PERSPECTIVES on Science and Christian Faith

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In this issue . . .

"The fear of the Lord
is the beginning of Wisdom."
Psalm 111:10

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Perspectives on Science and Christian Faith

MANUSCRIPT GUIDELINES

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mise of demarcationism, finding no principled way to tell science and nonscience apart.

But scientists want to distinguish the claims of science about the causes, for example, of volcanic eruptions from the popular Hawaiian lore, which claims that volcanoes erupt when the gods are angry, or of falling objects from the Bushmen's belief that Coke bottles fall from the sky because of the temporary insanity of the gods. If falsification fails to adequately demarcate science from nonscience, can anything else do the job? To examine this question, I begin with the court case of *McLean v. Arkansas*, in which a falsificationist approach was used to attempt to demonstrate that Young Earth Creationism (YEC) is not a science.[1] I will then show that we can make sense of a proper means of demarcating science from nonscience only after we have made sense of a demarcation criterion *within* science.

Demarcation in Biology—The Story of *McLean v. Arkansas*

In this 1981 trial, Judge Overton overturned an Arkansas state law mandating the teaching of "Creation-Science" (YEC) largely by demarcating science from nonscience. For legal reasons (concerning the three-pronged test for an unconstitutional establishment of religion), Overton believed that it was necessary to prove that YEC was a nonscience in order to render its teaching unconstitutional. For my purposes, the crucial aspects of his ruling are the demarcation criteria he took from the philosopher Michael Ruse. Overton lists these five essential characteristics of science:

1. It is guided by natural law.
2. It has to be explanatory by reference to natural law.
3. It is testable against the empirical world.
4. Its conclusions are tentative, i.e., not necessarily the final word.
5. It is falsifiable.[2]

Overton later added other ways of understanding science, such as the sociological tautology "science is what scientists do." But he leans on the above criteria of demarcation in coming to his decision.

Ruse then engaged in a published debate (with Laudan) over the demarcation criteria that informed this opinion.[3] Ruse claims that YEC is unfalsifiable, dogmatic or unrevisable, and untestable. At crucial points (e.g., the act of creation itself), it explicitly disavows that natural law can explain the event or is at work at all. Thus, Ruse claims that creationism fails to meet any of the five criteria deemed essential to science, and accordingly cannot be science. Indeed, if satisfying these criteria are truly necessary conditions for science, failing even one would be enough to render a subject nonscientific.

Laudan's rebuttal observes that the last three criteria are too weak to demarcate science from nonscience, and the first two claims are too strong. If in fact these criteria serve as necessary conditions for science, then many (if not all) historically exemplary cases of science would fail to count as scientific. Newton, for example, postulated the existence of gravity well before he (or anyone else) had a satisfactory explanation of it.[4] Likewise, plate tectonics is a contemporary scientific theory whose causal mechanisms are not yet understood well enough to fashion predictive laws. The same goes for meteorology; and chaos theory suggests that in some disciplines, such law-like generalizations may be impossible. Most importantly for this case, important parts of evolutionary theory (such as the thesis of common ancestry or of natural selection) would fail these tests, apparently rendering evolutionary theory a nonscience.

Further, Laudan claims that YEC could easily be rendered falsifiable, testable, and even tentative. He suggests that adopting the following claim would do so: "I will abandon my views if we find a living specimen of a species intermediate between man and apes." Laudan believes that such a statement is

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Conference on Naturalism, Theism, and the Scientific Enterprise

The NTSE Conference at the University of Texas (February 20–23, 1997) brought together 120 scientists, scholars, and students from North America and Europe to discuss the relationship between methodological naturalism, theistic hypotheses and explanations, and the practice of science. The keynote speakers included Phillip Johnson (University of California-Berkeley), Alvin Plantinga (University of Notre Dame), Michael Ruse (University of Guelph), and Frederick Grinnell (Utah Southwestern Medical Center). Thirty-nine papers were read by specialists in the philosophy of science, history, geology, biology, physics, computer science, rhetoric, theology, and the social sciences. The discussions and questions took place at a very high level and were characterized throughout by friendliness and mutual respect. Real progress was made, with all sides enriched by the encounter, and a convergence of views developed on some centrally important issues. For example, you would find almost universal agreement among philosophers that Cartesian foundationalism and logical positivism are failed projects, and you would find substantial agreement on how and why they failed. Similarly, the philosophers, scientists, and scholars who attended made substantial progress together on the very important question: Is methodological naturalism an essential part of science? During the conference, we moved together toward several shared conclusions:

1. We cannot make a priori pronouncements about what kind of theory or what kind of explanation can properly be made in the course of scientific inquiry. In principle, there is nothing to exclude reference to superhuman, or even extra-cosmic, intelligence.

2. Good science consists in working within research programs that are progressive in the following senses: (a) they generate empirically testable, novel predictions; (b) they generate explanations of a wide range of phenomena on the basis of a simple, spare system of postulated entities and relationships; (c) they deal with anomalies and predictive failures without resorting to ad hoc repairs or epicycles. The inspiration for a scientific research program can come from anywhere, including religious

In This Issue

For this special issue of *Perspectives on Science and the Christian Faith*, we have selected five of the papers that were read at the conference in Austin.

The first, "Methodological Naturalism" by Prof. Alvin Plantinga, America's leading Christian philosopher, is a masterful treatment of the philosophical and foundational issues.

The second, "Charles S. Peirce, Scientific Method and God" by Prof. Terry Pence, is a historical study of the greatest of all American philosophers, the pragmatist Charles Saunders Peirce. Pence shows that Peirce's philosophy of science did not exclude, either in theory or in practice, reference to Divine agency in scientific theories.

The third paper, "Naturalism and Non-Teleological Science: A Way to Resolve the Demarcation Problem between Science and Religion" by Keith Abney, argues that it is impossible to banish teleology from biology, and that theism and naturalism offer genuinely scientific alternatives by way of explaining the origin and nature of teleological facts.

Prof. Timothy Shanahan's paper, "Darwinian Naturalism, Theism and Biological Design," examines the notions of "perfect" and "imperfect design" as used in biological arguments for and against an Intelligent Designer.

Finally, William Dembski's "Intelligent Design as a Theory of Information" sketches a new mathematical theory of information that will enable scientists to generate precise criteria of when an inference to intelligent design is and is not warranted.

conviction, but the evaluation of an existing program must be rigorously empirical.

3. If theistic science or intelligent design theory is to become a progressive research program, it must do more than poke holes in the evidence for Darwinism: it must acquire auxiliary hypotheses about the intentions and preferences of the designer from which we can generate specific, testable predictions and informative explanations.

4. We should not expect intelligent design theory to offer much, if anything, in the way of support to Christian theology, which, anyway, does not stand in need of any such support. Instead, if we are to pursue theistic research programs, it must be for the sake of doing science and doing it well, not for the sake of religion. The cosmic designer investigated in science may be identified, on philosophical or theological grounds, with the God of Scriptures, but science itself cannot make this identification.

In addition to the NTSE conference articles, we offer two Communications. Adam Drozdek responds to Karl Bunsen's March 1997 paper, "Eternity and the Personal God," by proposing a complementary "human" approach. David Siemens then presents a corrective to J. P. Moreland's March 1997 article, "Complementarity, Agency Theory, and the God-of-the-Gaps."

A strong selection of books reviews and several letters to the editor follow. We welcome your (short) letters which often remind us that there is more than one way to "skin a cat."

I thank our guest editor, Rob Koons, for organizing the NTSE conference and for his contributions as guest editor for this issue.

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These four theses became so widely shared at the end of the conference that I think we could call them the Canonical View of the NTSE conference. This convergence was especially remarkable considering the wide diversity of views with which we began, including nonbelievers and adherents of all the major branches of Christendom, and both people sympathetic to and initially quite hostile toward the project of theistic science and to intelligent design theory. I should mention at least one other point upon which we reached a firm consensus: that the time has come to conduct the debate on methodological naturalism and theistic science on the merits (indeed, on the scientific merits) of the case, and we should no longer tolerate ad hominen attacks, with attendant name-calling, bullying, and intimidation ("He's just a lawyer ... he doesn't understand how science works ...," etc.). The project of launching theistic paradigms in science is now much larger than a one-man crusade and would go forward even if, per impossible, it were possible to silence or discredit Phillip Johnson. A growing number of young scientists, scholars, and philosophers of science are staking their careers on the prospects of an emerging design paradigm, including Dembski at Notre Dame, Nelson at Chicago, Meyer at Whitworth, and Corey at the Union Institute.

Most participants would also agree that the emerging design paradigm needs to be given adequate time to mature and develop before a definitive verdict can be rendered. The core idea of intelligent design must be supplemented with auxiliary hypotheses and generalizations about the structure of the design and about at what points the design makes contact with the natural world. We are at a stage analogous to Copernican astronomy before the discovery of Kepler's laws (to say nothing of Newton's).

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Methodological Naturalism?*

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Unmatched for sweep and eloquence, St. Augustine's *De Civitas Dei* is a magnificently powerful expression of a view of human history that has been taken up by a host of later Christians.[1] According to that view, human history involves a struggle, a contest, a battle between what he calls the *Civitas Dei*, the City of God, on the one hand, and, on the other, the City of the World or the City of Man. The former is devoted to the worship and service of the Lord; the latter serves quite a different master. Augustine believes that all of human history is to be understood in terms of this struggle, and nearly any cultural endeavor of any size or significance is involved in it. Now modern natural science is an enormously important aspect of contemporary intellectual life. There are of course those naysayers who see in it no more than technology, no more than a means of serving such practical ends as fighting disease and building bridges or space vehicles. But surely they are wrong. Science has indeed done these important things, but it has done more: it has also given us powerful insights into ourselves and into the world God has created. Science has transformed our intellectual landscape; it is difficult even to imagine what our intellectual life would be without it. If we follow Augustine, we should therefore expect that science, too, plays an important role in the contest he describes.

According to an idea widely popular ever since the Enlightenment, however, science (at least when properly pursued) is a cool, reasoned, wholly dispassionate[2] attempt to figure out the truth about ourselves and our world, entirely independent of ideology, or moral convictions, or religious or theological commitments. Of course this picture has lately developed some cracks. It is worth noting, however, that sixteen centuries ago Augustine provided the materials for seeing that this common conception cannot really be correct. It would be excessively naive to think that contemporary science is religiously and theologically neutral, standing serenely above that Augustinian struggle and wholly irrelevant to it. Perhaps *parts* of science are like that: the size and shape of the earth and its distance from the sun, the periodic table of elements, the proof of the Pythagorean Theorem—these are all in a sensible sense religiously neutral. But many other areas of science are very different; they are obviously and deeply involved in this clash between opposed worldviews. There is no neat recipe for telling which parts of science are neutral with respect to this contest and which are not, and of course what we have here is a continuum rather than a simple distinction. But here is a rough rule of thumb: the relevance of a bit of science to this contest depends upon how closely that bit is involved in the attempt to come to understand ourselves as human beings. Perhaps there is also another variable: how "theoretical" the bit in question is, in the sense of being directed at *understanding* as opposed to control.

It would be of great interest to explore this area further, to try to say precisely what I mean in saying that science is not religiously neutral, to see in exactly what ways Christianity bears on the understanding and practice of the many relevantly different sciences and parts of science. The first is not the focus of this paper, however; and the second question (of course) requires vastly more knowledge of science than I can muster. That is a question not just for philosophers, but for the Christian community of scientists and philosophers working together. What I shall do instead is vastly more programmatic. I shall argue that a Christian academic and scientific community ought to pursue science in its own way, *starting from* and taking for granted what we know as Christians. (This suggestion suffers from the

**This is a condensed version of a paper presented at the NTSE Conference and published in* Facets of Faith & Science, Vol. 1: Historiography and Modes of Interaction, *ed. Jitse M. van der Meer (Lanham, MD: University Press of America, 1996), 177–221. Reprinted by permission.*

considerable disadvantage of being at present both unpopular and heretical; I shall argue, however, that it also has the considerable advantage of being correct.) Now one objection to this suggestion is enshrined in the dictum that science done properly necessarily involves "methodological naturalism" or (as Basil Willey calls it) "provisional atheism."[3] This is the idea that science, properly so-called, cannot involve religious belief or commitment. My main aim in this paper is to explore, understand, discuss, and evaluate this claim and the arguments for it. I am painfully aware that what I have to say is tentative and incomplete, no more than a series of suggestions for research programs in Christian philosophy.

Weak Arguments for Methodological Naturalism

The natural thing to think is that (in principle, at any rate) the Christian scholarly community should do science, or parts of science, in its own way and from its own perspective. What the Christian community really needs is a science that takes into account what we know as Christians. Indeed, this seems the rational thing in any event; surely the rational thing is to use *all* that you know in trying to understand a given phenomenon. But then in coming to a scientific understanding of hostility, or aggression, for example, should Christian psychologists not make use of the notion of sin? In trying to achieve scientific understanding of love in its many and protean manifestations, for example, or play, or music, or humor, or our sense of adventure, should we also not use what we know about human beings being created in the image of God, who is himself the very source of love, beauty, and the like? And the same for morality? Consider that enormous, and impressive, and disastrous Bolshevik experiment of the twentieth century, perhaps the outstanding feature of the twentieth century political landscape: in coming to a scientific understanding of it, should Christians not use all that they know about human beings, including what they know by faith?

True: there could be *practical* obstacles standing in the way of doing this; but in principle, and abstracting from these practical difficulties (which in any event may be more bark than bite), the right way for the Christian community to attain scientific understanding of, say, the way human beings are and behave, would be to start from what we know about human beings, including what we know by way of faith. Hence the sorts of hypotheses we investigate might very well involve such facts (as the Christian thinks) as that we human beings have been created by God in his image, and have fallen into sin. These "religious" ideas might take a place in our science by way of explicitly entering various hypotheses. They might also play other roles: for example, they might be part of the background information with respect to which we evaluate the various scientific hypotheses and myths that come our way.

I say this is the natural thing to think: oddly enough, however, the *denial* of this claim is widely taken for granted; as a matter of fact, it has achieved the status of philosophical orthodoxy. Among those who object to this claim are Christian thinkers with impressive credentials. Thus Ernan McMullin:

> But, of course, methodological naturalism does not restrict our study of nature; it just lays down which sort of study qualifies as *scientific*. If someone wants to pursue another approach to nature—and there are many others—the methodological naturalist has no reason to object. Scientists *have* to proceed in this way; the methodology of natural science gives no purchase on the claim that a particular event or type of event is to be explained by invoking God's creative action directly.[4]

Part of the problem, of course, is to see more clearly what this methodological naturalism *is*. Precisely what does it come to? Does it involve an embargo only on such claims as that a particular event is to be explained by invoking God's creative action *directly*, without the employment of "secondary causes"? Does it also proscribe invoking God's *indirect* creative action in explaining something scientifi-

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cally? Does it pertain only to scientific *explanations*, but not to other scientific assertions and claims? Does it also preclude using claims about God's creative action, or other religious claims as part of the background information with respect to which one tries to assess the probability of a proposed scientific explanation or account? We shall have to look into these matters later. At the moment however, I want to look into a different question: what reason is there for accepting the claim that science does indeed involve such a methodological naturalism, however exactly we construe the latter? I shall examine some proposed reasons for this claim and find them wanting. I shall then argue that nevertheless a couple of very sensible reasons lie behind at least part of this claim. These reasons, however, do not support the suggestion that science is religiously neutral.

... proper science, as seen by the Enlightenment, is restricted to the deliverances of* reason *and* sense *(perception) which are the same for all people.

Well then, what underlies the idea that science in some way necessarily involves this principle of methodological naturalism? First, and perhaps most important: this conception of science is an integral and venerable part of the whole conception of faith and reason we have inherited from the Enlightenment. I do not have the space to treat this topic with anything like the fullness it deserves; but the central idea, here, is that science is objective, public, sharable, publicly verifiable, and equally available to anyone, whatever their religious or metaphysical proclivities. We may be Buddhist, Hindu, Protestant, Catholic, Muslim, Jew, Bahai, none of the above: the findings of science hold equally for all of us. This is because proper science, as seen by the Enlightenment, is restricted to the deliverances of *reason* and *sense* (perception) which are the same for all people. Religion, on the other hand, is private, subjective, and obviously subject to considerable individual differences. But then if science *is* indeed public and sharable by all, then of course one cannot properly pursue it by starting from some bit of religious belief or dogma.

One root of this way of thinking about science is a consequence of the modern foundationalism stemming from Descartes and perhaps even more importantly, Locke. Modern classical foundationalism has come in for a lot of criticism lately, and I do not propose to add my voice to the howling mob.[5] And since the classical foundationalism upon which methodological naturalism is based has run aground, I shall instead consider some more local, less grand and cosmic reasons for accepting methodological naturalism.

Methodological Naturalism Is True by Definition

So *why* must a scientist proceed in accordance with methodological naturalism? Michael Ruse suggests that methodological naturalism or at any rate part of it is *true by definition*:

> Furthermore, even if Scientific Creationism were totally successful in making its case as science, it would not yield a *scientific* explanation of origins. Rather, at most, it could prove that science shows that there can be *no* 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.[6]

Ruse suggests that methodological naturalism is true by definition of the term "science" one supposes; Ruse apparently holds there is a correct definition of "science," such that from the definition it follows that science deals only with what is natural, repeatable, and governed by law. (Note that this claim does not bear on the suggestions that a Christian scientist can propose hypotheses involving such "religious" doctrines as, say, original sin, and can evaluate the epistemic probability of a scientific hypothesis relative to background belief that includes Christian belief.) Ruse's claim apparently rules out hypotheses that include references to God: God is a supernatural being, hypotheses referring to him therefore deal with something besides the natural; hence such hypotheses cannot be part of science.

Three things are particularly puzzling about Ruse's claim. First, enormous energy has been expended, for at least several centuries, on the "demarcation problem": the problem of giving necessary and sufficient conditions for distinguishing science from other human activities.[7] This effort has apparently failed; but if in fact there *were* a definition of the sort Ruse is appealing to, then presumably there would be available a set of necessary and sufficient conditions for something as being science. Ruse does not address the many and (I think) successful arguments for the conclusion that there is no such set of necessary and sufficient conditions, let alone such a definition of the term "science"; he simply declares that—by definition—science has the properties he mentions.

Second, Ruse here proposes three properties that he says are by definition characteristic of any bit of science: that bit deals with things that (a) are repeatable, (b) are merely natural, and (c) are governed by natural law. But take repeatability, and consider this passage by Andrei Linde: speaking of the Big Bang, he says, "One might think it very difficult to extract useful and reliable information from the unique experiment carried out about 10^{10} years ago."[8] According to Linde, the Big Bang is unique and therefore, presumably, unrepeatable—at any rate it *might* turn out to be unrepeatable. If so, would we be obliged to conclude that contemporary cosmological inquiries into the nature of the Big Bang and into the early development of the universe are not really part of science?

Ruse suggests that methodological naturalism is true by definition of the term "science" one supposes; Ruse apparently holds there is a correct definition of "science," such that from the definition it follows that science deals only with what is natural, repeatable, and governed by law.

Consider next the property of being governed by law. The first point, here, would be that the very existence of natural law is controversial; Bas van Fraassen, for example, has given an extended and formidable argument for the conclusion that there are no natural laws.[9] There are *regularities*, of course, but a regularity is not yet a law; a law is what is supposed to *explain* and *ground* a regularity. Furthermore, a law is supposed to hold with some kind of *necessity*, typically thought to be less stringent than broadly logical necessity, but necessity nonetheless.[10] This idea of lawfulness, I think, is an inheritance of Enlightenment deism (see below, p. 148); and perhaps here as elsewhere Enlightenment deism misses the mark. Perhaps the demand for law cannot be met. Perhaps there are regularities, but no laws; perhaps there is nothing like the necessity allegedly attaching to laws. Perhaps the best way to think of these alleged laws is as universally or nearly universally quantified counterfactuals of divine freedom.[11] So suppose van Fraassen is right and there are no natural laws: would it follow by definition that there is not any science? That seems a bit strong. Further, it could be, for all we know, that there are some laws, but not everything is governed by them (or wholly governed by them). Perhaps this is how it is with earthquakes, the weather, and radioactive decay. Would it follow that one could not study these things scientifically?

The third puzzling thing about Ruse's claim: it is hard to see how anything like a reasonably serious dispute about what is and is not science could be settled just by appealing to a *definition*. One thinks this would work only if the original query were really a *verbal* question —a question like *Is the English word "science" properly applicable to a hypothesis that makes reference to God?* But that was not the question: the question is instead *Could a hypothesis that makes reference to God be part of science? That* question cannot be answered just by citing a definition.

"Functional Integrity" Requires Methodological Naturalism?

Diogenes Allen, John Stek, and Howard Van Till give answers of that sort. According to Van Till, God has created a world characterized by "functional integrity":

> By this term I mean to denote a created world that has no functional deficiencies, no gaps in its economy of the sort that would require God to act immediately, temporarily assuming the role of creature to perform functions within the economy of the created world that other creatures have not been equipped to perform.[12]

Note first that Van Till seems to be directing his fire at only one of the several ways in which Christians might employ what they know by faith in pursuing natural science; he is arguing that a scientific hypothesis cannot properly claim that God does something or other *immediately* or *directly*. (Note also that the claim here is not that such a hypothesis would not be *scientific*, but that it would be *false*.) What he says seems to be consistent, so far as I can tell, with the claim (say) that in doing their psychology Christian psychologists can properly appeal to the fact that human beings have been created in the image of God, or are subject to original sin.

So suppose we turn to Van Till's proscription of hypotheses to the effect that God has done something or other immediately or directly. This idea of direct action conceals pitfalls and deserves more by way of concentrated attention than I can give it here.[13] The basic idea, however, is fairly clear. An example of *indirect* divine creation would be my building a house; we may say that *God* creates the house, but does so indirectly, by employing *my* ac-

tivity as a means. So God acts indirectly if he brings about some effect by employing as a means the activity of something else he has created. God acts directly, then, if and only if he brings about some effect, and does not do so by way of employing as a means the activity of some created being.

***[Van Till argues] that a scientific hypothesis cannot properly claim that God does something or other* immediately *or* directly.**

Now Van Till suggests that God does nothing at all in the world *directly;* only *creatures* do anything directly. But no doubt Van Till, like any other theist, would agree that God directly conserves the world and all its creatures in being; he is directly active in the Big Bang, but also in the sparrow's fall. Were he to suspend this constant conserving activity, the world would disappear like a dream upon awakening. And no doubt Van Till would also agree (on pain of infinite regress) that if God does anything in the world indirectly, he also does something directly: presumably he cannot cause an effect indirectly without also, at some point, acting directly, creating something directly. Van Till must therefore be understood in some other way. Perhaps his idea is that God created the universe at some time in the *past* (acting directly at that time) but since then he never acts directly in the world, except for conserving his creation in being, and miracles connected with salvation history. But why think a thing like that? Consider the fact that Christians as diverse as Pope Pius XII and John Calvin have thought that God created human souls directly; can we simply assume without argument that they are mistaken? What is the warrant for supposing that God no longer acts directly in the world?

Van Till appeals for support, for this theological position, to Allen and Stek; Allen asserts that

> God can never properly be used in scientific accounts, which are formulated in terms of the relations between the members of the universe, because that would reduce God to the status of a creature. According to a Christian conception of God as creator of a universe that is rational through and through, there are no missing relations between the members of nature. If in our study of nature, we run into what seems to be an instance of a connection missing between members of nature, the Christian doctrine of creation implies that we should keep looking for one.[14]

Allen's suggestion seems to imply, not just that Christians cannot properly propose, as part of science, that God has done something directly, but also that it would be out of order to appeal, in science, to such ideas as that human beings have been created in God's image. For this idea is not a matter of saying how things in the world are related to each other; it is instead a matter of saying how some things in the world—we human beings—are related to God. Allen believes that scientific accounts must always be formulated in terms of the relationships between members of the created universe (and if that is true, then perhaps, as he says, referring to God in science would be to reduce him to a creature). Taken at face value, however, this seems hasty. A textbook on astronomy may tell you what the diameter of Jupiter is (or how old the earth, or the sun, or the Milky Way is). This does not tell you how things in the world stand related to each other, but instead just tells you something about one of those things; it is science nonetheless.

Allen's main point ... is that a scientific account cannot properly be formulated in terms of the relationship of anything to God.

Allen's main point, of course, is that a scientific account cannot properly be formulated in terms of the relationship of anything to God. But why not? What is the authority for this claim? Does not it seem arbitrary? Consider the truth that human beings have been created in the image of God, but have also fallen into sin. This dual truth might turn out to be very useful in giving psychological explanations of various phenomena. If it is, why should a Christian psychologist not employ it? Why would the result not be science? It could be that investigation would suggest that God created life directly; that it did not arise through the agency of other created things. If that is how things turn out, or how things appear at a given time, why not say so? And why not say so as part of science? As a Christian you believe, of course, that God made the world and could have done so in many different ways; why not employ this knowledge in evaluating the probability of various hypotheses (for example, the Grand Evolutionary Myth)? Christians also have beliefs about what is rational in Simon's sense—i.e., about what sorts of goals a properly functioning human being will have. Christians also have beliefs about what sorts of actions are in their own or someone else's best interests. Why not employ these beliefs in making a

scientific evaluation of the probability of, say, Simon's account of altruism, or in giving her own account of these phenomena?

Finally, consider John Stek:

> Since the created realm is replete with its own economy that is neither incomplete (God is not a component within it) nor defective, *in our understanding of the economy of that realm so as to exercise our stewardship over it*—understanding based on both practical experience and scientific endeavors—*we must methodologically exclude all notions of immediate divine causality*. As stewards of the creation, we must methodologically honor the principle that creation interprets creation; indeed, we must honor that principle as "religiously" as the theologian must honor the principle that "Scripture interprets Scripture"—or, since Scripture presupposes general revelation, that revelation interprets revelation. In pursuit of a stewardly understanding of the creation, we may not introduce a "God of the gaps," not even in the as-yet mysterious realm of subatomic particles. We may not do so (1) because God is not an internal component within the economy of the created realm, and (2) because to do so would be to presume to exercise power over God—the presumptuous folly of those in many cultures who have claimed to be specialists in the manipulation of divine powers (e.g., shamans in Russian folk religion and medicine men in primitive cultures).[15]

Stek insists that "we must methodologically exclude all notions of immediate divine causality" in our understanding of the economy of the created realm. One of his reasons seems to be that to appeal to a notion of immediate divine causality would be to introduce a "God of the gaps," and to do *that* would be to presume to exercise power over God. But am I really presuming to exercise power over God by, for example, concurring with John Calvin and Pope Pius XII, and many others, that God directly creates human beings? Or in claiming that he created life specially? At best, this requires more argument.

As Stek says, God is not an internal component within the created realm. It hardly follows, however, that he does not act immediately or directly in the created realm; like any theist, Stek too would agree that God directly and immediately conserves his creation in existence. And would not he also agree that if God creates anything indirectly, then he creates some things directly? So I am not sure why Stek thinks that we must observe this methodological naturalism. Why think that God does not do anything directly or create anything directly? What is the reason for thinking this? Scripture does not suggest it; there do not seem to be arguments from any other source; why then accept it?

These reasons, then, for the necessity or advisability of methodological naturalism do not seem strong; and since they *are* so weak, it is perhaps reasonable to surmise that they do not really represent what is going on in the minds of those who offer them. I suggest that there is a different and unspoken reason for this obeisance to methodological naturalism: *fear and loathing of God-of-the-gaps theology*. As we saw above, Stek declares that "In pursuit of a stewardly understanding of the creation, we may not introduce a 'God of the gaps'"; he, together with the other three authors I have cited in this connection (McMullin, Van Till and Allen), explicitly mention God-of-the-gaps theology and explicitly connect it with methodological naturalism via the suggestion that God has done this or that immediately. The idea seems to be that to hold that God acts directly in creation is to fall into, or anyway lean dangerously close to this sort of theology. But is this true? Precisely what *is* God-of-the-gaps theology?

Stek insists that "we must methodologically exclude all notions of immediate divine causality" in our understanding of the economy of the created realm.

There is not anything that it is *precisely*; it is not that sort of thing. Somewhat vaguely, however, it can be characterized as follows. The God-of-the-gaps theologian is an Enlightenment semideist who thinks of the universe as a vast machine working according to a set of necessary and inviolable natural laws. (Perhaps a God has created the universe: but if he did, it is now for the most part self-sufficient and self-contained.) These natural laws, furthermore, have a kind of august majesty; they are necessary in some strong sense; perhaps not even God, if there is such a person, could violate them; but even if he could, he almost certainly would not. (Hence the otherwise inexplicable worry about miracles characteristic of this sort of thought.) Natural science investigates and lays out the structure of this cosmic machine, in particular by trying to discover and lay bare those laws, and to explain the phenomena in terms of them. There seem to be *some* phenomena, however, that resist a naturalistic explanation—so far, at any rate. We should therefore postulate a deity in terms of whose actions we can explain these things that current science cannot. Newton's suggestion that God periodically adjusts the orbits of the planets is often cited as just such an example of God-of-the-gaps theology.

The following, therefore, are the essential points of God-of-the-gaps theology. First, the world is a vast machine that is almost entirely self-sufficient; divine activity in nature is limited to those phenomena for which there is no scientific, i.e., mechanical and naturalistic explanation. Second, the existence of God is a kind of large-scale hypothesis postulated to explain what cannot be explained otherwise, i.e., naturalistically.[16] Third, there is the apologetic emphasis: the best or one of the best reasons for believing that there is such a person as God is the fact that there are phenomena that natural science cannot (so far) explain naturalistically.

***I suggest that there is a different and unspoken reason for this obeisance to methodological naturalism:* fear and loathing of God-of-the-gaps theology.**

Now McMullin, Stek, Van Till, and Allen all object strenuously to God-of-the-gaps theology—and rightly so. This line of thought is at best a kind of anemic and watered-down semideism that inserts God's activity into the gaps in scientific knowledge; it is associated, furthermore, with a weak and pallid apologetics according to which perhaps the main source or motivation for belief in God is that there are some things science cannot presently explain. A far cry indeed from what the Scriptures teach! God-of-the-gaps theology is worlds apart from serious Christian theism. This is evident at (at least) the following points. First and most important, according to serious theism, God is constantly, immediately, intimately, and directly active in his creation: he constantly upholds it in existence and providentially governs it. He is immediately and directly active in everything from the Big Bang to the sparrow's fall. Literally nothing happens without his upholding hand.[17] Second, natural laws are not in any way independent of God, and are perhaps best thought of as regularities in the ways in which he treats the stuff he has made, or perhaps as counterfactuals of divine freedom. (Hence there is nothing in the least untoward in the thought that on some occasions God might do something in a way different from his usual way—e.g., raise someone from the dead or change water into wine.) Indeed, the whole *interventionist* terminology—speaking of God as *intervening* in nature, or *intruding* into it, or *interfering* with it, or *violating* natural law—all this goes with God-of-the-gaps theology, not with serious theism. According to the latter, God is already and always intimately acting in nature, which depends from moment to moment for its existence upon immediate divine activity; there is not and could not be any such thing as his "intervening" in nature.

These are broadly speaking metaphysical differences between Christian theism and God-of-the-gaps thought; but there are equally significant epistemological differences. First, the thought that there is such a person as God is not, according to Christian theism, a hypothesis postulated to *explain* something or other,[18] nor is the main reason for believing that there is such a person as God the fact that there are phenomena that elude the best efforts of current science.[19] Rather, our knowledge of God comes by way of *general* revelation, which involves something like Aquinas's general knowledge of God or Calvin's *sensus divinitatis*, and also, and more importantly, by way of God's *special* revelation, in the Scriptures and through the church, of his plan for dealing with our fall into sin.

According to [serious theism], God is already and always intimately acting in nature, which depends from moment to moment for its existence upon immediate divine activity; there is not and could not be any such thing as his "intervening" in nature.

