Doubting Darwin?

Creationist Designs on Evolution

Sahotra Sarkar

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Introduction

Good old-fashioned Creationism was the doctrine that the Book of Genesis is a scientific text that provides a historical record of the origin of the Earth's biota. It claimed that the world is about 10,000 years old and that the fossil record has to be reinterpreted to accommodate this chronology. Good old-fashioned Creationism was bold and fun: if the reinterpretation of the fossil record requires a change in the laws of physics, Creationism said, so be it. Creationism accepted that the Flood happened as the Bible records it. Sloths would have had to migrate from West Asia to the neotropics in the allotted time, wombats to Australia. These sloths would have to move very, very fast, something that they are physiologically not prone to do. Old-fashioned Creationism could live with all of that. Biogeography places formidable challenges to Creationism – but those who are unconstrained by the laws of physics would presumably find it child's play to alter the facts of mere biogeography. Creationism can even live with the fact, first described by Andreas Vesalius in 1543, that, very strangely, men have the same number of ribs as women.[1]

But Creationism underwent a long-overdue Reformation in the 1990s in an attempt to make it more compatible with the findings of modern science. Unreformed Creationism lives on, in places such as the Creation Evidence Museum in Glen Rose, Texas. The museum sells books with titles such as *Crash Goes Darwin . . . and His Origin of Species*, *Dinosaurs by Design*, and *Noah's Ark: A Feasibility Study*;[2] fascinating books, but largely irrelevant as the Reformation has swept across all those institutions which urge the rejection of contemporary science and a return to an essentially fundamentalist religious view of the world. These institutions – for instance, the so-called Discovery Institute in Seattle – want to reform biological curricula in high schools in the United States and elsewhere to bring God back into science classrooms. But they do not want unreformed Creationism – at least that is the official story. They want Reformed Creationism.[3]

According to Reformed Creationism, we need no longer believe that the world is only about 10,000 years old, or that all extant animals are descended from those that jumped off Noah's Ark on Mount Ararat some 8,000 years ago. Darwin and evolution are no longer always equated with evil and blasphemy.[4] Instead, Reformed Creationism accepts parts of evolutionary biology, including some role for natural selection. It accepts that blind variation and natural selection – "Darwin's law of higgledy-piggledy" as the physicist John Herschel dismissively called it[5] – can explain phenomena such as the evolution of drug resistance in bacteria or pesticide resistance in insects. Most versions of Reformed Creationism even accept that natural selection may have modified traits such as the size and shape of bird beaks. For instance, they sometimes accept that natural selection molded the beaks of Darwin's finches in the Galápagos Islands where the size of available seeds selected for the form of beaks.[6] These versions of Reformed Creationism generally accept common descent: that all extant organisms are descended from a single ancestor in the recesses of deep time,[7] presumably the first cell.

Nevertheless, Reformed Creationism urges us to reject the view that evolutionary theory, coupled with our increasing knowledge of the physics and chemistry of living organisms, will eventually explain the emergence of all biological phenomena. Moreover, to get a full theory, it claims, we will have to embrace supernatural (or at least extra-natural) mechanisms. In particular, we will have to invoke the operation of a designing intelligence guiding the process of organic change. Reformed Creationism is called Intelligent Design (ID). Its intellectual stalwarts are Philip Johnson, William A. Dembski, and Michael J. Behe and much of this book will concern their arguments, though several lesser players will also enter the stage.[8]

The Central Argument

ID creationists' most fundamental biological claim is that complex adaptations could not have been produced by natural selection or any other natural process. Their emergence requires the intervention of an extra-natural designer. Bacterial flagella and the blood clotting cascade in mammals are their favorite examples though there are several others (see Chapter 6). This claim of impossibility is supposed to be bolstered by some alleged mathematical results from computer science and information theory – we will examine all these issues in this book.

One central argument underpins all of ID creationism. Briefly, that argument runs as follows: *first*, evolutionary theory is supposed to allow only: (i) the inheritance of traits; (ii) the occurrence of blind variation; and (iii) natural selection. (Chapter 2 will contain a detailed examination of these assumptions.) *Second*, according to this argument, evolutionary theory cannot at present explain many natural phenomena, in particular, the evolutionary emergence of biological complexity. *Third*, this failure is so blatant that it shows that evolutionary theory does not even have the conceptual resources to explain the emergence of complexity. (This "no conceptual resources" claim is critical to the success of the argument because, without it, evolutionary biologists have an obvious response: wait and see – as our science progresses, we will resolve the present difficulties.) *Fourth*, proponents of ID go on to claim, there is good reason to believe that the required resources must include intelligent mechanisms.

The aim of this book is to examine this argument – for ease of future reference, we will call it the "Central Argument" of Intelligent Design. Though the rejection of the Central Argument is the main conclusion defended in this book, what evolutionary biology actually says – and does not say – receives just as much critical attention as the Central Argument. This is also a book about biology, its philosophy, and its history – a feature of this book which makes it different from several very competent critiques of ID that have appeared recently.[9] However, Ken Miller's 1999 book, *Finding Darwin's God*, discusses a lot of the biology excellently.[10] Miller's book focuses on the ID creationists' major claims from the late 1990s. This book concentrates on the period since 2000 and, in that sense, complements Miller's treatment though there is some overlap (mainly in Chapter 6). Finally, this book is also a qualified defense of *naturalism*, the claim that the methods of science and their extensions are all we have to guide us through the enterprise of obtaining knowledge of the world. Here it parts company with Miller and his theological preoccupation of reclaiming God from the creationists – see Chapters 8 and 9. Naturalism, as we shall see later in the book (particularly in Chapter 9), is the real target of ID creationists and we will see how it fares under their criticisms.

Let us return to the "no conceptual resources" claim which, as we noted earlier, is critical to ID's Central Argument. There are two ways in which this claim can be fleshed out: (i) there is an abstract characterization of what is permitted by a theory, and a theorem or some such result that shows that some specific observed phenomenon is not permitted by the theory. This provides, essentially, a *reductio ad absurdum* argument against the theory; or, (ii) there is a body of phenomena that has proved recalcitrant to explanation over a sustained period of time, and these phenomena are better explained by some other fundamentally different theory even if that theory calls into question what was then the dominant scientific metaphysics. (Metaphysics, here, is taken to mean the most general assumptions about the world which all scientific theories must satisfy even when they disagree with each other.) ID creationists have tried both the options mentioned above. We will call the former the "inconsistency" option and the latter the "incompleteness" option.

Note that, if we accept the Central Argument, we must first give up one of the most successful scientific theories of our time – the theory of evolution by natural mechanisms. (Recall the evolutionary geneticist Theodosius Dobzhansky's famous, though perhaps rhetorically overstated, dictum: "Nothing in biology makes sense except in the light of evolution."[11]) We must next give up the dominant and even more successful metaphysics that has grounded science since at least the Copernican era: naturalism. Naturalism is often taken to claim that all that exists in the universe is processes and entities knowable to us through scientific methods, that is, through logic and our senses, with no recourse to entities and processes entirely inaccessible to these methods. When formulated in this way, naturalism makes both metaphysical and epistemological claims, about what may exist and how we may come to know about them. Ultimately, naturalism is the real target of ID because it forbids the reintroduction of divinity into the empirical world. The attack on evolutionary theory is a necessary stage in this campaign because evolutionary theory claims that, not only the entire biological world, but even our most fundamental human features – our minds, our morals – should be accounted for without appeal to extra-natural intervention.

However, a defense of evolution in the present context of what constitutes *science* does not require the metaphysical component of naturalism. All it requires is a very weak form of epistemological naturalism, usually called methodological naturalism, which limits science to those facts that are accessible to naturalistic methods as defined above.

Methodological naturalism allows the possibility of a religious realm to be explored using religious practices. It merely asks that this realm be kept distinct from science. Though Chapter 9 of this book will defend a stronger form of naturalism than methodological naturalism, the weak doctrine is all that we need to defend evolutionary biology against ID creationism.

