THE SCIENTIFIC STATUS OF INTELLIGENT DESIGN:

THE METHODOLOGICAL EQUIVALENCE OF NATURALISTIC AND NON-NATURALISTIC ORIGINS THEORIES[1]

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Editors Note: This article appeared in a collection of essays published in 2002 entitled *Science and Evidence of Design in the Universe* (Ignatius) . "The Scientific Status of Intelligent Design" addresses a series of methodological or philosophical objections that have been lodged against the theory of intelligent design, including the claim that the theory of intelligent design is not testable. Since many in the media have repeated this and other similar arguments against design we have decided to repost Dr. Meyer's article in this prominent position on our website.

Throughout the *Origin of Species*, Darwin repeatedly argues against the scientific status of the received "theory of Creation." He often faults his creationist rivals not just for their inability to devise explanations for certain biological data, but for their inability to offer *scientific* explanations at all. Indeed, some of Darwin's arguments for descent with modification depended, not on newly discovered facts unknown to the special creationists, but upon facts such as fossil progression, homology and biogeographical distribution that had neither stymied nor puzzled many creationists, but which, in Darwin's view, creationists could not explain in a properly scientific way.[2] What Darwin questioned in his attack against creationism was not just, to put the issue in modern terms, the "empirical adequacy" of then current creationist theories, but rather the methodological (and therefore scientific) legitimacy of the creationist program itself. Thus, Darwin would emphatically dismiss the creationist account of homology, for example, by saying "but that is not a *scientific* explanation."[3]

Underlying Darwin's repudiation of creationist legitimacy lay an entirely different conception of science than had prevailed among earlier naturalists.[4] Darwin's attacks on his creationist and idealist opponents in part expressed and in part established an emerging positivistic[5] "episteme" in which the mere mention of unverifiable "acts of Divine will" or "the plan of creation" would increasingly serve to disqualify theories from consideration as science qua science. This decoupling of theology from science and the redefinition of science that underlay it was justified less by argument than

by an implicit assumption about the characteristic features of all scientific theories—features that presumably could distinguish theories of a properly scientific (that is, positivistic) bent from those tied to unwelcome metaphysical or theological moorings. Thus, both in the *Origin* and in subsequent letters one finds Darwin invoking a number of ideas about what constitutes a properly scientific explanation in order to characterize creationist theories as inherently "unscientific." For Darwin the *in principle* illegitimacy of creationism was demonstrated by perceived deficiencies in its method of inquiry such as its failure to explain by reference to natural law,[6] and its postulation of unobservable causes and explanatory entities such as mind, purpose or "the plan of creation."[7]

Future defenders of Darwinism would expand this strategy.[8] Throughout the twentieth century those attempting to defend naturalistic evolutionary theories from challenge by *any* non-naturalistic origins theory have often invoked various norms of scientific practice. These norms have typically been derived from philosophy of science, most particularly from the logical positivists or the neo-positivists (such as Sir Karl Popper or Carl Hempel). Both the positivistic standard of verifiability and the neopositivistic standards of falsifiability and lawlike explanation have functioned as methodological yardsticks or "demarcation criteria" for measuring, and finding deficient, all theories of creation or even theories of intelligent design. Such theories have been declared "unscientific by definition" on numerous philosophical and methodological grounds.

The use by evolutionary biologists of so-called demarcation arguments—that is, arguments that purport to distinguish science from pseudoscience, metaphysics or religion—is both ironic and problematic from the point of view of philosophy of science. It is ironic because many of the demarcation criteria that have been used against non-naturalistic theories of origin can be deployed with equal warrant against strictly naturalistic evolutionary theories. Indeed, a corpus of literature now exists devoted to assessing whether neo-Darwinism, with its distinctively probabilistic and historical dimensions, is scientific when measured against various conceptions of science.[9] Some have wondered whether the use of narrative explanation in evolutionary biology constitutes a departure from a strict reliance upon natural law. Others have asked whether neo-Darwinism is falsifiable, or whether it makes true or risky predictions. In 1974, Sir Karl Popper declared neo-Darwinian evolutionary theory "untestable" and classified it as a "metaphysical research programme." While he later revised his judgment, he did so only after liberalizing his notion of falsifiability to allow the weaker notion of "falsifiability in principle" to count as a token of scientific status.

The use of demarcation arguments to settle the origins controversy is also problematic because the whole enterprise of demarcation has now fallen into disrepute. Attempts to locate methodological "invariants" that provide a set of necessary and sufficient conditions for distinguishing true science from pseudoscience have failed.[10] Most philosophers of science now recognize that neither verifiability, nor testability (nor falsifiability), nor the use of lawlike explanation (nor any other criterion) can suffice to define scientific practice. As Laudan puts it, "If we could stand up on the side of reason, we ought to drop terms like 'pseudo-science'…they do only emotive work for us."[11]

Nevertheless, philosophical arguments about what does or does not constitute science continue to play a vital role in persuading biologists that alternative scientific explanations do not and (in the case of nonnaturalistic or nonmaterialistic explanations) can not exist for the origin of biological form and structure. Indeed, demarcation criteria continue to be cited by modern biologists as reasons for disregarding the possibility of intelligent design as a theory of biological origins.[12]

This essay will examine the in principle case against the scientific status of intelligent design. It will examine several of the methodological criteria that have been advanced as means of distinguishing the scientific status of naturalistic evolutionary theories from nonnaturalistic theories such as intelligent design, special creation, progressive creation and theistic evolution. I will argue that attempts to make distinctions of scientific status a priori on methodological grounds inevitably fail, and instead that a general equivalence of method exists between these two broadly competing approaches to origins. In so doing, I will attempt to shed light on the specific question of whether a scientific theory of intelligent design could be formulated, or whether methodological objections, forever and in principle, render this possibility "self contradictory nonsense" as Ruse, Stent, Gould and others have claimed (of, at least, scientific creationism).[13] Throughout this paper, I will use the alliterative terms "design" and "descent" as a convenient shorthand to distinguish (a) theories that invoke the efficient causal action of an intelligent agent (whether divine or otherwise) as part of the explanation for the origin of biological form and complexity, from (b) theories (such as Darwin's "descent with modification") that rely *exclusively* on naturalistic processes to explain the origin of biological form and complexity.[14]

By way of qualification, it should be noted that by defending the methodological and scientific legitimacy of intelligent design, this chapter is not seeking to rehabilitate the empirically inadequate biology of many nineteenth-century creationists or their belief in the absolute fixity of species; nor is it attempting to endorse modern young-earth geology. The following analysis concerns the methodological legitimacy of "design" in principle as defined above, not the empirical adequacy of specific theories that might invoke intelligent design in the process of making other empirical claims.

The methodological equivalence of intelligent design and naturalistic descent will be suggested in three stages by three lines of argument. First, the reasons for the failure of demarcation arguments within philosophy of science generally will be examined and recapitulated. This analysis will suggest that attempts to distinguish the scientific status of design and descent a priori may well be suspect from the outset on philosophical grounds. Second, an examination of specific demarcation arguments that have been employed against design will follow. It will be argued that not only do these arguments fail, but they do so in such a way as to suggest an equivalence between design and descent with respect to several features of allegedly proper scientific practice—that is, intelligent design and naturalistic descent will be shown equally capable or incapable of meeting different demarcation standards, provided such standards are applied disinterestedly. Third, design and descent will be compared in light of recent work on the logical and methodological character of historical inquiry. This analysis will show that the mode of inquiry utilized by advocates of both design and descent conforms closely to that evident in many other characteristically historical disciplines. Thus a more fundamental methodological equivalence between design and descent will emerge as a result of methodological analysis of the historical sciences.

Part 1: The General Failure of Demarcation Arguments

To show that design "can never be considered a scientific pursuit,"[15] biologists and others have asserted that design does not meet certain objective criteria of scientific method or practice. In short, biologists have employed so-called demarcation arguments to separate a scientific approach to origins (descent) from an allegedly nonscientific approach

(design). While an examination of the particular criteria employed in such arguments will not concern us in the first part of this chapter, the general practice of demarcation will.

From the standpoint of the philosophy of science, the use of demarcation arguments is generally problematic. Historically, attempts to find methodological "invariants" that provide a set of necessary and sufficient conditions for distinguishing true science from pseudoscience have failed.[16] Moreover, most current demarcation arguments presuppose an understanding of how science operates that reflects the influence of a philosophy of science known as logical positivism. Yet since the 1950s philosophers of science have decisively rejected positivism for a number of very good reasons (see below). As a result, the enterprise of demarcation has generally fallen into disrepute among philosophers of science.

In his essay "The Demise of the Demarcation Problem," philosopher of science Larry Laudan gives a brief but thorough sketch of the different grounds that have been advanced during the history of science for distinguishing science from nonscience.[17] He notes that the first such grounds concerned the degree of certainty associated with scientific knowledge. Science, it was thought, could be distinguished from nonscience because science produced certainty whereas other types of inquiry such as philosophy produced opinion. Yet this approach to demarcation ran into difficulties as scientists and philosophers gradually realized the fallible nature of scientific disciplines and theories. Unlike mathematicians, scientists rarely provide strict logical demonstrations (deductive proofs) to justify their theories. Instead, scientific arguments often utilize inductive inference and predictive testing, neither of which produces certainty. As Owen Gingerich has argued, much of the reason for Galileo's conflict with the Vatican stemmed from Galileo's inability to meet scholastic standards of deductive certainty a standard that he regarded as neither relevant to nor attainable by scientific reasoning.[18] Similar episodes subsequently made it clear that science does not necessarily possess a superior epistemic status; scientific knowledge, like other knowledge, is subject to uncertainty.

By the nineteenth century, attempts to distinguish science from nonscience had changed. No longer did demarcationists attempt to characterize science on the basis of the superior epistemic status of scientific theories; rather, they attempted to do so on the basis of the superior methods science employed to produce theories. Thus science came to be defined by reference to its method, not its content. Demarcation criteria became methodological rather than epistemological.[19]

Nevertheless, this approach also encountered difficulties, not the least of which was a widespread disagreement about what the method of science really is. If scientists and philosophers cannot agree about what *the* scientific method is, how can they disqualify disciplines that fail to use it? Moreover, as the discussion of the historical sciences in part three of this chapter will make clear, there may well be more than one scientific method. If that is so, then attempts to mark off science from nonscience using a single set of methodological criteria will most likely fail. The existence of a variety of scientific methods raises the possibility that no single methodological characterization of science may suffice to capture the diversity of scientific practice. Using a single set of methodological criteria to assess scientific status could therefore result in the disqualification of some disciplines already considered to be scientific.[20]

As problems with using methodological considerations grew, demarcationists shifted their focus again. Beginning in the 1920s, philosophy of science took a linguistic or semantic turn. The logical positivist tradition held that scientific theories could be distinguished from nonscientific theories not because scientific theories had been produced via unique

or superior methods, but because such theories were more meaningful. Logical positivists asserted that all meaningful statements are either empirically verifiable or logically undeniable. According to this "verificationist criterion of meaning," scientific theories are more meaningful than philosophical or religious ideas, for example, because scientific theories refer to observable entities such as planets, minerals and birds, whereas philosophy and religion refer to such unobservable entities as God, truth and morality.

Yet as is now well known, positivism soon self-destructed. Philosophers came to realize that positivism's verificationist criterion of meaning did not achieve its own standard. That is, the assumptions of positivism turn out to be neither empirically verifiable nor logically undeniable. Furthermore, positivism's verificationist ideal misrepresented much actual scientific practice. Many scientific theories refer to unverifiable and unobservable entities such as forces, fields, molecules, quarks and universal laws. Meanwhile, many disreputable theories (e.g., the flat-earth theory) appeal explicitly to "common-sense" observations. Clearly, positivism's verifiability criterion would not achieve the demarcation desired.

With the death of positivism in the 1950s, demarcationists took a different tack. Other semantic criteria emerged, such as Sir Karl Popper's falsifiability. According to Popper, scientific theories were more meaningful than nonscientific ideas because they referred only to empirically falsifiable entities.[21] Yet this, too, proved to be a problematic criterion. First, falsification turns out to be difficult to achieve. Rarely are the core commitments of theories directly tested via prediction. Instead, predictions occur when core theoretical commitments are conjoined with auxiliary hypotheses, thus always leaving open the possibility that auxiliary hypotheses, not core commitments, are responsible for failed predictions.

Newtonian mechanics, for example, assumed as its core three laws of motion and the theory of universal gravitation. On the basis of these, Newton made a number of predictions about the positions of planets in the solar system. When observations failed to corroborate some of his predictions, he did not reject his core assumptions. Instead, he scrutinized some of his auxiliary hypotheses to explain the discrepancies between theory and observation. For example, he examined his working assumption that planets were perfectly spherical and influenced only by gravitational force. As Imre Lakatos has shown, Newton's refusal to repudiate his core in the face of anomalies enabled him to refine his theory and eventually led to its tremendous success.[22] Newton's refusal to accept putatively falsifying results certainly did not call into question the scientific status of his gravitational theory or his three laws.

