Chapter 4

DARWIN AND NATURALISM

Any confusion between the ideas suggested by science and science itself must be carefully avoided.
—Jacques Monod, Chance and Necessity, p. xiii.

4.1. DARWIN’S DISCUSSIONS OF GOD

What is methodological naturalism? As a first approximation, soon to be refined, it is the thesis that science should not make claims about the existence and properties of a supernatural deity. A familiar picture of Darwin is that he was a methodological naturalist; after all, he replaced the theory of special creation—the idea that species were separately created by God—with the naturalistic theory of common ancestry plus natural selection. This picture of Darwin is consistent with the fact that his was not the first naturalistic theory of evolution. Lamarck’s theory (§1.2) appeared some fifty years before the Origin, and way before Lamarck, there was the Epicurean theory that particles whirling in the void link together and form stable combinations that then persist (§3.1). Lamarckism and Epicureanism, as well as the other naturalistic theories that Darwin mentions in the “Historical Sketch” that he added to the third edition of the Origin, do not much resemble modern evolutionary theory, while Darwin’s theory very much does. And modern evolutionary biology conforms to what methodological naturalism requires. This may encourage us to erroneously conclude that Darwin was the originator of naturalism, at least in biology. In fact, Darwin was adding his voice to a movement that had steadily gathered momentum over the centuries, in biology and in the other sciences as well (Numbers 2003).

If Darwin was a methodological naturalist, it is odd that the Origin begins and ends with remarks about God. Even before he speaks his own first words in the book, he quotes two philosophers—William Whewell and Francis Bacon—on the subject of how God and nature are related:
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But with regard to the material world, we can at least go so far as this—we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general laws.—W. Whewell, Bridgewater Treatise.

To conclude, therefore, let no man out of a weak conceit of sobriety, or an ill-spirited moderation, think or maintain, that a man can search too far or be too well studied in the book of God's word, or in the book of God's works; divinity or philosophy; but rather let men endeavour an endless progress or proficiency in both.—Bacon, Advancement of Learning.

In the Origin's last paragraph, Darwin (1859, 490) says that, in the beginning, "life was breathed into a few forms, or into one." A few pages earlier, he says that "all organic beings which have ever lived on this earth have descended from some one primordial form, into which life was first breathed" (Darwin 1859, 484). Who is this breather to whom Darwin refers? Darwin's readers doubtless knew, but just to make sure, Darwin added "by the Creator" to both remarks in the second edition. He removed one of these additions from the third, but never removed the other (Darwin 1959, 753, 759). A comment that Darwin makes in an 1863 letter to Hooker may help explain why he made the one deletion:

I have long regretted that I truckled to public opinion, and used the Pentateuchal term of creation, by which I really meant "appeared" by some wholly unknown process. It is mere rubbish, thinking at present of the origin of life; one might as well think of the origin of matter. (Darwin 1887, vol. 2, 202–203)

It is unclear why Darwin did not delete "by the Creator" from the other passage.

How can the picture of Darwin as a methodological naturalist be consistent with these theological remarks? Maybe the answer is that theology was mere window dressing in the Origin, something that occurs only at the start by way of a perfunctory nod to philosophers and at the end in a paragraph that is self-consciously poetic. One reason to resist this suggestion is that theology enters the Origin as part of

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Darwin's argument, not merely as part of his rhetoric. Darwin is at pains to show that his own theory is superior to the theory of special creation, and some of his criticisms of this antinaturalistic theory involve theological assumptions, as I'll now explain.

The substance of Darwin's quotation from Whewell is something that Darwin returns to at the end of the Origin, where he says:

Authors of the highest eminence seem to be fully satisfied with the view that each species has been independently created. To my mind 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, like those determining the birth and death of the individual. (Darwin 1859, 488)

If God is a majestic law-giver and not a meddler who tinkers with piecemeal details, then the doctrine of special creation is theologically implausible (Brooke 2009, 263). In the competition between special creation and Darwin's own theory, a point against the former is a point in favor of the latter.

A second theological argument that Darwin makes against special creation concerns imperfect adaptation:

On the view of each organic being and each separate organ having been specially created, how utterly inexplicable it is that parts, like the teeth in the embryonic calf or like the shriveled wings under the soldered wing-covers of some beetles, should so frequently bear the plain stamp of inutility! (Darwin 1859, 480)

This argument survives in the writings of many of Darwin's intellectual heirs—for example, in Stephen Jay Gould's (1980b) discussion of the panda's thumb. Radick (2005) calls it the no-designer-worth-his-salt argument. According to this line of reasoning, Darwin's theory of common ancestry plus natural selection predicts imperfect adaptations, while the hypothesis of special creation makes it very surprising that imperfect adaptations are so common. The observations therefore favor Darwin's theory over special creation. This is a good likelihood argu-
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ment ($\S$1.3), provided that the following assumption is true: if God made organisms, they probably would not have so many imperfect adaptations.3 Darwin’s argument involves a substantive theological assumption about the goals and abilities God would have if he existed (Nelson 1996; Soher 2008b, 126–28).

A third argument Darwin makes against special creation begins with his noticing that offspring sometimes fail to resemble their parents. He mentions, for example, that “we see several very distinct species of the horse-genus becoming, by simple variation, striped on the legs like a zebra, or striped on the shoulders like an ass” (Darwin 1859, 165–67). Individuals that belong to one species in a genus occasionally produce offspring that resemble individuals in another species of the same genus, and a hybrid whose parents come from species $A$ and $B$ in a genus sometimes resembles its own parents less than it resembles an individual from a congeneric species $C$. Darwin believed that these facts are easily explained by the fact of common ancestry. They are no more surprising than the fact children sometimes have features that resemble their cousins more than their parents. In contrast, the fact that offspring sometimes fail to resemble their parents, he thinks, is a problem for the doctrine of special creation. Darwin recognizes that the creationist may reply by simply asserting that the Creator arranged things thus, but he finds this reply objectionable:

To admit this view is, as it seems to me, to reject a real for an unreal, or at least for an unknown, cause. It makes the works of God a mere mockery and deception; I would almost as soon believe with the old and ignorant cosmogonists, that fossil shells had never lived, but had been created in stone so as to mock the shells now living on the seashore. (Darwin 1859, 167)

Here again, the observations are said to back creationists into a corner, and the problem with this corner is that it is theologically implausible (Dilley 2009). If God is no deceiver, the doctrine of special creation is mistaken.