A demand that we give up a particular scientific theory is not radical: the history of science is littered with examples of highly successful scientific theories being replaced by successors that are even better. The caloric theory of heat gave way to the kinetic theory in the nineteenth century.[12] Heat turns out not to be a fluid called "caloric"; rather, it is the agitation of matter in motion as the kinetic theory demands. Darwin's blending theory of inheritance was similarly replaced by Mendel's particulate theory.[13] Offspring traits are not intermediates between parental traits produced by a mingling of hereditary material. Rather, parents pass on discrete factors or "genes" (more accurately, *alleles* or versions of genes) which help specify offspring traits. Offspring traits may well be identical to those of one of the parents or even one of the grandparents. The growth of science requires the replacement of old theories and their replacement by better new ones.

The Evidence for Evolution

We can reasonably be asked to give up a theory if it fails to save the phenomena. A central claim of ID is that, indeed, there are many phenomena that evolutionary theory cannot explain. We will examine those claims in detail in later chapters of the book. Meanwhile, it will suffice here to sample some of the phenomena that evolutionary theory does explain and which, therefore, provide our evidence for evolution. This is not to suggest that evolutionary theory is complete or that there are no legitimate debates about evolution. We will discuss a host of problems in Chapter 4. But, here, we present the case *for* evolutionary theory.

Evolution means modification by common descent through a variety of natural mechanisms. Most, though not all, evolutionary biologists believe that the most important of these mechanisms is natural selection, the production of more offspring by some types over others. Assuming that some of the traits of the parental types are inherited by the offspring, these traits will spread because of the higher number of such offspring – there is nothing mysterious about natural selection. Modifications arise because of changes in the genes through which parental characteristics are transmitted to the next generation. Some modifications are minor. For instance, a mutation in a single gene in humans can make the bearer produce a different form of hemoglobin than the usual one and become susceptible to sickle cell disease (a painful form of anemia). However, this mutation also makes bearers, provided they also carry a copy of the normal gene, resistant to many types of malaria. Thus, in an environment in which these forms of malaria are prevalent, the modification would be selected for.

Not all modifications are minor and, according to evolutionary theory, the accumulation of many minor modifications may lead to major changes. Thus, humans and the great apes all descended from a common ancestor from which humans have diverged quite radically through successive small modifications. Similarly, birds are generally believed to have evolved out of theropod dinosaurs through small modifications though some recent findings suggest a more complicated story.[14] All mammals similarly evolved from a group of reptiles that lived over 200 million years ago.[15] We will encounter many other examples later in the book.

Though this level of detail is atypical for an Introduction to a book, the rest of this section will document some of the specific evidence for evolution. The aim is to drive home the variety and depth of the evidence that makes the theory so compelling for biologists. ID creationists must seriously confront all this evidence if they are intellectually honest. As the noted evolutionary biologist Ernst Mayr points out, our confidence for evolution comes from the consilience of four major types of evidence: (i) the fossil record; (ii) morphological similarities between organisms; (iii) biogeography; and (iv), of late, the molecular constitution of organisms.[16] What follows is not intended as a systematic survey of all of the evidence for evolution: even a cursory such survey would fill a book much longer than this. Moreover, because contemporary ID creationists generally do not deny either the fact of evolution or the operation of the standard mechanisms of evolutionary change, denying only that these mechanisms suffice to explain *all* of organic change, such a survey is not strictly necessary. Nevertheless, having the concrete evidence of the achievements of evolutionary theory fresh in our minds will help us navigate the issues discussed in this book:

(i) *The Fossil Record*. Darwin and the early proponents of evolution all started from the fossil record, and so shall we. Fossils of extinct organisms are found in geological strata that can be accurately dated using a variety of techniques including radioactive dating with carbon (C-14), potassium (K-40), uranium (U-238), and other isotopes. Fossils found in recent strata are closely related to – and sometimes indistinguishable from – extant organisms. But this similarity diminishes steadily, layer by layer, as we examine fossils from more distant strata. There are gaps in the fossil record but, as time has gone on, these gaps or missing links have become less numerous. Sometimes spectacular discoveries have filled these missing links. For instance, in 1861, a fossil of a bird found in the upper Jurassic era (145 million years ago [Mya]), Archaeopteryx, was discovered in southern Germany. It had teeth, a long tail, and other characteristics of the reptilian ancestor posited for birds by evolutionary biologists. But it also had a large brain, large eyes, feathers, and wings. The latter set of features showed it to be a transitional form between modern birds and the common more reptilian ancestor of both modern reptiles and birds. It was almost certainly capable of flight. Since 1940, at least 12 other "missing" links between birds and their reptilian ancestors have been discovered.[17]

In some cases the fossil record is remarkably complete with most expected transitional forms having already been found.[18] These cases include the lineage leading from therapsid reptiles to mammals and that leading from Eohippus (the ancestral horse) to Equus (the modern horse). Moreover, with virtually no exception, fossils have been found only in the time period evolutionary theory predicts that they should be found. There are no anomalous fossils, for instance, fossils of the same species found in inconsistent geological strata. If we found a fossil rabbit in strata from the Jurassic era (206–144 Mya), as the great evolutionary biologist, J. B. S. Haldane, once remarked, we would consider abandoning the theory of evolution. The fossil record supports evolution – descent with modification – though, by itself, it cannot give direct evidence of the mechanisms of that change, whether it is entirely due to natural selection. To get a handle on why evolution occurred, we must turn to morphological variation among the organisms that exist today.

(ii) *Morphology*. As evidence for evolution, morphological similarity performs even better than the fossil record in providing support for evolution and even helps to resolve the problem of identifying mechanisms of evolution. Morphological similarity is ubiquitous, not only between ancestor and descendant as determined from the fossil record, but also between related organisms today. Even before Darwin, starting especially with the work of the Swedish botanist Carl Linnaeus in the eighteenth century, morphological similarity was used by systematicists to organize all known species in a taxonomic hierarchy allegedly created by God. Evolution, that is, descent with modification from a common ancestor, gave a straightforward earthly explanation of this hierarchy. Descent with modification is why the wings of birds resemble the anterior extremities of mammals – the two structures are *homologous* because their similarity is explained by the fact that they share a common ancestor. Homologies – similarities due to common ancestry – are critical to our arguments because even ID creationists admit that close homologies (that is, overwhelming similarities) between related species point to gradual changes from the common ancestor. We will often argue from homology throughout this book.

In cases such as that of wings we can infer – though not prove conclusively, as skeptics love to point out – the role of natural selection in modifying the form. We can tell a consistent story of such modification through the extensive fossil record. Vestigial organs – for instance, the human appendix – are similarly explained as homologs of functional similar organs in related organisms. Moreover, once we go beyond fossils and also focus on organisms living today, we can elucidate the mechanisms of evolutionary change and, ideally, even test quantitative models of natural selection. Comparative morphology begins to fill in the gap left by the fossil record about the possible mechanisms of descent with modification.

(iii) *Biogeography*. Biogeography provides equally compelling evidence for evolution. For many observed biogeographical patterns there is no explanation other than evolution with branching descent. There is only one species of mockingbird in continental South America (*Mimus gilvus*).[19] However, during the voyage of the *Beagle* Darwin found three different mockingbird species, now called *Nesomimus trifasciatus*, *N. parvulus*, and *N. melanotis*, in three different islands of the Galápagos group. Evolution explains how each of these diverged from a common ancestor they shared with *M. gilvus*. In the case of Darwin's finches, also from the Galápagos islands, quantitative work has detailed how changes in beak morphology in different islands are brought about by natural selection.[20] Evolution explains biogeography at every spatial scale, as Darwin's co-discoverer of the theory of natural selection, Alfred Russel Wallace, showed in detail in the 1870s.[21]

Evolution explains why the faunas of Europe and North America on different sides of the north Atlantic ocean are similar while the faunas of Africa and South America on different sides of the south Atlantic ocean are not. It even explains puzzling discontinuous geographical distributions of related species. For instance, true camels (*Camelus dromedarius* and *C. bactrianus*) are found only in Asia and Africa. Their closest relatives are the llamas (*Lama glama*, *L. glama pacos* or alpaca, and *L. guanicoe* or guanaco) and vicuñas (*Vicugna vicugna*) of South America. But, if evolution is the continuous process that we believe it to be, there should be camels of some sort or other in North America. There are none at present, but the fossil record includes a large fauna of Tertiary era North American camels, now long extinct. Camels are believed to have originated in North America and migrated to South America, Eurasia, and Africa. The fauna of Europe and North America are similar because a land bridge connected the two in the early Tertiary era, 40 Mya. In contrast, continental drift separated Africa and South America 80 Mya and their fauna have diverged ever since. Biogeography, morphology, and the fossil record mutually reinforce each other in the service of evolutionary theory.

