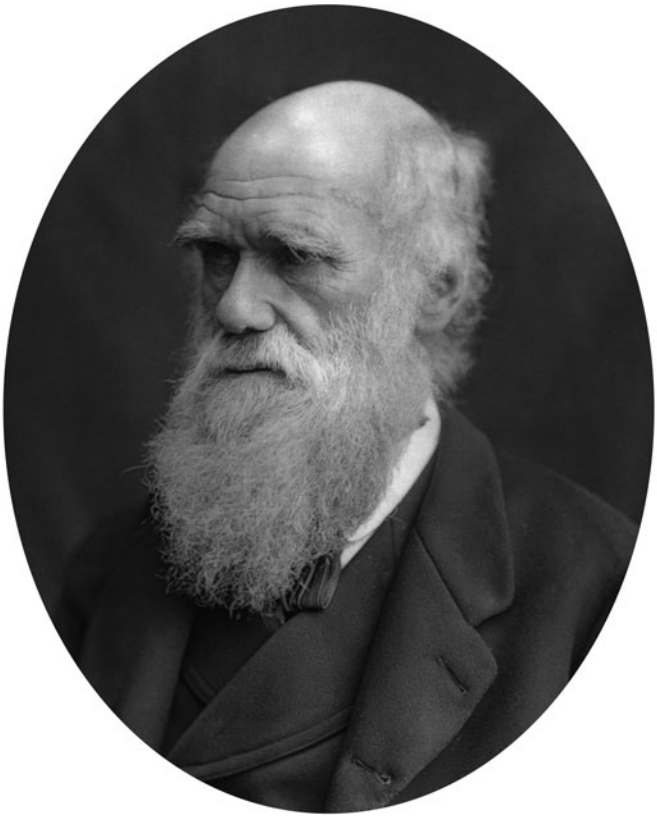
Chapter 4
Darwin and evolution

When the English naturalist Charles Darwin died at his Kent home in April 1882 at the age of 73, he was already a celebrity. Not only in Britain but around the world he was famed as the author of the theory of evolution that had transformed science and become the defining philosophy of the age. The news of his death was greeted by a campaign in the press for a funeral at Westminster Abbey. Despite lingering doubts about Darwin's religious beliefs, it was soon agreed that no other tribute would be adequate. The great and the good would gather to mark the astonishing theoretical achievements, the patience and industry of decades of research, and the dignity and modesty of this unassuming English gentleman. At the funeral, the Reverend Frederic Farrar's sermon compared Darwin's scientific genius with that of his countryman, Isaac Newton, next to whose memorial in the abbey Darwin's own final resting place would be. Farrar also explained that Darwin's theory of evolution was quite consistent with an elevated sense of the actions of the Creator in the natural world. The funeral symbolized the acceptance by the Anglican establishment of Darwin and of evolution, just over 20 years after the publication of *On the Origin of Species* in 1859.

It was a somewhat suspicious and hesitant kind of acceptance, though. Not everyone in the Church of England, nor in society at

large, was happy to 'go the whole orang' – the geologist Charles Lyell's phrase for accepting that evolution applied to humans too. Indeed, it has always been human evolution in particular, rather than the evolution of bacteria, beetles, barnacles, or bats, that has really captured the imagination and unsettled the beliefs of the wider public. Religious ideas about the elevated place of humanity in the creation, and especially about the soul and morality, were the ones most directly challenged by the evolutionary science that Darwin's career helped to establish as a new orthodoxy. Among those who have resisted Darwinism for religious reasons over the last century and a half, some have done so on the grounds of its conflict with a literal interpretation of scripture. For many others, however, their resistance has been to the theory of evolution's apparent incompatibility with belief in free will, moral responsibility, and a rational and immortal human soul.

In this chapter and the next, we will explore these and other reasons why the theory of evolution has been considered so dangerous, starting in this chapter with Darwin's religious views, the reception of his theory, and its theological implications, before moving on in Chapter 5 to the modern American controversy about teaching evolution in schools. The figure of Charles Darwin himself continues to haunt these discussions. His image adorns not only the covers of countless books on the subject of evolution but also even the British ten pound note. The most frequently used pictures of Darwin are those from his old age in which his white beard and portentous expression conjure up images of biblical prophets, perhaps even of God. The theory of evolution by natural selection has become identified with this single iconic historical individual. Darwin's own scientific and religious views are often discussed and sometimes misrepresented in polemical works about evolution and religion. It is important therefore to have a grasp of what this revolutionary scientific thinker really thought and why.



8. A photographic portrait of Charles Darwin made by Lock and Whitfield in 1878

Darwin's religious odyssey

In his early 20s, Darwin was looking forward to a career in the Church of England. He had embarked on medical training in Edinburgh a few years earlier but had found the lectures boring and the demonstrations of surgery disgusting. Now his father sent him off to Christ's College, Cambridge, where young Charles

signed up to the Thirty-Nine Articles of the Church of England and set about studying mathematics and theology with a view to entering holy orders after graduation. But Darwin found that theology appealed about as much as surgery. His real passion at this time was for beetle-hunting rather than Bible-reading, and he had an early triumph when one of the specimens he had identified appeared in print in an instalment of *Illustrations of British Entomology*. In 1831 this enthusiastic young amateur naturalist was invited to join the *HMS Beagle* as a companion to the ship's captain, Robert Fitzroy, and to undertake collections and observations on matters of natural-historical interest. Perhaps he was not, after all, destined to become the Reverend Charles Darwin.

The voyage of the *Beagle* lasted from 1831 to 1836. The primary purpose of the expedition was to complete the British Admiralty's survey of the coast of South America, but its five-year itinerary also took in Australia, New Zealand, and South Africa. Darwin's observations of rock formations, plants, animals, and indigenous peoples were incidental to the purpose of the expedition but absolutely central to his own intellectual development. On board the *Beagle*, Darwin's religious views started to evolve too. He had no doubt that the natural world was the work of God. In his notebook he recorded his impressions of the South American jungle: 'Twiners entwining twiners – tresses like hair – beautiful lepidoptera – Silence – hosannah.' To Darwin, these jungles were 'temples filled with the varied productions of the God of Nature', in which no-one could stand without 'feeling that there is more in man than the mere breath of his body'. He even admired the civilizing effects of the work of Christian missionaries too, observing that 'so excellent is the Christian faith, that the outward conduct of the believers is said most decidedly to have been improved by its doctrines'.

Back in England, however, after the voyage, Darwin would start to have doubts. His grandfather, father, and elder brother

had all rejected Christianity, adopting either Deism or outright freethinking unbelief. He seemed to be heading in a similar direction. His reasons were many. His travels had revealed to him at first hand the great variety of religious beliefs and practices around the world. All these different religions claimed to have a special revelation from God, but they could not all be right. Then there was his moral revulsion at the Christian doctrine that while the faithful would be saved, unbelievers and heathens, along with unrepentant sinners, would be consigned to an eternity of damnation. Darwin thought this was a 'damnable doctrine' and could not see how anyone could wish it to be true. This objection hit him with particular force after the death of his unbelieving father in 1848.

There were two ways in which Darwin's re-reading of the book of nature also gave him reasons to re-think his religion. He and others before him had seen in the adaptation of plants and animals to their environments evidence of the power and wisdom of God. But Darwin now thought he saw something else. Hard though it was for him to believe it himself – the human eye could still give him a shudder of incredulity – he came to think that all these adaptations came about by natural processes. Variation and natural selection could counterfeit intelligent design. Secondly, along with the silent beauty of the jungle he had also observed all sorts of cruelty and violence in nature, which he could not believe a benevolent and omnipotent God could have willed. Why, for example, would God have created the ichneumon wasp? The ichneumon lays its eggs inside a caterpillar, with the effect that when the larvae hatch they eat their host alive. Why would God create cuckoos which eject their foster siblings from the nest? Why make ants that enslave other species of ant? Why give queen bees the instinct of murderous hatred towards their daughters? 'What a book a Devil's chaplain might write', Darwin exclaimed, 'on the clumsy, wasteful, blundering low & horridly cruel works of nature!'

9. An ichneumon wasp injecting its eggs into the caterpillar that will play host to the wasp larvae and, in due course, provide their first meal

Darwin never became an atheist. At the time he wrote *On the Origin of Species* he was still a theist, although not a Christian. By the end of his life he preferred to adopt the label 'agnostic', which had been coined by his friend Thomas Huxley in 1869. Darwin, for the most part, kept his religious doubts to himself. He had many reasons to do so, not least his desire for a quiet life and social respectability. The most important reason, though, was his wife Emma. In the early years of their marriage, Emma, a pious evangelical Christian, wrote a letter to Charles of her fears about his loss of faith in Christianity and the consequences for his salvation. She could not bear the thought that his doubts would mean they were not reunited after death in heaven. The death of their beloved young daughter Annie in 1851 brought home again the need for the consolation of an afterlife. The difference between Charles and Emma on this question was a painful one. Among Darwin's papers after his death, Emma found the letter she had written to him on the subject 40 years earlier. On it her husband

had added a short note of his own: 'When I am dead, know that many times, I have kissed and cryed over this.'