The function of auxiliary hypotheses in scientific testing suggests that many scientific theories, including those in so-called hard sciences, may be very difficult, if not impossible, to falsify conclusively. Yet many theories that have been falsified in practice via the consensus judgment of the scientific community must qualify as scientific according to the falsifiability criterion. Since they have been falsified, they are obviously falsifiable, and since they are falsifiable, they would seem to be scientific.[23]

And so it has gone generally with demarcation criteria. Many theories that have been repudiated on evidential grounds express the very epistemic and methodological virtues (testability, falsifiability, observability, etc.) that have been alleged to characterize true science. Many theories that are held in high esteem lack some of the allegedly necessary and sufficient features of proper science. As a result,[24] with few exceptions[25] most contemporary philosophers of

science regard the question "What methods distinguish science from nonscience?" as both intractable and uninteresting. What, after all, is in a name? Certainly not automatic epistemic warrant or authority. Thus philosophers of science have increasingly realized that the real issue is not whether a theory is scientific but whether it is true or warranted by the evidence. Thus, as Martin Eger has summarized, "demarcation arguments have collapsed. Philosophers of science don't hold them anymore. They may still enjoy acceptance in the popular world, but that's a different world."[26]

The "demise of the demarcation problem," as Laudan calls it, implies that the use of positivistic demarcationist arguments by evolutionists is, at least prima facie, on very slippery ground. Laudan's analysis suggests that such arguments are not likely to succeed in distinguishing the scientific status of descent vis-a-vis design or anything else for that matter. As Laudan puts it, “If we could stand up on the side of reason, we ought to drop terms like ‘pseudo-science.’… They do only emotive work for us.”[27]

If philosophers of science such as Laudan are correct, a stalemate exists in our analysis of design and descent. Neither can automatically qualify as science; neither can be necessarily disqualified either. The a priori methodological merit of design and descent are indistinguishable if no agreed criteria exist by which to judge their merits.

Yet lacking any definite metric, one cannot yet say that design and descent are methodologically equivalent in any nontrivial sense. In order to make this claim we must compare design and descent against some specific standards. Let's now consider the specific demarcation arguments that have been erected against design. For though demarcation arguments have been discredited by philosophers of science generally, they still enjoy wide currency in the scientific and "popular world,"[28] as the following section will make abundantly clear.

Part 2: Specific Demarcation Arguments Against Design

Despite the consensus among philosophers of science that the demarcation problem is both intractable and ill-conceived, many scientists continue to invoke demarcation criteria to discredit quacks, cranks and those otherwise perceived as intellectual opponents. Yet to the average working scientist Laudan's arguments against demarcation may seem counter intuitive at best. On the surface it may appear that there ought to be some unambiguous criteria for distinguishing such dubious pursuits as parapsychology, astrology and phrenology from established sciences such as physics, chemistry and astronomy. That most philosophers of science say that there are not such criteria only confirms the suspicions many scientists have about philosophers of science. After all, don't some philosophers of science say that scientific truth is determined by social and cultural context? Don't some even deny that science describes an objective reality?

Well, as it turns out, one does not need to adopt a relativistic or antirealist view of science to accept what Laudan and others say about the demarcation problem. Indeed, the two positions are logically unrelated. Laudan is not arguing that all scientific theories have equal warrant (quite the reverse) or that scientific theories never refer to real entities. Instead, he simply says that one cannot define science in such a way as to confer automatic epistemic authority on favored theories simply because they happen to manifest features alleged to characterize all "true science." When evaluating the warrant or truth claims of theories, we cannot substitute abstractions about the nature of science for empirical evaluation.

Nevertheless, establishing Laudan's general thesis is not the main purpose of this chapter. This chapter is not seeking to establish the impossibility of demarcation in general, but the methodological equivalence of intelligent design and naturalistic descent. Since some may yet doubt that demarcation *always* fails, the following section will examine some of the specific demarcation arguments that have been deployed against design by proponents of descent.[29] It will suggest that these arguments fail to provide any grounds for distinguishing the methodological merit of one over the other and, instead, that careful analysis of these arguments actually exposes reasons for regarding design and descent as methodologically equivalent. Indeed, the following analysis will suggest that metaphysically neutral criteria do not exist that can define science narrowly enough to disqualify theories of design *tout court* without also disqualifying theories of descent on identical grounds.

Unfortunately, to establish this conclusively would require an examination of all the demarcation arguments that have been used against design. And indeed, an examination of evolutionary polemic reveals many such arguments. Design or creationist theories have been alleged to be necessarily unscientific because they (a) do not explain by reference to natural law,[30] (b) invoke unobservables,[31] (c) are not testable,[32] (d) do not make predictions,[33] (e) are not falsifiable,[34] (f) provide no mechanisms,[35] (g) are not tentative[36] and (h) have no problem-solving capability.[37]

Due to space constraints, a detailed analysis of only the first three arguments will be possible. Nevertheless, an extensive analysis of (a), (b) and (c) will follow. These three have been chosen because each can be found in one form or another all the way back to the *Origin of Species*. The first one, (a), is especially important because the others derive from it—a point emphasized by Michael Ruse,[38] perhaps the world's most ardent evolutionary demarcationist. Consequently an analysis of assertion (a) will occupy the largest portion of this section.[39] There will also be a short discussion of arguments (d), (e) and (f) and references to literature refuting (g) and (h). Thus while an exhaustive analysis of all demarcationist arguments will not be possible here, enough will be said to allow us to conclude that the principal arguments employed against design do not succeed in impugning its scientific status without either begging the question or undermining the status of descent as well.

Explanation via natural law. Now let us examine the first, and according to Michael Ruse[40] most fundamental, of the arguments against the possibility of a scientific theory of design. This argument states: "Scientific theories must explain by natural law. Because design or creationist theories do not do so, they are necessarily unscientific."

This argument invokes one of the principal criteria of science adopted by Judge William Overton after hearing the testimony of philosopher of science Michael Ruse in the Arkansas creation-science trial of 1981-82.[41] As late as March 1992, Ruse continued to assert "must explain via natural law" as a demarcation criterion, despite criticism from other philosophers of science such Philip Quinn and Larry Laudan.[42] Ruse has argued that to adopt the scientific outlook, one must accept that the universe is subject to natural law, and further, that one must never appeal to an intervening agency as an explanation for events. Instead, one must always look to what he calls "unbroken law" if one wishes to explain things in a scientific manner.

There are several problems with this assertion and the conception of science that Ruse assumes.[43] In particular, Ruse seemed to assume a view of science that equates scientific laws with explanations. There are two problems with this

view and correspondingly two main reasons that "explains via natural law" will not do as a demarcation criterion.

First, many laws are descriptive and not explanatory. Many laws describe regularities but do not explain why the regular events they describe occur. A good example of this drawn from the history of science is the universal law of gravitation, which Newton himself freely admitted did not explain but instead merely described gravitational motion. As he put it in the "General Scholium" of the second edition of the *Principia*, “I do not feign hypotheses”—in other words, “I offer no explanations.”[44] Insisting that science must explain by reference to "natural law" would eliminate from the domain of the properly scientific all fundamental laws of physics that describe mathematically, but do not explain, the phenomena they "cover."[45] For the demarcationist this is a highly paradoxical and undesirable result, since much of the motivation for the demarcationist program derives from a desire to ensure that disciplines claiming to be scientific match the methodological rigor of the physical sciences. While this result might alleviate the "physics envy" of many a sociologist, it does nothing for demarcationists except defeat the very purpose of their enterprise.

There is a second reason that laws cannot be equated with explanations or causes. This, in turn, gives rise to another reason that science cannot be identified only with those disciplines that explain via natural law. Laws cannot be equated with explanations, not just because many laws do not explain but also because many explanations of particular events, especially in applied or historical science, may not utilize laws.[46] While scientists may often use laws to assess or enhance the plausibility of explanations of particular events, analysis of the logical requirements of explanation has made clear that the citation of laws is not necessary to many such explanations.[47] Instead, many explanations of particular events or facts, especially in the historical sciences, depend primarily, even exclusively, upon the specification of past causal conditions and events rather than laws to do what might be called the "explanatory work." That is, citing past causal events often explains a particular event better than, and sometimes without reference to, a law or regularity in nature.[48]

One reason laws play little or no role in many historical explanations is that many particular events come into existence via a series of events that will not regularly reoccur. In such cases laws are not relevant to explaining the contrast between the event that has occurred and what could have or might have ordinarily been expected to occur. For example, a historical geologist seeking to explain the unusual height of the Himalayas will cite particular antecedent factors that were present in the case of the Himalayan orogeny but were absent in other mountain-building episodes. Knowing the laws of geophysics relevant to mountain-building generally will aid the geologist very little in accounting for the contrast between the Himalayan and other orogenies, since such laws would presumably apply to all mountain-building episodes. What the geologist needs in the search for an explanation in this case is not knowledge of a general law but evidence of a unique or distinctive set of past conditions.[49] Thus geologists have typically explained the unique height of the Himalayas by reference to the past position of the Indian and Asian land masses (and plates) and the subsequent collision that occurred between them.

The geologist's situation is very similar to that faced by historians generally. Consider the following factors that might help explain why World War I began: the ambition of Kaiser Wilhelm's generals, the Franco-Russian defense pact and the assassination of Archduke Ferdinand. Note that such possible explanatory factors invariably involve the citation of past events, conditions or actions rather than laws. Invoking past events as causes in order to explain subsequent events or present evidences is common both in history and in natural scientific disciplines such as historical geology. As

Michael Scriven has shown, one can often know what caused something even when one cannot relate causes and effects to each other in formal statements of law.[50] Similarly, William Alston has shown that laws alone often do not explain particular events even when we have them.[51] The law "Oxygen is necessary to combustion" does not explain why a particular building burned down at a particular place and time.[52] To explain such a particular fact requires knowing something about the situation just before the fire occurred. It does little good to know scientific laws; what one requires is information concerning, for example, the presence of an arsonist or the lack of security at the building or the absence of a sprinkler system. Thus Alston concludes that to equate a law with an explanation or cause "is to commit a 'category mistake' of the most flagrant sort."[53]

Perhaps another example will help. If one wishes to explain why astronauts were able to fly to the moon when apples usually fall to the earth, one will not primarily cite the law of gravity. Such a law is far too general to be primarily relevant to explanation in this context, because the law allows for a vast array of possible outcomes depending on initial and boundary conditions. The law stating that all matter gravitates according to an inverse square law is consistent with both an apple falling to the earth and with an astronaut flying to the moon. Explaining why the astronaut flew when apples routinely fall, therefore, requires more than citing the law, since the law is presumed operative in both situations. Accounting for the differing outcomes—the falling apple and the flying astronaut—will require references to the antecedent conditions and events that differed in the two situations. Indeed, explanation in this case involves an accounting of the way engineers have used technology to alter the *conditions* affecting the astronauts to allow them to overcome the constraints that gravity ordinarily imposes on earthbound objects.

Such examples suggest that many explanations of particular events—explanations that occur frequently in fields already regarded as scientific—such as cosmology, archaeology, historical geology, applied physics and chemistry, origin-of-life studies and evolutionary biology would lose their scientific status if Ruse's criterion of "explains via natural law" were accepted as normative to all scientific practice.

Consider an example from evolutionary biology that impinges directly on our discussion. Stephen Jay Gould, Mark Ridley and Michael Ruse argue that the "fact of evolution"[54] is secure even if an adequate theory has not yet been formulated to describe or explain how large-scale biological change generally occurs. Like Darwin, modern evolutionary theorists insist that the question whether evolution[55] did occur can be separated logically from the question of the means by which nature generally achieves biological transformations. Evolution in one sense—historical continuity or common descent—is asserted to be a well-established scientific theory[56] because it alone explains a diverse class of present data (fossil progression, homology, biogeographical distribution, etc.), even if biologists cannot yet explain how evolution in another sense—a general process or mechanism of change—occurs. Some have likened the logical independence of common descent and natural selection to the logical independence of continental drift and plate tectonics. In both the geological situation and the biological there exist theories about *what happened* that explain why we observe many present facts, and separate theories that explain *how* things *could have* happened as they apparently did. Yet the former purely historical explanations do not require the latter nomological[57] or mechanistic explanations to legitimate themselves. Common descent explains some facts well, even if nothing yet explains how the transformations it requires could have occurred.

This example again illustrates why historical explanations do not require laws.[58] More important, it also demonstrates

why Ruse's demarcation criterion proves fatal to the very Darwinism he is seeking to protect. Common descent, arguably the central thesis of the *Origin of Species*, does not explain by natural law. Common descent explains by postulating a hypothetical pattern of historical events which, if actual, would account for a variety of presently observed data. Darwin himself refers to common descent as the *vera causa* (that is, the actual cause or explanation) for a diverse set of biological observations.[59] In Darwin's historical argument for common descent, as with historical explanations generally, postulated past causal events (or patterns thereof) do the primary explanatory work. Laws do not.[60]

At this point the evolutionary demarcationist might grant the explanatory function of antecedent events but deny that scientific explanations can invoke *supernatural* events. To postulate naturally occurring past events is one thing, but to postulate supernatural events is another. The first leaves the laws of nature intact; the second does not and thus lies beyond the bounds of science. As Ruse and Richard Lewontin have argued, miraculous events are unscientific because they violate or contradict the laws of nature, thus making science impossible.[61]

Many contemporary philosophers disagree with Ruse and Lewontin about this, as have a number of good scientists over the years—Isaac Newton and Robert Boyle, for example. The action of agency (whether divine or human) need not violate the laws of nature; in most cases it merely changes the initial and boundary conditions on which the laws of nature operate.[62] But this issue must be set aside for the moment. For now it will suffice merely to note that the criterion of demarcation has subtly shifted. No longer does the demarcationist repudiate design as unscientific because it does not "explain via natural law"; now the demarcationist rejects intelligent design because it does not "explain naturalistically." To be scientific a theory must be naturalistic.

But why is this the case? Surely the point at issue is whether there are independent and metaphysically neutral grounds for disqualifying theories that invoke nonnaturalistic events—such as instances of agency or intelligent design. To assert that such theories are not scientific because they are not naturalistic simply assumes the point at issue. Of course intelligent design is not wholly naturalistic, but why does that make it unscientific? What noncircular reason can be given for this assertion? What independent criterion of method demonstrates the inferior scientific status of a nonnaturalistic explanation? We have seen that "must explain via law" does not. What does?