(iv) *Molecular evidence*. Finally, the past fifty years have churned out a vast body of molecular evidence all pointing towards evolution. The more related that two organisms are according to evolutionary theory, the more similar should be the molecules constituting them. The agreement between theory and evidence has often been spectacular. Molecules evolve in the same way as other structural elements of organisms: descent with modification is ubiquitous. However, different types of molecules evolve at different rates: fibrinopeptides, molecules involved in the clotting of blood, evolve very rapidly; histones, small chromosomal proteins, are exceedingly conservative, that is, resistant to evolutionary change. Molecular analysis has also cleared up many evolutionary puzzles. Fungi were long regarded as being plants or at least close to plants. Yet, their cell walls consist of chitin, also found in the hard parts of insects, but never in plants. Molecular analysis revealed that the basic chemistry of fungi is close to that of animals. Today, fungi are classified in a separate kingdom distinct from both plants and animals. Once we turn to the DNA in our genetic material, we see evolutionary theory quantitatively confirmed in many cases. For instance, if natural selection is a major force of evolution, we would expect DNA sequences coding for functional protein molecules to be much more constrained, and evolving much more slowly, than non-coding non-functional DNA sequences. That is exactly what we find. Molecular evidence also dispels the view – once also held by the majority of evolutionary biologists – that all modern animal phyla appeared more or less fully formed and almost suddenly, in the pre-Cambrian era, about 550 Mya – there will be more on this in Chapters 4 and 7. Molecular homologies are ubiquitous and we will turn to them in Chapter 6. These homologies are now extensively used to reconstruct evolutionary history.

Rejecting Theories

Convincing scientists – or even the educated public – to give up a theory as powerful as the theory of evolution will not be easy. But, recall that the ID creationists would not be satisfied with merely that; they also want a transformation of our metaphysics. They want us to give up naturalism. On occasion, we do give up metaphysical assumptions. Though naturalism itself has not been called into question within science since its rise to dominance in the seventeenth century, there are several examples of deeply held – and empirically successful – theories being replaced by successors deemed metaphysically impossible in earlier times.

Consider the following four examples, keeping in mind the question whether contemporary ID is on par with any of them. We range over the sciences also to highlight the fact that ID's assault on naturalism is an assault on all of science, and not only evolutionary biology:

(i) *Newton's mechanics*. Let us begin with the part of physics we teach first in high school, and which we continue to use in most of our everyday life: classical mechanics. In 1687 Isaac Newton published *Principia Mathematica* in which he propounded the three laws of motion that still bear his name. He also propounded a new theory of gravitation – the "Law of Universal Gravitation." Newton's theory unified celestial and terrestrial mechanics: it showed that the laws governing the fall of bodies on earth (for instance, Galileo's law of the pendulum) explained the laws which governed the motion of planets, that is, Kepler's three laws. Newton's theory correctly predicted the return of Halley's comet in 1758. There was never much doubt about its predictive power and success.

The trouble was that Newton's theory assumed action-at-a-distance, that distant bodies influence each other instantaneously through gravitation. The dominant scientific metaphysics of the day, the mechanical philosophy of Boyle, Descartes, and Huygens, did not permit action-at-a-distance: all interactions were supposed to be mediated by local contact between impenetrable particles of matter. From the point of view of the mechanical philosophy, action-at-a-distance was "occult," as Leibniz put it, or even "absurd," as Huygens opined.[22] But the mechanical philosophy had no convincing account, let alone a quantitative explanation, of planetary motion. Descartes, for instance, had a purely qualitative theory of vortices that was never successfully quantified. Attempts to find a quantitative mechanical explanation of planetary phenomena continued well into the eighteenth century, at times co-opting the efforts of such eminent mathematicians as Leonhard Euler.

But all this effort was expended to no avail. By the end of the eighteenth century it was clear that the mechanical philosophy probably did not have the conceptual resources to account for all physical phenomena: gravitation had remained recalcitrant for over a century, and Newton's simple law saved the phenomena though it required a change of metaphysics. Action-at-a-distance had come to stay and the mechanical philosophy was on its way out by the nineteenth century. In a last-ditch effort, some figures such as Hermann von Helmholtz tried to resuscitate the mechanical philosophy by changing its assumptions to allow action-at-a-distance so long as it was governed by "central" forces (roughly, forces directed along lines joining the centers of material bodies). But these efforts were of no avail. The phenomena had forced a change of metaphysics.

(ii) *General relativity.* Newton's eminence in the eighteenth century is aptly captured by Alexander Pope's intended epitaph for him:

> "Nature and Nature's Laws lay hid in night
> God said: let Newton be and all was light."

Central to Newton's reputation was his law of gravitation discussed earlier. By 1798 Henry Cavendish had measured the gravitational constant found in Newton's law, obtaining a value the accuracy of which has not been very significantly improved to this day. The early nineteenth century only saw Newton's theory of gravitation extend its success. Using

Newton's law, in the 1840s, John Couch Adams and Jean Joseph Le Verrier showed that well-known anomalies in the motion of Uranus, that is, deviations from what was predicted by Newton's law, could be explained by positing the existence of an eighth planet and retaining Newton's law. Le Verrier's prediction was immediately confirmed in Berlin by Johann Gottfried Galle in 1846. Adams was English, Le Verrier French, and a bitter priority dispute broke out with each backed by his own national scientific establishment. At stake was the name of the new planet which eventually came to be called "Neptune."

The discovery of Neptune was the high point of the history of Newton's theory of gravitation because another much more recalcitrant anomaly soon emerged. In 1859 Le Verrier pointed out that there was a discrepancy between the observed motion and the predicted motion of the perihelion of Mercury (the point at which it is closest to the Sun) as predicted by Newton's law.[23] Le Verrier found the discrepancy to be 38″ per century; by 1882 it was known to be 43″. Over the years many solutions were proposed: Venus was 10% more massive than believed; there was another planet or a ring of matter within Mercury's orbit; Mercury had a moon; the Sun was more oblate than observed; and so on. It was also proposed that Newton's theory required modification, and this was the only proposal not soon ruled out by experiment or observation. At the beginning of the twentieth century the perihelion problem remained unresolved.

The solution came from Einstein around 1915.[24] But it required more than any ordinary modification of Newton's law of gravitation. Einstein's new theory of gravitation, also known as general relativity, reinterpreted gravitation as the curvature of space-time. It cast aside the view, then doubted by no one, that space and matter were independent of each other. Along with that metaphysical principle went the claim that the Euclidean (or flat) geometry of space is a necessary truth. We live in a curved space-time, one in which that curvature is continually changing as pieces of matter move around. General relativity did more than only explain the perihelion shift of Mercury. It predicted that light would bend around matter. A 1919 British expedition led by Arthur Eddington to the western Pacific to record the passage of light during an eclipse found just what was predicted. Subsequent experiments have only added to our confidence in the theory in spite of the metaphysical readjustments it has demanded. It is fitting to conclude with an addendum, by John Colling Squires, a British journalist, to the couplet by Pope with which we started:

"It did not last: the Devil howling 'Ho!
Let Einstein be!' restored the status quo."