The theory of evolution by natural selection

The observations made by Darwin during his *Beagle* voyage proved crucial to his later theoretical speculations. As with all scientific observations, these only made sense with reference to existing theoretical frameworks, in this case to William Paley's natural theology and Charles Lyell's geology. On his return to England, reading a work of political economy by the Reverend Thomas Malthus would provide Darwin with a further and critically important idea, which would become the linchpin of his theory.

Like all Cambridge students at the time, Darwin was well versed in the works of William Paley. An Anglican clergyman, philosopher, and theologian, Paley was one of the most popular religious writers of the 18th and 19th centuries. His 1802 book *Natural Theology, or Evidence of the Existence and Attributes of the Deity, Collected from the Appearances of Nature* compared plants and animals to a pocket watch. Any structure with many intricately crafted parts working together to achieve a specified end – telling the time in the one case, gathering pollen, flying, or seeing, in the other – must have had a designer. Just as a watch has a human watchmaker, Paley reasoned, to the satisfaction of the young Darwin and tens of thousands of other readers, so the works of nature – its flowers and its bees, its birds' wings and its human eyes – must have had a supremely powerful and intelligent designer, namely God. Unlike Thomas Paine and the Deists, who took this argument as the main basis for their religion, Paley thought that this kind of natural theology was of use largely as a supplementary argument confirming what was already known from the Bible, and from the inner voice of one's conscience. What Darwin specifically took from Paley was the tendency to

find everywhere in nature extraordinary evidence of design, of contrivance, of adaptation.

A second key component of Darwin's world view was provided by a book he read during the *Beagle* voyage, Sir Charles Lyell's *Principles of Geology*, published in three volumes between 1830 and 1833. Lyell's book argued that the history of the earth was one of gradual changes operating over long periods of time rather than one of regular violent catastrophes. His was a reformist rather than a revolutionary view of geology – time was to replace violence as the principal agent of change. Darwin came to see geological phenomena through Lyell's eyes. He witnessed an earthquake, for example, in Chile in 1835. After the quake he noticed that the shoreline had risen slightly. He also observed similar elevated beaches at much higher levels up in the Andes. If geological change could be explained by such gradual modifications over time, perhaps biological change could too. Darwin later confessed, 'I always feel as if my books came half out of Lyell's brains.'

When Darwin got back to England and started to try to make sense of the numerous specimens of plants and animals he had collected during the voyage, he began to focus on the 'species question'. This was the 'mystery of mysteries' for those seeking a naturalistic explanation of the origins of the different forms of life. In the 1830s, Darwin was confronted with two alternative explanations which were both equally unpalatable to him. Either each species had been created at a particular time and place by God, as most other naturalists believed, or else all life had started, perhaps spontaneously, in a simple form and had gradually climbed the ladder of life in the direction of greater complexity and perfection. The first option was unattractive because it posited a whole series of miraculous interventions by God in the history of life. What Darwin wanted to find was an explanation in terms of natural laws. The second option, the French naturalist Jean-Baptiste Lamarck's theory of 'transmutation', developed in his *Philosophie Zoologique* (1809), involved too many

unacceptable theoretical assumptions for Darwin, such as the idea that life was continuously being spontaneously generated and starting its ascent up the ladder of life, that all life was climbing in the same direction up this single ladder, and that a creature's own voluntary efforts could alter its physical structure. Lamarck's theory was also widely believed to be connected to religiously unacceptable ideas of materialism and determinism – in other words, to the view that all phenomena, both mental and physical, could ultimately be explained in terms of causal interactions between particles of matter.

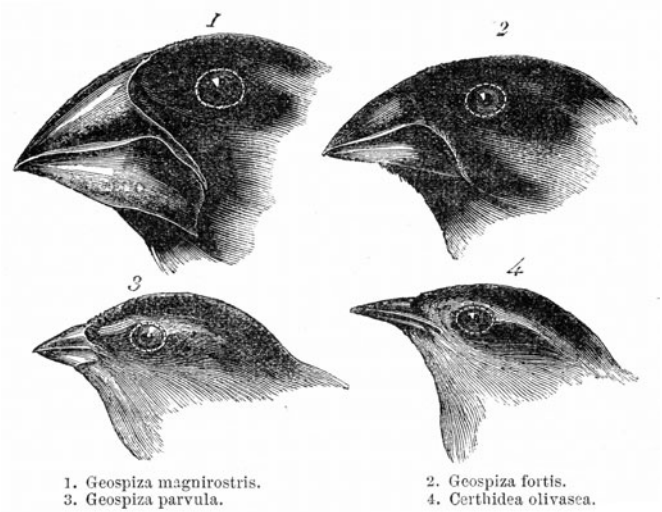
The animal life of the Galapagos islands – its finches and giant tortoises, its iguanas and mocking birds – was later to provide one of the keys to unlocking the 'mystery of mysteries'. During his five weeks on the island in 1835, Darwin became aware that these creatures differed in form from one island to the next, and also between the islands and the South American mainland. Subsequently, back in England, Darwin started to see these differences as useful evidence for evolution. At the time, he did not take great care to mark which finches had been collected from which island. And in the case of the giant tortoises, he even ate some of the evidence, recording in his diary: 'Eating tortoise meat. By the way delicious in soup.'

The Galapagos finches have become a popular example with which to explain Darwin's theory since they nicely illustrate the dilemma he faced as he thought about the history of life in the 1830s. Each island had its own species of finch, with differences in the sizes and shapes of their beaks. Did this require Darwin to believe that there had been a separate act of creation by God on each island, and another one on the mainland too? This seemed scientifically and theologically inelegant, to say the least. A unidirectional transmutationist model would not work either, since there was no obvious way to arrange these different species in a single line with one developing into the other. From the late 1830s, Darwin filled his notebooks with arguments and

10. A giant Galapagos tortoise of the kind Darwin enjoyed eating during his visit to the islands in 1835

counter-arguments trying to solve these sorts of problems. He thought about the way that breeders of pigeons selected particular individuals among each generation when trying to produce unusual new varieties. The analogy with artificial selection would be central to his argument. Even more central, though, was an idea he took from *An Essay on the Principle of Population* (1798) by Thomas Malthus.

Darwin read Malthus's *Essay* in 1838 and saw how it could be applied to the species question. Malthus's concern was with human populations. He believed that these had a natural tendency



11. An illustration from Darwin's *Journal of Researches into the Natural History and Geology of the Countries Visited During the Voyage of H.M.S. Beagle* (1845), showing a selection of the different species of finch collected during the voyage

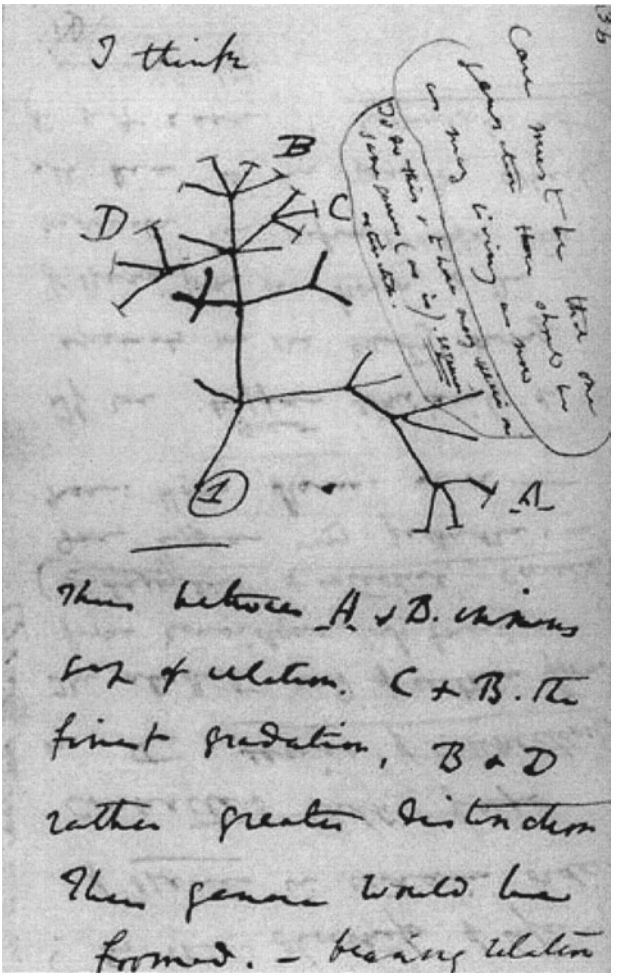
to increase at an exponential rate from one generation to the next (1, 2, 4, 8 …), while the amount of food that a society could produce increased only arithmetically (1, 2, 3, 4 …). This led, in each generation, to a struggle for resources. The strong would survive but the weak would perish. Looking at the entangled creepers of the South American jungle, the parasitic and murderous instincts of insects, and even at the plants and weeds in his own back garden, Darwin could see something similar going on – a competition for resources which those creatures with even a slight advantage over their competitors would win. This struggle for existence and the resulting 'survival of the fittest', as the evolutionary philosopher Herbert Spencer would call it, became the central idea of Darwin's theory. Alfred Russel Wallace, who came up with the idea of natural selection in the 1850s, 20 years

later than Darwin but before Darwin had published his theory, also gave credit to Malthus as a source of inspiration.