God-of-the-gaps theology, therefore, is every bit as bad as McMullin, Van Till, Stek, and Allen think. (Indeed, it may be worse than Van Till and Stek think, since some of the things they think—in particular their ban on God's acting directly in nature—seem to me to display a decided list in the direction of such theology.) Serious Christians should indeed resolutely reject this way of thinking. The Christian community knows that God is constantly active in his creation, that natural laws, if there are any, are not independent of God, and that the existence of God is certainly not a hypothesis designed to explain what science cannot. Furthermore, the Christian community begins the scientific enterprise already believing in God; it does not (or at any rate need not) engage in it for apologetic reasons, either with respect to itself or with respect to non-Christians. But of course from these things it does not follow for an instant that the Christian scientific community should endorse methodological natural-

ism. The Christian community faces these questions: How shall we best understand this creation God has made, and in which he has placed us? What is the best way to proceed? What information can we or shall we use? Well, is it not clear initially, at any rate, that we should employ whatever is useful and enlightening, including what we know about God and his relationship to the world, and including what we know by way of special revelation? Could we not sensibly conclude, for example, that God created life, or human life, or something else specially? (I do not say we *should* conclude that: I say only that we *could*, and should if that is what the evidence most strongly suggests.) Should we not use our knowledge of sin and creation in psychology, sociology, and the human sciences in general? Should we not evaluate various scientific theories by way of a background body of belief that includes what we know about God and what we know specifically as Christians? Should we not decide what needs explanation against that same background body of beliefs?

... our knowledge of God comes by way of **general** *revelation, ... and also, and more importantly, by way of God's* **special** *revelation, in the Scriptures and through the church, of his plan for dealing with our fall into sin.*

Well, why not? That certainly seems initially to be the rational thing to do (one should make use of all that one knows in trying to come to an understanding of some phenomenon); and it is hard to see anything like strong reasons against it. We certainly do not fall into any of the unhappy ways of thinking characteristic of God-of-the-gaps theology just by doing one of these things. In doing these things, we do not thereby commit ourselves, for example, to the idea that God does almost nothing directly in nature, or that the universe is something like a vast machine in whose workings God could intervene only with some difficulty; nor are we thereby committed to the idea that one of our main reasons for belief in God is just that there are things science cannot explain, or that the idea of God is really something like a large-scale hypothesis postulated to explain those things. Not at all. Indeed, the whole God-of-the-gaps issue is nothing but a red herring in the present context.[20]

Two Stronger Arguments for Methodological Naturalism

These arguments, therefore, are not very convincing; but there are two quite different, and I think, stronger arguments or lines of reasoning for embracing methodological naturalism in the practice of science. The first of these really deserves a paper all to itself; here, unfortunately, I shall have to give it relatively short shrift.

Duhemian Science

We can approach this argument by thinking about some striking passages in Pierre Duhem's *The Aim and Structure of Physical Theory*.[21] Duhem was both a serious Catholic and a serious scientist; he was accused (as he thought) by Abel Rey of allowing his religious and metaphysical views as a Christian to enter his physics in an improper way.[22] Duhem repudiated this suggestion, claiming that his Christianity did not enter his physics in an improper way, because it did not enter his physics in any way at all.[23] Furthermore, he thought the *correct* or *proper* way to pursue physical theory was the way in which he had in fact done it; physical theory should be completely independent of religious or metaphysical views or commitments.

He thought this for two reasons. First, he thought religion bore little relevance to physical theory: "Was it not a glaring fact to us, as to any man of good sense, that the object and nature of physical theory are things foreign to religious doctrines and without any contact with them?"[24]

But there is something else, and something perhaps deeper. Although Duhem may have thought that *religious* doctrines had little to do with physical theory, he did not at all think the same thing about metaphysical doctrines. In fact he believed that *metaphysical* doctrines had often entered deeply into physical theory. Many theoretical physicists, as he saw it, took it that the principal aim of physics is to *explain* observable phenomena. Explanation is a slippery notion and a complex phenomenon; but here at any rate the relevant variety of explanation involves giving an account of the phenomena, the appearances, in terms of the nature or constitution of the underlying material reality. He goes on to give a striking illustration, recounting how atomists, Aristotelians, Newtonians, and Cartesians differ in the explanations or accounts they give of the phenomena of magnetism: atomists give the requisite explanation, naturally enough, in terms of atoms; Cartesians in terms of pure extensions; and Aris-

totelians in terms of matter and form.[25] The differences among these explanations, he says, are metaphysical; they pertain to the ultimate nature or constitution of matter. But of course if the aim is to explain the phenomena in terms of the ultimate nature or constitution of matter, then it is crucially important to get the latter right, to get the right answer to the metaphysical question "What *is* the nature or constitution of matter?" In this way, he says, physical theory is subordinated to metaphysics: "*Therefore, if the aim of physical theories is to explain experimental laws, theoretical physics is not an autonomous science; it is subordinate to metaphysics.*"[26]

Well, what is the matter with that? The problem, says Duhem, is that if you think of physics in this way, then your estimate of the worth of a physical theory will depend upon the metaphysics you adopt. Physical theory will be dependent upon metaphysics in such a way that someone who does not accept the metaphysics involved in a given physical theory cannot accept the physical theory either. And the problem with *that* is that the disagreements that run riot in metaphysics will ingress into physics, so that the latter cannot be an activity we can all work at together, regardless of our metaphysical views:

> Now to make physical theories depend on metaphysics is surely not the way to let them enjoy the privilege of universal consent.... If theoretical physics is subordinated to metaphysics, the divisions separating the diverse metaphysical systems will extend into the domain of physics. A physical theory reputed to be satisfactory by the sectarians of one metaphysical school will be rejected by the partisans of another school.[27]

So here we have another argument for methodological naturalism, and a simple, commonsense one at that: it is important that we all—Christian, naturalist, creative antirealist, whatever—be able to work at physics and the other sciences together and cooperatively; therefore we should not employ in science views, commitments, and assumptions only some of us accept—that is, we should not employ them in a way that would make the bit of science in question unacceptable or less acceptable to someone who did not share the commitment or assumption in question.[28] But then we cannot employ, in that way, such ideas as that the world and things therein have been designed and created by God. Proper science, insofar as it is to be common to all of us, will have to eschew any dependence upon metaphysical and religious views held by only some of us; therefore we should endorse methodological naturalism. We do not, of course, have to be metaphysical naturalists in order to pursue Duhemian science; but if science is to be properly universal, it cannot employ assumptions or commitments that are not universally shared.

Duhemian science, therefore, is maximally inclusive; we can all do it together and agree on its results. But what about those who, like Simon, for example, think it is important also to do a sort of human science which starts, not from methodological naturalism, but from metaphysical naturalism? And what about those who, like the atomists, Cartesians, and Aristotelians think it is important to pursue a sort of science in which the aim is successful explanation in terms of underlying unobservable realities? And what about Christians or theists, who propose to investigate human reality employing all that they know, including what they know as Christians or theists? So far as Duhem's claims go, there is nothing improper about any of this. Should we call this kind of activity "science"; does it deserve that honorific term? There is no reason in Duhem for a negative answer. It is important, to be sure, to see that science of this sort is not *Duhemian* science and does not have the claim to universal assent enjoyed by the latter; but of course that is nothing against it.

[In Duhemian science, science] cannot employ assumptions or commitments that are not universally shared.

According to the fuller Duhemian picture, then, we would all work together on Duhemian science; but each of the groups involved—naturalists and theists, for example, but perhaps others as well—could then go on to incorporate Duhemian science into a fuller context that includes the metaphysical or religious principles specific to that group. Let us call this broader science "Augustinian science." Of course the motivation for doing this will vary enormously from area to area. Physics and chemistry are overwhelmingly Duhemian[29] (of course the same might not be true for *philosophy* of physics); here perhaps Augustinian science would be for the most part otiose. The same goes for biological sciences: surely much that goes on there could be thought of as Duhemian science. On the other hand, there are also non-Duhemian elements in the neighborhood, such as those declarations of certainty and the claims that evolutionary biology shows that human and other forms of life must be seen as a result of chance (and hence cannot be thought of as designed). In the human sciences, however, vast stretches are clearly non-Duhemian; it is in these

areas that Augustinian science would be most relevant and important.

So return to our central question: should the Christian scientific community observe the constraints of methodological naturalism? So far as this argument is concerned, the answer seems to be: yes, of course, in those areas where Duhemian science is possible and valuable. But nothing here suggests that the Christian scientific community should not also engage in non-Duhemian, Augustinian science where that is relevant. There is nothing here to suggest that "if it ain't Duhemian, it ain't science."

Science Stoppers?

There is still another reason for methodological naturalism; this one, too, is common sense simplicity itself. God has created this whole wonderful and awful (both taken in their etymological senses) world of ours. One of the things we want to do as his creatures is to understand the world he has made, see (to the extent that we can) how it is made, what its structure is, and how it works. This is not, of course, the only thing God's children must do with the world; we must also appreciate it, care for it, love it, thank the Lord for it, and see his hand in it. But understanding it is valuable, and so is understanding it in a theoretical way. One way of understanding something is to see how it is made, how it is put together, and how it works. That is what goes on in natural science. The object of this science is nature; for Christians, its aim (one of its aims) is to see what the structure of this world is and how it works; this is a way of appreciating God's creation, and part of what it is to exercise the image of God in which we have been created.

But there will be little advance along this front if, in answer to the question, Why does so and so work the way it does? or What is the explanation of so and so? we regularly and often reply "Because God did it that way" or "Because it pleased God that it should be like that." This will often be true,[30] but it is not the sort of answer we want at that juncture. It goes without saying that God has in one way or another brought it about that the universe displays the character it does; but what we want to know in science are the answers to questions like "What is this made out of? What is its structure? How does it work? How is it connected with other parts of God's creation?" Claims to the effect that God has done this or that (created life, or created human life) *directly* are in a sense science stoppers. If this claim is true, then presumably we cannot go on to learn something further about how it was done or how the phenomenon in question works; if God did it directly, there will be nothing further to find out. How does it happen that there is such a thing as light? Well, God said, "Let there be light" and there was light. This is of course true, and of enormous importance, but if taken as science it is not helpful; it does not help us find out more about light, what its physical character is, how it is related to other things, and the like. Ascribing something to the direct action of God tends to cut off further inquiry.

Ascribing something to the direct action of God tends to cut off further inquiry.

Of course this is a reason for only *part* of methodological naturalism. There are several *different* ways in which Christianity might enter into the texture of science: (1) stating and employing hypotheses according to which God does things directly; (2) stating and employing hypotheses according to which he does something indirectly; (3) evaluating theories with respect to background information that includes Christian theism; (4) employing such propositions as *human beings have been created in God's image*, either directly or as background; (5) doing the same for such doctrines as that of original sin, which do not involve any direct mention of God at all; and (6) deciding what needs explanation by way of referring to that same background. The considerations cited in the last paragraph are at best a reason for a proscription of (1).

But they are not even much of a reason for that. The claim that God has directly created life, for example, may be a science stopper; it does not follow that God *did not* directly create life. Obviously we have no guarantee that God has done everything by way of employing secondary causes, or in such a way as to encourage further scientific inquiry, or for our convenience as scientists, or for the benefit of the National Science Foundation. Clearly we cannot sensibly insist in advance that whatever we are confronted with is to be explained in terms of something *else* God did; he must have done *some* things directly. It would be worth knowing, if possible, which things he *did* do directly; to know this would be an important part of a serious and profound knowledge of the universe. The fact that such claims are science stoppers means that as a general rule they will not be helpful; it does not mean that they are never true, and it does not mean that they can never be part of a proper scientific theory. (And of course it does not even bear on the other ways in which Christianity or Christian theism can be relevant to science.) It is

a giant and unwarranted step from the recognition that claims of direct divine activity are science stoppers to the insistence that science must pretend that the created universe is just there, refusing to recognize that it is indeed *created*.

So there is little to be said for methodological naturalism. Taken at its best, it tells us only that Duhemian science must be metaphysically neutral and that claims of direct divine action will not ordinarily make for good science. And even in these two cases, what we have reason for is not a principled proscription but a general counsel that in some circumstances is quite clearly inapplicable. There is no reason to proscribe a question like: "Did God create life specially?"; there is no reason why such a question cannot be investigated empirically;[31] and there is no reason to proscribe in advance an affirmative answer.

***... human history is dominated by a battle, a contest between the* Civitas Dei *and the City of Man. ... [We are] to pursue the various areas of intellectual life as citizens of the* Civitas Dei.**

Christian thought (particularly since the High Middle Ages) as opposed to Greek (and in particular Aristotelian thought)[32] contains a strong tendency to see the world as through and through *contingent*. The world need not have existed; that is, God need not have created it. The world need not have had just the structure it does have; that is, God could have created it differently. This sense of the contingency of nature has been one important source of the emphasis upon the *empirical* character of modern science. As a sort of rough rule of thumb, we can say that it is by *reason*, by a priori thought, that we learn of what cannot be otherwise; it is by the senses, by way of a posteriori inquiry that we learn about what is contingent.[33] But the world as God created it is full of contingencies. Therefore we do not merely think about it in our armchairs, trying to infer from first principles how many teeth there are in a horse's mouth; instead we take a look. The same should go for the question how God acts in the world: here we should rely less upon a priori theology and more upon empirical inquiry. We have no good grounds for insisting that God *must* do things one specific way; so far as we can see, he is free to do things in many different ways. So perhaps he did create human life specially; or perhaps he has done other things specially. We cannot properly rule this out in advance by way of appeal to speculative theology; we should look and see.

My main point, therefore, can be summarized as follows. According to Augustine, Kuyper, and many others, human history is dominated by a battle, a contest between the *Civitas Dei* and the City of Man. Part of the task of the Christian academic community is to discern the limits and lineaments of this contest, to see how it plays out in intellectual life generally, and to pursue the various areas of intellectual life as citizens of the *Civitas Dei*. This naturally suggests pursuing science using all that we know: what we know about God as well as what we know about his creation, and what we know by faith as well as what we know in other ways. That natural suggestion is proscribed by the Principle of Methodological Naturalism. Methodological naturalism, however, though widely accepted and indeed exalted, has little to be said for it; when examined cooly in the light of day, the arguments for it seem weak indeed. We should therefore reject it, taken in its full generality. Perhaps we should join others in Duhemian science; but we should also pursue our own Augustinian science.

By way of conclusion, I call attention to something else John Stek has said:

> Theology must take account of all that humanity comes to know about the world, and science must equally take account of all that we come to know about God. In fact, we cannot, without denying our being and vocation as stewards, pursue theology without bringing to that study all that we know about the world, nor can we, without denying our being and vocation as stewards, pursue science without bringing to that study all that we know about God.[34]

Just so. ❖

Notes

[1]For example, many Reformed Christians follow Abraham Kuyper in holding that intellectual endeavor in general and natural science in particular are not independent of religious commitment. Perhaps the credit for this idea should go not to Augustine, but to Tertullian. Tertullian has suffered from a bad press; one of his major emphases, however, is that scholarship—intellectual endeavor—is not religiously neutral.

[2]The idea is not, of course, that a scientist will not be passionate either about science generally, or his favorite theories, or his reputation; it is rather that none of these properly enters into the evaluation of a scientific theory or explanation.

[3]"Science must be provisionally atheistic or cease to be itself." B. Willey, "Darwin's Place in the History of Thought," in *Darwinism and the Study of Society*, edited by M. Banton (Chicago: Quadrangle Books, 1961), 1–16. Willey does not mean, of course, that one who proceeds in this way is properly accused of atheism. In the same way, to call this procedure or proscription "methodological naturalism" is not to imply that one who proceeds in this way is really a naturalist. See E. McMullin, "Plantinga's Defense of Special Creation," *Christian Scholar's Review* 21 (September, 1991): 57.

[4]McMullin, "Plantinga's Defence," 57.

[5]I have argued elsewhere that one condition of rationality laid down by modern classical foundationalism is in fact self-referentially incoherent. See, for example, A. Plantinga, "Reason and Belief in God," in *Faith and Rationality*, edited by A. Plantinga and N. Wolterstorff (Notre Dame: University of Notre Dame Press, 1983), 60ff.

[6]Ruse, *Darwinism Defended* (Reading: Addison-Wesley, 1982), 322 (my italics).

[7]See, for example, L. Laudan, "The Demise of the Demarcation Problem," in *But is it Science?* edited by M. Ruse (New York: Prometheus Books, 1988), 337–50.

[8]A.D. Linde, "Particle Physics and Inflationary Cosmology," *Physics Today* (September, 1987): 61.

[9]See B. van Fraassen, *Laws and Symmetry* (Oxford: Oxford University Press, 1989), chaps. 2–5.

[10]See, for example, D. Armstrong, *What is a Law of Nature?* (Cambridge: Cambridge University Press, 1983), 39ff.

[11]That is, propositions that state how God (freely) treats the things he has made, and how he would have treated them had things been relevantly different. "Nearly universally quantified": if we think of them this way, we can think of miracles as going contrary to law without thinking of them (inconsistently) as exceptions to some universal and necessary proposition.

[12]H.J. Van Till, "When Faith and Reason Cooperate," *Christian Scholar's Review* 21 (September, 1991): 42.

[13]See, for example, W. P. Alston, "Divine and Human Action," in *Divine and Human Action: Essays in the Metaphysics of Theism*, edited by T. Morris (Ithaca: Cornell University Press, 1988), 257–80.

[14]D. Allen, *Christian Belief in a Postmodern World* (Louisville: Westminster/John Knox Press, 1989), 45.

[15]J. H. Stek, "What Says the Scriptures?" in *Portraits of Creation: Biblical and Scientific Perspectives on the World's Formation*, edited by H. J. Van Till, R. E. Snow, J. H. Stek, and D. A. Young (Grand Rapids: William B. Eerdmans Publishing Company, 1990), 261.

[16]I do not mean to suggest that one who espouses or advocates God-of-the-gaps theology herself believes in God only as such a hypothesis: that is quite another question.

[17]In addition, most medieval Christian thinkers have also insisted on a separate divine activity of God's; any causal transaction in the world requires his *concurrence*. Problems arise here; to some ears it sounds as if this doctrine is motivated less by the relevant evidence than by a desire to pay metaphysical compliments to God.

[18]See my "Is Theism Really a Miracle?" *Faith and Philosophy* 3, no. 2 (1986): 132ff.

[19]A further problem with this way of thinking: as science explains more and more, the scope for God's activity is less and less; it is in danger of being squeezed out of the world altogether, thus making more and more tenuous one's reasons (on this way of thinking) for believing that there is such a person as God at all. (Of course it must also be acknowledged on the other side that things sometimes go in the opposite direction; for example, it is much harder now than it was in Darwin's day to see how it could be that life should arise just by way of the regularities recognized in physics and chemistry.)

[20]Further, Newton seems to me to have suffered a bum rap. He suggested that God made periodic adjustments in the orbits of the planets: true enough. But he did not propose this as a reason for believing in God; it is rather that (of course) he already believed in God, and could not think of any other explanation for the movements of the planets. He turned out to be wrong; he could have been right, however, and in any event he was not endorsing any of the characteristic ideas of God-of-the-gaps thought.

[21]P. Duhem, (1906) *The Aim and Structure of Physical Theory*, translated by P. P. Wiener, with the foreword by Prince Louis de Broglie (Princeton: Princeton University Press, 1954).

[22]A. Rey, "La Philosophie Scientifique de M. Duhem," *Revue de Métaphysique et de Morale* 12 (July, 1904): 699ff.

[23]See the appendix to *The Aim and Structure of Physical Theory*, which is entitled "Physics of a Believer" and is a reprint of Duhem's reply to Rey; it was originally published in the *Annales de Philosophie Chrétienne* 1 (October and November, 1905): 44f. and 133f.

[24]Duhem, 278.

[25]Duhem, 10–18.

[26]Duhem, 10.

[27]Duhem, 10.

[28]This would not preclude, of course, employing such ideas in theories proposed, not as true, but only as empirically adequate.

[29]The Principle of Indifference is non-Duhemian, but it is not easy to find other examples. (I am assuming that *interpretations* of quantum mechanics [as opposed to quantum mechanics itself] belong to philosophy rather than physics.)

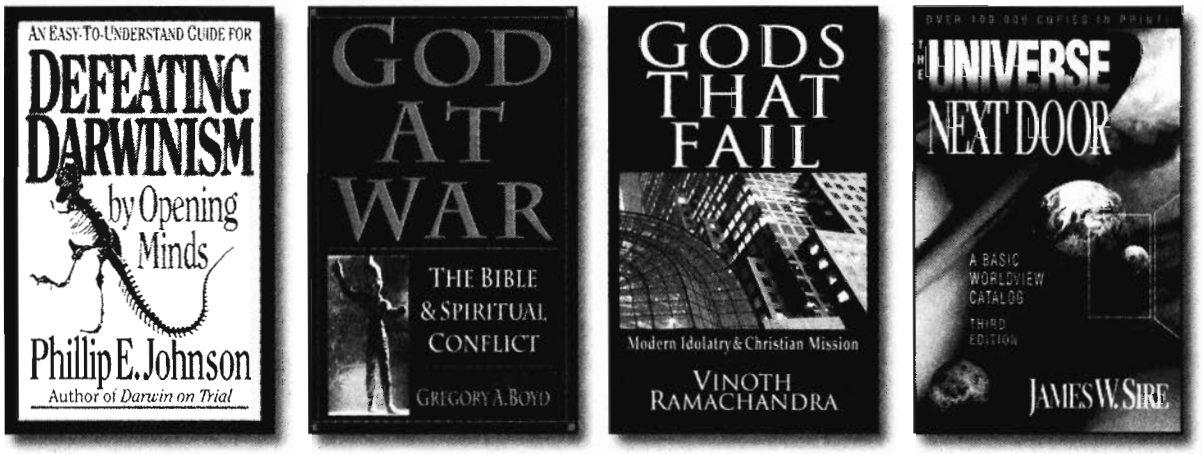
[30]Though not always: if the question is "Why was there such a thing as WW II?" the answer is not "Because it pleased God to do things that way." God of course *permitted* World War II to take place; but it was not pleasing to him.

[31]Why could a scientist not think as follows? God has created the world, and of course has created everything in it directly or indirectly. After a great deal of study, we cannot see how he created some phenomenon P (life, for example) indirectly; thus probably he has created it directly.

[32]See Aristotle, *Posterior Analytics*, bk. I, 1–2, 4, where Aristotle declares that *scientia* is a matter of seeing what necessarily follows from what one sees to be necessarily true. (Of course Aristotle's own practice is not always easy to square with this suggestion.)

[33]Of course, this is at best a rough and general characterization: we can obviously learn of necessities a posteriori (for example, by using computers to prove complicated theorems) and perhaps also of contingencies a priori. This question of the connection between the a priori and the necessary, on the one hand, and the contingent and the a posteriori on the other (the question of the relationship between the a priori/a posteriori distinction and the necessary/ contingent distinction) is as deep as it is fascinating.

[34]Stek, 260–1.



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Charles S. Peirce, Scientific Method, and God

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Charles S. Peirce, the founder of American pragmatism, wrote extensively about a form of inference called abduction, or more familiarly, reasoning to the best explanation. He claimed that it was essential to the growth of science. In this article, I examine Peirce's theory of abduction to see if he thinks that this essential form of reasoning precludes appeals to a supernatural agency. I argue that it does not and that Peirce himself defends just such an abductive inference in his "A Neglected Argument for the Reality of God."

Charles S. Peirce (1839–1914), founder of American pragmatism, claimed that there were three kinds of reasoning: deductive, inductive, and abductive. The last of these is more familiarly called reasoning to the best explanation. Two important claims which he made about abduction were that it was the only ampliative kind of reasoning and that it was essential to science. In calling it the only form of ampliative inference, Peirce meant reasoning which can give us more information than is contained in the premises. It is essential to the growth of science because "every plank of its advance is first laid by retroduction (i.e., abduction) alone."[1]

The question I wish to address in this paper is whether abduction or reasoning to the best explanation, as understood by Peirce, must preclude the supernatural from the explanans. Does Peirce, for example, believe that we should rule out appeals to supernatural agency on grounds of simplicity or requirements of empirical consequence from the explanation? The thesis of this paper is that he does not. I will try to explain Peirce's theory of abduction and show that it has no restrictions which would a priori eliminate appeals to the supernatural. I cite Peirce's own piece of abductive reasoning in "A Neglected Argument for the Reality of God" as primary evidence that, for him, there is no essential hostility between the most essential aspect of scientific reasoning and broadly theistic conclusions.

**ASA Associate Member*

Peirce's Theory of Abduction[2]

Hypothesis Generation

Induction and deduction are commonly acknowledged kinds of reasoning, but Peirce claimed that, besides these, there is a third kind that he variously called abduction, hypothesis, hypothetic inference, retroduction, and presumption. In his mind, this was not so much a discovery as a recovery of a type of reasoning that Aristotle had mentioned.[3] Peirce argues that in classifying types of reasoning, one should aim at bringing out the amount and kind of certainty that each form of reasoning affords and "bring out the possible and *esperable uberty* [fruitfulness], or value in productiveness of each kind."[4] Regarding abduction and its relationship to deduction, he says:

> From the first type (deduction) to the third (abduction) the security decreases greatly, while the *uberty* as greatly increases ... I don't think the adoption of a hypothesis on probation can properly be called induction; and yet it is *reasoning* and though its *security* is low, its uberty is high.[5]

Abduction is an ampliative kind of reasoning. It is the only one which can introduce novel ideas differing in kind from those found in the premises or explanandum. This sort of reasoning takes place at the very beginning of scientific inquiry. In fact, "all the ideas of science come to it by way of abduction."[6] Abduction takes place when:

> Upon finding himself confronted with a phenomenon unlike what he would have expected under the circumstances, he looks over its features and notices some remarkable character or relation among them, which he at once recognizes as being characteristic of some conception with which his mind is already stored, so that a theory is suggested which would *explain* (that is render necessary) that which is surprising in the phenomena.[7]

Peirce also notes an interesting and controversial aspect of abduction when he says:

> Abduction, although it is very little hampered by logical rules, nevertheless is logical inference, asserting its conclusion only programmatically or conjecturally, it is true, but nevertheless having a definite logical form.[8]

This logical form is the following: "The surprising fact C, is observed. But if A were true, C would be a matter of course; Hence, there is reason to suspect that A is true."[9]

Abduction then is an explanatory inference from certain data. Peirce claims that it is an inferential process because reasons can be adduced for the hypothesis.[10] Although at one point he says: "Reasoning, properly speaking, cannot be unconsciously performed ... For reasoning is deliberate, voluntary, critical, controlled, all of which it can be if it is done consciously,"[11] Peirce also describes abduction as a kind of guessing instinct. Abduction, he says: "... tries what *el lume naturale* [the light of nature] ... can do. It is really an appeal to instinct."[12] "The abductive suggestion comes to us like a flash. It is an act of insight, although of extremely fallible insight."[13]

At first glance, this would seem to disqualify abduction as a form of reasoning on Peirce's own account. But while Peirce believes that reasoning is a conscious process, he nevertheless holds that:

> All that is necessary is that we should, in each case, compare premises and conclusion, and observe that the relation between facts, expressed in the premises involves the relation between facts implied in our confidence in the conclusion.[14]

In other words, the fact that Peirce defines reasoning as conscious, voluntary, controlled, and capable of being criticized at every point does not, as yet, rule out abduction as a form of reasoning, because one isn't required to be conscious of the whole process. Thus, although a certain hypothesis may occur as a flash of insight, the flash of insight is not justification. It is something which can be supported by reasons—sometimes good, sometimes bad.

A historical example will illustrate this point. In 1879 Louis Pasteur noticed a "surprising fact." He injected some chickens with bacillus that had been around for several months. Instead of dying as expected, the chickens became only slightly ill and then recovered. Pasteur concluded that the old cultures had spoiled. So he obtained a new culture of virulent bacilli from chickens afflicted with a current outbreak of cholera. Then he again injected the chickens along with some new ones. In due time, all the first-time injected chickens died. Those previously injected with the old "spoiled" stuff lived. When Pasteur was told what had happened, he, according to an eyewitness, "remained silent for a minute, then exclaimed as if he had seen a vision: 'Don't you see that these animals have been vaccinated!'"[15] Nearly a hundred years earlier, Edward Jenner had seen the connection between cowpox and smallpox. Even the term "vaccination" derives from the Latin word for cow, *"vacca."* The germ theory of disease was more recent. Pasteur was the first to connect the two and give birth to modern immunology. The point, however, is that Pasteur's theory was an abductive inference—whether it occurred to him in a minute, ten seconds, or a flash of insight. The surprising fact was that the previously inoculated chickens did not die. If his hypothesis, "These animals have been vaccinated," was true then, of course, they did not die. But Pasteur could equally have supposed any number of hypotheses that could have accounted for the fact that these chickens did not die. For instance, it

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may have been that the assistant forgot to inoculate them again; or, these chickens were just heartier than the new batch; or, it could have been something in their diet; or, they were charmed, etc. All these are abductions. Whether they occur as flashes of insight, they are supportable by reasons—some more plausible than others.

Hypothesis Selection

Another aspect of Peirce's theory of abduction concerns whether it meant to include not only hypothesis generation but also a theory of hypothesis selection.[16] In hypothesis generation, abduction can be a kind of insight or intuition that is "little hampered by rules." In hypothesis selection, abduction seems to be a logical inference that involves some explicit considerations that govern the process of selecting a hypothesis.[17] Although these are perhaps separate issues, they are not separable processes in practice, nor are they kept apart in Peirce's thought.[18] There are passages in which Peirce notes the considerations which go into hypothesis selection. These may be summarized as follows:

1. It must explain the facts.
2. It must be experimentally verifiable.
3. It must be economical.

The first consideration is the essential feature of abduction. Peirce writes in many places that, "Abduction ... amounts ... to observing a fact and then professing to say what it was that gave rise to the fact ..."[19] and "abduction consists in studying facts and devising a theory to explain them."[20]

In hypothesis generation, abduction can be a kind of insight or intuition that is "little hampered by rules." In hypothesis selection, abduction [is] a logical inference that involves some explicit considerations that govern the process of selecting a hypothesis.

The second consideration is equally insisted upon, as for example, in this passage:

> The principle rule of presumption (abduction) is that its conclusion should be such that definite consequences can be plentifully deduced from it of a kind which can be checked by observation.[21]

It is consideration three, however, which brings in processes that are "little hampered" by logical rules. Peirce believes that "before you try a complicated hypothesis you should make quite sure that no simplification of it will explain the facts equally well"[22] or "try the theory of fewest elements first; and only complicate it as such complication proves indispensable to the truth."[23]

Abduction and God

Given this sketch of the theory of abduction, it would be pertinent to ask whether explanations referring to God as part of the explanans would be prohibited. As a theory of hypothesis generation, the theory of abduction seems to be no bar to the God hypothesis. It is an ampliative form of inference which can bring forth any kind of explanan. Abduction as a theory of hypothesis selection, however, does seem to present some problems. Would a God hypothesis meet the criteria of simplicity and empirical verifiability? I believe that Peirce would answer "Yes." The best evidence for this claim is his discussion of just these points in "A Neglected Argument for the Reality of God."[24]

In this article, Peirce presents an abductive argument for the reality of God. He defends the appropriateness of making this sort of inference from playful musing speculation on such surprising facts as the variety, homogeneity, interconnectedness, and beauty in the cosmos; our ideas; and our active powers to connect our ideas to facts and things. What is surprising is that he goes out of his way to suggest that this inference meets the canons of scientific inference, when it was surely open to him to say that the inference is justified, but not science.

Consider the ways in which he defends the process and the project. It seems to me that at every turn, he could have accepted the objection and sidestepped it by saying that theology has its own canons of evidence and domain so it need not meet those of science. He could have said this, but he does not.

A priori Barriers to Inquiry

Peirce dismisses those who would suggest there is no point or profit in speculating along certain lines of inquiry. He colorfully calls them "tribes of Sir Oracles, colporting brocards to bar off one or another roadway of inquiry."[25] Auguste Comte is named as a tribal leader. The examples he cites of short-lived maxims were: "No science must borrow

the methods of another" (an a priori methodological restriction) and "It is not the business of science to search for origins" (an a priori restriction on the proper domain of science). Peirce thinks that history has shown that these types of a priori roadblocks to inquiry are laughably obsolete.

Peirce could have said that such restrictions are all fine and dandy *for science*, but we need not heed them because we are doing something different. It is a different game; it has different rules. He could have said this, but he does not.