Unobservables and testability. At this point evolutionary demarcationists must offer other demarcation criteria. One that appears frequently both in conversation and in print finds expression as follows: "Miracles are unscientific because they can not be studied empirically.[63] Design invokes miraculous events; therefore design is unscientific. Moreover, since miraculous events can't be studied empirically, they can't be tested.[64] Since scientific theories must be testable, design is, again, not scientific." Molecular biologist Fred Grinnell has argued, for example, that intelligent design can't be a scientific concept because if something "can't be measured, or counted, or photographed, it can't be science."[65] Gerald Skoog amplifies this concern: "The claim that life is the result of a design created by an intelligent cause can not be tested and is not within the realm of science."[66] This reasoning was invoked in a 1993 case at San Francisco State University as a justification for removing Professor Dean Kenyon from his classroom. Kenyon is a biophysicist who has embraced intelligent design after years of work on chemical evolution. Some of his critics at SFSU argued that his theory fails to qualify as scientific because it refers to an unseen Designer that cannot be tested or, as Eugenie Scott said, “You can’t use supernatural explanation because you can’t put an omnipotent deity in a test tube…as soon as

creationists invent a 'theo-meter' maybe we could test for miraculous intervention."[67]

The essence of these arguments seems to be that the unobservable character of a designing agent renders it inaccessible to empirical investigation and thus precludes the possibility of testing any theory of design. Thus the criterion of demarcation employed here conjoins "observability and testability." Both are asserted as necessary to scientific status, and the converse of one (unobservability) is asserted to preclude the possibility of the other (testability).

It turns out, however, that both parts of this formula fail. First, observability and testability are not both necessary to scientific status, because observability at least is not necessary to scientific status, as theoretical physics has abundantly demonstrated. Many entities and events cannot be directly observed or studied—in practice or in principle. The postulation of such entities is no less the product of scientific inquiry for that. Many sciences are in fact directly charged with the job of inferring the unobservable from the observable. Forces, fields, atoms, quarks, past events, mental states, subsurface geological features, molecular biological structures—all are unobservables inferred from observable phenomena. Nevertheless, most are unambiguously the result of scientific inquiry.

Second, unobservability does not preclude testability: claims about unobservables are routinely tested in science indirectly against observable phenomena. That is, the existence of unobservable entities is established by testing the explanatory power that would result if a given hypothetical entity (i.e., an unobservable) were accepted as actual. This process usually involves some assessment of the established or theoretically plausible causal powers of a given unobservable entity. In any case, many scientific theories must be evaluated indirectly by comparing their explanatory power against competing hypotheses.

During the race to elucidate the structure of the genetic molecule, both a double helix and a triple helix were considered, since both could explain the photographic images produced via x-ray crystallography.[68] While neither structure could be observed (even indirectly through a microscope), the double helix of Watson and Crick eventually won out because it could explain other observations that the triple helix could not. The inference to one unobservable structure—the double helix—was accepted because it was judged to possess a greater explanatory power than its competitors with respect to a variety of relevant observations. Such attempts to infer to the best explanation, where the explanation presupposes the reality of an unobservable entity, occur frequently in many fields already regarded as scientific, including physics, geology, geophysics, molecular biology, genetics, physical chemistry, cosmology, psychology and, of course, evolutionary biology.

The prevalence of unobservables in such fields raises difficulties for defenders of descent who would use observability criteria to disqualify design. Darwinists have long defended the apparently unfalsifiable nature of their theoretical claims by reminding critics that many of the creative processes to which they refer occur at rates too slow to observe. Further, the core historical commitment of evolutionary theory—that present species are related by common ancestry—has an epistemological character that is very similar to many present design theories. The transitional life forms that ostensibly occupy the nodes on Darwin's branching tree of life are unobservable, just as the postulated past activity of a Designer is unobservable.[69] Transitional life forms are theoretical postulations that make possible evolutionary accounts of present biological data. An unobservable designing agent is, similarly, postulated to explain features of life such as its information content and irreducible complexity. Darwinian transitional, neo-Darwinian mutational events,

punctuationalism's "rapid branching" events, the past action of a designing agent—none of these are directly observable. With respect to direct observability, each of these theoretical entities is equivalent.

Each is roughly equivalent with respect to testability as well. Origins theories generally must make assertions about what happened in the past to cause present features of the universe (or the universe itself) to arise. They must reconstruct unobservable causal events from present clues or evidences. Positivistic methods of testing, therefore, that depend upon direct verification or repeated observation of cause-effect relationships have little relevance to origins theories, as Darwin himself understood. Though he complained repeatedly about the creationist failure to meet the *vera causa* criterion—a nineteenth-century methodological principle that favored theories postulating observed causes—he chafed at the application of rigid positivistic standards to his own theory. As he complained to Joseph Hooker: "I am actually weary of telling people that I do not pretend to adduce *direct* evidence of one species changing into another, but that I believe that this view in the main is correct because so many phenomena can be thus grouped and *explained*"[70](emphasis added).

Indeed, Darwin insisted that direct modes of testing were wholly irrelevant to evaluating theories of origins. Nevertheless, he did believe that critical tests could be achieved via indirect means. As he stated elsewhere: "This hypothesis [common descent] must be tested . . . by trying to see whether it explains several large and independent classes of facts; such as the geological succession of organic beings, their distribution in past and present times, and their mutual affinities and homologies."[71] For Darwin the unobservability of past events and processes did not mean that origins theories are untestable. Instead, such theories may be evaluated and tested indirectly by the assessment of their explanatory power with respect to a variety of relevant data or "classes of facts."

Nevertheless, if this is so it is difficult to see why the unobservability of a Designer would necessarily preclude the testability of such a postulation. Though Darwin would not have agreed, the basis of his methodological defense of descent seems to imply the possibility of a testable theory of design, since the past action of an unobservable agent could have empirical consequences in the present just as an unobservable genealogical connection between organisms does. Indeed, Darwin himself tacitly acknowledged the testability of design by his own attempts to expose the empirical inadequacy of competing creationist theories. Though Darwin rejected many creationist explanations as unscientific in principle, he attempted to show that others were incapable of explaining certain facts of biology.[72] Thus sometimes he treated creationism as a serious scientific competitor lacking explanatory power; at other times he dismissed it as unscientific by definition.

Recent evolutionary demarcationists have contradicted themselves in the same way. The quotation cited earlier from Gerald Skoog ("The claim that life is the result of a design created by an intelligent cause can not be tested and is not within the realm of science") was followed in the same paragraph by the statement "Observations of the natural world also make these dicta [concerning the theory of intelligent design] suspect."[73] Yet clearly something cannot be both untestable in principle and subject to refutation by empirical observations.

The preceding considerations suggest that neither evolutionary descent with modification nor intelligent design is ultimately untestable. Instead, both theories seem testable indirectly, as Darwin explained of descent, by a comparison of their explanatory power with that of their competitors. As Philip Kitcher—no friend of creationism—has

acknowledged, the presence of unobservable elements in theories, even ones involving an unobservable Designer, does not mean that such theories cannot be evaluated empirically. He writes, "Even postulating an unobserved Creator need be no more unscientific than postulating unobserved particles. What matters is the character of the proposals and the ways in which they are articulated and defended."[74]

Thus an unexpected equivalence emerges when design and descent are evaluated against their ability to meet specific demarcation criteria. The demand that the theoretical entities necessary to origins theories must be directly observable if they are to be considered testable and scientific would, if applied universally and disinterestedly, require the exclusion not only of design but also of descent. Those who insist on the joint criteria of observability and testability, conceived in a positivistic sense, promulgate a definition of correct science that evolutionary theory manifestly cannot meet. If, however, a less severe standard of testability is allowed, the original reason for excluding design evaporates. Here an analysis of specific attempts to apply demarcation criteria against design actually demonstrates a methodological equivalence between design and descent.

Other demarcation criteria. I claim that a similar equivalence between design and descent will emerge from an analysis of each of the other criteria—(d) through (h)—listed above. Falsification, for example, in addition to the problems mentioned in part one, seems an especially problematic standard to apply to origins theories. So does prediction. Origins theories must necessarily offer ex post facto reconstructions. They therefore do not make predictions in any strong sense. The somewhat artificial "predictions" that origins theories do make about, for example, what evidence one ought to find if a given theory is true are singularly difficult to falsify since, as evolutionary paleontologists often explain, "the absence of evidence is no evidence of absence."[75]

Similarly, the requirement that a scientific theory must provide a causal mechanism fails to provide a metaphysically neutral standard of demarcation for several reasons. First, as we have already noted, many theories in science are not mechanistic theories. Many theories that explicate what regularly happens in nature either do not or need not explain why those phenomena occur mechanically. Newton's universal law of gravitation was no less a scientific theory because Newton failed—indeed refused—to postulate a mechanistic cause for the regular pattern of attraction his law described. Also, as noted earlier, many historical theories about *what* happened in the past may stand on their own without any mechanistic theory about *how* the events to which such theories attest could have occurred. The theory of common descent is generally regarded as a scientific theory even though scientists have not agreed on a completely adequate mechanism to explain how transmutation between lines of descent can be achieved. In the same way, there seems little justification for asserting that the theory of continental drift became scientific only after the advent of plate tectonics. While the mechanism provided by plate tectonics certainly helped render continental drift a more persuasive theory,[76] it was nevertheless not strictly necessary to know the mechanism by which continental drift *occurs* (1) to know or theorize that drift *had occurred* or (2) to regard the continental drift theory as scientific.

Yet one might concede that causal mechanisms are not required in all scientific contexts, but deny that origins research is such a context. One might argue that since origins theories necessarily attempt to offer causal explanations, and since design admittedly attempts to explain the origin of life or major taxonomic groups, its failure to offer a mechanism disqualifies it as an adequate theory of origins.

But this argument has difficulties as well. First, an advocate of design could concede that his theory does not provide a complete causal explanation of how life originated without forfeiting scientific status for the theory. Present clues and evidences might convince some scientists *that* intelligence played a causal role in the design of life, without those same scientists' knowing exactly *how* mind exerts its influence over matter. All that would follow in such a case is that design is an incomplete theory, not that it is an unscientific one (or even an unwarranted one). And such incompleteness is not unique to design theories. Both biological (as just discussed) and chemical evolutionary theories have often provided less than completely adequate causal scenarios. Indeed, most scientific theories of origin are causally incomplete or inadequate in some way.

In any case, asserting mechanism as necessary to the scientific status of origins theories begs the question. In particular, it assumes without justification that all scientifically acceptable causes are *mechanistic* causes. To insist that all causal explanations in science must be mechanistic is to insist that all causal theories must refer only to material entities (or their energetic equivalents). Yet this requirement is merely another expression of the very naturalism whose methodological necessity has been asserted because of ostensibly compelling demarcation arguments. Insofar as the statement "All scientific theories must be mechanistic" *is* a demarcation argument, this requirement is evidently circular. Science, the demarcationist claims, must be mechanistic because it must be naturalistic; it must be naturalistic because otherwise it would violate demarcation standards—in particular, the standard that all scientific theories must be mechanistic.

This argument clearly assumes the point at issue, which is whether or not there are independent—that is, metaphysically neutral—reasons for preferring exclusively materialistic causal explanations of origins over explanations that invoke putatively immaterial entities such as creative intelligence, mind, mental action, divine action or intelligent design. While philosophical naturalists may not regard the foregoing as real, they certainly cannot deny that such entities could function as causal antecedents if they were.

Thus we return to the central question: What noncircular reason can be offered for prohibiting the postulation of nonmechanistic (e.g., mental or intelligent) causes in scientific origins theories? Simply asserting that such entities may not be considered, whatever the empirical justification for their postulation, clearly does not constitute a justification for an exclusively naturalistic definition of science. Theoretically there are at least two possible types of causes: mechanistic and intelligent. The demarcationist has yet to offer a noncircular reason for excluding the latter type.[77]

Part 3: The Methodological Character of Historical Science

Let us now turn to a more fundamental reason for the methodological equivalence of design and descent. As stated earlier, the equivalence of design and descent follows from an understanding of the distinctive logical and methodological character of the historical sciences. An examination of scientific disciplines concerned with past events and causes, such as evolutionary biology, historical geology and archaeology, reveals a distinctive pattern of inquiry that contrasts markedly with nonhistorical sciences such as branches of chemistry, physics or biology that are concerned primarily with the discovery and explication of general phenomena. This section will show that both design and descent do, or could, instantiate this distinctive historical pattern of scientific investigation. In other words, a fundamental methodological equivalence between design and descent derives from a common concern with history—

that is, with historical questions, historical inferences and historical explanations.

We can see this historical concern first by looking at why the demarcation arguments analyzed earlier fail. Consider, for example, the assertion that to be scientific one must explain by reference to natural law. To insist that "science must explain by natural law" betrays much confusion—about the alleged universality of explanation in science, about the necessary role of laws in explanations and about the distinction between laws and causes. But fundamentally this demarcation criterion fails to do the work required of it by evolutionary writers because it ignores that some scientific disciplines ("historical" according to my lexicon) seek to explain events or data not primarily by reference to laws but by reference to past causal events or sequences of events—what might be called "causal histories." Since natural laws are not necessary to such activity, the demarcation criterion "must explain by natural law" can't be used to distinguish between two competing programs of historical scientific research, whether evolutionary or otherwise.

Next consider the idea that scientific theories must not postulate unverifiable or unobservable entities. Certainly this criterion is untenable in light of many fields, not the least of which is modern physics. Yet it is completely irrelevant to historical study almost in principle. All historical theories depend on what C. S. Peirce called "abductive inferences."[78] Such inferences frequently posit unobservable past events in order to explain present phenomena, facts or clues. Making a claim about history nearly always involves postulating, invoking, or inferring an unobservable event or entity that cannot be studied directly. The attempt to distinguish the methodological merit of competing origins theories on the basis of unobservables therefore seems quite misguided and futile.

Finally, consider the claim that to be scientific a theory must be testable. As we saw above, neither design nor descent can meet standards of testability that require strict verifiability. I have also emphasized that neither can meet standards of testability that depend on notions of repeatability. Yet both can meet alternate standards of testability, such as inference to the best explanation or "consilience," that involve notions of comparative explanatory power. This equivalence was suggested again from the historical nature of the claims that design and evolutionary theorists make. Like other historical theorists, both make claims about events they believe occurred in the past that cannot be directly verified and may never recur. Yet like other historical theories, these theories can be tested after the fact by reference to their comparative explanatory power. To impose stricter standards ignores the limitations inherent in all historical inquiry and thus again fails to provide grounds for distinguishing the status of competing historical or origins theories.

