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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

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New

James C. Peterson

PSCF is always looking for the best essays to serve our readers. Maybe you have one in mind. As was described in the December editorial, we seek, first of all, writing that fits our purpose. *PSCF* publishes articles that contribute to the scholarly discussion of how the Christian faith interacts with the sciences. There are already hundreds of years of interplay between the sciences and Christian faith, but there is much more ahead. Studying the areas in which they challenge or offer insight for each other is fruitful and important. As a peer-reviewed journal in that pursuit, we are looking for contributions that are new, arguably true, of interest to our readers, and well communicated. I will devote future editorials to each of these essential characteristics. Here I will focus on the key standard of making a contribution that is new.

What is new in the essay is not necessarily the core idea addressed in an article. It may be an explanation of a new argument in support of a perspective, or the highlighting of a neglected argument that undermines it. Or it could be a new way of expressing an idea that then reaches an audience that did not grasp it as well before. Or perhaps it is a new application of an idea already gathering currency from argument elsewhere. The contribution can be at many points, but there is a new contribution.

Of course, simply being new is not enough for publication. Peer reviewers will not always agree on the merits of a particular article, but the articles that are published will have obtained substantial consensus that something new is offered and that it is compelling enough to warrant consideration. When differing views with substantial merit come to the fore, the journal will provide space for those views to make their case. Sometimes contrary articles will appear next to each other, and sometimes they will appear in subsequent issues as the discussion develops. While each article contributes, it is not expected that any one will be the final definitive statement.

Most new ideas do not pop into existence as a form of spontaneous generation. A new contribution is rarely an isolated one. It usually comes from an ongoing dialogue that can benefit from an insightful turn. These new perspectives and ideas can come from people just beginning to study a field, but it takes time and diligent study for them to know that they have found such a contribution. The student paper that earns praise for its exploration of a subject area new to the student, is probably not a groundbreaking study for experts in the field. It takes time and labor to master a field well enough to know that what is an insight to the author will be an insight to those who have reflected on the field for a major portion of their lives. That is a high, but attainable, bar. It is reached by the authors in every issue of *PSCF*. The articles show in their discussion and citations that the authors have taken into account the byways already tried on their topic, and so are offering a new step for consideration. To that end it is helpful that prospective authors have their work checked by colleagues with applicable expertise before the essay is offered to the journal. Blind peer review at the journal then tests the proposed article further. This vetting process is an investment of editorial time to guard the reader's time. It indicates to the reader that the argument is one worthy of attention.

Ecclesiastes despairs that there is nothing new under the sun. Actually, this journal exists because there is always more to learn. There can be recurring questions and themes, but each new article brings forward some aspect worthy of consideration that was not part of the literature before. That is the case with this issue; it adds to our thinking about the contribution and limitations of what we can accomplish in our scientific pursuits. ✠

Editorial

In This Issue

James K. A. Smith argues that science is always pursued by humans from a cultural perspective because anything human beings do is from a cultural perspective. This reminds us that our science pursuits can become entangled with false beliefs. What is claimed as a finding of science is not automatically a trump card.

In the next article, Robert Bishop describes, in an incisive history, the telling example of materialism creeping into the scientific endeavor. For Bishop, the *methodological* naturalism of the long-practiced scientific method should be quite distinct from the *metaphysical* naturalism that some have claimed rather vociferously of late. Confusing science with a metaphysical claim against God's reality and presence is an accretion of a materialist culture. Such is not entailed by scientific method properly understood and carried out.

In the following article, René van Woudenberg specifically delineates some of the limits to what science can describe. A great strength of the scientific method is in recognizing what it does not achieve, as well as what it does. Science does not investigate or represent all that we know. Science is good at what it does, but due humility and accuracy require that we also recognize what it does not do.

In that honest context, Kathryn Applegate has found methodological naturalism to be an effective tool to understand much of God's creation. Applegate advocates that practicing science from the perspective of methodological naturalism, properly understood, is not anti-God, as some have charged. She appreciates as well that methodological naturalism offers a culture of cooperation and correction that helps people to work together across cultural divides.

Walter Bradley then gives us an example of directing the powerful tools of science and engineering to the service of the poor—a sterling use.

As always, ongoing discussion is crucial for potential insight and correction. In letters to the editor, Edwin Yamauchi and Kenell Touryan suggest an earlier date for the birth of Jesus than the one advocated by James Nollet in our December issue. Those letters are preceded by the always appreciated review of the latest books.

James C. Peterson, *Editor* ✠

Reviewers in 2012

We wish to thank the following scholars for their crucial service in anonymous peer review.

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James K. A. Smith

Science and Religion Take Practice: Engaging Science *as* Culture

James K. A. Smith

This article argues that current paradigms in the theology/science conversation effectively treat "science" as if it were equivalent to "nature"—with detrimental effects for the encounter between Christian theology and the natural sciences. In contrast, I suggest that recognizing science as culture has important implications for reconfiguring the theology/science dialogue.

Political cartoons often argue by means of caricature. Indeed, the very definition of a "cartoon" is that it is an *outline*—a bold-edged sketch that captures something not in fine detail but in broad strokes. The genre of the political cartoon often makes its point by exaggeration. Hence the "caricatures" of political figures that we find in the *New York Review of Books* often overemphasize certain traits; and yet, in doing so, they immediately capture something true that we all recognize.

In the spirit of that genre, let me try to press a point by means of admitted "cartoons" and caricatures of a sort. In that spirit, I would like to float just one tiny little provocative claim. Consider it a discussion starter: The theology/science dialogue, as it has often been conducted, operates on the basis of a category mistake. In particular, I think that some of the regnant paradigms in science-and-theology discourse have been playing with loaded dice such that the house (science) always wins. Or, for Holiness folks who will not get the gambling metaphor, I want to suggest that an increasingly dominant paradigm in the theology/science dialogue has set up an uneven playing field that has put Christian theology in the position of having to play uphill. The goal of this article is to level that playing field by reflecting briefly on the nature of "culture" and then tease out the implications of that for understanding what we are doing when we stage a "dialogue" between science and Christian faith.

Category Mistakes: Science, Nature, Culture, Theology

The primary category mistake I want to note stems from the fact that much of the science/theology conversation has operated on the basis of a certain positivism vis-à-vis "science," and taken the "findings" of science as if they were pristine disclosures of "nature."[1] Thus we increasingly encounter familiar tropes about "what we now know" or "what science says," which are all too often followed by identifying some Christian doctrine that needs now to be abandoned or modified.[2] Both "new atheists" and Christian scholars can tacitly work

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within this paradigm. Indeed, some of the features of this paradigm are what we usually associate with "liberal" Christianity. But I suggest that some evangelicals—who hold a high view of Scripture—have unwittingly bought into aspects of this paradigm, which might explain certain trajectories in recent debates about evolution, human origins, and the Fall.

On both ends of the continuum, there is a similar (though perhaps unwitting) assumption about the nature of *science*: science is either the pristine deliverer of the cold, hard, secular truth; or science is the crystal clear lens for disclosing the "message" in the book of nature.[3] As such, science is taken to be an odd sort of transparent black box which simply discloses the "objective" features of *nature*. Thus, while the "dialogue" is purportedly between "science" (roughly, a constellation of academic disciplines) and "theology" (roughly, another academic discipline), *in fact* or *functionally*, the dialogue often assumes that theology is a kind of human cultural product whereas science is merely the conduit for disclosing the cold, hard realities of "nature"—to which theology must answer, demur, or affirm. After all, who is going to argue with "nature"? Only crazy "anti-realists" [I have yet to meet one] would think that you can argue with *science* because they think that you can argue with *nature*. But for the rest of us who are sane and responsible, including those of us who are theologians, we have to concede that there is no arguing with nature, and therefore there is no arguing with science.

Like a schoolchild of years ago, we have to suck it up, lay out our hand, and bear the brunt of the strap. Theology needs to be *disciplined* by the findings of science and submit itself to the cold, hard realities of nature.[4] If this turns out badly for some traditional or "fantastic" theological claims, then theologians have to take that as part of their whipping, and leave the principal's office grateful that they have been chastised since this discipline will make them more intellectually responsible. On this (admittedly cartoonish) account, the theologian brings his work to the scientist's desk, who then determines what is acceptable and what is unacceptable given the "realities" of nature, and the theologian leaves, hat-in-hand, grateful for whatever scraps of theological claims remain after the tutor's red ink has shredded the student's paper.

This configuration of the theology/science dialogue sets up an asymmetrical relationship because of an equivocation about the nature of "science." While the conversation claims to be a dialogue between "science" and "theology," I think that *functionally* it is taken to be a confrontation between *nature* and *culture*.

science :: theology
nature :: culture

But that is a category mistake. In fact, a dialogue between "science" and "theology" is always already a dialogue between "culture" and "culture," both of which are confronted by, constrained by, and answer to a certain "givenness" that we often describe as "nature."

science :: theology
culture :: *culture*

nature[5]

In other words, the theology/science conversation has tended to ignore the fact that science is a *cultural* institution. By a "cultural institution," I mean, first of all, an institution that is a product of human *making*, a contingent product of *poiesis*.[6] Culture is the unfolding of potentialities that are latent or implicit in "nature," as it were. So aspects of "culture" are the fruit of human making and unfolding; they are not "natural kinds." A painting by Picasso, an elementary school, a Boeing 747, and a political constitution are all examples of "culture," of human making. They are not "naturally occurring" entities that one would bump into if there were not human agents who unfolded them and brought them into being. Thus cultural institutions are networks of practices, habits, and material environments that are the product of human making.

A hospital, for example, is a cultural institution that is "unfolded" by a human community and is composed of both a particular built-environment (ER and ORs, ambulances and CAT scan machines, etc.) and networks of practices and traditions which are learned by apprenticeship (e.g., the "disciplines" of surgery and medicine, the traditions of care that define nursing). Hospitals do not fall from the sky, nor do they simply crawl up from the lagoon in the La Brea Tar Pits. They emerge as products of human making—which means that they are essentially historical and contingent. They unfold over

time, but they could have unfolded otherwise, or even not at all.

Now, it seems to me that the science/theology conversation happily acknowledges that *theology* is a cultural institution. How could one not? Theology is a product of religious traditions and communities, which are themselves paradigmatic instances of "cultural institutions" that are historical, contingent, and certainly not "natural."[7] They have unfolded over time, have unfolded differently in different places, could have unfolded otherwise, and might even have not unfolded at all. Thus "theology," as a cultural institution, is recognized as a kind of "hermeneutic" reality—it offers interpretations of the world, is shaped by different traditions and presuppositions, and represents a "take" on things. From the perspective of the regnant paradigm in the theology/science conversation, this means that theology is sort of one step back from "reality." It is a cultural institution that ascribes "meaning" to reality/nature, whereas "science" is a conduit for disclosing the realty of nature *as such*.

The regnant paradigm has failed to *functionally* appreciate (even if it might officially concede) that science is also a cultural institution. "Science"[8] is not a naturally occurring entity like igneous rocks or sea horses; that is, science is not something that emerges from the swamp or falls from the sky apart from human making. Rather, science is a network of material practices, built environments (including laboratories, instrumentation, etc.), traditions of apprenticeship, and learned rituals that emerged over time, in particular configurations, in different places.[9] So any conversation between "science" and "theology" is never going to be simply a matter of getting theology to face up to "nature"; rather, it is always already a *cross-cultural* dialogue. It is a conversation between two different cultural institutions, each with its own traditions, practices, built environments, and meaning-systems. Because of its lingering positivism, the theology/science dialogue—at least as I have seen it—tends to operate in isolation from a vast (and growing) literature on science *as* culture, such as the social history of experimentation, the politics of The Royal Society, the material dynamics of apprenticeship, the economics of instrumentation and technological developments, the cultural embeddedness of medicine, and so on.

Robert Brandom articulates the nature/culture distinction as the distinction between things that have *natures* and things that have *histories*. While the stuff of physics has a "nature," physics as a discipline of scientific study has a history. And in fact, "even concepts such as *electron* and *aromatic compound* are the sort of thing that has a history."[10] So the sciences are cultural products; indeed, the very distinction between nature and culture is itself a cultural formation.[11] Thus the encounter between theology and science is not equivalent to an encounter between theology and *nature*. As Joseph Rouse comments,

> Scientific practices are often construed as apart from any surrounding culture, and even free from culture, but such construals are not adequate to the richness and complexity of scientific work. Recognizing the intimate entanglement of the sciences with other practices does not diminish or blur their significance but instead acknowledges their pervasiveness throughout the world.[12]

The point here is *not* a debunking project; that is, I am not pointing out that science is a cultural institution in order to dismiss it or to grant license to ignore it. Rather, the point is to situate science *as* a cultural institution in order to clarify the category mistake and thus level the playing field for the science/theology dialogue.

Science Takes Practice

What would it mean to appreciate science *as* culture, as a *cultural* institution? What are the implications of recognizing science as a cultural institution for the theology/science dialogue? Briefly, I will note just a few.

Leveling the Playing Field

As already indicated, one important implication of recognizing science as culture is a leveling of the playing field in the theology/science dialogue. While it might be the case that theology must rightly be constrained by the "givenness" of nature—the world that pushes back on our claims—that is not the same as saying that theology must bow at the feet of *science*. We need to recognize a distinction between science and nature, a distinction too often erased in the theology/science conversation. Science is not

just a transparent magnifying glass or pristine conduit that delivers nature "as it really is." Science is a cultural institution (or, better, a constellation of cultural institutions) that is, of course, especially attentive to nature and is interested in describing and perhaps even explaining nature. Science exposes itself to nature's push-back through the rigors and disciplines of experimentation and observation. But that does not make science "natural." It remains a cultural layer of human making. And in this respect, it is in the same boat as theology (and literature and sociology and …).

Therefore, theology should no longer feel that it has to defer to science *as if* it were thereby subjecting itself to nature or "reality" (as in, "science tells us …"). While theological claims are rightly disciplined by the ways in which the givenness of the world "pushes back" on our claims, this is not synonymous with being disciplined by science. In the vein of John Milbank's manifesto regarding theology's deference to the social sciences, we might also suggest that theology ought to drop the false humility and reassert itself as a cultural voice with the same epistemic standing as science.[13] The asymmetry of the conversation so far has been predicated on a privileged place of science as a veritable divine letter carrier, as the deliverer of nature's truth who sets the rules of the game. But science is a player, not referee or judge.

Appreciating the Role of Practices

The theology/science conversation should also stop thinking of "science" as a *static body of findings* and instead consider science as a *dynamic process of finding*. The way the theology/science dialogue is usually conducted one would almost guess that "science" existed only in journals. The "science" in the theology/science dialogue is a remarkably disembodied phenomenon—as if there were no laboratories, instruments, or communities. But science is not just the *results* of science, the data sets or images that get produced at the end of a very long process. Nor is science just a matter of *theory*. Rather, "science" is perhaps best identified as the *practices* that yield such fruit. This will require that we give up lingering perceptions of science as itself mechanistic or technicistic, along with theory-centric conceptions of science as the sort of thing best pursued by brains-in-vats. Science is a deeply social, communal project, composed of material practices and rituals that are handed on as traditions, absorbed as habits, and enacted in experimental performances that, literally, create worlds.

How might the theology/science dialogue look different, not only if we recognize science *as* culture, but recognize it also as a *community* with a set of cultural practices? This will require appreciating the central role of experimentation, along with all the rituals and traditions that inform it. Thus Robert Crease suggests that experimentation is a kind of "performing art."[14] Theories cannot do the work that experimental "art" does because

> a scientific entity does not show up in a laboratory the way an airplane shows up on a radar screen, a fully formed thing out there in the world whose presence is made known to us by a representation. Nor is a scientific entity like a smaller version of the airplane, which could be perceptible if only scaled up large enough. Nor, finally, is a scientific entity like some distant and unknown object on the radar screen that when closer becomes perceptible. A scientific entity becomes perceptible only in performance.[15]

So experimentation "is not merely a *praxis*—an application of some skill or technique—but a *poiesis*; a bringing forth of a phenomenon."[16] While science seeks to be disciplined by nature, there is also a sense in which science *creates* its own phenomena. It constitutes its world through experimental performance which is a *learned* performance requiring its own set of virtues and skills, deft employment of instrumentation, and a kind of "know-how" that is not theoretical, and perhaps not even "intellectual."[17]

Hans-Jörg Rheinberger, in his stunning philosophical history of the protein synthesis, notes the ways in which the "stuff" of science—"epistemic things" or "research objects"—emerges because of experimental conditions that are created by "technical objects" (such as instruments). The epistemic things "articulate" themselves "through" a "wider field of epistemic practices and material cultures" which includes both instruments and theories.[18] In important ways, the "epistemic things" that will emerge "usually cannot be anticipated when an experimental arrangement is taking shape."[19] (So there are a lot more surprises in science than one would guess from the picture we get from

the theology/science dialogue.) Thus "experimental systems are necessarily localized and situated *generators of knowledge*."[20] What science *finds* is significantly determined not only by what science goes looking for, but also by *how* it looks. And that "how" is not primarily a theory but a constellation of practices that constitute an experimental system. As these systems build up over time and generate linkages with other experimental systems, there emerge what Rheinberger calls "experimental cultures" which "share a certain material style of research" or "laboratory style." At that point, experimental systems begin to take on a life of their own.[21] They generate epistemic things by generating microworlds—which are responses to nature but should not be identified with nature.[22] Hence, once again, we see the importance of not mistaking science with nature. We also note Rheinberger's concluding caveat—cautioning that this is not meant to thereby reject science:

> To characterize science as practice and as culture does not amount, as far as I apprehend it, to determining the social influences hindering or furthering the sciences. It does not amount to a critique of ideologies of science in the traditional sense. Rather, it amounts to characterizing the sciences themselves as cultural systems that shape our societies and all the while trying to find out what makes the sciences different and confers on them their peculiar drive, not privileging them with respect to other cultural systems.[23]

Meaning and Interpretative Practices

This priority of practice to theory should make us attentive to the nature of scientific practices—which is what defines the landmark (but underappreciated) work of Joseph Rouse.[24] Rouse emphasizes a "normative" understanding of practices which attunes us to just how "loaded" scientific practices are. He emphasizes,

> What a practice is, including what counts as an instance of the practice, is bound up with its significance, in terms of *what is at issue* and *at stake* in the practice, to whom or what it matters, and thus with how the practice is appropriately or perspicuously described.[25]

What is at stake and what is at issue is embedded in the practices and constitutes a particular hermeneutic construal of the world. There is always a normativity at work in practices, including experimental practice. Practices are "defined" not only by the specific activities that "compose" them, but also "by what those activities are *about* (what is 'at issue' in the practices) and by what is *at stake* in their success and continuation."[26]

This is the basis for Rouse's core thesis: *practices matter*. Practices have something at issue and something at stake.[27]

> One has not understood a practice unless one has grasped the point of the practice, that is, what is at issue and what is at stake. The recognition that practices are focused by such issues and stakes does not, however, challenge my earlier insistence on the openness of the practice.[28]

This means that scientific practices are not just pure conduits of a "given" world of "facts," but rather are world-*constituting*. It is practices which "give meaning," and thus scientific practices—as cultural institutions—are as "meaning-giving" as those of theology. This means that we need to reconnoiter how we have traditionally understood the theology/science distinction. Scientific practices are not merely passive, "observational" practices that simply yield "facts." Like theology, they also give meaning—they render significance. So the encounter between Christian theology and science cannot be a division of labor whereby science discloses the "facts" and then Christian faith renders a "meaning" consistent with those facts. While there is no inherent conflict between Christian faith and science[29] (where science is understood as the human cultural practice of attending to and understanding the natural world), we need to recognize that there *can* be conflict between the different meanings they assign to the natural world. Sometimes in our eagerness to dispatch with simplistic, unproductive models that posit a battle between science and faith, we too quickly look to reconcile what really are competing visions of the world. Recognizing science *as* culture should at least grant us permission to demur from the magisterial authority that science assumes in its disclosure of "the facts of the matter."