The Problem of Simplicity

Whatever the God hypothesis explains can be explained or explained away on some other hypothesis. Since naturalistic explanations are going to be used anyway, doesn't any appeal to God as an explanatory hypothesis needlessly proliferate a theoretical entity and violate one of Peirce's own rules of economy of research, namely, of two hypotheses, the simpler is to be preferred?

[Pierce] argues that the God hypothesis does meet the simplicity criterion.

Peirce could dodge this issue by arguing for the inapplicability of the simplicity criterion. Instead he argues that the God hypothesis does meet the simplicity criterion. Now if you just count explanatory assumptions, the God hypothesis is more complicated, but is this how simplicity should be understood? Peirce does not believe that fewest is always the truest. He only insists that the uncomplicated hypothesis be tried first, since it may be the easiest to refute. But which hypothesis is the simplest? Is there some objective criteria to determine it? Consider this warning by a contemporary philosopher of science, Carl Hempel:

> Any criteria of simplicity would have to be objective, of course; they could not just refer to intuitive appeal or to the ease with which a hypothesis or theory can be understood or remembered, etc., for these vary from person to person.[26]

and then consider Peirce's answer:

> Modern science has been built after the model of Galileo who founded it on *il lume naturale*. That truly inspired prophet had said that of two hypotheses, the *simpler* is to be preferred, but I was formerly one of those who, in our dull self-conceit fancying ourselves more sly then he, twisted the maxim to mean the logically simpler, the one that adds the least to what has been observed.... It was not until long experience forced me to realize that subsequent discoveries were every time showing I had been wrong, while those who understood the maxim as Galileo had done, early unlocked the secret, that the scales fell from my eyes and my mind awoke to the broad and flaming daylight that it is the simpler Hypothesis in the sense of the more facile and natural, the one that instinct suggests, that must be preferred; for the reason that, unless man may have a natural bent in accordance with nature's, he has no chance of understanding nature at all.[27]

Thus, in elaborating what is meant by economy, Peirce describes two sorts of simplicity. The first he calls "logical simplicity." This is the hypothesis that "has the fewest elements" is least complicated, or is easiest to refute. Another type of simplicity goes unnamed but might be called "natural simplicity." This is the type of simplicity just described in the quotation above. The relative importance of these two senses of simplicity is captured in this remark: "I do not mean that logical simplicity is a consideration of no value at all, but only that its value is badly secondary to that of simplicity in the other sense."[28] What is more important, the God hypothesis has this type of natural simplicity to the highest degree.

The Problem of Direct Verification and Empirical Consequence

It could be argued that the God hypothesis posits a theoretical entity which is not directly observable and has few empirical consequences. Peirce rejects the former criterion and tries to finesse the latter.

One rule for hypothesis selection noted above was that a hypothesis should have empirical consequences. That remark should not, however, be interpreted as support for positivism or the claim that only what is empirically verifiable can be included in a hypothesis. Peirce actually repudiates the descriptive positivism found in Comte and others.[29] In a review of James' *Principles of Psychology*, Peirce chides him for rejecting theoretical entities. He claims that this is a matter of James' personal taste:

> Nor is it in the least true that physicists confine themselves to such a "strictly positivistic point of view." Students of heat are not deterred by the impossibility of directly observing molecules from considering and accepting the kinetical theory; students of light do not brand speculation on the luminiferous ether as metaphysical; and the substantiality of matter itself is called in question in the vortex theory, which is nevertheless considered as perfectly germane to physics. All these are "attempts to explain

phenomenally given elements as products of deeper-lying entities." In fact this phrase describes, as well as loose language can, the general character of scientific hypotheses.[30]

Does the God hypothesis have empirical consequences? Here I think that Peirce has three responses. The first is to say that we can't expect too much in the way of empirical consequences from the God hypothesis because "the hypothesis can be apprehended so very obscurely that in exceptional cases alone can any definite and direct deduction from its ordinary abstract interpretation be made."[31] Second, the hypothesis has pragmatic consequences of a sort in the way it regulates and commands influence over the life of the believer.[32] Lastly, the God hypothesis does have empirical consequences after all. At the end of the article, Peirce says that the God hypothesis "is connected so with a theory of thinking that if this be proved so is that."[33] Peirce thinks that since the theory of the nature of thinking has empirical consequences, the God hypothesis can claim some of its empirical credit.

Conclusion

In this paper, I have tried to show that the most important kind of reasoning which takes place in science is abductive reasoning or reasoning to the best explanation. Peirce viewed abductive inferences which appeal to God as an explanation as legitimate as any scientific inference. I have construed his "A Neglected Argument for the Reality of God" as arguing for this point. Now I would like to offer some ideas as to why Peirce thinks this.

Peirce viewed abductive inferences which appeal to God as an explanation as legitimate as any scientific inference.

Two reasons occur to me. The first is that Peirce is a critical realist. He believes that scientists have made correct guesses about the nature of reality and that God is real as well. Unless you are prepared to argue that parts of reality can only be discovered by incommensurable means or that there are incommensurable domains of knowledge, one seems driven to the conclusion that claims about reality should meet some common, or at least similar, standards. It is not just that science and its methods can epistemologically dictate the grounds of rational acceptability, it also goes the other way around. That is, where it appears that the canons of scientific evidence or method have apparently precluded what we know to be true, it is time to reform the science. The adequacy of proposed methods is to be measured against what we know to be true.

My second speculative thought about why Peirce wishes to conform the argument for God into a scientific inference is this: the God hypothesis and materialistic explanations are, at times, in competition for explaining the same facts. If this is the case, then it would make sense that the God hypothesis should try to best the materialist hypothesis on the criteria it thinks it meets. ❖

Notes

[1]Charles Sanders Peirce, *Collected Papers of Charles Sanders Peirce*, 8 vols., Charles Hartshorne and Paul Weiss, eds. (Cambridge, MA: Harvard University Press, 1958). Citations in the notes will cite only the title, the volume number, the date where there is one, and then the paragraph. Subsequent references will cite title and paragraph. This reference is from "A Neglected Argument for the Reality of God," Vol. 6 (1908), 477.

[2]The following is an account of the more salient features of Peirce's theory of abduction. Most of Peirce's doctrines show signs of development and this theory is no exception. For my purposes, however, I will ignore the subtleties of this development and refer mainly to the mature theory. For an account of this development one may consult Arthur Burks, "Peirce's Theory of Abduction," *Philosophy of Science* (October 1946): 301–306; Francis E. Reilly, *Charles Peirce's Theory of Scientific Method* (New York: Fordham University Press, 1970), 31–35; and especially K. T. Fann, *Peirce's Theory of Abduction* (The Hague: Martinus Nijhoff, 1970).

[3]"Lessons from the History of Science" Vol. 1 (c. 1896), 65.

[4]"A letter to F. A. Woods," Vol. 8 (1913), 384.

[5]Ibid., 387–88.

[6]Harvard Lecture V, "On Three Kinds of Goodness," Vol. 5 (1903), 145.

[7]"Syllabus," Vol. 2 (1903), 776. Cf. "A Letter to Paul Carus," Vol. 8 (1910), 229.

[8]Harvard Lecture VII, "On Pragmatism and Abduction," Vol. 5 (1903), 188.

[9]Ibid., 189.

[10]See "On the Natural Classification of Arguments," Vol. 2 (1867), 511n.

[11]*Minute Logic*, Chapter 2, Section 2, "Why Study Logic?" Vol. 2 (1902), 182. For a valuable discussion of these four marks of reasoning (deliberate, voluntary, critical, controlled), see Maryann Ayim, "Retroduction: The Rational Instinct," *Transactions of the Charles S. Peirce Society* 10 (Winter 1974): 34–43. See especially pp. 37–38.

[12]Cambridge Lectures, Lecture 1, "Philosophy and the Conduct of Life," Vol. 1 (1898), 630.

[13]Harvard Lecture VII, "On Pragmatism and Abduction," Vol. 5 (1903), 181.

[14]*Minute Logic*, 183.

[15]Cf. Arthur Koestler, *The Act of Creation: A Study of the Conscious and Unconscious in Science and Art* (New York: Dell, 1964), 112–114.
[16]The question is explicitly addressed by Harry G. Frankfurt in his "Peirce's Theory of Abduction," *The Journal of Philosophy* 55 (July 3, 1958): 593–597.
[17]Cf. "On the Logic of Drawing History from Ancient Documents Especially from Testimonies," Vol. 7 (1901), 220.
[18]This is the solution to the problem that K. T. Fann suggests in *Peirce's Theory*, p. 41.
[19]Cambridge Lectures, Lecture III, "The First Rule of Logic," Vol. 5 (1898), 581.
[20]Harvard Lecture V, "On Three Kinds of Goodness," Vol. 5 (1903), 145. Cf. "A Letter to Paul Carus," Vol. 8 (1910), 229.
[21]From Contributions to Baldwin's *Dictionary of Philosophy and Psychology*, Vol. 2 (1901), 786. Cf. also Harvard Lecture VII, "On Pragmatism and Abduction," Vol. 5 (1903), 196.
[22]Harvard Lecture III, "On Phenomenology," Vol. 5 (1903), 60.
[23]*Grand Logic*, "The Essence of Reasoning," Vol. 4 (1893), 35.
[24]"A Neglected Argument for the Reality of God" Vol. 6 (1908), 452–491. This article was originally published in *Hibbert Journal* 7 (1908): 90–112.
[25]Ibid., 460.
[26]Carl G. Hempel, *Philosophy of Natural Science*. Foundations of Philosophy Series (Englewood Cliffs, NJ: Prentice-Hall, 1966), 41.
[27]"A Neglected Argument," 477. It is interesting that although Hempel insists upon an "Objective Criteria" for simplicity and Peirce denies there is one in Hempel's sense, Hempel ends on this note: "Thus, while all the different ideas here briefly surveyed shed some light on the rationale of the principle of simplicity, the problems of finding a precise formulation and a unified justification for it are not as yet satisfactorily solved" (*Natural Science*, 45). A more extensive treatment of the simplicity criterion can be found in Fann, *Peirce's Theory*, 47–51; and Reilly, *Scientific Method*, 38–41.
[28]"A Neglected Argument," 477.
[29]Lowell Lectures, Lecture VIII, "How to Theorize," Vol. 5 (1903), 597.
[30]Review of William James' *The Principles of Psychology*, Vol. 7 (1891), 60.
[31]"A Neglected Argument," 489.
[32]Ibid., 490.
[33]Ibid., 491.

Naturalism and Nonteleological Science: A Way to Resolve the Demarcation Problem Between Science and Nonscience

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Demarcating science from nonscience became a hot topic in the wake of Judge Overton's opinion in McLean v. Arkansas *(1982). The ensuing discussion by philosophers of science Larry Laudan and Michael Ruse provides an instructive example of how* not *to solve the problems of demarcating science from nonscience. Overton follows Ruse in viewing demarcation through Popperian falsificationism, which would unfortunately render much of what we call "science" nonscientific. Laudan's response is to jettison the possibility of demarcation and simply accept Young Earth Creationism as a science, albeit a "bad" one. One result is how the case reveals a chasm between those who automatically debunk the potential legitimacy of "supernatural" causation and those who do not—even among naturalists!*

As a result, I use the Overton decision as a springboard for the advocacy of a terminological change in the debate over naturalism and demarcation, one which renders the nature of the disputes more perspicuous. I suggest that we divide the sciences by their causal-explanatory structure, and, in particular, by their ability to abstract from the causal power of agency (whether human or divine) in their proper explanations. The sciences are thus demarcated into the "teleological" and the "nonteleological," rather than the more usual division between "social" and "natural." Once this is understood, it is clear that the "nonteleological" sciences forego, in principle, *any possibility of supernatural causation in their proper explanations, and hence leave no room for most interesting varieties of theism. If we take these sciences and their methods as constitutive of "naturalism," then it can be sharply demarcated from theism. However, if "teleological" sciences are taken seriously (e.g., biology!), then science and nonscience must be demarcated carefully, by appealing to the values inherent in good scientific explanations, rather than their rejection of teleology.*

The project of naturalizing epistemology can simply be defined as the attempt to make all knowledge scientific. For this attempt to succeed, it would seem that we need to know what counts as "scientific" and what does not. Hence, the so-called "demarcation problem" between science and nonscience looms large for naturalists. Notably, Karl Popper termed demarcation the "crucial problem of epistemology," and believed that his falsificationist methodology of "conjectures and refutations" did in fact solve the problem. But the last 15 years have seen a steady attack on the adequacy of Popper's falsificationist methodology for the project of demarcation. Philosophers such as Larry Laudan proclaim the de-

sufficient to render creationism tentative or revisable, testable, and falsifiable—and is exceedingly likely never to be falsified.[5]

For Ruse, an inquiry that explains by natural laws—or hopes to—is scientific, and whenever that inquiry (or any other) lapses from its commitment to law-like explanation, it becomes nonscience, and (hence?) "religious."

Ruse's rejoinder to Laudan first points out that the *legal* case against the Arkansas statute could not merely assert that creationism is weak science, because the teaching of bad science is not barred by the U.S. Constitution, and so the statute would not have been overturned. Instead, the court had to find that it was not science at all, and thus(?!) was religion. For plate tectonics, Ruse simply claims that geologists do not invoke "miracles" when they lack knowledge of the requisite laws of continental drift. To illustrate how his criteria supposedly work, Ruse suggests that transubstantiation fails all five criteria, whereas Mendelian genetics passes all five. Implicit in Ruse's claim appears to be something like the following: "mature" sciences are those with well-defined natural laws explaining the behavior of the objects in their domain, whereas "immature" sciences are those which have to issue a promissory note when asked for such laws governing the behavior of their domain. All science then either has natural laws that exhaustively describe the behavior of all objects in its domain, or is actively seeking such laws where it does not yet have them. And for Ruse, "natural" laws appear to be nonteleological—they cannot appeal to the purposes of an agent, lest creation be thought of as the law-like work of an Agent. So for Ruse, an inquiry that explains by natural laws—or hopes to—is scientific, and whenever that inquiry (or any other) lapses from its commitment to law-like explanation, it becomes nonscience, and (hence?) "religious."

Ensuing criticism finds that Ruse's criteria must be repudiated, for Laudan's reasons and more. First, the idea that nomological explanation is intrinsic to science (Criteria 1 and 2) has been abjured by several other notable philosophers of science. Nancy Cartwright articulates the view that laws are illicit idealizations and that scientific explanation is causal but not law-like.[6] Also, Bas van Fraassen in *Laws and Symmetry* has a chapter entitled "What if there are no laws? A manifesto" in which he argues that there is no reason to think that natural laws actually exist; science proceeds just fine if laws only exist in the mathematical models of nature that science constructs, and not in nature itself.[7]

Further, Laudan's criticism of falsifiability as a criterion is itself flawed, but not in a way that saves Ruse's construal. It so happens that the statement Laudan commends to the YEC as testable, revisable, and falsifiable ("I will abandon my views if we find a living specimen of a species intermediate between man and apes") is *prima facie* false in its very construction by the standards of contemporary cladistic taxonomy. Taxonomic methodology combines the thesis of common ancestry with the measurement of relative genetic chromosome sharing to determine the approximate date at which species diverged. Such methods are now thought to imply that humans should be considered a member of the "apes," because humans and chimpanzees are more closely related than chimpanzees and orangutans. In order to have a falsifiable, but not a falsified, statement, the creationist would need to say something more like: "I will abandon my views if we find a living specimen of a species intermediate between man and chimpanzees." Laudan's own advice to the creationist, if taken literally, would not save YEC from falsification!

How does all this bear on the possibility of demarcation? Ruse's criteria are clearly inadequate—Darwinian natural selection and other sciences fail some of these five criteria, even on a relatively undemanding construal. But that is a reason to reject these particular demarcation tests, not a reason to give up on demarcating science from nonscience entirely. To think there are no other alternatives is to commit a logical fallacy.

Ruse's real problem seems to be with the idea that evolutionary biology can countenance the workings of an Agent—God—as part of its proper explanations. The insistence on natural law may simply serve as a disguised form of rejecting all teleological explanations in science. This accords with one construal of methodological naturalism, one which holds that science does not allow final causes or agency as proper causal explanans in science. Accordingly, we thus need to move on to a consideration of the relationship of teleology in science, and particularly the role of teleology in evolutionary biology.

Teleology in Science—The Case of Biology

To evaluate a better means of demarcation, we first need to understand the role of teleology in science. A popular view (at least among natural scientists) of the ongoing "mechanization of the world-picture" takes science to have foresworn teleological causation entirely. Therefore, its attempts to explain phenomena in terms of the purposes of an agent are unscientific. Daniel Dennett represents a contemporary figure, who assiduously pursues this anti-teleological project. In his famous division into physical, design, and intentional stances of explanation, the last two stances have heuristic value (as "shortcuts"), but are in principle reducible to the physical stance.[8] The Churchlandian vision of the future, "neurophilosophy," in which we properly eschew beliefs, desires, and other related teleological notions, also serves as a reaffirmation of this project.[9]

Certainly, some sciences do appear to eschew teleology in their proper explanations—astronomy differs from astrology in this way, and geology nowadays rejects the ire of a goddess inhabiting a volcano as part of any proper explanation of an eruption. But there are reasons to believe that teleology is not eliminable from all of the endeavors which fall under the rubric of "science"—and so the first task will be to establish a demarcation principle *within* science. That is, we first need to demarcate the sciences that can eschew teleology in their proper explanations from those which find it necessary to invoke final causes. I will call this the distinction between the "teleological" and the "nonteleological" sciences. Now, which one is biology?

It is a vexed question in contemporary scholarship, for the apparent persistence of teleology in biology is noteworthy. As Stanford historian of biology Timothy Lenoir notes:

> Teleological thinking has been steadfastly resisted by modern biology. And yet, in nearly every area of research biologists are hard pressed to find language that does not impute purposiveness to living forms.[10]

But some of them try. One guiding assumption in contemporary neo-Darwinism, represented by Dawkins,[11] Papineau,[12] and Dennett,[13] is that the causal explanations of natural selection and adaptation are always retrospective. Fitness and functionality in biology thus become mere consequences of the vagaries of the course of natural selection—the only goal is to avoid extinction. The idea of evolving "to" something is rendered illegitimate—evolutionary appearances of "design" were undirected and purposeless, a view Dawkins memorably captured in the title of his book, *The Blind Watchmaker*. But this view runs the danger of collapsing fitness into a tautology—whatever is fittest is simply whatever survives. To introduce other criteria is to import a degree of positive teleological ordering and purpose into the course of evolution. Likewise, adaptationism becomes problematic—perhaps all adaptations are simply "just-so" stories, a view Gould calls Panglossian—so that we live in the best adapted of all possible worlds. If not, how else can this merely negative teleology explain the course of evolution, without any independent criterion of fitness? Dennett asks the crucial question about teleology for our purposes: "Does the macromolecule *really* want to replicate itself?"[14]

We first need to demarcate the sciences that can eschew teleology in their proper explanations from those which find it necessary to invoke final causes.

In short, the "modern synthesis" in evolutionary biology has problems with teleology. In the preface to his influential anthology on evolutionary biology, Sober writes of teleology:

> Functional claims of this sort have quite disappeared from physics. Whereas Aristotle thought the planets, no less than living things, have goals, this teleological conception of the world is now the relic of a bygone age. Planets move as they do because of the laws of motion; they do not act as they do for the good of anything.
>
> Darwin is rightly famous for having introduced an important materialist element into the science of life. Organisms are goal-directed systems because they have evolved. Their behaviors are suited to the tasks of survival and reproduction because natural selection has allowed some traits, but not others, to be passed from ancestors to descendants.[15]

Sober thus sees Darwin as "naturalizing" teleology by explaining it entirely in terms of natural selection. But how did any matter come to have the goals of survival and reproduction necessary to this naturalization of teleology? Can it really explain the complexity of life?

To address the problem of the origin of complexity is really to re-ask Dennett's question, "Does the

macromolecule *really* want to replicate itself?" Stuart Kauffman uses new aspects of chaos theory to answer "Yes ... accidentally." He believes in "order for free," that at a certain level of complexity, self-organization spontaneously takes place, much like a phase transition or symmetry breaking. Macromolecules randomly accreted for billions of years until they reached a certain level of order by accident. At that point, the principle of self-organization took over. They began to take steps to retain and perpetuate that self-organization—that is, they began to try to survive and replicate. Thus, evolution by natural selection began—and so, Kauffman believes, will occur anywhere a certain threshold of complexity has been reached, no matter how it happened.[16]

Thus, teleology is naturalized by spontaneously coming into existence at a threshold level of complexity. If this supposition is right, then the debate should be about the initial origin of complexity, and its likelihood—the type of work Kauffman does.[17]

Biology and Teleology—A Tentative Conclusion

So most contemporary, evolutionary biology attempts to "naturalize" away any teleology in biology, indicating that only negative teleology through natural selection exists. Problems for that account persist, however; Ruse's criteria fail in particular on the construal that only natural laws explain, and those laws must be nonteleological. But support for a Rusean position comes even from theists such as John Polkinghorne, who claims that science only answers "how" questions, never "why" questions—the latter being the province of theology.

Suppose, however, that the continuing need for functional explanation allows us to admit biology as a teleological science. Certainly humans, as biological objects, evince a positive teleology—we are agents, if anything is. What then for the demarcation of science from nonscience? The YEC claims biology is a teleological science, in which God, as understood through a pseudoliteral rendering of Genesis, is a divine Agent who created everything in six days some mere thousands of years ago. But the putative existence of positive teleology in evolutionary biology, and its explanation of ourselves as agents, may not need to invoke a divine Agent. Hence, the acceptance of teleology in biological science does not entail the scientific acceptability of any theistic perspective, much less YEC.

We need a diagnosis of the mistakes of both Ruse and YEC. Their falsely shared assumption appears to center on the equation of nonteleological explanations with scientific and atheistic ones, and likewise of teleological explanations with nonscientific and theistic claims. I hold instead that some teleological explanations are indeed scientific, so that we must demarcate science from nonscience in some other way. Hence, we need to develop other criteria for demarcation. In particular, I advocate the method of examining the *character* of the inquiry we term "scientific" to determine what counts as a science or not. I hope to show that certain virtues discovered in the course of history are necessary for an inquiry to be called science; but once discovered, they remain constitutive of the character of ideal scientific inquiry.[18]

Conclusion—How to Demarcate Science from Nonscience

A promising place to look for the enduring values of science is Kitcher, who agrees with Laudan's criticisms of Ruse's oversimplistic criteria, but does not thereby give up on demarcation. Kitcher claims that "successful science" has certain virtues which are missing in pseudoscience or nonscience.[19] In particular, a successful science has three apparently necessary virtues: (1) *Independent testability,* "achieved when it is possible to test auxiliary hypotheses independent of the particular cases for which they are introduced"; (2) *Unification,*"the result of applying a small family of problem-solving strategies to a broad class of cases"; and (3) *Fecundity,*"which grows out of incompleteness when a theory opens up new and profitable lines of investigation."[20] In fact, these virtues are not strictly logically necessary, but rather serve as benchmarks of how good a science is. A doctrine which fails to capture any of these, however, fails to be a science at all.[21]

Kitcher believes that these tests can cumulatively create a usable criterion of demarcation. He then argues that contemporary, evolutionary theory does pass most of these tests, whereas YEC does not. For example, biological fitness is explained in terms of survival to reproduction *under normal circumstances,* so that a positive teleology is built into evolutionary theory. As a result, Kitcher believes that biologists can "make independently testable claims about what gives the organisms in question whatever fitness they have."[22] So the independent testability of evolutionary theory is established, and fecundity is clear in the sense that modern genetics, molecular biology, and manifold other fruitful avenues of investigation have sprung from the fruits of Darwinism.[23] Further, testability and falsifiability are not quite the same thing; we need a complete world picture to gain

authentic falsifiability, whereas we need only partial falsifiability to test—we need only to specify a way in which the world "is not," a mode of existence which, if found out to be the case, would constitute a test failure. Evolutionary theory can and does pass such a test, whereas YEC cannot (if God tricks us) or does not—as the fossils and geological strata attest. Kitcher's criteria thus avoid the pitfalls of Ruse's naive falsificationism. Therefore, we need not think that all three (or more) criteria are necessary to be achieved in full for ascribing the status of "science" to a form of inquiry—rather, they cumulatively establish the character of the practice of science, without perhaps thinking of any of them as either necessary or sufficient conditions for science. We thus understand a proper demarcation between science and nonscience in terms of the character of scientific inquiry—and any practice that substantially violates that character (i.e., fails to progress over time in most or all of the values of science) can be judged as nonscience.

I conclude this examination of two demarcation principles—one within science, one between science and nonscience—by drawing some larger morals. First, arguing that teleology has its place in science does not somehow validate YEC. In fact, the evidence for teleology in biological explanation, and in particular the best explanation of human agency, actually speaks unequivocally against the truth of Bible-inspired fundamentalist creationism. Whatever the former status of YEC, Kitcher's criteria tell us, indubitably, that it is unscientific today. The "today" reminds us that our knowledge grows and progresses over time, and what was once a possible science may no longer be; for what we believe possible is always a function of what we already take for granted. Hence, we must acknowledge the historical boundedness of the scientific enterprise, and see science as irreducibly diachronic in its demarcation procedures. The strict creationists of pseudo-literalism[24] in Genesis propound a doctrine that we now know to be false, whether or not those in former times could know it so. Just as phlogiston theories were once science, but are no more—they are "merely" part of the history of science—so with YEC. Hence, anyone wishing to teach it now must have a religious purpose, and Judge Overton rightly saw it as such, even if his arguments were flawed.

On the other hand, if someone wishes to introduce ideas of teleology into biology and question the "naturalistic" reduction or elimination of Aristotle's final cause, then a great deal of empirical evidence is with them—not least ourselves as biological objects, the result of evolution. The burden of proof is clearly upon those who wish to say that all agency can be eliminated from evolutionary biology, not least because one product of evolution—*homo sapiens*—daily demonstrates such teleological power. That admission does not magically entail the truth of any robust version of theism, however.

Kitcher claims that "successful science" ... has three apparently necessary virtues ... that can cumulatively create a usable criterion of demarcation.

The historical nature of demarcation apparently requires that we give up attempts to completely characterize knowledge in synchronic fashion. But this ineluctable historicity should not blind us to the need for intersubjective causal and metaphysical constructs to anchor the objective success of science. We have seen that some possible causal talk is unscientific—it cannot pass the tests of fecundity and unification with what else we know. On such criteria, as Kitcher points out, YEC is not a science now, whatever its status in the distant past, for it now clearly violates many criteria which constitute good science.

What does this mean for the relationship of science to the rest of our knowledge—and for scientism? If an inquiry which intentionally violates the criteria becomes nonscience, does it thereby become nescience? That is the question of scientism. An adequate answer begins with the recognition that naturalism in philosophy normally claims methodological and axiological continuity with the sciences. If so, then naturalism and teleology must be compatible, for to have an axiology entails that one has goals or purposes. So any quick denial of teleology by philosophical naturalism seems far-fetched.[25]

As a result, I believe that the distinction between the teleological and nonteleological sciences remains a more profitable one than the usual methods of dividing the cognitive territories of the various sciences. The result is that any plausible naturalism which seeks to scientize philosophy must admit the legitimacy of teleology. But even if a methodological naturalism which eschews all teleology is implausible, the more difficult problem of assessing explicitly teleological versions of naturalism (scientism) remains. The naturalist's move at this point is to consider this a scientific question, and I favor that move in this context—but which science?

It is philosophy of science which determines the propriety of demarcation in science, and hence for the naturalist, philosophy of science will be a meta-science. Of course, philosophy of science also must be a teleological science, if it is a science at all. Philosophy of science is replete with talk of the aims or goals of science, as a human activity with human agents pursuing cognitive, epistemic, pragmatic, and other goals, both individual and collective. That foe of demarcation, Larry Laudan, explicitly divides inquiry along three axes—theoretical, methodological, and axiological. The last builds in goals or purposes—and so considerations of teleology—into a proper understanding of philosophy of science. Laudan's proclamation that science cannot be demarcated from other forms of inquiry, along with his naturalism, then entails that any rational inquiry would have goals as well. Rationality is thoroughly imbued with teleology, in his account.

But I demur with at least one premise here—that science cannot be demarcated from other forms of inquiry. Laudan's pragmatic axiology claims that science has no privileged aims, not even truth—and hence threatens to slip into relativism, for when any inquiry's legitimacy is relativized to the goals of that particular inquiry, cognitive relativism lurks nearby. While science does include teleology, that does not mean it includes any sort of inquiry with any possible set of purposes, willy-nilly. Instead, we need to find some fixed goals of science to determine the character of science, and how its character differs from the character of other forms of inquiry. In short, an accurate axiology of science will help us determine how to demarcate it from other practices of human inquiry. Kitcher's three apparently necessary criteria give us a start on that task, and much work on scientific axiology continues today. It is that work which will lead us to the truth about the proper aims of science, and how then to demarcate the enterprise we call science from other, less-reputable ways of understanding the world in which we live. ❖

Notes

[1]In the April 1997 issue of *Acts & Facts* from the ICR, Henry Morris prefers the terms "literal creationism" or "biblical creationism" to "young earth creationism." Since the point of such theories is to maintain that from a literal reading of Genesis the earth is merely a few thousand years old, I will maintain the more common usage of YEC.

[2]*McLean v. Arkansas*, opinion by Judge Overton, section IV(C), reprinted in Michael Ruse, ed., *But Is It Science?* (Buffalo: Prometheus, 1988), 318.

[3]Larry Laudan, "Science at the Bar—Causes for Concern," in Michael Ruse, ed. *But Is It Science?* (Buffalo: Prometheus, 1988).

[4]Ibid. Laudan reminds us that science often purports to explain the existence of a phenomenon before a fully law-like account is available. Newton's gravity had this problem, as was pointed out, to little avail, by George Berkeley; only with the advent of general relativity is gravitation "explained," and even that is subject to change, e.g., if Penrose's "tensor" theory or superstring theory was to be accepted.

[5]Philip Quinn, "The Philosopher of Science as Expert Witness," in *Science and Reality*, eds. Cushing, Gutting, and Delaney (Notre Dame, IN: University of Notre Dame Press, 1984), 378. In a further criticism of these three criteria as demarcating science from nonscience, Quinn notes that tentativeness is a psychological, rather than epistemic, condition on a state of belief—the ferocity (or lack thereof) with which a proposition is maintained is usually assumed to have nothing at all to do with its truth-status. Hence, only falsifiability and testability are potentially legitimate criteria—and YEC can meet them.

[6]In Nancy Cartwright, *How the Laws of Physics Lie* (Oxford: Oxford University Press, 1983) and Nancy Cartwright, *Nature's Capacities and Their Measurement* (Oxford: Clarendon Press, 1989).

[7]Bas van Frassen, *Laws and Symmetry* (Oxford: Clarendon Press, 1989). Although neither van Fraassen nor Cartwright's denial of the need for laws has yet earned a universal consensus, they are both extremely influential figures in the field. Also, the very idea that there exists some atemporal set of essential characteristics of science has come under increasing attack; if true, this would invalidate Ruse's entire procedure of attack upon creationism, which depends upon identifying criteria that are necessary (if not sufficient) for identifying a subject as a science.

[8]Daniel Dennett, *Darwin's Dangerous Idea* (New York: Simon and Schuster, 1995) is (among other things) a book-length attempt to defend the reduction of all apparent teleology into the negative purposes of natural selection.

[9]Paul Churchland, *The Engine of Reason, The Seat of the Soul* (Cambridge, MA: MIT Press, 1995).

[10]Timothy Lenoir, *The Strategy of Life* (Chicago: University of Chicago Press, 1989), preface, ix.