So the evolutionary demarcation arguments above seem to fail in part because they attempt to impose (as normative) criteria of method that ignore the historical character of origins research. Indeed, each one of the demarcationist arguments listed above fails because it overlooks a specific characteristic of the historical sciences. But what are these characteristics? And could *they* provide grounds for distinguishing the scientific, or at least methodological, status of design and descent?

The nature of historical science. Answering these questions will require briefly summarizing the results of my doctoral research on the logical and methodological features of the historical sciences.[79] Through that research I have identified three general features of historical scientific disciplines. These features derive from a concern to reconstruct the past and to explain the present by reference to the past. They distinguish disciplines motivated by historical concerns from disciplines motivated by a concern to discover, classify or explain unchanging laws and properties of nature. These

latter disciplines may be called "inductive" or "nomological" (from the Greek word *nomos*, for law); the former type may be called "historical."[80] I contend that historical sciences generally can be distinguished from nonhistorical scientific disciplines by virtue of the three following features:

1. The historical interest or questions motivating their practitioners: Those in the historical sciences generally seek to answer questions of the form "What happened?" or "What caused this event or that natural feature to arise?" On the other hand, those in the nomological or inductive sciences generally address questions of the form "How does nature normally operate or function?"

2. The distinctively historical types of inference used: The historical sciences use inferences with a distinctive logical form. Unlike many nonhistorical disciplines, which typically attempt to infer generalizations or laws from particular facts, historical sciences make what C. S. Peirce has called "abductive inferences" in order to infer a past event from a present fact or clue. These inferences have also been called "retrodictive" because they are temporally asymmetric—that is, they seek to reconstruct past conditions or causes from present facts or clues. For example, detectives[81] use abductive or retrodictive inferences to reconstruct the circumstances of a crime after the fact. In so doing they function as historical scientists. As Gould has put it, the historical scientist proceeds by "inferring history from its results."[82]

3. The distinctively historical types of explanations used: In the historical sciences one finds causal explanations of particular events, not nomological descriptions or theories of general phenomena. In historical explanations, past causal events, not laws, do the primary explanatory work. The explanations cited earlier of the Himalayan orogeny and the beginning of World War I exemplify such historical explanations.[83]

In addition, the historical sciences share with many other types of science a fourth feature.

4. Indirect methods of testing such as inference to the best explanation: As discussed earlier, many disciplines cannot test theories by direct observation, prediction or repeated experiment. Instead, testing must be done indirectly through comparison of the explanatory power of competing theories.

Descent as historical science. Enough has been said previously—about the function of common descent as an explanatory causal history, the retrodictive character of Darwin's inference of common descent and his use of indirect methods of theory evaluation—to suggest that evolutionary research programs conform closely to the general methodological pattern of the historical sciences. But a few additional observations may make this connection more explicit.

With respect to the first characteristic of historical science enumerated above (historical motive or purpose), Darwin clearly was motivated by such a purpose. One of Darwin's primary goals in the *Origin of Species* was to establish a historical point[84]—namely, that species had not originated independently but had derived via transmutation from one or very few common ancestors. Indeed, Darwin sought to show that the history of life resembled a single, continuous branching tree, with the first and simplest living forms represented by the base of a tree and the great diversity of more complex forms, both past and present, represented by the connecting branches. This picture of biological history contrasted markedly with that of his creationist opponents, who envisioned the history of life as an array of parallel

(nonconvergent) lines of descent. Darwin's (perhaps primary) purpose in the *Origin of Species* was to argue for this continuous view of life's history as opposed to the discontinuous view favored by his creationist opponents.

Thus he would repeatedly explicate his priorities in such a way as to show the primacy of his concern to demonstrate the historical thesis of common descent, even over his concern to establish the efficacy of his proposed mechanism, natural selection. He himself tells us what he had in mind: "I had two distinct objects in view; *firstly* to shew that species had not been separately created [i.e., that they had evolved from common ancestors], and *second*, that natural selection had been the chief agent of change"[85] (emphasis added).

Similarly, at the close of his chapter 13 Darwin states the priorities of his argument by concluding: "The several classes of facts which have been considered . . . proclaim so plainly that the innumerable species, genera, and families with which the world is peopled are all *descended* . . . from common parents and have been modified in the course of descent, that I should without hesitation adopt this view, *even if* it were unsupported by other facts or arguments"[86] (emphasis added).

Not only was Darwin motivated by a historical purpose, but he also used (concerning feature 2 above) a characteristically historical mode of reasoning. As Gould has argued so persuasively, Darwin used historical inferences. Beginning in the middle of his chapter on the "Geological Succession of Organic Beings" and continuing through his next three chapters, Darwin offered a series of arguments to support his historical claim of common descent.[87] These arguments are instances of retrodictive or abductive reasoning. In each case, extant evidence from the fossil record, comparative anatomy, embryology and biogeography were used as clues from which to infer a pattern of past biohistorical events. Notice, for example, the language Darwin uses in his argument from vestigial structures: "Rudimentary organs may be compared with the letters in a word, still retained in the spelling but become useless in the pronunciation, but *which serve as a clue in seeking for its derivation*."[88]

Notice, too, the temporally asymmetric character of each of the inferences he employs: "The several *classes of facts* which have been considered . . . proclaim so plainly that the innumerable species, genera, and families with which the world is peopled are all *descended*, each within its own class or group, *from common parents*." [89] As Gould has written, Darwin used a method of "inferring history from its results."[90]

Darwin not only inferred an historical past, but (with respect to feature 3 above) he also formulated historical explanations. Indeed, a reciprocal relationship exists between historical inferences and explanations. Historical scientists will often seek to infer causal antecedents that, if true, would explain the widest class of relevant data. The causal past inferred on the basis of its potential to explain will often serve, when accepted, as an explanation. Darwin repeatedly argued that the supposition that all organisms descended from common parents should be accepted because it "explains several large and independent classes of facts."[91] Moreover, common descent (and the past events implied by it) served as a *causal* explanation for Darwin. He refers to "propinquity of descent" as "*the only known cause* of the similarity of organic beings."[92] Elsewhere he refers to common descent or "propinquity of descent" as the *vera causa* (or true cause) of organic similarity.[93] By inferring descent as a past cause, Darwin constructed a historical explanation in which a pattern of past events did the primary explanatory work in relation to the facts of biogeography, fossil progression, homology and so on. As Gould has put it, the *Origin of Species* makes "the claim that *history* stands as the

coordinating reason for relationships among organisms."[94]

The explanatory function of antecedent events and causal histories is perhaps even more readily apparent in the work of many chemical evolutionary theorists. Alexander Oparin, Russian scientist and father of modern origin-of-life research, formulated detailed causal histories involving a sequence of hypothetical past events to explain how life emerged in its present form.[95] The formulation of these "scenarios," as they are called in origin-of-life biology, has remained an important part of origin-of-life studies to the present.[96] Thus evolutionary biologists employ not only historical inferences but also historical explanations in which past causal events, or patterns thereof, serve to explain the origin of present facts.

As already discussed, Darwin also (with respect to feature 4 above) employed a method of indirect testing of his theory by assessing its relative explanatory power. Recall his statement that "this hypothesis [i.e., common descent] must be tested . . . by trying to see whether it explains several large and independent classes of facts."[97] He makes this indirect and comparative method of testing even more explicit in a letter to Asa Gray:

> I . . . test this hypothesis [common descent] by comparison with as many general and pretty well-established propositions as I can find—in geographical distribution, geological history, affinities &c., &c. And it seems to me that, supposing that such a hypothesis were to explain such general propositions, we ought, in accordance with the common way of following all sciences, to admit it till some better hypothesis be found out.[98] (emphasis added)

Design as historical science. The foregoing suggests that evolutionary biology, or at least Darwin's version of it, does conform to the pattern of inquiry described above as historically scientific. To show that design and descent are methodologically equivalent with respect to the historical mode of inquiry outlined above, it now remains to show that a design argument or theory could exemplify this same historical pattern of inquiry.

In the case of feature 1 this equivalence is quite obvious. As just noted, a clear logical distinction exists between questions of the form "How does nature normally operate or function?" and those of the form "How did this or that natural feature arise?" or "What caused this or that event to occur?" Those who postulate the past activity of an intelligent Designer do so as an answer, or partial answer, to questions of the latter historical type. Whatever the evidential merits or liabilities of design theories, such theories undoubtedly represent attempts to answer questions about what caused certain features in the natural world to come into existence. With respect to an interest in origins questions, design and descent are clearly equivalent.

Design and descent are also equivalent with respect to feature 2. Inferences to intelligent design are clearly abductive and retrodictive. They seek to infer a past unobservable cause (an instance of creative mental action or agency) from present facts or clues in the natural world such as the informational content in DNA, the irreducible complexity of molecular machines, the hierarchical top-down pattern of appearance in the fossil record, and the fine-tuning of physical laws and constants.[99] Moreover, just as Darwin sought to strengthen the retrodictive inferences that he made by showing that many facts or classes of facts could be explained on the supposition of common descent, so too may proponents of design seek to muster a wide variety of clues to demonstrate the explanatory power of their theory. In the

second half of this volume, for example, evidence from at least four distinct domains of the natural world will be cited to demonstrate the explanatory power (or "consilience") of the design inference.

With respect to feature 3, design inferences, once made, may also serve as causal explanations. The same reciprocal relationship between inference and explanation that exists in arguments for descent can exist in arguments for design. Thus, as noted, an inference to intelligent design may gain support because it could, if accepted, explain many diverse classes of facts. Clearly, once adopted it will provide corresponding explanatory resources. Moreover, theories of design involving the special creative act of an agent conceptualize that act as a causal event,[100] albeit involving mental rather than purely physical antecedents. Indeed, design theories—whether posited by young-earth Genesis literalists, old-earth progressive creationists, theistic macromutationalists or religiously agnostic biologists—refer to antecedent causal events or express some kind of causal scenario just as, for example, chemical evolutionary theories do. As a matter of method, advocates of design and descent alike seek to postulate antecedent causal events or event scenarios in order to explain the origin of present phenomena. With respect to feature 3, design and descent again appear methodologically equivalent.

Much has already been said to suggest that with respect to features design may be tested indirectly in the same way as descent. Certainly, advocates of design may seek to test their ideas as Darwin did—against a wide class of relevant facts and by comparing the explanatory power of their hypotheses against competitors'. Indeed, many biologists who favor design now make their case for it on the basis of its ability to explain the same evidences that descent can as well as some that descent allegedly cannot (such as the presence of specified complexity or information content in DNA).[101]

Thus design and descent again seem methodologically equivalent. Both seek to answer characteristically historical questions, both rely upon abductive inferences, both postulate antecedent causal events or scenarios as explanations of present data, and both are tested indirectly by comparing their explanatory power against that of competing theories.

A theory of everything? Yet before one is willing to concede this methodological equivalence, one might demand to know whether design can really function as a valid explanation without trivializing scientific inquiry. The worry about theories of design concerns not their explanatory power, but the inability to constrain that power. Would a theory of design leave scientists with nothing to do, since presumably the phrase “God did it” could be invoked as the answer to every scientific question? As David Hull wrote recently, “scientists have no choice [but to define science as totally naturalistic]. Once they allow reference to God or miraculous forces to explain the first origin of life or the evolution of the human species, they have no way of limiting this sort of explanation.”[102] This also finds expression in the familiar theistic worry about “God-of-the-gaps” arguments. So both theists and secularists may worry: “if design is allowed as a (historically) scientific theory, could it not be invoked at every turn as a theoretical panacea, stultifying inquiry as it goes? Might not design become a refuge for the intellectually lazy who have refused to study what nature actually does?”

The distinction between the historical and the nomological helps to show how design can be both appropriate and inappropriate (and thus constrained) depending upon the context of inquiry. That is, this distinction helps to show why the past action of an intelligent agent may serve as a legitimate explanation in the historical sciences, whereas it would not in many nonhistorical scientific contexts.

When scientists address questions of what nature normally does or how one part of nature generally affects another, any reference to the particular action of agents becomes inappropriate because it fails to address the question motivating the inquiry. Consider the question “how does atmospheric pressure affect crystal growth?” To state “crystals were designed by a creative intelligence” (or, for that matter, “crystals evolved via natural processes”) fails to answer the question. Here appropriate answers are necessarily both naturalistic and nomological because the question asks how one part of nature generally affects another. Yet a naturalistic answer is necessary only because of the focus of the question. Inductive sciences typically seek to establish general causal or descriptive *relationships* (laws), whereas historical sciences typically infer particular past causal *events*. To propose the action of agency (as an event in space and time) when a descriptive or causal law is required fails to address the challenge of nomological inquiry. To answer “God created it” to a geologist who inquires about the stress/strain relationship of a particular rock type or to a cell biologist inquiring about how a given protein normally binds to the cytoskeleton is contextually inappropriate. Neither divine nor human action qualifies as a law. Such answers do not so much violate the rules of science as much as common sense considerations of context. They do stultify inquiry, but only because they miss the point of a particular type of inquiry altogether.

It not does follow, however, that references to agency are necessarily inappropriate when reconstructing a causal history—when attempting to answer questions about how a particular feature in the natural world (or the universe itself) arose. First, classical examples of inappropriate postulations of divine activity (that is, God-of-the-gaps arguments) occur almost exclusively in the inductive or nomological sciences, as Newton's ill-fated use of agency to provide a more accurate description of planetary motion suggests.[103] Secondly, the action of agents is routinely invoked to account for the origin of features or events within the natural world. Forensic science, history and archaeology, for example, all sometimes postulate the past activity of human agents to account for the emergence of particular objects or events. Several such fields suggest a clear precedent for inferring the past causal activity of intelligent agents within the historical sciences. (Imagine the absurdity of someone claiming that scientific method had been violated by the archaeologist who first inferred that French cave paintings had been produced by human beings rather than by natural forces such as wind and erosion).