Conclusion

I have tried to suggest that one of the regnant, albeit implicit, paradigms in the science/theology dialogue

tends to operate on the basis of a category mistake; namely, it ends up treating the "science" pole as if it just represented "nature," whereas theology is taken to be an instance of "culture." But science, too, is a cultural institution. How would the theology/science dialogue look different if we took this to heart?

Well, it would *not* be license for Christian theologians to dismiss scientific claims whenever they are inconvenient or pose a challenge to core Christian claims. As I have repeatedly emphasized, the upshot of this analysis is not to level the playing field so that theology can try to evade engagement with the natural sciences. Nor is the goal to simply invert the asymmetry and allow theology to trump the findings of the natural sciences.

The outcome of my argument is more modest. At the very least, if we truly level the playing field and recognize that science is a mode of cultural meaning-making and not a transparent, pristine conduit of "the way things are," then we cannot simply cite "the secure findings of science" as sufficient ground for dismissing or revising core doctrines of the Christian faith. Insofar as contemporary discussions in the theology/science dialogue repeat tropes of this sort, we should also be on the lookout for implicit, functional ways in which we unwittingly ascribe to "science" a magisterial authority *as if* it were nature itself. ✠

Notes

[1]This is the reason why theological claims generated by the theology/ science dialogue tend toward versions of a "natural theology." For two robust—but very different—Christian critiques of the very project of natural theology, see Alvin Plantinga, "The Reformed Objection to Natural Theology," *Proceedings of the American Catholic Philosophical Association* 54 (1980): 49–63 and Stanley Hauerwas, *With the Grain of the Universe: The Church's Witness and Natural Theology* (Grand Rapids, MI: Brazos, 2001). I might note that the line of argument I am sketching in this brief article could be read as a "natural science" equivalent of John Milbank's radical critique of the alleged "neutrality" of the *social* sciences in *Theology and Social Theory* (Oxford: Blackwell, 1991). For a further unpacking of that, see Conor Cunningham, *Darwin's Pious Idea: Why the Ultra-Darwinists and Creationists Both Get It Wrong* (Grand Rapids, MI: Eerdmans, 2010).

[2]Consider, for example, the trope found in a recent article published in *Perspectives on Science and Christian Faith*, in which we are told about the radical theological revisioning that is required based on the "secure findings of science." See Daniel Harlow, "After Adam: Reading Genesis in an Age of Evolutionary Science," *Perspectives on Science and Christian Faith* 62, no. 3 (2010): 192.

[3]No Christian scholar is going to explicitly assert that she or he is setting science "over" Scripture. I am suggesting that we need to move beyond explicit claims about how they perceive the relationship between science and theology and instead look at the implicit *function* of science within their proposals.

[4]There is a political correlate to this: those who simply accept the paradigm of liberal democracy will assert that Christian claims in the public sphere need to be "disciplined" by the expectations and strictures of democracy.

[5]This, in fact, is much too simplistic, but will have to remain heuristic for now. The nature/culture distinction is not so neat and tidy. For instance, I do not mean to suggest that "culture" is just a kind of layer on nature; nor do I mean to suggest that cultural animals are not always already "natural" animals. But we cannot do justice to these issues in this brief conversation-starter. If I had more time, I would pursue this in dialogue with Bruno Latour's notion of "hybridities." See Latour, *We Have Never Been Modern*, trans. Catherine Porter (Cambridge, MA: Harvard University Press, 1993), 85–111.

[6]This should be a relatively noncontroversial claim. For a discussion of culture in terms of *making*, see Andy Crouch, *Culture Making* (Downers Grove, IL: InterVarsity Press, 2008).

[7]Though certain lines of research (e.g., accounts of altruism in evolutionary psychology, or more recently, neuroscientific accounts of religion as found in Pascal Boyer, *Religion Explained* [New York: Basic Books, 2002] and Justin Barrett, *Born Believers: The Science of Children's Religious Belief* [New York: Free Press, 2012]) have sought to suggest that "religion" is a kind of natural outworking of the sort of biological creatures that we are, I am agnostic about these proposals at this point. In any case, this would not harm the thesis here since the point is just that, in some significant sense, "culture" is nature "plus" something, not *instead of* nature. Of course, the human work of culture-making is made possible by a substrate of biological capabilities.

[8]It is even tendentious to keep talking about "science" as if it were some monolithic reality. Just what makes neuroscience, physics, and ecology part of the same thing, "science"? My thanks to Matt Walhout for continuing to press this point.

[9]See Stephen Gaukroger's magisterial history, *The Emergence of a Scientific Culture: Science and the Shaping of Modernity 1210–1685* (Oxford: Oxford University Press, 2009).

[10]Robert Brandom, *Articulating Reasons: An Introduction to Inferentialism* (Cambridge, MA: Harvard University Press, 2000), 26–7.

[11]Ibid., 27.

[12]Joseph Rouse, *How Scientific Practices Matter: Reclaiming Philosophical Naturalism* (Chicago, IL: University of Chicago Press, 2002), 166.

[13]See John Milbank, *Theology and Social Theory: Beyond Secular Reason* (Oxford: Blackwell, 1990):

> The pathos of modern theology is its false humility. For theology, this must be a fatal disease, because once theology surrenders its claim to be a meta-

> discourse, it cannot any longer articulate the word of the creator God, but is bound to turn into the oracular voice of some finite idol, such as historical scholarship, humanist psychology, or transcendental philosophy. If theology no longer seeks to position, qualify or criticize other discourses, then it is inevitable that these discourses will position theology. (p. 1)

It should perhaps be noted that John Milbank could never be confused with a "fundamentalist."

[14]Robert P. Crease, *The Play of Nature: Experimentation as Performance* (Bloomington, IN: Indiana University Press, 1993), esp. 74-102. My thanks to Arie Leegwater and Matt Walhout for pointing me to this resource.

[15]Ibid., 85–6.

[16]Ibid., 82.

[17]The point is that such know-how is more on the order of what Heidegger describes as the "understanding" or preunderstanding, or what Charles Taylor calls a "social imaginary."

[18]Hans-Jörg Rheinberger, *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube* (Stanford, CA: Stanford University Press, 1997), 28–9.

[19]Ibid., 74.

[20]Ibid., 76, emphasis added.

[21]Ibid., 138–9.

[22]Rouse rightly emphasizes that "there is no such thing as the 'social world' (or the 'natural world') except as reified abstractions from *the* world" (*How Scientific Practices Matter*, 173).

[23]Rheinberger, *Toward a History of Epistemic Things*, 140.

[24]I cannot begin to do justice to Rouse in this context. For further discussion that is particularly relevant in this context, see Matthew Walhout, "Looking to Charles Taylor and Joseph Rouse for Best Practices in Science and Religion," *Zygon* 45 (2010): 558–74.

[25]Rouse, *How Scientific Practices Matter*, 175.

[26]Joseph Rouse, "The Significance of Scientific Practices," in *Engaging Science: How to Understand Its Practices Philosophically* (Ithaca, NY: Cornell University Press, 1996), 142. I think one of the great missed opportunities, so far, is the lack of any serious engagement between Rouse and Alasdair MacIntyre, which I think would prove especially important to Christian theorists.

[27]This sounds like teleological language to me—and it explains why Rouse immediately emphasized that claiming that practices have something at issue/at stake does *not* challenge his earlier claim to their openness (Ibid., 142). I would agree: teleological orientation does not equate to "shutting down" surprise (contra Jacques Derrida).

[28]Ibid.

[29]See Alvin Plantinga's robust argument in *Where the Conflict Really Lies: Science, Religion, and Naturalism* (New York: Oxford University Press, 2011).

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Robert C. Bishop

Article

God and Methodological Naturalism in the Scientific Revolution and Beyond

Robert C. Bishop

There is debate among Christians about whether the sciences presuppose a form of naturalism that rules out the activity and existence of God. Historically, neither natural philosophy, the forerunner of modern scientific inquiry, nor the developing sciences of the eighteenth and nineteenth centuries were based upon such metaphysically naturalistic assumptions. Instead, as a matter of scientific practice, a form of theological neutrality was often the norm. This neutrality can be seen in leaders of the Scientific Revolution. The story of how that neutrality came to be questioned is a complicated one, spanning the eighteenth and nineteenth centuries.

Introduction[1]

When discussing the relationship of naturalism to the sciences, it is customary to distinguish two forms. *Metaphysical* naturalism is the philosophical belief that material reality is the only reality. There is no God, nor angels, spirit beings, or spiritual realm. In contrast, *methodological* naturalism (MN) is an approach to scientific investigation that seeks to take phenomena on their own terms to understand them as they actually are.

There is significant confusion among Christians over whether modern scientific investigation requires metaphysical naturalism or whether scientific investigation can be a robust application of MN. Contemporary Christian debates over naturalism and science tend to ignore the role played by forms of MN in natural philosophy in the ancient and medieval periods. More importantly, our debates usually fail to recognize MN's role in the Scientific Revolution and the practice of modern science from that period forward. There are several strands to this story. I will start by highlighting four theological strands that contributed to the ground-breaking natural philosophy of the seventeenth century that fed directly into MN, and then I will briefly sketch the history of the rise of metaphysical naturalism.[2]

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The Doctrine of Creation: Ontological Homogeneity

Early Christian thinkers struggled with their Greek philosophical and cultural context to formulate the doctrine of creation.[3] Natural philosophers in ancient Greece and Rome conceived the celestial realm as being of a qualitatively different order of being (divine, infinite, perfect) than that of the terrestrial (mundane,

finite, imperfect, changeable). Under such a conception, the celestial and terrestrial realms were treated as being distinctly different from each other. In particular, the purposes for studying the divine and perfect celestial realm differed significantly from those motivating study of the mundane. Moreover, the principles by which the celestial and terrestrial realms operate were considered to be different; hence there was much less application of mathematics, systematic observation, and record keeping to the terrestrial realm with the expectation of discovering regular patterns.

Furthermore, early Christian thinkers had to consider biblical revelation proclaiming that all things were created through and for Christ (e.g., John 1:1–3, Col. 1:16), and their Greek cultural inheritance that taught an eternal universe with qualitatively distinct celestial and terrestrial realms. Eventually the Patristic fathers came to the recognition that if everything was created by and for Christ, then the entire universe was not eternal but a creation *ex nihilo*. This element of the doctrine of creation was wrung from deep reflection on the contrast between the prevailing Greek philosophical views and special revelation.[4] Part and parcel with creation *ex nihilo* is the Creator/creature distinction, the qualitative distinction between the Creator and that which is created. These central tenets of the doctrine of creation led early Christian thinkers to the realization that the celestial realm, as a created thing, could not be divine.[5]

Still, the power of Greek thought—particularly in Plato and Aristotle—exerted a tremendous pull on early Christian thought, as many Patristics continued to maintain a qualitative distinction between the celestial and terrestrial realms. The former was still considered a realm of changeless perfection and made of a different element (quintessence) than the latter, which was made of the elements earth, water, air, and fire; was imperfect and changeable; and, consequently, was of a lower grade of being. However, some Patristic thinkers—Basil and Philoponus—were able to recognize that the thrust of biblical revelation was that the only distinction in being was that between Creator and created. They argued that the doctrine of creation led to the conclusion that the being of everything created—terrestrial and celestial—is of the same order of being.[6] Instead of a great chain of being, there was no distinction of being between celestial and terrestrial realms. Everything created had the same status, that of creature. "The creation is homogeneous in the sense that everything has the same ontological status before God, as the object of his creating will and love. All is 'very good' because he created it, mind and matter,"[7] so that whether mind and matter are qualitatively distinct or not, there was no hierarchy ranking mind over matter or the celestial over the terrestrial.

Philoponus traced the consequences of ontological homogeneity to the conclusion that creation has a genuine nature or order. "Philoponus insisted that nature could not be understood as the finite representation of infinite reality but as real in itself."[8] By implication, all things in creation have genuine natures. In particular, the celestial and terrestrial realms were of the same order of being, implying that the same principles governed the two realms and that they were made of the same matter. The nature of their distinction lay in difference, not order of being. This was the basis for Philoponus's critique of Aristotelian natural philosophy, particularly Aristotle's account of motion.[9]

The insights of ontological homogeneity were lost during much of the Middle Ages (though recaptured on rare occasions). They eventually reemerged in Duns Scotus, Jean Buridan, and Galileo.[10] Ontological homogeneity became the consensus view among natural philosophers in the seventeenth century, so that it was plausible to give an account of motion that was unified in its treatment of celestial and terrestrial motions (e.g., Newton's theory of motion).

Divine Freedom

A second theological strand is divine freedom in creation. Although there were longstanding debates about whether God created freely or could only create out of necessity, the former view eventually won out.[11] Bishop Tempier of Paris's 1277 condemnation included, among its 219 prohibitions, a condemnation of teaching that any of God's acts are done out of necessity. Although not the only theological development that led to an emphasis on divine freedom in creation, the condemnation played a role in motivating a shift to a more empirical approach to understanding the nature of God's creation, a shift that was already underway in natural philosophy. The renewed emphasis on divine

freedom in creation often reinforced the need for an empirical approach to the study of creation.[12]

The link between God's freedom in creation and natural philosophical inquiry is neither necessary nor inexorable, and is illustrated in seventeenth-century debates about the laws of nature. For example, if one believed that God created out of necessity, one tended to think that natural laws were discoverable by reason alone (e.g., Spinoza), whereas if one believed God was free to create any world he chose, one tended to think that natural laws were discoverable empirically (e.g., Bayle).[14] The view among many, if not most, natural philosophers of the seventeenth century was that God as sovereign Creator could freely make any creation he saw fit.

One implication of divine freedom in *ex nihilo* creation, the Creator/creature distinction and the ontological homogeneity of creation, was that the creation has *contingent rationality*. The sense of contingency, here, is twofold. First, creation is contingent in that it utterly depends upon God for its very existence (a creation out of nothing tends to fall back into nothing). Second, creation is contingent in that God could have made a wide variety of possible creations. In freedom and love he chose one in particular. Philoponus rightly saw that the contingency of creation implies that we have to investigate it to discover what kind of nature God had given to creation. Moreover, we can have confidence in such investigations because the rationality of God's created order is intelligible; hence the biblical view is that creation's nature is revelatory of itself. By and large, seventeenth-century natural philosophers (Cartesian natural philosophers being an important exception) followed this line of thought, emphasizing that empirical means were best suited to discovering the nature of creation.

Two Books Metaphor

The two books metaphor—creation and the Bible are two different books whose ultimate source is God—also has a long history, going back at least as far as Origen of Alexandria. Although theologians tended to view the book of nature as a source of general revelation about God, natural philosophers tended to argue that the book of nature also revealed the workings of creation.[15] Galileo is one of the most well-known proponents of this view. He argued that the book of nature was written in the language of mathematics and revealed the nature of creation.[16] Galileo gave voice to the growing application of mathematics to all areas of natural philosophy of the sixteenth and seventeenth centuries: To properly read or understand creation's processes, laws, and so forth, requires quantifying them so as to understand as accurately as possible their created natures given by God. Kepler, in a letter to J. G. Herwart von Hohenburg, March 26, 1598, put it like this:

> as we astronomers are priests of the highest God in regard to the book of nature, we are bound to think of the praise of God and not of the glory of our own capacities … Those laws are within the grasp of the human mind; God wanted us to recognize them by creating us after his own image so that we could share in his own thoughts.[17]

Kepler believed that the language of mathematics was crucial to "thinking God's thoughts" about the nature of creation, and he took seriously the role of astronomers as priests articulating God's book of nature.[18]

The Fall and Knowledge

Along with the infusion of new knowledge of mathematics and natural philosophy from the translation of Islamic texts, the ancient struggles with skepticism were rediscovered through either the translation of Islamic texts or the discovery of long-forgotten texts in monasteries. Space does not permit exploring how the renewal of that struggle in Renaissance thought contributed to the effort to develop a mitigated or constructive skepticism leading to a seventeenth-century epistemology of experiment.[19] However, one important theological strand in this story is the explicit linkage of error and cognitive limitations, as sources of skepticism, with sin and the Fall.

As Peter Harrison argues, many—though not all—seventeenth-century discussions of error and limitations on human reason were deeply colored by a biblical understanding of sin and the Augustinian conception of the Fall.[20] Although there was disagreement on how thoroughly the Fall affected the capacities for knowledge, there was wide agreement that instruments and/or procedures had to be developed to overcome the epistemic consequences of the Fall and other skeptical worries to the degree possible.[21] One of the goals of these mitigation attempts was to restore as much as possible of the human

capacities to know the nature of creation genuinely. This epistemological project was daunting, however. Although there was theological grounding in the doctrine of creation for thinking that creation was orderly and intelligible, coming to understand creation's nature was generally considered to be a difficult and arduous task. Natural philosophers of the seventeenth century knew that creation did not yield her secrets easily, and was not fully knowable or understandable to finite minds. Still, the epistemic goal was to understand the nature of God's creation—the laws, parts, properties, and processes—to the fullest extent humanly possible. The birth of modern science—its experimental and mathematical methods—was not a byproduct of a renewed confidence in reason, as we are often told, but a healthy appraisal of the deficiencies and limitations of human capacities for knowing.[22]

Pulling the Strands Together

The doctrine of creation's emphasis on *ex nihilo* creation and ontological homogeneity, the impact of divine freedom in creation, the idea that creation could be read as a book, and the skeptical attitude toward human capacities to know—along with other strands I have not mentioned—fed into the same conclusion: To understand creation requires taking the nature of created things on its own terms. Hence, methods and approaches to knowing had to be constructed that enabled natural philosophers to be in the best position to discover and explore the objects and phenomena of creation. To put the point in terms popular in the seventeenth century, natural philosophers realized that they needed modes of inquiry that could focus on making known the nature of the secondary causes through which God worked in creation. This was not a set of tasks that could be carried out by reading the book of Scripture, but by learning how to read the book of nature accurately.

This seventeenth-century focus on secondary causes rather than on the Bible—what we would recognize as a form of MN—was what guided natural philosophers in their study of created natures, on their own terms, to understand them as accurately as possible. In other words, for these natural philosophers, MN was a commitment to particular methods of inquiry *for a particular limited purpose*: To understand the nature of the matter, forces, and laws that God had made. Many of the scientific revolutionaries thought that to fulfill this purpose required a quantifiable, empirical approach to studying nature in contrast to a purely rationalistic approach or one that tried to read the nature of creation solely from the Bible. However, seventeenth-century natural philosophers—whether empiricists or not—were united in their conviction that the ultimate goal was understanding what kind of creation God had made and how God was at work in and through creation. Focusing on so-called natural causes, for them, in no way implied that God was absent from creation nor even that God was somehow excluded from explanations of how creation worked.