[11]Richard Dawkins, *The Blind Watchmaker* (New York: Norton, 1986). Dawkins attempts to naturalize teleology by explicitly rejecting the argument of the impossibility of speciation through gradual change. He does so by distinguishing between single-step selection and "cumulative selection." Dawkins sees selection over many generations as rendering probable what we would otherwise naively regard as improbable, because death makes evolutionary change nonrandom—it pushes such change in the direction of overall enhanced fitness. It was Darwin's genius, on this view, to provide the mechanism of selection as a naturalistic means for generating the complexity of living things. Fitness is naturalized, yet evolution is given a *telos*—that is, a nonrandom direction. That *telos*, however, is nothing more than avoiding death and reproducing. Dawkins thus ascribes what I term a "negative teleology" to cumulative natural selection—fitness consists in avoiding death, at least long enough to reproduce. That is the sole positive purpose of the otherwise random and blind process; no further purpose can be gleaned.

[12]David Papineau, "Biology, philosophical problems of," entry in *The Oxford Companion to Philosophy*, ed. Honderich

(New York: Oxford UP, 1995), elaborates: "Most contemporary philosophers of biology now hold that functional explanations in biology are now disguised *causal* explanations, which explain biological traits not by looking forward to *future beneficial* results, but by looking backwards to the *past* evolutionary histories in which such results led to the natural selection of the traits in question" (p. 94).

[13]Daniel Dennett, *Kinds of Minds* (New York: Basic Books, 1996), 27–28. Perhaps Dennett better explains what is at stake: he reiterates his longstanding threefold division between the physical, design, and intentional stances of explanation. The crucial difference between the latter two and the physical stance can be summed up in one word: teleology. The latter two stances, and particularly the intentional stance, take the attempt to look forward to some particular goal (and the attempt to realize it) as the proper method of explanation. Dennett writes: "The intentional stance is the strategy of interpreting the behavior of an entity ... by treating it *as if* it were a rational agent who governed its 'choice' of 'action' by a 'consideration' of its 'beliefs' and desires" (p. 27). Dennett italicizes the "as if" to demonstrate his intentional stance antirealism. He is at pains to show that as a heuristic, the intentional stance can provide explanatory shortcuts for phenomena ranging from the behavior of alarm clocks to chess playing programs to ... Life (and not just the game!). But is it merely a heuristic?

[14]Ibid., 27.

[15]Elliot Sober, ed., *Conceptual Issues in Evolutionary Biology*, 2d ed. (Cambridge, MA: MIT Press, 1994), preface.

[16]Stuart Kauffman, *At Home in the Universe* (New York: Oxford University Press, 1995).

[17]There are critics. For example, Michael Behe ("Molecular Machines: Experimental Suppport for the Design Inference," paper presented to the C. S. Lewis Society, 1994) disagrees about the antecedent likelihood of complexity of the proper type spontaneously arising. He argues that irreducible complexity exists in the biological realm and can only be explained by intelligent design.

[18]Theologically speaking, this position is related to views I have on progressive revelation, developed in my *Experimental Philosophy of Science*, unpublished.

[19]Philip Kitcher, *Abusing Science* (Cambridge, MA: MIT Press, 1982), 45.

[20]Ibid., 48.

[21]Ibid. Kitcher in effect applies an erotetic test, listing a series of significant questions for the methodology and axiology of a science:

> Do the doctrine's problem-solving strategies encounter recurrent difficulties in a significant range of cases? Are the problem-solving strategies an opportunistic collection of unmotivated and unrelated methods? Does the doctrine have too cozy a relationship with auxiliary hypotheses, applying its strategies with claims that can be tested only in their applications? Does the doctrine refuse to follow up on unresolved problems, dismissing them as "exceptional cases?" Does the doctrine restrict the domain of its methods, forswearing excursions into new areas of investigation where embarrassing questions might arise? If all, or many, of these tests are positive, then the doctrine is not a poor scientific theory. It is not a scientific theory at all (pp. 48–49).

[22]Ibid., 59.

[23]Here the tautology objection is taken on by explaining fitness in terms of the expected reproductive success of an organism, as opposed to its actual reproductive success; that "expected" success is explicable only by reference to its genetic makeup, not its phenotype. Hence, a teleological element is inescapably built into a proper understanding of fitness—it must understand fitness in terms of the proper function of a particular genotype, or its fitness for a particular ecological niche, for survival to reproduction *under normal circumstances*. This "forward-looking" definition of fitness erases the problem of tautology, at the cost of having a robust teleology in biology.

[24]Pseudoliteralism, because scholars have reason to doubt that a literal rendering of the original Hebrew of Genesis 1 indicates a strictly *ex nihilo* creation (more probably, Yahweh is seen as inducing structure upon a previously formless "stuff"), and even more importantly, the literary genre of Genesis 1, a type of poetic parallelism, indicates a "literal" reading of a 6-day creation would be as mistaken as believing a myocardial infarction had taken place when a poet says "my heart is broken."

[25]This is especially true (as I hope I have shown) if evolutionary biology is a crucial science for naturalism (as Philip Kitcher, "The Naturalists Return," *Philosophical Review*, 101 [1992]: 53–114; Philip Kitcher, *The Advancement of Science* [New York: Oxford University Press, 1993]; and Alex Rosenberg, "A Field Guide to Recent Species of Naturalism," *British Journal for the Philosophy of Science* 47 [1996]: 1–29 maintain). In any case, certain other disciplines crucial to naturalistic projects, such as history (Kitcher, "The Naturalists Return"; Larry Laudan, *Science and Relativism* [Chicago: University of Chicago Press, 1990]; et al.) and psychology (Kitcher, "The Naturalists Return") do ineluctably involve teleology, unless a Churchlandian "neurophilosophy" eventually replaces all teleological talk as fundamentally mistaken.

Darwinian Naturalism, Theism, and Biological Design

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Naturalists frequently suggest that the imperfection *found in living things is clear evidence that organisms are the products of natural processes* rather than *the products of intelligent design. I challenge this "Imperfection Argument" by identifying and evaluating the presuppositions upon which it depends. Although the naturalist's argument is shown to be unsound, this does not vindicate the intelligent design position. I suggest that it is unlikely that the issue of biological design will serve the agendas of either naturalists or theists, and consequently that a healthy dose of humility concerning this issue is perhaps the true mark of wisdom.*

> Natural selection will not produce absolute perfection, nor do we always meet, as far as we can judge, with this high standard under nature ... The wonder indeed is, on the theory of natural selection, that more cases of the want of absolute perfection have not been detected (Charles Darwin, *The Origin of Species*, Chapter VI).

The issue of "biological design" has long been at the center of the debate between naturalists and theists.[2] A traditional natural theological argument for the existence and attributes of a deity took the remarkable *design* evident in living things as its starting point.[3] Such design was interpreted as unmistakable evidence for an intelligent, purposeful designer. It was argued that such design could *only* be explained by appeal to a divine designer. However, since Darwin's work in the mid-nineteenth century and subsequent work in this century, naturalists have been in a much stronger position to argue that natural processes alone are, in principle, adequate to account for the designed appearance of living things.[4] They argue that it is no longer *necessary* to appeal to an intelligent designer to account for the apparent design of living things. At the very least, Darwin's theory shows how such design *could* come about through nonintelligent, nonpurposeful processes. That is, Darwin showed how such an explanation of biological design is *possibly* true. But, as theists will rightly point out, this, at most, shows that a theistic account of biological design is not *required*. It does not establish the stronger claim that a theistic account of biological design is *false*, much less that theism itself is false. Consequently, theists are free to agree that natural processes operating without foresight are adequate to explain biological design, but they may also insist that theism provides another explanation, equally rational and plausible.

At this point the debate seems to be at a standoff. Biological design can, in principle, be explained in either naturalistic or theistic terms. Pressing the issue, the naturalist can make a distinction between *good* and *poor* biological design. While acknowledging that instances of *good* biological design can be equally well explained in terms of both naturalism and theism, the naturalist notes that there are *other* cases of *poor* biological design that cannot be so easily accounted for on theistic principles. For example, the naturalist can point out that in addition to the stunning instances of marvelous adaptations that seem to perfectly fit organisms for their ways of life, there are also undeniable instances of very poorly designed biological systems, of what Richard Dawkins calls "botched jobs." These observations form the basis for a powerful criticism of theistic accounts of biological design, and, by implication, of theism itself.

Biological imperfections are unbecoming to a divine designer. A designer with complete knowledge and unlimited power would surely come up with something better than these manifestly inferior products. Since such imperfections pervade nature (and are much easier to detect once one has abandoned the view that, appearances aside, all biological structures *must* be perfect because they are God's handiwork), the belief that an intelligent designer is responsible for living things becomes progressively less plausible. At the same time, however, naturalists have a plausible explanation for why one finds instances of both extreme perfection of design *and* of what appear to be less than optimal designs from an engineering point of view. Because naturalism can explain both perfection and imperfection of biological design, but theism stumbles on the problem of biological imperfection, it appears that naturalism is poised to defeat theism as an explanation for the nature of living things. Living things provide no *positive* evidence for an intelligent designer, and a careful examination of living things actually provides evidence *against* the existence of an intelligent designer. In short, while biological imperfection constitutes a logical deduction from naturalist principles, it constitutes a remarkable *prima facie* defeater for theism.

My aim in this paper is to examine this argument more carefully. Is it really true that Darwinian naturalism provides a superior explanation of biological imperfection than theism? To answer this question one must address several logically prior questions: On what grounds can we assess claims about goodness of biological design? In what sense might biological systems be described as "perfect" or "imperfect?" How do naturalists go about explaining both perfection and imperfection of biological design? Are instances of biological imperfection really defeaters (*prima facie* or otherwise) for theism? Finally, at the end of the day, what implications (if any) follow from the fact of biological imperfection for the naturalist/theist debate?

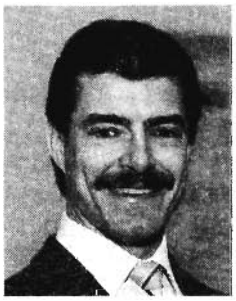
The Argument from Imperfection

The "Imperfection Argument" sketched above appears in the popular writings of biologists with remarkable regularity. Probably the most famous contemporary statement of the argument is Stephen Jay Gould's essay, "The Panda's Thumb."[5] Gould argues that the "panda's thumb," which is an elongation of the radial sesamoid bone in the wrist, is a "funny solution" to the problem of stripping the bark from bamboo shoots. Thus, he claims that it clearly shows its origin via contingent, historically constrained, natural processes, rather than as the product of an intelligent designer. As Paul Nelson notes, this argument is a favorite of Gould's, appearing repeatedly in his writings.[6] Gould makes the central point of such examples clear:

> If God had designed a beautiful machine to reflect his wisdom and power, surely he would not have used a collection of parts generally fashioned for other purposes.... Odd arrangements and funny solutions are the proof of evolution—paths that a sensible God would never tread but that a natural process, constrained by history, follows perforce.[7]

Despite the rhetorical power of this example, Gould's "panda's thumb" argument suffers from the fact that it is far from clear that the so-called panda's thumb is really such a "funny solution" as he supposes. There is good evidence that this structure suits the panda's mode of life admirably, and might better be thought of as a marvelous adaptation—e.g., an instance of *good* biological design.[8] To make the naturalist's argument against intelligent design as strong as possible, we need to focus on more clear-cut instances of biological imperfection.

Richard Dawkins provides the types of examples we need, namely, examples of "outright imperfections in ... design."[9] The first example concerns "flatfish" (e.g., halibut, sole, plaice). These are bony fish that, instead of swimming in a "vertical" position like most bony fish, lie on their *side* on the ocean



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bottom and swim in this essentially horizontal position. The problem with this arrangement is that when a typical fish takes to lying on its side on the ocean bottom, one eye will always be staring down into the sand—making the eye effectively useless. Flatfish have "compensated" for this weakness by undergoing a developmental process in which the lower eye moves around to the upper side of the fish. Juvenile flatfish start life swimming near the surface in the usual vertical position for bony fishes. But then a developmental process begins in which "the skull starts to grow in a strange, asymmetrical, twisted fashion, so that one eye, for instance the left, moves over the top of the head to end up on the other side. The young fish settles on the bottom, both its eyes looking upwards, a strange Picasso-like vision."[10]

The second example also concerns eyes—in this case, vertebrate eyes. All vertebrate retinas are covered with "photocells" (rods and cones) leading to "wires" (nerves) which eventually converge in the optic nerve. The optic nerve carries signals to the visual processing centers in the brain. So far so good. But Dawkins then notes that:

> Any engineer would naturally assume that the photocells would point toward the light, with their wires leading backwards towards the brain. He would laugh at any suggestion that the photocells might point away from the light, with their wires departing on the side *nearest* the light. Yet this is exactly what happens in all vertebrate retinas. Each photocell is, in effect, wired in backwards, with its wire sticking out on the side nearest the light. The wire has to travel over the surface of the retina, to a point where it dives through a hole in the retina (the so-called "blind spot") to join the optic nerve. This means that light, instead of being granted an unrestricted passage to the photocells, has to pass through a forest of connecting wires, presumably suffering at least some attenuation and distortion ...[11]

Dawkins mentions that the attenuation and distortion caused by the backwards wiring of the photocells may not be very great, "but, still, it is the *principle* of the thing that would offend any tidy-minded engineer!"[12]

I selected these two examples because each clearly involves design which is less than optimal from an engineering perspective, and because in each case, Dawkins wants to draw the conclusion that such poor design is difficult to explain on the assumption that living things have been designed by an intelligent designer. The contrast is clearly between creation by an intelligent designer and production by unintelligent natural processes. As Dawkins notes: "Evolution can sometimes be more strongly supported by evidence of telling imperfections than by evidence of perfection."[13] If Dawkins truly wants to explain "why the evidence of evolution reveals a universe without design" (the subtitle of his book, *The Blind Watchmaker*), then by "evolution" here, he must mean more than just descent with modification. Evolution has to mean descent with modification without any type of intelligent design or guidance involved in any way. According to Dawkins, the theist is faced with a serious problem if things like flatfish were designed by an intelligent designer. He notes:

> The whole skull of a bony flatfish retains the twisted and distorted evidence of its origins. Its very imperfection is powerful testimony of its ancient history, a history of step-by-step change *rather than of deliberate design*. No sensible designer would have conceived such a monstrosity if given a free hand to create a flatfish on a clean drawing board.[14]

With these examples in mind, we can now state the Imperfection Argument more clearly as follows:

The Imperfection Argument

P1: For any property p of a biological entity, p is the product either of a wise and powerful designer, *or* of unintelligent, historically constrained, natural processes (e.g., natural selection).

P2: If p is the product of a wise and powerful designer, then p should be perfect.

P3: p is not perfect.

C: Therefore, p is not a product of a wise and powerful designer, but came about by unintelligent, historically constrained, natural processes.

The imperfection argument underlies the claims associated with the two examples described above. It is undeniable that such examples have great persuasive force. But our question here is whether we *ought* to be swayed by them. Is the Imperfection Argument sound? Should one accept its conclusion based on its premises? Are the premises themselves true?

The Imperfection Argument Examined

Mutually Exclusive Alternatives?

Consider the first premise. P1 assumes that creation by an intelligent designer and production by natural processes are mutually exclusive possibilities. Yet many theists will be happy to admit that living things may have at least some properties because of unintelligent, historically constrained, natu-

ral processes. That is, theists are free to suppose that God instituted the physical and biological laws that govern the evolutionary process, and then gave the actual working out of evolution relatively free reign. God would then be directly responsible for "setting up" the process of evolution, but only indirectly responsible for the specific products subsequently produced. As Loren Haarsma points out:

> Proponents of evolutionism frequently argue that biological life could not have been intelligently designed because it shows many examples of "flawed design," such as the blind spot in the human eye. But surely this is just a divine example of the straw-man argument. It ignores the option that the Creator might design an entire evolutionary system and choose to work through natural processes and "chance" events to produce the desired results—even if certain details appear as minor flaws.[15]

Therefore, theists are free to argue that God chose to create the present biota of the earth through natural laws (progressive creation). They can argue that the Darwinian explanation of biological perfection and imperfection may be essentially correct, while rejecting the naturalist assumption that the entire process proceeds without the instigation of an intelligent designer. Creation through such "secondary causes" might even be considered more becoming to the divine wisdom—a view that Darwin drew attention to in the *Origin*.[16] He states elsewhere in the *Origin* that "All corporeal endowments" may be *progressing* toward perfection without yet *being* perfect. Present biological imperfection is compatible with ultimate biological perfection.

[Theists] can argue that the Darwinian explanation of biological perfection and imperfection may be ... correct, while rejecting the naturalist assumption that the entire process proceeds without the instigation of an intelligent designer.

Why, then, might someone suppose that there are mutually exclusive alternatives of the sort assumed in P1? We can, of course, revise P1 so that it *does* state mutually exclusive alternatives.

P1′: For any property p, of a biological entity, p is either the *direct* product of a wise and powerful designer, *or* of unintelligent, historically constrained natural processes (e.g., natural selection), but not of both.

Reformulating P1 in this fashion *does* present mutually exclusive alternatives. However, this formulation cannot be used in an argument against theism, but only against the considerably more narrow position that asserts that living things were originally created in something like their present form. While some theists *do* hold this view, it is not identical with, nor a logical consequence of, theism as defined earlier. As it stands, therefore, P1 describes a false dichotomy, and consequently ought to be rejected.

What Should We Expect from a Divine Designer?

Consider the second premise. According to P2, if a given property of a biological entity is the product of a wise and powerful designer, then that property should be perfect. What *reasons* might be offered in support of this claim? In particular, what property or set of properties of God's nature entails that everything he creates must be perfect? P2 presupposes that a divine designer would only want to produce organisms that lack the kinds of imperfections identified above. But this assumption is open to question. Theists *already* believe that God created the world. None believe that every aspect of the world is perfect. Created things—it might be argued—are, in virtue of being created, necessarily limited and imperfect. The imperfection of biological things would not then be a *distinct* problem requiring special explanation. Any argument that assumes that God, being perfect, could only create perfect entities, rests on the dubious idea that a perfect being could only *want* to create other perfect beings. There is, of course, no reason to assume this. It has the undesirable consequence of making God far more *limited* than the intelligent creatures, which theists believe he created. There is no obvious necessary connection between the perfection of a Creator and the perfection of that which he creates. While we might expect a good Creator to create at least some "good" creatures, nothing about the goodness of God entails that he should create *only* perfect creatures. P2 is thus entirely without support.

"Perfect Design"

Finally, we must consider the claim that a given property of a biological entity is not perfect (i.e., P3). Naturalists, like Dawkins, point out that instances of contraptions and contrivances—imperfections of design—are just what one would expect from the Blind Watchmaker, natural selection. The implication is that one would expect much better from a divine designer. But how much better? Just a little better? This seems arbitrary. For each little bit better

designed an organism is, one could then ask why it was not just a bit better designed than *that*. The only non-arbitrary degree of goodness of design is perfection itself. Why think that this is even *possible*? Is the notion of a perfectly designed organism a coherent idea?

Proponents of the Imperfection Argument claim that imperfection among the properties of living things is a powerful argument* against *theism and* in support of *some type of naturalistic account of evolution.

"Perfect design" is simply the limit notion of *good* design. Examples of *good* biological design are a dime a dozen. Dawkins discusses bat sonar as an example of good design, and once one becomes familiar with the astounding details of this example, it is hard to think of a better example of well-designed functional complexity. There are, however, better examples of biological *perfection*, i.e., cases where it is difficult to imagine a *superior* solution to a particular problem. The best examples come from cases of mimicry in which one species (typically harmless) mimics another (typically poisonous or toxic). Examples of protective mimicry include the (tasty) Viceroy butterfly that mimics the (toxic) Monarch butterfly, nonvenomous snakes that mimic in their coloration highly venomous snakes, and (nonstinging) flies that closely resemble honeybees. Other examples come from protective camouflage, for example, stick insects and leaf insects that closely resemble the foliage they live on, larva of swallowtail butterflies that resemble bird droppings, etc.[17] In each case, there is a "model" and a "mimic." To the extent that the mimic is indistinguishable to predators from the model, to that extent the mimic is "perfect." In these cases, we seem to have a clear-cut—and even operationally useful—notion of biological perfection. While such organisms are presumably less than perfect in other respects, in the limited domain of mimicry, such organisms could not be improved upon.

When we consider whole organisms, however, things are very much different. What sorts of characteristics would a perfect organism have? Using standard measures of adaptedness, we would have to say that a perfect organism is one that lives forever, converts all of its energy consumption into reproductive activities, produces viable offspring at an infinite rate, moves through the environment with zero friction, is impervious to enemies or predators, can hear all frequencies of sound waves, see all wavelengths of electromagnetic radiation, etc. The idea of such an organism existing is, of course, absurd. It is not even a *possible* organism. As Maynard Smith notes, in thinking about the perfection of biological systems, it becomes clear that specifying the range of possible phenotypes becomes crucial.[18] The problem here is that we have no way of knowing what this range is. Moreover, it is not clear that the concept of a "perfect organism" is compatible with biodiversity. Perhaps, at most, *one* truly perfect phenotype is possible. In this case, biological perfection could only be achieved at the expense of the wide variety of kinds of life forms that we do find.[19] Local perfection could be achieved only at the expense of global perfection. The crucial point here is that we are in no position to know whether such global considerations are relevant or not. Consequently, we are in no position to conclude that it is unbecoming of a divine designer to design less than perfect organisms.

Naturalism and Biological Imperfection

Naturalist Explanations of Biological Imperfection

The analysis of the Imperfection Argument above suggests that it is wanting in several important respects. There is also a second, related issue concerning this argument that we have not yet examined. Proponents of the Imperfection Argument claim that imperfection among the properties of living things is a powerful argument *against* theism and *in support of* some type of naturalistic account of evolution. The claims of Gould and Dawkins given earlier only make sense if some type of naturalistic account of evolution provides a more adequate account of biological design than is available on theistic grounds.

Consider again the case of the flatfish, which was supposed to be a *prima facie* defeater for theism. The naturalist can explain this imperfection, at least in principle. According to Dawkins, when the free-swimming, vertically oriented ancestors of flatfish originally took to bottom dwelling, it was better off lying on its side than balancing precariously on its knife edge of a belly. Would-be intermediates between these ancestors and present-day flatfish that attempted this balancing act did worse in the short term than their more stable, bottom-hugging (side-lying) rivals. Dawkins speculates that in genetic hyperspace there is a smooth trajectory connecting these free-swimming, ancestral bony fish to contemporary flatfish lying on their sides with twisted

skulls. On the other hand, there was no smooth trajectory connecting these ancestors to (possible but unactualized) bony fish flattened horizontally.

Turning to his other example of biological imperfection, Dawkins admits that he doesn't know the exact explanation for why the vertebrate eye is structured as it is. But he is willing to bet that it had something to do with the trajectory through genetic hyperspace that would have to be traversed in order to turn the retina the right way around, once it had *already* started in the wrong direction. The idea is that some primitive ancestor to contemporary vertebrates acquired a light-sensitive photocell, and the "wires" from it just happened to be coming out the wrong side. But because this proved more advantageous than not having a functioning photocell at all, it provided some survival advantage for its possessor. Once this advantage was in place, any step backwards, for example, toward no functioning photocell at all, would have been selected against. So the process continued to build on its initial advantageous, but deeply flawed, beginning, eventually resulting in the highly useful, but functionally ill-conceived, vertebrate eyes of today. Initial contingency coupled with selective pressures drove the process of eye-building further along the path to contemporary vertebrate eyes. With each step along the way, it became progressively more difficult to go back and rewire the eyes in the functionally superior way. Selection can continue to improve the vertebrate eye in the future, but it is unlikely to undertake a fundamental overhaul of its basic design features, flawed though they are.

Assessing the Naturalist's Explanation of Biological Imperfection

One problem with Dawkins' argument concerning flatfish in terms of trajectories through genetic hyperspace is that he admits that there are *some* bony fish that *have* evolved flatness in a symmetrical, skate-like way. So, for at least *some* ancestral bony fish, there was an open trajectory from the ancestral, vertically-flattened structure to the contemporary, horizontally-flattened structure. Dawkins offers the suggestion that perhaps the ancestors of these latter fish "were already slightly flattened for some other reason."[20] Yes, perhaps. But if symmetrical flattening was possible for some bony fish, why wasn't it possible (or if it was possible, why wasn't it actualized) for others? Given the "probably costly distortions involved in having two eyes on one side," presumably selection would have favored the symmetrical over the asymmetrical design.[21] The only way to explain why the best design was realized in the one case but not in the other is to appeal to the contingency of initial conditions and the irreversible nature of selection-driven evolution once it has gotten underway. In other words, the explanation is entirely conjectural.

The Darwinian naturalist can only appeal to unknown, but possible,* contingent events *to explain why certain coordinates in design space have been occupied, while others remain vacant.

A similar type of problem attends the other example of biological imperfection Dawkins discusses. If some invertebrate eyes are wired the right way, then it is not clear why vertebrate eyes couldn't be wired the right way too. Granted that initial contingent events started things in the wrong direction, why couldn't these useful, but flawed, designs have been usurped by creatures with even more useful, properly designed eyes? A keystone of Dawkins' argument is that every slight improvement in any biological structure is enough to make it visible to selection, and hence selected. All it would have taken for properly-wired, vertebrate eyes to be the norm now would be for there to have been a few properly wired prototypes around when the actual vertebrate ancestors got their start. This does not seem *a priori* impossible. Yet Dawkins has to suppose that there were no well-designed competitors around, or if there were, that for some reason they did not usurp their poorly-designed cousins. Ultimately, therefore, the Darwinian naturalist can only appeal to unknown, but possible, *contingent events* to explain why certain coordinates in design space have been occupied, while others remain vacant.

Perfection, Imperfection, and Contingency

When we combine reflections on the two examples of biological imperfection Dawkins gives, the problems I have been noting become more acute. Just as we can compare "flawed" vertebrate eyes with the well-designed eyes of some invertebrates, so too we can compare the "flawed" morphological design of flatfish both with the superior morphological design of normal (vertically oriented) bony fish and with the horizontally flattened, but symmetrical, cartilaginous rays. If some shark-like ancestors could become flattened horizontally and remain symmetrical, why couldn't the bony ancestors of flatfish have accomplished the same thing? Granted, there may be differences between verte-

brates and invertebrates on the one hand, and bony fish and cartilaginous fish on the other, but it is still not clear why these differences could not be breached. In the case of the vertebrate eye, Dawkins tells us that once the eye was wired the "wrong" way, it became impossible (or at least extremely difficult) for natural selection to reorient the photocells in the right direction. On the other hand, in the case of the flatfish, there is an obvious biological imperfection (one eye staring down into the sand, and therefore effectively useless) that is "corrected" by juvenile flatfish undergoing a developmental process that moves the sandward-looking eye around to the top surface of the fish. If this developmental process is possible (which, being actual, it is), then why couldn't the same sort of process work for the photocells of the vertebrate eye? Both involve simply rotating and reorienting a structure, not dismantling it and starting over. In the occurrence of the photocells, one could imagine a smooth trajectory through design space in which the photocells, instead of facing directly backwards, face 10° to the side. Since the nerves would now occlude less of their light-oriented surface, there would be a slight (but perhaps significant) improvement in visual power. Another 10% rotation would produce additional improvements, etc., until the photocells were all facing in exactly the right direction (i.e., toward incoming photons). No saltations are required and no radical restructuring of the design of the eye is necessary, only a gradual, incremental reorientation of photocells in the direction of greater efficiency. Again, if such a process has occurred in flatfish with respect to the entire eye (and with corresponding changes in the skull), why not in the photocells of these very same eyes?

Darwinian naturalists acknowledge both the extreme perfection of some organic structures and the obvious imperfection of others, and explain both in terms of natural selection operating on initial contingency.

There thus seems to be a curious tension at the center of Darwinian naturalism. On the one hand, Darwinian naturalists are fond of stressing the power of natural selection to produce the extreme adaptedness and the virtual perfection of the structural and functional properties of living things. Unlike their natural theologian forbears, however, they wish to insist that such perfection come about without assistance from any kind of divine mind orchestrating this process. According to the Darwinian naturalist, the entirely opportunistic process of natural selection has the power to shape organisms to an almost unimaginable degree of perfection. On the other hand, one of the commonest and most persuasive arguments used by Darwinian naturalists against the hypothesis of special creation or divine control of the evolutionary process starts from recognition of the all-too-common instances of imperfection to be found in the living world, instances which suggest a more haphazard evolution of organic structures, one unbecoming the technical skills possessed by an intelligent divine designer. Consequently, Darwinian naturalists acknowledge both the extreme perfection of some organic structures and the obvious imperfection of others, and explain both in terms of natural selection operating on initial contingency. Is this a consistent position?

Conclusions: Theism and Naturalism as Explanations of Biological Design

As far as I can see, there is no *inconsistency* in the naturalist's explanation of perfection and imperfection in biological design. It is true that such explanations are frequently "speculative," but if we are only concerned with the issue of consistency, showing that something is *possible* is sufficient. Worries arise when one considers *justification* for the largely *post hoc* nature of naturalistic explanations of particular instances of good and poor biological design. It is far easier to explain instances of each in terms of postulated initial conditions and constraints than it is to identify the particular conditions and constraints operating in specific cases. Indeed, it may be impossible to do this in most cases.

Theists may be eager to exploit this weakness of naturalism, but here I believe that they should tread carefully. It is true that the Darwinian naturalist is forced to resort to speculative explanations for biological design, but it should not be thought that this fact in any way elevates the theistic position to a point above that of the naturalist.[22] Both must ultimately concede that there are *limits* to our present ability to account for some of the most striking features of the natural world. While the Darwinian naturalist can give a theoretically sophisticated and empirically rich account of why certain aspects of the world are the way they are, the theist can either (1) accept the Darwinian explanation, but insist that the naturalistic metaphysics often presupposed by Darwinians are mistaken, or (2) reject Darwinian explanations in favor of some type of direct creation model. In either case, the theist, no less than the

naturalist, is forced to resort to speculative hypotheses about why things are the way they are. Whereas the naturalist must appeal to contingency and historical constraints, the theist must appeal to God's voluntary actions. Since both theists and naturalists eventually come face-to-face with untrespassable epistemic limits, they may be closer to one another on the issue of explaining biological design than it at first appears.

[Naturalists and theists] must ultimately concede that there are **limits** *to our present ability to account for some of the most striking features of the natural world.*

In summary, while there is no *inconsistency* in the Darwinian naturalist explanation of biological design that can be exploited by theists, at the same time, the naturalist argument that imperfection of biological design refutes the theistic viewpoint is seen to be unsound. It therefore seems unlikely that the naturalism/theism debate will be resolved on the battlefield of biology. Darwinism did mark the end of the superior epistemic position occupied by theism *vis-à-vis* naturalism. As Dawkins remarks, before Darwin it was impossible to be an intellectually fulfilled atheist. Even Hume, who in other respects seems to have had little use for God, found it necessary in his *Dialogues Concerning Natural Religion* to admit that something akin to Mind is responsible for the order of the world.[23] Before Darwin, it was very difficult to believe that the order of nature could have arisen through purely natural processes. After Darwin, this became much more credible. It became a rational cognitive option. So Darwinism did have some effect on what it was and is rational to believe. In effect what Darwinism did was to level the playing field. Naturalism and theism became two almost evenly matched players on the intellectual field. It is hard to see how either could now displace the other. Both are logically compatible with the empirical evidence we have at our disposal, and with any evidence we are likely to encounter through additional scientific investigation.[24] There is, of course, a natural human tendency to take sides and seek intellectual closure. Sometimes such closure can be attained honestly; at other times, it cannot. A frank confession of our uncertainty here may be the mark of wisdom. ❖

Notes

[1]This article is a revised version of a paper presented at a conference on "Naturalism, Theism, and the Scientific Enterprise," University of Texas at Austin, February 20–23, 1997. I thank the participants in this conference, and my colleague James Hanink, for helpful comments on an earlier draft of this paper. I also thank Rob Koons for organizing this splendid conference.

[2]By "theism" I mean the position that affirms that there is an all-powerful, wholly good, and all-knowing Person who is distinct from the natural world. "Naturalism" (or "Ontological Naturalism," as distinct from "Methodological Naturalism") is the position that holds that the natural world comprises the whole of reality (and thus excludes the sort of Being affirmed by theism). By "design" I mean the manifest functional complexity of living things, without meaning to beg the question about whether such "design" is the product of an intelligent designer or unintelligent, unconscious natural processes. Although naturalists may wish to talk of "apparent design" to avoid attributing intentionality to the source or cause of functional complexity, for simplicity I will continue to speak of "design" in the sense defined above.