(iii) *Quantum mechanics*. Let us turn to what is regarded as the most radical conceptual change in physics in the twentieth century: quantum mechanics. One important innovation of early nineteenth-century physics was the wave theory of light, a departure from Newton's view that light consisted of particles. Shortly afterwards, in the 1830s and 1840s, Michael Faraday and others showed that electricity and magnetism were related phenomena. Between the 1850s and 1870s James Clerk Maxwell developed Faraday's intuitive ideas about "fields" of electrical and magnetic forces to formulate a unified mathematical theory of electromagnetism. One consequence of this theory was that light consisted of electromagnetic waves. Like all other waves, light waves were believed to be continuous. Light is both emitted and absorbed by matter creating what are called emission and absorption spectra: the precise distributions of the wavelengths at which light is either emitted or absorbed. These spectra are characteristic of the material being studied. By the 1890s several laws governing these spectra were empirically well established.

However, between 1900 and 1905 Max Planck and, especially, Einstein showed that these laws could be made consistent with the rest of physics only if we deny the unlimited validity of Maxwell's theory of light and accept that light comes in discrete chunks or "quanta." It took a quarter-century, until the late 1920s, to make any sense of quantum theory. It was a joint effort, with contributions from many physicists including Niels Bohr, Werner Heisenberg, Max Born, Erwin Schrödinger, and Paul Dirac. The result, quantum mechanics, is arguably the greatest achievement of physics to date. Quantum mechanics provides the foundation for chemistry, explaining the rules of valency. At the practical level, it provides the basis for electronics. It is indispensable for the understanding of particle physics. As the physicist Eugene Wigner liked to point out, with quantum mechanics, for the first time, we can explain the stability of matter, why matter does not decay spontaneously. Indeed, within the biological context, Schrödinger believed, erroneously as it turned out, that quantum mechanics would be necessary to explain the stability of genes (alleles) across hundreds of generations.[25]

But the acceptance of quantum mechanics came at an unprecedented metaphysical cost. We have been forced to abandon determinism: the doctrine that, given the present state of the world, the laws of nature are such that, at any future instant of time, there is only one possible state of affairs.[26] Traditionally, that assumption lay at the foundations of the scientific enterprise, the attempt to understand the universe in terms of exceptionless general laws. Quantum mechanics denies that. Moreover, it decrees that some individual systems may also not be in a determinate (or definite) state at all times, contrary to anything permitted in classical physics (and, indeed, the rest of science). Yet the empirical success of quantum mechanics forced a re-evaluation of such foundational claims. Einstein, for one, was never satisfied with the new metaphysics that quantum mechanics requires, and contemporary philosophers of science (and some physicists) continue to debate its interpretation. There are even those who retain the hope that future developments will allow us to regain the metaphysical certainties of old without eschewing the empirical success of the new physics. We will return to quantum mechanics in Chapter 10.

(iv) *Natural selection.* The fourth example is the one central to the concerns of this book: Darwin's and Wallace's theory of evolution by natural selection which will be treated in detail in Chapters 2 and 3. The success of the theory of natural selection removed design and teleology from nature, replacing them with explanations in which causes always precede effects, and nothing but physical law guides the course of all systems, including biological ones. As Francisco Ayala puts it: "It was Darwin's greatest accomplishment to show that the directive organization of living beings can be explained as a result of natural process, natural selection, without any need to resort to a Creator or other external agent."[27] ID creationists want to resuscitate design and teleology – *ipso facto*, they have to reject evolutionary theory or at least seriously delimit its domain.

Each of these examples is a successful path-breaking episode in the history of science. In each case a revision of metaphysics was forced by the astounding empirical success of a new bold theory which challenged established metaphysical principles. If ID creationists want their claims of revolutionary success to be taken seriously, what they must show is that the choice between ID and conventional evolutionary theory is similar to the choices faced in these examples. Otherwise we would have no reason to forsake well-established metaphysical principles. Moreover, in none of the first three examples, radical as they are, is naturalism itself at stake. To make us question naturalism itself, ID creationists must do even better than the proponents of the new theories in all these cases.

They must do at least as well as Darwin and Wallace and their followers when they reinterpreted the history of life in the nineteenth century without recourse to a designer.

In fact, they must do better. With respect to naturalism, the case of the theory of natural selection is curious. Before the acceptance of that theory, the adaptation of organisms was beyond what natural law could explain:[28] they were yet to be brought within the realm of science in the same way many aspects of our mental and cultural lives today are beyond what contemporary science can explain. (This is not to say that some scientists, for instance, human sociobiologists and Evolutionary Psychologists, do not claim to provide such explanations. It is to deny that these claims are credible – there will be more on this point in Chapters 2 and 4.) What the theory of natural selection did was to draw adaptation into the realm of science. Now ID wants to reclaim complex adaptations from the scientists. But they are faced with the situation that naturalism works not only for the study of adaptations, but for all of the rest of science.[29] So, ID creationists are faced with an even more difficult task than the one that confronted Darwin and Wallace. The founders of evolutionary theory were only establishing consistency between a recalcitrant domain (the study of adaptations) and the rest of science. ID creationists want to reject all of it. We should be impressed by the audacity of the project though, as this book will show, some humility would have served the ID creationists better.

Let us set aside evolutionary theory for the time being – after this chapter, the rest of this book, except Chapter 8, will only concern it. The other three examples provide reliable methodological principles for us to adopt.[30] There are at least six lessons to be learned:

(i) we should abandon theories only when there is compelling unimpeachable evidence against them, unimpeachable in the sense of not being merely a question of controversial interpretation of the evidence.[31] There was no doubt about whether the successful predictions made by Newton's law of gravitation posed a problem for the mechanical philosophy. There was also no doubt about the relevance of the anomalous motion of the perihelion of Mercury to Newton's law of gravitation: even proponents of the law regarded the anomaly as a problem;

(ii) before abandoning a theory altogether, it is reasonable to attempt to modify it minimally or change our other less important assumptions to see if we can accommodate the recalcitrant data. This point is exemplified by the relatively minor modifications of Newton's law attempted in the nineteenth century, as well as the modifications of assumptions about the mass of Venus, the shape of the Sun, and so on, all to save Newton's law of gravitation;

(iii) in the face of problems with a theory, before abandoning the metaphysical principles underlying the theory, it is again reasonable to try to find alternatives to the theory that remain consistent with those principles. Trying to find mechanical explanations of planetary phenomena was entirely appropriate. Trying to modify Newton's law minimally to save the basic framework of his theory was also appropriate. Metaphysical principles which lie at the foundation of a science are not for everyday exchange, as Thomas Kuhn and Imre Lakatos pointed out long ago;[32]

(iv) we should abandon an old metaphysical principle and adopt a theory based on new ones only when there is clear and compelling evidence for the latter – every example above illustrates this point;

(v) mere metaphysical difficulty with a theory is not sufficient for its rejection: there must be a compelling empirically successful alternative. Contrary to Philip Johnson, "purely negative arguments," criticizing alleged explanatory failures of evolutionary theory, is not good enough.[33] Thus Newton's law triumphed over the mechanical philosophy, relativity eventually replaced Newton's mechanics, etc., only because of unimpeachable positive evidence supporting the successful alternatives. Moreover, so long as a theory is empirically successful, in the absence of such an alternative, we will tolerate any deviant metaphysics it embraces. Empirical success trumps metaphysical scruples. Action-at-a-distance was palatable so long as Newton's law faced no anomaly. Quantum mechanics continues to be endorsed in spite of all its discomfiting metaphysical commitments; and

(vi) all these examples and the preceding points show that confidence in metaphysical principles is based, ultimately, on empirical facts, in exactly the same way that confidence in a particular theory is. Yet, this is what proponents of ID try to deny.[34]

Two final comments about these four examples are relevant to our context: (a) we continue to tolerate empirically successful theories, while we hope to do better eventually, even if they invoke inconsistent scientific or metaphysical principles. It is well known that the deterministic world of general relativity is in conflict with the indeterminism of quantum mechanics, and both theories claim to have all physical systems within their domains. Theories that would resolve this conflict remain speculative at present. Nevertheless, we continue to hold both theories because, in practice, they are used in sufficiently different domains so that the potential conflict can be ignored: quantum mechanics is used for atoms and smaller entities, general relativity for planets, stars, galaxies, and larger entities. Good theories are rare: we use them wherever we have them and we do not give them up easily; (b) our examples come from both physics and biology. This is important because part of the rhetoric of ID is to argue that there are relevant differences between physics and biology which show that the reliability of mature biological theories is not anything like that of mature physical theories. To show that changes of metaphysics and changes of theory in physics follows the same pattern as in biology undercuts that claim.