This "naturalistic" or neutral focus has been part and parcel of natural philosophy from ancient times.[23] For Christians engaged in natural philosophy during the medieval period and into the early modern period, the commitment of many to a form of MN is articulated well in David Lindberg's summary of Albertus Magnus. In the thirteenth century, Magnus proposed distinguishing

> between philosophy and theology on methodological grounds and to find out what philosophy alone, without any help from theology, could demonstrate about reality. Moreover, Albert did nothing to diminish or conceal the "naturalistic" tendencies of the Aristotelian tradition. He acknowledged (with every other medieval thinker) that God is ultimately the cause of everything, but he argued that God customarily works through natural causes and that the natural philosopher's obligation was to take the latter to their limit … Albert pointed out that God employs natural causes to accomplish his purposes; and the philosopher's task is not to investigate the causes of God's will, but to inquire into the natural causes by which God's will produces its effect. To introduce divine causality into a philosophical discussion … would be a violation of the proper boundaries between philosophy and theology.[24]

Examples from the Scientific Revolution

Tycho Brahe, Johannes Kepler, Galileo Galilei, Robert Boyle, and Isaac Newton are just some of the names associated with the Scientific Revolution.[25] Here,

I will focus on Boyle and Newton as practitioners of MN in the spirit of Magnus.

Boyle

Much recent scholarship clearly demonstrates that theological motivations lay behind Boyle's approach to natural philosophy and informed his approach to studying creation.[26] While he believed God could intervene in the natural course of things, Boyle conceived the task of natural philosophy as studying and understanding creation on its own terms. As he puts it in *The Christian Virtuoso*, "For [natural philosophers] consult experience both frequently and heedfully; and … they are careful to conform their opinions to it; or if there be just causes, *reform their opinions by it*."[27] This is one of many places where he makes it clear that natural philosophy's task is to explain phenomena of creation in terms of natural processes.

For Boyle, then,

> Nature is a "book" written by an omniscient and omnicompetent author … One cannot reason on purely a priori grounds about such a divinely created product, because God's reason and power extend far beyond human faculties. Rather, one must look at nature—read the text—in order to determine what was actually done. The world is like a text. It is a coherent, albeit extremely complex, whole. To understand any part of the great cosmic mechanism, the relations that hold between that part and the rest of the whole have to be known … For Boyle, the experimental method was a means by which one could "interpret" the book of nature … the experimental philosophy was designed as a method of interpretation.[28]

Boyle believed that God's two books were distinct, though related:

> He was opposed to any "unwholesome mixture" of the two disciplines [study of Scripture, study of nature]. The two books could be used to shed light on each other, but care was required so as not to confound them.[29]

In the book of nature was to be found detailed knowledge of the creatures mentioned in the Bible. The doctrine of creation, drawn from special revelation, could teach us that all the details of nature have a purpose in God's plan and that explanatory frameworks such as atomism cannot be understood atheistically on pain of adopting an incoherent foundation. Boyle defended the idea that biblical studies were superior to natural theology for learning about God and his activity.[30] In contrast, the study of creation was superior to biblical studies for learning about the particulars of creatures and natural principles.[31]

For Boyle, the process of coming to understand creation was very similar to that of coming to understand a text.

> The goal of understanding nature, as God's production … [required] the same type of hermeneutic principles that were employed for an actual text, as constraints upon the theories that we construct for the "explanations" of nature's processes … Boyle's choice of method was guided by his ontological view of nature as a divine text.[32]

Hence, Boyle's experimental approach to inquiry was a means for gathering as much information as possible about creation's processes for the construction of "the most coherent interpretation of how the particulars of nature are connected into one grand cosmic mechanism."[33]

With respect to MN, then, Boyle argued that it was illegitimate to explain the operations of natural phenomena in terms of the actions of spiritual beings, because such explanations gave us no insight into the physical nature of the phenomena and the principles by which they operated.[34] Without denying that God was the Creator, Sustainer, and Governor of the entirety of creation, Boyle sought to study and understand natural phenomena without "intermeddling with supernatural mysteries."[35] It was inappropriate to invoke God or other spiritual entities in the explanations of the detailed workings of creation *if the task was to understand those workings on their own terms*. For Boyle, rational and practical engagement with creation was the only means for us to increase our knowledge of the phenomena of creation on their own terms.[36]

Ultimately, for Boyle, the better we understand things of nature on their own terms, the better positioned we are to think theologically about creation and to see God's purposes in these things. Boyle's "epistemological conception of the progressive nature of knowledge entailed the belief that it could only be achieved through a complex process of interpretation and the reconciliation of truths from all areas of learning."[37] His pattern for relating natural philosophy to biblical knowledge and theology was

to treat these domains as distinct but related, working out the nature of matter and secondary causes, then turning to think biblically and theologically about those discoveries.[38]

Of course Boyle was not working in a vacuum; he was following a well-established tradition. For example, Tycho Brahe had articulated a multipronged approach to understanding the cosmos that involved mathematical astronomy, natural philosophy, and biblical/theological study as three distinct fields of knowledge that had a complex interrelationship.[39] However, it was Kepler who combined a resolute commitment to discovering the truth about the universe as God made it with a view of mathematical astronomy as having a genuine correspondence with the causes of the motions of the planets.

Kepler also distinguished the disciplines of theology from natural philosophy and astronomy. For instance, in his *Astronomia Nova*, Kepler writes that "while in theology it is authority that carries the most weight, in philosophy it is reason."[40] It was not uncommon in sixteen- and seventeenth-century Europe for theology and natural philosophy to be treated as distinct domains of knowledge—having some partial overlap—that drew on distinct methods. But it was Kepler who brought realism into theorizing the nature of the heavens, for example, that hypotheses about planetary motion should involve genuine causes of that motion rather than merely being mathematical constructs that accurately reproduce observations. In this way, Kepler saw himself as an "exegete of the Book of Nature."[41]

Newton

One of Newton's great contributions to natural philosophy was to marry mathematical modeling and experimental observations in a form familiar to us in contemporary physical science. He used thought experiments involving simplifications and idealizations of realistic situations, developed mathematical models for these idealized situations, applied idealized models to real situations comparing results with observations, and systematically refined the simplifications and idealizations until the models achieved experimental agreement. In this way, he was able to work out the mathematical form of gravity and other forces.[42]

Newton's methodology was an attempt to understand forces on their own terms, namely, as secondary causes through which God works in creation, with the ultimate aim being to "know by natural philosophy what is the first Cause."[43] Newton, though doubting that Christ was co-eternal and equal to the Father, nevertheless viewed Jesus as a key mediator through whom creation was made.[44] Christ served a vice-regent role, not only as the Creator of all things, but also as overseeing and directing the forces causing the motion of material bodies, while God the Father worked through gravity as an expression of his omnipresence.[45]

Therefore, for Newton, MN in the form of experiment and mathematical modeling was in service of revealing God's wisdom and glory in creation, through demonstrating its uniformity and intelligibility rather than expunging God from natural philosophy. Similar to Magnus and Boyle, Newton recognized,

> That religion & Philosophy are to be preserved distinct. We are not to introduce divine revelations into Philosophy, nor philosophical opinions into religion.[46]

Hence, he also endorsed MN as the appropriate way to study the secondary causes of creation. For instance, in a letter to Richard Bentley, Newton maintained that if God chose to produce gravity mechanically, then a mechanical cause should be sought. However, if God chose some other means, the phenomenon of gravity was still genuine and law-like.

> Gravity must be caused by an agent acting constantly according to certain laws, but whether this agent be material or immaterial is a question I have left to the consideration of my readers.[47]

In other words, gravity has God as its primary cause even if Newton was unable to discover the nature of its secondary cause.

> God caused gravitational attraction by his omnipresent activity according to principles that he had established, called by Newton "active principles" or "laws of motion." Working in accord with these principles, God animated nature, providing life to a world of dead matter.[48]

Although the idea that God's activity in creation was always mediated was steadily declining in the seventeenth century,[49] Newton seems to have continued

maintaining that God accomplishes his purposes in creation through means. Newton's universe was far from the clockwork machine, with God as a distant supervisor.[50] Furthermore, as with Magnus, Kepler, and Boyle, Newton viewed biblical studies, theology, and natural philosophy as distinct enterprises, yet as interacting fields of knowledge relating to one another.[51]

The Turn to Metaphysical Naturalism

If the scientific revolutionaries were theists who deployed MN in the service of discovering the nature of God's creation, then what happened in the intervening centuries such that the sciences and their methodologies now are routinely disassociated from God? I will start by briefly tracing four trends in the transformation of religion in the eighteenth century that set much of the scene for this dissociation. While many parishioners in the pew may not have gone very far in the direction of these trends, many natural philosophers, theologians, pastors, and writers of the eighteenth century did.

1. Even in the seventeenth century, the rich biblical picture of divine action in creation as mediated—taking place through or being shaped by divine command, Jesus and the Spirit, and ministerially through creation itself—had largely been reduced to just mediation through divine command. Increasingly, the laws of nature became the key mediators of everything that happened in creation. Although Newton managed to maintain a richer sense of divine mediated action in creation, the generation of Newtonians after him did not.[52]

2. Following Augustine, medieval philosophy and theology stressed God's will and power in creation. As a consequence, God's ultimate relationship to creation as one of covenantal love often fell out of the focus of Western thinkers. Hence, voluntarism usually sounded notes about God's will in creation being arbitrary. Under the growing conception of creation as a machine designed by a Master Engineer, by early in the eighteenth century the very idea of God arbitrarily and unpredictably intervening in creation became psychologically jarring to the majority of theists.[53] A mechanical picture of creation absent a rich doctrine of creation seemed to imply deism, but there was psychological pressure in this direction, too.

Deism sprang to full flower in the eighteenth century with the laws of nature mediating all that happened in creation, instead of Jesus, serving as mechanical vice-regent. The culmination of this line of development was *providential deism*, the idea that "God's beneficence" consisted solely "in constructing the world so that it conduced to good."[54] The Master Engineer was so gracious and wise that creation, from its beginning, had been given all the resources it needed to achieve the good that God had set for it. No interventions in the natural order were needed. Providential deism of the eighteenth century did have one crucial advantage over older understandings of providence with respect to the temper of the times: instead of invoking mysterious actions of God in creation, everything was accomplished through natural laws and processes, which were accessible to reason and observation.

3. Natural theology underwent a shift in the seventeenth century that had a significant influence in the eighteenth century (although this is not to say that all natural theology fell into this one pattern). Whereas Newton still maintained that God's existence, wisdom, and power were best demonstrated by the total order exhibited by the system of the world, most theists followed the lead of Boyle and John Ray's *The Wisdom of God Manifested in the Works of the Creation* (1691) in looking to particular features of creation for evidence of God's existence, wisdom, and power (e.g., organs such as the eye and hand, and organisms exquisitely suited to their environments).[55]

Early in the eighteenth century, every area of natural philosophy was marshaled for natural theology. By the end of the eighteenth century, most natural philosophers and theists admitted that the details of astronomy, physics, chemistry, and geology were ambiguous at best, regarding evidence for a Deity other than the natural laws which still pointed to a wise Creator.[56] Only what would become biology—the study of organisms and their relations to their environments—was generally acknowledged as being replete with exquisite examples of the Master Engineer's hand.

4. Closely related to this shift in natural theology was a shift in the appraisal of the relationship between reason and revelation. Already by the mid-seventeenth century, the Socinians had elevated human reason to a high role in faith and biblical interpretation. As the seventeenth century progressed, both theologians and natural philosophers had a tendency to promote natural revelation—God's book of nature—to being on par with the Bible. As belief was being transformed into rationally verified propositions—a transformation begun in the sixteenth century and completed in the eighteenth[57]—the Bible and faith were being torn in two directions: intellectual assent based on demonstrated propositions vs. arational trust and love. In the eighteenth century,

> Deism professed to be a religion founded on reason alone, composed solely of truths about God evident in the order of nature, subjecting all beliefs to the test of reason and experience.[58]

For some theists in the early eighteenth century, Scripture became optional because they believed that whatever revealed truths there were in the Bible could be ascertained from reason and experience alone. It did not take long for a number of theists to conclude that the Bible was suspicious because reason and experience could not demonstrate many things found in Scripture, such as the Trinity, the Incarnation and resurrection, and miracles. Whether because the Bible was viewed as redundant or as suspicious, as the eighteenth century rolled on, a large number of theists discarded Scripture and formulated their beliefs about God based solely on reason and experience. Human reason had been elevated above revelation for many theists. Still, deism "rested squarely on the rational necessity of God," a conviction that even Voltaire could not rationally deny.[59]

Despite all these religious changes, at the end of the eighteenth century forms of MN were still the rule of the day among natural philosophers, still the appropriate way to understand the nature of God's creation even if, for most of them, God was a distant spectator. A sharp distinction was maintained between theological proofs for God based on science, and scientific conclusions about the nature of creation. The latter were "held to be strictly confined to the naturalistic subject matter of the individual science."[60] And so things continued well into the nineteenth century. Yet, what a difference from the seventeenth century! By the 1830s, "Scientists with the large exception of biologists, needed God now only as a First Cause, the Author of natural laws. The laws themselves explained what actually happened."[61] Rationalism in religion ran strong, and not only among natural philosophers and scientists.

> The great wave of rationalizing that had gathered theological force since Newton's day found ardent disciples among nineteenth-century churchmen. The most striking religious minds of the century—such as Schleiermacher in Germany, Coleridge in England, Emerson in America—distinguished themselves by swimming against this tide. But more representative theologians dove into quasi-scientific natural theology with a zeal that would have done credit to any Enlightenment rationalizer.[62]

Trends dating back to before the early modern period are instrumental to understanding the significant shift represented in the nineteenth-century narrowing of all forms of knowledge down to one. This complicated set of mutually shaping and reinforcing intellectual trends involved the rise of ever-narrowing models of rationality and knowledge; the drive for quantification, mercantilism, and capitalism; bureaucratization; secularization; changes in the conception of persons (e.g., individualism) and society; and the stunning successes of the natural sciences.[63] By mid-nineteenth century, to count as knowledge was to be a concrete proposition about tangible reality that is demonstrable via logic or experience. This was the positivist ideal of knowledge in which the exemplars were (1) tangible facts, material objects, demonstrable truths, laws, and principles, (2) exact in the sense of logically or mathematically precise, and (3) verifiable through logic, observation, and experiment. This ideal held for all knowledge (e.g., scientific, mercantile, and theological).

The religious implications of this positivist model of knowledge were disastrous. First, faith was now viewed as an altogether different category from knowledge and truth. Second, God was treated as an object of natural knowledge in parallel with balance sheets and chemical compounds.[64] Clergy in the nineteenth century were at least as much to blame as the scientists for religious knowledge being reduced to this narrow ideal.[65]

By 1859, the intellectual space, making agnosticism and atheism sustainable ways of life, was fully

constructed just in time for the publication of Charles Darwin's *On the Origin of Species*.[66] In 1869, Thomas Huxley coined the term "agnosticism" to describe "a permanent suspension of belief in God. This settled inability to accept the reality of God, rather than positive atheism, became the distinctively modern unbelief."[67]

The intellectual trends surveyed so far continued their development, leading to the importation of metaphysical naturalism into science. Against this backdrop, some key developments were as follows:

1. To those theists who had built their natural theology on reason and experience alone, the publication of *On the Origin of Species* in 1859 delivered what registered as a psychological blow to the argument for design. Darwin was able to offer an account of how organs and species might become well suited to their environments through evolutionary mechanisms such as natural selection.[68] Biology had been one of the last scientific domains which seemed to offer direct evidence of God's creative activity in nature, and for many people, Darwin appeared to have knocked out that line of evidence. Explanations for organs and organisms in terms of natural processes seemed much more credible to many. The possible exception was the origin of life itself in which God might still be necessary. But God's role as First Cause

> dissipated into mist. Most scientists, qua scientists, simply stopped talking about such metaphysical questions. Many of the amateurs of science, taking their cue from Herbert Spencer, solemnly if vaguely invoked Force as the primal creative power inherent in the universe [leaving the idea of a purposive Creator aside]. Those who invoked Force as a creative power believed themselves to be speaking science. That they were, for the most part, speaking hokum only underlines again the enormous appeal of scientific explanations.[69]

2. Darwin's emphasis on natural processes for scientific explanations followed a pattern already set in explicit discussions of scientific methodology in the first half of the nineteenth century (e.g., Herschel and Lyell).[70] These nineteenth-century discussions—conducted by Christians and other theists—built on the methodological traditions of the seventeenth century (and even earlier as in Magnus). Darwin's constant complaint about appeals to divine creation of species was that they are not scientific explanations because they did not tell us how secondary causes were involved in the natural history of organisms (his explanatory complaints have nothing to do with questions about God's existence).

Even in the aftermath of Darwin's publications, Congregational minister and geologist George Frederick Wright defended MN on Christian grounds in an 1876 issue of *Bibliotheca Sacra:*

> It is not in accordance with what we specially value in the modern habits of thought, to cut the Gordian knot with the simple assertion, "so God has made it," … Such a course would be suicidal to all scientific thought, and would endanger the rational foundation upon which our proof of revelation rests. It is superstition and not reverence, which leads us to avoid the questions concerning the order and mode of the divine operations … We are to press known secondary causes as far as they will go in explanation of facts. We are not to resort to an unknown cause for explanation of phenomena until the power of known causes has been exhausted. If we cease to observe this rule there is an end to all science and of all sound sense.[71]

Wright goes on to invoke Newton's example of forces as the scientific explanation for God's activity in the heavens. Hence, many Christians still viewed science as revealing God's laws in creation, whereas many theists and all agnostics and atheists viewed science as silent on God.[72] In the last third of the nineteenth century, some who adopted the latter view veered into scientism—the philosophy that only scientific methods deliver knowledge and only scientific knowledge counts. This camp was composed of some scientists who were bent on undermining and marginalizing the Anglican Church in England, and several nonscientists who were completely enchanted by science but hardly understood what it was.[73] Scientism was the logical endpoint of the overly narrowed model of knowledge described above. Unfortunately, this minority late nineteenth-century view became quite influential, seeping into all manner of intellectual cracks and crevasses in contemporary culture.[74]

3. In the wake of *On the Origin of Species*, anthropological explanations for the origin and development of religion gained much greater plausibility in intellectual circles. In 1873, Robert Ingersoll summarized

the trend of these anthropological explanations: "Every new religion has a little less superstition than the old, so that the religion of science is but a question of time."[75] If God and religion could be accounted for by natural sociological developments, so the thinking went, then supernatural explanations were superfluous and dubious.