There is another more fundamental reason why postulating the past action of agency can be appropriate in the historical sciences: historical explanations require the postulation of antecedent causal events; they do not seek to infer laws.[104] To offer past agency as part of an origins scenario or explanation is, therefore, contextually appropriate because the type of theoretical entity provided corresponds to the type required by historical explanations. Simply put, past agency is a causal event. Agency, therefore, whether seen or unseen, may serve as a contextually appropriate theoretical entity in a historical explanation, even if it could not do so in a nomological or inductive theory. Mental action may be a causal event, even if it is not a law.

In any case, postulations of design are constrained by theoretical competition. The plausibility of historical theories must be adjudicated against background information about the causal powers and proclivities of both nature and agency.[105] Intelligent design can be offered, therefore, as a necessary or best historical explanation only when available naturalistic processes seem incapable of producing the *explanandum* effect, and when intelligence is known to be capable of, and thought inclined to, produce it. Thus, modern scientific advocates of intelligent design such as Charles

Thaxton, Walter Bradley, Dean Kenyon, Michael Behe and William Dembski insist that they postulate antecedent intelligent activity, not because of what we do not know, but because of what we do know about what is, and is not, capable of producing, for example, “information” (Meyer, Thaxton and Bradley and Kenyon),[106] “small probability specifications” (Dembski)[107] or “irreducible complexity” (Behe).[108] Conversely, there are many effects that do not, based upon our present background knowledge of causal powers, suggest design as either a necessary or best explanation.

An example may help to illustrate this. In the wooded neighborhood where I live near Whitworth College there are many pine trees. Every Friday morning I notice a group of pine cones piled neatly on a blue tarp next to my neighbor's curbside garbage cans. I know that Friday is trash day and that my elderly neighbor detests pine cones, pine needles and other debris on his lawn. Given this background information, I infer that he has intentionally piled the pine cones on his tarp by design. While it is true that I have occasionally seen a few pine cones clustered together under his trees, I have never seen so many piled so neatly “in the wild.” Nor do I think it likely that natural causes could have removed my neighbor's tarp from his garage and positioned it next to his garbage cans (and under the cones) without assistance. Wind, rain and gravity may be powerful, but they are not that smart. Thus, on the basis of my background knowledge about the capabilities of nature and agents (and in this case, the proclivities of my neighbor), I infer that personal agency—intelligent design—has played a causal role in the assembly of the pile next door.[109] Indeed, I make a similar inference every fall when I walk on campus to see that some mysterious agency has spelled out the names of the freshmen dormitories—“Stewart Hall,” “MacMillian Hall,” etc.—with mounds of still more pine cones on the lawns of these residence halls.

Nevertheless, I do not always infer intelligent design as the cause of every phenomenon. My own lawn is usually covered with pine cones in a haphazard fashion. While it is possible that the pine cones in my yard assumed their configuration as the result of a personal agent this seems quite unlikely to me. First, I doubt that anyone would waste their time placing pine cones in my yard in such a random arrangement. Second, I have witnessed pine cones falling and producing such random scatters many times. Thus, the distribution of pine cones on my lawn seems best explained by a combination of natural factors: wind, rain, gravity, the position of the trees, the slope of the yard, the length of the grass, etc. Similarly, the configuration of cones in another neighbor's yard, though arranged in a less random way in two distinct clusters, also seems to reflect purely natural causes, since each cluster lies just beneath one of the two solitary pines in the adjacent yard.

In both these cases—that is, where the cones are fairly randomly scattered and where they are clustered in a more orderly way— intelligent design does not seem the best explanation, even though agents are capable of producing such effects. Instead, in the absence of good reasons to suspect that agents *would* want to produce these effects and some sign that one did, it seems more probable to attribute these effects to natural processes with proven causal efficacy. Moreover, as Dembski has shown, neither low probability events nor high probability events allow intelligent design to be unambiguously detected. Instead, intelligent design can be unambiguously detected only in *specified* events of very small probability.[110] The pine cones on the tarp and especially those spelling messages on the dormitory lawns provide good examples of small probability events that are specified. In the latter case, the improbable arrangement of the cones is specified by an alphabet convention in order to achieve communication. Since contemporary design theorists do not just assert that intelligent design has occurred, but that the effects of design are unambiguously detectable in certain

natural features such as the highly specified encoded information inscribed along the spine of the DNA molecule, their theoretical claims are anything but vacuous or trivial.

Indeed, if design theorists are correct, design can not be inferred for every effect, even if intelligent design is a possible cause of all effects. Because intelligent agents, and presumably the Divine Agent, have causal powers that nature does not have, intelligent design may always be a possible explanation. Nevertheless, possible explanations are not necessarily the best explanations. Intelligent design is not always the best explanation for a variety of reasons. Human action or special (that is, detectable) divine action may not have played a causal role in certain natural events; intelligent design, whether human or divine, may not always be detectable even when it has played a causal role; natural objects and processes have real causal powers (even for theists who accept God's sustaining governance of nature) that may be clearly evident in a given phenomenon. Thus, at least for those scientists who seek the best explanations, intelligent design can not be invoked as a theory of everything. It may function as a possible theory of everything, but it can function as the best explanation or best theory of only some things. Intelligent design need be neither vacuous nor unconstrained.

Further, postulations of intelligent design are constrained by background assumptions about the proclivities of potential designing agents, both human and divine. In particular they are constrained by assumptions about the assumed character and inclinations of God. Most biblical theists, for example, assume that God acts in at least two ways: (1) through the natural regularities or laws that he upholds and sustains through his invisible power and (2) through more dramatic, discernible and discrete actions at particular points in time. Because theists assume that the second mode of divine action is by far the more rare, and usually associated with the accomplishment of some particular divine purpose on behalf of human beings (for example, creation or redemption) theists assume that divine action of the second variety will be unlikely as an explanation of most particular events. It might be the case that the wind storm that blew the scales of justice off of the Old Bailey in London in 1987 was a special act of God, but most theists would—in the absence of any discernible redemptive import associated with the event—tend to regard it as part of the ordinary (albeit God-governed) concourse of nature. Theists generally approach their study of nature with a set of background assumptions that would lead them to regard most hypotheses of special divine action as unlikely, though not completely impossible. As such, theism itself constrains design inferences. Theistic background assumptions would generally allow consideration of special divine action as the best or most likely explanation for a particular event only when it seemed empirically warranted and theologically plausible. Nevertheless, given a biblical (though not necessarily literalist) understanding of creation and sufficient empirical justification, there is no reason to believe that both these conditions could not be met in some cases, as with, for example, explanations of the origin of life, human consciousness or the universe.

An example of theological plausibility functioning to limit design hypotheses can be found by examining the reception of Newton's famous postulation of special divine intervention to stabilize the orbital motion in the solar system. Newton postulated the periodic and special intervention of God to correct for an apparently accumulating instability in the orbits of the outer planets (Jupiter and Saturn) within the solar system. While this episode is often cited to illustrate why divine action or design can never be considered as a scientific explanation, it actually illustrates a more subtle point: how such inferences were constrained by considerations of theological plausibility.

To many eighteenth-century scientists, Newton's interventionist theory seemed ill-formed and unlikely not because it contradicted an inviolate methodological convention, as has often been asserted.[111] Newton himself made highly regarded design arguments in other contexts and believed gravitation was caused by constant spirit action.[112] Instead, Newton's argument for angelic action was rejected because it seemed both theologically unlikely (given prevailing background assumptions about how God interacts with nature and given the nomological context of inquiry) and less elegant than the explanation that Laplace would later offer in the 1770s.

The theistic research program of Newton's day assumed that the regularity and universality of natural laws reflected the ordered mind and sovereign power of the Creator. Kepler and Newton both wanted to use science to demonstrate this. To hypothesize as Newton did that divine gerrymandering was required to maintain the orbital stability of the solar system seemed improbable and ad hoc to *theistic* scientists. It did so because it clearly violated, not a methodological prohibition against reference to divine action, but a fundamental theological background assumption of many scientists at the time—namely, that special or discrete divine action was unlikely and unnecessary where God's *potentia ordinate*, his regular orderly power, was sufficient and already at work.[113] Thus, when Laplace later demonstrated the stability of the planetary system by showing that orbital perturbations oscillated within fixed quantifiable limits, [114] he "saved" the very regularity of celestial mechanics that was the triumph of the theistic research program initiated by Kepler, and later advanced by Newton himself via the theory of universal gravitation.

The preceding considerations suggest that allowing the design hypothesis as the best explanation for some events in the history of the cosmos will not cause science to come grinding to a halt. While design does have the required features of some scientific (historical) explanations, it can not be invoked appropriately in all scientific contexts. Furthermore, because effective postulations of design are constrained by empirical considerations of causal precedence and adequacy, and by extraevidential considerations such as simplicity and theological plausibility, concerns about design theory functioning as a "theory of everything" or "providing cover for ignorance" or "putting scientists out of work" can be shown to be unfounded.[115] Many important scientific questions would remain to be answered if one adopted a theory of design. Indeed, all questions about how nature normally operates without the special assistance of divine agency remain unaffected by whatever view of origins one adopts. And that, perhaps, is yet another equivalence between design and descent.[116]

Conclusion: Toward a Scientific Theory of Creation

So what should we make of these methodological equivalencies? Can there be a scientific theory of intelligent design? At the very least it seems we can conclude that we have not yet encountered any good in principle reason to *exclude* design from science. Design seems to be just as scientific (or unscientific) as its naturalistic competitors when judged according to the methodological criteria examined above. Moreover, if the antidemarcationists are correct, our lack of universal demarcation criteria implies there cannot be a negative a priori case against the scientific status of design—precisely because there is not an agreed standard as to what constitutes the properly scientific. To say that some discipline or activity qualifies as scientific is to imply the existence of a standard by which the scientific status of an activity or discipline can be assessed or adjudicated. If no such standard presently exists, then nothing positive (or negative) can be said about the scientific status of intelligent design (or any other theory for that matter).

But there is another approach that can be taken to the question. If (1) there exists a distinctively historical pattern of inquiry, and (2) a program of origins research committed to design theory could or does instantiate that pattern, and (3) many other fields such as evolutionary biology also instantiate that pattern, and (4) these other fields are already regarded by convention as science, there can be a very legitimate if convention-dependent sense in which design may be considered scientific. In other words, the conjunction of the methodological equivalence of design and descent and the existence of a convention that regards theories of descent as scientific implies that design should—by that same convention—be regarded as scientific too. Thus, one might quite legitimately say that both design and descent are historically scientific research programs, since they instantiate the same pattern of inquiry.

Perhaps, however, one just really does not want to call intelligent design a scientific theory. Perhaps one prefers the designation "quasi-scientific historical speculation with strong metaphysical overtones." Fine. Call it what you will, provided the same appellation is applied to other forms of inquiry that have the same methodological and logical character and limitations. In particular, make sure both design and descent are called "quasi-scientific historical speculation with strong metaphysical overtones."

This may seem all very pointless, but that in a way is just the point. As Laudan has argued, the question whether a theory is scientific is really a red herring. What we want to know is not whether a theory is scientific but whether a theory is true or false, well confirmed or not, worthy of our belief or not. One can not decide the truth of a theory or the warrant for believing a theory to be true by applying a set of abstract criteria that purport to tell in advance how all good scientific theories are constructed or what they will in general look like

Against method? Now none of the above should be construed to imply that methodology does not matter. The purpose of this essay is not to argue, as Paul Feyerabend does, against method.[117] Methodological standards in science can be important for guiding future inquiry along paths that have been successful in the past. The uniformitarian and/or actualistic method in the historical sciences, for example, has proved a very helpful guide to reconstructing the past, even if it can't be used as demarcation between science and pseudoscience, and even if some theories constructed according to its guidelines turn out to be false.

Standards of method may also express some minimal logical and epistemic conditions of success—for example, the conditions related to causal explanation.[118] Successful causal explanations must as a condition of logical sufficiency cite more than just a necessary condition of a given outcome.[119] To explain why a given explosion occurred, it will not suffice to note that oxygen was present in the atmosphere; nor can the death of a patient be explained simply by citing the patient's birth, though clearly birth is necessary to death. These cases illustrate how methodological guidelines (whether tacit or explicit) can help eliminate certain (in this case logically) inadequate hypotheses, even if such guidelines cannot be used to define science exhaustively. Methodological anarchism need not result from a rejection of methodological demarcation arguments.

Nevertheless, following methodological criteria and recipes (of any of the preceding types) does not guarantee theoretical success; nor, again, can such recipes be used to define science exhaustively, if for no other reason than the variety of scientific methods that exist. Moreover, methodological recipes can sometimes become fatal to the success of inquiry if they so dictate the content of acceptable theorizing that they automatically eliminate empirically and logically

possible explanations or theories.

And this, I believe, has occurred within origins research. The deployment of flawed or metaphysically tendentious demarcation arguments against legitimate theoretical contenders has produced an unjustified confidence in the epistemic standing of much Darwinian dogma, including "the fact of evolution" defined as common descent. If competing hypotheses are eliminated before they are evaluated, remaining theories may acquire an undeserved dominance.

So the question isn't whether there can be a scientific theory of design or creation. The question is whether design should be considered as a competing hypothesis alongside descent in serious origins research (call it what you will). Once issues of demarcation are firmly behind us, understood as the red herrings they are, the answer to this question *must* clearly be yes—that is, if origins biology is to have standing as a fully rational enterprise, rather than just a game played according to rules convenient to philosophical materialists.

Naturalism: the only game in town? G. K. Chesterton once said that "behind every double standard lies a single hidden agenda."[120] Advocates of descent have used demarcation arguments to erect double standards against design, suggesting that the real methodological criterion they have in mind is naturalism. Of course for many the equation of science with the strictly materialistic or naturalistic is not at all a hidden agenda. Scientists generally treat "naturalistic" as perhaps the most important feature of their enterprise.[121] Clearly, if naturalism is regarded as a necessary feature of all scientific hypotheses, then design will not be considered a scientific hypothesis.