Darwin now had his solution. The adaptation of organisms to their environment, and the origins of separate species, should be explained not in terms of the creative acts of Paley's designer, but by geographical distribution, random heritable variation, competition for resources, and the survival of the fittest over vast aeons of time. Natural selection could come in many different guises – as a disease, a predator, a drought, a shortage of your favourite food, a sudden change in the weather – but those individuals in each generation who happened by good luck to be the best equipped to cope with these natural assaults would flourish and leave offspring, while the less well adapted would perish without issue. Repeat that process for hundreds of millions of years and the whole panoply of species now observed could evolve from the simplest forms of life.

So, according to this theory, the species of Galapagos finches were not separately created, nor were they on the successive rungs of a single ladder of life; instead, they were at the ends of different branches of a huge family tree – the tree of life. The differences in the kinds of food that had been available on the different islands – seeds, insects, or cactuses – meant that different sizes and shapes of beak would have bestowed a greater advantage in the struggle for existence depending on geographical location. These species had diverged from a common ancestor species, originally blown across from the mainland. Nature had then acted like the pigeon-fancier, selecting those individuals with the desired characteristics, and allowing them to breed.

When, in 1858, Darwin received a letter from Wallace outlining a theory virtually identical to his, he was spurred into a more rapid publication of his ideas than he had planned. At a hurriedly arranged meeting of the Linnaean Society, an announcement was made of Darwin's and Wallace's theories. The following year saw



12. One of Darwin's first sketches, in his notebooks of the late 1830s, of his idea of a branching tree of life connecting all organisms through a shared ancestry

the publication by John Murray of Albemarle Street, London, of *On the Origin of Species by Means of Natural Selection, or The Preservation of Favoured Races in the Struggle for Life*. The author's credentials were prominently displayed on the title page: 'Charles Darwin, M.A., Fellow of the Royal, Geological, Linnaean, etc., Societies; Author of *Journal of Researches During H.M.S. Beagle's Voyage Round the World*'. Hopefully this impressive potted curriculum vitae would make the book's revolutionary contents more palatable to its Victorian readers.

'Our unsuspected cousinship with the mushrooms'

Those first readers of *On the Origin of Species* were presented with a view of nature in which God had been pushed to the margins rather than banished completely. God was no longer needed to create each individual species but Darwin, whether for the sake of convention or out of his own remaining religious convictions, presented his argument as favouring a kind of theistic evolution. On opening their copy of the book in 1859, the first words that a reader would have come across were two theological epigraphs – one a quotation from the Anglican divine and polymath, William Whewell, the other from Francis Bacon, one of the leading lights of the scientific revolution of the 17th century. Whewell stated that in the material world 'events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general laws'. According to Bacon, one could never have too much knowledge of either the book of God's word or the book of God's works, divinity or philosophy, 'rather let men endeavour an endless progress or proficience in both'.

When it came to the concluding section of the book, Darwin reiterated Whewell's view that God acted in a law-like rather than a miraculous fashion. 'To my mind,' Darwin wrote,

> it accords better with what we know of the laws impressed on matter by the Creator, that the production and extinction of the past and present inhabitants of the world should have been due to secondary causes … When I view all beings not as special creations, but as the lineal descendants of some few beings which lived long before the first bed of the Silurian system was deposited, they seem to me to become ennobled.

In the famous closing sentences of the book, Darwin marvelled that from 'the war of nature, from famine and death', the highest forms of life had been produced. He concluded:

> There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.

From the second edition onwards, in case there was any doubt about his meaning, he changed the phrase 'breathed into a few forms or into one' to 'breathed by the Creator into a few forms or into one'.

There were some within the Christian churches who were persuaded by Darwin's new natural theology. There was indeed greater grandeur and nobility, they agreed, as well as more simplicity and order, in a world where God had created through a law-like process of evolution, rather than one in which God periodically intervened to top up the planet's flora and fauna after particularly destructive catastrophes. We have already seen in Chapter 3 that Henry Drummond was one such individual. The historian, Christian socialist, and novelist Charles Kingsley was another. His famous children's story *The Water Babies*, published in 1863, included an allusion to his approval for Darwin's new theory. The little boy Tom approaches 'Mother Carey', a personification of nature, and says 'I heard, ma'am, that you

were always making new beasts out of old.' Mother Carey replies 'So people fancy. But I am not going to trouble myself to make things, my little dear. I sit here and make them make themselves.' A future Archbishop of Canterbury, Frederick Temple, was another Anglican who supported the idea that God might have created through variation and natural selection rather than by a succession of miracles. On the other side of the Atlantic also there were individuals, such as the Harvard botanist and Presbyterian Asa Gray, who were persuaded to adopt a theistic version of Darwinian evolution.

But there were instances of conflict too, most famously in the form of a dramatic confrontation at the British Association for the Advancement of Science in Oxford in 1860. Darwin himself was not present at the occasion, but his theory was discussed in a paper applying Darwinian ideas to the question of intellectual and social progress. The general issue of Darwinism was then opened up to the floor for further debate. The first speaker was the Bishop of Oxford, Samuel Wilberforce. He spoke at some length about Darwin's theory. We do not have a record of exactly what he said, but we can make an educated guess based on his review of *On the Origin of Species* which appeared in the conservative *Quarterly Review*. In that review, Wilberforce noted that the conclusion implied by Darwin's book, namely that 'mosses, grasses, turnips, oaks, worms, and flies, mites and elephants, infusoria and whales, tadpoles of today and venerable saurians, truffles and men, are all equally the lineal descendants of the same aboriginal common ancestor' was certainly a surprising one, but one which he would have to admit if the scientific reasoning were sound. He was not going to object, he wrote, to Darwin's inference of 'our unsuspected cousinship with the mushrooms' on biblical grounds, since it was most unwise to try to judge the truth of scientific theories with reference to revelation. However, drawing heavily on the work of the country's leading anatomist, Richard Owen, Wilberforce found plenty of scientific objections to the theory, focusing especially on the lack of fossil evidence of transitional

forms, and on the fact that however many varieties of pigeons and dogs may have been produced under domestication, pigeons had always remained pigeons and dogs always dogs. There had been no hint of a new species.

Although he did not base his objections on a literal reading of the Bible, Wilberforce's resistance to evolution, like that of many religious believers since his day, did derive from a commitment to a biblically inspired world view in which human beings were separate from and superior to the rest of the animal world. The Christian teaching that God took on human form in the person of Jesus Christ also gave that human form a particularly special significance. To claim that man was nothing more than an 'improved ape' rather than 'Creation's crown and perfection' was, Wilberforce pointed out, therefore demeaning to God as well as to humanity. At the Oxford meeting, at the end of his remarks, Wilberforce is reported to have turned to one of Darwin's staunchest advocates, Thomas Huxley, who was present among the throng of almost a thousand people, and asked him whether he was descended from an ape on the side of his grandmother or his grandfather. It was intended as a joke, but Huxley was apparently white with anger as he whispered to his neighbour, 'The Lord hath delivered him into mine hands.' Huxley rose and replied severely that he would rather be descended from an ape than from a man who used his intellect and influence to introduce ridicule into a grave scientific discussion. As the temperature in the packed auditorium rose, and at least one woman fainted in the excitement, Darwin's old companion from *HMS Beagle*, Captain Fitzroy, stood up holding a Bible aloft with both hands and denounced Darwin's theory. Another of Darwin's inner circle, the botanist Joseph Hooker, then weighed in with what was, on Hooker's own account, a decisive intervention on the side of Darwinism.