Given Darwin’s assertion that God works in nature via “secondary causes” and his assertion that God is no deceiver, one of his comments concerning Paley’s intelligent design explanation of the vertebrate eye is puzzling. Darwin (1859, 188) notes, first, that “it is scarcely possible to avoid comparing the eye to a telescope. We know that this instrument has been perfected by the long-continued efforts of the highest human intellects; and we naturally infer that the eye has been formed by a somewhat analogous process.” But then he asks two questions: “But may not this inference be presumptuous? Have we any right to assume that the Creator works by intellectual powers like those of man?” (Darwin 1859, 188) I take these questions are rhetorical. Darwin is saying that it is presumptuous to think that God makes organisms “by intellectual powers like those of man.” God is so radically different from human beings that we have no way of knowing what his goals are, or even if he has goals in anything like the way that human beings do. If this is right, then the problem with special creation is that it is predictively vacuous. In another passage in the Origin, Darwin puts the point with a touch of irony: “On the ordinary view of the independent creation of each being, we can only say that so it is—that it has so pleased the Creator to construct each animal and plant” (Darwin 1859, 435). The problem with creationism is that it can accommodate any observation but can predict none of them.4 The hypothesis that an intelligent designer made object $X$ predicts nothing about the features $X$ will have unless we know something about the goals and abilities this designer would have if he existed (Soher 2008b). If creationism is flawed in this way, that is a point in favor of common ancestry plus natural selection in the two-way competition. The thesis that God’s goals are hidden from us is Darwin’s fourth theological argument against creationism.5

The fifth and last context I want to discuss in which Darwin puts theological assumptions to work concerns the problem of evil. After the Origin’s publication, Darwin wrote to Asa Gray, his premier North American advocate:

I had no intention to write atheistically. But I own that I cannot see as plainly as others do, and as I should wish to do, evidence of design and beneficence on all sides of us. There seems to me too much misery in the world. I cannot persuade myself that a beneficent and omnipotent God would have designedly created the Licheneouside with the express intention of their feeding within the living bodies of Caterpillars, or that a cat should play with mice. Not believing this, I
see no necessity in the belief that the eye was expressly designed. On the other hand, I cannot anyhow be contented to view this wonderful universe, and especially the nature of man, and to conclude that everything is the result of brute force. I am inclined to look at everything as resulting from designed laws, with the details, whether good or bad, left to the working out of what we may call chance. (Darwin 1887, vol. 2, 311–12)

Darwin also addresses the problem of evil in the *Origin*.

It may not be a logical deduction, but to my imagination it is far more satisfactory to look at such instincts as the young cuckoo ejecting its foster-brothers,—ants making slaves,—the larve of ichneumonide feeding within the live bodies of caterpillars,—not as specially endowed or created instincts, but as small consequences of one general law, leading to the advancement of all organic beings, namely, multiply, vary, let the strongest live and the weakest die. (Darwin 1859, 243–44)

Why does Darwin say that it may be more “satisfactory” to regard these gruesome and repellant examples as consequences of a general law (natural selection) rather than as “specially endowed or created”? Several historians have suggested that the problem of evil motivated Darwin to embrace the deistic view that God creates general laws and does not designedly create separate species and their adaptations (Dilley 2009). They argue that Darwin thought that God is off the hook with respect to the problem of evil if he is responsible only for the laws. Gillespie (1971, 127) uses the phrase “divine exonerations,” and Brooke (1991, 316) says that Darwin “considered the possibility that a universe in which the laws were designed, but the details left to chance, might relieve the Creator of direct responsibility for the more macabre features of creation.” The biologist Francisco Ayala (2007) has also endorsed this interpretation of Darwin’s theory, which is why Ayala calls his book *Darwin’s Gift to Science and Religion*. The gift to religion is a solution to the problem of evil. A consequence of this solution to the problem of evil is that Creationism is mistaken. This is another theological argument that has the consequence that Darwin’s own theory is superior to the theory of special creation.

If this is Darwin’s solution to the problem of evil, it faces an obvious objection. If the laws of nature produce great suffering, why didn’t God choose different laws that would have had different consequences? There is room to wonder how seriously Darwin took this solution. Consider what he says in a letter of 1866: “It has always appeared to me more satisfactory to look at the immense amount of pain & suffering in this world, as the inevitable result of the natural sequence of events, i.e. general laws, rather than from the direct intervention of God though I am aware this is not logical with reference to an omniscient Deity.” Note also that the phrase “it may not be a logical deduction” occurs in the passage from the *Origin* that I quoted.

In the letter to Asa Gray quoted above, Darwin embraces the first cause argument for the existence of God. The point is even clearer in a passage from his *Autobiography*, which he wrote at the end of his life as a private document for his family. Darwin describes “the extreme difficulty or rather impossibility of conceiving this immense and wonderful universe, including man... as the result of blind chance or necessity... I feel compelled to look to a First Cause having an intelligent mind in some degree analogous to that of man; and I deserve to be called a theist” (Darwin 1958, 92–93). Does this passage indicate that Darwin was a deist, holding that God created the universe and arranged the laws of nature (and the initial conditions) so that organisms, including man, would evolve? Though Darwin often sounds like a deist, at other times he sounds like an agnostic. Right after he endorses the first cause argument in the *Autobiography*, he hedges; he says that human beings may not be capable of thinking straight about these lofty metaphysical questions. A page later, he hedges some more, saying that he is an “agnostic,” by which he says he means someone “who has no assured and ever present belief in the existence of a personal God or of a future existence with retribution and reward” (Darwin 1958, 92–93). We now use the term *agnostic* to mean someone who neither believes nor disbelieves that God exists; agnostics usually defend their position by claiming that the question of God’s existence cannot be answered by appeal to evidence. Darwin means something different in this passage; he uses “agnostic” to mean someone who doesn’t believe in heaven and hell or in a God who answers one’s prayers. A deist is an agnostic in this...
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sense. After Darwin's death, his son Francis quotes him as saying that "the mystery of the beginning of all things is insoluble by us; and I for one must be content to remain an Agnostic" and that "I think an Agnostic would be the more correct description of my state of mind. The whole subject [of God] is beyond the scope of man's intellect" (Darwin 1887, 313). Here Darwin says he is an agnostic in the modern sense of that term, which is inconsistent with deism.