But must all scientific hypotheses be entirely naturalistic? Must scientific origins theories, in particular, limit themselves to materialistic causes? Thus far none of the arguments advanced in support of a naturalistic definition of science has provided a noncircular justification for such a limitation. Nevertheless, perhaps such arguments are irrelevant. Perhaps scientists should just accept the definition of science that has come down to them. After all, the search for natural causes has served science well. What harm can come from continuing with the status quo? What compelling reasons can be offered for overturning the prohibition against nonnaturalistic explanation in science?

In fact, there are several. First, with respect to origins, defining science as a strictly naturalistic enterprise is metaphysically gratuitous. Consider: It is at least logically possible that a personal agent existed before the appearance of the first life on earth. Further, as Bill Dembski argues in the next chapter,[122] we do live in the sort of world where knowledge of such an agent could possibly be known or inferred from empirical data. This suggests that it is logically and empirically possible that such an agent (whether divine or otherwise) designed or influenced the origin of life on earth. To insist that postulations of past agency are inherently unscientific in the historical sciences (where the express purpose of such inquiry is to determine what happened in the past) suggests we know that no personal agent could have existed prior to humans. Not only is such an assumption intrinsically unverifiable, it seems entirely gratuitous in the absence of some noncircular account of why science should presuppose metaphysical naturalism.

Second, to exclude by assumption a logically and empirically possible answer to the question motivating historical science seems intellectually and theoretically limiting, especially since no equivalent prohibition exists on the possible nomological relationships that scientists may postulate in nonhistorical sciences. The (historical) question that must be

asked about biological origins is not "Which materialistic scenario will prove most adequate?" but "How did life as we know it actually arise on earth?" Since one of the logically and syntactically appropriate answers to this later question is "Life was designed by an intelligent agent that existed before the advent of humans," it seems rationally stultifying to exclude the design hypothesis without a consideration of all the evidence, including the most current evidence, that might support it.

The a priori exclusion of design diminishes the rationality or origins research in another way. Recent nonpositivistic accounts of scientific rationality suggest that scientific theory evaluation is an inherently comparative enterprise. Notions such as consilience[123] and Peter Lipton's inference to the best explanation[124] discussed above imply the need to compare the explanatory power of competing hypotheses or theories. If this process is subverted by philosophical gerrymandering, the rationality of scientific practice is vitiated. Theories that gain acceptance in artificially constrained competitions can claim to be neither "most probably true" nor "most empirically adequate." Instead such theories can only be considered "most probable or adequate among an artificially limited set of options."

Moreover, where origins are concerned only a limited number of basic research programs are logically possible.[125] (Either brute matter has the capability to arrange itself into higher levels of complexity or it does not. If it does not, then either some external agency has assisted the arrangement of matter or matter has always possessed its present arrangement.) The exclusion of one of the logically possible programs of origins research by assumption, therefore, seriously diminishes the significance of any claim to theoretical superiority by advocates of a remaining program. As Phillip Johnson has argued,[126] the use of "methodological rules" to protect Darwinism from theoretical challenge has produced a situation in which Darwinist claims must be regarded as little more than tautologies expressing the deductive consequences of methodological naturalism.

An openness to empirical arguments for design is therefore a necessary condition of a fully rational historical biology. A rational historical biology must not only address the question "Which materialistic or naturalistic evolutionary scenario provides the most adequate explanation of biological complexity?" but also the question "Does a strictly materialistic evolutionary scenario or one involving intelligent agency or some other theory best explain the origin of biological complexity, given all relevant evidence?" To insist otherwise is to insist that materialism holds a metaphysically privileged position. Since there seems no reason to concede that assumption, I see no reason to concede that origins theories must be strictly naturalistic.

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Footnotes

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[2] Creationists such as Louis Agassiz, for example, accepted the notion of successive acts of creation (separated in time) to explain the succession of increasingly complex organisms attested to by the fossils as one moved up the stratigraphic column.

Homology refers to the observed similarity in the structural characteristics of diverse organisms. The bat, the porpoise, the mole and humans, for example, all possess a pentadactyl (five-pronged) limb. Darwin believed such similarities reflected the fact that each of these diverse organisms shared a common ancestry, while creationist and idealist biologists such as Louis Agassiz and Richard Owen regarded these similarities as having resulted from the use of a similar plan of design by a Creator.

Biogeographical distribution refers to the pattern of distribution of organisms in a geographic region. Darwin believed that the way organisms were distributed geographically demonstrated that they share a common ancestor. Darwin noted, among other things, that the extent to which the Galapagos Island finches differed from each other in several physical characteristics such as their coloring, their beak size and shape, was related to the distances between different species. His argument persuaded most biologists that the finches did indeed share a common ancestry. While his observations posed a challenge to those nineteenth-century biologists who were committed to the absolute immutability of species, they did not necessarily trouble those creationist biologists who were willing to concede some variation

within limits and who postulated separate creation events in different geographic locales. See W.M. Ho, *Methodological Issues in Evolutionary Theory* (Unpublished Ph.D. dissertation from the University of Oxford, Oxford, England, 1965), pp. 8-68.

[3] Charles Darwin, *The Origin of Species by Means of Natural Selection* (1859. Reprint. Harmondsworth: Penguin Books, 1984), p. 334; N.C. Gillespie, *Charles Darwin and the Problem with Creation* (Chicago: University of Chicago Press, 1979), pp. 67-81.

[4] Gillespie, *Charles Darwin and the Problem*, pp. 1-18, 41-66, 146-56.

[5] The term “positivistic” here refers not to the “logical positivism” of A.J. Ayer and the Vienna circle which did not emerge until the 1920s, but to a generic positivism that had begun to influence scientists throughout most of the nineteenth century. As a philosophy of science, nineteenth-century positivism is associated with Auguste Comte. As Gillespie (*Charles Darwin and the Problem*, pp. 41-66, esp. 54, 167) and many of Darwin's letters and notebooks show (for example, Darwin's letters to Asa Gray and Charles Lyell dated July 20, 1856 and August 2, 1861 respectively, F. Darwin and A.C. Seward, eds., *More Letters of Charles Darwin*, 2 vols. [London: John Murray, 1903], 1: 190), Darwin's conception of science was influenced by Comte, who asserted that true science must move beyond references to God (a theological stage) and other unobservable entities (a metaphysical stage) and focus on observable phenomena reducible to laws (positive science). Thus, it is not anachronistic to refer to Darwin as positivistic.

[6] As Darwin put it:

> On the ordinary view of each species having been independently created, we gain no scientific explanation for any one of these facts. We can only say that it has pleased the Creator to command that past and present inhabitants of the world should appear in a certain order [fossil progression] and in certain areas [biogeographical distribution]; that He has impressed upon them the most extraordinary resemblances [homology], and has classed them in groups subordinate to groups. But by such statements we gain no new knowledge; *we do not connect together facts and laws*; we explain nothing. Quoted in Gillespie, *Charles Darwin and the Problem*, p. 76. Emphasis mine.

[7] Darwin, *Origin of Species*, pp. 201, 430, 453; V. Kavalovski, “The *Vera Causa* Principle: A Historico-Philosophical Study of a Meta-Theoretical Concept from Newton through Darwin” (Unpublished Ph.D. dissertation from the University of Chicago, Chicago, Illinois, 1974), pp. 104-29.

[8] M. Ruse, *Darwinism Defended: A Guide to the Evolution Controversies* (London: Addison?Wesley, 1982), pp. 59, 131-40, 322-24; M. Ruse, “Creation Science Is Not Science,” *Science, Technology and Human Values* 7, no. 40 (1982): 72-78; M. Ruse, “A Philosopher's Day in Court,” in *But Is It Science? The Philosophical Question in the Creation/Evolution Controversy*, edited by M. Ruse (Buffalo: Prometheus Books, 1988) pp. 13-38; M. Ruse, “Witness Testimony Sheet: McLean v. Arkansas,” in *But Is It Science*, pp. 287-306, esp. 301; M. Ruse, “They're Here!” *Bookwatch Reviews* 2 (1989): 4; M. Ruse, “Darwinism: Philosophical Preference, Scientific Inference, and Good Research Strategy,” in *Darwinism: Science or Philosophy*, edited by J. Buell and V. Hearn (Richardson: Foundation for

Thought and Ethics, 1994), pp. 21-28; S.J. Gould, "Genesis and Geology," in *Science and Creationism*, edited by A. Montagu (New York: Oxford University Press, 1984), pp. 126-35; G.S. Stent, "Scientific Creationism: Nemesis of Sociobiology," in *Science and Creationism*, pp. 136-41; R. Root?Bernstein, "On Defining a Scientific Theory: Creationism Considered," in *Science and Creationism*, pp. 64-94; P.L. Quinn, "The Philosopher of Science as Expert Witness," in *But Is It Science*, pp. 367-85; L. Laudan, "Science at the Bar: Causes for Concern," in *But Is It Science*, pp. 351-55; A.D. Kline, "Theories, Facts, and Gods: Philosophical Aspects of the Creation-Evolution Controversy," in *Did the Devil Make Darwin Do It*, edited by D.B. Wilson (Ames: Iowa State University Press, 1983); D.J. Futuyma, *Science on Trial: The Case for Evolution* (New York: Pantheon Books, 1983), pp. 161-74; G. Skoog, "A View from the Past," *Bookwatch Reviews* 2 (1989): 1-2; S.J. Gould, "Evolution as Fact and Theory," in *Science and Creationism*, pp. 118-21; P. Kitcher, *Abusing Science: The Case Against Creationism* (Cambridge: MIT Press, 1982), pp. 45-54, 126-27, 175-76.

[9] M. Scriven, "Explanation and Prediction in Evolutionary Theory," *Science* 130 (1959): pp. 477-82; P.T. Saunders and M.W. Ho, "Is Neo-Darwinism Falsifiable? And Does It Matter?" *Nature and System* 4 (1982): 179-96; K. Popper, *Unending Quest* (London: William Collins and Sons, 1974), pp. 167-75.

[10] L. Laudan, "The Demise of the Demarcation Problem," in *But Is It Science?*, pp. 337-50.

[11] Laudan, "Demise of the Demarcation Problem," p. 349.

[12] Ruse, *Darwinism Defended*, pp. 59, 131-140, 322-24; Ruse, "Creation Science Is Not Science," pp. 72-78; Ruse, "Philosopher's Day in Court," 13-38; Ruse, "Witness Testimony Sheet," pp. 287-306, esp. 301; Ruse, "They're Here!" Gould, "Genesis and Geology." Ruse, "Darwinism," pp. 21-28; Stent, "Scientific Creationism: Nemesis of Sociobiology," pp. 136-141; Root-Bernstein, "On Defining a Scientific Theory," pp. 64-94; Quinn, "The Philosopher of Science," pp. 367-85; Laudan, "Science at the Bar"; Kline, "Theories, Facts, and Gods," pp. 37-44; Futuyma, Science on Trial, pp. 161-174; Skoog, "A View from the Past," pp. 1-2; Gould, "Evolution as Fact and Theory," in *Science and Creationism*, pp. 118-121; Kitcher, *Abusing Science*, pp. 45-54, 126-27, 175-76.

[13] Ruse, "Creation Science Is Not Science," pp. 322-24; Stent, "Scientific Creationism: Nemesis of Sociobiology," pp. 137; Gould, "Evolution as Fact and Theory," in *Science and Creationism*, p. 118.

[14] In making this distinction I do not mean to exclude various theories of theistic evolution from consideration as scientific—just the reverse. Such theories vary in content and may be more difficult to classify as either theories of design or descent. Nevertheless, the following classification may prove helpful. Theories that invoke the causal powers of the Divine agent as part of their explanatory framework (that is, where God in some way directs the evolutionary process) can reasonably be considered to be theories of intelligent design, whereas theistic evolutionary theories that do not involve God in their explanatory framework (that is, where God does not in any way direct the evolutionary process, but at most upholds the natural law in an undetectable way) can be considered functionally naturalistic, and thus, theories of descent.

[15] James Ebert et al., *Science and Creationism: A View from the National Academy of Science* (Washington, D.C.:

National Academy Press, 1987), p. 8.

[16] L. Laudan, "The Demise of the Demarcation Problem," in *But Is It Science?* ed. M. Ruse (Buffalo, N.Y.: Prometheus Books, 1988), pp. 337-50.

[17] Ibid.

[18] O. Gingerich, "The Galileo Affair," Scientific American, August 1982, pp. 133-43.

[19] Laudan, "Demise of the Demarcation Problem."

[20] Ibid.

[21] Ibid.

[22] I. Lakatos, "Falsification and the Methodology of Scientific Research Programmes," in *Criticism and the Growth of Knowledge*, ed. I. Lakatos and A. Musgrave (Cambridge, U.K.: Cambridge University Press, 1970), pp. 189-95.

[23] Laudan, "Demise of the Demarcation Problem"; Laudan, "Science at the Bar," p. 354.

[24] This excessive reliance on a philosophical definition of science to circumvent the hard work of evaluating specific empirical claims ironically credits the philosophy of science with more power than it possesses. That such appeals to philosophical considerations are typically made by positivist-minded scientists who regard appeals to "philosophy" as anathema only compounds the irony of the demarcationist enterprise. If any demarcating is to be done, it ought to be done by the philosophers of science who specialize in such second-order questions about the definition of science. Yet for reasons specified already, philosophers of science have increasingly spurned this enterprise.

[25] Most who make these demarcation arguments are practicing scientists. Nevertheless, they can be found frequently in the work of the philosopher of science Michael Ruse: *Darwinism Defended*, pp. 59, 131-40, 322-24; "Creation Science Is Not Science," pp. 72-78; "Philosopher's Day in Court," pp. 13-38; "Witness Testimony Sheet," pp. 287-306, esp. 301; "They're Here!" p. 4; "Darwinism: Philosophical Preference," pp. 1-6.