It is a colourful story, and one that has become part of Darwinian folklore. In 1860, Wilberforce, Huxley, and Hooker all thought

13. Cartoons from *Vanity Fair* depicting Professor Thomas Huxley and Bishop Samuel Wilberforce, whose encounter in Oxford in 1860 became legendary

that they had won the day. But by the time the tale came into wider circulation a couple of decades later, Huxley and Hooker, who had long been pressing for the autonomy of science from the Church, had risen to positions of much greater influence. The ascendancy of the professionalizing agnostics within the British scientific establishment was witnessed by the fact that both Hooker and Huxley were chosen to serve as Presidents of the Royal Society. The Huxley-Wilberforce story was then used retrospectively, as a piece of victors' history, to suggest a clearer triumph for scientific naturalism over Anglican conservatism than had really been achieved in Oxford in 1860. It suited the new elite to be able to tell the story in a way that seemed to foreshadow and legitimize their own rise to power, while simultaneously depoliticizing the issue. The 1860 confrontation between Samuel Wilberforce and Richard Owen, on the one hand, and the

young Darwinians, on the other, had resulted from a struggle for dominance within the institutions of British science and education – a conflict between competing social interests as well as between competing interpretations of the scientific evidence for evolution. The later recasting of the Huxley-Wilberforce debate as one more instance of a simple and timeless conflict between 'science' and 'religion' helped to suggest that the agnostics' rise to power was the result of an inexorable historical process rather than a deliberate political campaign.

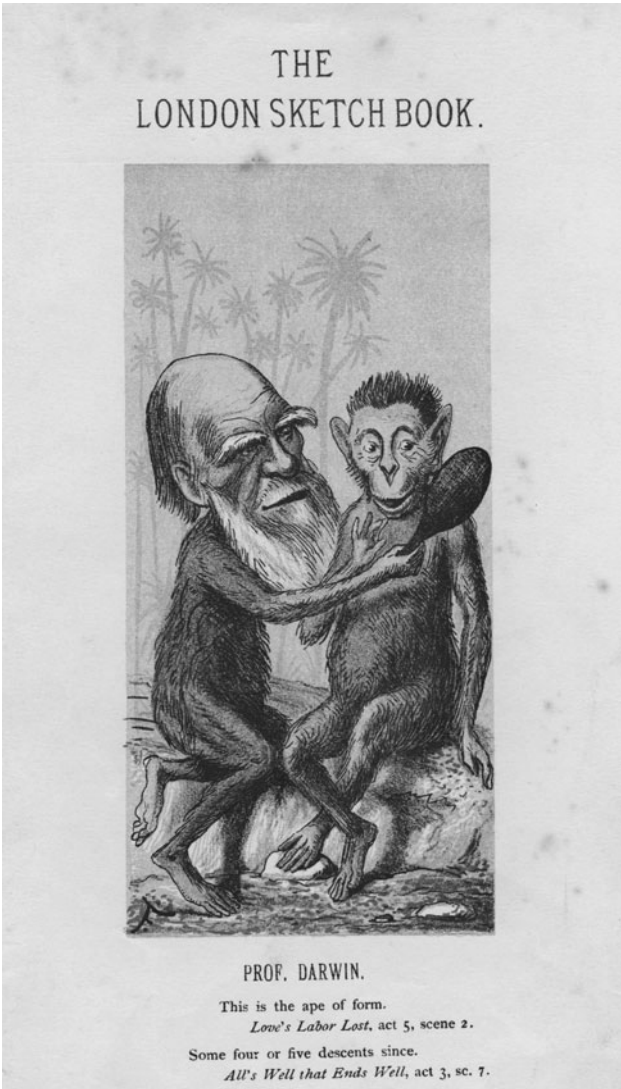
Evolution and theology

Wilberforce's review of *On the Origin of Species* identified the theological issues which would play out repeatedly among Christians, Jews, Muslims, and others as they considered the implications of evolution for their religious beliefs in the 19th century and afterwards. Some of these were not new. Discoveries in astronomy and geology had already given theologians plenty of opportunity to discuss the relative authority of science and scripture in determining natural knowledge. Darwin's view of nature drew particular attention to suffering, violence, and death. But people hardly needed Darwin to tell them that these were features of the natural world in general and of human life in particular. Again, theologians were already aware of the problem of evil, and had various responses to it. One common response to human evil was to explain that God must allow his creatures free will, which could be turned to either good or evil ends. Bishop Wilberforce's response to Darwin's remarks on imperfections in nature, and on the apparent cruelty of such creatures as the ichneumon wasp, was to refer to the Christian idea of the Fall. On this view, when Adam and Eve, the crowns and rulers of creation, were expelled from the Garden of Eden for their disobedience, it was not just they and their human descendants who fell from grace into a disordered state; it was the whole of nature. As Wilberforce put it, the 'strange forms of imperfection and suffering amongst the works of God' were the ongoing expression

of 'the strong shudder which ran through all this world when its head and ruler fell'.

What was theologically new and troubling was the destruction of the boundary securely separating humanity from the 'brute creation' (and, to a lesser but significant extent, the destruction of the boundaries separating kinds of plants and animals from each other). The publication of Darwin's theories about human evolution in *The Descent of Man* (1871) and *The Expression of the Emotions in Man and Animals* (1872) provided further material for discussions about the relationship between humanity and the other animals. In these works Darwin speculated, as he had not dared to in 1859, on how even the most elevated of human faculties – the emotions, the moral sense, and religious feelings – might have evolved by natural means (including the 'Lamarckian' process of the inheritance of acquired characteristics, which Darwin always maintained operated alongside his own favoured mechanism of natural selection).

By the end of the 19th century, there was no serious scientific opposition to the basic evolutionary tenets of descent with modification and the common ancestry of all forms of life. There was considerable dispute about the explanatory sufficiency of the mechanism identified by Darwin and Wallace as the main driving force of evolution, namely natural selection acting on random variations. Lamarckian mechanisms of various forms were still discussed, and the process of heredity was a matter of dispute. From 1900 onwards, there were debates between those who used the work of Gregor Mendel to argue that characteristics were inherited in all-or-nothing units of the kind that came to be known as 'genes', and those who believed that inheritance was a question of an infinitely gradated 'blending' of traits. Only during the 1930s and 1940s did the modern evolutionary framework of neo-Darwinism, with which we are now familiar, take shape. That framework combined Mendelian genetics with the theory of natural selection, and finally rejected evolutionary theories that



14. One of many 19th-century images which satirized Darwin's theory of human evolution by depicting him as an ape

appealed either to the inheritance of acquired characteristics or to some innate life-force driving evolution from within.

Throughout these developments, theologians continued to make various uses of evolutionary ideas. The early 20th century saw a flourishing of ideas about creative evolution and guided evolution that appealed to religious thinkers. Since then, the triumph of neo-Darwinism has posed different theological problems. Within each faith tradition, there have been those who embrace evolution but also those who reject it – each has its own evolutionists, its own creationists, and many others in between.

For Jews, the theory of evolution not only raises questions about biblical interpretation and about human nature but also has connotations of Nazism and the Holocaust. Ideas about the 'survival of the fittest' were used by Nazis to try to justify their racist and eugenic ideology. Their regime was responsible for the murder of millions of Jews and others of supposedly 'inferior' races during the Second World War. The theory of evolution by natural selection has been used to bolster all sorts of different ideologies, including socialism, liberalism, and anarchism. Recent historical research has even shown how evolutionary ideas were used in the construction and defence of Zionism. While the idea of evolution has proved to be politically very malleable, it is generally accepted that in itself the scientific theory does not lead to any of these positions. Ideas of evolution will surely nonetheless continue to carry a menacing undertone given the anti-Semitic uses to which they have been put in the past. It has been pointed out that two biologists who were prominent in resisting more deterministic evolutionary theories of mind and society in the later 20th century, namely Stephen Jay Gould and Richard Lewontin, were both Jewish (although they both had scientific and political reasons for resisting such theories too).

Since the 19th century, the Roman Catholic Church has gradually developed an official line accepting that the human species

has physically evolved in the way described by science, but which states that each individual human soul is created in the image of God and cannot be explained merely as the product of materialistic evolution. There have been Roman Catholics on and slightly beyond the fringes of orthodoxy who have spoken in favour of evolution, such as the 19th-century anatomist St George Mivart, who tried to persuade the Church of the plausibility of theistic evolution, and the Jesuit palaeontologist Pierre Teilhard de Chardin, whose popular mid-20th-century books interpreted evolution as a divinely guided cosmic process with human moral and spiritual awareness as its goal. Pope Benedict XVI, speaking at his inaugural mass in 2005, struck a cautionary note on the subject. 'We are not,' he said, 'some casual and meaningless product of evolution. Each of us is the result of a thought of God. Each of us is willed, each of us is loved, each of us is necessary.' The Roman Catholic Church has not generally been supportive of the anti-Darwinian 'Intelligent Design' movement, however. The Pope's warnings are not against evolution as science but against adopting the idea of evolution as an overarching view that deprives the world of meaning and purpose. It seems that the Catholic Church remains ambivalent towards evolution. One of the leading advocates of 'Intelligent Design', Michael Behe, and one of its most accomplished scientific critics, Kenneth Miller, are both Roman Catholics.

In recent decades, the most prominent religious opponents of evolution have come from within two particular traditions – Protestantism and Islam. The varieties of creationism that have emerged in these traditions in the 20th and 21st centuries are remote from the theological and scientific discussions about Darwinism that took place in the late 19th century. In order to understand the 20th-century rise of scientific creationism, we need now to turn our attention to the history and politics of the United States of America.