[3]This tradition perhaps reached its zenith in William Paley's *Natural Theology* (London: Rivington, 1802).

[4]That natural processes *are* in fact (and not just in principle) adequate to explain functional biological complexity has not, of course, been universally accepted. For recent dissenting views, see J. P. Moreland (ed.), *The Creation Hypothesis: Scientific Evidence of an Intelligent Designer* (Downers Grove, IL: IVP, 1994), and Michael J. Behe, *Darwin's Black Box: The Biochemical Challenge to Evolution* (New York: Free Press, 1996).

[5]Stephen Jay Gould, *The Panda's Thumb: Reflections in Natural History* (New York: Norton, 1980).

[6]Paul A. Nelson, "The Role of Theology in Current Evolutionary Reasoning," *Biology & Philosophy* 11(1996): 493–517. Nelson provides an insightful discussion of the pervasiveness of theological considerations in contemporary evolutionary reasoning. Although I encountered his paper only after this one was substantially complete, his paper helped me to bring some issues in this paper into clearer focus.

[7]Gould, *The Panda's Thumb*, 20–21.

[8]See G. Schaller, H. Jinchu, P. Wenshi, and S. Jing, *The Giant Pandas of Wolong* (Chicago: University of Chicago Press, 1986).

[9]Richard Dawkins, *The Blind Watchmaker: Why the Evidence of Evolution Reveals a World Without Design* (New York: Norton, 1986), 91.

[10]Ibid., 92.

[11]Ibid., 93.

[12]Ibid.

[13]Ibid., 91.

[14]Ibid., 92; emphasis added.

[15]Loren Haarsma, "Why Believe in a Creator?" *World & I*, 11 (1996): 337.

[16]See the quotations by William Whewell and Joseph Butler that appear opposite the title page of the *Origin of Species*.

[17]For examples, see Denis Owen, *Camouflage and Mimicry* (Chicago: University of Chicago Press, 1982).

[18]John Maynard Smith, "Optimization Theory in Evolution," *Annual Review of Ecology and Systematics*, 9 (1978): 32.

[19]Nelson ("The Role of Theology in Current Evolutionary Reasoning," 503–4) points out a related problem. When we consider any instance of biological imperfection we can judge it either on its own terms (e.g., as a piece of biological engineering), or as a component of a larger system of which it is perhaps only a small part. Apparent imperfection of a part is compatible with the perfection of the whole. It is, of course, difficult to conceive of how inverted retina could contribute to the perfection of the universe. But the objection succeeds to the extent that it draws attention to a questionable assumption of the Imperfection Argument, *viz.*, that biological perfection can be judged *locally*.

[20]Dawkins, *The Blind Watchmaker*, 93.

[21]Ibid., 92.

[22]There may, of course, be *other* reasons for preferring a theistic to a naturalistic worldview, or vice versa, but my concern here is only with the issue of biological design. It almost goes without saying that theists (e.g., Christians) have never considered "biological design" to be the primary, much less the only, argument in support of their religious beliefs. Indeed, talking of "arguments" reveals very clearly that the issue of biological design functions primarily in apologetic contexts rather than in the day-to-life of faith that most Christians would consider the center of gravity for their beliefs.

[23]David Hume, *An Enquiry Concerning Human Understanding*, edited, with an Introduction by Eric Steinberg (Indianapolis, IN: Hackett Publishing Co., 1977). Originally published in 1779.

[24]Even if natural selection proves inadequate to account for certain biological structures, e.g., the sorts of structures discussed by Behe (*Darwin's Black Box*), there will always be *other* potentially explanatory naturalistic principles to appeal to, e.g., "self-organization" *a la* Stuart A. Kaufmann, *The Origins of Order: Self-Organization and Selection in Evolution* (New York: Oxford University Press, 1993). As *metaphysical* positions, naturalism and theism are in principle compatible with any empirical states of affairs.

Books Received and Available for Review

(Please contact the book review editor if you would like to review one of these books. Please choose alternate selections.)
Richard Ruble, Book Review Editor, *Perspectives on Science and Christian Faith*, 212 Western Hills Drive, Siloam Springs, AR 72761

Piero & Alberto Angela, *The Extraordinary Story of Life on Earth*, Prometheus Books, 1996
C. R. Albright, Ed., *Beginning with the End: God, Science, and Wolfhart Pannenberg*, Open Court, 1997
Stephen Bocking, *Ecologists and Environmental Politics: A History of Contemporary Ecology*, Yale University Press, 1997
Gary Cziko, *Without Miracles: Universal Selection and the Second Darwinian Revolution*, MIT Press, 1995
Paul Edwards, *Reincarnation: A Critical Examination*, Prometheus Books, 1996
M. H. Ellis, *Unholy Alliance: Religion and Atrocity in Our Time*, Fortress Press, 1997
John Forster, Ed., *Valuing Nature? Economics, Ethics, and Environment*, Routledge, 1997
Barbara Gaddy, et al, *School Wars: Resolving Our Conflicts Over Religion and Values*, Jossey-Bass, 1996
Migene Gonzaler-Wippler, *What Happens After Death: Scientific and Personal Evidence for Survival*, Llewellyn Publications, 1997
Alan Guth, *The Inflationary Universe: The Quest for a New Theory of Cosmic Origins*, Addison-Wesley, 1997
Z. Hayes, *A Window to the Divine: Creation Theology*, Franciscan Herald Press, 1997
Milton Heifetz, *Ethics in Medicine*, Prometheus Books, 1996
J. R. Hunter, *Simple Things Won't Save the Earth*, University of Texas, 1997
Malcolm Jeeves, *Human Nature at the Millennium*, Baker, 1997
J. J. Kotva, Jr., *The Christian Case for Virtue Ethics*, Georgetown University Press, 1996
Aaron Lynch, *Thought Contagion: How Belief Spreads Through Society*, Basic Books, 1996
Steven McKenzie, *All God's Children: A Biblical Critique of Racism*, John Knox Press, 1997
Dan Maguire & A. Fargnoli, *On Moral Grounds: The Art/Science of Ethics*, Crossroads, 1996
David Millar, *Dictionary of Scientists*, Cambridge University Library, 1996
Jay Newman, *Religion and Technology*, Praeger, 1997
Larry L. Rasmussen, *Earth Community, Earth Ethics*, Orbis, 1996
Edward Shafranske, *Religion and the Clinical Practice of Psychology*, APA, 1996
A. L. Sherman, *The Soul of Development: Biblical Christianity and Economic Development in Guatemala*, Oxford University Press, 1997
R. C. Sproul, Ed., *Playing God: Dissection Biomedical Ethics and Manipulating the Body*, Baker Book House, 1997
M. R. Steele, *Christianity, Tragedy, and Holocaust Literature*, Greenwood, 1995
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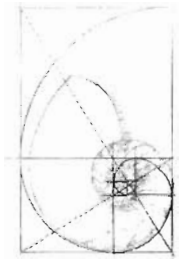

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Intelligent Design as a Theory of Information

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For the scientific community, intelligent design represents creationism's latest grasp at scientific legitimacy. Accordingly, intelligent design is viewed as yet another ill-conceived attempt by creationists to straightjacket science within a religious ideology. But, in fact, intelligent design can be formulated as a scientific theory having empirical consequences and devoid of religious commitments. Intelligent design can be unpacked as a theory of information. Within such a theory, information becomes a reliable indicator of design as well as a proper object for scientific investigation. In my paper, I shall (1) show how information can be reliably detected and measured, and (2) formulate a conservation law that governs the origin and flow of information. My broad conclusion is that information is not reducible to natural causes, and that the origin of information is best sought in intelligent causes. Intelligent design, thereby, becomes a theory for detecting and measuring information, explaining its origin, and tracing its flow.

Information

In *Steps Towards Life,* Manfred Eigen identifies what he regards as the central problem facing origins-of-life research: "Our task is to find an algorithm, a natural law that leads to the origin of information."[1] Eigen is only half right. To determine how life began, it is indeed necessary to understand the origin of information. Even so, neither algorithms nor natural laws can produce information. The great myth of modern evolutionary biology is that information can be gotten on the cheap without recourse to intelligence. It is this myth I seek to dispel, but to do so I shall need to give an account of information. No one disputes that there is such a thing as information. As Keith Devlin remarks:

> Our very lives depend upon it, upon its gathering, storage, manipulation, transmission, security, and so on. Huge amounts of money change hands in exchange for information. People talk about it all the time. Lives are lost in its pursuit. Vast commercial empires are created in order to manufacture equipment to handle it.[2]

But what exactly is information? The burden of this paper is to answer this question, presenting an account of information that is relevant to biology.

The fundamental intuition underlying information is not, as is sometimes thought, the transmission of signals across a communication channel, but rather the actualization of one possibility to the exclusion of others. As Fred Dretske puts it:

> Information theory identifies the amount of information associated with, or generated by, the occurrence of an event (or the realization of a state of affairs) with the reduction in uncertainty, the elimination of possibilities, represented by that event or state of affairs.[3]

To be sure, whenever signals are transmitted across a communication channel, one possibility is actualized to the exclusion of others, namely, the signal that was transmitted to the exclusion of those that weren't. But this is only a special case. Information in the first instance presupposes not some medium of communication, but contingency. Robert Stalnaker makes this point clearly: "Content requires

*ASA Member

contingency. To learn something, to acquire information, is to rule out possibilities. To understand the information conveyed in a communication is to know what possibilities would be excluded by its truth."[4] For there to be information, there must be a multiplicity of distinct possibilities, any one of which might happen. When one of these possibilities does happen and the others are ruled out, information becomes actualized. Indeed, information in its most general sense can be defined as the actualization of one possibility to the exclusion of others (observe that this definition encompasses both syntactic and semantic information).

This way of defining information may seem counterintuitive since we often speak of the information inherent in possibilities that are never actualized. Thus we may speak of the information inherent in flipping one-hundred heads in a row with a fair coin even if this event never happens. There is no difficulty here. In counterfactual situations, the definition of information needs to be applied counterfactually. Thus to consider the information inherent in flipping one-hundred heads in a row with a fair coin, we treat this event/possibility as though it were actualized. Information needs to be referenced not just to the actual world, but also cross-referenced with all possible worlds.

Complex Information

How does our definition of information apply to biology, and to science more generally? To render information a useful concept for science we need to do two things: first, show how to measure information; second, introduce a crucial distinction—the distinction between *specified* and *unspecified* information. First, let us show how to measure information. In measuring information, it is not enough to count the number of possibilities excluded, and offer this number as the relevant measure of information. The problem is that a simple enumeration of excluded possibilities tells us nothing about how those possibilities were individuated in the first place. Consider, for instance, the following individuation of poker hands:

#1 A royal flush.
#2 Everything else.

To learn that something other than a royal flush was dealt (i.e., possibility #2) is clearly to acquire less information than to learn that a royal flush was dealt (i.e., possibility #1). Yet if our measure of information is simply an enumeration of excluded possibilities, the same numerical value must be assigned in both instances since in both instances a single possibility is excluded.

It follows, therefore, that how we measure information needs to be independent of whatever procedure we use to individuate the possibilities under consideration. The way to do this is not simply to count possibilities, but to assign probabilities to these possibilities. For a thoroughly shuffled deck of cards, the probability of being dealt a royal flush (i.e., possibility #1) is approximately .000002 whereas the probability of being dealt anything other than a royal flush (i.e., possibility #2) is approximately .999998. Probabilities by themselves, however, are not information measures. Although probabilities properly distinguish possibilities according to the information they contain, nonetheless probabilities remain an inconvenient way of measuring information. There are two reasons for this. First, the scaling and directionality of the numbers assigned by probabilities need to be recalibrated. We are clearly acquiring more information when we learn someone was dealt a royal flush than when we learn someone wasn't dealt a royal flush. And yet the probability of being dealt a royal flush (i.e., .000002) is minuscule compared to the probability of being dealt something other than a royal flush (i.e., .999998). Smaller probabilities signify more information, not less.

The second reason probabilities are inconvenient for measuring information is that they are multipli-

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cative rather than additive. If I learn that Alice was dealt a royal flush playing poker at Caesar's Palace and that Bob was dealt a royal flush playing poker at the Mirage, the probability that both Alice and Bob were dealt royal flushes is the product of the individual probabilities. Nonetheless, it is convenient for information to be measured additively so that the measure of information assigned to Alice and Bob jointly being dealt royal flushes equals the measure of information assigned to Alice being dealt a royal flush plus the measure of information assigned to Bob being dealt a royal flush.

An obvious way to transform probabilities that circumvents both these difficulties is to apply a negative logarithm to the probabilities. Applying a negative logarithm assigns the more information to the less probability and transforms multiplicative probability measures into additive information measures, because the logarithm of a product is the sum of the logarithms. What's more, in deference to communication theorists, it is customary to use the logarithm to the base 2. The rationale for this choice of logarithmic base is as follows. The most convenient way for communication theorists to measure information is in bits. Any message sent across a communication channel can be viewed as a string of 0's and 1's. For instance, the ASCII code uses strings of eight 0's and 1's to represent the characters on a typewriter, with whole words and sentences in turn represented as strings of such character strings. In like manner, all communication may be reduced to the transmission of sequences of 0's and 1's. Given this reduction, the obvious way for communication theorists to measure information is in the number of bits transmitted across a communication channel. Since the negative logarithm to the base 2 of a probability corresponds to the average number of bits needed to identify an event of that probability, the logarithm to the base 2 is the canonical logarithm for communication theorists. Thus, we define the measure of information in an event of probability p as $-\log_2 p$.[5]

What about the additivity of this information measure? Recall the example of Alice being dealt a royal flush playing poker at Caesar's Palace and Bob being dealt a royal flush playing poker at the Mirage. Let's call the first event A and the second B. Since randomly dealt poker hands are probabilistically independent, the probability of A and B taken jointly equals the product of the probabilities of A and B taken individually. Symbolically, $P(A\&B) = P(A) \times P(B)$. Given our logarithmic definition of information, we thus define the amount of information in an event E as $I(E) =_{def} -\log_2 P(E)$. It then follows that $P(A\&B) = P(A) \times P(B)$ if and only if $I(A\&B) = I(A) + I(B)$. Since in the example of Alice and Bob $P(A) = P(B) = .000002$, $I(A) = I(B) = 19$, and $I(A\&B) = I(A) + I(B) = 19 + 19 = 38$. Thus the amount of information inherent in Alice and Bob jointly obtaining royal flushes is 38 bits.

Since many events are probabilistically independent, information measures exhibit much additivity. But since many events are also correlated, information measures exhibit much nonadditivity as well. In the example of Alice and Bob, Alice being dealt a royal flush is probabilistically independent of Bob being dealt a royal flush, and so the amount of information in Alice and Bob both being dealt royal flushes equals the sum of the individual amounts of information.

Since many events are probabilistically independent, information measures exhibit much additivity. But since many events are also correlated, information measures exhibit much nonadditivity as well.

Now let's consider a different example. Alice and Bob together toss a coin five times. Alice observes the first four tosses but is distracted, and so misses the fifth toss. On the other hand, Bob misses the first toss, but observes the last four tosses. Let's say the actual sequence of tosses is 11001 (1 = heads, 0 = tails). Thus Alice observes 1100* and Bob observes *1001. Let A denote the first observation, B the second. It follows that the amount of information in A&B is the amount of information in the completed sequence 11001, namely, 5 bits. On the other hand, the amount of information in A alone is the amount of information in the incomplete sequence 1100*, namely 4 bits. Similarly, the amount of information in B alone is the amount of information in the incomplete sequence *1001, also 4 bits. This time the information doesn't add up: $5 = I(A\&B) \neq I(A) + I(B) = 4 + 4 = 8$.

Here A and B are correlated. Alice knows all but the last bit of information in the completed sequence 11001. Thus when Bob gives her the incomplete sequence *1001, all Alice really learns is the last bit in this sequence. Similarly, Bob knows all but the first bit of information in the completed sequence 11001. Thus when Alice gives him the incomplete sequence 1100*, all Bob really learns is the first bit in this

sequence. What appears to be four bits of information actually ends up being only one bit of information once Alice and Bob factor in the prior information they possess about the completed sequence 11001. If we introduce the idea of conditional information, this is just to say that $5 = I(A\&B) = I(A) + I(B \mid A) = 4 + 1$. $I(B \mid A)$, the conditional information of B given A, is the amount of information in Bob's observation once Alice's observation is taken into account. This, as we just saw, is 1 bit.

$I(B \mid A)$, like $I(A\&B)$, $I(A)$, and $I(B)$, can be represented as the negative logarithm to the base two of a probability, only this time the probability under the logarithm is a conditional, as opposed to an unconditional, probability. By definition, $I(B \mid A) =_{def} -\log_2 P(B \mid A)$, where $P(B \mid A)$ is the conditional probability of B given A. But since $P(B \mid A) =_{def} P(A\&B)/P(A)$ and since the logarithm of a quotient is the difference of the logarithms, $\log_2 P(B \mid A) = \log_2 P(A\&B) - \log_2 P(A)$, and so $-\log_2 P(B \mid A) = -\log_2 P(A\&B) + \log_2 P(A)$, which is just $I(B \mid A) = I(A\&B) - I(A)$. This last equation is equivalent to

$$I(A\&B) = I(A) + I(B \mid A) \qquad (*)$$

Formula (*) holds with full generality, reducing to $I(A\&B) = I(A) + I(B)$ when A and B are probabilistically independent, in which case $P(B \mid A) = P(B)$ and thus $I(B \mid A) = I(B)$.

... the complexity of information increases as [the information measure] increases (or, correspondingly, as [the probability measure] decreases).

Formula (*) asserts that the information in both A and B jointly is the information in A plus the information in B that is not in A. Its point, therefore, is to spell out how much additional information B contributes to A. As such, this formula places tight constraints on the generation of new information. Does, for instance, a computer program, call the program A, by outputting some data, call the data B, generate new information? Computer programs are fully deterministic, and so B is fully determined by A. It follows that $P(B \mid A) = 1$, and thus $I(B \mid A) = 0$ (the logarithm of 1 is always 0). From Formula (*) it therefore follows that $I(A\&B) = I(A)$, and that the amount of information in A and B jointly is no more than the amount of information in A by itself.

For an example in the same spirit, consider that there is no more information in two copies of Shakespeare's *Hamlet* than in a single copy. This is patently obvious, and any formal account of information had better agree. To see that our formal account does indeed agree, let A denote the printing of the first copy of *Hamlet*, and B the printing of the second copy. Once A is given, B is entirely determined. Indeed, the correlation between A and B is perfect. Probabilistically this is expressed by saying the conditional probability of B given A is 1, namely, $P(B \mid A) = 1$. In information-theoretic terms this is to say that $I(B \mid A) = 0$. As a result $I(B \mid A)$ drops out of Formula (*), and so $I(A\&B) = I(A)$. Our information-theoretic formalism, therefore, agrees with our intuition that two copies of *Hamlet* contain no more information than a single copy.

Information is a complexity-theoretic notion. As a purely formal object, the information measure described here is a complexity measure.[6] Complexity measures arise whenever we assign numbers to degrees of complication. A set of possibilities will often admit varying degrees of complication, ranging from extremely simple to extremely complicated. Complexity measures assign non-negative numbers to these possibilities so that 0 corresponds to the most simple and ∞ to the most complicated. For instance, computational complexity is always measured in terms of either time (i.e., number of computational steps) or space (i.e., size of memory, usually measured in bits or bytes) or some combination of the two. The more difficult a computational problem, the more time and space are required to run the algorithm that solves the problem. For information measures, the degree of complication is measured in bits. Given an event A of probability P(A), $I(A) = -\log_2 P(A)$ measures the number of bits associated with the probability P(A). We therefore speak of the "complexity of information" and say that the complexity of information increases as I(A) increases (or, correspondingly, as P(A) decreases). We also speak of "simple" and "complex" information according to whether I(A) signifies few or many bits of information. This notion of complexity is important to biology since not just the origin of information stands in question, but also the origin of complex information.

Complex Specified Information

Given a means of measuring information and determining its complexity, we turn now to the distinction between *specified* and *unspecified* information. This is a vast topic whose full elucidation is beyond the scope of this paper.[7] Nonetheless, in what fol-

lows I shall try to make this distinction intelligible, and offer some hints on how to make it rigorous. For an intuitive grasp of the difference between specified and unspecified information, consider the following example. Suppose an archer stands 50 meters from a large blank wall with bow and arrow in hand. The wall, let us say, is sufficiently large that the archer cannot help but hit it. Consider now two alternative scenarios. In the first scenario, the archer simply shoots at the wall. In the second scenario, the archer first paints a target on the wall, and then shoots at the wall, squarely hitting the target's bull's-eye. Let us suppose that in both scenarios the arrow lands in the same spot. In both scenarios, the arrow might have landed anywhere on the wall. What's more, any place where it might land is highly improbable. It follows that in both scenarios highly complex information is actualized. Yet the conclusions we draw from these scenarios are very different. In the first scenario, we can conclude absolutely nothing about the archer's ability as an archer, whereas in the second scenario, we have evidence of the archer's skill.

The actualization of a possibility (i.e., information) is specified if the possibility's actualization is independently identifiable by means of a pattern.

The obvious difference between the two scenarios is that in the first, the information follows no pattern, whereas in the second, it does. Now the information that tends to interest us as rational inquirers generally, and scientists in particular, is not the actualization of arbitrary possibilities which correspond to no patterns, but the actualization of circumscribed possibilities which *do* correspond to patterns. There's more. Patterned information, though a step in the right direction, still doesn't quite get us specified information. The problem is that patterns can be concocted after the fact so that instead of helping explain information, the patterns are merely read off already actualized information.

To see this, consider a third scenario in which an archer shoots at a wall. As before, we suppose the archer stands 50 meters from a large blank wall with bow and arrow in hand, the wall being so large that the archer cannot help but hit it. As in the first scenario, the archer shoots at the wall while it is still blank. This time suppose that after having shot the arrow, and finding the arrow stuck in the wall, the archer paints a target around the arrow so that the arrow sticks squarely in the bull's-eye. Let us suppose further that the precise place where the arrow lands in this scenario is identical with where it landed in the first two scenarios. Since any place where the arrow might land is highly improbable, highly complex information has been actualized as in the other scenarios. What's more, since the information corresponds to a pattern, we can even say that in this third scenario highly complex patterned information has been actualized. Nevertheless, it would be wrong to say that highly complex specified information has been actualized. Of the three scenarios, only the information in the second scenario is specified. In that scenario, by *first* painting the target and *then* shooting the arrow, the pattern is given independently of the information. On the other hand, in the third scenario, by first shooting the arrow and then painting the target around it, the pattern is merely read off the information.

Specified information is always patterned information, but patterned information is not always specified information. For specified information, not just any pattern will do. Therefore we must distinguish between the "good" patterns and the "bad" patterns. We will call the "good" patterns *specifications*. Specifications are the independently given patterns that are not simply read off information. By contrast, we will call the "bad" patterns *fabrications*. Fabrications are the *post hoc* patterns that are simply read off already existing information.

Unlike specifications, fabrications are wholly unenlightening. We are no better off with a fabrication than without one. This is clear from comparing the first and third scenarios. Whether an arrow lands on a blank wall and the wall stays blank (as in the first scenario), or an arrow lands on a blank wall and a target is then painted around the arrow (as in the third scenario), any conclusions we draw about the arrow's flight remain the same. In either case, chance is as good an explanation as any for the arrow's flight. The fact that the target in the third scenario constitutes a pattern makes no difference since the pattern is constructed entirely in response to where the arrow lands. Only when the pattern is given independently of the arrow's flight does a hypothesis other than chance come into play. Thus only in the second scenario does it make sense to ask whether we are dealing with a skilled archer. Only in the second scenario does the pattern constitute a specification. In the third scenario, the pattern constitutes a mere fabrication.

The distinction between specified and unspecified information may now be defined as follows: the actualization of a possibility (i.e., information) is speci-

fied if the possibility's actualization is independently identifiable by means of a pattern. If not, then the information is unspecified. Note that this definition implies an asymmetry between specified and unspecified information: specified information cannot become unspecified information, though unspecified information can become specified information. Unspecified information can become specified as our background knowledge increases. For example, a cryptographic transmission, whose cryptosystem we have yet to break, will constitute unspecified information. However, as soon as we break the cryptosystem, the cryptographic transmission becomes specified information.

Information can be specified, complex, or both complex and specified. Information that is both complex and specified I call "complex specified information," or CSI for short.

What is it for a possibility to be identifiable by means of an independently given pattern? A full exposition of specification requires a detailed answer to this question. Unfortunately, such an exposition is beyond the scope of this paper. The key conceptual difficulty here is to characterize the independence condition between patterns and information. This independence condition breaks into two subsidiary conditions: (1) a condition to stochastic conditional independence between the information in question and particular relevant background knowledge; and (2) a tractability condition by which the pattern in question can be constructed from the aforementioned background knowledge. Though these conditions make good intuitive sense, they are not easily formalized.[8]

If formalizing what it means for a pattern to be given independently of a possibility is difficult, determining in practice whether a pattern is given independently of a possibility is much easier. If the pattern is given prior to the possibility being actualized—as in the second scenario above where the target was painted before the arrow was shot—then the pattern is automatically independent of the possibility, and we are dealing with specified information. Patterns given prior to the actualization of a possibility are just the rejection regions of statistics. There is a well-established statistical theory that describes such patterns and their use in probabilistic reasoning. These are clearly specifications since having been given prior to the actualization of some possibility, they have already been identified, and thus are identifiable independently of the possibility being actualized.[9]

Many interesting cases of specified information, however, are those in which the pattern is given *after* a possibility has been actualized. This is the case with the origin of life: life originates first and only afterwards do pattern-forming, rational agents (like ourselves) enter the scene. It remains the case, however, that a pattern corresponding to a possibility, though formulated after the possibility has been actualized, can constitute a specification. Certainly this was not so in the third scenario above, where the target was painted around the arrow only after it hit the wall. But consider the following example. Alice and Bob are celebrating their fiftieth wedding anniversary. Their six children all show up bearing gifts. Each gift is part of a matching set of china. There is no duplication of gifts, and together the gifts constitute a complete set of china. Suppose Alice and Bob were satisfied with their old set of china, and had no inkling prior to opening their gifts that they might expect a new set of china. Alice and Bob are therefore without a relevant pattern whither to refer their gifts prior to actually receiving the gifts from their children. Nevertheless, the pattern they explicitly formulate only after receiving the gifts could be formed independently of receiving the gifts—we all know about matching sets of china and how to distinguish them from unmatched sets. This pattern therefore constitutes a specification. What's more, there is an obvious inference connected with this specification: Alice and Bob's children were in collusion, and did not present their gifts as random acts of kindness.

But what about the origin of life? Is life specified? If so, to what patterns does life correspond, and how are these patterns given independently of life's origin? Obviously, pattern-forming rational agents like ourselves don't enter the scene till after life originates. Nonetheless, there are functional patterns to which life corresponds, and which are given independently of the actual living systems. An organism is a functional system comprising many functional subsystems. The functionality of organisms can be cashed out in any number of ways. Arno Wouters cashes it out globally in terms of viability of whole organisms.[10] Michael Behe cashes it out in terms of the irreducible complexity and minimal function of biochemical systems.[11] Even the staunch Darwinist Richard Dawkins admits that life is specified functionally, cashing out the functionality of organisms in terms of reproduction of genes. Thus he writes:

"Complicated things have some quality, specifiable in advance, that is highly unlikely to have been acquired by random chance alone. In the case of living things, the quality that is specified in advance is ... the ability to propagate genes in reproduction."[12]

Information can be specified, complex, or both complex and specified. Information that is both complex and specified I call "complex specified information," or CSI for short. CSI is what all the fuss over information has been about in recent years, not just in biology, but in science generally. It is CSI that for Manfred Eigen constitutes the great mystery of biology, and one he hopes eventually to unravel in terms of algorithms and natural laws. It is CSI that for cosmologists underlies the fine-tuning of the universe, and which the various anthropic principles attempt to understand.[13] It is CSI that David Bohm's quantum potentials are extracting when they scour the microworld for what Bohm calls "active information."[14] It is CSI that enables Maxwell's demon to outsmart a thermodynamic system tending toward thermal equilibrium.[15] It is CSI on which David Chalmers hopes to base a comprehensive theory of human consciousness.[16] It is CSI that within the Kolmogorov-Chaitin theory of algorithmic information takes the form of highly compressible, nonrandom strings of digits.[17]

CSI is not just confined to science. It is indispensable in our everyday lives. The 16-digit number on your VISA card is an example of CSI. The complexity of this number ensures that a would-be thief cannot randomly pick a number and have it turn out to be a valid VISA card number. What's more, the specification of this number ensures that it is your number, and not anyone else's. Even your telephone number constitutes CSI. As with the VISA card number, the complexity ensures that this number won't be dialed randomly (at least not too often), and the specification ensures that this number is yours and yours only. All the numbers on our bills, credit slips, and purchase orders represent CSI. CSI makes the world go round. It follows that CSI is a rife field for criminality. CSI is what motivated the greedy Michael Douglas character in the movie *Wall Street* to lie, cheat, and steal. CSI's total and absolute control was the objective of the monomaniacal Ben Kingsley character in the movie *Sneakers*. CSI is the artifact of interest in most techno-thrillers. Ours is an information age, and the information that captivates us is CSI.

Intelligent Design

From where does the origin of complex specified information come? In this section, I shall argue that intelligent causation, or equivalently design, accounts for the origin of complex specified information. My argument focuses on the nature of intelligent causation, and specifically, on what it is about intelligent causes that makes them detectable. To see why CSI is a reliable indicator of design, we need to examine the nature of intelligent causation. The principal characteristic of intelligent causation is *directed contingency*, or what we call *choice*. Whenever an intelligent cause acts, it chooses from a range of competing possibilities. This is true not just of humans, but also of animals and extraterrestrial intelligences. A rat navigating a maze must choose whether to go right or left at various points in the maze. When SETI (Search for Extra-Terrestrial Intelligence) researchers try to discover intelligence in the extraterrestrial radio transmissions they are monitoring, they first assume that an extraterrestrial intelligence could have chosen any number of possible radio transmissions. Then they try to match the transmissions they observe with certain patterns as opposed to others (patterns that presumably are markers of intelligence). Whenever a human being utters meaningful speech, a choice is made from a range of possible sound-combinations that might have been uttered. Intelligent causation always entails discrimination, choosing certain things, ruling out others.

***The principal characteristic of intelligent causation is* directed contingency, *or what we call* choice.**

Given this characterization of intelligent causes, the crucial question is how to recognize their operation. Intelligent causes act by making a choice. How then do we recognize that an intelligent cause has made a choice? A bottle of ink spills accidentally onto a sheet of paper; someone takes a fountain pen and writes a message on a sheet of paper. In both instances, ink is applied to paper. In both instances, one among an almost infinite set of possibilities is realized. In both instances, a contingency is actualized and others are ruled out. Yet in one instance we infer design, in the other chance. What is the relevant difference? Not only do we need to observe that a contingency was actualized, but we ourselves need also to be able to specify that contingency. The contingency must conform to an independently given pattern, and we must be able to independently formulate that pattern. A random ink blot is unspecifiable; a message written with ink on paper is

specifiable. Wittgenstein made the same point: "We tend to take the speech of a Chinese for inarticulate gurgling. Someone who understands Chinese will recognize *language* in what he hears. Similarly I often cannot discern the *humanity* in man."[18]

In hearing a Chinese utterance, someone who understands Chinese not only recognizes that one from a range of all possible utterances was actualized, but is also able to specify the utterance as coherent Chinese speech. Contrast this with someone who does not understand Chinese. In hearing a Chinese utterance, someone who does not understand Chinese also recognizes that one from a range of possible utterances was actualized, but this time, because lacking the ability to understand Chinese, is unable to specify the utterance as coherent speech. To someone who does not understand Chinese, the utterance will appear gibberish. Gibberish—the utterance of nonsense syllables uninterpretable within any natural language—always actualizes one utterance from the range of possible utterances. Nevertheless, gibberish, by corresponding to nothing we can understand in any language, cannot be specified. As a result, gibberish is never taken for intelligent communication, but always for what Wittgenstein calls "inarticulate gurgling."