[26] M. Eger, quoted by J. Buell in "Broaden Science Curriculum," *Dallas Morning News*, March 10, 1989.

[27] Laudan, "Demise of the Demarcation Problem," p. 349.

[28]Ruse, "Witness Testimony Sheet," pp. 287-306; W. R. Overton, "United States District Court Opinion: *McLean v. Arkansas*," in *But Is It Science?* ed. M. Ruse (Buffalo, N.Y.: Prometheus Books, 1988), pp. 307-31.

[29]It needs to be acknowledged that creationists such as Duane Gish have also employed demarcation arguments against descent. D. Gish, "Creation, Evolution and the Historical Evidence," in *But Is It Science?* ed. M. Ruse (Buffalo, N.Y.:

Prometheus Books, 1988), p. 267.

[30]Ruse, "Witness Testimony Sheet," p. 301; Ruse, "Philosopher's Day in Court," p. 26; Ruse, "Darwinism: Philosophical Preference," pp. 1-6.

[31] Skoog, "View from the Past"; Root-Bernstein, "On Defining a Scientific Theory," p. 74.

[32] Gould, "Genesis and Geology," pp. 129-30; Ruse, "Witness Testimony Sheet," p. 305; Ebert et al., *Science and Creationism*, pp. 8-10.

[33] Root-Bernstein, "On Defining a Scientific Theory," p. 73; Ruse, "Philosopher's Day in Court," p. 28; Ebert et al., *Science and Creationism*, pp. 8-10.

[34] Kline, "Theories, Facts and Gods," p. 42; Gould, "Evolution as Fact and Theory," p. 120; Root-Bernstein, "On Defining a Scientific Theory," p. 72.

[35] Ruse, *Darwinism Defended*, p. 59; Ruse, "Witness Testimony Sheet," p. 305; Gould, "Evolution as Fact and Theory," p. 121; Root-Bernstein, "On Defining a Scientific Theory," p. 74.

[36]A. Kehoe, "Modern Anti-evolutionism: The Scientific Creationists," in *What Darwin Began*, ed. L. R. Godfrey (Boston: Allyn and Bacon, 1985), pp. 173-80; Ruse, "Witness Testimony Sheet," p. 305; Ruse, "Philosopher's Day in Court," p. 28; Ebert et al., *Science and Creationism*, pp. 8-10.

[37] Kitcher, *Abusing Science*, pp. 126-27, 176-77.

[38] Ruse, "Philosopher's Day in Court," pp. 21, 26.

[39] Ibid. One further word of clarification: I am referring to all of the demarcation criteria used in arguments (a)-(h) as methodological criteria. Some of these criteria specify semantic conditions, as noted in my discussion of Laudan's work above. Nevertheless, even these have implications for how scientific theorizing is to be done. To say, for example, that scientific theories must be falsifiable is also to say that in the process of testing one must, as a matter of method, make a prediction or otherwise state a theory in such a way as to allow its falsification. When I say, therefore, that design and descent are methodologically equivalent, I mean that both approaches to origins are equally capable or incapable of fulfilling the demands of various demarcation criteria, whether strictly methodological, epistemic or semantic.

[40] Ruse, "Philosopher's Day in Court," pp. 21-26.

[41]Ibid., p. 26; Ruse, "Witness Testimony Sheet," p. 301.

[42] Ruse, "Darwinism: Philosophical Preference," pp. 1-6; Quinn, "Philosopher of Science as Expert Witness," pp. 367-85; Laudan, "Science at the Bar," pp. 351-55.

[43] By asserting that science must explain by natural law, Ruse is presupposing something called the "covering law" or the "deductive-nomological" view of scientific explanation. The covering-law model was a very popular conception of science during the 1950s and 60s. It was promulgated primarily by the neopositivist philosopher Carl Hempel. Unfortunately, unsolved problems with the covering-law model of science are legion. C. Hempel, "The Function of General Laws in History," *Journal of Philosophy* 39 (1942): 35-48; G. Graham, *Historical Explanation Reconsidered* (Aberdeen: Aberdeen University Press, 1983), pp. 17-28; Meyer, "Of Clues and Causes," pp. 40-76; W. P. Alston, "The Place of the Explanation of Particular Facts in Science," *Philosophy of Science* 38 (1971): 13-34; M. Scriven, "Explanation and Prediction in Evolutionary Theory," *Science* 130 (1959): 477-82; M. Scriven, "Truisms as the Grounds for Historical Explanations," in *Theories of History*, ed. P. Gardiner (Glencoe, Ill.: Free Press, 1959), pp. 443-75; M. Scriven, "Causes, Connections and Conditions in History," in *Philosophical Analysis and History*, ed. W. Dray (New York: Harper & Row, 1966), pp. 238-64; M. Mandelbaum, "Historical Explanation: The Problem of Covering Laws," His-tory Theory 1 (1961): 229-42; P. Lipton, *Inference to the Best Explanation* (London: Routledge, 1991), pp. 43-46.

[44] The Latin text reads "Hypothesis non fingo." I. Newton, *Isaac Newton's Papers and Letters on Natural Philosophy*, ed. I. Bernard Cohen (Cambridge, Mass.: Harvard University Press, 1958), p. 302.

[45] Laudan, "Science at the Bar," p. 354.

[46] Scriven, "Truisms as the Grounds," p. 450; Meyer, "Of Clues and Causes," pp. 40-76.

[47] Alston, "Place of the Explanation"; Meyer, "Of Clues and Causes," pp. 40-75.

[48] Meyer, "Of Clues and Causes," p. 48.

[49] Meyer, "Of Clues and Causes," pp. 51-56; M. Scriven, "Causation as Explanation," Nous 9 (1975): 14; Lipton, Inference to the Best Explanation, pp. 47-81.

[50]Scriven, "Truisms as the Grounds," pp. 446-63, 450. One could, for example, legitimately assert that a particular earthquake caused a bridge to collapse even if all other bridges in the area did not fall and even if all earthquakes do not destroy bridges.

[51] Alston, "Place of the Explanation," pp. 17-24.

[52]Alston makes the same point about laws that state sufficient conditions of a particular outcome as well. Alston (ibid., p. 24) considers the law "Passage of a spark through a mixture of hydrogen and oxygen is sufficient for the formation of water." This, he says, exemplifies a sufficient condition law (hereafter SC). Alston argues that knowing such a law does not alone furnish the scientist with enough information to explain a particular case of water formation, because other sufficient conditions of water formation may have been responsible for the case in question. After all, water forms in a fuel cell without a spark, activating the hydrogen-oxygen combination. Knowing an SC law does not allow one to

infer from an instance of the consequent (in this case water formation) that the sufficient condition was antecedently present (in this case a spark in the appropriate gas mixture) unless one *also* knows that the antecedent is the only known sufficient condition of the consequent that is, unless one knows that the antecedent is both a sufficient and a necessary condition of the consequent. Explaining a case of water formation will require independent evidence that a spark was in fact passed through an appropriate gas mixture (as opposed to some other causal antecedent) prior to the event. As Alston states, we can "not tell from the law itself which of the sufficient conditions is responsible in a particular case." Thus, laws of the SC type do not, without supplementary information, constitute explanations of particular facts. To regard laws and explanations as logically identical is, therefore, again mistaken.

[53] Ibid., p. 17.

[54] Ruse, *Darwinism Defended*, p. 58; Gould, "Evolution as Fact and Theory," pp. 119-21; M. Ridley, *The Problems of Evolution* (Oxford, U.K.: Oxford University Press, 1985), p. 15. For a cogent discussion of the different meanings of evolution and the logical independence of the theory of common descent and the various mechanistic theories about how transmutation might occur, see also K. S. Thomson, "The Meanings of Evolution," *American Scientist* 70 (1982): 529-31. Strictly speaking, common descent is an abductive or historical inference, as Ruse himself acknowledges when he speaks of "inferring historical phylogenies" ("Darwinism: Philosophical Preference," p. 7). As defined by C. S. Peirce, abductive inferences attempt to establish past causes by examining their results or effects. As such, it is more accurate to refer to common descent as a theory about facts—that is, a theory about what in fact happened in the past. Unfortunately, such historical theories, and the inferences used to construct them, can be notoriously inconclusive or "underdetermined." As Gould has stated, "Results rarely specify their causes unambiguously" ("Senseless Signs of History," p. 34). Ho, "Methodological Issues," pp. 8-60; E. Sober, *Reconstructing the Past* (Cambridge, Mass.: MIT Press, 1988), pp. 1-4.

[55] By "evolution" here they mean continuous morphological change over time such that all, or most all, organisms are related by common ancestry.

[56] Ruse and Gould regard the theory of common descent as so well established as to make it virtually indistinguishable from a "fact." Ruse, *Darwinism Defended*, p. 58; Gould, "Evolution as Fact and Theory," pp. 119-21.

[57] From the Greek word *nomos* for law.

[58] Indeed, it is even debatable whether the selection-mutation mechanism of neo-Darwinism can be expressed as a system of laws (i.e., nomologically), though some so-called axiomatists such as Williams and Lloyd have tried. My point here is that whether one regards selection-mutation as a nomological theory or as a mechanistic theory, common descent does not depend on it for its scientific status. The logical and epistemic independence of descent from selection-mutation demonstrates the ability of some theories to explain in the absence of either laws or mechanisms.

[59] Darwin, Origin of Species, p. 195.

[60] The untenable nature of Ruse's position is manifest in his own admission that modern evolutionary theory does not

meet the demarcation standards that he promulgates elsewhere as normative for his opponents. See, for example, his discussion of population genetics in *Darwinism Defended*, where he acknowledges that "it is probably a mistake to think of modern evolutionists as seeking universal laws at work in every situation" (p. 86).

[61] Ruse, "Darwinism: Philosophical Preference," pp. 1-6; Ruse, "Witness Testimony Sheet," p. 301; Ruse, "Philosopher's Day in Court," p. 26. As Ruse puts it: "Even if Scientific Creationism were totally successful in making its case as science, it would not yield a 'scientific' explanation of origins. The Creationists believe that the world started miraculously. But miracles lie outside of science, which by definition deals only with the natural, the repeatable, that which is governed by law" (*Darwinism Defended*, p. 182). Richard Lewontin expresses a similar fear in *Scientists Confront Creationism*: "Either the world of phenomena is a consequence of the regular operation of repeatable causes and their repeatable effects, operating roughly along the lines of known physical law, or else at every instant all physical regularities may be ruptured and a totally unforeseeable set of events may occur. . . . We can not live simultaneously in a world of natural causation and of miracles, for if one miracle can occur, there is no limit" ([New York: Norton, 1983], p. xxvi).

[62] This dichotomy between "unbroken law" and the action of agency is merely a species of the same genus of confusion that led Ruse and others to insist that science always explains via laws. In Ruse's case the dichotomy is manifest in his assertion that invoking the action of a divine agent constitutes a "violation of natural law." I disagree. Pitting the action of agents (whether seen or unseen) against natural law creates a false opposition. The reason for this is simple. Agents can change initial and boundary conditions, yet in so doing they do not violate laws. Most scientific laws have the form "If A, then B will follow, given conditions X." If X is altered or if A did not obtain, then it constitutes no violation of the laws of nature to say that B did not occur, even if we expected it to. Agents may alter the course of events or produce novel events that contradict our expectations, without violating the laws of nature. To assert otherwise is merely to misunderstand the distinction between antecedent conditions and laws. C. S. Lewis, *God in the Dock* (London: Collins, 1979), pp. 51-55. See R. Swinburne, *The Concept of Miracle* (London: Macmillan, 1970), pp. 23-32, and G. Colwell, "On Defining Away the Miraculous," *Philosophy* 57 (1982): 327-37, for other defenses of the possibility of miracles that assume and respect the integrity of natural laws.

[63] See also Kavalovski, "Vera-Causa Principle," pp. 104-29, for a discussion of the so-called *vera causa* principle, a nineteenth-century methodological principle invoked by Darwin to eliminate from consideration creationist explanations judged to be unobservable (Darwin, *Origin of Species*, pp. 201, 430, 453).

[64] Skoog, "View from the Past"; Gould, "Genesis and Geology," pp. 129-30; Ruse, "Witness Testimony Sheet," p. 305.

[65] Grinnell, "Radical Intersubjectivity: Why Naturalism Is an Assumption Necessary for Doing Science," paper presented at Darwinism: Scientific Inference or Philosophical Preference? conference, Southern Methodist University, Dallas, March 26-28, 1993.

[66] Skoog, "View from the Past."

[67] S.C. Meyer, "A Scopes Trial for the '90s," *The Wall Street Journal*, December 6, 1993, p. A14; S. C. Meyer, "Open

Debate on Life's Origin," *Insight*, February 21, 1994, pp. 27-29; Eugenie Scott, “Keep Science Free From Creationism,” *Insight*, February 21, 1994, p. 30.

[68] H. Judson, *The Eighth Day of Creation* (New York: Simon and Schuster, 1979), pp. 157-90.

[69] Meyer, "Of Clues and Causes," p. 120; Darwin, Origin of Species, p. 398; D. Hull, *Darwin and His Critics* (Chicago: University of Chicago Press, 1973), p. 45.

[70] C. Darwin, *More Letters of Charles Darwin*, ed. F. Darwin, 2 vols. (London: Murray, 1903), 1:184.

[71] Quoted in S. J. Gould, "Darwinism Defined: The Difference Between Theory and Fact," *Discovery*, January 1987, p. 70.

[72] Darwin's use of both methodological and empirical arguments against creationism has been well documented: Gillespie, *Charles Darwin and the Problem*, pp. 67-81; Kavalovski, "Vera Causa Principle," pp. 104-29; Meyer, "Of Clues and Causes," pp. 123-25; Recker, "Causal Efficacy," p. 173; Hull, "Darwin and the Nature of Science," pp. 63-80. For examples of Darwin's methodological arguments see Darwin, *Origin of Species*, pp. 201, 430, 453. For examples of his empirical arguments see *Origin of Species*, pp. 223, 386, 417-18.