The first three lessons listed above are relevant to the "no conceptual resources" claim of the Central Argument but only when that claim is based on the incompleteness option (that is, there remain recalcitrant phenomena unexplained). The inconsistency option – rejecting a theory because what it permits, at a very general level, is inconsistent with observed phenomena – has rarely been deployed in the history of empirical science though there is one ambiguous example among the cases we have already introduced.[35] Einstein's dissatisfaction with quantum mechanics led him to formulate an alternative deterministic framework in the 1930s.[36] These ideas were developed by John S. Bell in the 1960s to derive a mathematical inequality which violated quantum mechanical predictions.[37] A large number of experimental tests since have uniformly come out in favor of quantum mechanics. This example may be regarded simply as a case in which two theories make definite predictions and one of them does so correctly. However, it is probably more useful to regard it as a case where the inconsistency option is being deployed against a theory. The Einstein–Bell argument is based on very general and compelling assumptions of what any deterministic theory should look like, rather than being an explicit theory, and the theoretical predictions of quantum mechanics are inconsistent with what is permitted by this deterministic framework.[38]

In spite of the rarity of its deployment in the history of science, much of this book will concern the inconsistency option because of its systematic use by ID creationists. To that extent we will charitably allow negative argumentation: it will not make any difference to the conclusions we reach. Typically ID creationists provide what they take to be an abstract characterization of evolutionary theory, then examine what they claim to be the range of possibilities that are permitted by it, and then produce an alleged empirical counter-example from the biological world. Rare though it may be in the history of science, this is a legitimate strategy so long as the characterization, the derivation of the range of possible outcomes, and counter-example, is each correct. (Moreover, *reductio ad absurdum* proofs, which provide a useful analogy, are commonplace in mathematics.) But the very fact that ID creationists use an option so rarely used in the history of science already suggests that ID creationists do not wish to play by the everyday rules of scientific practice. But, perhaps, this is inevitable since their claims are so radical – after all, in demanding a rejection of naturalism, they want a change of metaphysics more fundamental than all but the last of our examples.

Plan of the Book

We will conclude this Introduction by sketching the course of the book. Chapter 2 of this book deals with Darwin, Wallace, and the first formulation of the theory of natural selection. It delves into some details of those aspects of the development of evolutionary theory that remain salient to discussions of ID today. It includes a discussion of Wallace's heresy, his endorsement of the existence of a spiritual world interacting with ours, which has been surprisingly ignored by ID creationists. Chapter 3, which is also mainly historical, turns to the question why the theory of natural selection required a change of worldview or metaphysics at least as profound as that required by Newton's theory of gravitation, relativity theory, or quantum mechanics. This chapter also disposes of the most traditional objection to natural selection, Paley's argument from design, and its attempted recent resurrection by Dembski. This refutation is not particularly difficult or insightful but, nevertheless, is included here for the sake of completeness. For all the wild enthusiasm of ID supporters, Dembski's resurrection is ultimately no better than Paley's original argument.

Chapter 4 gives a historical account of the emergence of contemporary evolutionary theory and of its central claims today. The history is used to provide a survey of contemporary evolutionary theory. The chapter also includes a discussion of several issues that remain in legitimate debate within evolutionary theory. It also introduces distinctions that will be enforced throughout the rest of this book: those between contemporary evolutionary theory, the more restricted theory of natural selection, and Darwinism in the sense of what Darwin historically said. ID creationists routinely conflate these categories for rhetorical purposes, for instance, to use some limitation of Darwinism to argue against contemporary evolutionary theory. The illegitimacy of such a move will be a recurrent theme in this book.

Chapter 5 turns to the so-called No Free Lunch (NFL) theorems from computation theory that are supposed to show that natural selection is no better than random search in attempting to find a well-designed solution to evolutionary problems. This chapter points out that evolution is largely not an optimization process and very rarely falls within the orbit of such theorems. Even where it does, the ID creationists' interpretation of the NFL theorems is illegitimate. Chapter 6 turns to what Behe calls "irreducibly complex systems" that are supposed to be "in principle" unevolvable because their functioning requires the coordinated action of unsubstitutable parts. This chapter shows through the detailed examination of a variety of examples – both Behe's and others – that the claim of "in principle" unevolvability is false. Moreover, though there are many instances of complexity that continue to challenge evolutionary explanations, there is a growing set of cases in which this challenge has already been met.

Chapter 7 turns to the question whether modern information theory poses a challenge to the theory of evolution. It points out that the standard quantitative models of information allow accumulation of information through evolution by natural selection. It notes that Dembski's account of "information" is idiosyncratic. Consequently, information theory cannot be legitimately be used to challenge – or defend – evolutionary theory. This chapter also analyzes – and disposes of – Dembski's claims about the challenge posed by "complex specified information" to evolutionary theory. Claims such as Dembski's law of the conservation of information are largely figments of an apparently over-excited imagination.

Chapter 8 turns to an issue somewhat beyond the mainly biological concerns of this book: the "fine-tuning" argument which is supposed to show that certain cosmic coincidences lie beyond the scope of naturalistic explanation. It shows that this argument is no better than Dembski's failed argument from design. Chapter 9 turns to the question of whether ID – including the fine-tuning argument – poses a credible challenge to naturalism. Distinguishing between methodological and metaphysical naturalism, it argues that no such challenge has been launched against the former, noting that this modest conclusion is all that is required to fully defend evolutionary theory. In contrast, the legitimacy of metaphysical naturalism (even if that doctrine is correct) is irrelevant to that question. Nevertheless, to the extent that practice of science brings with it metaphysical commitments, it defends metaphysical naturalism. But this defense is limited – the practice of science does not require religious belief or disbelief properly understood, when religion and science are seen to perform different, perhaps complementary, individual and social functions. Chapter 10 draws some conclusions, pointing out that scientists do take credible challenges to evolutionary theory seriously, examines the ways in which ID fails to be *science*, and considers whether it belongs in high school curricula.

An alert reader will have noticed that though this chapter has recapitulated ID's Central Argument against evolutionary theory and, in the process, has given a cursory description of what evolutionary theory claims (at least, as described by ID creationists), we have not been presented with a summary of ID theory: though books entitled *Intelligent Design* have appeared, ID creationists are remarkably evasive about what their theory is besides vague claims such as intelligence guides organic evolution or that ID has something to do with the transfer of information.[39] ID creationists have largely concentrated on attacks on evolutionary theory – hence the focus of this book.

Finally, though this chapter began with a mention of the socio-political agenda of the ID movement – to return God to the classrooms, and though the Preface laid out the political context in which we work as philosophers and scientists, this book is not about the politics of the ID movement. We only return to the socio-political arena in Chapter 10 and, even there, do so only very briefly. As the outline above delineates, the aim of this book is to provide a general analysis of the arguments and evidence presented by ID creationists and to do so accurately but accessibly because some ID creationists tend to mislead ordinary readers by clothing disreputable claims in vestments of impenetrable symbolism.[40]

9

Naturalism and Its Discontents

When asked about his religious inclinations, J. B. S. Haldane is supposed to have quipped that when he designed an experiment he assumed that God, the Devil, and the angels would not interfere with it. Haldane's assumption embraces a minimal form of methodological naturalism. For Philip Johnson and many other proponents of ID and other versions of creationism, their ultimate target is not merely the theory of evolution; rather, it is naturalism itself, the denial of any divinity operating in nature. This chapter will take up the question of naturalism and whether ID creationists have offered any reason for us to consider abandoning it. Recall, in this context, a lesson we gleaned from the examples of scientific and metaphysical change discussed in Chapter 1: the reasons required for giving up our foundational principles must be very compelling. Moreover, except in the case of the theory of natural selection, even the radical conceptual changes discussed in Chapter 1 did not raise questions about methodological naturalism, and the theory of natural selection finally brought biological adaptation under its purview.