The actualization of one among several competing possibilities, the exclusion of the rest, and the specification of the possibility actualized encapsulate how we recognize intelligent causes, or equivalently, how we detect design. The Actualization-Exclusion-Specification triad constitutes a general criterion for detecting intelligence—be it animal, human, or extraterrestrial. Actualization establishes that the possibility in question is the one that actually occurred. Exclusion establishes that there was genuine contingency (i.e., that there were other live possibilities, and that these were ruled out). Specification establishes that the actualized possibility conforms to a pattern given independently of its actualization.

Now where does choice, which we've cited as the principal characteristic of intelligent causation, figure into this criterion? The problem is that we never witness choice directly. Instead, we witness actualizations of contingency which might be the result of choice (i.e., directed contingency) or the result of chance (i.e., blind contingency). Specification is the only means available to us for distinguishing choice from chance, directed contingency from blind contingency. Actualization and exclusion together guarantee that we are dealing with contingency. Specification guarantees that we are dealing with a directed contingency. The Actualization-Exclusion-Specification triad is therefore precisely what we need to identify choice and with it intelligent causation.

The contingency must conform to an independently given pattern, and we must be able to independently formulate that pattern.

Psychologists who study animal learning and behavior have known of the Actualization-Exclusion-Specification triad all along, even if implicitly. For these psychologists—known as learning theorists—learning is discrimination.[19] To learn a task an animal must acquire the ability to actualize behaviors suitable for the task as well as the ability to exclude behaviors unsuitable for the task. Moreover, for a psychologist to recognize that an animal has learned a task, it is necessary not only to observe the animal making the appropriate behavior, but also to specify this behavior. Thus to recognize whether a rat has successfully learned how to traverse a maze, a psychologist must first specify the sequence of right and left turns that conducts the rat out of the maze. No doubt, a rat randomly wandering a maze also discriminates a sequence of right and left turns. But by randomly wandering the maze, the rat gives no indication that it can discriminate the appropriate sequence of right and left turns for exiting the maze. Consequently, the psychologist studying the rat will have no reason to think the rat has learned how to traverse the maze. Only if the rat executes the sequence of right and left turns specified by the psychologist will the psychologist recognize that the rat has learned how to traverse the maze. We regard these learned behaviors as intelligent causes in animals. Thus, it is no surprise that the same scheme for recognizing animal learning recurs for recognizing intelligent causes generally, to wit, actualization, exclusion, and specification.

This general scheme for recognizing intelligent causes coincides precisely with how we recognize complex specified information. First, the basic precondition for information to exist must hold, namely, contingency. Thus one must establish that any one of a multiplicity of distinct possibilities might obtain. Next, one must establish that the possibility which was actualized after the others were excluded was also specified. So far the match between this general scheme for recognizing intelligent causation and how we recognize complex specified information is

exact. Only one loose end remains—complexity. Although complexity is essential to CSI (corresponding to the first letter of the acronym), its role in this general scheme for recognizing intelligent causation is not immediately evident. In this scheme, one among several competing possibilities is actualized, the rest are excluded, and the possibility which was actualized is specified. Where in this scheme does complexity figure in?

To recognize intelligent causation, we must establish that one possibility from a range of competing possibilities was actualized, determine which possibilities were excluded, and then specify the actualized possibility.

The answer is that it is there implicitly. To see this, consider again a rat traversing a maze, but now take a very simple maze in which two right turns conduct the rat out of the maze. How will a psychologist studying the rat determine whether it has learned to exit the maze? Just putting the rat in the maze will not be enough. Because the maze is so simple, the rat could by chance just happen to take two right turns, and thereby exit the maze. The psychologist will therefore be uncertain whether the rat actually learned to exit this maze, or whether the rat just got lucky. But contrast this now with a complicated maze in which a rat must take just the right sequence of left and right turns to exit the maze. Suppose the rat must take one hundred appropriate right and left turns, and that any mistake will prevent the rat from exiting the maze. A psychologist who sees the rat take no erroneous turns and in short order exit the maze will be convinced that the rat has indeed learned how to exit the maze, and that this was not dumb luck. With the simple maze, there is a substantial probability that the rat will exit the maze by chance; with the complicated maze, this is exceedingly improbable. The role of complexity in detecting design is now clear, since improbability is precisely what we mean by complexity (cf. section "Complex Information").

We can summarize this argument for showing that CSI is a reliable indicator of design as follows: CSI is a reliable indicator of design because its recognition coincides with how we recognize intelligent causation generally. To recognize intelligent causation, we must establish that one possibility from a range of competing possibilities was actualized, determine which possibilities were excluded, and then specify the actualized possibility. What's more, the competing possibilities that were excluded must be live possibilities, sufficiently numerous so that specifying the actualized possibility cannot be attributed to chance. In terms of probability, this means that the specified possibility is highly improbable. In terms of complexity, this means that the specified possibility is highly complex. All the elements in the general scheme for recognizing intelligent causation (i.e., Actualization-Exclusion-Specification) find their counterpart in complex specified information—CSI. CSI pinpoints what we need to be looking for when we detect design.

As a postscript, I call the reader's attention to the etymology of the word "intelligent." It derives from two Latin words, the preposition *inter*, meaning between, and the verb *lego*, meaning to choose or select. Thus, according to its etymology, intelligence consists in *choosing between*. It follows that the etymology of the word "intelligent" parallels the formal analysis of intelligent causation just given. Thus, "Intelligent design" is a thoroughly apt phrase, signifying that design is inferred precisely because an intelligent cause has done what only an intelligent cause can do—make a choice.

The Law of Conservation of Information

Evolutionary biology has steadfastly resisted attributing CSI to intelligent causation. Though Eigen recognizes that the central problem of evolutionary biology is the origin of CSI, he has no thought of attributing CSI to intelligent causation. According to Eigen, natural causes are adequate to explain the origin of CSI. The only question for him is which natural causes explain the origin of CSI. Eigen ignores the logically prior question of whether natural causes can even, in principle, explain the origin of CSI. Yet this is a question that undermines his entire project.[20] Natural causes are, in principle, incapable of explaining the origin of CSI. They can explain the flow of CSI, being ideally suited for transmitting already existing CSI. What they cannot do, however, is originate CSI. This strong proscriptive claim, that natural causes can only transmit CSI but never originate it, I call the Law of Conservation of Information. It is this law that gives definite scientific content to the claim that CSI is intelligently caused. The aim of this last section is briefly to sketch the Law of Conservation of Information.[21]

To see that natural causes cannot account for CSI is straightforward. Natural causes comprise chance and necessity.[22] Because information presupposes contingency, necessity is by definition incapable of producing information, much less complex specified information. For there to be information, there must be a multiplicity of live possibilities, one of which is actualized, and the rest of which are excluded. This is contingency. But if some outcome B is necessary given antecedent conditions A, then the probability of B given A is one, and the information in B given A is zero. If B is necessary given A, Formula (*) reduces to I(A&B) = I(A), which is to say that B contributes no new information to A. It follows that necessity is incapable of generating new information. Observe that what Eigen calls "algorithms" and "natural laws" fall under necessity.

Natural causes are therefore incapable of generating CSI.

Since information presupposes contingency, let us take a closer look at contingency. Contingency can assume only one of two forms. Either the contingency is a blind, purposeless contingency—which is chance; or it is a guided, purposeful contingency—which is intelligent causation. Since we already know that intelligent causation is capable of generating CSI (cf. section, "Intelligent Design"), let us next consider whether chance might also be capable of generating CSI. First notice that pure chance, entirely unsupplemented and left to its own devices, is incapable of generating CSI. Chance can generate complex unspecified information, and chance can generate noncomplex specified information. What chance cannot generate is information that is jointly complex and specified.

Biologists by and large do not dispute this claim. Most agree that pure chance—what Hume called the Epicurean hypothesis—does not adequately explain CSI. Jacques Monod is one of the few exceptions, arguing that the origin of life, though vastly improbable, can nonetheless be attributed to chance because of a selection effect.[23] Just as the winner of a lottery is shocked at winning, so we are shocked to have evolved. But the lottery was bound to have a winner, and so too something was bound to have evolved. Something vastly improbable was bound to happen, and so, the fact that it happened to us (i.e., that we were selected—thus the name selection effect) does not preclude chance. This is Monod's argument and it is fallacious. It utterly fails to come to grips with specification. Moreover, it confuses a necessary condition for life's existence with its explanation. Monod's argument has been refuted by the philosophers John Leslie,[24] John Earman,[25] and Richard Swinburne.[26] It has also been refuted by the biologists Francis Crick,[27] Bernd-Olaf Küppers,[28] and Hubert Yockey.[29] Selection effects do nothing to render chance an adequate explanation of CSI.

Most biologists, therefore, reject pure chance as an adequate explanation of CSI. The problem here is not simply one of faulty statistical reasoning. Pure chance as an explanation of CSI is also scientifically unsatisfying. To explain CSI in terms of pure chance is no more instructive than pleading ignorance or proclaiming CSI a mystery. It is one thing to explain the occurrence of heads on a single coin toss by appealing to chance. It is quite another, as Küppers points out, to follow Monod and take the view that "the specific sequence of the nucleotides in the DNA molecule of the first organism came about by a purely random process in the early history of the earth."[30] CSI cries out for an explanation, and pure chance won't do. As Richard Dawkins correctly notes: "We can accept a certain amount of luck in our [scientific] explanations, but not too much."[31]

If chance and necessity left to themselves cannot generate CSI, is it possible that chance and necessity working together might generate CSI? The answer is "No." Whenever chance and necessity work together, the respective contributions of chance and necessity can be arranged sequentially. But by arranging them sequentially, it becomes clear that at no point in the sequence is CSI generated. Consider the case of trial-and-error (trial corresponds to necessity and error to chance). Once considered a crude method of problem solving, trial-and-error has so risen in the estimation of scientists that it is now regarded as the ultimate source of wisdom and creativity in nature. The probabilistic algorithms of computer science all depend on trial-and-error.[32] So too, the Darwinian mechanism of mutation and natural selection is a trial-and-error combination in which mutation supplies the error and selection the trial. An error is committed after which a trial is made. But at no point is CSI generated.

Natural causes are therefore incapable of generating CSI. This broad conclusion I call the Law of Conservation of Information, or LCI for short. LCI has profound implications for science. Among its corollaries are the following: (1) The CSI in a closed system of natural causes remains constant or decreases; (2) CSI cannot be generated spontaneously, originate endogenously, or organize itself (as these terms are used in origins-of-life research); (3) The CSI in a closed system of natural causes either has

been in the system eternally or was at some point added exogenously (implying that the system though now closed was not always closed); (4) In particular, any closed system of natural causes that is also of finite duration received whatever CSI it contains before it became a closed system.

This last corollary is especially pertinent to the nature of science for it shows that scientific explanation is not coextensive with reductive explanation. Richard Dawkins, Daniel Dennett, and many scientists are convinced that proper scientific explanations must be reductive, moving from the complex to the simple. Dawkins writes: "The one thing that makes evolution such a neat theory is that it explains how organized complexity can arise out of primeval simplicity."[33] Dennett views any scientific explanation that moves from simple to complex as "question-begging."[34] Thus Dawkins explicitly equates proper scientific explanation with what he calls "hierarchical reductionism," according to which "a complex entity at any particular level in the hierarchy of organization" must properly be explained "in terms of entities only one level down the hierarchy."[35] While no one will deny that reductive explanation is extremely effective within science, it is hardly the only type of explanation available to science. The divide-and-conquer mode of analysis behind reductive explanation has strictly limited applicability within science. In particular, this mode of analysis is utterly incapable of making headway with CSI. CSI demands an intelligent cause. Natural causes will not do. ❖

Notes

[1]Manfred Eigen, *Steps Towards Life: A Perspective on Evolution*, translated by Paul Woolley (Oxford: Oxford University Press, 1992), 12.

[2]Keith J. Devlin, *Logic and Information* (New York: Cambridge University Press, 1991), 1.

[3]Fred I. Dretske, *Knowledge and the Flow of Information* (Cambridge, MA: MIT Press, 1981), 4.

[4]Robert Stalnaker, *Inquiry* (Cambridge, MA: MIT Press, 1984), 85.

[5]See Claude E. Shannon and W. Weaver, *The Mathematical Theory of Communication* (Urbana, IL: University of Illinois Press, 1949), 32; R. W. Hamming, *Coding and Information Theory*, 2d edition (Englewood Cliffs, NJ: Prentice-Hall, 1986); or any mathematical introduction to information theory.

[6]Cf. William A. Dembski, *The Design Inference: Eliminating Chance through Small Probabilities* (Forthcoming, Cambridge University Press, 1998), Chap. 4.

[7]The details can be found in my monograph, *The Design Inference*.

[8]For the details refer to my monograph, *The Design Inference*.

[9]Cf. Ian Hacking, *Logic of Statistical Inference* (Cambridge: Cambridge University Press, 1965).

[10]Arno Wouters, "Viability Explanation," *Biology and Philosophy*, 10 (1995): 435–457.

[11]Michael Behe, *Darwin's Black Box: The Biochemical Challenge to Evolution*. (New York: The Free Press, 1996).

[12]Richard Dawkins, *The Blind Watchmaker* (New York: Norton, 1987), 9.

[13]Cf. John D. Barrow and Frank J. Tipler, *The Anthropic Cosmological Principle* (Oxford: Oxford University Press, 1986).

[14]Cf. David Bohm, *The Undivided Universe: An Ontological Interpretation of Quantum Theory* (London: Routledge, 1993), 35–38.

[15]Cf. Rolf Landauer, "Information is Physical," *Physics Today* (May: 23–29, 1991): 26.

[16]Cf. David J. Chalmers, *The Conscious Mind: In Search of a Fundamental Theory* (New York: Oxford University Press, 1996), Chap. 8.

[17]Cf. Andrei N. Kolmogorov, "Three Approaches to the Quantitative Definition of Information," *Problemy Peredachi Informatsii* (in translation), 1(1) (1965): 3–11; Gregory J. Chaitin, "On the Length of Programs for Computing Finite Binary Sequences," *Journal of the ACM*, 13 (1966): 547–569.

[18]Ludwig Wittgenstein, *Culture and Value*, edited by G. H. von Wright, translated by P. Winch (Chicago: University of Chicago Press, 1980), 1e.

[19]Cf. James. E. Mazur, *Learning and Behavior*, 2d ed. (Englewood Cliffs, NJ: Prentice Hall, 1990); Barry Schwartz, *Psychology of Learning and Behavior*, 2d edition (New York: Norton, 1984).

[20]Manfred Eigen, *Steps Towards Life*.

[21]A full treatment will be given in *Uncommon Descent*, a book I am jointly authoring with Stephen Meyer and Paul Nelson.

[22]Cf. Jacques Monod, *Chance and Necessity* (New York: Vintage, 1972).

[23]Ibid.

[24]John Leslie, *Universes* (London: Routledge, 1989).

[25] John Earman, "The Sap Also Rises: A Critical Examination of the Anthropic Principle," *American Philosophical Quarterly*, 24(4) (1987): 307–317.

[26]Richard Swinburne, *The Existence of God* (Oxford: Oxford University Press, 1979).

[27]Francis Crick, *Life Itself: Its Origin and Nature* (New York: Simon and Schuster, 1981), Chap. 7.

[28]Bernd-Olaf Küppers, *Information and the Origin of Life* (Cambridge, MA: MIT Press, 1990), Chap. 6.

[29] Hubert P. Yockey, *Information Theory and Molecular Biology* (Cambridge: Cambridge University Press, 1992), Chap. 9.

[30]Bernd-Olaf Küppers, *Information and the Origin of Life*, 59.

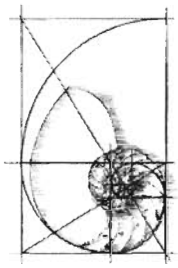
[31]Richard Dawkins, *The Blind Watchmaker*, 139.

[32]E.g., genetic algorithms—see Stephanie Forrest, "Genetic Algorithms: Principles of Natural Selection Applied to Computation," *Science*, 261 (1993): 872–878.

[33]Richard Dawkins, *The Blind Watchmaker*, 316.

[34] Daniel C. Dennett, *Darwin's Dangerous Idea: Evolution and the Meanings of Life* (New York: Simon & Schuster, 1995), 153.

[35]Richard Dawkins, *The Blind Watchmaker*, 13.



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Communications

Time and Eternity

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In "Eternity and the Personal God," Karl Busen addresses the problem of an alleged incompatibility between God's eternity and his personhood: it is sometimes claimed that God can be either an eternal being or a person, but not both at the same time.[1] Nelson Pike, for example, claims that mental activities such as thinking, remembering, imagining, etc. are inherently temporal, thus they cannot be executed in eternity, if eternity is understood as timelessness rather than time endlessness. To grapple with this problem, Busen calls on the distinction, introduced by David Park, between Time 1 and Time 2. Time 1 is modeless, like the time parameter used in equations; Time 2 is characteristic of human consciousness, distinguishing among the three modes of time: past, present, and future.

Busen's solution applies Park's thesis of complementarity of Time 1 and Time 2 to the eternity of God: "The biblical God is eternal and assumedly timeless (or better, in Time 1)." Moreover, "the biblical God is personal and in Time 2 ... God's 'timeless' eternity and his temporal relationship to the world would then be part of his essence" (p. 45). There is here, however, at least a terminological dissonance. Can Time 1 be considered timeless, or can any time, for that matter, be timeless? Time 1 is what it is, namely time, although its modes are suspended. Time variables in physical equations, however, refer to time—physical, real, objective time—and their modeless way of operation consists in not tying the equations to any particular point of time. The equations are valid any time, any *time*, so that specific time has to be supplied in the equation if it is to be applicable in a particular situation. Leaving out this instantiation in the equation does not make the time timeless, it only makes equations generally valid.

The same is true for any type of variable, particularly space. If a space variable in an equation is used, does it mean that some spaceless space is meant? After all, it can be considered a modeless space (although not in all equations) that does not make any distinction between left and right, up and down, etc. Therefore, Time 1 can be considered at best an image of timeless eternity but should not be identified with it. In this way, God's eternity would be elevated above the time physicists use in their equations, unless physicists' tenseless time is endowed with a metaphysical dimension. That is also what Busen suggests when he mentions that "God transcends the two times" (p. 46). Thus, if Time 1 is to be an image of eternity, then Paul Tillich's statement that "it would be foolish to imply that time is the image of timelessness" may sound too harsh, let alone, unjustified.

True, God transcends the two times, and according to Thomas Aquinas, God "is his own eternity," or "eternity is nothing else but God himself."[2] Thus, reducing such a grand vision of God's eternity to timeless time of physical equations does not appear to be a well-directed enterprise. Eternity, as Aquinas repeats after Boethius, is a "simultaneously whole and perfect possession of interminable life."[3] Interminable, that is, unbounded, and hence, it can be claimed, infinite. In this way, infinity would be an underlying concept of eternity. Descartes used this attribute as a principal attribute of God: God is infinite and God's actual infinity is tantamount to his perfection, by which infinity acquires the status of a sacred attribute which is reserved to God alone.[4] This is similar to Aquinas's belief that eternity is perfect possession of interminable (infinite?) life, and thus God is identified with eternity. This statement, however, can be strengthened if we realize

that Park's division is not sufficient for proper understanding of the importance of eternity.

Augustine was the first to convey the idea that God is greater than infinity, since to God even the infinite is finite. Thus, according to Augustine, there are three different levels of reality: the finite, the infinite, and the absolute. Augustine might have been influenced here by Plotinus's concept of One: the One—like Plato's idea of good—is outside of essence and being.[5] Augustine's views were later corroborated by developments in set theory. There are finite sets and transfinite sets, but there is no set encompassing all sets: such an assumption leads to antinomies. Georg Cantor was quick to use his mathematical analyses for theological purposes and saw in the hierarchy of transfinite numbers stairs leading to the throne of God.[6] This tripartite division of reality—the finite, infinite, and suprainfinite—can also be seen in the realm of time.

To be sure, one must not be as cavalier about the concept of eternity as Leibniz, to whom "there is nothing simpler than the concept of eternity."[7] It seems, however, that eternity can be understood in three ways: (1) time without end, (2) truths valid always and everywhere, and (3) atemporal existence.[8] Park's Time 1 is of the second category since it pertains to the universality of physical laws. Atemporal existence, most important within God's eternity, seems to be included in Busen's statement that "God transcends the two times." God surpasses the bounds of time. He is a timeless, atemporal being who is faintly reflected in Time 1. So Time 1, to use Cantor's saying, resembles stairs which lead to the throne of God. But Time 1 is hardly the essence of God. The division would be among what is limited in time, what is endless, and what is eternal. Only God is in the third category.[9]

Does this mean that God is detached from time, like the God of deists? Because God is his eternity, does it mean that God himself has no connection with time? Busen says that for Aquinas "God's eternity has no connection with time" (p. 41). Aquinas himself plainly states that God's "eternity includes all times."[10] This should be obvious in systems that accept that the world has been created, created by an eternal Being, and that the world was infused with time. For this world, the material world, time is an inseparable characteristic, even its essence. But in such systems as Aristotle's, where the world is uncreated and God plays only the role of the prime mover, eternity would include all times because eternity is time. Secondly, extratemporal eternity includes time(s) because of the Incarnation, which is a primary argument in Christianity.

Busen tries to answer the question whether God's eternity can be reconciled with his personhood. He answers "Yes" at the cost of sometimes blurring the line between the eternal and the temporal by leaning toward confining God's eternity to Pike's Time 1. The fact that he also says that "God transcends the two times" indicates that he is not comfortable with this stress put on Time 1. And he should not be.

Let us look at the problem not from the perspective of the divine but from that of the human. Does the fact that people perform their mental activities in time mean that their temporality constitutes humanness of humans? After Pike, Busen lists "processes of reflecting, deliberating, anticipating, intending, and remembering" as temporal processes and thus "agreeing with the definition of a person" (p. 41). But why are these processes taking place? All these processes allow us to transcend time, to break its power, and to surpass its limits. Thanks to memory we are not just immersed in the present, but we can also live our past, although the past is already gone. Thanks to deliberating, anticipating, and intending we can also live the future, although the future does not exist yet. When living in time, we do our best to break its barriers and with these mental processes we can overcome its limitations. Even "perception puts time in parentheses to fix the world in some kind of eternity,"[11] since perception brings perceptual data to be operated on by the mind—by memory, reasoning, etc. Therefore, perception allows time to stand still, or better yet, to break its hold on us. Thus, although mental processes are temporal, their role is to bring us into the extratemporal. The processes themselves in humans are conducted in time, but this is accidental. This does not constitute the essence of humanness; this is not why a person is a person.

A person should be eternity-oriented and should use personal abilities to go beyond time. Personal development does not lie in limiting oneself to time, but in opening oneself to the influx of the eternal, in eternity-directedness. As aptly put by Aquinas, "we must reach to the knowledge of eternity by means of time."[12] We are temporal beings, thus we have to use temporal means to turn our faces toward the eternal. This is not an impossible task, since, as the apostle Paul wrote to the Romans in the spirit of natural theology, God's "eternal power and divine nature" are "clearly visible through his works" (Rom. 1:20). Do we undermine our humanity by directing ourselves toward the eternal? If so, the religious life would be anything but an inducement to the development of personality. But we are urged to be born from above to reach eternal union with God, from above (ἄνωθεν)—not anew or again

(πάλιν), although only the former entails the latter—that is, from heaven, with the help of the eternal. Is this birth to stifle our personality, or to develop it? If the contact with the eternal were an adversary of personal development, of what is human in us, then mystics would be the most miserable of people—mystics who are "capable of living the real life of Eternity in the midst of the real time," who are "bringing Eternity into Time," and who are to the Eternal Goodness what hands are to a man.[13] Obviously, these are rhetorical questions. We undermine our humanity if we turn our back on the eternal and the supratemporal, and confine ourselves to the temporal, pretending that it makes us more human. That is why Pascal complained so bitterly about the fact that people cling to *divertissement* which is a way for people to divert their minds from what exceeds the boundary of the world in order not to think about what is truly important. People throw themselves into the here and now, into the passing moment through the means of gambling, horse racing, and other types of entertainment. These diversions, however, make them less human by chaining them to the passing of time; by limiting their memory, reflection, imagination, etc.; and by immersing them in time.

This does not mean that the temporal should be abandoned altogether and that we should turn our backs on our world. This was a danger of quietism. No, the world and the temporal ought to be viewed from the perspective of the eternal, as a necessary stage in our pilgrimage beyond the limits of time and space. Only equipped with this eternal perspective can we accomplish the fullest personal development. It is not that we have to struggle to acquire such a perspective, after all, as it says in Ecclesiastes 3:11, God put eternity in our hearts. We have to struggle to renounce this perspective, and that is what was so upsetting to Pascal when he wrote about *divertissement*. Human personality develops by saturating it with the eternal, which is understood not as tenselessness of the time of physics, but as the eternal of God's reality.

After all, "time does not have original reality, but derived."[14] As created human beings, we have a derived reality as well. Thus, if we direct ourselves to the temporal, we make ourselves doubly derived, and we turn time into a barrier between ourselves and the eternal instead of making it the nexus. Furthermore, it can become a nexus if the eternal in us allows us to see the temporal in the proper light, if we do not allow diversions to interfere and obfuscate the proper view. The diversions allow the temporal dross in personality to accumulate; and the eternal perspective allows it to dissolve in the eternal light, whereby personality, i.e., human personality, can burgeon.

All these remarks are to point to the fact that our humanity is strengthened by the eternal perspective. Without it human personality withers and human being turns just into being. Eternity is, therefore, no foe to human personality. Is it to God's, as Busen is afraid of?

The arguments used against God's personality are of at least of two types: from memory and from knowledge.[15] As to memory, it is said that time is indispensable for memory, since remembering refers to things past. We can retort briefly that an eternal, timeless being forgets nothing it knows, having perfect and infallible memory. Does this capacity make this being a nonperson? In this way, the more a human could remember, the more inhuman he would be. Uncommonness does not have to mean inhumanity or impersonality.

Secondly, an eternal being's knowledge can be questioned, since such a being—being extratemporal—cannot acquire knowledge or display it. In summary, when an eternal being knows everything from eternity, he does not have to learn, he just knows everything. Does this deprive this being of personality? Though it is a debatable issue, there are strong indications that humans have innate knowledge, or at least, innate dispositions (to mention only linguistic competence). Do they thereby lose a part of their personality? Also, some knowledge may never be manifested to anyone; does it have a negative impact on a person's personality?

Arguments against God's personality are mostly very weak and include a time factor in definitions of personality components: memory must take place in time, knowledge is acquired in time, etc. Similarily, Leibniz accepted existence of infinite sets, but not infinite numbers, because by definition numbers are finite. This all changed with Cantor. Similar definitional restrictions may hinder ascribing personal traits to God. If these restrictions are lifted, then it will turn out that God does have personality and in the fullest sense possible. We then can second the statement that "only God's personality is guaranteed by his eternity,"[16] a personality that is proportional to eternity, not to temporality. ❖

Notes

[1]Karl M. Busen, "Eternity and the Personal God," *Perspectives on Science and Christian Faith* 49 (1997): 40–49.

[2]Thomas Aquinas, *Summa theologiae* 1.10.2. This definition is endorsed by Tibor Horvath, *Eternity and Eternal Life: Speculative Theology and Science in Discourse* (Waterloo: Wilfrid Laurier University Press, 1993), 4, 79, and 104; Constantin Gutberlet, *Die Theodicee* (Münster: Theissingsche Buchhandlung, 1909), 256; and Gerhard Wilczek, *Zeit und Ewigkeit*, (Pfaffenhofen: Ilmgau Verlag, 1985), ch. 3. Such a view is shared not only by Thomists, since it can also be found in Augustine who identified eternity with divine essence: "In the nature of God ... there is only what *is*, and this is eternity itself" (*Enarrationes in Psalmos* 9.11; *De Trinitate* 4.1). It was once noted that the relationship between time and eternity was the main preoccupation of Augustine in Jules Chaix-Ruy, *Saint Augustin: Temps et histoire* (Paris: Études Augustiniennes, 1956), 3.

[3]Aquinas, *Summa* 1.10.1.

[4]Descartes, third *Meditation*, see also my paper, "Descartes: Mathematics and Sacredness of Infinity," *Laval théologique et philosophique* 52 (1996): 167–178.

[5]Étienne Gilson, *Introduction a l'étude de saint Augustin* (Paris: Vrin, 1949), 261.

[6]Adam Drozdek, "Beyond Infinity: Augustine and Cantor," *Laval théologique et philosophique* 51 (1995): 127–140.

[7]G. W. Leibniz, "Letter to Remond de Montmort 1715," in *Selections* (New York: Charles Scribner's Sons, 1951), 556.

[8]See, for instance, Jacques Durandeaux, *L'Éternité dans la vie quotidienne* (Bruges: Desclée de Brouwer, 1964), 150.

[9]This, however, raises a theologically interesting problem of the position of angels. Aquinas places them in *aevum* which is not eternity, because "before and after are compatible with it," nor time, since time does not limit angelic beings (*Summa* 1.10.5). Horvath sees in this a statement of the fact that angels have personal time, *Eternity and Eternal Life*, 106. It seems that the time and *aevum* can be predicated of created beings only, whereas eternity can be predicated of an uncreated being, God.

[10]*Summa* 1.10.2.

[11]Durandeaux, *L'Éternité*, 37.

[12]Aquinas, *Summa* 1.10.1.

[13]Evelyn Underhill, *Practical Mysticism* (New York: Dutton, 1948), 154, 161.

[14]Jean Pucelle, *Le temps* (Paris: PUF, 1959), 87.

[15]Paul Helm, *Eternal God: A Study of God Without Time* (Oxford: Clarendon Press, 1988), ch. 4

[16]Horvath, *Eternity*, 104.

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On Moreland: Spurious Freedom, Mangled Science, Muddled Philosophy

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J. P. Moreland, in "Complementarity, Agency Theory, and God of the Gaps" (*PSCF*, March 1997, pp. 2–14), has problems at several points. In the first place, he claims that the complementarity view makes the theological level emerge from the sociological level, which in turn emerges from the psychological level, and on down ultimately to the level of energy, the lowest level of the physical universe. He further claims that complementarity eliminates personal identity and libertarian freedom. What he claims holds of philosophical naturalism, a view akin to materialism. Believing that all reality is open to scientific study, the adherents to naturalism require that "science" swallow up whatever remnants are allowed of theology and philosophy. But this cannot apply to the view that scientific disciplines and religious interpretations *complement* each other, for complements are externally related.

Is it not curious that Moreland begins with the complementarian views of Christians (pp. 3–7), switches to compatibilism (pp. 7–10), and then introduces "complementarian compatibilists" (p. 11), immediately following this last with statements from naturalistic philosophers to support his analysis? Does this look like reasoned discourse, or like the familiar propaganda ploy, guilt by association? Is he massaging the terms to make them fit the desired outcome?

Determinism, Indeterminism, and Freedom

To correct the errors Moreland claims complementarians make, he wants science to include such concepts as "libertarian freedom," which have no possible empirical consequences. Consider a strict determinist who claims that every human action is part of an inexorable causal chain, that the feeling everyone has of choosing is merely an illusion. How does one prove that the person could have acted differently? The person cannot return to the situation S in which one claims to have freely chosen action A, and this time choose B. The best would be a similar situation S′ different from S, at least in having the S-A sequence in its past. No matter what the situation addressed, neither viewpoint can predict a different outcome. Both strict determinism and free will are philosophical assumptions, unproved and unprovable, made by human beings.

There is, however, a curious bit of evidence for human freedom: it is in fact tacitly assumed by strict determinists. They consistently try to persuade others that they should accept determinism when, on their view, one cannot help what he believes. Reduced to its ultimate essentials, this is "Do what you cannot do," a most curious command.