Whether Darwin settled into agnosticism or forever vacillated between deism and agnosticism, two points are clear. The first is that his religious trajectory was not the product of his biological theories. Rather, the work was done by philosophical considerations—the problem of evil, the first cause argument, and a growing skepticism about our ability to think clearly about the origin of the universe. The second is that Darwin walked away from Christianity. He uses unusually strong language in the Autobiography, saying that Christianity is a "damnable doctrine," since it maintains that his father and brother, and almost all his best friends, will forever suffer the torments of hell simply because they are not believers (Darwin 1958, 87, 238). Darwin says that he "can hardly see how anyone ought to wish Christianity to be true." It is interesting that his wife Emma remained a Christian and simply dismissed the doctrine of eternal damnation as unchristian (Moore 1989, 203).

4.2. REFINING METHODOLOGICAL NATURALISM

I began this chapter by saying that methodological naturalism is the thesis that science should make no claims about the existence and properties of a supernatural deity. I did not say that scientists should abstain from doing so. Scientists discuss nonscientific matters, and there is nothing wrong with their doing so. Darwin expressed his hatred of slavery and he was a scientist, but the wrongness of slavery isn't part of a scientific theory; it is a claim about ethics. The same point applies to Darwin's embracing the first cause argument for the existence of God; here he is describing his philosophical views. Methodological naturalism does not prohibit scientists from making philosophical claims.

Even so, the formulation I gave of methodological naturalism needs work: science is an activity, and activities don't make claims. People make claims when they endorse the truth of various propositions, and propositions make claims in the sense that they have various entailments. A step in the right direction is to divide methodological naturalism in two:

Methodological naturalism about theories: scientific theories should not make claims about the existence of a supernatural deity.

Methodological naturalism about evidence and arguments: scientific evidence and arguments should not make claims about the existence of a supernatural deity.

By replacing the term "science" with the distinction between "scientific theories" and "scientific evidence and arguments," this formulation allows methodological naturalists to criticize antinaturalist theories for being at odds with what we observe. For example, contemporary geologists are not compromising their naturalism by pointing out that young earth creationism conflicts with the evidence we have for an ancient earth.

This two-part representation of methodological naturalism introduces a second change. I began this chapter by saying that methodological naturalism requires science not to talk about the existence and properties of a supernatural deity, but now I have deleted the injunction against discussing God's properties. My reason for doing so is that every statement has implications about the properties that God would have if he existed. The proposition that life began on Earth about 3.8 billion years ago entails that God (if he exists) didn't start life on Earth some 6,000 to 10,000 years ago. The point generalizes; the statement that my car is gray entails that if there is a God, he didn't prevent my car from being gray. To require science to say nothing about the properties that God would have if he existed is to require science to say nothing at all. It is enough that methodological naturalism prohibits scientific theories from making claims about whether God exists. This definition of the view has the consequence that Darwin's own theory obeys methodological naturalism, while creationism does not.
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There is more going on in the Origin than Darwin’s statement of his own theory. There is the evidence he presents and his criticisms of competing accounts. It is perfectly clear that some of Darwin’s evidence is entirely naturalistic. For example, he cites various nonadaptive similarities as evidence for common ancestry (§1.3), and the description of these similarities entails nothing about whether God exists. But, as discussed in the previous section, Darwin on several occasions uses theological arguments against creationism. Does this violate the second part of what methodological naturalism demands? It does if his arguments include the premise that God exists. However, Darwin’s theological arguments against creationism can be interpreted so that they are perfectly consistent with the methodological naturalism I just defined. The arguments all attempt to show that Creationism is false whether or not God exists. We can view these arguments as all having the following form:

If God exists, then God has feature X.
If God has feature X, then creationism is false.

Therefore, if God exists, then creationism is false.
And if God does not exist, then creationism is false.

Therefore, creationism is false, regardless of whether God exists.

Darwin fleshes out the X in this skeleton argument by asserting that God, if he exists, will create general laws rather than make species piecemeal, that he will not be a deceiver, that he will not make so many imperfect adaptations, and so on. None of these conditional claims entails that God exists.

It is one thing for Darwin’s theological arguments against creationism to conform to the dictates of methodological naturalism, another for them to be successful. Theologians may want to argue with Darwin on this latter point. However, for most modern scientists, Darwin’s claims about the properties that God would have if he existed are pretty much irrelevant. Surely, these scientists will say, we can simply chop away at the Origin and isolate a core of theory and evidence that is naturalistic through and through. This core will omit part of what Darwin says in the Origin, but maybe that isn’t objectionable if our goal is just to identify what is scientifically valuable in the work Darwin did; this is a different goal from that of understanding Darwin in all his complexity.

The problem with this naturalistic core—Darwin’s own theory and his naturalistic evidence for it—is that it has the consequence that Darwin’s “one long argument” is no argument at all. This is because testing is an essentially contrastive activity (§3.1); whenever theories fail to bear a deductive relationship to observations, evidence for a theory must be evidence that favors that theory over this or that alternative.7 Testing a theory means testing it against rivals. Darwin’s argument for common ancestry plus natural selection needs to include one or more alternative theories for him to argue against. The main alternative on which Darwin focuses is special creation.8 Does Darwin need to discuss this nonnaturalistic theory, if only as a foil?

No act of imagination is needed to equip Darwin’s naturalistic theory with naturalistic alternatives, where the competition can be judged by evidence that is purely naturalistic. This is something that is entirely standard in the evolutionary biology of the present. For example, biologists now consider whether various traits have evolved by selection or drift, where the data considered are gene sequences gathered from a group of related species. And biologists consider whether all life traces back to a single common ancestor, or if there is separate ancestry, and cite the near universality of the genetic code as a strong argument in favor of the former (§1.4). Testing in evolutionary biology is contrastive, but the competition is of one naturalistic theory against another. Creationism is not treated as a competing scientific hypothesis, to be dealt with by seriously mustering evidence against it. Rather, it usually is treated as nonscience, as the first part of methodological naturalism requires. Darwin’s partial naturalism has given way to the more thorough-going naturalism of the present.

A few further clarifications are needed of the two-part thesis of methodological naturalism. The first is that it differs from the following thesis about what there is:
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Metaphysical Naturalism: No supernatural deity exists.

Evolutionary theory is neutral with respect to this second form of naturalism; like scientific theories generally, it ignores supernatural deities rather than denying their existence. The next point concerns the term supernatural. Think of nature as the totality of entities, events, and processes that have spatiotemporal location; supernatural entities, as I'll use the term, do not. My third comment is that I have formulated both methodological and metaphysical naturalism so that they are specifically about God and do not pertain to the category of supernatural entities more generally; this wider philosophical context is something to which I'll return.