Both methodological and metaphysical naturalism will be defended in this chapter, but what is here called "metaphysics" will probably not excite many professional metaphysicians. In any case, the concerns of this chapter are strictly philosophical – scientists may well choose to skip it and proceed directly to the concluding chapter.

What Naturalism Is

There is a variety of views about what constitutes naturalism. For Michael Ruse, the "methodological naturalist is the person who assumes that the world runs according to unbroken law; that humans can understand the world in terms of this law; and that science involves just such understanding without any reference to extra or supernatural forces like God."[1] Almost all scientists, like Haldane, assume some form of methodological naturalism similar to this, no matter what their personal religious beliefs happen to be. Beyond methodological naturalism lies a more ambitious and ambiguous doctrine, metaphysical naturalism (sometimes also called ontological naturalism). For Ruse, "metaphysical naturalism . . . argues that the world is as we see it and that there is nothing more."[2] The contrast should be obvious: unlike the metaphysical naturalist, for the methodological naturalist, "[w]hether there are [supernatural] forces or beings is another matter entirely and simply not addressed by methodological naturalism."[3] In this book we will construe methodological naturalism in Ruse's sense though what we identify as metaphysical naturalism will be somewhat different.

Though Ruse is a critic of ID creationism, there is no substantive difference between this definition of methodological naturalism and those produced by most explicitly religiously motivated ID creationists. For instance, Johnson writes: "A methodological naturalist defines science as the search for the best naturalistic theories. A theory would not be naturalistic if it left something . . . to be explained by a supernatural cause."[4] Thus the definition of methodological naturalism we use on this book is not controversial in the sense that it will distinguish us from the creationists.

Most critics of ID creationism emphasize the *methodological* aspect of methodological naturalism more explicitly than Ruse. What they emphasize is a commitment to scientific method and, consequently, defeasibility. This is the possibility that accepted results may be shown to be wrong in the future in spite of satisfying every methodological stricture at present, and even the methods used to obtain results are subject to revision in the light of future experience. As Pennock puts it: "The Methodological Naturalist does not make a commitment directly to a picture of what exists in the world, but rather to a set of methods as a reliable way to find out about the world – typically the methods of the natural sciences, and perhaps extensions that are continuous with them – and indirectly to what those methods discover."[5] This description does not contradict Ruse's definition. Rather it presumes the former definition because the typical methods of the natural sciences assume humanly recognizable lawlike behavior of parts of the world, no matter whether those laws are deterministic or only statistical. Suppose that some hitherto unknown entity is discovered to influence observable events but does so in some lawlike fashion. This "lawlike" fashion may even be "random": there are laws – the laws governing stochastic processes – that regulate what random events may or may not do. Such entities become part of science, to be studied by scientific methods demanding, typically, a certain amount of precision and repeatability. The extent of precision and repeatability depends on the context. The methods used in science are flexible, and naturalism inherits that flexibility.[6] All it excludes is caprice and unintelligibility in the behavior of things which, given the paucity of the details that they are willing to furnish, is what ID creationists such as Johnson seem to suggest constitutes "creation."

Let us initially also assume that the distinction between methodological and metaphysical naturalism is cogent – we will question this assumption later. For some ID creationists, including Johnson, *methodological* naturalism, provided that we honestly stick to it, is unproblematic. For Johnson, trouble arises only because methodological naturalism slides inexorably to metaphysical naturalism.[7] Others are more critical. Alvin Plantinga, for example, will have no truck with methodological naturalism itself. We will consider both types of objection, but let us start with a more detailed look at what naturalism is.

Nagel's Legacy

The first point to note is that, during the twentieth century, critics of naturalism – methodological or metaphysical – included many who accepted the theory of evolution and even some who had no religious inclinations. Defenders of naturalism also did not form a homogeneous group. ID creationists – in particular, Johnson – present naturalism and creationism as if these were mutually exclusive and jointly exhaustive alternatives.[8] This is the same game as that played by Dembski in his attempt to resuscitate the design argument, where regularity, chance, and design were similarly presented as mutually exclusive and jointly exhaustive options (see Chapter 3). In both cases the claim that the alternatives are jointly exhaustive relies on logical skullduggery: one of the options (design, in Chapter 3, and creation, here) is defined to include everything that is left when the others are excluded. But the alternatives are not jointly exhaustive provided we take creation to have some teeth, that is, we assume that creationist epistemology claims something more is at stake than that there may be methods of gaining knowledge other than the methods of science.

We will not accept the claim that all those who are not naturalists are necessarily creationists. The reason for this is that most (probably almost all) philosophers who reject naturalism also reject creationism. Naturalists have been uncommon in twentieth-century epistemology but creationists, unreformed or Reformed, have been even rarer. Just as denying naturalism does not establish creationism, denying creationism successfully will also not establish naturalism, not even methodological naturalism, let alone metaphysical naturalism. For the naturalists, in the context of twentieth- and twenty-first-century philosophy, their most significant opponents were not creationists. Rather, they were the so-called "traditionalists" in epistemology.[9] Traditionalists, from this perspective, rely on intuition for epistemological insight, sometimes aided by armchair reflection, but with no serious concern for the details of empirical scientific knowledge or the methods required to obtain that knowledge.

Against these traditionalists, W. V. Quine is perhaps the best-known advocate of naturalism in twentieth-century philosophy. Nevertheless, the *locus classicus* of that position is the work of the philosopher of science, Ernest Nagel, who, perhaps more clearly than Quine, understood and emphasized how much it marks a departure from traditional Western epistemology.[10] Nagel's naturalism followed the sciences in being based on the epistemological primacy of experience: "naturalism . . . merely formulates what centuries of human experience have repeatedly confirmed . . . [It is] a generalized account of the world encountered in experience and in critical reflection, and a just perspective upon the human scene."[11] However, unlike a scientific theory, naturalism does not "specify a set of substantive principles with the help of which the detailed course of concrete happenings can be explained or understood." Rather, it depicts an attitude.

Four themes were central to Nagel's naturalism. Together they emphasize the point that naturalism is a thesis as much about the nature of epistemology as it is a thesis within epistemology:

(i) naturalism requires a minimal ontological commitment to the primacy of the physical world, as Nagel puts it, "the existential and causal primacy of organized matter in the executive order of nature . . . [T]here is no place for the operation of disembodied forces." Here, this aspect of Nagel's naturalism is accepted but only because the laws of science we so far know also assume the primacy of physical matter (that is to say, physicalism);

(ii) a recognition that no philosophical position or scientific theory is going to be a theory of everything. Thus, naturalism recognizes that "the manifest plurality and variety of things, of their qualities and their functions, are an irreducible feature of the cosmos . . . and that the sequential orders in which events occur or the manifold relations of dependence in which things exist are *contingent* connections, not the embodiment of a fixed and unified pattern of logically necessary links";[12]

(iii) according to naturalism, a priori justification is neither required nor desirable for philosophical positions, and perhaps not even possible. It is also characteristic of naturalism that it does not exclude other philosophical frameworks on a priori grounds; experience, possibly including introspective reflection, is the arbitrator of disputes; and

(iv) most importantly, since naturalism is derived from experience, it, as well as any other philosophical position, is fallible, just like the claims of science. The warrant for any epistemological proposition comes not from its being "self-luminous" or "self-evident," nor "from a faith in the uniformity of nature or in other principles with a cosmic scope. The warrant derives exclusively from the specific evidence available for that proposition, and from the contingent historical fact that the special ways employed in obtaining and appraising the evidence have been generally effective in yielding reliable knowledge."[13]

The last move, deriving support for philosophical positions from their success in the field, is central to our defense of naturalism. It was already invoked in Chapter 1 where it was pointed out that empirical success is ample and adequate motivation for our metaphysical conservatism in rejecting extra-natural causes.

On questions of detail, Nagel's is one type of naturalism. Naturalism comes in many varieties, as Nagel and others have explicitly noted.[14] Some of the more extreme versions of naturalism deny the existence of normativity in philosophy, that philosophy, whether it be in epistemology or ethics or aesthetics, concerns what we should believe or do, beyond what we do believe and do. Nagel makes no such claim. Quine and other behaviorists would deny the admissibility of introspection and self-reflection in our assessment of the success or failure of our views. Nagel places no such restriction.