According to Moreland, the sole alternatives are strict determinism and his version of libertarian freedom. The agency which this freedom provides involves "gaps in the fabric of the natural world" (p. 3). This clearly implies indeterminism, the absence of cause. Unfortunately, indeterminism requires that there be no control, a state beyond even deterministic chaos and chance. Instead of indeterminism, human free will requires a type of determinism, self-determination. Strict determinism holds that every human act, like other events, is merely part of an unalterable causal chain. We expect this of all inanimate objects, quantum effects notwithstanding, but not of persons. Nevertheless, human beings are not outside causal chains, despite what Moreland claims. Formulating the matter precisely is exceedingly difficult. Arguably, more nonsense has been written about determinism, indeterminism, and free will than any other set of topics in philosophy. However, we may say that a person can nudge the causal sequence into alternate paths, for our powers do not extend beyond a choice. This is the freedom which is assumed by at least the majority of compatibilists, whose view is caricatured by Moreland.

**ASA Fellow*

In this connection, it appears that Moreland keeps his theology and religion rigidly separated from his philosophy. The person who wrote, "I do not do the good I want to do. On the contrary, I keep doing the evil I don't want to do,"[1] did not recognize his "libertarian freedom," which Moreland's philosophical construction requires him to have. Realistically evaluated, only God has the libertarian freedom which Moreland ascribes to created persons.

"Complete" vs. Complement

Moreland wrote about "complete" physical descriptions as if they must be all-encompassing, excluding all other possible considerations (pp. 10f). If there exist dogmatically reductionistic materialists, they may hold such a view. But even they may acknowledge other explanations. Consider a personal computer, booted, a program operating. I press a key. In principle, a computer super-engineer could describe the entire sequence, from the key-code produced and its transmission; the sequence of transistors turned on or off in the CPU, auxiliary chips, memory chips, video board chips; the electrons produced by the CRT gun, accelerated, swept and modulated by electrostatic and magnetic fields, and how the required control is achieved; the specific pixels energized by these electrons, as well as the electrons that hit the mask, etc.—a great mass of information. While this would describe the physics in excessive detail, it tells us nothing about the purpose of the key press or the meaning of what appeared on the screen, yet these go to form the reason why we use computers. "What are the physical parameters and events?" and "What is it good for?" are complementary questions. Neither precludes the other.

Moreland has produced a straw man, but one with a curious consequence. If, as he claims, physics is not self-contained, that is, if there are nonphysical causes of physical phenomena, where does he draw the line? Psychokinesis? Energy vortexes, like those claimed to exist near Sedona, AZ? Crystals? Pyramidology? Alien intelligences exerting forces we cannot detect or measure? Astral influences? Despite being debunked as far back as the fourth century by Augustine of Hippo, today there are many more astrologers than astronomers. So how does one, who accepts Moreland's view objectively, separate the bogus claims from relevant considerations and secure adoption only of the latter?

The *Hubris* of God-of-the-gaps

Moreland argues explicitly for a God-of-the-gaps (pp. 6f). An unrecognized underlying assumption of this view has been noted.[2] Does he really want to claim that he knows the limits of the principles the Creator could have imposed when in the beginning he created heaven and earth (Gen. 1:1)? He mentions "the direct creation of first life and the various kinds of life" (p. 12). Is he then revising the inspired record, which does not include *br'* (or *bara'*) in the appearance of life on the third day (Gen. 1:11–13)? Should the inspired author have applied *br'* more than once in the description of what happened the sixth day (vv. 24–31)?

We must grant that Moreland may back away from rewriting Genesis. We may further grant that the absence of *br'* in connection with plant life does not prove that life originally came into being purely by natural processes. But we must also insist that science does not demonstrate that life cannot be produced by inorganic processes. There are computations that claim to prove the impossibility. But I recall that it was impossible to produce anything but racemic mixtures by inorganic processes. Now they have found an excess of levorotary amino acids in a meteorite.[3] L-amino acids are those found in all living things on earth. Do we want to opt for life forms in outer space?

This is perhaps the most recent in a series of discoveries that have narrowed the gaps. Perhaps the earliest was the synthesis of urea by Wöhler in 1828, although it was "impossible" for anything but life to produce organic compounds. This last was one claim of vitalism, which insisted that life is a substance. Despite setbacks, vitalism continued into the twentieth century.[4] As it became clear that the doctrine could be draped over any pile of data whatsoever and that it made no testable prediction at all, it was abandoned by biologists. We still use the vitalists' term, "protoplasm." But it no longer refers to the substance which makes material things alive. When I was in college, I recall the professor discussing embryological development, the multitude of seemingly chaotic changes occurring as cells divided and redivided. How did it all come out right? "God," he said. Now I read, among other reports of discoveries, that chemical gradients control the development of legs and wings, whether vertebrate or arthropod. Sometimes we can extract or synthesize a chemical and observe its effect on cultured cells. Other times we can knock out a gene or trigger either excess production or its appearance at an abnormal time. The gaps which were once filled by appeals to "life" or to God are fewer and smaller. Moreland flatly discounts and dismisses such considerations. However, extrapolation from observable trends indicates that this is a rearguard action in imminent danger of being surrounded and overwhelmed—except that "true believers" never recog-

nize defeat. Like Giordano Bruno and Michael Servetus, they are intransigent heretics. Moreland will proclaim a revived vitalism. He will continue to claim that almost every genus and even many species are the products of uncounted individual creative acts. He will further distort the evidence and the views of his opponents to fit his position. But no one has to believe him.

What the Proof Covers

Moreland and his associates do not seem to realize what has been proved about the "design" concept. Gaining a clear understanding of its relevance will be helped by a bit of history.

Logical positivists, also known as logical empiricists, dominated philosophy in the United States for part of this century. One of their major projects was the elimination of "metaphysical"[5] terms. Included were all valuational and ethical terms, along with all theology and most traditional philosophy. They laid down the dictum that every acceptable term had to be strictly definable in terms of observables.[6] They soon discovered that theoretical terms like "atoms" and "ions," and even disposition terms like "soluble," could not be so defined. So they loosened the stricture to allow terms which could be connected to observables. Carnap formalized this new criterion in reduction sentences, like: "If a galvanometer is in a circuit, a direct current is flowing in the circuit if, and only if, the galvanometer needle is deflected."[7] However, he later discovered that science cannot function within the strictures of reduction sentences.[8] Stephen C. Meyer has essentially extended what Carnap discovered, showing that no *a priori* strictures can be placed on the vocabulary and techniques of science.[9]

Moreland wants to turn this around from "you cannot limit ..." to "you must include ..." This is inconsistent with the demonstration that no strictures can be placed. "Abandon methodological naturalism" is another useless and contradictory stricture.

Internal and External Language

O'Connor speaks relevantly of the utility of methodological naturalism.[10] We may expand his argument in a different direction. "Mass" is obviously an important scientific term, from Newton's $f = ma$ to Einstein's $E = mc^2$. This does not mean that I can insist that it be applied by psychologists to determine the mass of anger when someone loses his temper. Conversely, I cannot ask how angry a uranium nucleus is when it spalls. Each scientific discipline restricts itself to the terms it finds useful, amenable to its approach to reality. Since no aspect of anger and other emotions can be measured in grams, meters, ergs, or most of the other units used by physicists, it cannot be incorporated into their science. Occasionally, someone will discover a new connection and extend a science. Rumford, for example, connected work and heat, overturning the view that heat is a substance; Carnot connected work and caloric (later changed to energy), introducing entropy. But such extensions seem either to develop from within or to result from combining disciplines. They are not the products of dicta.[11]

Where measurement is difficult and indirect, the precision of formulas like those in the physical sciences is obviously not possible. For example, one may not be certain of a diagnosis, whether depression, stenosis, Alzheimer's disease, an iatrogenic problem, or some different syndrome. However, with the evidence available at an autopsy, the diagnosis becomes more definite, even if sometimes disputable. But always, given a specific state of medical knowledge, the possible diagnoses are fairly clear, even if a specific practitioner may admit, "I never thought of that."[12]

There are many terms relevant to the practice of science that are not scientific: grant, licensed, unlicensed, approved, unapproved, legal, illegal, informed consent, etc. All these have some type of paper test—a document which may be framed, an entry in a file, a prohibition in a legislative enactment or judicial interpretation, or a lack of such. There may be disputes about some of these matters: lawyers want a good living. But the problems are more easily resolved than those of ethics. How far, for example, in the absence of legal enactments or contractual stipulations, may one go with biological or chemical controls for weeds and pests, bioengineered plants and animals, experiments with human embryos, new treatments for diseases? Opinions vary widely. None of these matters is amenable to scientific investigation, except in the trivial sense that one may develop a sociological profile of the community's value system. One cannot determine right from wrong by a head count, nor by an experiment.

What we need to recognize is that, however important ethical, valuational, legal, and other types of terms may be, they do not enter into what scientists *qua* scientists test for. This is the point of Laplace's response when asked why he had not included mention of the deity in his monumental *Mechanique celeste: "Je n'ai pas besoin de cette hypothèse."* He was not flip, merely correct scientifically, in contrast to Newton who thought he had to depend on God from time

to time to keep the solar system from crashing. "Design" is similar. It has no place in scientific contexts. It belongs to philosophical discussion.

Rational "Design"

"Design science" is one of the latest attempts to prove that there is a God. Whereas most earlier approaches tend to be philosophical, it calls on what has been more esteemed during the current century. But the attempt must fail. True, "the heavens declare the glory of God."[13] But they do not convince all.[14] Indeed, there is biblical evidence that the attempt to show God's existence is misguided. "To approach God, one must believe that he is and that he rewards those who seek him."[15] Were there demonstration, it would no longer be belief. This does not eliminate natural theology, but it clearly limits it.

Meyer's work has relevance within natural theology and apologetics. He has shown that design and creation cannot be disproved by any scientific discipline. This clears away the common misconception that science supports materialism. Therefore, it should be better known. ❖

Notes

[1]Rom. 7:19, my translation. The key to interpreting this chapter, I think, is the tense of the verbs. The first verses are past, Paul's pre-Damascus life. Verses 14–23 are present, his status as he wrote. The next verse is future, the culmination of salvation, what I John 3:2 tells us. Many people object to this, for they do not identify with Paul's declaration of sinning. I believe that, if they were as sensitive to sin as Paul, they would echo his statement. I recall that a color-blind man reported that there were no brilliant red hibiscuses when the bushes were covered with them. He could not see what was there. Will not the "sin-blind" react analogously?

[2]Siemens, "Don't Tar Van Till: A Response to Anderson and Mills," *PSCF* 49 (March 1997): 70.

[3]John R. Cronin and Sandra Pizzarello, "Enantiomeric Excesses in Meteoritic Amino Acids," *Science* 275 (14 February 1997): 951–955. See Jeffrey L. Bada, "Extraterrestrial Handedness?" ibid.: 942f.

[4]Interestingly, Moreland's suggestion that a human being is a substance (pp. 4f, 7, 10) is vitalistic. "... if one discovered that living systems are discontinuous with nonliving systems" (p. 12) expresses his vitalistic expectation.

[5]This is not the metaphysics and occult of bookstore shelves, which mainly involve spiritism and related religious views. In philosophy, metaphysics covers such abstruse topics as being *qua* being. Positivists used "metaphysics" as their ultimate term of opprobrium.

[6]They ignored, indeed denied, the theoretical content of descriptive terms. But this is a problem which cannot be discussed here.

[7]Rudolf Carnap, "Testability and Meaning," *Philosophy of Science* 3 (1936): 419–471; 4 (1937): 1–40.

[8]Ibid., "The Methodological Character of Theoretical Concepts," in Herbert Feigl and Michael Scriven, *Minnesota Studies in the Philosophy of Science I* (Minneapolis: University of Minnesota Press, 1956), 38–76.

[9]This also slams the door on any attempt to argue that science can rule out theism or prove materialism.

[10]Robert O'Connor, "Science on Trial: Exploring the Rationality of Methodological Naturalism," *PSCF* 49 (March 1997): 15–30.

[11]Lysenkoism, the application of Marxist dogma to genetics, illustrates what happens when outside dicta are forced on science.

[12]I recall a report of an obviously ailing patient presented to a group of physicians. Since he was obviously affluent, not one of the assembled doctors thought of the proper diagnosis, scurvy.

[13]Ps. 19:1, and note the following verses.

[14]See Pss. 14:1; 53:1.

[15]Heb. 11:6, my translation.

Book Reviews

WHO'S WHO IN THEOLOGY AND SCIENCE: An International Biographical and Bibliographical Guide to Individuals and Organizations Interested in the Interaction of Theology and Science compiled and edited by the John Templeton Foundation. New York: Continuum, 1996. xviii + 713 pages, indexes. Hardcover; $59.50.

The method of selection was to start with a "core list" of scholars that was compiled by a few prominent scholars in the field and invite them to complete and submit an information form, along with recommendations for other people to include in the directory, thus widening the coverage in ever expanding ripples.

They did supplement this self-building list with names that they culled from the journals and institutions prominent in the field. However, there is no claim to comprehensiveness; rather, it is suggested that this directory should serve as the "starting point" for users to build their own networks of relevant scholars. This method has the advantage of taking a field that is "burgeoning but still rather nebulous" (p. xi) and allowing the participants to define it. One must wonder, however, if the field is really so nebulous that a preliminary definition is not possible. For instance, the writers and organizations prominent in creation science are not represented here. Was this a conscious decision, or is this simply an artifact of the method of selection and the scholars with whom they started? A consideration of the "nebulous" nature of the field, and the very wide range of scholars selected, gives one a conviction that the exclusion was deliberate.

A majority of those included are from the academic world and many—such as Carl F. H. Henry (theology), Davis A. Young (earth science), and Edwin M. Yamauchi (history)—are distinguished. Viewpoints also range widely. The editors are quick to assure us that "the Foundation's views concerning the strong interpenetration of theology and science are not shared by everyone, or perhaps even a majority of those included in this Directory" (p. vii), although more will see science and theology as complementary and related "avenues of truth." Theological positions range from those that can only speak of a "Divine Spirit" to the solid orthodox conservatism of Carl F. H. Henry.

This directory is an international "user's guide to the people, organizations, and journals currently active in the dialogue between science and theology" (p. xi). Thirty-six areas of competence are listed, ranging from administration to theology/religion. Philosophy, physics, ethics, psychiatry, and sociology are a few of the others.

This directory is very well organized for reference. It includes four directories and five indexes. Directories A & B contain the responses of 1,086 individuals from the U.S. and 39 other countries. Directories C & D describe 73 institutions, organizations, journals, and newsletters. There is a name and address only list of 49 more organizations and publications as well as an alphabetical index, a geographical index, a primary subject index, and a journal index. Almost 32% of the organizations and 35% of the individuals are from outside the U.S.

This is not the normal "Who's Who" and the editors wisely warn the reader to use it cautiously, in light of its specialized purpose and nature. There is no attempt to give a complete summary of the individual's complete curriculum vitae; rather, the information given is selected because of its relevance and usefulness to the dialogue between science and theology and to assess the individual's work, interests, and accomplishments in this area. With very few exceptions, the data comes only from people who responded to the questionnaires with a wide variation in the quantity, quality, and significance of the information.

There was no editorial attempt to evaluate the entries and the accuracy of the entries was left entirely up to the respondents. A complete entry will contain present position and address, date of birth, phone and fax numbers, e-mail numbers, education, previous positions, editorial positions, other relevant experience, languages spoken, selected memberships, discipline(s) and other related areas of interest, and a selected bibliography of up to ten publications of relevance to the field and similar categories where relevant. In some cases, the definition of relevant used by the respondent must have been quite broad. The Directory can be recommended for the purpose claimed by the editors: an excellent resource to begin one's own, individually tailored, network of scholars.

Reviewed by Eugene O. Bowser, Reference Librarian, James A. Michener Library, The University of Northern Colorado, Greeley, CO 80639.

THE END OF SCIENCE: Facing the Limits of Knowledge in the Twilight of the Scientific Age by John Horgan. New York: Addison-Wesley Publishing Company, Inc., 1996. 308 pages, index and footnotes. Hardcover; $24.00.

An American fable, probably apocryphal, tells of an executive in the Patents Office resigning his job in 1890 because, he said, "Nearly everything that can be invented now has been!" Now comes John Horgan, science writer for the *Scientific American* (that journal which has the self-appointed task of telling us how to think about science), interviewing dozens of scientists and philosophers on a similar issue. Horgan poses the question this way:

1. Have the BIG questions all been answered?
2. Is the age of great discoveries now behind us?
3. Are scientists now reduced to puzzle-solving, just adding details, and possibly precision, to today's existing theories?

Horgan argues persuasively for "endism," a "yes" answer to all the questions above. As a result, he sees science losing its place in the hierarchy of disciplines and eventually becoming much like the field of literary criticism. His arguments are based, not so much on his own ideas, but on the ideas freely shared by the people he interviews. Most of the "big" names are included: Popper, Kuhn, Feyerabend, Weinberg, Wheeler, Dawkins, Chomsky, Eccles, and many others.

This is a frustrating book; one wishes to enter into the interview, to ask the questions Horgan glosses over, to clarify points. It is also an exciting book, for it covers a common topic across many disciplines. But it is a depressing book as well; one comes away from it with an impression similar to the writer of Ecclesiastics: all is vanity. Yet, it is an uplifting book for the Christian; I see in it the logical end of treating "science" as a faith position.

This may be a short-lived book, for it is very much bound to the "state of the art" of the early 90s. The subject it covers, however, will continue to be an issue for decades to come, and I foresee extensive quotations from it for many years to come.

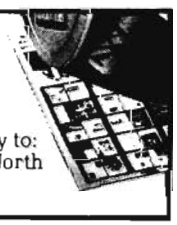
Horgan writes with insight into the end of progress, philosophy, physics, cosmology, evolutionary biology, social science, neuroscience, and so on. In an epilogue, titled "The Terror of God," Horgan speculates what this means. He writes:

> The ostensible goal of science, philosophy, religion and all forms of knowledge is to transform the great "Hunh" of mystical wonder into an even greater "Aha" of understanding. But after one arrives at THE ANSWER, what then? There is a kind of horror in thinking that our sense of wonder might be extinguished, once and for all time, by our knowledge. What, then, would be the purpose of existence? There would be none (p. 266).

The book ends with this plaintive wail, "And now that science—true, pure, empirical science—has ended, what else is there to believe in?"

I recommend this book to all ASA members. It ought to be readable by most persons at the college level and perhaps even by some advanced high school students. The issues raised are important. The views it collects under a single cover are a unique look at science not found in the textbooks. Much time and effort went into its research, and the results are well worth our attention. It is easy to read, controversial and, above all, entertaining.

Reviewed by John W. Burgeson, 6715 Colina Lane, Austin, TX 78759.



GOD, CHANCE AND NECESSITY by Keith Ward. Oxford, England: Oneworld Publications, 1996. 212 pages, index. Paperback; $14.95.

Ward is Regius Divinity Professor at the University of Oxford. His previous publications include *The Concept of God, Defending the Soul,* and *Images of Eternity.* The current book is a dedicated refutation of scientific atheism. It is not, as one might conclude from the title, a sustained attack on Jacques Monod. It is an attack on metaphysical materialism, as exhibited by Carl Sagan, Stephen Hawking, Peter Atkins, Richard Dawkins, and others. Darwin's uncertainties and ambivalences are explicitly mentioned. Ward's fundamental point is that scientific knowledge does not undermine belief in God; on the contrary, God is the best explanation for the total set of properties of the universe and all contained therein. Materialism, he argues, can present a coherent picture only by "eliminating" (ignoring) complexity, which is called exclusive simplicity. There are ten chapters with headings such as: "The Origin of the Universe," "Is There Any Point? Where the Universe Is Going," "Darwin and Natural Selection," "The Metaphysics of Theism," and "The Future of Evolution."

In discussing the origin of the universe, Ward begins with the issue of reason or purpose. Hume was the first to assert that there is no reason for the universe, that it just is. "The Big Bang just happened, for no particular reason ..." By applying this kind of logic to the existence of physical law, complexity, quantum indeterminism, and moral freedom, Ward shows the absurdity of this position. (One might add to the list the "irreducible complexity" analyzed so powerfully by Michael Behe.) He asks rhetorically about the origin of physical law. "The whole of science proceeds on the assumption that a reason can be found for why things are as they are, [and] that it is the end of science if one finds an 'uncaused' event." He also mentions, but does not discuss the implications of, the behavior of systems "far from equilibrium." This would have been a good opportunity to distinguish between predictability and determinism. Chaotic systems are perfectly deterministic and totally unpredictable. While not doubting statements about quantum indeterminacy, I am not satisfied that this has relevance above the sub-atomic level. Ward uses indeterminacy in support of an "open," i.e. unpredictable, world. He has thereby sidestepped a very large problem; he treats it with alacrity, not with rigor.

Ward devotes considerable attention to Atkins, who, it would seem, has made some highly provocative metaphysical assertions. Among other things, Atkins claims that "physical reality is mathematics and mathematics is physical reality." Ward identifies this as espousal of the fallacy of misplaced concreteness, and catches Atkins in a breathtaking *non sequitur.* He goes on to conclude that Atkins is actually committed to theism but does not know it. The chapter dealing with Atkins' claim that "everything is extraordinarily simple" is quite cogent and well argued.

In the chapter dealing with Darwin, Ward correctly observes that Darwin did not think that natural selection was the only principle accounting for evolution. So the attack here is against Darwinism, the fundamental prem-

ises of which are the randomness of mutation and the absence of purpose in the process of evolution. (Ward did not cite the work of John Cairns which demonstrates apparently directed mutations.) With regard to the highly contentious and *post hoc* concept of biological fitness, Ward observes that the fittest are not known in advance. If humans should become extinct, then maybe ants would be considered the most fit. In my opinion, Ward devotes too much space to demonstrating that Darwinism, with its tunnel vision focused on fitness, cannot account for many of the properties of humans, for example, consciousness. This is described as requiring "a very high standard of story-telling or myth making ... [which] with the aid of hindsight can explain absolutely anything." He seems to get caught up in a contradiction with regard to Donald Campbell's "top-down" causation and Whitehead's mutual causation, but it occurs in such a way as to have no importance for the sequel. Ward is not the first nor the most eloquent to point out that much of Darwin's thinking seems to come directly from Adam Smith; specifically the fundamental assumption by Darwin, and later in a more strident and dangerous form by the Darwinists, that the essence of life is competitive. Explaining the clear existence of widespread cooperation in the organic world has been a long-standing problem for Darwinists. In fact sociobiology owes its existence to an offhand remark by J. B. S Haldane: "... I would give up my life for two brothers or four cousins ..."

When I began writing this review, I re-opened Ward to check something and wound up re-reading the whole book a second time. It is a highly readable little book, which probably means that it is not tightly argued. But it covers so much ground that this would be expecting too much. It is most enjoyable and highly rewarding.

Reviewed by Braxton M. Alfred, Professor of Biological Anthropology, University of British Columbia, Vancouver, BC V6T 1Z1.

A THEORY OF ALMOST EVERYTHING: A Scientific and Religious Quest for Ultimate Answers by Robert Barry. Oxford, England: Oneworld Publications, 1996. 200 pages, index. Paperback; $13.95.

What is the meaning of life? Robert Barry's answer lies in a mystical synthesis of modern physics with world religions. The book is partitioned into three sections beginning with self-consciousness, progressing through consciousness of the physical universe, and culminating in mystical consciousness. References are collated at the end of the book and are further referenced to a bibliography that spans everything from the theologically orthodox to the not so orthodox.

"The Selfish Universe" (Part 1) demonstrates that people have limited control over the external world. Society imposes rules and regulations and even other people's opinions influence individuals in becoming a "self-fulfilling prophecy." "The philosopher Ecclesiastes sums up our situation when he declares his life useless, despite his possessing everything in this world that most of us desire. His dilemma, however, and ours, arises from living life for the illusory self and failing to live life for the whole" (p. 34). Ecclesiastes, the wisest man that ever lived, is wrong, or at least unenlightened according to Barry, and Barry graciously provides a history of consciousness to help us become enlightened.

In the beginning was the big bang followed by the evolution of man, and "Somewhere along the line, simple *consciousness* arose" (p. 37)—a mere trifling problem in evolutionary theory. The Bible's analogy says that Adam "rose (or fell, according to the story) to a new level of consciousness—that of self consciousness" (p. 38). Unfortunately people have remained in this deprived state until God—here Barry means that bad Christian God—was replaced by the self.

Barry digresses from the search for complete self-consciousness for a chapter while he summarizes modern physics. The point is to show the indeterminacy of the space-time model of physics. Barry proposes "an extension of the basic idea behind relativity in an attempt to account for both mind and matter in a single theory ... I suggest that we consider a reality consisting of seven dimensions—three of space, one of time, and three of mind" (pp. 99–100). After all "Is there really any difference between the Infinite encountered by scientists (in concepts such as 'black holes,' quantum 'waves,' or the big bang 'singularity') and the infinite (or God) of religion?" (p. 123). The logic is superb, so let's hypothetically agree with Barry that God and the concept of black holes are essentially the same. Now, however, we encounter a problem since Barry states that God is *above* these seven dimensions—not *in* a dimension (p. 108). The author modestly states "My proposed dimensions of mind require some development ..." (p. 105) with which this reviewer heartily concurs.

The way to understand this rather complicated situation is to realize that, above all else, we live in "The Mystical Universe" (Part 3). Barry uses a history of religion to show that mysticism is an intrinsic part of all faiths. Barry's chronology implies an unusual religious evolution beginning with Hinduism, progressing through Christianity (with some unique exegeses) and culminating in the Baha'i faith. We must embrace this new-found mysticism because this is "the common essence of religion ... [and is the basis] I believe, for the latest scientific thinking" (p. 146). We are at the dawn of a new age and a new physics, at least according to those who know best: James Lovelock (founder of the Gaia hypothesis); Sir George Trevelyan (founder of the British New Age Movement); and Alvin Toffler (author of *The Third Wave*) to name a few. There is no mention of how the new age is being heralded in such places as Bosnia, Rwanda, and Algeria but the author assures us that if this theory "serves you in any way—helps you to integrate existing knowledge, enables you to make some reliable prediction, helps you to extract some meaning from life, reduces your feelings of alienation, or gives you a sense of purpose—you will adopt it" (p. 108).

Barry tackles a difficult task of harmonizing science and philosophy and supports his position with several

interesting psychological studies. Barry has a knack for making seemingly innocuous statements that on greater reflection have huge ramifications for Christianity. For example, "Does it really matter whether God spoke directly to us in Jesus, or whether He spoke to us indirectly *through* Jesus" (p. 133, italics in original). ASA members will not agree with Barry's conclusions but may find the book useful as a summary of the spirit of our age.

Reviewed by Fraser F. Fleming, Assistant Professor of Chemistry, Duquesne University, Pittsburgh, PA 15282.

THE NATURE OF SPACE AND TIME by Stephen Hawking and Roger Penrose. Princeton: Princeton University Press, 1996. vii + 141 pages. Hardcover.

In a book I reviewed for the December 1996 issue of this journal, the Rev. Dr. David Wilkinson claimed that philosopher William Craig was wrong to label Cambridge physicist Stephen Hawking an "anti-realist" because of his use of "imaginary time." (See Craig's incisive critique of *A Brief History of Time* in his *Theism, Atheism, and Big Bang Cosmology* [Oxford]). Says Wilkinson, "It is wrong to write off Hawking as just an idealist or having just an instrumentalist view of his theory. He is using a mathematical technique in order to describe the real Universe" (p. 156). However, this recent book by Hawking and Roger Penrose, a professor of mathematics at the University of Oxford, contradicts Wilkinson's assertion and vindicates Craig: Hawking, in fact, does *not* believe in "a real Universe," and he is an instrumentalist in the idealist camp!

The Nature of Space and Time is an illuminating book that requires a good grasp of physics to be fully appreciated. There are pertinent philosophical and theological questions raised by the book: how we are to understand science, the origin of the universe, and God's existence. In the first six chapters, Hawking and Penrose alternately present their respective positions regarding space-time, relativity theory, quantum mechanics/quantum cosmology, the nature of space-time singularities, and related issues. The final chapter is an interesting debate between them.

On the one hand, Penrose does not consider quantum mechanics a sufficient answer to our questions about the origin and nature of the universe ("we need more" [p. 106]). Penrose uses classical general relativity to explain how the universe works. Hawking, on the other hand, appeals to quantum mechanics and quantum cosmology to fill the gaps of classical theory. Hawking states that while general relativity reveals that there should be a singularity in our past, it itself cannot predict the universe (p. 75). Contrasting their positions, Penrose comments: "If one compares this debate with the famous debate of Bohr and Einstein, I should think that Stephen [Hawking] plays the role of Bohr, whereas I play Einstein's role!" (p. 134).

What is a significant and recurring theme in the book is the different philosophical positions that Hawking and Penrose maintain. Hawking unashamedly admits, "I'm a positivist" (p. 121; cf. p. 123)—a glaringly *unscientific*, philosophically problematic pronouncement. (Does this not appear to rule out God *a priori* as having anything to do with the origin of the universe?) Penrose, on the other hand, is a realist, who believes that good scientific theories correspond to a real world (p. 134).

Like Bohr, Hawking is an anti-realist of the instrumentalist stripe. Along with Wilkinson, many have taken Hawking's ideas to be describing the physical world ("the real Universe"). But Hawking does not care if theories have any physical significance (p. 3): "a physical theory is just a mathematical model and ... it is meaningless to ask whether it corresponds to reality" (p. 4). Again, "I don't demand that a theory correspond to reality because I don't know what it is ... All I'm concerned with is that the theory should predict the results of measurements" (p. 121).

As one reads Hawking here and elsewhere, one gets the impression that he would like to eliminate God as the possible Originator of the universe despite his claims to be open to such a proposal. He attempts to do so by eliminating the initial singularity through the positing of imaginary—not actual—time. Thus "[the universe] would quite literally be created out of nothing: not just out of the vacuum, but out of absolutely nothing at all, because there is nothing outside the universe" (p. 85).

Massive philosophical questions remain to be answered by Hawking, however. How can the universe emerge from mathematical *abstractions*, which have no efficient causal power to instantiate anything at all? Why (as Craig asks elsewhere) should we think imaginary duration makes any more sense than imaginary length or imaginary volume? How can Hawking coherently justify his spatialization of time? Why should we prefer Hawking's understanding of tenseless, Euclidean time (B-theory) over an intuitively-preferable view of time that accounts for past, present, and future (A-Theory)? (For instance, why should we embrace his reductionist view of time as exclusively *physical time* when a succession of *mental* events would be sufficient to ground time?) How has Hawking in any intelligible sense eliminated the need for a Creator?

These questions aside, Hawking and Penrose present a lively and instructive discussion about some of the current issues in physics and cosmology. Whatever side one takes on such matters, the debate should not be ignored.

Reviewed by Paul Copan, Marquette University, Coughlin Hall, 132, P.O. Box 1881, Milwaukee WI 53201-1881.

COSMIC BEGINNINGS AND HUMAN ENDS: Where Science and Religion Meet by Clifford N. Matthews and Roy Abraham Varghese, Eds. Chicago: Open Court Publishing Co., 1995. 427 pages, $21.95.

The editors have collected 22 essays based on presentations at the Symposium on Science and Religion held

in Chicago in October 1993 in connection with the Parliament of the World's Religions. The title of this book was the theme of the Symposium. There were 7000 attendees at the Parliament.

The authors of the essays at the Science/Religion Symposium were requested by the editors to address the following questions: (1) What are your views on cosmic beginnings, particularly with reference to the origin of the universe, of life and of *homo sapiens*? (2) What are your views on human ends, especially as this relates to the framework of cosmic beginnings? (3) What do you think should be the relationship between religion and science?

As expected, the answers given depended upon the religious or philosophical positions of the authors and their academic disciplines. Fifteen of the authors are college professors (two emeritus) and three are astronomers. There is one medical doctor, one university president, two Nobel prize winners, and one retired NSF program director. All contributors, therefore, had respectable intellectual and educational credentials, and were qualified to bring a reasoned approach to the theme. Only two of the 22 essayists referred to themselves as Christians. The atheistic position was quite evident in some essays. Some essayists wrote from Confucian, Taoist, or Buddhist backgrounds.

The answers to the three central questions were very interesting. With regard to origins (question 1), the answers could be summarized in the following statements. Nine had "no opinion" or else neglected to reply. Seven accepted the "big bang" cosmological theory, two could only speculate, two said that there are many universes in addition to ours, one said that the universe is not real, and one believed in a Creator.