4. The uniqueness of human beings as distinct from the rest of the animals became highly questionable in the second half of the nineteenth century. We are told in special revelation that humans are made in God's image; over the centuries, that image was interpreted as various forms of distinctness from the rest of creation. Yet, by this period, "biblical evidence" held no sway over many thinkers. Instead, under the reigning model for knowledge, human distinctiveness had to be "scientifically discernible." Since nineteenth-century developments in neurophysiology were progressively demonstrating that human consciousness and cognition were crucially linked to our brains and that our brains were very similar to those of the great apes, evidence for human distinctiveness appeared to be lacking. Humanity was becoming more naturalized in the minds of many, while our ability to know supernatural things, such as God, immortality, and the soul, appeared outside the reach of knowledge. Ingersoll articulated the sense of the age for many thinkers: "Beyond nature man cannot go even in thought—above nature he cannot rise—below nature he cannot fall."[76]

All of the preceding trends developed within a doctrine of creation so atrophied that a pernicious false dilemma was solidly in place by the end of the eighteenth century:

> Events in creation either happen due to God's unmediated intervention or due to natural processes without any divine influence whatsoever.[77]

Outside of Christian circles, few thinkers believed that natural processes were God's ordinary ways of working in creation (even many Christians fell sway to viewing God as absent from natural processes). So the second branch of the false dilemma pictured the world of distant deism, completely cut off from God. It is not surprising, then, that between widespread rising skepticism about whether knowledge of God was possible and widespread focus on natural processes, nineteenth-century sciences largely dispensed with invoking God in explanations. Metaphysical naturalism was fast becoming the norm in educated circles (save largely for Christian thinkers). Turner summarizes the 1860s–1880s this way:

> Although many scientists clung to the faith that their work pointed to God, God no longer formed a necessary part of the scientific understanding of reality.[78]

The rise of metaphysical naturalism was complete by the 1880s. What was called natural philosophy through the 1850s still shared many metaphysical interests that were inviting toward theism. But the new post-1850s discipline known as "science" had a much narrower nonmetaphysical focus:

> a narrowing of the range of valid scientific knowledge so as to exclude all inferences about supposed nonphysical realities. The older idea of [natural philosophy], prevalent through the early decades of the [nineteenth] century, envisioned a spacious and rather laxly policed territory of [natural philosophic] knowledge. [Natural philosophy] meant something like "orderly and methodically digested and arranged" knowledge of nature. No fortified frontiers prevented [natural philosophy] from exploring metaphysical as well as physical questions about the natural world [witness Boyle and Newton] … In effect, science by fiat redefined its meaning of "natural" so as to preclude the traditional necessity of a supernatural on which nature depended. It did this de facto, not by denying the supernatural, but by refusing to consider as within the bounds of scientific knowledge anything but the physical. This was at root why scientific laws had to be reconceived as merely observed regularities rather than manifestations of divine will … The prodigious American physicist Joseph Henry defined as essential to a "scientific truth" its enabling "us to explain, to predict, and in some cases to control the phenomena of nature." But what could be accurately predicted was inherently limited to what could be carefully and precisely observed; that is, to physical reality. Thus, this predictive drive demanded ever more rigorous verification by physical evidence of scientific hypotheses. *Hypotheses projected beyond human experience of the natural world—even if formed by it—are worthless … because we have no way of testing them. The very purpose of modern science forced it gradually but inexorably to narrow its focus to physical reality alone*.[79]

Most American scientists in this period were Christians or at least theists, though they perhaps did not notice how metaphysical naturalism came to replace MN in scientific practice for so many of their non-Christian colleagues.[80]

Conclusions

There is a long history of religious neutrality in natural philosophy from the ancient Greeks to Medievals such as Magnus; to methodological revolutionaries such as Kepler, Boyle, and Newton; to nineteenth-century scientists such as Wright. Historically, then, metaphysical naturalism arises much later than what we today call MN, coming to flower in the latter half of the nineteenth century. Hence, metaphysical naturalism is not a necessary presupposition for MN. While it is tempting to see the rise of metaphysical naturalism as the ontologizing of methodological naturalism—and there is some truth to this diagnosis—metaphysical naturalism is not explainable without a host of other mutually reinforcing intellectual trends indicated above.[81]

Moreover, as the doctrine of creation slowly atrophied over the course of the seventeenth century and took a nosedive in the eighteenth century, natural philosophic explanations—what we would now call scientific explanations—gradually began to be viewed as replacements for God's active involvement in creation rather than being viewed as possible explanations for *how* God worked in creation (hence the false dilemma mentioned above, regarding understanding how events in nature happen).

Methodological naturalism presupposes no such competition with or replacement of God's working in creation. In the seventeenth-century context, such neutrality functioned as an injunction to understand nature on its own terms, implying natural philosophers did not invoke God's *unmediated* action in creation to explain events and patterns in creation. The ultimate purpose of MN was to glorify God through understanding secondary causes much in the spirit of Magnus.[82]

Unfortunately, since the end of the nineteenth century, MN has often been confused with metaphysical naturalism. For instance, Brad Gregory describes MN as

> the methodological postulate of metaphysical naturalism, which entails that for science to be science, by definition it can pursue, identify, and entertain only natural causes as plausible explanations of natural phenomena, with the universe as a whole regarded *as if it were a closed system of natural causes*.[83]

And Bruce Gordon says that MN

> maintains that for the purposes of science one cannot appeal to transcendent causes, and therefore scientific research must be pursued *as if metaphysical naturalism were true*.[84]

Since MN has nothing to do with metaphysical naturalism, to formulate MN in terms of such naturalism betrays a serious lack of historical understanding of the concept as well as a lack of clear thinking about the distinction between methodological naturalism and metaphysical naturalism.

It is also important to note an insidious side effect flowing out of the seventeenth-century emphasis on God's rule of creation through laws for thinking about creation: While God as Ruler, through laws, came to central stage in books and pamphlets written by natural philosophers, God as Redeemer receded into the shadows. This theological shift in emphasis corresponds to a focus on God's will, wisdom, and power in relation to creation at the expense of his covenental love for creation and plan of salvation. Although often ignored in historical accounts, this theological shift was an important strand contributing to the eighteenth-century idea that a perfectly wise Creator would make a creation that requires no divine interventions whatsoever. The intuition was that it would be demeaning to the grandeur of a Creator if he had to do anything in creation after its origin (an intuition that is alive and well in contemporary atheist writings such as Richard Dawkins's *The God Delusion*). This intuition was crucial to the rise of providential deism in the eighteenth century which, in turn, accelerated the separation of natural philosophy from faith/theology.

Nevertheless, natural philosophers involved in the Scientific Revolution uniformly believed that their efforts to understand the universe were efforts aimed at understanding God's creation—understanding the characteristics of things *he had made*. The pursuit of observational, experimental, and

mathematical methods of investigation as a means of understanding the nature of God's creation that were distinct from theological means, was fully justified in their minds by their commitment to some robust version of the doctrine of creation in which nature was a creation of God. As such, they saw that methodological naturalism was the appropriate theistic stance to take toward the study of nature. ✠

Notes

[1]This is an expanded version of a talk given at the 66th Annual Meeting of the American Scientific Affiliation in Naperville, Illinois, July 28–August 1, 2011. I thank Ted Davis, Ron Numbers, and anonymous referees for their constructive comments, saving me from several embarrassments. Any remaining embarrassments are solely my responsibility.

[2]Some, such as Bruce Gordon ("In Defense of Methodological Neutrality," 66th Annual Meeting of the American Scientific Affiliation, July 28–August 1, 2011), question the applicability or projectability of MN as a characterization of scientific work prior to the late nineteenth century because they see its contemporary usage as inextricably intertwined with metaphysical naturalism.

[3]As Colin Gunton points out, "[T]here could be no doctrine of creation without the setting in which it was hammered out," in *The Triune Creator: A Historical and Systematic Study* (Grand Rapids, MI: Eerdmans, 1998), 41.

[4]For example, in his unfinished *Literal Commentary of Genesis*, Augustine noted that the "plain sense" of Gen. 1:1–2 was that God began his work of creation with (probably eternally) preexistent matter (a reading of Gen. 1:1–2 that his Manichean opponents favored). In contrast, Augustine argued that these verses pointed to the deeper meaning, that God had created *ex nihilo,* because we know from the New Testament that God is the Author and Founder of all things, and this implies that matter has a beginning through God (hence, it cannot preexist God's founding creative acts). So Gen. 1:1–2 must mean—contrary to the "plain sense"—that God initially created matter.

[5]For a fuller treatment of the doctrine of creation, see Gunton, *The Triune Creator*, and Robert C. Bishop, "Recovering the Doctrine of Creation: A Theological View of Science," http://biologos.org/uploads/static-content/bishop_white_paper.pdf.

[6]For example, Philoponus argued that the Sun was composed of fire as ordinarily found on Earth, in *Commentary on Aristotle's 'Meteorology,'* ed. M. Hayduck, *Commentaria in Aristotelem Graeca* (CAG) 14.1 (Berlin: Reimer, 1901), 49. He also argued that the motions of the planets could be explained by an impetus impressed upon them by God, the same form of impetus at work in terrestrial phenomena such as the motion of arrows and rocks, in *On the Creation of the World* (*De opificio mundi*), ed. W. Reichardt (Leipzig: Teubner, 1897), I.12. The dynamics of motion was the same in the heavens as it was on Earth.

[7]Gunton, *The Triune Creator*, 72.

[8]Harold P. Nebelsick, *Renaissance and Reformation and the Rise of Science* (Edinburgh: T&T Clark, 1992), 13.

[9]Joseph L. Spradley, *Visions That Shaped the Universe: A History of Scientific Ideas about the Universe* (New York: McGraw-Hill, 1994), 51–6.

[10]Nebelsick, *The Renaissance*; Spradley, *Visions That Shaped the Universe*; Gunton, *The Triune Creator*.

[11]Nebelsick, *The Renaissance*; Gunton, *The Triune Creator*.

[12]R. Hooykaas, "The Rise of Modern Science: When and Why?," *The British Journal for the History of Science* 20 (1987): 453–73; Toby E. Huff, *The Rise of Early Modern Science: Islam, China and the West* (Cambridge: Cambridge University Press, 1993), 104–6, 179–89, 339–42; Edward Grant, *The Foundations of Modern Science in the Middle Ages: Their Religious, Institutional and Intellectual Contexts* (Cambridge: Cambridge University Press, 1996), chaps. 5–8; Gunton, *The Triune Creator*, 106–7; Edward B. Davis, "Christianity and Early Modern Science: The Foster Thesis Reconsidered," in *Evangelicals and Science in Historical Perspective*, ed. David N. Livingstone et al. (New York: Oxford University Press, 1999); David D. Lindberg, *The Beginnings of Western Science: The European Scientific Tradition in Philosophical, Religious, and Institutional Context, Prehistory to AD 1450*, 2nd ed. (Chicago, IL: University of Chicago Press, 2007), 233–53.

[13]J. R. Milton, "Laws of Nature," in *The Cambridge History of Seventeenth-Century Philosophy*, ed. Daniel Garber and Michael Ayers (Cambridge: Cambridge University Press, 1998), 680–701.

[14]There is a further distinction among natural philosophers regarding divine freedom. If one believed that God's freedom in creation was exercised in service of reasons accessible to human minds, then one tended to think that reason alone could arrive at the true laws of nature (e.g., Descartes).

[15]Kenneth J. Howell, *God's Two Books: Copernican Cosmology and Biblical Interpretation in Early Modern Science* (Notre Dame, IN: University of Notre Dame Press, 2002); Klaas van Berkel and Arjo Vanderjagt, eds., *The Book of Nature in Early Modern and Modern History* (Leuven, Belgium: Peeters Publishers, 2006); Mary L. VandenBerg, "What General Revelation Does (and Does Not) Tell Us," *Perspectives on Science and Christian Faith* 62, no. 1 (2010): 16–24.

[16]For example, see Stillman Drake, *Discoveries and Opinions of Galileo* (New York: Anchor Books, 1957), 173–216.

[17]Carola Baumgardt, *Johannes Kepler: Life and Letters* (New York: Philosophical Library, 1951), 44, 50.

[18]For instance, see Gerald Holton, *Thematic Origins of Scientific Thought: Kepler to Einstein*, rev. ed. (Cambridge, MA: Harvard University Press, 1988), 68–9. This momentum for mathematizing more and more of nature received its biggest impulse in the infusion of new mathematical learning and practice from the many Islamic texts that flowed back into Medieval and Renaissance Europe.

[19]See Richard H. Popkin, *The History of Skepticism from Erasmus to Spinoza* (Berkeley: University of California Press, 1979), and *The History of Skepticism: From Savonarola to Bayle* (Oxford: Oxford University Press, 2003).

[20]Peter Harrison, *The Fall of Man and the Foundations of Science* (Cambridge: Cambridge University Press, 2007).

[21]Descartes was something of an exception to these trends with respect to mitigating what he took to be the unreliability of sense experience.

[22]Harrison, *Fall of Man*. As he sums it up,

> [For many in the seventeenth century,] the birth of modern experimental science was not attended with a new awareness of the powers and capacities of human reason, but rather the opposite—a consciousness of the manifold deficiencies of the intellect, of the misery of the human condition, and of the limited scope of scientific achievement. (p. 258)

See also, Popkin, *The History of Skepticism from Erasmus to Spinoza*, and *The History of Skepticism: From Savonarola to Bayle*.

[23]Joseph Spradley, "Methodological Naturalism in Ancient and Medieval Science," 66th Annual Meeting of the American Scientific Affiliation, July 28–August 1, 2011; "How Have Christian Faith and Natural Science Interacted in History?," in Dorothy F. Chappell and E. David Cook, eds., *Not Just Science: Questions Where Christian Faith and Natural Science Intersect* (Grand Rapids, MI: Zondervan, 2005), 27–47; Lindberg, *Beginnings of Western Science*.

[24]Lindberg, *Beginnings of Western Science*, 240–1.

[25]The idea that there was a scientific revolution has come in for a great deal of criticism of late. For example, see Andrew Cunningham and Perry Williams, "De-Centering the 'Big Picture': 'The Origins of Modern Science' and the Modern Origins of Science," *The British Journal for the History of Science* 26 (1993): 407–32. Although there is reason to be cautious in using such a grand term, I think it still has merit for delineating an important period in the history of the development of modern science.

[26]For instance, see Robert Boyle, *A Free Enquiry into the Vulgarly Received Notion of Nature*, ed. Edward B. Davis and Michael Hunter (Cambridge: Cambridge University Press, 1996); Rose-Mary Sargent, *The Diffident Naturalist: Robert Boyle and the Philosophy of Experiment* (Chicago, IL: University of Chicago Press, 1995); Jan W. Wojcik, *Robert Boyle and the Limits of Reason* (Cambridge: Cambridge University Press, 1997).

[27]Robert Boyle, *The Works of the Honorable Robert Boyle*, ed. T. Birch, vol. 5 (Hildesheim: Georg Olms, 1965 [1772]), 513–4, emphasis added.

[28]Sargent, *Diffident Naturalist*, 110–2.

[29]Ibid., 112.

[30]Boyle, *Works*, vol. 4, 7.

[31]Ibid., *Works*, vol. 2, 19–20.

[32]Sargent, *Diffident Naturalist*, 122.

[33]Ibid., 122.

[34]Boyle, *Works,* vol. 4, 68, 78; and *Works,* vol. 5, 165.

[35]Ibid., *Works,* vol. 3, 7.

[36]Ibid., *Works,* vol. 2, 61. Understanding phenomena on their own terms also means understanding them in context: "A body is not to be considered barely in itself, but as it is placed in, and is a portion of the universe" (*Works,* vol. 3, 303). However, for Boyle, MN did not extend to the origin of matter, or living creatures; God created these immediately rather than mediating them through natural processes (Edward Davis, private communication).

[37]Sargent, *Diffident Naturalist*, 115.

[38]Ibid., and Wojcik, *Robert Boyle*.

[39]Howell, *God's Two Books*, chap. 3.

[40]As quoted in ibid., 120.

[41]Ibid., chap. 4.

[42]I. Bernard Cohen, *The Newtonian Revolution: With Illustrations of the Transformation of Scientific Ideas* (Cambridge: Cambridge University Press, 1980).

[43]Isaac Newton, *The Correspondence of Isaac Newton*, vol. 3, ed. H. W. Turnbull (Cambridge: Cambridge University Press, 2008), 369; and Newton, *Opticks: or A Treatise of the Reflections, Refractions, Inflections & Colours of Light*, based on the 4th ed., ed. I. B. Cohen et al. (New York: Dover, 1979), 405. There is some ambiguity as to whether forces in Newton's view are physical or nonphysical—corporeal or noncorporeal, in his terms. See J. T. Dobbs, "Newton's Alchemy and His Theory of Matter," *Isis* 73 (1982): 511–28.

[44]Isaac Newton, Keynes MS 3, fol. 12, King's College, Cambridge, http://www.newtonproject.sussex.ac.uk/view/texts/normalized/THEM00003; and Isaac Newton, Yahuda MS 15, fols. 47v, 96v, Jewish National and University Library, Jerusalem, http://www.newtonproject.sussex.ac.uk/view/texts/normalized/THEM00220.

[45]Dobbs, "Newton's Alchemy," 526–8.

[46]Isaac Newton, Keynes MS 6, fol. 1r, King's College, Cambridge, http://www.newtonproject.sussex.ac.uk/view/texts /normalized/THEM00006.

[47]Newton, Letter of 25 February 1693, *Correspondence*, vol. 3, 254.

[48]Gary B. Deason, "Reformation Theology and the Mechanistic Conception of Nature," in David C. Lindberg and Ronald N. Numbers, eds., *God and Nature: Historical Essays on the Encounter between Christianity and Science* (Berkeley: University of California Press, 1986), 167–91.

[49]Gunton, *The Triune Creator*.

[50]Dobbs, "Newton's Alchemy;" Davis, "Newton's Rejection of the 'Newtonian Worldview': The Role of Divine Will in Newton's Natural Philosophy," in Jitse M. van der Meer, ed., *Facets of Faith and Science, vol. 3: The Role of Beliefs in the Natural Sciences* (Lanham, MD: University Press of America, 1996), 75–96.

[51]Indeed, Newton believed that this was the normal pattern in religion from ancient times forward: Theology, philosophy, and astronomy were acknowledged to be distinct fields of study, yet interacted to produce true knowledge with theology as the broadest, encompassing the others. See Isaac Newton, Yahuda MS 41, fol. 4v, Jewish National and University Library, Jerusalem, http://www.newtonproject.sussex.ac.uk/view/texts/normalized/THEM00077. In that belief, he was surely right (Howell, *God's Two Books*).

[52]Gunton, *The Triune Creator*; Bishop, "Recovering the Doctrine of Creation;" James Turner, *Without God, Without Creed: The Origins of Unbelief in America* (Baltimore, MD: The Johns Hopkins University Press, 1985); Margaret Jacob, "Christianity and the Newtonian Worldview," in Lindberg and Numbers, eds., *God and Nature*, 238–55.

[53]Turner, *Without God*, chap. 2; Jacob, "Christianity and the Newtonian Worldview."

[54]Turner, *Without God*, 40.

[55]Ibid.; Jon H. Roberts, "Myth 18: That Darwin Destroyed Natural Theology," in Ronald L. Numbers, ed., *Galileo Goes to Jail and Other Myths about Science and Religion* (Cambridge, MA: Harvard University Press, 2009), 161–77. The argument from design appealing to the order and intelligibility of the world through laws did make a comeback in the second half of the nineteenth century.