Chapter 5
Creationism and Intelligent Design

E. coli is the poster-bug for 'Intelligent Design'. It propels itself with an ingenious rotating tail or 'flagellum' – a sort of bacterial outboard motor. With its many connected parts working together towards the specified end of locomotion, this flagellum fulfils the criteria for design set out by William Paley in 1802. But surely the triumph of the modern theory of evolution has made it impossible to prefer Paley's theological explanation of such adaptations to Darwin's naturalistic one? Apparently not for everyone.

Since the early 1990s, supporters of the movement promoting 'Intelligent Design' or 'ID' in the United States have been mounting a challenge to the neo-Darwinian theory that all forms of life have evolved through the processes of genetic variation, heredity, and natural selection. Devotees of ID, including the lawyer Philip Johnson, the mathematician, philosopher, and theologian William Dembski, and the biochemist Michael Behe, say that it represents a serious scientific challenge to evolution. They think that certain aspects of the natural world, such as the bacterial flagellum, are too complex and too unlikely to have been produced by processes of genetic mutation and natural selection. And they use detailed calculations, based on debatable mathematical assumptions about information and probability, to quantify that unlikeliness and to justify their incredulity. Michael Behe focuses especially on complex chains of chemical

processes within cells such as the series of reactions involved in the clotting of blood in mammals, known as the 'blood clotting cascade'. He is, if you like, Paley with a doctorate in biochemistry. The most plausible explanation of the 'irreducible complexity' of the flagellum, the blood clotting cascade, and many other phenomena which rely on complicated interactions between multiple components, Behe believes, is that they were produced by an intelligent designer (whom he and most of his readers suppose to be God).

The American Association for the Advancement of Science has stated that ID is characterized by 'significant conceptual flaws in its formulation, a lack of credible scientific evidence, and misrepresentations of scientific facts' and that its central concept is 'in fact religious, not scientific'. In a landmark case in Pennsylvania in 2005, Judge John E. Jones ruled against the Dover Area School Board's policy of requiring biology teachers to read out a statement about ID. Judge Jones stated that ID was religious, not scientific; and that the decision of the Board to adopt this policy, breaching the First Amendment prohibition on state sponsorship of religion, showed 'breathtaking inanity'. Religious leaders have come out against ID too. An open letter affirming the compatibility of Christian faith and the teaching of evolution, first produced in response to controversies in Wisconsin in 2004, has now been signed by over ten thousand clergy from different Christian denominations across America. In 2006, the director of the Vatican Observatory, the Jesuit astronomer George Coyne, condemned ID as a kind of 'crude creationism' which reduced God to a mere engineer.

Given the impressive array of scientific, legal, and theological opinion ranged against it, you might wonder how the ID movement ever became as popular as it undoubtedly has within certain sectors of American society. To answer that question it is necessary to understand the history both of anti-evolution campaigns in the United States since the 1920s and of state and

federal courts' use of the First Amendment to keep religion out of public schools from the 1960s onwards. What these histories reveal is that the ID movement is the latest in a series of attempts by a broadly conservative and Christian constituency in the United States to have religiously motivated anti-evolutionary ideas taught in the public schools. The debate about evolution and ID is a conflict not primarily between science and religion but between different views about who should control education.

Opponents of the various forms of scientific creationism and ID have sometimes portrayed them as a 'return to the Middle Ages'. This reveals a common historical misunderstanding. These movements are the products of 20th- and 21st-century America. They simultaneously mimic and reject modern science and have become quite widespread in modern America through the convergent influence of a number of factors, including an advanced state of scientific development, a high level of religious observance, and a strictly enforced separation between church and state.

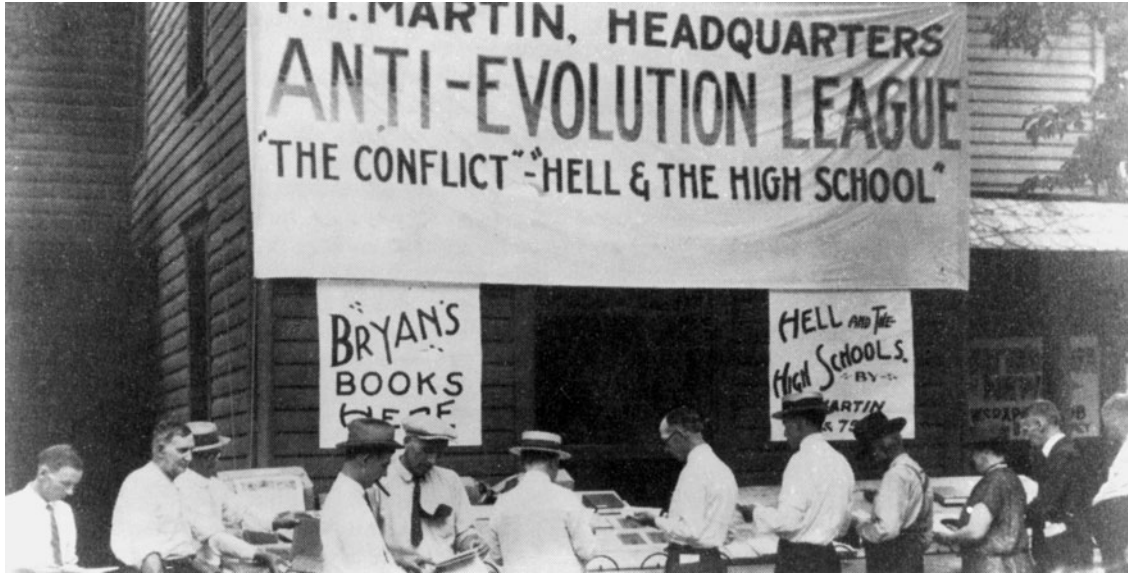
The Scopes trial

On 21 March 1925, Austin Peay, the Governor of Tennessee, put his signature to an Act making it unlawful for a teacher employed by the State of Tennessee to 'teach any theory that denies the story of the Divine Creation of man as taught in the Bible, and to teach instead that man has descended from a lower order of animals'. Other states, including Mississippi and Arkansas, adopted similar anti-evolution measures in the 1920s, but it was in the small town of Dayton, Tennessee, that the issue came to a head.

The American Civil Liberties Union (ACLU) saw the passing of the Tennessee law as an opportunity to take a stand in defence of intellectual freedom. They placed an advertisement seeking a volunteer to bring a test case. Some of the lawyers and businessmen of Dayton, grasping the opportunity to put their

town on the map, persuaded a local science teacher, John Scopes, to put himself forward. What followed generated more publicity than the townsfolk of Dayton can possibly have envisaged. The Dayton 'Monkey Trial' became international news and was the first to be broadcast on national radio. It also attracted two of the most famous lawyers of the age, William Jennings Bryan acting for the prosecution, and Clarence Darrow for the defence. Bryan had stood three times for President, as the candidate of the Democratic Party, and three times had been defeated. Known as 'The Great Commoner' because of his belief in the absolute sovereignty of the people, an opponent of imperialistic foreign policy and supporter of votes for women, in later life Bryan became increasingly taken up with moral and religious crusades, including his support for Prohibition and his biblically based opposition to the teaching of evolution in schools. Darrow was a famous agnostic and a leading member of the ACLU.

The clash between Bryan and Darrow, and the associated carnival of religious and evolutionary activism which descended upon Dayton in July 1925, has been memorably, if not altogether accurately, depicted in the 1960 film *Inherit the Wind*. The story has been brilliantly and more reliably retold by Edward J. Larson in his *Summer for the Gods: The Scopes Trial and America's Continuing Debate over Science and Religion*, which won the Pulitzer Prize for History in 1998. Although the courtroom confrontation between Bryan and Darrow became legendary, as a legal drama it was of limited interest. No-one denied that Scopes had broken the law. Both sides accepted that Scopes had taught evolution, and when the trial came to its conclusion, he was duly convicted and ordered by the judge to pay a fine of 100 dollars. The main purpose of the case, as far as Darrow and the ACLU were concerned, was to obtain a conviction at Dayton which could then be appealed to higher state and federal courts, in order to test the constitutionality of the anti-evolution law. For Bryan, the purpose of convicting Scopes was to strike a political blow for



15. The stall of the Anti-Evolution League in Dayton, Tennessee, during the Scopes trial

honest Christian folk who wanted to shield their children from the anti-religious ideas of an arrogant intellectual elite.