For question 2, five had vague "non-answers," four failed to answer or did not know, four said that it is a mystery or an open question, two said "human life is insignificant," and one said human destiny was "to be in harmony with the Supreme Being." The remaining essayists made statements like "the answer is only valid in the realm of faith," "it depends on the future evolutionary steps," "we need to change the goals of the old patriarchal religion," "we must work for social justice," and "we should go with the flow consistent with natural law."

The third question evoked even more diverse answers than the first two. Four essayists did not respond; three said, "Science and religion need each other;" three said, "No reconciliation is needed since there is no conflict" (due in large part to their definition of religion); and two said that science and religion should have mutual respect for each other. One author made the assertion that "dogmatic religion is the cause of all the evil in the world." Another author contended that "religion must become scientific." One essayist made the point that "both science and religion are based on faith-filled assumptions." Another essayist espoused the philosophy of *Gaia* and concluded that there is no conflict with science if one believes in *Gaia*.

One would not expect a unity of viewpoints on the book's theme with contributors from such diverse backgrounds and experience. I believe the book has value as a summary of the collective mind of contemporary academia. As I read the book, I was impressed with the deep-rooted atheism of many intellectuals in academic circles. It is well recognized that the prevailing worldview in academia is *scientific naturalism*. Several notable Christian writers such as Charles Colson and Phillip E. Johnson have made frequent reference to this state of affairs in their recent writings. I was impressed with the following statement in the Introduction by James Kenney: "A culture necessarily depends upon a set of assumptions so interwoven that to challenge one strand is to threaten the entire structure." Johnson has challenged the evolutionary strand in *Darwin on Trial* and *Reason in the Balance*. Although *Cosmic Beginnings* does not offer confirmation of Kenney's thesis, it does offer some examples in support of it. In my opinion, this book points out the need for Christian scientists, theologians, and philosophers to stand up, be counted, and challenge the methodological naturalism prevailing in contemporary intellectual circles. If one desires a taste of the worldview of many contemporary academic leaders, then I suggest that they read this book.

Reviewed by O. C. Karkalits, Dean, College of Engineering and Technology, McNeese State University, Lake Charles, LA 70609.

THE GREAT DINOSAUR EXTINCTION CONTROVERSY by Charles Officer and Jake Page. Reading, MA: Addison Wesley Publishing Company, Inc., 1996. 200 pages, index. Hardcover; $25.00.

Officer is a research geology professor at Dartmouth College, and speaks with some authority on the geological considerations of extinctions. He refers to some of his own studies as well as hundreds of others in a well done bibliography. Page is a science writer, previous founder and director of Smithsonian Books, and Editorial Director of Natural History. He has experience with the politics and recent history of science.

This book discusses, refutes, and offers a plausible alternative to the Alvarez hypothesis for the extinction of the dinosaurs. Alvarez hypothesized that an impact of an extraterrestrial object may have caused their demise (and that of other life forms) 65 million years ago. After laying a groundwork including background on meteorites, comets, dinosaurs, geology, and species extinctions, the authors look both at the scientific evidence (or lack thereof), and the fascinating (and sobering) politics of science involved in this particular issue.

They discuss the "paradigm shift" which occurred when Luis and Walter Alvarez and others proposed a meteorite as a possible mechanism for the mass extinctions at the end of the Cretaceous, 65 million years ago. This hypothesis was accepted by many scientists in an unusually quick and complete way, perhaps due to the

reputation of Nobel laureate Luis Alvarez, whereas the evidence to support it is actually relatively incomplete. The authors look at the strengths and weaknesses of this hypothesis, and then go on to explore alternative hypotheses which may conform to more of the available data. For the many, like myself, who have been dinosaur aficionados since childhood, and also for scientists who believe science to be fully objective or who realize they may need to learn to be wary of overly objectifying science, this is a good book.

A few geologists examined the data and found various flaws with the hypothesis, including many "detail" flaws—rocks and fossils which did not match a "single event" or an "impact" type of hypothesis. They review three major facts which may not be common knowledge: (1) the dinosaurs did not die out "suddenly," but apparently slowly died out over several million years, (2) the dinosaurs were not the only creatures wiped out by whatever event—or more likely, events—wiped out about half of all living species then in existence over the course of a few million years, 60–70 million years ago, and (3) that major extinction event was not the only event. Many other extinctions have occurred, and one larger event did occur about 250 million years ago, wiping out roughly 80–90% of all species then in existence. In addition, evidence regarding iridium and shocked quartz is supposedly consistent with only extraterrestrial objects. However, there is mounting evidence that these may be formed by volcanism, which is what the authors hypothesize. One more flaw with the impact theory is that to date, there is no crater clearly in evidence which corresponds to the supposed impact of 65 million years ago.

The politics of science is the other major theme of this book. The authors accurately note, "Scientists, contrary to the popular archetype, are often quite unobjective in the pursuit of truth." This is a highly relevant topic for all scientists, as well as others, to consider. A discussion of the "silly season" explores how the impact group came up with many ways to change the story to fit the facts, once facts came to light which clearly refuted the hypothesis. The authors refer to this as "degenerative science," and propose that "progressive science" advances hypotheses which suggest new expected discoveries which can then be proven or disproved through experiment or evidence.

The authors did more than poke numerous holes in the impact theory. They proposed alternate and plausible theories, and presented evidence which has been found, as well as further expected discoveries. If further investigation reveals that indeed, linkages among volcanism, sea level, reasonable related changes in the atmosphere (including acid rain, ozone depletion, and weather changes), and global temperature exist and correspond to the geologic record of extinctions, this theory will gain further credence.

Readers may find this book useful in discussions of objectivity (or lack thereof) in science, and it may be useful for all of us to get a dose of humility about our knowledge. None of us know it all, and we would be wise to continue to seek sincerely, rather than jump to judgmental conclusions. Awareness of how the media can further warp the fabric of science may help to avoid some of these pitfalls. By the end of the book, the reader may feel even more humble than previously, as well as more doubtful of almost all the publications which one reads. Perhaps this is wise, even if it seems to make us less trusting of individual investigators or even of whole schools of science.

However, even if the impact theory proposed by the Alvarez group is conclusively proven to have been the wrong hypothesis, it will still have started the ball really rolling towards what has been for many a childhood fantasy: understanding more clearly what really caused the extinction of the dinosaurs. One final note from the authors that "... the extent (to which) this furor distracted humanity's attention from the ways in which it is itself inaugurating a period of mass extinctions..." (p. 187), reminds us to consider the goals of our scientific objectives, as well as the means. The authors conclude "happily, the very processes of sciences have so far tended to overcome these human shortcomings over time." This will be true as long as we question hypotheses and continue to sincerely seek the truth.

Reviewed by Steven G. Hall, P.E., Doctoral Candidate, Agricultural and Biological Engineering, 419 Riley-Robb Hall, Cornell University, Ithaca, NY 14853.

A HANDBOOK IN THEOLOGY AND ECOLOGY by Celia Deane-Drummond. London: SCM Press Ltd., 1996. 178 pages. Paperback.

This book is the product of sponsorship by the World Wildlife Federation (WWF) and extensive consultation by Dearie-Drummond with the International Consultancy on Religion, Education and Culture (ICOREC). The author's specific qualifications are not mentioned. There are nine chapters with such headings as "Practical Issues of Environmental Concern," "Ecology and Biblical Studies," and "Ecology and Celtic Christianity." It is designed for use in a classroom or study group, and interspersed within the text are breaks for discussion and questions (e.g., "Write out a list of the questions that villagers would raise in discussions over a land reclamation project ... How could their needs be taken into account?" and "Read the account in Bede of the Council of Whitby in 663. Put your findings in the form of a drama.") I found this annoying, but the book is not produced for reading cover to cover at one sitting.

Chapter 1 sets the stage. It lays out the magnitude of the growing crisis. This seems to repeat the alarmist pronouncements that one can get in any daily newspaper and, while there was some material new to me, having accepted that there is an imminent disaster, I did not need the recitation. Further the science here is superficial, because only consequences are presented, with very little attention to dynamics.

Chapter 2 is a Bible study course for environmental concerns. There are declarations here which are bound to be controversial, such as "Genesis was written as a poem to express the faith of the Israelites." In one of the question interludes, the author presents some attitudes about the origin of the universe for discussion: agnostic, Christian theistic, and Creationistic. She then asks for the basic presuppositions of each view. This could certainly be an interesting and useful exercise—for a lifetime. But the outstanding feature of this chapter is the numerous biblical references, such as peace with animals (Isa. 11) and the covenant of peace (Ez. 34:25). There is a good, but too brief, discussion of the Wisdom literature; and a curious reference to Prov. 8:22–31. It seems to be placed here to demonstrate something about *Sophia* ("feminine") wisdom, and ignores the matter of God's not being alone at the beginning. Rom. 8:18–23, Col. 1:15–23 and Rev. 21:1–8 all receive extended attention. There is also a consideration of the Book of Wisdom, which is one of the books of the Apocrypha.

Chapter three is devoted to a discussion of Celtic Christianity. The asceticism of the Celtic saints will make anyone feel like a sybarite; they were a remarkable lot. The lives of St. Patrick (St. Patrick's shield), Pelagius ("a unity of action in human freedom and God's grace, both are gifts from God"), St. Columba ("The person to whom little is not enough will not benefit from more.") are sketched. By legend, St. Brigit was present at the birth of Christ. As fascinating as all this is, a question arises as to its relevance to the topic. The Celtic tradition was more prone to nature mysticism than the Roman. The author's intent seems to be a recommendation that the West should adopt some of the Celtic attitudes toward reverence for all of creation. While in basic agreement, it seems a bit quixotic to me. We are what we are, and that program is most likely to succeed which demands the least.

There are chapters dealing with writing ecological liturgies: one on *Gaia* which shows that the hypothesis has been adopted by groups with quite different agendas, and another on ecological politics (where Ernst Shumacher's landmark work dealing with intermediate technology was finally mentioned). The chapter on "Future directives for an ecological theology" makes some interesting points: that the principles of global justice and ecological responsibility need to be added to that of sustainable development and that an ecological road tax needs to be levied along with a ban on freight transport by road.

There are two appendices. One includes a harvest liturgy taken from Creation Festival Liturgy by WWF/ICOREC. The second includes a self-explanatory list, "What on earth can I do?"

This book is not what I had expected and hoped for, but that is not the author's fault. It is rather superficial, but it was prepared for the purpose of focusing discussion and as a learning tool for those with limited background in science. Its success will depend heavily on the commitment of the leader.

Reviewed by Braxton M. Alfred, University of British Columbia, Vancouver, BC V6T 1Z1.

STORIES OF THE BEGINNING: Genesis 1–11 and Other Creation Stories by Ellen van Wolde (John Bowdon, trans.) London, England: SCM Press Ltd., 1996. 265 pages, notes, bibliography. Paperback.

While this intensive approach to Genesis may be familiar territory for biblical scholars, the author, a student of Umberto Eco and Professor of Old Testament Exegesis and Hebrew in The Netherlands, offers insights and reflections for other students of Old Testament literature and associated Jewish and Christian beliefs. This fresh examination of the biblical language brings the reader to the texts as though for a first reading, taking for granted little of what has become familiar. Professor van Wolde would not have us read our own history back into the original texts.

In her plain, accessible style, van Wolde also declines to yield to a Christian gloss in her interpretations, preferring a more literal reading and shaking up long-accepted bases for Christian theology found in the fall. She presents the texts as an evolving expression of relationships between both varying aspects of God and the world to those humankind who become his people and assume their place in his world. As with creation stories at large, Genesis provides a foundation for existence in filling its beginnings with meaning, some of it quite different from that to which we have become accustomed. Van Wolde challenges us to relinquish our traditional readings to discover what a naive exploration of the language can reveal. When we do so, she reveals that Genesis effectively combines two levels of history: that of a biological-physiological process and that of transmitted experiences.

Notably, she reminds us that in Genesis God is reaching out to and dealing with humankind, not the reverse. God, then, is the center of Genesis. Moreover, our point of reference is uniquely in God, rather than in "our kind." Throughout these chapters, everything is in a process of becoming by God's hand and "every human being is a pointer to God for another human being" (p. 29). Good and bad are pointedly distinguished from good and evil, as humankind undergoes distinct stages in necessary maturation under the guidance of God, even though the result is a divergence from him. Significantly and characteristically, van Wolde notes that this divergence is a matter of God's allowing humankind to mature, rather than a matter of sin, that is, morality or ethics. At the same time God is making himself known to humankind through divine names, "a kind of window though which we look, which offers the writer and readers the possibility of making the unimaginable imaginable" (p. 136).

The author's approach is to examine the Genesis excerpts a passage at a time, followed by discourse on the text, with selected Hebrew words subjected to lengthy exploration. Along the way, she dwells on meaningful puns we may have missed in past accounts. She can take the reader by surprise and make us wish we, too, were scholars of ancient Hebrew. While not all of what van Wolde proffers is entirely convincing, the reader will find much to ponder in what she is saying, whether agreeing or disagreeing with her and even when the language lacks

a certain finesse (perhaps a function of translation). Her mini-lessons in Hebrew are highly effective, and she pays more than lip service to alternative translations. Thus, the reader can come to a personal conclusion as to what the text is conveying. As an aid to this effort, the highlights of each passage are clearly summarized before the next is addressed.

About three-quarters into the volume, brief excerpts from a representative selection of worldwide creation stories are provided. Instead of comparisons to Genesis, these stories are allowed to speak on their own terms. Some of these excerpts are told in more affective language than that of Genesis. Here van Wolde is not looking for universals but for distinctive character in the selections provided. It is this character which provides insight into other cultures and into our own. In contrast with the dissertations on Genesis, each brief excerpt is presented with only minimal introduction. Even less attention is devoted to the scientific story of creation, which is better addressed elsewhere. This material does round out the structure of the volume but might better have been omitted. Obviously, van Wolde's best effort is reserved for those first eleven chapters of Genesis. That is where the reader will become engrossed.

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BIOETHICS: A Primer for Christians by Gilbert Meilaender. Grand Rapids: Eerdmans Publishing, 1996. 120 pages, index. Paperback, $10.00.

Meilaender has written a brief but profoundly contemplative book covering the essentials of bioethics, primarily for a Christian audience. However, others will not be disappointed as he presents complicated issues clearly, giving an overview of the "why and what" of evangelical thinking on bioethics.

He starts with a chapter on "Christian Vision," briefly stating the theological principles that he applies to his thinking in bioethical issues. I found it very relevant and helpful because he uses these principles to weave his arguments together with a remarkable level of coherence. He repeatedly draws on these principles as he considers each topic in detail. He covers all the current ethical dilemmas in society that have emerged with the development of technology. Chapters include "Procreation Versus Reproduction," "Abortion," "Genetic Advance," "Prenatal Screening," "Suicide and Euthanasia," "Refusing Treatment," "Who Decides?" "Gifts of the Body: Organ Donation," "Gifts of the Body: Human Experimentation," and "Sickness and Health."

The book is generously peppered with nuggets, for example, in the chapter on "Procreation Versus Reproduction," he states "we tempt ourselves to think of the child as the product of our rational will, and we destroy the intimate connection between the love-giving and life-giving aspects of the one-flesh marital union." The book gently reminds us of how easy it is to slip into perspectives that give credence to the spirit of the age.

My only major concern with his arguments was in his chapter on abortion. In it he suggests reasons why one may conclude that human life begins a little later than conception. He also states reasons why one may consider life to begin at conception. However, both conclusions I believe are drawn from a shaky presupposition. His reasons for fixing the beginning of unique human life arise from "knowledge of human development" which implies that scientific reasoning alone can determine the origins of human life. That our life begins at conception is transcendent truth; natural reasoning alone cannot fix the beginning of unique individual life. We do not create life nor do we own it: the definition of life transcends natural ways of knowing, and we can only accept life as a sacred gift from our Creator.

I would highly recommend this book to those of us who find most books on bioethics dry and pedantic. This book represents gracious scholarship intended, as the title states, to equip the Christian in the pew with a biblical view on bioethics. Here is a proclamation of Kingdom ethics in an ever changing world.

Reviewed by Joseph Gladwin, Department of Forest Science, Oregon State University, Corvallis, OR 97331.

LEADING LAWYERS' CASE FOR THE RESURRECTION by Ross Clifford. Edmonton, Alberta, Canada: Canadian Institute, 1996. 144 pages. Paperback.

In the introduction, Clifford relates that he was influenced early in his Christian life by reading a book containing views of two lawyers. In this book, Clifford summarizes and evaluates what some leading lawyers say about the Christian faith. Why lawyers? Clifford gives this answer: "Lawyers, unlike philosophers and theologians, have the skills to assess the reliability of documents such as ones in which the Jesus story is told" (p. 11). While this is a debatable statement (some of the leading Christian apologists have not been lawyers), it does not take away from the value of the book.

Besides Jesus' resurrection, the book's eight chapters speak to the authorship, reliability, truthfulness, and complementarity of the gospels, the extracanonical evidence for Jesus, the utility of faith, and the legitimate response to Jesus.

Of the three appendices, the most interesting and helpful contains quotations by leading lawyers on the resurrection of Jesus. There is no index but the book is short enough to locate information without difficulty. Clifford gives bibliographic information to aid the reader in locating resources.

Clifford presents three principles to guide the reader: (1) evidence does not bring 100 percent certainty; (2) to make a decision against the evidence is to commit intel-

lectual suicide and be intellectually dishonest; and (3) doubt folds in the face of facts. This book is appropriate for the lay person, the young Christian, or the apologetic neophyte. Its succinctness and persuasive tone qualify it as an evangelistic tool. It will also be helpful to those who prepare lectures or sermons since it contains many useful and pithy quotes.

Reviewed by Richard Ruble, John Brown University, Siloam Springs, AR 72761.

THE ROAD TO UNDERSTANDING: More than Dreamt of in Your Philosophy by Joseph M. Bochenski, (Gerard M. Verschuuren trans.). North Andover, MA: Genesis Publishing Co., 1996. 137 pages, index. Paperback; $13.95.

The author states that we all philosophize, whether we like it or not, but, at the same time, "philosophizing is one of the most beautiful and noble pursuits there is in a human life" (p. 18). But although the pursuit is noble and beautiful, there are also "enormous difficulties involved." To bring philosophy closer to a nonprofessional philosopher and to bring people closer to philosophy, Bochenski wrote a great little book that serves the purpose exceedingly well. Notwithstanding the small size of the book, the author manages to present basic tenets of philosophy, pointing to a variety of solutions for particular philosophical problems and to difficulties involved with each solution. Some solutions are far from intuitive. Bochenski, however, exercises a charitable attitude to each of them by presenting their philosophical core and finding a worthwhile side in each of them.

The book consists of ten chapters, each devoted to one particular philosophical problem: the concept of philosophy itself, the concept of knowledge, truth, thinking, laws, values, humanity, being, society, and the absolute. Bochenski presents philosophical problems surrounding these major philosophical concepts, and misses no opportunity to present his personal opinion concerning some issues. It is clear that Bochenski breathes and lives philosophy, and his enthusiasm becomes quite contagious when reading his popular prolegomenon to philosophy.

Reviewed by Adam Drozdek, Duquesne University, Pittsburgh, PA 15282.

Letters

Reflections on *PSCF* Articles

Some of the articles in *PSCF* have raised questions in my mind lately and I would like to express a few thoughts.

As a Christian believing in Jesus Christ as my Savior, I believe that God is the true Creator, that he created and is responsible for the cosmos. When we study science, no matter what field, we are studying God's handiwork and discovering the natural rules that govern it, the rules that God has set up to control the cosmos. In this light the process of evolution, whatever it consists of, is God's way of doing things. I also believe that God always knows what he is doing; he does not perform miracles. We may see them as miracles because we do not understand what God is doing. Probably our greatest handicap is the dimension of time. We feel that we have to put everything into a time reference, which limits our ability to understand the cosmos and greatly perplexes our studies.

Our greatest problem is that we believe that we can arrive at the final truth of life and of the cosmos. The writers of the various articles generally reveal this conviction. They categorize and codify the results of their studies until they arrive at a system of conclusions which they firmly believe is the truth. I am 77 years old now and have followed the teachings of science for most of my life. I have seen many theories of science firmly established, only to be discarded later and replaced with other theories that are discarded in turn. The theories we accept today will also be discarded or altered in their turn before many years pass. Or, the other way around. I remember when established scientists mocked the idea of the Big Bang, talk about shifting continents was even more absurd—I still think it is absurd because I have studied too much geology—and the idea of the earth's magnetic pole reversing was laughed out of town only a few years ago.

What is wrong is the way we understand life. Scientists need to study more literature and attain a more balanced concept of life. *The truth lies in paradox* and can never be categorized and codified. Our Christian faith and our Bible are based on paradox. God, the great Creator who can do anything, came to this earth in Jesus Christ, was humiliated and put to death on the cross to pay the penalty for our sins, which we had committed in rebellion against him. This is utterly ridiculous, but it works! It is the greatest paradox of history; it has given humankind a new concept of God and drawn millions of people to God. It is so different from the way we function naturally. God has given us a pattern to use as we follow Jesus; it is through humility and defeat that we gain the victory. What an awesome thought; we always think that with the strongest arguments and the most forceful presentation, we will win.

A few years ago the periodical *Scientific American* devoted a whole issue to the activities of the living cell. I was utterly amazed after I finished reading it. The cell is so small I can't even see it with my eyes but it contains an unbelievable maze of activities. Then I looked to the other side, to the geology of the physical earth around me. Could I believe that random chance had transformed the one side into the maze of the other side? Not even with my eyes shut. But I do believe that God is the Creator of the cosmos and everything in it. As scientists study the cosmos and the life it contains, much light is thrown

on the way God works but we will never fathom the depths of his methods and activities. If we did we would become equal to God himself. In the field of genetics we are now within eyesight of approaching that goal but humans need first to deal with their sinful nature.

Let's keep in focus, as Christians, when we study evolution or any other science, we are studying God's handiwork, how he has created, and how he creates today.

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Response to Bube

In my opinion, Richard Bube's *Communication* (*PSCF* 48 [Dec. 1996]: 250–253) contains a number of serious theological errors. In the first place, his definition of "man" as a creature that "is based on 'human' genetic material," is inadequate, since it fails to isolate this as *Adamic* genetic material. Eve herself was made by God with the assistance of genetic material taken from Adam (Gen. 2:18–23; 1 Cor. 11:8, 9), and man's common descent thereafter from Adam and Eve (Gen. 3:20; 1 Chron. 1:1–28) is strongly stressed throughout the OT. The word "man" in the OT is usually either *'adam* or *'iysh*. Where it is *'adam*, rather than translating it as "man" or "men," it would generally be quite accurate to translate it as "Adamite(s)." If this were done, it would highlight just how important the OT considers it is to recognize that all human beings are *Adamites*. This same teaching is found in such NT passages as Acts 17:26 (NASB, cf. Luke 3:38); Rom. 5 and 1 Cor. 15. In failing to recognize this, Bube has, in my opinion, failed to properly define what a man is.

I consider that his tolerance towards *in vitro* fertilization (Bube's model 2) also shows a failure to uphold the sanctity of human life, since many Adamites are conceived and die for every conception that makes it through the IVF program. Therefore, I consider it a program that violates the sixth commandment and fails to recognize the true value of human life.

Furthermore, Bube then conjectures artificial creation of either "manufactured" sperm, or sperm and ovum. This also fails to recognize that man now has a fallen sinful nature and is subject to spiritual and physical death because of a historical fall by Adam in the Garden of Eden (Gen. 3; 2 Cor. 11:3; 1 Tim. 2:13, 14). All men are guilty of Adam's sin of eating the apple; and God subjected men between Adam and Moses to death, exclusively due to their racial relationship to Adam (Rom. 5:12–14; see L. Berkhof's *Systematic Theology*, pp. 211–243—A Federalist's View, and A. H. Strong's *Systematic Theology* pp. 597–627—An Augustinian's View). Bube asks if one could say of such creatures that they were "sinful and in need of a Savior?" or "a real 'human person' for whom Christ died?" But any such "manufactured" human beings would not be full-blooded Adamites, and so being outside of Adam's race, would, like the creature Bube refers to which is "clearly not a member of *Homo Sapiens*" be therefore outside the orbit of redemption. This is very clear from Rom. 5:11–21, where the Bible makes it clear that *Christ died for Adam's race* and no other.

Medical science's progress has been constantly opening up a range of new matters. But Bube's position should be understood purely as an esoteric intellectual expedition into the often dangerous jungles of bioethics; Bube is trying to "beat a path" on matters that may never become a real possibility for human science anyway. However, I would note that Bube's basic models have previously arisen in literature and fable in the form of *incubus*—with male demon spirit impregnation of a woman by a demon spirit, or *succubus*—with human male impregnation of a female demon spirit (Bube's model 3); a demon spirit taking on a human form (sometimes described as occurring through *ectoplasm)* (Bube's model 4)—which of course is a necessary step for *incubus* or *succubus;* and demon spirits or unfallen angels in their spirit form—although only demon spirits could meet Bube's "sinful" requirement (Bube's model 5).

Though conservative Protestants differ on the issue of what the prohibited marriages of Gen. 6 were, I understand Gen. 6:2 to be written in such a way as to convey multiple meanings. Thus there were some mixed marriages between Seth's race ("the sons of God" i.e., the godly race) and Cain's race ("the daughters of men" i.e., the earthly and spiritually non-godly race—n.b. Gen. 4:1–15, 19, 23, 24) (Gen. 4:16–5:32), which violates God's laws against race mixing and religious mixing. But some mixed marriages between humans ("the daughters of men") and fallen angels ("the sons of God," cf. Job 2:1) also occurred. It is also my opinion that "the sons of God" refers to some male human beings (see the universal Fatherhood of God, Luke 3:38; Acts 17:26–29 NASB), who polygamously "took" female human "wives." Since there was only a limited number of women, "violence" among combative males ensued (cf. Gen. 4:19, 23). Thus by natural selection, some stronger males fathered some "giants."

Without expanding on the other matters, I note that Jewish writings from around the time of the NT that support the proposition that the prohibited antediluvian marriages included angel-human marriages, include Josephus (*Antiquities* Bk. 1, ch. 3, s. 1) and the psuedepigraphal *Book of Enoch* (ch. 6–15). Unlike Bube who would ascribe "value" and "rights" to, for example, those produced by model 3, God is said to declare in the *Book of Enoch*, "Proceed against the bastards ... the children of fornication: and destroy [them]" (10:9). Many, including myself, consider that this type of thinking is then manifested in the NT (2 Pet. 2:4, 5; Jude 14,15 cf. Enoch 1:9 {Pseud.}). For example, in Enoch, the demon spirits who engaged in Bube's models 3 & 4 raise a petition for clemency. Enoch then goes and preaches *at* the spirits in hell, telling them that their doom is sealed (14:1–7). This, to my mind, is strikingly similar to Christ preaching to the spirits in hell and likewise telling them that they were well and truly defeated and beyond any chance of redemption (1 Pet. 3:18–20, cf. Acts 2:27, 31 and Ps. 16:10). Indeed, it is generally recognized that there are two broad classes of de-

mon spirits: those in "chains" because of what they did in antediluvian times (1 Pet. 3:19; 2 Pet. 2:4), and those that are still able to cause trouble here on earth (e.g., Mark 5:9; 1 Pet. 5:8; Rev. 16:13, 14). The evidence to date is that demon spirits no longer seek to follow Bube's model 3 because they know that if they do, God will throw them into the chains of hell. However, there is evidence of sex with demons *not* leading to any form of procreation.

It seems to me that Bube's model 2, in which he refers to an IVF child in the womb of a woman that is not the mother's, is necessarily polygamous, since it means reproductive organs are used that do not belong to a married couple. This, in my opinion, also touches on one of the reasons for the Flood, namely, polygamy (Gen. 4:19), although it also contains some notable dissimilarities to the pre-Flood situation. Whatever the situation for polygamy was in post-Flood OT times, Christian morality clearly requires monogamy; for our Lord does not say that whoever divorces contrary to God's law and remarries "engages in lawful polygamy," but rather, "committeth adultery" (Matt. 19:9).

Furthermore, while his models 3, 4, & 5 may to some extent be distinguished from the matters of demonology that I have mentioned, on the basis that Bube is referring to construction of new creatures—which he freely admits is not now a scientific possibility, whereas demons are pre-existing life forms; nevertheless, it seems to me that he is offering a philosophical justification for demon spirits to do things, and have the type of "value" and "rights" that they enjoyed in antediluvian times. If that sounds like a hard word against Bube, let me say that I consider it is *a fair word*. After all, God Almighty caused a universal deluge that killed all human beings other than the eight people in Noah's ark (Heb. 11:7; 1 Pet. 3:20; 2 Pet. 2:5; 3:6), at least in part, for doing the type of things that Bube is suggesting here. On my understanding of Holy Scripture, I would say he has a faulty understanding of Gen. 1–9. For example, Gen. 1 teaches that God created man *in his image*, and so I would reject the proposition that men have any business even trying to construct artificial humans, or creatures something like them. It is an example of men seeking to "be as gods" (Gen. 3:5). Therefore I think it fair to give him warning, in the hope he and like-minded people will repent (Ezek. 3:17–19).

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Response to Seely

I found Paul Seely's critique of Concordist Theory a refreshing return to the authority of Scriptures—until I got to his proposed "More Biblical Approach" (*PSCF* June 1997, p. 93).

Scripture can and does include concessions to hardened hearts, but never at the expense of providing God's truth to his faithful followers. Seely refers to Mark 10:5, but he stopped too soon! In Mark 10:6 Jesus made it quite clear that the unconceded truth (in this case, about marriage and divorce) is also to be found in Scripture, which by its priority takes precedence over the law of Moses. To argue as Seely does that Genesis 1 is a concession to hardness of heart requires that he show *also from Scripture* what the prior unconceded truth is.

I applaud Seely's innovative proposal here, but I wonder if it might be motivated more by a scientific agenda than a concern for truth. I suggest he consider carefully whether Mark 7:13 and Mark 12:24 might be more relevant than Mark 10:5.

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Tanner: Right, But ...

While Tanner's point in "'Planet Earth'? or 'Land'?" (June 1997, pp. 111–115) is right and relevant, he unfortunately repeats canards that seem to me to spring from the mistaken notion that only moderns are advanced enough to be right. Columbus may have been derided by the illiterate, but all educated persons for centuries had known that the earth is spherical. Probably first enunciated in the fifth century B.C. by Parmenides of Elea and Pythagoras,[1] it was accepted by Plato, who had the earth revolving.[2] Aristotle even gave two proofs for the sphericity of the earth: the circular shadow at all lunar eclipses and the change in the stars visible from different locations.[3] He (fourth century B.C.), Archimedes (third century B.C.), Posidonius (second century B.C.),[4] as well as Eratosthenes, estimated the size of the earth. Ptolemy (ca. A.D. 150) based his map on Posidonius' figure[5] and his astronomy on Aristotle's view. Some Pythagoreans had the earth moving.[6] Aristarchus of Samos (ca. 250 B.C.) and Seleukos (a century later) were Copernicans seventeen centuries early, an inspiration to Copernicus.[7]

The uneducated of every period probably thought the earth flat, along with some others. I have a pamphlet that rejects Copernicanism on biblical grounds. As with other brethren and other topics, dubious hermeneutics ousts science. Further, it seems that we had to wait till modern times for the silly theory that we live inside an 8000-mile-diameter sphere. Apparently the ancients were not that stupid.

[1]L. L. Laudan, "Geodesy," *Encyclopedia Americana* (1995), 12:432.
[2]*Timaeus, 33b–34c, 40b–c.*
[3]*De caelo*, II, 14, 297b25–298a7.
[4]Laudan, *loc. cit.*; Gordon R. Lewthwaite, "Geography," ibid., 438.
[5]Lewthwaite, loc. cit.
[6]Aristotle, op. cit., II, 13, 293a20–293b15.
[7]Edward Rosen, "Copernicus," *Encyclopedia Americana* (1995), 7:555.

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Local Sections

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"Upholding the Universe by His Word of Power" Hebrews 1:3

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