What do creationists say about the relation of evolutionary biology to methodological and metaphysical naturalism? Proponents of an older school of creationism sometimes agree that methodological naturalism is a correct principle for science, but then they deny that evolutionary theory measures up. These creationists maintain that evolutionary theory is an atheistic philosophy that masquerades as science; it embraces metaphysical naturalism and therefore violates the neutrality required by the methodological principle. In contrast, members of a more recent school of creationism, whose proponents dislike being called "creationists" and prefer the label "intelligent design theorists," often agree that contemporary evolutionary biology obeys methodological naturalism, but then they add that this is a defect, not a laudable achievement. These creationists think that methodological naturalism is a shackle whose grip on science needs to be broken. Refusing to consider questions about the supernatural, they contend, is the act of an ostrich sticking his head in the sand.

What kind of theistic neutrality has evolutionary theory achieved? It is obvious that the theory isn't neutral with respect to all claims about God. For example, the theory is inconsistent with the creationist position (C) depicted in figure 4.1. This form of creationism claims that the evolutionary process is fundamentally incapable of producing the complex adaptive traits that we see in the organisms around us, and that these are the result of God's direct intervening in nature. The second position I want to consider is Deism. Deism predates evolutionary theory. It holds that God created the universe, made the laws of nature, and then stood back and let those laws produce all the natural phenomena we now observe. In figure 4.1, I've represented a version of Deism (D) that holds that God uses the evolutionary process to create the complex adaptive features that organisms have; he starts that process and then never needs to intervene for the process to yield the complex adaptations that we observe. This form of deism makes it clear that evolutionary biology does not contradict the proposition that God exists. In addition to Creationism and Deism, there is a third position to consider; it says that evolutionary theory helps explain the features that organisms have, but that it is explanatorily incomplete, in that God has been at work as well. This may sound like Creationism, but it is not. The deistic position (D) and this third position (S) are both versions of "theistic evolution," in that both affirm that God exists and that evolutionary theory is true.

![Figure 4.1](image)

The arrows in figure 4.1 represent causal relationships. I will assume that causality does not require determinism. Smoking cigarettes causes lung cancer, but that doesn't mean that you will get lung cancer if you smoke. It doesn't even mean that smoking is part of a larger set of causal conditions that jointly suffice for lung cancer. Perhaps the universe is irreducibly chancy. As a rough approximation, we can think of causes as events that increase the probabilities of their effects.
Causality can be deterministic (with complete sets of causes pushing the probabilities of their effects to a value of 1), but it need not be.

Two of the three positions represented in figure 4.1 involve divine intervention in the world of space and time after the evolutionary process is under way. But what does "divine intervention" mean? In theology, it is often understood to mean God's violating the laws of nature.\textsuperscript{13} I do not use the term in this way. What I want to consider under the heading of (S) is the view that God supplements what happens in the evolutionary process without violating any laws. An intervention, as I'll understand the term, is a cause; it can trigger an event or sustain a process. Physicians do both when they intervene in the lives of their patients. Physician intervention does not entail any breakage in the laws of nature; neither does God's.\textsuperscript{14}

I'll assume in what follows that the God we are discussing, if he exists, is a supernatural being. Not all conceptions of God are like this; the ancient Greeks thought their gods lived on Mount Olympus, and Spinoza thought that God is identical with nature itself. Methodological naturalism does not prohibit bringing such natural deities into science. Although there may be other reasons to keep them out, that is not my subject here.

4.3. WHY EVOLUTIONARY THEORY DOES NOT RULE OUT AN INTERVENING GOD

Consider the thesis that there is more going on in the evolutionary process than is dreamt of in evolutionary biology. This is the thesis that there are "hidden variables"—causal influences on evolutionary outcomes that are not described in our science. If evolutionary theory were causally complete, there would be no room for this idea. However, we have no assurance that the theory covers all the facts that are causally relevant to what happens in evolution. Please note that I am not saying that there is evidence that such hidden variables exist; my claim is only that they are not ruled out by current theory.

The case for thinking that evolutionary theory does not preclude the existence of hidden variables begins with the simple fact that the theory is probabilistic. To see why, let's begin with a simple analogy—the tossing of a coin. Suppose you toss a coin repeatedly and obtain evidence that justifies the following conclusion:

\begin{align*}
(1) \Pr(\text{the coin lands at } t_2 \mid \text{the coin is tossed at } t_1) &= 0.5.
\end{align*}

Someone who believes that determinism is true can accept proposition (1) but will maintain that there is more involved in the process of tossing the coin than is described in this probability statement. The determinist will maintain that:

\begin{align*}
(2) \Pr(\text{the coin lands at } t_2 \mid \text{a complete description of the initial conditions at } t_1) &= 0 \text{ or } 1.
\end{align*}

Although propositions (1) and (2) may seem to disagree about what the coin's probability of landing heads is, in fact they are not in conflict. Since statements (1) and (2) conditionalize on different propositions, both can be true. Conditional probability is like spatial distance. There is no such thing as the one true distance to Madison. There is the distance from Los Angeles to Madison and the distance from New York to Madison. Distance is inherently relational. Similarly for conditional probabilities.\textsuperscript{15}

To illustrate the idea that (1) and (2) are compatible, I want to consider a Newtonian model of coin tossing that Diaconis (1998) describes. The initial conditions for a toss determine whether the coin lands heads or tails. The reason a sequence of tosses exhibits a mixture of heads and tails is that the initial conditions vary from toss to toss. To simplify matters, we assume that there is no air resistance, that the tossed coin spins around a line through its plane, and that the coin lands without bouncing (perhaps in sand). The relevant initial conditions are then fixed by specifying the values of $V$ (the upward velocity of the tossed coin) and $\omega$ (the angular velocity, specified in revolutions per second). If $V$ is very low, the coin doesn't go up much when it leaves the tosser's hand; if $\omega$ is very low, the coin, as Diaconis says, "rises like a pizza without turning over." Depending on the values of $V$ and $\omega$, the coin will turn over 0, 1, 2, 3, \ldots times before it lands. Suppose the coin we are considering starts each tossing session by being heads up in the
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tosser’s hand. Then, if the coin turns over 0 or an even number of times, it lands heads; if it turns over an odd number of times, it lands tails. These different possibilities correspond to the regions of parameter space shown in figure 4.2. Starting at the origin and moving northeast, the different stripes correspond to 0 turns, 1 turn, 2 turns, etc. In this Newtonian model, each outcome of tossing the coin is a deterministic consequence of the initial conditions, as proposition (2) asserts. However, this does not mean that proposition (1) is mistaken in its claim that the coin has a probability of landing heads of 0.5, given just the fact that it is tossed. A probabilistic model of coin tossing is consistent with the thesis that the system is deterministic. If determinism is true, there are hidden variables, not represented in the proposition (1).