[56]Turner, *Without God*, 55–7, 77; Roger Hahn, "Laplace and the Mechanistic Universe," in Lindberg and Numbers, eds., *God and Nature*, 264–71).
[57]Turner, *Without God*.
[58]Ibid., 51.
[59]Ibid., 53.
[60]Ibid., fn. 53, 283, 77.
[61]Ibid., 77.
[62]Ibid., 96.
[63]Ibid.; Charles Taylor, *A Secular Age* (Cambridge, MA: Belknap Press, 2007).
[64]Turner, *Without God*, 132–40. Although we tend to associate these three features of knowledge with science, Turner points out that in the nineteenth century,

> Empirical rationality fitted rather well the developing environment of commercial capitalism. A penchant for rational organization helped to bring success in an increasingly complicated and interwoven tangle of economic relationships. A sharp eye on specific concrete realities aided in taking advantage of rapidly changing markets. (p. 132)

In other words, the developing model of knowledge found reinforcement as much in merchant and commercial values as in science.
[65]Ibid., chaps. 3–4 and 6.
[66]Hence, Richard Dawkins's oft-repeated claim that Darwin made it possible to be an intellectually fulfilled atheist is historically inaccurate to say the least.
[67]Turner, *Without God*, 171.
[68]Design arguments based on the overall order of nature were less disturbed (Roberts, "Myth 18: That Darwin Destroyed Natural Theology").
[69]Turner, *Without God*, 180.
[70]Ronald L. Numbers, "Science without God: Natural Laws and Christian Beliefs," in Lindberg and Numbers, eds., *When Science and Christianity Meet* (Chicago, IL: University of Chicago Press, 2008), 277–9.
[71]George F. Wright, *Studies in Science and Religion* (Andover, MA: Warren F. Draper, 1882). Kepler said something very similar in 1606 in reference to explaining the origin of a newly discovered star: "However, we should consider all [other possibilities] before that of [special] creation as that is to end all discussion," *De Stella Nova*, chap. 22 in Johannes Kepler, *Gesammelte Werke*, vol. 1, ed. Walther von Dyck and Max Caspar (Munich: C. H. Beck'sche Verlagsbuchhandlung, 1938), 257 (my translation).
[72]Turner, *Without God*, 175–87; Numbers, "Science without God," 279–81; Matthew Stanley, "The Uniformity of Natural Laws in Victorian Britain: Naturalism, Theism, and Scientific Practice," *Zygon* 46, no. 3 (2011): 537–60. Stanley points out Huxley's clever relabeling of theistic scientists' statements of MN as metaphysically naturalistic.
[73]Turner, *Without God*, 189–202; Numbers, "Science without God," 281–2; Timothy Larsen, *Crisis of Doubt: Honest Faith in Nineteenth-Century England* (Oxford: Oxford University Press, 2009).
[74]Ian Hutchinson, *Monopolizing Knowledge: A Scientist Refutes Religion-Denying, Reason-Destroying Scientism* (Belmont, MA: Fias Publishing, 2011).
[75]Robert G. Ingersoll, *The Works of Robert G. Ingersoll*, vol.1, ed. R. Green (New York: Dresden Publishing, 1909), 192.
[76]Ibid., 27.
[77]This false dilemma is still pervasive in the science-religion literature.
[78]Turner, *Without God*, 180–2. The quotation is from pp. 181–2.
[79]Ibid, 184–6, emphasis added.
[80]Cunningham and Williams, "De-Centering the 'Big Picture,'" make the argument that modern science, in a substantial sense, began with this secularizing of science in addition to replacing the term "natural philosophy" with "science" as we now understand the latter term.
[81]Nor is the rise of metaphysical naturalism explainable apart from a host of moral commitments and ethical ideals (e.g., ibid., especially chap. 7; Taylor, *Secular Age*).
[82]There are parallels in biblical interpretation from the Reformation. For instance, Luther recognized that the Moon's light, say, could be described as a sign of divine providence, while at the same time it was described by astronomers as a reflection of the Sun's light. Similarly, Calvin taught that Moses and other biblical authors described heavenly phenomena as they appeared to observers in their day, while astronomers would give technical descriptions for purposes that differed from those of Moses. As Gary Deason summarizes in "Reformation Theology,"

> Recognizing the accommodation of the text to the general reader, the interpreter could avoid conflict with contemporary astronomy by claiming that the biblical author described the heavens as they appeared to the unlearned eye, not as they might be understood by the astronomer. (p. 171)

The astronomers' descriptions are analogous to MN in that they did not replace religious descriptions, but served different purposes from the latter (cf. Howell, *God's Two Books*; Harrison, *Fall of Man*).
[83]Brad S. Gregory, "No Room for God? History, Science, Metaphysics, and the Study of Religion," *History and Theory* 47 (2008): 495–519 (emphasis added).
[84]Bruce Gordon, "In Defense of Methodological Neutrality" (emphasis added). Alvin Plantinga has a subtle example of this in *Where the Conflict Really Lies: Science, Religion, and Naturalism* (New York: Oxford University Press, 2011). He characterizes MN as "a proposed condition or constraint on proper science, or the proper practice of science, not a statement about the nature of the world" (p. 169). He then strengthens this characterization: "More generally, the idea is that in science we should proceed *as if* the supernatural is not given" (p. 170, emphasis added). More importantly, he elaborates MN as "a constraint on the evidence base of any scientific inquiry" (p. 172). The real problems begin when Plantinga states that "the evidence base of a Christian theist will include (among much else) belief in God" but MN rules out such evidence (p. 173). MN now is confused with metaphysical naturalism because the latter explicitly rules God out, but MN on Plantinga's construal now rules God out. However, beliefs are not evidence for scientists. Plantinga has introduced a philosophical notion of evidence into a discussion of scientific evidence and methodology, and has thereby created a confusion that does not properly exist in scientific methodology itself.

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René van Woudenberg

Article

Limits of Science and the Christian Faith

René van Woudenberg

This article[1] is a discussion of the claim that, given the findings of science, the rational stance to take toward Christian belief is either to abandon it or to reform it drastically. It is argued that science has a number of limits, and that when these are taken into serious consideration, the claim loses much of its force.

Ever since the rise of modern science many people have claimed that, given the findings of science, the rational stance to take toward the traditional Christian faith is either to abandon it or to reform it drastically. This claim has been supported by considerations having to do with, among other things, chance, evolution, and the laws of nature. I am not going to deal now with any of these more specific considerations (as I have done on other occasions) but will, instead, say something far more general about science. I am going to propose that the claim that I have just mentioned can only appeal to one when one neglects or somehow plays down the importance of certain limitations of science. Accordingly, I will spend quite some time arguing that science, as we currently know it, is limited in various (and I think rather obvious) respects. Saying that science is limited is, of course, very different from criticizing science. My guitar, I must say, has its limits: it cannot bring forth the golden sound of a horn. Saying as much, however, is not criticizing my guitar.

My article is organized as follows. In the first section, I argue for various limits of science, but lay no claim to completeness. In the second section, I spell out how these limits are relevant for the claim that, due to science, the rational stance to take toward Christian faith is either to abandon it or to reform it drastically. As to the two key notions in my title: by science, I mean in the main the natural sciences; but occasionally I shall use the term in the more encompassing continental style, so as to include the humanities. By Christian faith, I mean the faith a person has who wholeheartedly endorses the great traditional creeds such as the Apostles' Creed.

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1. Limits of Science

It bears noting that the "limits of science" can either be of a practical kind (having to do with limits in financial and technological resources, as well as to do with what is ethically permitted or required in the process of inquiry) or of a principled nature. The limits I have my eyes on are of the second, in principle, sort. The arguments I shall offer all have different points of departure, but, as will appear in due course, are nonetheless related in many respects.

a. A Limit from Extra-Scientific Knowledge

One of the aims of science is to obtain knowledge. Scientists immerse themselves in all kinds of activities in order

to acquire knowledge. But how shall we understand "knowledge"? In contemporary analytic epistemology, knowledge is analyzed as true belief that has some further property, for instance, that it is justified or warranted. On this analysis, one cannot know that, say, the cat is on the mat, unless one believes that the cat is on the mat and unless it is true that the cat is on the mat. But although true belief is necessary for knowledge, it is not deemed sufficient for it. For someone may, for no good reason, believe that the cat is on the mat, and the cat may even be on the mat, without that person's knowing the cat is on the mat. That person's belief is true, but by luck—that person's belief lacks something important: it lacks justification or warrant, for that belief has nothing going for it, it is not formed or acquired in an appropriate way. Knowledge, we might therefore say, is true belief that is warranted.

There has been, and still is, considerable debate as to what this property of justification or warrant exactly is. Is it "believed for good reasons," or "based on sufficient evidence," or "being certain," or "coherence with a large body of other beliefs," or "resulting from a reliable process," or "being produced by a properly functioning faculty that is successfully aimed at truth and that worked in an appropriate environment"… or what?[2] For present purposes, however, I need not enter this debate, for the point I want to establish can be made irrespective of one's favorite analysis of the property under dispute. But I do need to note that I will be thinking of scientific knowledge as true belief whose warrant derives, somehow, from science or scientific research. How exactly scientific research can provide warrant is a topic of great interest, one that I presently need not go into either, because the point that I want to establish can be made irrespective of how exactly warrant-through-science works.

One of the aims of doing science is to obtain knowledge. It should be uncontroversial, however, that there are many things we know without science in any way being involved in the production of that knowledge or warrant for it. Examples abound. I open my eyes and see (and hence know) that the lights are on, that the sky is blue, and that I have a white shirt on. I also know that the world is older than three minutes, that China is a very big country. I furthermore know that 5 + 7 = 12, that if John is taller than Jack, Jack is not taller than John, and that six could not have been odd. I also know that I was in Toronto last week, that I am suffering from a mild pain in my left ankle, and that I was born and raised in The Hague. I furthermore know many moral truths: that honesty is much better than dishonesty, that lying is wrong, that I ought to help my ageing mother, that there is more demerit in an unjust act than in an ungenerous one. Next, there are many very general truths that I happen to know, such as that there are very many people, that they live on the surface of the earth, that they need food and liquids to keep themselves alive, that they need love and respect, that there are very many countries in which these people live, and that these countries have governments, some of which are bad, but others of which are tolerably good. And as it is with me, so it is with you.

The point of rehearsing these obvious and perhaps boring truisms is, of course, that we have acquired vast amounts of knowledge without engaging in anything that could be called "scientific research," and hence without the warrant condition for knowledge being satisfied by anything scientific. Let us call knowledge that is, in fact, obtained independently of science, and furthermore is not based on testimony about things that have been established through scientific investigation, extra-scientific knowledge.

Now one might have knowledge that is in fact extra-scientific but that could have been scientific. Many things that we in fact know without the help of science are such that they could be known with the help of science. For example, I know that my great-grandfather was a shipbuilder by profession; the warrant condition for my knowing is satisfied by testimony from my mother and other members of the family. But the warrant condition could also have been satisfied by something that involves scientific inquiry: for instance, by my reading of a book by a professional historian on shipbuilding in early twentieth-century Dutch harbors, or by having carried out such research myself. In that case, my knowledge that my great-grandfather was a shipbuilder by profession would be an instance of the scientific variety. (And what if I have both scientific and nonscientific warrant for that knowledge? Then there is no simple answer to the question, "Is your knowledge scientific?")

But not all extra-scientific knowledge is such that, although it is in fact acquired and warranted by something that does not involve science, it could also be acquired and warranted by something that does involve science. Much of our knowledge can, as a matter of principle, not be acquired or warranted through scientific research. It seems impossible that I know, or come to know, that lying is wrong in a way that somehow involves science; it seems impossible that science can satisfy the warrant condition for such knowledge. The same holds for other things that I know, such as that honesty is much better than dishonesty, or that I have an obligation to care for my children. Other examples, perhaps somewhat more controversial, would be the knowledge I have of some of my own mental states. It seems impossible that I know, or come to know, that I have a headache (when I have one), independently of my feeling a headache and exclusively in a way that involves, in one way or another, science. For, as Thomas Reid rightly said, "Pain consists in being felt." This is, of course, not to deny that I might learn all sorts of things about headaches, or about my own headache, through science. But what seems impossible is that I learn that I have a headache through scientific research. Let us call this sector of extra-scientific knowledge the sector of irreducibly extra-scientific knowledge.

My contention is that irreducibly extra-scientific knowledge marks a limit of science: there is knowledge that we have that cannot be obtained through or receive warrant from science. Contending this is, of course, criticizing neither science nor this sector of our knowledge. My contention will, of course, meet with scepticism. Emotivists and other moral antirealists, for example, will deny that there are moral truths, and hence dispute that there is such a thing as moral knowledge—this would be a problem for my argument because important instances of irreducibly extra-scientific knowledge that I gave were examples of moral knowledge. In response, I can only say that I reject moral antirealism for reasons that have nothing to do with the present argument.[3] Another response to my contention might be to bite the bullet and deny that extra-scientific beliefs ever amount to knowledge. This, however, would be deeply problematic. For scientific knowledge *depends* in many ways on extra-scientific knowledge, for instance, on what we know through perception, such as that the thermometer now reads 118 degrees Fahrenheit. Without such extra-scientific knowledge it is hard to see how science could even get started.

The point I have been trying to make is that science (as we now know it) is limited in that there is knowledge that as a matter of principle cannot be gained through, and is not warranted by, scientific research. I concur therefore with Nicholas Rescher when he says that "even in the strictly cognitive domain, scientific knowledge is only one sort of knowledge," to which he adds:

> The facts to which science addresses itself are ... those that arise from intersubjectively available observation rather than personal sensibility ... This quantitative orientation of our natural science means that the qualitative, affective, evaluative dimension of human cognition is bypassed. Our knowledge of the value dimension of experience—our recognition as such of these features of things in virtue of which we deem them beautiful or delightful or tragic—remains outside the range of science.[4]

There is, then, a limit to science from irreducibly extra-scientific knowledge. In the next section, I am going to explore this point when I will be suggesting that the Christian faith gives us knowledge of divine things—knowledge that science cannot give us and for which it cannot provide the warrant.

b. A Limit from Knowledge by Acquaintance

In epistemology, a distinction is sometimes made between "knowledge of truth," or "propositional knowledge," on the one hand, and "knowledge by acquaintance" on the other[5]—between knowing about things, and knowing things. By my own experience I am acquainted with, for instance, the taste of wine, the smell of roses, and the colors of Rembrandt's *Night Watch*. And there is a sense of "knowing" whereby someone acquainted with the taste of wine can be said to "know" that taste in a way that someone not thus acquainted cannot. It is one thing to be acquainted with the taste of wine, and another to know truths (or true propositions) about it—to know that Italian wines generally taste sweeter than French ones, due to various minerals and different weather conditions, for example. It is logically possible to have the first kind of knowledge but lack the second. One can know something in the sense of

being acquainted with it and know, at the same time, no, or almost no, truths about what one is acquainted with. One can be acquainted with colors without knowing much about colors, and so on.

This distinction is also relevant when it comes to knowing people.[6] One can know many truths about someone one is not acquainted with. Many people know many truths about the second president of the United States, John Adams: for example, that he was happily married to his wife Abigail; that he stayed an extended period of his life in Europe, especially in France but also in The Netherlands; that he obtained an important loan to finance the Revolution from a Frisian banker; that he was an ardent lover of poetry; that his son John Quincy Adams also became president; and so on. We can know these truths about him without ever having met him or being acquainted with him in the sense of having had personal interaction with him. But, although one may know many truths about Adams, there is a sense in which we do not know him. It is that sense of "know" that forbids me to say "yes" when I am asked, "Do you know George Bush?" I do not know that man, because I never have met him, have never been acquainted with him—even though I know many truths about him.

The difference between knowledge by acquaintance and propositional knowledge has to do with truth in the following way: the objects of propositional knowledge (the things we usually talk about by using "that" clauses, for example, that John Adams was the second president of the US, that the thermometer reads 68°F, etc.) have truth value—they are either true or false. But the objects of knowledge by acquaintance (such as the taste of wine and John Adams) are not the sorts of things that have, or even can have, truth value; neither the taste of wine nor John Adams can be true or false.

One aim of doing science is to obtain knowledge, or at the very least to formulate and deal with items such as conjectures, hypotheses, theories, predictions, and so on, that are all propositional in nature and thus have truth value. What we want to find out by doing science is whether certain theories, hypotheses, and so forth (which really are complex propositions) are true or not. What this means is that science operates on the propositional level and that in so far as it gives us knowledge, it gives us propositional knowledge. But scientific knowledge never gives us knowledge by acquaintance, even though it is, to a certain extent,[7] based on such acquaintance. For how could a theory of light, such as Newton's (or Goethe's for that matter), have been devised, if Newton (or Goethe) had not been acquainted with the phenomenon of light? Many scientific theories are based upon phenomena that we can, in principle, be acquainted with.

If I am right about this, there appears to be a second limit for science, in that science, if it gives us knowledge at all, gives us propositional knowledge, but no knowledge by acquaintance. Nothing that qualifies as "knowledge by acquaintance" merits the label "scientific knowledge," even though, as I have suggested, science is to a certain extent based on such knowledge. Later on I am going to explore this point when I will be arguing that the classical Christian faith partly (and only sometimes) involves knowledge by acquaintance of God.

That science is limited in the way argued for in this section, has been used by Frank Jackson in his famous "knowledge argument" against physicalism—in which "physicalism" is the thesis that the actual world is entirely physical.[8] Since traditional Christianity, too, is committed to the denial of physicalism, it will be worthwhile taking a quick look into the argument.

Suppose that physics is completed, and that a human person—in Jackson's argument she is called Mary—has been comprehensively instructed about the physical world (she has been instructed in physics, chemistry, and neurophysiology and knows all there is to know about the causal and relational facts consequent upon all this) in a rather peculiar situation: she was instructed in the black-and-white room that she was born into and never left, through a black-and-white television screen. Having been comprehensively instructed, Mary knows everything that can be known about the physical nature of the world. And if physicalism is true, so the argument goes, she knows all there is to know. To suppose otherwise would be to suppose that there is more to know than all physical facts, which is exactly what physicalism is committed to denying. So Mary knows all truths, also, for example, all truths about

human visual perception. As Mary has never been outside that black-and-white room, she never has seen the greenness of grass. Suppose now that Mary is to exit her room. Will she then come to know something she did not know before? Well, Mary knows everything there is to know about human visual perception. Yet she had never laid eyes on green grass. So, Jackson argues, upon leaving her room, Mary learns something new, the intrinsic characteristics of the experience of color perception. Mary, the argument concludes, does not know everything. And this, Jackson says, indicates that certain facts about color perception cannot be accounted for in a complete physical description of the brain processes of someone who has a color experience. So, upon walking out, Mary obtains knowledge that she has not and could not have acquired through science.[9]

c. A Limit from Presuppositions

There can be no science without scientists making various very general suppositions that, because of their special nature, could be called presuppositions. In this section, I want to argue that there are no scientific proofs of the truth of these presuppositions. And this, I shall contend, constitutes another limit of science. I shall single out three presuppositions.