Nagel's naturalism is particularly attractive because of its modesty. This modesty makes its defense relatively easy, especially when we restrict ourselves to methodological naturalism as an appropriate epistemology of science. A defense of evolutionary theory against the capricious and fantastic world of ID requires no more, though, as we shall see, much more can be said in favor of naturalism.

Perhaps what is most important about this version of naturalism is that all our empirical knowledge can be brought to bear upon our epistemological problems. Suppose that we are worried about the reliability of some inferential strategy. Then what can be brought to bear upon the discussion goes well beyond the merely logical or mathematical properties of that strategy: it includes not only empirical facts from psychology and cognitive science, but facts about our past experience with that strategy, most importantly, the history of science. Similarly, when we turn to normative questions of ethics, the history of human cultures has as much relevance as what we know of the biological origin of our emotions, desires, and ability to reason. Human cultural history can trump the claims of human sociobiology and Evolutionary Psychology. We may even choose to interpret and learn from our religious superstars – Moses, Lao-tze, Gautama Buddha, Christ, and so on. Naturalism does not prevent that. But it denies the authority of the text over that of our collective experience.

The Problem of Normativity

Naturalism in philosophy is not without its share of problems. In particular, normativity presents a problem for naturalism, one which prevents the contexts of epistemology and ethics from being entirely symmetrical. The discussion above assumed that we knew what constituted successful science; otherwise, we would not be in a position to judge which methods worked well and which did not. To know what constitutes successful science, the objection goes, we must go beyond naturalism because we are now broaching a normative question. At stake here is the assumption that we can never have sufficient empirical knowledge of norms to ground claims about the success of science.

How do we, as naturalists, ground these judgments? As Abner Shimony, Philip Kitcher, and others have pointed out, all we need is some minimal agreement about the ultimate goals of science.[15] These goals or "cognitive values," as Kitcher puts it, include understanding: "a structured account of nature"[16] besides many pragmatic goals such as prediction and control. (Prediction, control, and understanding comprise the nineteenth-century physiologist Claude Bernard's well-known trinity of the goals of science.[17]) Once we are given these goals, we can decide which of our epistemological practices have been successful in the past, and which have not. We need not have complete agreement about these goals; we merely need to have sufficient commonality. Where agreement is incomplete, we may have epistemological questions that continue to be debated. We may also change our goals over time, but we will do so because of empirical facts about the world. This type of argument offers no a priori certainty about our epistemological principles – but so be it. Naturalism never promised a single unified doctrine at the end of the day. Not only did it not promise a priori certainty, in fact, in Nagel's version, it explicitly denied it. There is no more certainty in philosophy than there is in science.

In ethics, at this point, it is not clear that we have a good analogy any longer. It is far less obvious that there is sufficient agreement about moral goals to ground our ethical principles and practices to the extent that we can resolve socially difficult cases such as euthanasia, abortion, and so on. Perhaps the only message to be taken from naturalism is a somewhat dispiriting one: we have to be modest about what degree of ethical certainty we can achieve in such cases. Luckily, ethical naturalism is not at stake here except insofar as it should be kept in mind that there is no claim here that ethical principles can be reduced to biological evolution, let alone natural selection acting on our individual ancestors in a distant past about which we can know very little. Naturalism, even in ethics, does not lead inexorably to human sociobiology or Evolutionary Psychology. There is more to the empirical world, including our cultural world, than what can be explained by the theory of natural selection.

Creationist Critiques

If naturalism is defeasible, then it is obviously legitimate to attempt to discredit it, as some creationists have done. Let us initially restrict ourselves to methodological – rather than metaphysical – naturalism. Philosophical arguments against naturalism in the context of the evolution–creationism debate have largely come from Alvin Plantinga who denies that science requires even methodological naturalism. What Plantinga means by "science" is worse than unclear – it evidently is much more than what we customarily take to be indicated by that term. But this largely linguistic issue need not detain us here. Plantinga has offered a variety of arguments – at least, what are intended as arguments – against methodological naturalism, some more scientifically respectable than others.

Among the less respectable moves is an exhortation – and not an argument – to Christian scientists to pursue "Augustinian" or "theistic science."[18] Christian scientists are supposed to view the world against the background of a presumed conflict between the "City of God" and the "City of Man," to interpret all intellectual life as episodes of this conflict, opt for those activities that are consistent with citizenship in Civitas Dei, and use categories such as original sin in the construction of the social sciences. Obviously, methodological naturalism is irrelevant to this enterprise which is more reminiscent of the Crusades than any episode in the history of the sciences.

But we do not need someone unsympathetic to religion to point out what is wrong with Plantinga's claims. As the Catholic priest – and noted philosopher of science – Ernan McMullin puts it:

> I do not think . . . that [Plantinga's] theistic science should be described *as* science. It lacks the universality of science, as that term has been understood in the Western tradition. It also lacks the sort of warrant that has gradually come to characterize natural science, one that points to systematic observation, generalization, and the testing of explanatory hypotheses. It appeals to a specifically Christian belief, one that lays no claim to assent from a Hindu or an agnostic. It requires faith, and faith (we are told) is a gift, a grace, from God. To use the term "science" in this context seems dangerously misleading; it encourages expectations that cannot be fulfilled, in the interests of adopting a label generally regarded as honorific.[19]

On this point, no further argument need be produced. Let us, instead, recall with reverence the spirit of the Enlightenment – which Plantinga explicitly dismisses – that took science and reason to be tools by which we can emerge from prejudice, from mere parochialism, to appreciate what is truly human in us.

Plantinga's various other arguments to show that methodological naturalism is conceptually incoherent are marginally more respectable.

The project, at least, is logically well conceived whether or not Plantinga realized it. Suppose, contrary to Plantinga's last exhortation, we take science to constitute what we ordinarily call science. If we also accept that the customary methods of science are naturalistic, as even Plantinga does, there are only two ways in which methodological naturalism can fail: (i) it may be leading science astray, barricading its frontiers and preventing progress; or (ii) it is conceptually flawed or incoherent which, ultimately, must be self-defeating. Given the advance of science during the past few centuries, and of the technology it has spawned, the first possibility is worse than implausible. So, only the second option remains and it makes sense that Plantinga should try to establish the incoherence of methodological naturalism.

The trouble is that the arguments deployed for this purpose make little sense. Plantinga offers two main arguments. The first begins with the observation that there are unique events postulated by science, for instance, the Big Bang. Now, methodological naturalism assumes that all events must be governed by laws, which, at the very least, must consist of observed regularities of nature. Therefore, Plantinga argues, unique events cannot be accounted for by a science that relies on methodological naturalism. But why rely on the Big Bang? Every event in the universe is unique (unless we allow time travel). The fallacy lies in the assumption that such uniqueness presents any problem for governance by natural law: it is the laws of nature, referring to repeatable events, along with specified conditions of the universe at some given time, that predict the particular concatenation of circumstances that constitute the Big Bang, or any other event, whether it be in the past or the future.[20] Unique events pose no problem for naturalistic science.

Plantinga has other variations of this argument all designed to show that laws of nature should not be regarded as central to science. These include an argument that relies on the claim that there are no laws of nature because philosophers of science dispute the details of what constitutes such a law. The response is trivial and obvious: methodological naturalism asks that we deploy exactly the type of reasoning and inference procedures we do every day when we do science. It is irrelevant whether we call these laws, regularities, or rules. The point is that we do not go beyond what is accessible to our experience and scientific reason when we try to explain features of the world.

Arguments of this type are unsophisticated enough about the nature of science and its epistemology that they do not merit serious attention.

