternal burden of academic life. First, Buckland required the support of Oxford’s proctors, who met weekly ‘to deliberate upon all matters relating to the preservation and liberties of the University’; if they approved, they would forward the petition to the university’s chancellor, who in 1818 was the former prime minister Lord Grenville; it would then be Grenville who would plead Buckland’s case to the Treasury. Before the proctors, Buckland submitted that, by establishing lectures at Oxford, and so by bringing geology under the supervision of the ancient university, it would prevent improper inquiries from undermining biblical authority: ‘Geology is a Branch of Knowledge . . . of so much National importance’, he argued, ‘and so liable to be perverted to Purposes of a tendency dangerous to the Interests of Revealed Religion, that it is . . . a proper and desirable subject for a Course of Public Lectures in Oxford’. It was Buckland’s good fortune that Grenville agreed, writing to the current prime

minister Lord Liverpool that ‘the advantages of this particular science, as forming one essential link in the great chain of Natural History’, were evident. As for Buckland himself, Grenville vouched that he was ‘a Person who in pursuit of that Study has already done much credit to the University and to his Country’, concluding that there could not be a more deserving recipient of ‘His Royal Highness’s bounty’. Though Buckland soon complained that £200 was nowhere near enough, he had his money. Yet with his new position came one immediate obligation: the delivery of an inaugural lecture.¹³

William Buckland would deliver this lecture on geology – Oxford’s first on what some were calling ‘undergroundology’ – in May 1819 at a time of social, political, and intellectual turmoil. Luddites had been ranging across the Midlands, destroying the machinery that they blamed for job losses and lower wages; the Prince Regent had survived an attempt on his life; and the Cato Street conspirators were soon plotting the assassination of the cabinet. Worst of all, the Manchester and Salford Yeomanry would run their sabres through the massive, peaceful rally for parliamentary reform at St Peter’s Field, thereby committing the massacre of Peterloo. Lord Liverpool’s ministry responded to this distress by pursuing a legislative agenda that was no less repressive than the government’s reaction to Jacobinism in the 1790s. The Six Acts, as they were known, were among the most draconian ever placed on the statute book. Under the Seditious Meetings Act, any public meeting of more than fifty people which intended to discuss religious or political matters required the sanction of a sheriff or magistrate; the Blasphemous and Seditious Libels Act allowed the courts to sentence writers to transportation for fourteen years; and the Newspaper and Stamp Duties Act imposed heavier duties on publications that contained either news or opinion.¹⁴

One of the *causes célèbres* of this fractious period was the middle-aged London bookseller William Hone, whom the authorities charged in 1817 with seditious blasphemy over three parodies of Church and state. In *John Wilkes’s Catechism*, Hone wrote ten new commandments for the Tory regime and praised ‘Our Lord who art in Treasury’.¹⁵ In *The Sinecurist’s Creed*, he sang ‘Glory be to Old Bags [Lord Liverpool], and to Derry Down Triangle [Castlereagh]’.¹⁶ And in *The*