![Figure 4.2: Coins in black regions of parameter space land heads; coins in white regions land tails (Brooke 1998).](image)

Let’s consider the parallel situation with respect to the claim that biologists are making when they say that mutations are “undirected” or “unguided.” By this they simply mean that mutations do not occur because they would be useful to the organism. Mutations do have their causes—for example, radiation—but that is a different matter. Biologists perform experiments to test the hypothesis that mutations are undirected. I want to describe a very simple experiment that brings out some of the important features that more complex and sophisticated experiments have. Consider a species of blue organisms. Suppose these organisms would benefit from protective coloration if they were placed in a green or a red environment; being green is better than being red if the environment is green, but the reverse is true if the environment is red. Our experiment is to place some of these blue organisms in a red environment and some in a green environment and then record the frequencies with which red and green mutations occur, as shown in figure 4.3.

![Figure 4.3: The frequencies with which blue organisms mutate to red or to green in two different environments.](image)

Suppose the observed frequencies are nearly identical. The conclusion a scientist will draw is that mutation probabilities are not influenced by what would be good for the organism. This should be understood for what it is—a good hypothesis whose justification comes from the frequencies of events in a sample. My point here is the same as the one about coin tosses. The hypothesis that the different mutations have the same probabilities in different environments does not rule out the possibility that there are hidden variables; perhaps each mutation that occurs is the result of its own suite of deterministic causes. If the data do not rule out hidden variables, they also do not rule out supernatural hidden variables.16

Our view of whether mutations are guided by unseen forces should be shaped by the same considerations that govern our view of whether
coin tosses are influenced by unseen forces. Experts on coin tossing will
tell you that coins do not land heads because this would be good for
gamblers. Geneticists will tell you that mutations do not occur because
they would be good for the organisms that have them. We should accept
what the experts are saying, but we should realize that their task is the
interpretation of frequency data.

In the simple experiment just described, in which we track the
mutations that blue organisms experience, the competing hypotheses
describe the probabilities of different mutations in different environ-
ments. One hypothesis says that the probability of a red mutation in a
red environment is greater than the probability of a red mutation in a
green environment. Another says that these probabilities have the same
value. Notice that these models say nothing about whether there have
ever been mutations that God made sure would happen. Scientists do
not have a way of testing this theistic assertion. However, that does not
show that it is false. Scientists sometimes use the derisive comment “not
even false” to characterize hypotheses that cannot be tested. The deri-
sion can be separated from a point on which theists and atheists should
agree: there is a difference between hypotheses that the evidence tells
us are false and hypotheses that our data do not permit us to test.

The thesis that mutations are undirected is sometimes presented as
a rock-bottom “philosophical” commitment of evolutionary biology,
akin to materialism and just as central to the scientific worldview. This
is a mistake. True, the thesis is central to biology, but it has nothing to
do with materialism or theism. It is like the thesis that an organism can’t
synthesize vitamin D from sunlight or can’t regenerate lost limbs. It is
an empirical question whether mutation probabilities have the shape
due to their of what would be good for the organism. The fact that
many organisms do not experience guided mutations does not rule out
the possibility that some do, in some environments. If it turns out that
some organisms have the capacity to favorably adjust their mutation
probabilities in the light of environmental change, evolutionary
biology will have the task of explaining why this is so. Mutation rates
vary from species to species, across environments for a given species, 17
and they have different values for different parts of an organism’s
genome. It is a good scientific question why this is so.

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The fact that mutations are undirected in the sense that I have
described is not a problem for theism. Maybe God arranged for muta-
tions to be undirected. And if some mutations in some organisms in
some environments turn out to be directed, that is no threat to atheism.
Atheism has no more of a stake in mutations being undirected than it
has in organisms being unable to synthesize vitamin D from sunlight.
The theory of evolution does not rule out deism, the thesis that God
starts the universe in motion and forever after declines to intervene. But
the theory also does not rule out a more active God whose interven-
tions into nature fly under the radar of evolutionary biology. Divine
intervention isn’t part of science, but the theory of evolution does not
entail that none occur. 18

4.4. SHOULD SCIENTIFIC THEORIES
TALK ONLY ABOUT WHAT EXISTS IN
NATURE?

What reasons have been offered for accepting methodological natu-
ralism? Sometimes the claim is advanced that science, by definition,
eschews discussion of the supernatural. If the point is put by saying that
natural science asserts nothing about the supernatural, the claim sounds
like it must be true. 19 In fact, this definitional ploy accomplishes nothing.
Even if “science” is defined as an activity that obeys the requirements
of methodological naturalism, the question remains of why time and
energy and money should be devoted to doing science rather than to
doing schmience. 20 Schmience is just like science, except that it doesn’t
definitionally demand a commitment to methodological naturalism. As
mentioned earlier, proponents of intelligent design want schmience to
replace science as a project to which society devotes itself. A substan-
tive reason is needed for thinking that methodological naturalism pro-
vides good advice for inquiry. The victory that the definitional argu-
ment achieves is empty.

It is interesting to note, in this connection, that science does not, as
a matter of fact, avoid postulating supernatural entities. Here I am not
talking about what science says concerning the existence of God.
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Rather, I have in mind a different sort of supernatural entity—numbers. Evolutionary theory entails that numbers exist, and numbers are supernatural entities. Or, at least, that's the view of numbers endorsed by a certain philosophy of mathematics. Mathematical Platonism says that numbers and other mathematical objects exist but do not have spatiotemporal location. Mathematical Platonism is not universally accepted among philosophers. However, it does have a lot to be said for it, and many philosophers think it is correct. Here is a brief sketch of why Platonism looks plausible. Consider the claim that there are infinitely many prime numbers. This is a true statement, as any number theorist will tell you. But what are these things called numbers? What must they be like for this statement to be true? First, it is important not to confuse numbers and numerals; numerals are names for numbers. The statement about primes isn't about names; it's about the things those names name. The statement would still be true if there were no language users, and hence no names for the numbers. Indeed, the statement would still be true if there were no matter in the universe. This is what leads Platonists to claim that numbers are supernatural entities.