[73] Skoog, "View from the Past."

[74] Kitcher, *Abusing Science*, p. 125. While Kitcher allows for the possibility of a testable theory of divine creation, he believes creationism was tested and found wanting in the nineteenth century.

[75] This phrase is actually used by astronomer Carl Sagan (in Carl Sagan and Ann Druyan, *Shadows of Forgotten Ancestors* [New York: Random House, 1992], p. 387) but clearly expresses the posture of many evolutionary gradualists and punctuationalists with respect to the absence of transitional intermediates in the fossil record.

[76] The same could be said of the neo-Darwinian selection-mutation mechanism vis-a-vis the theory of common descent. In both cases, however, issues of warrant and issues of scientific status should not be confused.

[77] For a design argument not based on religious authority (i.e., contra g: "Creationist or design theories are not tentative"), see Denton, *Evolution*, pp. 338-42. For an examination and refutation of demarcation argument h (i.e., "Creationist or design theories have no problem-solving capability"), see J. P. Moreland's forthcoming "Scientific Creationism, Science and Conceptual Problems," in *Perspectives on Science and Christian Faith*.

[78] C.S. Peirce, "Abduction and Induction," in *The Philosophy of Peirce*, ed. J. Buchler (London: Routledge, 1956), pp. 150-56; C. S. Peirce, *Collected Papers*, ed. C. Hartshorne and P. Weiss, 6 vols. (Cambridge, Mass.: Harvard University Press, 1931), 2:375; K. T. Fann, *Peirce's Theory of Abduction* (The Hague: Martinus Nijhoff, 1970), p. 33; Meyer, "Of Clues and Causes," pp. 24-34.

[79] Meyer, "Of Clues and Causes."

[80] These three features can be used as a set of individually necessary and jointly sufficient conditions for the identification of historical, as opposed to nonhistorical, sciences. Nevertheless, this demarcation or definition is admittedly arbitrary. It does not imply that some sciences do not combine elements of both historical and inductive inquiry, or that many disciplines do not have both inductive and nomological branches—e.g., cosmology and cosmogony. This "demarcation" is also unproblematic because it makes no claim, implicit or explicit, for a privileged epistemological status for disciplines that manifest historical features. The distinction is not, however, without justification, since each of the individually necessary conditions of a historical science do distinguish real qualitative or logical differences between types of inferences, explanations or questions.

[81] A.C. Doyle, "The Boscome Valley Mystery," in *The Sign of Three: Peirce, Holmes, Popper*, ed. T. Sebeok (Bloomington: Indiana University Press, 1983), p. 145.

[82] S.J. Gould, "Evolution and the Triumph of Homology: Or, Why History Matters," *American Scientist* 74 (1986): 61.

[83] This is not to deny that laws or process theories may play roles in support of causal explanation, as even opponents of the covering-law model such as Scriven admit. Scriven notes that laws and other types of general process theories may play an important role in justifying the causal status of an explanatory antecedent and may provide the means of inferring plausible causal antecedents from observed consequents. Nevertheless, as both Scriven and I have argued elsewhere, laws are not necessary to the explanation of particular events or facts; and even when laws are present, antecedent events function as the primary causal or explanatory entity in historical explanations. Scriven, "Truisms as the Grounds," pp. 448-50; Scriven, "Explanation and Prediction," p. 480; Scriven, "Causes, Connections and Conditions," pp. 249-50; Meyer, "Of Clues and Causes," pp. 18-24, 36-72, 84-92.

[84] Meyer, "Of Clues and Causes," pp. 112-36.

[85] C. Darwin, The *Descent of Man*, 2nd ed. (London: A. L. Burt, 1874), p. 61.

[86] Darwin, *Origin of Species*, p. 434. Darwin's next line on the following page and the very first line of his concluding chapter again suggest the primacy of his concern to establish "descent with modification" and the supportive role that natural selection played in his argument. In his words: "As this whole volume is one long argument, it may be convenient to the reader to have the leading facts and inferences briefly recapitulated. That many grave objections may be advanced against [a] the theory of descent with modification [b] through natural selection, I do not deny."

[87] Ibid., pp. 331-434.

[88] Ibid., p. 432.

[89] Ibid., p. 434.

[90] Gould, "Evolution and the Triumph," p. 61.

[91] Quoted in Gould, "Darwinism Defined," p. 70.

[92] Darwin, *Origin of Species*, p. 399.

[93] Ibid., pp. 195, 399. As Kavalovski has noted, Darwin did not limit his claim of *vera causa* to natural selection but included descent itself under this appellation (Kavalovski, "Vera Causa Principle," pp. 104-5). In chapter 5, on "Laws of Variation," Darwin refers explicitly to "community of descent" as a vera causa of homologies among plant species (*Origin of Species*, p. 195). Despite many references to natural selection as a *vera causa* of morphological change in general, Darwin also seemed to recognize the need to postulate an historical cause (i.e., a pattern of past events) to explain the particular facts mentioned above. Darwin makes this relationship between causal postulations about the past and explanations of present phenomena explicit at one point in chapter 13 by stating that "we may thus account even for the distinctness of whole classes from each other . . . by the belief that many ancient forms of life *have been utterly lost*" (ibid., p. 413).

[94] Gould, "Evolution and the Triumph," p. 60.

[95] A.I. Oparin, *The Origin of Life*, trans. S. Morgulis (New York: Macmillan, 1938).

[96] Meyer, "Of Clues and Causes," pp. 237-40.

[97] Quoted in Gould, "Darwinism Defined," p. 70.

[98] F. Darwin, ed., *Life and Letters of Charles Darwin*, 2 vols. (London: D. Appleton, 1896), 1:437.

[99] Denton, *Evolution*, pp. 338-42; Thaxton, Bradley and Olsen, *Mystery of Life's Origin*, pp. 113-65, 201-4, 209-12.

[100] Thaxton, Bradley and Olsen, *Mystery of Life's Origin*, pp. 201-12.

[101] Ambrose, *Nature and Origin*; Denton, *Evolution*; Augros and Stanciu, *The New Biology*; Kenyon and Davis, *Of Pandas and People*.

[102] D.L. Hull, “God of the Galapagos,” *Nature* 352 (1991): 485-86.

[103] Such a concern was recently raised for example in Nancey Murphy's critique of Phillip Johnson's book *Darwin on Trial* (N. Murphy, “Phillip Johnson on Trial: A Critique of His Critique of Darwin,” *Perspectives on Science and Christian Faith* 45, no. 1 [1993]: 34). There Murphy cites concern among theistic scientists about the God-of-the-gaps objection as a reason for the exclusion of creative intelligence as a candidate explanation for the origin of life. As Murphy explains, even many theistic scientists worry that theistic explanations give up on science too soon, thus making the God hypothesis vulnerable to future scientific advance. Yet, clearly, these scientists accept a definition of

science and scientific advance that presupposes the very naturalism already asserted as necessary to science. Why can a theistic explanation not constitute a scientific advance? Murphy offers no answer to this question, beyond her reference to the story of Laplace's mathematical model supplanting Newton's interventionist explanation of planetary motion.

[104] See the subsection *Explanation via natural law* of Part 2.

[105] Meyer, *Of Clues and Causes*, pp. 77-136.

[106] Thaxton, Bradley and Olsen, *The Mystery of Life's Origin*, pp. 113-65, 201-04, 209-12; Kenyon and Davis, *Of Pandas and People*; W. Bradley and C.B. Thaxton, "Information and the Origin of Life," in *The Creation Hypothesis: Scientific Evidence for an Intelligent Designer*, edited by J.P. Moreland (Downers Grove: InterVarsity Press, 1994), pp. 173-210.

[107] P. Nelson, "Thinking about the Theory of Design," *Origins Research* 15, no. 2 (1993): 6-8.

[108] M. Behe, *Darwin's Black Boxes* (New York: Free Press, 1996); Nelson, pp. 6-8.

[109] Note that I do not need to know something about by neighbor's proclivities, character or purposes (in this case, his dislike of yard debris) in order to make a secure inference to intelligent design, though knowing something about his proclivities does strengthen my confidence in the inference that I have drawn. I can know that something was designed without knowing why or who designed it.

[110] Dembski's work, which will be soon submitted as both a Ph.D. thesis and an academic monograph, is succinctly described in a review article by Paul Nelson in the journal *Origins Research*. P. Nelson, "Thinking about the Theory of Design." *Origins Research* 15, no. 2: 6-8.

[111] Murphy, "Phillip Johnson on Trial," p. 33.

[112] As Newton wrote to Bentley in 1692: "It is inconceivable that inanimate brute Matter should, without the Mediation of something else which is not material, operate upon and affect other Matter without mutual Contact…" (Newton, *Isaac Newton's Papers and Letters on Natural Philosophy*, p. 302).

[113] In any case, none of the emphasis on the regularity and constancy of laws prevented either Boyle or Newton from invoking special divine action as an explanation for the origin of particular natural features (M.A. Stewart, ed., *Selected Philosophical Papers of Robert Boyle* [New York and Manchester: Manchester University Press, 1979], p. 144). Boyle postulated design for the origin of atomic structure; Newton did so in optics and astronomy. Those (such as Murphy, p. 33) who cite these two men as the source of the current positivistic prohibition against mixing science and metaphysics are simply incorrect. (Instead they should consult Gillespie, *Charles Darwin and the Problem*, pp. 1-66 on Darwin's positivism.) Boyle in fact devised an interesting classification scheme that makes explicit the metaphysical nonneutrality of origins questions (Stewart, pp. 172-75), which he thought occurred in a region where natural philosophy and religion overlapped. While Newton tended to reserve the term natural philosophy for nomological

disciplines, he in no sense agreed that empirical evidence was metaphysically neutral, for the reasons already stated.

[114] C.B. Kaiser, *Creation and the History of Science*, History of Christian Theology Series, vol. 3 (Grand Rapids: William B. Eerdmans Publishing Company, 1991), p. 264.

[115] Following Sober, I regard simplicity as a notion that can not be formally explicated but which, nevertheless, plays a role in scientific theory evaluation. Like Sober I believe that intuitive notions of simplicity, economy or elegance express or are informed by tacit background assumptions. I see no reason that theistic explanations could not be either commended or disqualified on the basis of such judgments just as materialistic explanations are. E. Sober, *Reconstructing the Past* (Cambridge: MIT Press, 1988), pp. 36-69.

[116] Theists who invoke the special assistance or activity of Divine agency to explain an origin event or biblical miracle, for example, are not, as is commonly asserted, guilty of semi-deism. Those who infer that God has acted in a discrete, special and perhaps more easily discernible way in one case, do not deny that he is constantly acting to "uphold the universe by the word of his power" at all other times. The medievals resisted this false dichotomy by affirming two powers of God, or two ways by which he interacts with the world. The ordinary power of God they called his *Potentia Ordinata* and the special or fiat power they called his *Potentia Absoluta*. W. Courtenay, "The Dialectic of Omnipotence in the High and Late Middle Ages," in *Divine Omniscience and Omnipotence in Medieval Philosophy*, edited by T. Rudavsky (Norwell: Kluwer Academic Publishers, 1984), pp. 243-69. Many modern theists who affirm the special action of God at a discrete point in history have this type of distinction in mind.

[117] It may sound as though I am endorsing a philosophical relativism about science, or the kind of methodological anarchism advocated by the philosopher of science Paul Feyerabend in his book *Against Method* (London: Verso, 1978). Quite the contrary: I am not an antirealist, nor do I deny the importance of methodology to the process of formulating warranted belief. Precisely because I recognize the importance of a great number of quite distinct and well-established methods at work within fields already widely acknowledged to be scientific, I deny the utility of attempts to give a single, universal methodological characterization of science.

[118] For example, theories that offer antecedent conditions that are merely necessary to a given outcome do not succeed logically as explanations of that outcome. The methodological convention extant within most historical sciences requiring postulated antecedents to meet a criterion of etiological plausibility (causal adequacy) expresses this logical requirement. See my discussion of the logical and contextual requirements of causal explanation in Meyer, "Of Clues and Causes," pp. 60-71, 84-92.

[119] The logical and epistemic conditions of successful causal explanation are difficult to make explicit, though they are quite easy to apply apparently via a kind of tacit understanding. For a more comprehensive (explicit) discussion of the logical and contextual requirements of causal explanation, see Meyer, "Of Clues and Causes," pp. 36-76.

[120] G.K. Chesterton, *Orthodoxy* (London: John Lane, 1909).

[121] As Basil Willey put it: "Science must be provisionally atheistic or cease to be itself" ("Darwin's Place," p. 15). See

also Ruse, *Darwinism Defended*, p. 59; Ruse, "Witness Testimony Sheet," p. 305; Gould, "Evolution as Fact and Theory," p. 121; Root-Bernstein, "On Defining a Scientific Theory," p. 74; Ruse, "Darwinism: Philosophical Preference," pp. 1-13.

[122] W.A. Dembski, "The Very Possibility of Intelligent Design," paper presented at Science and Belief, First International Conference of the Pascal Centre, Ancaster, Ontario, August 11-15, 1992.

[123] P. Thagard, "The Best Explanation: Criteria for Theory Choice," *Journal of Philosophy* 75 (1978): 79; Meyer, "Of Clues and Causes," pp. 99-109; W. Whewell, *The Philosophy of the Inductive Sciences*, 2 vols. (London: Parker, 1840), 2:109, 242; L. Laudan, "William Whewell on the Consilience of Induction," *The Monist* 55 (1971): 371-79.

[124] Lipton, *Inference to the Best Explanation*.

[125] See Haeckel, *Wonders of Life*, pp. 110-11.

[126] Johnson, *Darwin on Trial*. See also Gillespie, *Charles Darwin and the Problem*, pp. 1-18, 41-66, 146-56, for an interesting discussion of the way Darwin succeeded in redefining science so as to make creationist or idealist dissent impossible from within science. <<

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