Although some saw the Scopes trial as a simple confrontation between science and religion, the political speeches made by William Jennings Bryan at the time reveal that the more powerful dynamic was a generally conceived conflict between the fundamentals of Christianity and the evils of the modern world. Bryan was a defender of the newly formed movement for Christian 'fundamentalism'. For the fundamentalists, the spread of Darwinism was both a cause and a symptom of the degeneration of human civilization which they witnessed all around them, from the barbaric violence of the First World War in Europe to the sensual decadence of the Jazz Age in America. Christianity and a literal reading of the Bible were bulwarks against these developments. Bryan and others feared that teaching children they were animals would brutalize and degrade them. Bryan noted that in a diagram in Hunter's *Civic Biology*, the textbook from which Scopes had taught evolution, humanity was 'shut up in the little circle entitled "Mammals", with thirty-four hundred and ninety-nine other species':

> Does it not seem a little unfair not to distinguish between man and lower forms of life? What shall we say of the intelligence, not to say religion, of those who are so particular to distinguish between fishes and reptiles and birds, but put a man with an immortal soul in the same circle with the wolf, the hyena and the skunk? What must be the impression made upon children by such a degradation of man?

Bryan and the fundamentalists got what they wanted. In the decades after Scopes was convicted, evolution rarely featured on school science syllabuses, even in states where it was not illegal. On appeal, the Tennessee Supreme Court overturned the conviction not on the constitutional grounds sought by the ACLU but on a technicality. It should have been the jury and not the

16. A fundamentalist cartoon from the 1920s depicting the theory of evolution as the tune played by a new 'Pied Piper' – 'Science falsely so-called' – leading the children of America down the 'path of education' towards the dark cavern of 'disbelief in the God of the Bible'

judge who had set the amount of the fine. It would be another 40 years before an anti-evolution law would finally be challenged in front of the United States Supreme Court.

Varieties of creationism

'Creationism' is a term that can loosely be used to refer to any religious opposition to evolution. Such opposition has taken and continues to take many different forms. What all creationists

share is a belief that the universe and life on earth were created immediately and supernaturally by God, and that human beings and all other species were each created separately and in their current form. In other words, creationists deny the common ancestry of all plants and animals. Creationists base their resistance to evolution at least partly on the authority of their sacred text, whether the Hebrew Scriptures, the Christian Bible, or the Quran. The Book of Genesis, for instance, relates that God, over a period of six days, created each kind of living creature separately, made man and woman in his own image, and set them above the rest of creation, before resting on the seventh day. As the King James translation put it:

> And God said, Let us make man in our image, after our likeness: and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth.

The Quran teaches that Allah is the Creator of everything, bringing the heavens, the earth, and everything in it immediately into existence, and making human beings out of clay and each species separately.

Many creationists have based their stance on a literal interpretation of scripture. Those religious traditions that place a strong emphasis on textual authority, notably some varieties of Protestantism and Islam, are therefore more inclined towards strict creationism. As we have already seen in the case of arguments about Copernican astronomy, however, it is not easy to specify which parts of the scriptures are to be taken absolutely literally. As William Jennings Bryan pointed out during his cross-examination by Clarence Darrow at the Scopes trial, when the Bible said 'Ye are the salt of the earth', the text did not mean that 'man was actually salt or that he had flesh of salt, but it is used in the sense of salt as saving God's people'. That text, Bryan said, was to be 'accepted as it is given', namely 'illustratively' rather

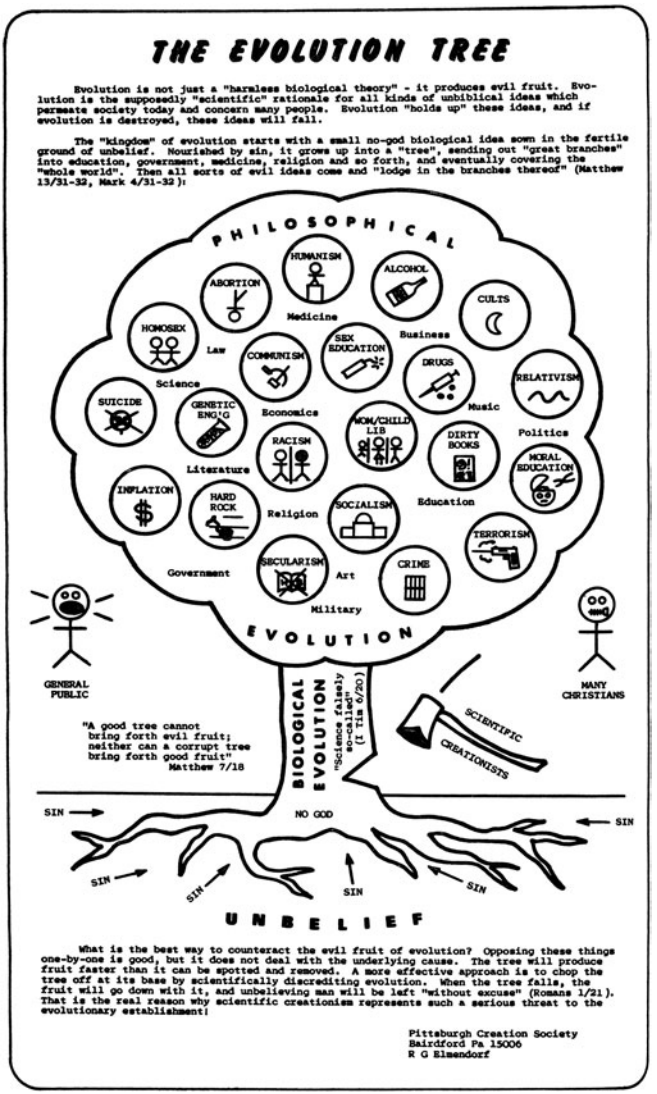
than literally. Darrow pressed Bryan further. He wanted to know whether Jonah really had been swallowed by a whale. Bryan corrected him – it was actually a 'big fish'. But, yes, he believed in a God who could make a whale, or a big fish, and a man, and who could 'make both what He pleases'. Darrow moved on to Adam, Eve, and their family. Did Bryan believe that Eve was 'literally made out of Adam's rib'? Bryan said he did. Adam and Eve had two sons, Cain and Abel. But, Darrow wondered, 'Did you ever discover where Cain got his wife?' Bryan was unperturbed: 'No, sir; I leave the agnostics to hunt for her.'

Then Darrow came to questions with obvious scientific relevance. When the Bible said that the sun had been stopped in the sky, did that mean that in those days the sun went round the earth? No, Bryan said, he believed that the earth went round the sun and what the passage meant was that the earth was stopped in its rotation. Then what about the age of the earth? Many bibles had the date 4004 BC printed in the margin to indicate the date of creation, as calculated from the text itself. Did Bryan believe the earth was about six thousand years old? 'Oh, no; I think it is much older than that.' 'How much?' He could not say. What about the six days of creation in Genesis? Were they twenty-four-hour days? Bryan was clear on that one: 'I do not think they were twenty-four-hour days.' Rather, they were 'periods'. God could have taken six days, six years, six million years, or six hundred million years to create the earth. 'I do not think it is important whether we believe one or the other', Bryan said. Soon afterwards, this famous exchange descended into acrimony. Bryan claimed that Darrow was trying to use the courtroom to attack the Bible. Darrow told Bryan he was merely examining 'your fool ideas that no intelligent Christian on earth believes'.

This famous moment during the Scopes trial reveals two important things about creationism generally. First, even among Christian creationists there has been disagreement about how to interpret Genesis. In the early 20th century, many adopted the

'day-age' interpretation favoured by Bryan according to which each biblical 'day' was in fact a geological 'age' during which many different species were created. Others maintained belief in a very ancient earth by inferring a long 'gap' between the first moment of creation and the six-day creation. Within that gap there might have been multiple cataclysms and new creations, responsible for producing the fossil record. 'Young Earth Creationism' or 'Creation Science' is a more extreme version of creationism, according to which the biblical chronology is to be accepted and fossil evidence is to be explained not by successive creations and cataclysms but entirely as the result of Noah's flood, approximately five thousand years ago. The Creation Science movement's key texts, second only to the Bible in importance, were works by the Seventh-Day Adventist geologist George McCready Price. His *Illogical Geology: The Weakest Point in the Evolution Theory* (1906) and *New Geology* (1923) both explained geological evidence by a recent universal deluge.

Price's books were the inspiration for the Creation Science revival of the 1960s and 1970s, led by a Texan Baptist teacher of civil engineering, Henry M. Morris. The Creation Research Society was founded by Morris in 1963, and the Institute for Creation Research in 1970. Both were designed to promote a more extreme and allegedly more scientific form of fundamentalist creationism than had ever existed before. As with Bryan's anti-evolution campaign, the core motivation for the Creation Science movement was a desire to protect Christian communities from the corrosive and degenerate influences of the modern world. The range of evils thought to grow out of a belief in evolution in the 1970s were graphically illustrated in R. G. Elmendorf's 'Evolution Tree', which bore fruit ranging widely from secularism, socialism, and relativism to alcohol, 'dirty books', 'homosex', and even terrorism. This brand of anti-evolutionary thought has spread from America around the world. In recent years an Islamic author from Turkey writing under the pen-name of Harun Yayha has produced many widely read books denouncing Darwinism as a 'deceit' and a



17. A creationist image of the 1970s: the 'Evolution Tree' is nourished by sin and unbelief, and its fruits include a range of secular ideologies, immoral activities, and economic and social evils.