I hope this brief comment gives the reader a feeling for why many philosophers think that Platonism is a plausible account of pure mathematics. But what has this to do with evolutionary theory? The answer is that many statements in mathematized evolutionary theory entail that numbers exist. Scientists hardly notice that their models have this implication, but such models are everywhere. Consider, for example, the claim that the rates of molecular evolution in two lineages are different. The Platonistic commitments of this statement become visible when it is stated a bit more formally:

There exists a number \( d \neq 0 \), such that \( R_1 - R_2 = d \), where \( R_1 \) is the rate of evolution in the first lineage and \( R_2 \) is the rate in the second.

Or consider the claim that the fitness of a certain trait \( T \) in a population is frequency dependent and is a linear function of its frequency. In other words:

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There exist numbers \( m \neq 0 \) and \( b \) such that the fitness of trait \( T = mx + b \), where \( x \) is the frequency of the trait.

These claims are subject to empirical test, and it may turn out that the evidence leads us to reject them both. Perhaps there is a molecular clock in the two lineages; perhaps trait \( T \)'s fitness is frequency independent. The important point is that scientists do not recoil in horror from these two models just because they entail that numbers exist. And if these two models are rejected, there are other models, with other Platonistic commitments, that evolutionary biologists embrace.

I mentioned before that accepting methodological naturalism does not require one to embrace metaphysical naturalism. Now let's ask the converse question: does accepting metaphysical naturalism oblige one to accept the methodological thesis? At first glance, the answer seems to be yes: if there are no supernatural entities, a true scientific theory cannot claim that such things exist. If the goal of science is to find true theories, then scientific theories should not assert that supernatural entities exist. The problem with this argument is that science needs mathematics, whether or not Platonistic entities exist. If numbers do not exist, then mathematics is a useful fiction; indeed, it is an indispensability fiction. Scientific theories should include mathematical statements that entail that numbers exist whether or not this existence claim is correct. Scientists shouldn't worry about whether numbers exist; they should just help themselves to this assumption. Whether numbers exist is something for philosophers to puzzle over.21

My argument, I want to emphasize, does not rest on the assumption that mathematical Platonism is true. That, as I've said, is a matter of philosophical debate. My claim is that science would still be capable of explaining and predicting what we observe, and doing all the wonderful things that scientists prize, even if mathematical Platonism were true. The success of the scientific enterprise does not in any way depend on its eschewing mention of all supernatural entities. In fact, the success of science requires that science postulate some supernatural entities, if mathematical Platonism is true.
4.5. ARE ALL CLAIMS ABOUT THE SUPERNATURAL UNTESTABLE?

Another way to defend methodological naturalism is to claim that statements about the supernatural are untestable. This is an old saw, and several philosophers (e.g., Quinn 1984; Laudan 1988) have cited counterexamples. I have already mentioned the following statement:

A supernatural deity created life on earth about 10,000 years ago.

Scientists have abundant evidence for life's being much older; if so, this statement about the supernatural is testable. The same point pertains to many statements that are about numbers:

The number of apples in the basket is prime.

Both of these example statements are about supernatural entities, but they are not solely about the supernatural. The former is about life on earth and God; the second is about apples and numbers. Both of these "mixed" statements are testable.

Pennock (2009, 550–51), elaborating on ideas he developed earlier (Pennock 1999), disagrees:

Both Laudan and Quinn cite the young-earth creationist view that God created the earth 6,000 to 10,000 years ago as a hypothesis that is testable and found to be false. But this and other examples that are offered to show the possibility of tests of the supernatural invariably build in naturalistic assumptions that creationists do not share. Confronted with the empirical evidence for an ancient earth, creation scientists dismiss the relevance of any such observations on the ground that God simply made the earth appear to be old (or "mature"). Some think of this as a rest of faith so that one learns to accept the authority of the Bible over that of one's (mere) senses. The point here is that we cannot overlook or ignore, as Laudan and company regularly do, the fact that creationists have a fundamentally different notion from science of what constitutes proper evidential grounds for warranted belief. The young-earth view is certainly disconfirmed if we are con-

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sidering matters under MN [methodological naturalism], but if one takes the supernatural aspect of the claim seriously, then one loses any ground upon which to test the claim.

Pennock is describing an exasperating style of argument that creationists deploy. Let us see how it applies to a simpler example. Consider the statement

(Purple-ID) A supernatural deity caused everything in the world to be purple.

This statement is about the supernatural, and it makes an observational prediction. Of course, a defender of Purple-ID might reply that things only seem to have colors other than purple. Friends of Purple-ID can do for their theory what friends of young-earth creationism have done for theirs. However, this is a fact about people, not about propositions. Notice the shift from propositions to people in the passage I quoted from Pennock. He begins by discussing a proposition (that God created the earth 6,000 to 10,000 years ago) and then shifts to a fact about how creationists defend this proposition, pointing out that "creationists have a fundamentally different notion from science of what constitutes proper evidential grounds for warranted belief [emphasis mine]." It is true that creationists have been unscientific, but this is a fact about them; nothing follows about the character of the theory they wish to defend. To see this point, consider a dogmatic Darwinian or a dogmatic Newtonian who argues unscientifically; this fact about them does not show that their theories are unscientific.

Pennock (2009, 552) thinks that the words that come out of the mouths of creationists have a radically different meaning from the same words that come out of the mouths of noncreationists. He says that when scientists consider "the earth is 10,000 years old" or "everything is purple," they assign these sentences a "naturalistic meaning," but when young-earth creationists or defenders of Purple-ID utter these sentences, the sentences have a "supernaturalistic meaning." This claim of Pennock's is a claim in the philosophy of language, one that I find dubious. Creationists and anti-creationists disagree about a great deal,
but that doesn't show that they assign different meanings to statements like "everything is purple" and "the earth is 10,000 years old." Being dogmatic about your pet theory does not entail that the theory you are being dogmatic about takes on a meaning that differs from the meaning the theory has when contemplated by your less-dogmatic associates.22