But Plantinga has another apparently more sophisticated argument up his sleeve which is particularly important in our context because it dwells on evolution.[21] The essence of this argument consists of the following: naturalists are committed to the belief that our cognitive faculties arose because of evolution by natural selection. But the theory of natural selection, according to Plantinga, says that our cognitive faculties are not reliable. Therefore, since we arrived at the theory of natural selection through our cognitive facilities, it is not reliable. We should, therefore, abandon it – naturalism is self-defeating.[22] The trouble is that every premise in this argument is flawed.[23]

Naturalism, as we have construed it here, can deploy all the resources of the empirical sciences.[24] If it turns out that natural selection does not permit the evolution of sufficiently reliable cognitive faculties, and we have evidence to suggest that our cognitive faculties are so reliable, as naturalists we will simply look for other models of the emergence of our cognitive faculties. We will begin to study other biological mechanisms of evolutionary change, as well as social and cultural mechanisms. In fact, contrary to the more enthusiastic claims of human sociobiologists and Evolutionary Psychologists, there is ample reason to suspect that the evolution of our cognitive faculties requires more than natural selection among individuals competing with each other. But how unreliable does natural selection make our cognitive faculties? All Plantinga can do is point out, as Darwin did, that there are possible evolutionary scenarios in which unreliable features would be selected: for instance, natural selection cannot distinguish between adaptive behaviors produced by true beliefs and adaptive behaviors produced by false beliefs. (Ultimately, this observation is the lynchpin of Plantinga's argument.) But how likely is this? More importantly, how likely is it that, *typically*, false beliefs – and let us think of beliefs as internal representations of the world in the animal minds of our ancestors – would lead to adaptive behaviors? (Typicality is required because our cognitive faculties, and not merely some particular behaviors, are supposed to be unreliable.)

If we are careful to stick to what we actually know about human evolutionary history, at present we know very little about our cognitive evolution. Nevertheless, it seems odd to assume that we know that our cognitive faculties are unreliable if they are produced by natural selection. But that is what Plantinga's argument requires. But suppose, for the sake of argument, we concede the point to Plantinga. What does it show? Merely that, as with the rest of science, we must be modest about how much certainty we can claim about evolutionary theory. It does not follow from Plantinga's argument that, if our cognitive faculties are unreliable, all, or even the vast majority, of our beliefs must be incorrect. In particular, it does not follow that the theory of natural selection must be incorrect – purely logically, there is no paradox here. (As Fitelson and Sober have put it: "One lesson that should be extracted is a certain humility – an admission of fallibility."[25]) This argument is hardly a devastating objection to methodological naturalism.

There is yet another response to Plantinga, though one he will probably not appreciate. In contrast to the theory of natural selection, according to Plantinga, traditional theism confers a high degree of reliability on our cognitive processes. Now suppose that an evolutionary theorist believes, as is very likely, that these cognitive processes, along with the evidence discussed in earlier chapters, confer a high probability to evolutionary theory. Then, we should conclude that traditional theism confers a high probability to the truth of evolutionary theory. Now suppose, with Plantinga, that evolutionary theory (and, ipso facto, naturalism) denies theism. We have a self-defeating argument, now going against theism. The point is that neither of these arguments shows anything. Plantinga's attacks on methodological naturalism are at best innocuous or, more accurately, incoherent.

Where are we left? Not with any plausible critique of methodological naturalism within science. This is not surprising: even most theologians would probably not expect otherwise. Most critics of ID creationism would probably stop here, and political prudence would also dictate such a course, so as to avoid disagreements that are not necessary to defend science against creationism. But let us go further in the next section with the explicit proviso that it delves into an issue that is not necessary to develop and defend the other arguments of this book.

Metaphysical Naturalism

Let us finally turn to the much more troubling – and interesting – issue of metaphysical naturalism. The usual line of argument endorsed by most critics of ID and other forms of creationism is that science in general, and evolutionary biology in particular, makes no commitment to metaphysical naturalism. Metaphysical naturalism is typically construed as Ruse describes it (see above): as an ontological thesis, stated with a priori certainty, about the absolute non-existence of entities other than those posited by our current scientific theories. If this is what metaphysical naturalism is, then it is beyond what science can tell us. Evolutionary biology hardly needs any such assumption. In this sense, at least, the usual line of argument is correct. But there is no reason why naturalists should accept such a view of metaphysics, unless, of course, the ultimate purpose is to reject the very possibility of metaphysics. Such a rejection was a rather common desire among twentieth-century philosophers, though, as usual, with many antecedents in the empiricist tradition, most notably, Hume.

But this is not the only view of metaphysical commitment. It is, for instance, not the view of metaphysics adopted in Chapter 1 where metaphysics was taken to consist of a set of foundational assumptions supposed to be respected by all admissible scientific theories. Once we view metaphysics in this way, as Pierre Duhem – a practicing Catholic and superb philosopher of science – pointed out a century ago, science is never innocent of metaphysics.[26] This, presumably, is the kernel of truth in Johnson's claim that methodological naturalism necessarily collapses into metaphysical naturalism. Descartes, Huygens, and Leibniz assumed the mechanical philosophy as they pondered on the motion of planets. Newton, at least in practice, advocated more tolerance about permissible explanations, but put a much greater weight than Descartes on quantitative agreement between the predictions of a theory and the phenomena to be explained. (Newton, in this sense, was a positivist.) Duhem correctly pointed out that we will partly evaluate every theory, and thus, every explanation relying on that theory, on the basis of its metaphysical presuppositions. Huygens and Leibniz were justifiably skeptical of Newton's law of universal gravitation: it violated the mechanical philosophy's proscription of action-at-a-distance.

When we do evolutionary biology, we assume the metaphysics of that theory: the type of mechanisms it admits, that is, "blind" material interactions with no directionality built into them (recall the discussion of Chapter 4). We accept the role of chance and we accept the lawlike operation of natural selection and all principles of the physical science. When one such "blind" mechanism fails, we seek another that is equally "blind." This is all that metaphysical naturalism amounts to, no more and no less. Suppose, contrary to fact but for the sake of argument, that ID creationists had produced decent explanations of some phenomenon not well explained by evolutionary theory. Presumably such an explanation would invoke some directional or "intelligent" mechanism. Assume that these mechanisms did not obey natural laws (whatever that might mean). Even then we would, with some justice, be skeptical of such explanations because it would have violated metaphysical naturalism. Nevertheless, and this is where philosophical modesty and open-mindedness come to the front, naturalism demands that even metaphysical principles be subject to revision in the light of experience. In Chapter 1 we saw how that could happen.

The four examples of major scientific developments with which we started in Chapter 1 all underscore the value of metaphysical conservatism: as scientists, we do not trade our metaphysical principles in the market every day. Nevertheless, they also underscore that a naturalistic attitude towards metaphysics accepts the possibility of metaphysical revision. But such revision is not taken lightly. Let us return to evolutionary biology, and to the theory of natural selection. What Darwin and Wallace showed (recall the discussion of Chapter 3) was that the adaptedness of living organisms, that is, the appearance of design in nature, can be explained by appeal to natural selection acting on heritable individual variation. This move removed the necessity of any assumption of purpose or teleology in nature, let alone the operation of a sentient intelligent being. As emphasized in Chapter 3, it forced an unprecedented metaphysical revision.

Previous chapters have dealt fully with objections raised by ID creationists to the Darwin–Wallace solution to the problem of design. They have also dealt with the alleged lacunae of evolutionary theory. It should, by now, be uncontroversial that ID creationism's "no conceptual resources" claim about standard evolutionary theory cannot be sustained (recall Chapters 5 and 7). Even the most charitable account of ID creationism's arguments can point to no more than several partially solved biochemical and other problems that the theory of natural selection faces and none, yet, that bring into question the metaphysics of "blind" material interaction (recall Chapter 6). The contrast with the examples of metaphysical change in Chapter 1 could hardly be greater. We have no analog of action-at-a-distance, of the anomalous motion of mercury, or quantum jumps in the spectrum of light. We do not even have an analog of a new type of explanation for the apparent design of organisms. So far we have been provided with no reason to question, let alone abandon, metaphysical naturalism.

Philip Johnson will have to live with that. But he should take consolation from the fact that metaphysical naturalism, so construed, like its methodological counterpart, says nothing about the existence of God, the Devil, or angels, so long as they do not interfere with the more important scientific work of the laboratory.