'lie' and drawing on the techniques and arguments of American proponents of Creation Science.

The second general feature of creationism illustrated by Bryan's testimony is its ambivalent relationship with science. The reason Bryan accepted that the earth orbited the sun and that it was much more than six thousand years old was because of the scientific evidence to that effect. Why, then, was he committed to the belief that Eve had literally been made from Adam's rib, and that the Genesis account of creation was to be preferred to evolutionary science? At what point does the creationist stop believing the scientific evidence and start taking the Bible literally? And why? The answer in practice is, as we have already seen, that it has been the question of human evolution that has caused greatest unease, and it is at the suggestion of animal ancestry for humans that most creationists have felt they must draw the line.

Creationist ambivalence towards science is evident in other ways too. Many creationists, while resisting certain scientific results, specifically relating to evolution, still admire the success of science and seek to emulate or even appropriate that success. The recasting of fundamentalist anti-evolution as an alternative kind of science by Morris and the Creation Scientists was partly motivated by the desire to have creationism taught in the public schools as an alternative to evolutionary science. However, Price, whose geological works provided the scientific basis of their movement, wrote at a time before that had become the real issue. He genuinely wished to produce an understanding of nature that was both biblical and scientific.

One of the most popular books about Islam and science in the 20th century was *The Bible, The Quran and Science* by the Muslim physician Maurice Bucaille. Published in 1976, the book claimed that the word of God as revealed in the Quran (but not the Bible)

contained many statements that could only be understood in the light of modern science. Bucaille started a craze among Islamic commentators for finding verses in the Quran that seemed to foreshadow scientific discoveries as diverse as the expansion of the universe and the mechanisms of sexual reproduction. Other Islamic scholars, while rejecting both Bucaille's anachronistic hunt for modern science in the Quran and also Yayha's second-hand creationism, still seek a way to produce an 'Islamic science' which is truly scientific and yet which is divorced from purely materialistic interpretations incompatible with the Quran.

The First Amendment

Intelligent Design is not strictly speaking a form of creationism. Proponents of ID do not mention the Bible, let alone try to interpret it literally, and do not explain geological and fossil evidence in terms of a biblical flood. They accept the antiquity of the earth and of humanity, and in the case of some really liberal ID theorists, such as Michael Behe, do not even deny the common ancestry of humans and all other forms of life. Behe accepts more or less all of the standard evolutionary picture but identifies certain key phenomena, such as the biochemistry of the first cells, which he insists cannot be explained without the intervention of an intelligent designer. Other proponents of ID claim that the 'Cambrian explosion' of new complex forms of life about five hundred and thirty million years ago is inexplicable without intelligent intervention. The defenders of ID, to an even greater extent than the 'Creation Scientists' of previous decades, try to stay scrupulously within the bounds of scientific discourse and mention a 'designer' and 'intelligence', but never God, and certainly not the Bible. Some suspect that this reflects not the scientific nature of their enterprise but simply a canny awareness of the fact that they will need to look and sound as much like scientists as possible if their views are ever going to make it into the classrooms of America's public schools.

The Establishment Clause of the First Amendment to the US Constitution forbids the government from passing any law 'respecting an establishment of religion'. The original intention was not to exclude religion from public life altogether but to ensure that no particular form of Christianity become an established religion akin to the Church of England. There was also from the outset a broader hope that this Amendment would help to build, in the words of Thomas Jefferson, 'a wall of separation between Church and state'. The enactment of statutes forbidding state employees from contradicting the 'story of the Divine Creation of man as taught in the Bible' would seem on the face of it to put something of a hole in that wall.

From the middle of the 20th century onwards, the US Supreme Court became increasingly active in policing the observation of the Establishment Clause in publicly funded schools. State laws allowing time for silent prayer in schools, or for the reading of denominationally neutral prayers, or requiring the Ten Commandments to be posted on classroom walls were all declared unconstitutional. In the 1960s, an anti-evolution law from the Scopes era was finally challenged on similar constitutional grounds. A young biology teacher from Arkansas, Susan Epperson, supported by the ACLU, challenged a 1928 state law making it unlawful to teach 'the theory or doctrine that mankind ascended or descended from a lower order of animals'. The case went all the way to the US Supreme Court, which ruled that the law was in violation of the First Amendment. The Court declared, in November 1968, that 'fundamentalist sectarian conviction was and is the law's reason for existence'. The Epperson case marked the beginning of the legal process which would give rise to the Intelligent Design movement about 20 years later.

In the 1970s, the creationist camp adopted a new strategy, campaigning for legislation mandating 'balanced treatment' or 'equal time' in the classroom for two alternative scientific

theories – 'evolution science' and versions of Morris's 'Creation Science', which did not mention the Bible but asserted a separate ancestry for man and apes, a 'relatively recent inception of the earth and living kinds', and an explanation of geology by 'catastrophism, including a worldwide flood'. These measures did not stay long on the statute books. The Arkansas balanced treatment law was struck down at state level in 1982, on First Amendment grounds. In 1987, a similar law passed by the State of Louisiana came before the US Supreme Court. The Court ruled that the statute's purported secular aim of promoting academic freedom was a sham and that its real purpose was to 'advance the religious viewpoint that a supernatural being created humankind'. Because the primary aim of the Louisiana Act was to 'endorse a particular religious doctrine', it was in violation of the Establishment Clause of the First Amendment.

So, at the beginning of the 1990s, biblical anti-evolution laws had been declared unconstitutional; laws requiring 'balanced treatment' for evolution and 'Creation Science' had gone the same way; but opinion polls continued to find that between 45 and 50% of the population of the USA believed that human beings were created by God in their present form at some time in the last ten thousand years. (This figure remains the same today, with most of the rest of the population believing that humanity evolved through an evolutionary process somehow guided by God.) Legislators and members of school boards seeking to tap into the support of these voters now needed to develop a new strategy for getting God back into the classroom in scientific clothing. And that explains the birth of the 'Intelligent Design' movement. School boards and state legislatures across the US have considered measures introducing ID into science education. Judge Jones's ruling in 2005, which struck down the Dover School Board's policy on First Amendment grounds, because of the clear religious intention behind it, strongly suggests that ID will have no more legal success than previous kinds of religiously motivated anti-Darwinism. The First Amendment will continue to do its job.

In 1925, William Jennings Bryan saw that the central political question to be decided was 'Who shall control our public schools?' Debates about ID continue to bring out the social conflicts that arise in trying to answer that question. Bryan said that an evolutionist school teacher should not be allowed 'to accept employment in a Christian community and teach that the Bible is untrue' and to 'force his opinion upon students against the wishes of the taxpayers and the parents'. Bryan predicted that 'school board elections may become the most important elections held, for parents are much more interested in their children and in their children's religion than they are in any political policies'. In many parts of the USA Bryan's prediction came true. In some cases, the decisions of the courts to strike down creationist laws did indeed go against the wishes of parents and taxpayers. But, as Judge William Overton stated in ruling against the Arkansas 'balanced treatment' Act in 1982, 'The application and content of First Amendment principles are not determined by public opinion polls or by a majority vote.' No group, no matter how large or small, was allowed to 'use the organs of government, of which the public schools are the most conspicuous and influential, to foist its religious beliefs on others'.

Things have changed since Bryan's day, however. In recent years, it has been the democratic process itself rather than the courts which has done most to keep ID off science syllabuses. In Dover and elsewhere, members of school boards who have changed science standards to de-emphasize evolution or to include references to ID have generally been voted out at the next election. Was Bryan right after all, that it is best to let parents and taxpayers have the final say through the ballot box?

Explaining complexity

But suppose that the courts and the people were not opposed to the teaching of ID, or that the question of whether ID might be taught in science classes were to arise in a country lacking the

strict separation between state and religion enforced in the United States. What then? It would still be very unlikely that many people would consider ID a sensible subject for a science lesson. Good scientific, theological, and educational objections to such a proposal would be plentiful.

Starting with the scientific case against ID, there are two related points to make. First, evolutionary theory can in fact explain the biological complexity which ID claims defeats it; second, ID is excessively negative, looking for gaps in evolutionary science but without providing a coherent alternative theory in its place.