I therefore see no reason to retract my claim that there are mixed statements that are testable; mixed statements, recall, are ones that are about both supernatural entities and things that have spatiotemporal location. But what about statements that are purely about the supernatural? Consider another example that Pennock (1999, 196) discusses, namely Phillip Johnson's (1990) claim that "God creates for some purpose." Pennock asserts that Johnson's claim is untestable, and maybe he is right.23 However, it does not follow that all statements about the supernatural are untestable. So let's consider the following thesis: even if some of the mixed statements that creationists make are testable, their core propositions are not, and this is what makes their theory untestable. One problem with this thesis is that it is hard to tell what the core propositions are. Is "God exists" the only core proposition in young-earth creationism, or is "God created the earth between 6,000 and 10,000 years ago" also part of the core? The other problem is that even if some of the core propositions in a theory are untestable, it does not follow that the theory as a whole is untestable.24

Let us apply this question about creationism to science itself. Is every statement in a scientific theory testable? Mathematized theories in biology and in other sciences entail that numbers exist. Is the existence of numbers empirically testable? There is an irony here. The idea that scientific statements must be testable is familiar to us partly because of the large influence that Popper's (1959) views about falsifiability have had. Popper thought that testability, understood in terms of his idea of falsifiability, was the solution to the demarcation problem, which is the problem of separating scientific statements from nonscientific statements.25 Philosophers have recognized for a long time that falsifiability is a flawed account of testability (Sober 2007c, 2008b), but that is not the irony I have in mind. Rather, the irony is that some of Popper's contemporaries, the logical positivists, also thought that testability is a concept of central importance to science, but they denied that every statement in a scientific theory must be testable. Carnap (1950) and Reichenbach (1938), among other positivists, held that scientific theories often contain conventional elements. These are statements that are in a theory because they are useful, not because we can offer evidence that they are true. Carnap held that statements like "physical objects exist" and "numbers exist" are included in scientific theories for this reason. Physicists do not run tests to see whether physical objects exist; rather, they assume that there are physical objects, and then test statements like "electrons exist." And mathematicians do not construct proofs of the existence of numbers; rather, they assume that numbers exist, and then construct proofs of statements like "there are infinitely many primes." Contemporary discussion of methodological naturalism in connection with the debate between evolutionary biology and creationism owes a lot to Popper, the positivist heritage has largely been forgotten. That is too bad, because the idea that science uses framework assumptions that are untestable has a lot to be said for it.26

The positivists were not the only ones who recognized that a whole theory can be testable even if some of its parts are not. This difference between whole and part is something that Popper also saw; he did so by exploring the logic of his concept of falsifiability. Popper (1959, 249) notes that a theory can be falsifiable even though some of its consequences are not. For example, it is a feature of classical logic that every theory entails a tautology. However, tautologies are not falsifiable; no observation could refute the claim that either it is snowing or it is not.

It is easy to miss the fact that an empirically well-confirmed scientific theory may contain assumptions that are not empirically testable. This is because there is something intuitively attractive about the following principle:

The Special Consequence Condition of Confirmation: If observation O confirms theory T, and theory T entails that C is true, then O confirms C.

Confirmation of a statement does not mean that the observation proves that it is true; observational evidence hardly ever has such power in sci-
4.6. IS VIOLATING METHODOLOGICAL NATURALISM A SCIENCE-STOPPER?

Another popular defense of methodological naturalism is the claim that obeying this *ism is needed if science is to continue as a serious enterprise. The methodological principle is a necessary prophylactic; violating it is a "science stopper."

To evaluate this argument, let's begin with a simple historical point. Many central figures in the Scientific Revolution thought that science (which they called "natural philosophy") needs God to explain some natural phenomena. For example, Newton thought that the solar system would collapse without divine intervention. Newton did not always follow the precepts of methodological naturalism in his work, but that did not prevent him from doing good (or great) science. What is true about the science-stopper argument is that if you use "God wanted things to be so" as your one and only response to all the observations you make, you'll never do serious science. But the same is true of an obsessive devotion to the fact that carrots are orange. If you believe that this is the one and only explanation of everything that occurs, this belief will stop you from doing serious science. However, that is no reason to prohibit scientists from mentioning the color of carrots. Introducing God into science does not necessarily shut down the whole show, although it will do so if it is carried to monomaniacal extremes (as will any idle fife).

Newton's belief that the stability of the solar system depends on divine intervention did not stop him from doing great scientific work on gravitation. This shows that you can introduce God to explain *X* and still do good science about *Y*. But doesn't saying that God explains *X* rule out doing serious scientific work on why *X* is true? It need not. A scientist can believe that everything that happens in nature happens because it is God's will and still try to discover naturalistic explanations for natural phenomena. Deism asserts that everything we observe traces back to God but adds that there are naturalistic ("secondary") causes—-that lie between God and what we observe (figure 4.1). It may be replied that introducing the existence of God in this way is scientifically idle. Maybe so, but that does not show that invoking the existence of God must bring science to a stop.

My argument depends on a distinction—between saying that "God did it" is part of an explanation and saying that this is one's entire explanation. The latter practice, if applied to all natural phenomena, would spell the end of productive science. But that does not show that the former would also be lethal. This is why the science-stopper argument fails to justify methodological naturalism.

4.7. IF NUMBERS, WHY NOT GOD?

Mathematics is a necessary framework for science. Many of the scientific theories we prize presuppose that numbers exist. No such argument has been produced for including mention of God in scientific theories. Indeed, there have been many predictive scientific theories,
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developed over several centuries, that are silent on the question of whether God exists; these provide ample evidence that science does not need the God-postulate. These “silent theories” can be supplemented; one can add to them the claim that God exists, or the claim that he does not, or the claim that we don’t know whether there is a God, but in each case the supplements aren’t consequences of the science; rather, they are philosophical add-ons.

Arguments against introducing the claim that God exists into scientific theories have often been in-principle; they attempt to show that this theistic addition necessarily prevents science from reaching one of its goals. For example, it is claimed that the resulting theories cannot be tested or that introducing the God-postulate precludes the development of naturalistic explanations. The argument I would offer is more modest. Naturalistic science has been a success. Nature has presented us with scores of problems that have been addressed successfully by theories that are theistically neutral. The history of science provides very strong evidence that theism is not needed. The modest defense I would offer of methodological naturalism is simply this: if it isn’t broken, don’t fix it.

One glib retort to this suggestion is that science is already broken, and so it does stand in need of fixing. I suspect that this response stems from expecting science to do more than it is capable of doing. If you want scientific theories to tell you the difference between moral right and wrong, or what the meaning of life is, you will be disappointed. But this does not mean that science has failed. Science is not in that line of work. Methodological naturalism does not assert that the only way to gain knowledge is via the methods of science. It is a thesis about what scientific theories should assert, not about what nonscientific statements might have to offer. It therefore differs from Huxley’s (1892) “scientific naturalism” and from the testability theory of meaning advanced by the logical positivists.