1. In science, the principles of logic, such as *modus ponens*, are used. The truth of these principles, however, cannot be proved on the basis of arguments that only have premises that are established by scientific research. This cannot be done for at least two reasons. In the first place, the principles of logic are necessarily true, if true at all, but the findings of the natural sciences are, as a matter of principle, at best contingently true, if true at all. And this causes a problem, for necessary truths, if they are to be established, have to be established by reasoning that proceeds from necessarily true premises. But science can never provide necessary truths. Secondly, if the principles of logic are to be proved by argument, the proofs must not involve, or implicitly presuppose the truth of, those very principles. That would be begging the question. But any proof of the principles inevitably will have to beg the question. For one cannot prove anything (and a fortiori not the principles of logic) without using the principles of logic.[10]

2. In science, it must be presupposed that our basic cognitive faculties such as perception, reason, and memory are, by and large, reliable. One cannot rely on observations without presupposing that sense perception is by and large reliable; one cannot conduct experiments without presupposing that reason is by and large reliable; likewise one cannot do science without presupposing that memory is by and large reliable. But the reliability of our faculties cannot be proved on the basis of arguments that crucially involve premises obtained by scientific research in that the scientific research that will have to provide the premises of such an argument itself presupposes the reliability of the faculties whose reliability it aims to establish.

To this it could be added, as William Alston has argued, that the reliability of our faculties cannot be proved by arguments at all. Every attempted proof of the reliability of, for instance, sense perception will crucially involve premises won by the workings of that very faculty. Similar things, he convincingly argues, hold for reason and memory. All such attempts suffer from what he has called "epistemic circularity."[11]

3. Scientists not only presuppose the truth of the principles of logic and the reliability of our cognitive faculties, but they also presuppose various things about their object of research. They presuppose, for instance, that nature behaves uniformly. The principle of the uniformity of nature says that the patterns nature displays on a small scale, nature will also display on a large scale. That this particular piece of iron expands when it is heated, tells us something not only about this particular piece, but also about all iron. If we did not presuppose this principle, science would at once become impossible. We would not, in that case, have any reason to think that the causal connection between facts of type A and B that obtained yesterday in Amsterdam, will also, *ceteris paribus*, obtain tomorrow, there and/or in Brussels. Were the principle not presupposed, the testing of hypotheses would be pointless.

So, here are three presuppositions of science whose truth science is unable to prove. This does not mean there are no good grounds for adopting them. But it does mean that the person who refuses

to accept or believe anything unless it is proved by science (a position we might label scientism) is in serious trouble. Such a person should refuse to accept the principles of logic, refuse to assume that our basic cognitive faculties are by and large reliable, and refuse to accept the principle of the uniformity of nature. Such a person, then, refuses to accept the presuppositions of science and accordingly should be committed to not accepting anything science tells us. But that way lies madness. For we know and think many things on the basis of scientific research. Therefore, if one wants to save science as a source of knowledge (or warrant), one had better reject scientism.[12]

The existence of presuppositions of science, I submit, marks another limit of science. There are certain things absolutely fundamental to the scientific enterprise that science cannot prove to be true: its presuppositions. And this inability indicates a sort of limitation: it marks out something that science cannot do.

d. A Limit from Ultimate Questions

There can be no science (taken in a broad sense now) without scientists asking questions. We can think of science as a set of tentative answers to questions. These questions take on various different forms: for example, What is the cause of X (where X is some natural phenomenon, e.g., lightning and thunder)?, How can this pattern of phenomena be explained?, What are the ultimate constituents of matter?, What did Kant mean by the expression "the private use of reason"?, Why didn't president Bush completely dismantle Saddam Hussein's army in early 1991?, What is the best treatment for psychosis? Scientific questions differ greatly from one another. Some would be answered by citing facts, others by giving explanations, still others by citing reasons or motives, yet others by proposing a theory; some would be answered by offering an interpretation of a text, and some by suggesting a particular treatment, a particular course of action, and others in yet other ways.

So, the questions scientists ask are not all of a kind. Some philosophers, however, have held that scientific questions are characterized by a feature that nonscientific questions lack. Some Wittgensteinians, for example, have held that scientific questions have the particular feature that their answers take the form of explanations.[13] But this, as our sampling in the previous paragraph indicates, is not right. Furthermore, there are clearly extra-scientific questions whose answers have the form of explanations. Someone asking "Why are those windows wet?" asks for an explanation, but asks no scientific question.

It may, therefore, be impossible to characterize a scientific question fully. What should be evident, however, is that there are extremely important "ultimate" questions that cannot be answered by scientific research. I am thinking, of course, of such questions as the following: Why are we all here?, Why is there something and not nothing?, Do we possess freedom?, What moral principles should we heed?, Which moral virtues should we try to attain?, What things are of value?, Does God exist?, What does God (if he exists) require from us? The sciences (still taken in the broader sense to include psychology and sociology) do not answer these questions, and it would seem, cannot do so. What part of physics, or biology, or psychology, or sociology is ever going to provide answers to these questions? We seem to face another limit of science, namely, its inability to answer "ultimate" questions.

Not everyone, however, will agree. At one time (not so very long ago), the neo-positivists declared that because science cannot answer them, these questions are bad or meaningless. It is not that we cannot find answers to them, they held, but that those questions do not even make sense to begin with.[14] The famous "verification principle," advanced to discriminate between meaningful and meaningless questions, however, itself ran into trouble. One point brought against it was that many questions that are clearly meaningful, on that principle were declared meaningless. In such a case, one faces a dilemma: either maintain the principle and declare those questions meaningless, although they might still *seem* to be meaningful, or reject the principle and give those questions the attention they deserve. The latter seems the more reasonable way to proceed.[15]

Although the neo-positivist principle has receded into obscurity, many philosophers still hold that the thesis that science is limited in the way indicated in this section is false, but for other reasons. Paul Churchland, for instance, thinks that as science pro-

gresses, "ultimate" questions will not be answered but will simply wither away: no one will feel urged to pose them any longer for they no longer make sense; they will sound like the question "how does phlogiston work?" in our ears. Such questions, he holds, belong to, and arise out of, an unscientific commonsense view of the world, that is radically false.[16] Now this is no more than an expectation on Churchland's part—one that very well might not come to pass. But what should we do with these ultimate questions so long as Churchland's expectation is only an expectation? Should we abstain from asking them? But why? Given that ultimate questions continue to seem meaningful and important to us, and that science does not seem to have a handle on them, it follows that it would be wrong and unreasonable to turn to science for "ultimate answers." As Peter Medawar once quipped,

> To expect from science to answer the ultimate questions is tantamount to expecting to deduce from the axioms and postulates of Euclid a theorem having to do with how to bake a cake.[17]

This does not imply that ultimate questions cannot be answered at all. For, as I suggested earlier, there is knowledge other than scientific knowledge, and such knowledge might flow from sources that enable us to address even ultimate issues.

There are scientists and philosophers who, unlike the neo-positivists, reject verificationism, and who, unlike Churchland, do not think the "ultimate" questions will wither away as science marches on. According to these people, at least some of these questions are meaningful, and they add to this that science can answer, and has—as a matter of fact—already answered a fair number of them. Let me give just one example of this, having to do with the question of whether there is meaning to life.

In evolutionary biology, the notion of chance plays an important role—mutations in the genetic make-up of organisms are generally referred to as chance occurrences. A fair number of people assume that chance is incompatible with the notion of design and conclude, on the basis of that assumption, that the mutations are undesigned. From this, they conclude that life is a meaningless affair, that there really are no such things as morally good and morally bad actions, and that humans simply have to dance to the rhythm of their genes. This line of thought calls for a lengthy response that I will not give now (and biologists, in any case, do not generally view the evolutionary process taken as a whole as a chance process due to the stringent constraints imposed by natural selection). Instead I offer one short remark, namely, that this line of reasoning is confused because it does not properly distinguish among various notions of "chance."

When biologists say that mutations are chance events, they mean, among other things, that mutations do not result from some sort of prospective calculation on the part of the organism to the effect that, given the current local environment, the payoffs of a certain kind of mutation would be great. The mutation does not occur because it is fitness enhancing. But to go on from there and to make, on this basis, those further claims that I mentioned, surely is unwarranted. Those further claims simply do not follow—or they only follow when one helps oneself to a number of assumptions, none of which itself is the result of scientific research.

I have no very deep objection, however, to those who make claims of the following sort: "From a biological perspective, life has no meaning." For that claim signals the point I have been trying to make in this section: that science is not properly equipped to pronounce on ultimate matters. My not very deep objection to the claim is only that it is misleading in that it implicitly suggests that biology provides evidence for life's meaninglessness—which it does not. The more proper claim, therefore, would be "From a biological perspective, no pronouncement can be made on the meaning of life: neither that life is meaningful, nor that it is meaningless—biology is about other matters." So I submit that science is limited in the sense that it is unable and unequipped to answer ultimate questions.

e. A Limit from Inexplicable Brute Facts

Besides ultimate questions, there are other questions that the natural sciences cannot answer. In a sense, they are ultimate, too, but not in the "existential" way the questions in the previous section were supposed to be.

Among other things, scientists sometimes proffer explanations of phenomena. One type of explanation involves citing a universal law. That heated air moves upwards can be explained by reference to

Boyle's law. That the tree in my garden gives that particular shape of shadow can be explained by invoking, among other things, the laws of light. Explanations such as these consist at least in part in subsuming phenomena under universal laws. Such explanations are clearly valuable and add to our knowledge and understanding of the world. But such explanations leave unanswered the question of why those particular universal laws hold and not others. Universal laws, then, figure in many explanations, but their very existence is left unexplained. Surely, some laws can be explained by reference to more general laws, and those laws might be explained by yet more general laws. But there is an end to this. There comes a point where there is no remaining higher-level law. At a certain point, we face brute facts—that is, facts that cannot be explained by reference to laws, or laws of a higher level of generality.

The set of brute facts comprises not only universal laws, but also the so-called universal constants that figure in such laws, such as the gravitational constant.[18] These constants have specific values for which no further scientific explanation can be given. Other brute facts are of a more homely kind. Consider an apple. We can try to explain why this apple tastes the way it does. Such explanation will no doubt make reference to taste buds, to the way they are affected by the physical properties of the apple, to neurological impulses that are being transmitted to the brain, as well as to various laws. But such an explanation leaves unanswered the question of why this particular stimulus (this apple) gives rise to this extremely hard to describe, but very familiar, sensation of taste. Scientists may be able to tell something informative about the neurological transmission of impulses. But they cannot explain why such-and-such impulses cause such-and-such taste sensations. As Thomas Reid once said:

> No man can give a reason, why the vibration of a body might not have given the sensation of smelling, and the effluvia of bodies affected our hearing, if it has pleased our Maker. In like manner, no man can give a reason why sensations of smell, or taste, or sound, might not have indicated hardness, as well as that sensation which, by our constitution, does indicate it.[19]

Here again science encounters an inexplicable brute fact. The point I am navigating toward is that brute facts constitute a limit of (a particular kind of) science—natural science. The natural sciences as we now know them have a limit in that they cannot explain certain brute facts, even though these facts are invoked in explaining things other than themselves.

I should now like to point out that brute facts, in principle, can be explained, albeit by a type of explanation that is not employed in the natural sciences as we now know them. Whether that kind of explanation is allowable (either inside or outside the sciences) is a matter of great controversy. What I mean is this. One characteristic of explanations in the natural sciences is the negative fact that they do not refer to acts and intentions of personal agents. It seems quite obvious that many phenomena cannot be explained without such reference. To take an example from daily life: suppose I want an explanation of the puzzling fact that there is a book on my desk that I did not put there myself. One good explanation would be that my son put it there because he wanted me to read it. The puzzling fact is, in this case, explained by reference to an act (my son's putting the book on my desk) and an intention of a personal actor (my son's wish that I read the book). This type of explanation makes no reference to universal laws, only to acts and intentions. Explanations of this type have been called "personal explanations"[20] to bring out that such explanations refer to persons, but they have also been called "teleological explanations," to bring out that such explanations refer to goals and aims that agents have. In ordinary life, personal explanations have, intuitively, a great appeal. We cannot live without them.

One issue that has been raised about personal explanations is whether they can be reduced to the sort of explanations that are ubiquitous in the natural sciences (that make no reference to goals). I cannot properly enter into that matter here, but only report that attempts to show that they can, seem to me to be unsuccessful.[21]

One might think that if personal explanations make sense in everyday life, they might also make sense when applied to the brute facts of the natural world I have been speaking of. This suggestion will, naturally enough, meet with suspicion. Many will object to it and say that personal explanations, if they work at all, must be confined to ordinary life and

should not be employed in the natural sciences. But why should one grant so much? Surely, many difficult issues arise. But if there really are brute facts and if one furthermore thinks that personal explanations are, as a matter of principle, good explanations, then the field is open to explore the possibility of personal explanations of brute facts. And this, of course, is the substance of the current debate over the apparent fine-tuning of the cosmological constants. What is at issue here is the legitimacy, explanatory power, and intellectual plausibility of a personal explanation of the order in the cosmos—an explanation that refers to the acts and intentions of a nonhuman actor.[22]

This is not to say that the cosmic order must be explained in a personal explanation. One could take the line that that order is ultimately inexplicable (not only because there is no law to refer to, but also because there is no personal agent to refer to). This is not an impossible or an irrational position. But neither is the position of those who propose a personal explanation. It is not as if the one position is in accordance with the findings of science, whereas the other is in contradiction with it. The issue between these positions, in large part, turns on whether one thinks there is knowledge and warrant available from sources other than science—knowledge that, when it is available, one might use in crafting personal explanations of brute facts.

So, I submit, if science is thought of as allowing only "scientific explanations," then there will be many brute facts that defy scientific explanation. These facts are impenetrable for science and hence constitute a limit for it. This is not to deny that a serious discussion about the legitimacy and rationality of personal explanations is meaningful. But whatever position one reaches here will go beyond science (conceived of as allowing only scientific explanations). This, too, is a point I will be exploring in the final section.

f. A Limit from Norms for Theory Choice

Scientists devise hypotheses and theories, and they also evaluate them, comparing and contrasting them with alternative hypotheses and theories. Scientists make, and have to make, "theory choices" or "theory evaluations," and those choices and evaluations will have to be made in a reasoned way. But when is a reason to accept a particular hypothesis or theory a good reason, and when is it a bad one? This is the subject matter of what is sometimes called the "theory of scientific rationality."

It is generally agreed that certain reasons are of a bad kind. That a theory gives you a headache is no good reason to reject it, and that it boosts your popularity, if you adopt it, is no good reason to accept it. So there are norms of good and bad reasoning when it comes to theory choice and theory evaluation.

It could be argued, as Stephen Wykstra has done, that such norms occur at various levels.[23] There are, he argues, first of all, norms at a theoretical level. One example of this is simplicity. Confronted with different theories with respect to the same subject matter, this norm says that if theory A is simpler than theory B, A's being simpler than B is a good reason for preferring A over B. Secondly, there are norms at a methodological level. One example is induction. Given two different theories concerning the same subject matter, this norm says that if theory A is based on inductive inference, whereas theory B only on casuistry, A is to be preferred over B. Finally, there are norms at an axiological level, the level of values. One example is the "height" of a theory. An instance of this is Robert Boyle's adherence to corpuscular or "mechanical" philosophy for the reason that corpuscular explanations are exceptionally satisfying to the mind, much more so than Aristotelian explanations. Given two theories, only one of which involves corpuscular philosophy, this norm says that the one that involves that philosophy is to be preferred over the one that does not.

In order to be able to see what this has to do with limits of science, it needs to be noted that all of the norms mentioned can be, and in fact have been, contested by scientists and philosophers alike. On the theoretical level, it has been contested that simplicity should function as a norm. Reid, for instance, held that "if we conclude that [nature] operates in such a manner, only because to our understandings that appears ... simplest, we shall always go wrong."[24] A further problem with simplicity is that arguments for the conclusion that simpler theories are more likely to be true, such as Swinburne's, have met with stern opposition. On the methodological level, some have argued that the norm of induction itself is problematic, for, as Hume has argued, induction

cannot itself be justified. It cannot be shown that induction leads to truth, or high probability, or anything in that region. Finally, on the axiological level, it has been contested whether the corpuscular theory is "higher" or intellectually more satisfying than Aristotelianism.

The fact that theory choice and evaluation are informed by various contested and contestable norms indicates, I submit, another limit of science in the following way: science itself cannot tell us what the proper norms for theory choice and evaluation are. It is not the case that scientific research brings to light which norms are the ones that should regulate our choices and evaluations of theories. All kinds of extra-scientific convictions and beliefs on the part of the scientist (and the community of scientists) come into play here. This is another point I will be exploring in the second part of my article, when I will suggest that religious beliefs may inform one's norms for theory choice. (It should be noted that the recognition that the norms for theory choice are rooted in something other than science does not entail that those norms be subjective.)

This concludes my discussion of those limits of science that are most relevant for my purposes.[25] In the next section, I am going to explore these limits in a discussion of the claim that, given modern science, traditional Christian belief must be either abandoned or drastically reformed.

2. Christian Faith and the Limits of Science

I began by saying that it has been claimed that given the findings of modern science, the rational stance to take toward traditional Christian faith is either to abandon it or to reform it drastically. I did not say why that is supposed, but there are two broad types of reasons behind it: (a) science lends no warrant to Christian faith, and (b) science provides defeaters for the Christian faith.

In this section I will be exploring what we (I hope) have learned about the limits of science by bringing them to bear on these two broad types of reasons for the claim that, given the findings of science, we should either abandon or drastically reform the Christian faith.

a. Science Lends No Warrant to Christian Faith

"Christian faith," as I have presented it, involves belief—belief in God, in his goodness and unlimited power, in the salvation he offers through Christ's redemptive suffering and glorious resurrection, and so on. Clearly, science does not compel us to believe any of this nor does it provide warrant for such beliefs. But that is nothing against those beliefs. For, as I argued in section 1.a, there are many things we truly believe and know without the warrant condition for knowledge being satisfied by science. We have, I argued, extra-scientific knowledge of moral truths, of values, and of much else besides. To this list I now want to add the Christian beliefs just cited and suggest that these beliefs, too, can have warrant in a way that does not involve science.

How these beliefs can be warranted is the topic of the most exciting work in the philosophy of religion over the last four decades. It has been argued that there are various sources of belief in God and that there are various ways in which religious belief can be warranted. Alvin Plantinga has argued that there is such a thing as the *sensus divinitatis* that, in a wide variety of circumstances, elicits belief in God and gives it warrant.[26] William Alston has argued that there is such a thing as "Christian mystical perception" and that such perception warrants certain beliefs about God.[27] Nicholas Wolterstorff has argued that there is such a thing as divine discourse: God speaking to someone in a way that provides warrant to the beliefs engendered in the person spoken to. Finally, it has been argued that there is divine revelation and that beliefs formed in response to that can have warrant.[28]

The point of my argument is that the fact that science lends no warrant to religious belief is not much of an argument against such belief, because there are sources of warrant other than science. In section 1.b, I introduced the distinction between knowledge of truths (propositional knowledge) and knowledge by acquaintance and said that scientific knowledge (and scientific belief) is always propositional. This, too, is relevant for the claim that science gives no warrant to Christian faith, in the following way: Christian faith, as I said earlier on, involves not only propositional belief, but also—and maybe even more central to it—awareness of, or acquaintance with, God.