Arguments about 'irreducible complexity' are a new form of a very old anti-Darwinian argument, namely that complex structures could not have evolved by natural selection because the intermediate forms containing only some of the parts would not have been adaptive. What use is a part of an eye, half a wing, or three-quarters of a flagellum? In general terms, evolutionists have been able to answer this objection by finding, either in fossils or in living species, evidence of intermediate structures that did exist and were in fact adaptive. In the case of the eye, Darwin himself listed various forms of eyes, from a small patch of light-sensitive cells to the complex 'camera' eyes of humans and other animals, showing how each was adaptive and could have evolved into the next in the series. Scientists now estimate that this entire evolutionary process could even have been achieved within a mere half a million years. Advantages were also conferred by the precursors to fully fledged wings. Feathers, for instance, seem first to have evolved as a form of insulation before being co-opted by natural selection to aid a quite different function – flight. It is harder to produce these scenarios in the case of biochemistry because, obviously, chemical reactions, unlike feathers, do not fossilize. However, using evidence from currently living species it is possible to reconstruct evolutionary scenarios. This has been done, for instance, in the case of the famous bacterial flagellum, which, it has been suggested, evolved through the co-option of a

very similar existing structure (known as the type three secretory system) used by bacteria for injecting toxic proteins into the cells of their hosts. So the answer to the question 'What use is a part of an eye, half a wing, or three-quarters of a flagellum?', is 'Light-detection, warmth, and toxin-injection, respectively'.

A second objection to ID concerns its negative character. This is another respect in which ID differs from Scientific Creationism. Creationists of earlier decades proposed an alternative theory which boldly, biblically, and patently wrongly asserted that the earth was only a few thousand years old, that geology could be explained by a recent worldwide flood, and that humans did not share ancestors with other animals. The defenders of ID, on the other hand, simply draw attention to what they claim are phenomena (such as the Cambrian explosion or the blood clotting cascade) that display too much 'specified complexity' to have evolved by mutation and natural selection, and at that point invoke their unelaborated concept of an intelligent designer, barring the way to further investigation. The ID theory makes no novel predictions beyond the failure of evolutionary science to explain these phenomena. It is not clear where ID theorists would draw the line between that which can be explained by evolution and that which needs an intelligent designer. And it seems likely that, in future, as good evolutionary explanations are suggested for their favoured examples, as has already happened in the case of the flagellum, the number of cases for which 'design' can be claimed will slowly but surely dwindle.

One of the main theological objections to ID follows directly from this last point. In claiming that supernatural intervention is required to explain a certain subset of natural phenomena for which a full evolutionary explanation may currently be lacking, ID theorists seem to be positing a 'God of the gaps' of the kind discussed in Chapter 3. As gaps in evolutionary science are filled with naturalistic explanations, God will gradually be edged further

out. This tinkering God of ID, this God who seems to be an occasionally observable object in the natural world, found in our current ignorance rather than in our understanding, is no more attractive to theologians than to scientists – hence the thousands of clergy who have been moved to sign the open letter against ID mentioned above.

But is it science?

Judge Overton in the 1982 Arkansas case and Judge Jones in the 2005 case in Pennsylvania both declared that Creation Science and ID, respectively, not only contravened the First Amendment but were, in any case, not proper science. This is a common claim – that creationism and ID are not scientific because they fail to fulfil one or more criteria which characterize all genuine science. There are various candidates for such 'demarcation criteria'. Some say that true science must be empirically testable, others that it must make 'falsifiable' claims, others that it must offer explanations only in terms of natural laws and natural processes.

Philosophers of science are much less optimistic than they were a few decades ago about the possibility of finding any really coherent demarcation criteria. It is accepted that many scientific claims – including many of the most interesting ones – are not directly empirically testable but only become so as part of a complex network of auxiliary theoretical assumptions and scientific instruments. For instance, a mathematical model of the Big Bang cannot be tested by direct observation, but only indirectly through predictions about the behaviour of measuring apparatus when a particular reaction is set off in a massive particle accelerator. Creation Scientists made very clearly testable claims about the age of the earth and the separate ancestry of all species. Although it is an unusually minimal and largely negative kind of theory, ID certainly can generate empirically testable claims too, such as the assertion that adaptive precursors will never be found for various specified processes and structures

such as the blood clotting cascade or the bacterial flagellum. Creationists and ID proponents have regularly made testable claims. These claims have been tested and repeatedly found wanting.

It is also accepted that good scientists will often hold on to their theories in the face of inconsistent empirical evidence and seek to reinterpret that evidence rather than declare their theory 'falsified'. There is not yet an evolutionary account which successfully identifies every single stage in the evolution of the flagellum (or in the evolutionary history of many other organs or biochemical processes), but that does not mean that scientists should declare neo-Darwinism to have been 'falsified'. The modern framework of evolutionary theory successfully explains and unifies a huge body of evidence accumulated and interpreted over many generations. It makes sense of the fossil record, the geographical distribution of species, the physical similarities between related plants and animals, and the vestigial organs that testify to earlier evolutionary forms. Recent advances in genetic sequencing have provided a huge new mass of evidence which confirms evolutionary theory while identifying a whole new range of puzzles and anomalies. In the face of puzzles and anomalies a good scientist, especially when working with such a well-confirmed theory, does not declare their theory falsified, but designs new experiments and develops new theoretical models to solve those puzzles and resolve those anomalies. The central claims of ID theorists all seem to have been falsified. But in holding on to their theories and trying to provide an alternative interpretation of the evidence, they are only doing what all good scientists would do. A very significant difference, however, is that ID supporters lack any good reason for confidence in their original theory.

Testability and falsifiability are not satisfactory demarcation criteria. What about the insistence that proper scientific theories should be entirely naturalistic? This is a relatively new doctrine.

Neither Isaac Newton nor Charles Darwin, to take just two examples, felt that God had to be excluded entirely from their scientific accounts of the natural world. In scientific theories between the 17th and 19th centuries, God featured generally as a lawgiver rather than as a tinkerer, but God was not absolutely barred from professional scientific discourse until the later 19th century. In appealing to a supernatural cause as part of their science in the 21st century, ID theorists are certainly unconventional, eccentric, and out of step with recent practice, but that need not mean they are to be excluded from the realm of science altogether. There is no need for defenders of mainstream science to risk seeming ideological and doctrinaire by prejudging the kinds of entities that will feature in successful scientific theories in the future.

In short, opponents of ID who use the weapon of philosophical demarcation may be shooting themselves quite unnecessarily in the foot. In the United States, the pro-religious intent and effect of any policy mandating the teaching of creationism or ID will be enough to keep it off the statute book. There and elsewhere, scientists and theologians, as well as voters and judges, also have many good reasons to resist ID without straying into the fraught philosophical realm of demarcation.

Back to the classroom

The most recent slogan of the ID movement, echoing the calls for 'balanced treatment' of earlier decades, is 'Teach the Controversy'. The publisher's description of the ID textbook *Of Pandas and People* states that it 'promotes a widely recognized goal of science education by fostering a questioning, skeptical and scrutinizing mindset'. Other ID proponents claim they are seeking to improve public discussions of science and promote a more inclusive and 'controversy-based biology curriculum'. This is disingenuous. Of course science thrives on constant criticism, questioning, and controversy. Such controversies can be a very useful way to teach

science. To the extent that ID theorists have served as gadflies or catalysts to evolutionary science, they have performed a valuable scientific function. However, ID is not really a movement for educational reform. The 'controversy' in question has not arisen from any substantial scientific disagreement but is the product of a concerted public relations exercise aimed at the Christian parents of America.

Even if we are charitable and allow that ID might be a kind of science, it is a dreadfully obscure and unsuccessful kind of science. If, in the future, ID became the basis of a serious and fruitful scientific research programme and thus converted a substantial proportion of the scientific community to its views, then it might be reasonable to discuss the inclusion of ID on a science curriculum (if First Amendment objections could somehow be overcome). At the moment, ID is supported by a tiny handful of very marginal scientific figures, is rejected by the rest of the scientific world, and appeals to a wider public for patently religious reasons. There is an almost endless list of interesting scientific and philosophical controversies that would be candidates for inclusion on a 'controversy-based biology curriculum'. But many would be excluded because they were too technically demanding, too far removed from mainstream science, or too clearly manufactured by a special-interest group for political and ideological reasons. The debate about ID would fail on all three counts. In addition to the political, legal, scientific, and theological reasons for excluding ID from science classes, then, there are perfectly good educational ones too.

There is no genuine scientific controversy about the relative merits of evolution and ID. But creationism and ID do draw attention to genuinely controversial questions about the nature of science and its place in society: Should voters, elected politicians, judges, or scientific experts have the final say about what is taught in the science classes of publicly funded schools? Why has modern America proved such fertile ground for the growth

of anti-evolutionary movements? Can God ever be discovered through scientific methods? Can testability, falsifiability, naturalism, or any combination of these, be invoked as viable demarcation criteria? Wherever comparative religion and the history and philosophy of science are taught, creationism and ID can profitably be studied. Indeed, if the effect of the continued exclusion of ID from the science syllabus is that its advocates start a campaign for the inclusion of these other subjects on the curricula of publicly funded schools, then some educational good may still come out of this peculiarly American controversy.