Could a new form of inquiry be pursued in which theories are constructed that are both empirically successful and also are committed to the existence of God? There is a trivial way to do this: Just take a theory that we now admire, one that is theistically neutral, and append to it the statement “and this is God’s will.” The result is “theistic science,” but the theistic add-on is doing no real scientific work. It is idle. The same trick can be used to construct an atheistic science, and the atheistic addition is also scientifically idle. It is obscure how a theistically committed science (aka schmience) could proceed in which the theism is not idle and moreover does better than a science that is theistically neutral. It certainly could do a lot worse.

My discussion in §3.8 of how creationists and evolutionary biologists have theorized about sex ratios typifies the doubts I have about schmience. The creationist approach begins with the idea that the sex ratios found in different species are due to God’s will; the evolutionary approach begins with the idea that they are due to natural selection. If that were all there is to evolutionary biology, we might be tempted to conclude that the two approaches are on a par. But it is not, and they are not. In evolutionary biology, the starting thought gives rise to a variety of testable models that describe how different biological circumstances cause different sex ratios. Creationism, in contrast, simply hits a wall. It ends where it begins. Science is about the details, and this is just what creationism does not provide. In saying that creationism is woefully short on details, I don’t mean that it has not made detailed criticisms of evolutionary theory. Of course it has. What I mean is that creationism has not developed its own theories—theories that make predictions about what we should observe in the organisms around us. This is not to deny that creationism can accommodate what we have already observed. Current creationism can accommodate sex ratio data, just as Arbuthnot was able to do in 1710.

The modest argument I have given for methodological naturalism may invite the objection that I am cherry picking. I have mentioned the successes that theistically neutral scientific theories have had, but I have not mentioned their failures. These failures have certainly been numerous! Indeed, if science is a selection process in which alternative theories compete, each successful theory will be successful only in the sense that it is better than its competitors, which were relatively unsuccessful. My reply is that my argument does not depend on the absolute success rate of theistically neutral scientific theories being high. Of course there have been many failed naturalistic theories in the history of science. The question is whether they failed because they were theistically neutral. I claim that this is not the reason why. Consider two

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types of transition that can occur when a predecessor theory gives way to a successor theory. In the first, the shift is from a theory that violates methodological naturalism to one that obeys it; in the second, the shift is from a theory that obeys methodological naturalism to one that violates it. It is curious that improvements in theory have occurred more frequently in the first shift than in the second.\(^{33}\)

My argument for methodological naturalism is not an argument against theology between consenting adults. Those who wish to explore hypotheses about God’s relation to nature are obviously free to do so. The question is whether science should play by the rules of methodological naturalism, not whether all disciplines are obliged to embrace this ground rule. For example, work in the philosophy of religion routinely considers statements that affirm or deny the existence of a supernatural deity, and it would be absurd to suggest that this discipline should refrain from evaluating such propositions. Similar points apply to those who want to use their theological convictions to assess scientific theories. They are free to do so, but they need to recognize that the community of science now includes people with diverse theological viewpoints; theists of every stripe, as well as atheists and agnostics, can participate in this community if they leave their theologies (and atheologies) at the door. The plea to change science so that theological assumptions are deemed relevant to evaluating scientific theories is implicitly a plea to reduce the diversity of the scientific community.

It may seem harsh to require scientists who are sure there is a God to bracket this conviction when they do their science. Does methodological naturalism require theists to violate their intellectual integrity? To see that the answer is no, we must attend to the difference between declining to assert a proposition in an argument and repudiating one’s belief that the proposition is true. Scientists in their public discourse often leave aside many propositions of which they are certain. Nor is the bracketing involved here unique to science; rather, it is an aspect of how communities of rational inquiry do their work. If you are trying to convince someone that a particular proposition is true, and you want your argument to be effective, you must choose premises that the person you are addressing already believes or can be led to affirm based on what he or she already believes. Many of the propositions you believe are not

4.8. CONCLUDING COMMENTS

To modern scientists, it may seem obvious that scientific theories need mathematics, and equally obvious that they do not need theology. However, like all marriages and divorces, these two have their histories, and what may seem inevitable after the fact need not have seemed so before. One reason that methodological naturalism became increasingly persuasive over hundreds of years is that naturalistic explanations increased in number and power. But the triumph of methodological naturalism had another source; this was the development of a theological picture according to which a benevolent deity made the world in such a way that methodological naturalism would turn out to be a research strategy that human beings can successfully pursue. Recall from §4.1 the quotation from William Whewell with which Darwin begins the Origin.

But with regard to the material world, we can at least go so far as this—we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general laws.

Whewell’s words contrast two extremes—there are zero miracles in the material world or the material world is saturated with them—but the success of methodological naturalism does not require that the number be zero. Indeed, the history of methodological naturalism is inseparable from the idea of a God who sometimes intervenes in nature while, at the same time, ensuring that human beings are able to discover naturalistic explanations of what they observe (Numbers 2003; Brooke 2003).

When he heard Laplace’s exposition of the nebular hypothesis (a
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Newtonian explanation of the origin of the solar system), Napoleon
was taken aback. "Where is God in your theory?" he asked, and Laplace
is said to have replied that he had no need of that hypothesis. Many of
Darwin's contemporaries were shocked that he did not appeal to the
direct activity of a designing deity to explain organic diversity. Darwin
could have said what Laplace said; in fact, he did say as much. Atheists
may want to reach for Ockham's razor at this point and argue that the
success of these theories is evidence against the existence of God pre-
cisely because these theories show that the God hypothesis is not
needed in science. But the inference from "science can explain phe-
nomenon X without invoking the existence of God" to "God does not
exist" is shaky (Sober 2009b). It also is true that science can explain why
gold melts at a certain temperature without postulating the existence of
dinosaurs, but that isn't evidence that there were no dinosaurs. We need
to attend to Monod's good advice: "Any confusion between the ideas
suggested by science and science itself must be carefully avoided." New-
tonian theory and Darwinian theory suggest to some people that there is
no God. However, this is not what these theories say; it is a philosop-
hical interpretation of those theories, one whose justification requires
additional premises. Molière's Monsieur Jourdain was astonished to
learn that he had been speaking in prose for so many years. We should
not be astonished, when we discuss science, to find that we are actually
doing philosophy.