Christian mystics have written extensively about experiential acquaintance with God. And to a lesser degree the average Christian, too, has nonpropositional awareness of, or acquaintance with, God. As John Baillie thinks of faith, it is a

> primary mode of awareness. Faith does not deduce from other realities that are present the existence of God who is not present but absent; rather it is an awareness of the divine Presence itself, however hidden behind the veils of sense.[29]

Since science, as I have been arguing, can never give us knowledge by acquaintance, it should come as no surprise that it cannot give us knowledge by acquaintance of God either. And a fortiori it is not much of an argument against Christian faith that science does not give us such knowledge by acquaintance.

Some of the most important questions human beings ask, "ultimate questions," science is unable to answer—or so I have argued in section 1.d. Still, there might be knowable answers to them due to the extra-scientific sources of religious belief and warrant, such as the ones mentioned earlier. These sources might provide materials for answers, or parts of answers, to "ultimate questions." The meaning of life, these sources suggest, lies in living a life in communion with God. Why the world exists, these sources tell us, is because God willed it to exist. How we should live, they suggest, is such that we are devoted to serving and trusting God, and to seeking to love and serve our fellows. These answers may be warranted—even if their warrant does not derive from science.

Often it is suggested that whereas science is firm, Christian faith is shaky. One way this very general point has been fleshed out, is by indicating that Christian belief presupposes or involves all kinds of things that cannot be proved to a sufficiently skeptical mind, whereas science involves no such presuppositions—no presuppositions that cannot be proved to a sufficiently skeptical mind. But this way of putting things neglects the fact that science involves unproved and unprovable presuppositions. The point of my argument in section 1.e was that there is nothing wrong with science because it cannot prove its presuppositions. But if it is not wrong when science involves unproved presuppositions, then neither should it be wrong when the Christian faith involves unproved presuppositions. In both cases, there may be (and I think, in fact, are) sources of warrant available other than science.

It appeared that what can be learned (I hope) about the limits of science is richer than what is needed to address the claims that science gives no warrant to Christian faith and that science provides defeaters for the Christian faith. After all, I suggested that whereas science is unable to answer ultimate questions, the sources of Christian faith may provide warranted answers to such questions. This point clearly goes beyond addressing the above claims. And there is more along these lines, as I now should like to bring out.

In section 1.e, I argued that there are brute facts that are scientifically inexplicable. I also contrasted scientific explanations with personal explanations, and suggested that there might be personal explanations for natural brute facts, such as the apparent fine-tuning of the cosmological constants and laws. The Christian faith clearly favors, or at the very least, does not rule out, such teleological explanations. As a matter of fact, the possibility and advantage of such an explanation over simply taking for granted inexplicably brute facts might be a reason to take Christian belief with real seriousness.

One final thing along the same lines, that is, not directly addressing the claims that science gives no warrant to Christian faith and that science provides defeaters for the Christian faith, is suggested by what we have learned about the limits of science. Theory choice, I said, is regulated by norms—norms that themselves are the objects of a discussion that cannot be terminated by an appeal to science. The warrant for holding on to certain norms and not to others (or for assigning them a place in a hierarchy of norms above others, and not below them) will thus have to derive from something other than science. But if, as I have suggested, Christian faith receives warrant from extra-scientific sources, then a case could be made for the thesis that it is appropriate for Christian theists to include in the body of norms that guide theory choices explicitly theistic beliefs.[30]

b. Science Provides Defeaters for the Christian Faith

Let me finally turn to the claim that science provides defeaters for the Christian faith. Many such arguments have been proposed, having to do with psychoanalysis, evolutionary theory, evolutionary psychology, biblical criticism, and more. What light does what we have learned about the limits of science shed on the issue in general? This is a vast topic, but, in line with the character of my discussion so far, I can only offer some very general and highly programmatic remarks. When it is claimed that science provides defeaters for the Christian faith, we must never forget the following points:

1. Not everything that is claimed in the name of science is established scientific fact;
2. There is often quite some distance between what is scientifically established on the one hand, and speculative extrapolations from what is scientifically established on the other;
3. There is often also quite some distance between what is scientifically established on the one hand, and a worldview-driven appropriation of what is scientifically established;
4. When it is claimed that science provides defeaters for Christian beliefs, it would seem that what in fact provides those defeaters is not the scientifically established facts, but either the speculative extrapolations meant in (2), or the worldview-driven appropriations meant in (3);
5. Neither the speculative extrapolations nor the worldview-driven appropriations receive warrant from science;
6. It is therefore not un- (or anti-)scientific when one rejects those speculative extrapolations and worldview-driven appropriations.

These sketchy remarks cry out for further elaboration and illustration. But for now I must rest my case—the case being that science is limited in various important ways and that these limits give us, prima facie, no reason to think that science calls on Christian faith to change. ✠

Notes

[1]The Plantinga Fellow Lecture delivered at the University of Notre Dame, April 11, 2008. For discussion and comments on earlier drafts, I am grateful to Alvin Plantinga, Robert Audi, Bill Wood, Tim Pawl, Anders Kraal, Ted Warfield, Marian David, Jeroen de Ridder, Rik Peels, and Terence Cuneo. I am also grateful for the comments by two anonymous referees for the journal *Science and Christian Belief*.

[2]See R. Shope, *The Analysis of Knowing: A Decade of Research* (Princeton, NJ: Princeton University Press, 1983) and A. Plantinga, *Warrant: The Current Debate* (New York: Oxford University Press, 1993).

[3]My basic reason is that rejection of moral realism has all kinds of unlovely implications. See, for example, T. Cuneo, *The Normative Web: An Argument for Moral Realism* (Oxford: Oxford University Press, 2007).

[4]N. Rescher, *The Limits of Science* (Berkeley, CA: University of California Press, 1984), 209–10.

[5]This terminology gained currency through Bertrand Russell; see, for example, his *Problems of Philosophy* (Oxford: Oxford University Press, 1948), 46ff.

[6]It should be added that I am using this distinction here in a way Russell would not approve of. He held that we can have knowledge by acquaintance of colors and sounds, etc., universals, logical forms, and (perhaps) oneself, but not other persons. However, there is nothing in the distinction itself that would prevent other persons from being known by acquaintance. Russell's denial of this possibility is premised by other of his philosophical commitments.

[7]Only "to a certain extent" because theories are underdetermined by the acquaintance knowledge of their originators.

[8]F. Jackson, "What Mary Didn't Know," *The Journal of Philosophy* 83 (1986): 291–5.

[9]For a careful analysis and defense of this (kind of) argument, see H. Robinson, "The Anti-materialist Strategy and the 'Knowledge Argument,'" in *Objections to Physicalism*, ed. H. Robinson (Oxford: Clarendon, 1993), 159–84. Jackson has distanced himself from the knowledge argument, and no longer thinks it shows physicalism to be false. See his "Mind and Illusion" in *Minds and Persons*, ed. A. O'Hear (Cambridge: Cambridge University Press, 2003), 251–71. At this juncture, I can only declare that I find his distancing unconvincing.

[10]Husserl's case against nineteenth-century psychologism, that tried to place logic on an empirical footing or make it an empirical science, crucially rested on arguments such as the ones offered. See E. G. A. Husserl, *Logical Investigations*, Part I (1900), trans. J. N. Findlay (London: Routledge, 1970).

[11]W. P. Alston, *The Reliability of Sense Perception* (Ithaca, NY: Cornell University Press, 1992).

[12]This point has also been argued by D. Ratzsch, *Philosophy of Science: The Natural Sciences in Christian Perspective* (Downers Grove, IL: InterVarsity Press, 1986), 99f.

[13]V. Brümmer, "A Dialogue on Language Games," in *Interpreting the Universe as Creation*, ed. V. Brümmer (Kampen: Kok Pharos, 1991), 1–17. This idea is also endorsed throughout the works of D. Z. Phillips.

[14]For example, R. Carnap, "Überwindung der Metaphysik durch logische Analyse," *Erkenntnis* 3 (1932): 219–41.

[15]See A. Plantinga, *God and Other Minds* (Ithaca, NY: Cornell University Press, 1967), 156–68.

[16]Churchland labels his position "eliminative materialism," which he defines as "the thesis that our common-sense con-

ception of psychological phenomena constitutes a radically false theory, a theory so fundamentally defective that both the principles and the ontology of that theory will eventually be displaced, rather than smoothly reduced, by completed neuroscience." See P. Churchland, "Eliminative Materialism and the Propositional Attitudes," *The Journal of Philosophy* 78, no. 2 (1981): 67.

[17]P. Medawar, *The Limits of Science* (Oxford: Oxford University Press, 1986), 76.

[18]Note that the laws I am speaking of are whatever turn out to be the true laws. The laws that figure in current theories may not be among those.

[19]T. Reid, *An Inquiry into the Human Mind on the Principles of Common Sense* (1764), ed. W. Hamilton (Bristol: Thoemmes Press, 1994), 120–1.

[20]R. Swinburne, *The Existence of God*, rev. ed. (Oxford: Clarendon, 1991), 32–5.

[21]Donald Davidson is one among many who have argued that a personal explanation is a form of scientific explanation (see his "Actions, Reasons and Causes," *The Journal of Philosophy* 60 (1963): 685–700). Swinburne offers good arguments against Davidson's position; see Swinburne, *The Existence of God*, 36–42. Other powerful criticisms of Davidson's position are G. F. Schueler, *Reasons and Purposes: Human Rationality and the Teleological Explanation of Action* (Oxford: Clarendon, 2003) and S. Sehon, *Teleological Realism: Mind, Agency, and Explanation* (Cambridge, MA: MIT Press, 2005).

[22]See J. Foster, *The Divine Law Maker* (Oxford: Clarendon, 2005).

[23]S. Wykstra, "Reasons, Redemption, and Realism: The Axiological Roots of Rationality in Science and Religion," in *Christian Theism and the Problems of Philosophy*, ed. M. D. Beaty (Notre Dame: University of Notre Dame Press, 1990), 118–61.

[24]T. Reid, *Essays on the Intellectual Powers of Man* (1785), ed. W. Hamilton (Tyger Valley, South Africa: Ulan Press, 2011), 470.

[25]There are, indeed, more limits to science then the ones I have discussed. There is a limit due to the fact that scientists have to use classificatory ("formal") concepts that figure in necessary truths that can only be known a priori and hence do not result from but are presupposed by science (see G. Bealer, "The Philosophical Limits of Scientific Essentialism," in *Philosophical Perspectives*, vol. 1: *Metaphysics*, ed. J. E. Tomberlin (Atascadero: Ridgeview, 1987), 289–365). There also is a limit from the fact that human beings are fallible and sinful creatures. See A. Kuyper, *Principles of Sacred Theology* (New York: Scribner's, 1970).

[26]A. Plantinga, "Reason and Belief in God," in *Faith and Rationality: Reason and Belief in God*, ed. A. Plantinga and N. Wolterstorff (Notre Dame: University of Notre Dame Press, 1983); A. Plantinga, *Warranted Christian Belief* (Oxford: Oxford University Press, 2000).

[27]W. P. Alston, *Perceiving God: The Epistemology of Religious Experience* (Ithaca, NY: Cornell University Press, 1992).

[28]G. Mavrodes, *Revelation in Religious Belief* (Philadelphia, PA: Temple University Press, 1988); R. Swinburne, *Revelation: From Metaphor to Analogy* (Oxford: Clarendon, 1992).

[29]J. Baillie, *The Sense of the Presence of God* (New York: Scribner's, 1962), 88–9.

[30]N. Wolterstorff, *Reason Within the Bounds of Religion* (Grand Rapids, MI: Eerdmans, 1977), 63–4; N. Wolterstorff, "Theology and Science: Listening to Each Other," in *Religion and Science: History, Method, Dialogue*, ed. W. M. Richardson and W. J. Wildman (New York: Routledge, 1996), 95–104.

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Kathryn Applegate

A Defense of Methodological Naturalism

Kathryn Applegate

Methodological naturalism, the scientific practice of limiting the explanation of natural phenomena to only natural mechanisms, is a wise and powerful means of investigating the created order. While today it is often conflated with philosophical naturalism (the view that nature is all that there is), methodological naturalism was originally upheld by philosophers and scientists who sought to honor God by discovering his work in creation and by not invoking him in place of secondary causes. Methodological naturalism, backed by an understanding of the doctrine of creation, is for the Christian a theologically motivated practice. Whatever process one studies, from the birth of stars to intracellular dynamics, it does not explain away God's activity in the world. Also, methodological naturalism has the practical benefit of allowing people of diverse worldviews to discover the workings of God's creation, whether or not they acknowledge it as such.

Common Grace in the Lab

I do not recall when I first understood the distinction between "methodological naturalism," the convention in science of appealing to natural explanations for natural phenomena, and "philosophical naturalism," the worldview that denies the existence of God and the supernatural realm. I do, however, remember the wave of relief that washed over me when I realized that the practice of science does not entail functional atheism, as I worried it might, but rather is compatible with a number of different worldviews.[1] I was a young graduate student working in a lab of a dozen people from almost a dozen different countries, many with religious and philosophical outlooks radically different from my own. Yet, we worked well as a team in studying the role of the cell's internal scaffold, the cytoskeleton, in the process of cell migration.

Before I understood the distinction between methodological and philosophical naturalism, I had two recurring concerns. First, I feared that I was somehow neglecting God in my work, despite an active attempt to do my work "as unto the Lord" (Col. 3:23–24). Second, the atheist and agnostic scientists around me seemed to be discovering real facts about nature. This latter observation bothered me because, having grown up in the Bible Belt, I had spent time with Christian brothers and sisters who rejected all music, literature, educational styles, and so on that were not explicitly Christian. My family did not do this, nor did my church advocate it that I can recall, but somewhere along the line I internalized the belief that the work and thinking of unbelievers were fundamentally flawed.

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My expectation, then, was that science as practiced by Christians should look very different from science practiced by unbelievers. Thankfully, upon coming to graduate school in San Diego, I began worshiping at a church that gave me a theological foundation that showed me why this was not necessarily so. The pastor taught that because all people are made in the image of God, we can expect everyone to reflect God's truth and goodness to some extent. Also, just as he causes the sun to rise both on the evil and the good (Matt. 5:45), God dispenses incredible skills and intellect to all kinds of people to bless the whole human family.[2]

We often hear the phrase "all truth is God's truth" and are rightly reminded that all knowledge and wisdom come from above, but the larger context of St. Augustine's exhortation actually centers on this idea of common grace: "A person who is a good and true Christian should realize that truth belongs to his Lord, wherever it is found, gathering and acknowledging it even in pagan literature …"[3] These doctrines of the image of God and common grace helped me see my non-Christian scientific colleagues in a humbler and gentler light—despite our different worldviews, we were all seeking and finding a real form of truth.

Finding God's Glory through Methodological Naturalism

I still had the other concern, which was that while I could see God's purposeful hand in what I was studying, it did not translate into my experimental design or calculations or results in a manner that clearly differed from my secular colleagues. I saw God's creation when I looked in the microscope; I praised him for it; I even—tentatively—had some water-cooler conversations with my colleagues about it. But at the end of the day, how could I glorify God if he was not "allowed" as an explanation for the things I was studying? It felt contrived and dishonest to act as if God did not exist or was not at work in the world when I sensed so strongly the opposite, and yet that seemed to be the default assumption in the scientific community.

Relief came, as I said, when I discovered that acceptance of methodological naturalism does not also require acceptance of philosophical naturalism. At that time I was ignorant of the long history of scholarly conversation on this topic—much of which has taken place in this journal.[4] What I discovered was that not appealing to God in science is not the same as denying his activity in the world—far from it! Accepting that science is equipped to study only a subset of reality (that which is accessible to empirical investigation) is very different from asserting that everything that exists has come about by purely material causes. Furthermore, the Bible reveals a God who normally accomplishes his purposes through means such as natural processes or human activity.[5] His sovereignty and rational character give strong support for believing that creation operates primarily by regular principles that can be discovered through science.[6]

A robust Christian theism sees science as a systematic way of discovering God's means of creating and sustaining the material world.[7] In this light, the entire scientific enterprise brings God glory because it illuminates one of the two books of revelation he gave us, the book of nature.[8] Also, because God is the author of all things (the "first cause"), we need not worry that discovering natural mechanisms ("second causes") will, in any way, diminish his creativity and glory.

As history has shown, appealing to nonnatural explanations in the laboratory for phenomena we cannot explain tends to short-circuit discovery and gives the impression that God is at work only in areas of mystery. Appealing to natural explanations in science, on the other hand, helps us to better appreciate those nonnatural explanations arising from other disciplines and everyday life.[9] For example, we see God's hand and purpose at work in "knitting together" a baby in the womb, even as we marvel at the perfectly natural, regular details of the development process. Rather than causation being a zero-sum game in which teleological (that is, relating to purpose) and mechanistic explanations compete with one another, we can view them as complementary accounts of reality.

Methodological Naturalism: The Standard View

The distinction between methodological and philosophical naturalism turns up most frequently in

discussions of science and Christianity. In his impressive volume *Darwin's Pious Idea*, Christian philosopher Conor Cunningham makes the distinction in the first sentence of his 112-page chapter on naturalism, declaring methodological naturalism to be "eminently sensible" and philosophical naturalism to be "the liquidation of existence itself."[10] Scientism, the closely related philosophical position that "science is the only begetter of truth,"[11] is, according to Cunningham, "a massive intellectual pathology being peddled in the West."[12]

C. S. Lewis illustrates the difference between methodological and philosophical naturalism in his characteristically colorful style:

> Science works by experiments. It watches how things behave. Every scientific statement in the long run, however complicated it looks, really means something like, "I pointed the telescope to such-and-such a part of the sky at 2:20 a.m. on January 15th and saw so-and-so," … Do not think I am saying anything against science: I am only saying what its job is … But why anything comes to be there at all, and whether there is anything behind the things science observes—something of a different kind—this is not a scientific question.[13]

Of course there is much more to science than simple observation, but here Lewis correctly points out that science is limited in the kinds of questions it can answer. Confusion often results when we fail to recognize whether a given question is best answered by science or by philosophy.

Philosopher Michael Peterson, in an article about Lewis's views on natural theology and science, points out that

> Lewis was a purist regarding the role of science and rejected any notion that its methods can deal with qualitative matters and values, let alone prove (or disprove) a Transcendent Intelligence or God.[14]

Lewis frequently appealed to philosophical design arguments,[15] but he rejected scientific design arguments such as those made by the Intelligent Design (ID) movement today. The problem with ID as a scientific argument, Peterson points out, is that God's explanatory role in nature is made to compete with natural explanations.[16] Importantly, while several kinds of natural theology arguments either implicitly or explicitly make the case for a Transcendent Intelligence, Lewis shows that not all design arguments are equally valid, and we ought not to feel compelled to use weak ones.

In the early days of science, the practice of methodological naturalism was an admission of the limitations of empirical inquiry. The focus and function of scientific methods were to elucidate the secondary causes through which God works.[17] Methodological naturalism has been redefined over the past couple of centuries as a way to distinguish science from nonscience; now it is often used to cut the scientific wheat from the religious chaff.[18] As I am not a philosopher, I cannot adequately comment on the usefulness of methodological naturalism as a demarcation criterion. Its pre-nineteenth-century usage is what I defend here.

Methodological Naturalism: Rejected and Redefined

While it seems obvious to many of the working scientists I know, even to those who are agnostics or atheists, the view that science is silent on the question of God's existence is under assault in our culture today. The so-called New Atheists loudly declare that science, especially evolutionary biology, is the "universal acid" (to borrow Daniel Dennett's image) that will dissolve traditional religion. Young earth and old earth creationists, on the other hand, reinterpret scientific findings to make them support particular readings of the Bible. Both sides fall prey to scientism and abuse the limits of scientific knowledge.[19]

Modern science emerged in the Christian West, and historians have demonstrated that certain assumptions consistent with a biblical worldview were important in its development.[20] Methodological naturalism was encouraged by devout natural philosophers such as Francis Bacon, Robert Boyle, and Isaac Newton, and the practice continues to be defended by Christian scientists today.[21] The ID community tells a different story, however. In a primer about ID, William Dembski and Jonathan Witt argue that methodological materialism (their term for methodological naturalism) is inherently atheistic. In their view, it represents a marketing strategy for Darwinist ideology. They write,

> Only about one in ten Americans is an out-and-out atheist, but atheists have managed to extend their influence by selling religious people a related idea called methodological materialism. In its most ambitious form, methodological materialism says that we can believe whatever we want in our personal life, but when we're doing serious academic work, we should only consider and defend explanations fully consistent with philosophical materialism.[22]

This view of methodological naturalism as a back door to atheism and moral relativism represents a clear departure from the traditional view, and it is curious, given the sizeable number of scientists who accept the convention and yet enjoy an abiding faith.

While not all ID advocates make this argument, it has been observed that "the center of gravity of the [ID movement] is a rejection of methodological naturalism."[23] In his book *Signature in the Cell*, ID theorist Stephen Meyer argues that methodological naturalism is a restrictive and arbitrary standard in science. In 2005, Judge John E. Jones ruled in the famous Dover, Pennsylvania, trial that ID theory is not science. Seeking to demonstrate why the ruling was wrong, Meyer writes that Judge Jones rejected ID as science because of methodological naturalism. According to Jones's definition (which Meyer relegates to an endnote), methodological naturalism is the "self-imposed convention of science, which limits inquiry to testable, natural explanations about the natural world." In other words, the standard definition, no supernatural explanations allowed. But Meyer argues against Jones by using a subtly different definition himself:

> Methodological naturalism asserts that to qualify as scientific, a theory must explain all phenomena by reference to purely material—that is, nonintelligent—causes. As Nancey Murphy explains, methodological naturalism forbids reference "to creative intelligence" in scientific theories.[24]

In Meyer's view, methodological naturalism stipulates that all intelligent causes, including natural ones, are outside the bounds of science. Meyer then concludes that Jones's reasoning was circular. He writes,

> Intelligent design isn't science because it violates the principles of methodological naturalism [summary of Jones's ruling]. What is methodological naturalism? A rule prohibiting consideration of intelligent design in scientific theories [Meyer's definition].[25]

In other words, according to Meyer, ID is not science because of an arbitrary rule. Importantly, Meyer's arguments against methodological naturalism work by redefining it. He does not adhere to the traditional descriptions articulated by Judge Jones or even Nancey Murphy, whom he cites in his own definition. In the original context, Murphy's phrase "creative intelligence" clearly refers to a transcendent supernatural being, not to just any intelligent agent.[26] Very few scientists and scholars would agree with Meyer that science tries to explain all phenomena by reference to strictly nonintelligent causes. The true disagreement is over whether supernatural causation can be identified using the methods of science. Meyer's claim of a circular argument is a classic equivocation fallacy.

Meyer goes on to argue that methodological naturalism is constraining. As he points out, numerous fields of science study or look for signs of intelligence: archaeology uses cultural artifacts to reconstruct past human activity; forensic science examines evidence left at a crime scene to determine who was responsible; and the SETI (Search for Extraterrestrial Intelligence) project looks for alien communication from outer space. If these endeavors do not count as science according to methodological naturalism, Meyer argues, then methodological naturalism must be too restrictive a criterion for what constitutes science. It is easily seen, however, that these fields do abide by the traditional definition of methodological naturalism, which only excludes supernatural explanations, not all intelligent causes.

Meyer further contends that, in many cases, methodological naturalism does no harm, but neither is it necessary. He gives an example: if someone answers the question, "How does atmospheric pressure affect crystal growth?" by saying, "Crystals were designed by a creative intelligence," she has, according to Meyer, entirely missed the point—the answer should be about the relationship between gases and crystals. The question itself motivates the kind of answer it receives, and there is no need to prohibit inferences to a creative intelligence.[27]

This is true up to a point, but not all scientific questions are posed so specifically. What if the

question were instead, "What makes a crystal grow?" We could imagine a team of scientists going to great lengths to quantify crystal growth under different pressure and temperature conditions, and with different mineral compositions, only to have someone suggest that it was God—or the scientists in the laboratory!—that made the crystals grows.[28] While technically a legitimate response, it also misses the spirit of the question and still leaves open the question of how: the appeal to intelligence, supernatural or otherwise, does not actually answer the mechanistic question we seek to answer.

As can be seen in many of their writings, ID theorists believe that modern science is fundamentally flawed. In their view, we ought not to assume that all natural phenomena have a natural explanation. And certainly, as a Christian who believes that God sometimes chooses to work outside of his regular chosen means of ordering the world,[29] I agree. I question whether science is equipped to investigate miracles, not whether they occur. Miracles appear, to me at least, to be in the blind spot of science.

The great Cambridge astrophysicist Sir Arthur Eddington gave a memorable analogy to illustrate the limitations of science:

> Let us suppose that an ichthyologist is exploring the life of the ocean. He casts a net into the water and brings up a fishy assortment. Surveying his catch, he proceeds in the usual manner of a scientist to systematise what it reveals. He arrives at two generalisations: (1) No sea-creature is less than two inches long. (2) All sea-creatures have gills. These are both true of his catch, and he assumes tentatively that they will remain true however often he repeats it.[30]

One can immediately see the folly of assuming that the net can sample all the sea creatures in the ocean. Neither can science capture all of reality, including the possibility of God's direct action in natural history.

Importance of the Doctrine of Creation

Many have framed the concept of methodological naturalism as meaning that when scientists go to work, they either pretend that God does not exist or that he is inactive in the physical world. For example, William Dembski and Jonathan Witt write,

> [Methodological naturalism] affirms not so much that God does not exist as that God need not exist. Its message is not that God is dead but rather that God is absent. And because God is absent, intellectual honesty demands that we get about our work without invoking him.[31]

Clearly, if this is how people understand the practice, as I once did, there is justifiable concern. No Christian, even for professional reasons, can or should proceed this way, for to do so would quickly lead to a deistic or even atheistic perspective.

This mistaken formulation is no doubt due in part to the use of the word "naturalism." Biologist Denis Alexander argues that methodological naturalism is perfectly sensible as a practice but as a term it can easily be confused with philosophical naturalism.

> We don't call Christian accountants "naturalistic" because of the absence of theological terminology as they check the company accounts, any more than we expect our doctor to use theological language when she tells us that we've got the flu, or the mechanic to refer to biblical texts when servicing our car. The absence of specific references to God does not render our lives suddenly "naturalistic."[32]

Alexander suggests we drop the term "methodological naturalism" and simply talk about scientific explanations instead. While this seems like wise counsel indeed, it is hard to imagine that eliminating the term would resolve all problems—especially since the meaning of science itself has proven so difficult to nail down.

For scientists to consciously glorify God in their practice of methodological naturalism, I believe that they must have a full-bodied embrace of the doctrine of creation, such as that articulated by Robert Bishop in an essay on the BioLogos website.[33] Bishop points out many aspects of the doctrine that are relevant to science, but here I will comment on just two.

We have already noted that science arose out of a Christian worldview that assumed intelligibility and regularity in the created order. Theologians speak of creation having contingent rationality: not only is creation dependent on God's continual sustaining work, but God created freely, not out of

compulsion. He could have created in any number of ways but chose to do so in a way that is at least partially intelligible to us through the means of common experience and scientific testing. Because of this contingency, we cannot simply reason our way to an accurate picture of the natural world. Consistent with the biblical invitation to "taste and see that the Lord is good" (Ps. 34:8), we are called to explore God's creation with our senses and their technological extensions.

Creation also has functional integrity, meaning it has the capacity to be what God intends it to be in Christ. As Bishop points out,

> The regularities God established in creation that minister to and provide the capacity for creation to become what God calls it to be are the same regularities that scientists study.[34]

Functional integrity does not entail an independently functioning creation, however. In thinking about natural laws, no doubt many of us envision a mechanical clockwork universe. But the God of the Bible is not distant from his creation—in Christ "all things hold together" (Col. 1:17). G. K. Chesterton imagines God sustaining creation with the energy and playfulness of a child:

> A child kicks his legs rhythmically through excess, not absence, of life. Because children have abounding vitality, because they are in spirit fierce and free, therefore they want things repeated and unchanged. They always say, "Do it again"; and the grown-up person does it again until he is nearly dead. For grown-up people are not strong enough to exult in monotony. But perhaps God is strong enough to exult in monotony. It is possible that God says every morning, "Do it again" to the sun; and every evening, "Do it again" to the moon. It may not be automatic necessity that makes all daisies alike; it may be that God makes every daisy separately, but has never got tired of making them. It may be that He has the eternal appetite of infancy; for we have sinned and grown old, and our Father is younger than we. The repetition in Nature may not be a mere recurrence; it may be a theatrical ENCORE.[35]

Probably few of us think about divine action in this way, but I suspect it is closer to the spirit of biblical Christianity than the functional deism so pervasive in our churches today.[36] Perhaps surprisingly, methodological naturalism frees us to envision God not as periodically "intervening" in our world (a word which connotes meddling or tampering), but as faithfully and lovingly preserving, redeeming, and remaking all things in Christ. Methodological naturalism, when practiced by a Christian, presupposes the sovereignty and consistent sustaining work of God.

Some Advantages of Methodological Naturalism

Peterson calls methodological naturalism

> the idea that we should view science as a certain epistemological portal that we have refined over time and through which people of different religions, philosophies, and moral theories can make progress explaining natural phenomena by reference to natural causes.[37]

At the beginning of this article, I touched on my own pleasant experience of the communal nature and truth-generating power of science, despite the diverse worldviews of my lab-mates. Unfortunately, these dual aspects of science have contributed to a serious problem. The fact that science is so successful irrespective of one's religious persuasion has led to the perception that science is about facts, while faith is a mere matter of opinion. In reality, science and faith are not comparable per se—the better parallel is between science and theology, both of which generate truth claims through use of faith and reason. As illogical as it is, many have concluded that science is the basis of all true knowledge (that is, scientism) and that it may even represent a promising foundation for civil society. Lest we hold science itself responsible for this unfortunate development, we should remember that it is the good and noble things in life that make for the most seductive idols.[38] The fact that many in our age have worshiped at the throne of scientific progress does not mean that the practice of science is deeply flawed.[39] As a scientist, I see the collaborative success of science to be among the strongest and most pragmatic arguments for methodological naturalism. It just works.

Methodological naturalism also spurs us on toward deeper investigation of the natural world. What journal would accept a paper in which the author argued that stars form from the spirits of our ancestors, or that a tricky step in a chemical reaction

proceeds by the help of angels? These examples are silly, but the history of science is rife with examples of now-understood phenomena that were once attributed to the divine. With each new discovery, God's sphere of activity seemed to shrink. While it may be argued that this concern does not merit a full prohibition against appeals to supernatural causation, it does seem that such examples have occurred frequently enough to cast doubt that God is ever a good explanation. Recognizing God's governance over all of creation—whether we understand it or not—helps us avoid the temptation to invoke a miracle for some particular phenomenon.

Similarly, methodological naturalism prevents us from demeaning God by pitting him against his own creation. If it is to be either God or nature, we risk bringing God down to the level of a second cause such as photosynthesis or gravity. This way of thinking also tends to diminish God's regular sustaining activity in those parts of nature that we do understand. Methodological naturalism, paradoxically, helps us to appreciate perfectly legitimate nonscientific explanations. For example, a farmer can consider a rainstorm as an answer to prayer without rejecting the meteorological explanation for why it occurred.[40] Causation is not a zero-sum game.

Methodological naturalism further prevents us from trying to use science to answer ultimate, "worldviewish" questions.[41] Although it ably answers the "How" questions, science will always fail to answer the "Why" questions. How many times have we heard the New Atheists declare that science eliminates the need to believe in God? Equally disastrous are those attempts by well-meaning Christians to prove God's existence using science. Both sides give too much authority to science and fall prey to scientism. Methodological naturalism is a sensible safeguard against such worldview creep.

Finally, coming back to a practical argument, science depends on empirical evidence and testing. Since God (or the Intelligent Designer, as the ID community would say) is free and unpredictable, virtually any empirical observation could be explained as a result of design. Anyone who argues against design based on flaws in the system can be thus rebuked (and rightly so): who are we to say what the Designer would or would not do? So, then, how do we test hypotheses if we cannot make predictions? Meyer argues that ID theory can be tested by comparing it to all other hypotheses. If design has more explanatory power than all the others, it should be accepted as an inference to the best explanation. The problem, of course, is that the correct hypothesis may not yet be on the table. By practicing methodological naturalism, one does not deny the presence of design or teleology in the created order but simply removes it from the purview of science. And this, as we have already seen, is fine—as long as we see science as just one (albeit powerful) window into reality.

Conclusion

Far from leading us down a slippery slope to deism or atheism, methodological naturalism is a wise practice for Christians. Limiting science to natural explanations may not successfully uncover all the causes at work within our world, but this should not trouble us in the least—after all, it is not the job of science to provide a comprehensive view of reality.

Today, methodological naturalism is often misused to remove all reference to God or spiritual things from science. The version of methodological naturalism I have defended here is consistent with the view of Christian natural philosophers and scientists of previous ages who sought to honor God through their study of his creation. Methodological naturalism, along with the doctrine of creation, gives us freedom to explore God's regular means of creating and sustaining the material world. In doing so, we can bring our Creator greater glory and praise. ✠

Acknowledgments

Thanks to Robert Bishop for organizing the session on methodological naturalism at the 2011 ASA Annual Meeting, which inspired this article. Bishop, Darrel Falk, and Peter Jones provided insightful comments on early drafts.

Notes

[1]Some worldviews are not compatible with certain assumptions in science, such as the regularity of processes across time and space, or the rational link between observation and reality (e.g., radical skepticism). See Hugh

G. Gauch Jr., *Scientific Method in Practice* (Cambridge: Cambridge University Press, 2003), chap. 4.

[2]Consider, for example, how non-Christians demonstrated gifts of skill and intellect in ancient natural philosophy.

[3]St. Augustine, *On Christian Teaching (Oxford World's Classics)* (Oxford: Oxford University Press, 2009), II.72, 47. John Calvin expressed a similar conviction,

> All truth is from God, and consequently if wicked men have said anything that is true and just, we ought not to reject it, for it has come from God. (John Calvin, *Commentary on Timothy, Titus, Philemon* [Grand Rapids, MI: Christian Classics Ethereal Library], Commentary on Titus 1:12, 247–8, http://www.ccel.org/ccel/calvin/calcom43.html)

[4]See, for example, Alvin Plantinga, "Methodological Naturalism?," *Perspectives on Science and Christian Faith (PSCF)* 49, no. 3 (1997): 143–54; David J. Krause, "Response to Plantinga," *PSCF* 49, no. 4 (1997): 285–6; Robert C. O'Connor, "Science on Trial: Exploring the Rationality of Methodological Naturalism," *PSCF* 49, no. 1 (1997): 15–30; Robin Collins, "Response to O'Connor," *PSCF* 49, no. 4 (1997): 286–7; Keith Abney, "Naturalism and Nonteleological Science: A Way to Resolve the Demarcation Problem Between Science and Nonscience" *PSCF* 49, no. 3 (1997): 162–9; Walter R. Thorson, "Legitimacy and Scope of 'Naturalism' in Science," *PSCF* 54, no. 1 (2002): 2–21; Loren Haarsma, "Can Many World Views Agree on Science?," *PSCF* 54, no. 1 (2002): 28–9; Harry Lee Poe and Chelsea Rose Mytyk, "From Scientific Method to Methodological Naturalism: The Evolution of an Idea," *PSCF* 59, no. 3 (2007): 213–8; Walter R. Thorson, David F. Siemens Jr., and Harry Lee Poe, "Author Exchange: Poe," *PSCF* 60, no. 1 (2008): 39–42.

[5]See, for example, Psalm 104, where God sustains the regular activities of the created order, and Genesis 50:20, where Joseph professes that his brothers' evil actions were used by God to accomplish his divine purposes. Daniel 2:21 states God's sovereignty over both science and history:

> He changes times and seasons [a matter for science]; he removes kings and sets up kings [a matter for history] …

As one reviewer helpfully pointed out, some who balk at scientific explanations for natural events (such as the gradual development of species, including our own) do not seem to be as bothered by purely economic, political, or sociological explanations for events in human history. Why?

[6]See Thomas Torrance, *Divine and Contingent Order* (Oxford: Oxford University Press, 1981).

[7]Indeed, this was how many seventeenth-century natural philosophers understood their activities, as demonstrated by Robert C. Bishop in this issue, "God and Methodological Naturalism in the Scientific Revolution and Beyond," *PSCF* 65, no. 1 (2013): 10–23.

[8]According to Article 2 of the Belgic Confession,

> We know [God] by two means: First, by the creation, preservation, and government of the universe, since that universe is before our eyes like a beautiful book in which all creatures, great and small, are as letters to make us ponder the invisible things of God … Second, he makes himself known to us more openly by his holy and divine Word, as much as we need in this life, for his glory and for the salvation of his own.

[9]These points (and a number of others) are nicely argued in an essay in which Paul de Vries first coined the term "methodological naturalism." Paul de Vries, "Naturalism in the Natural Sciences: A Christian Perspective," *Christian Scholar's Review* 15, no. 4 (1986): 389.

[10]Conor Cunningham, *Darwin's Pious Idea: Why the Ultra-Darwinists and Creationists Both Get It Wrong* (Grand Rapids, MI: Wm. B. Eerdmans, 2010), 266–8.

[11]Richard C. Lewontin, "Billions and Billions of Demons," review of Carl Sagan, *The Demon-Haunted World: Science as a Candle in the Dark* (New York: Random House, 1996), *New York Review of Books* 44, no 1. (1997): 31.

[12]Cunningham, *Darwin's Pious Idea*, 300.

[13]C. S. Lewis, *Mere Christianity* (San Francisco, CA: HarperSanFrancisco, 2001), 22–3.

[14]Michael L. Peterson, "C. S. Lewis on Evolution and Intelligent Design," *Perspectives on Science and Christian Faith* 62, no. 4 (2010): 256.

[15]These included the traditional teleological argument, the cosmological argument, and the moral argument, among others.

[16]Peterson, "C. S. Lewis on Evolution and Intelligent Design," 258.

[17]See Bishop's article, "God and Methodological Naturalism in the Scientific Revolution and Beyond," in this issue.

[18]A lovely phrase used by Bishop in private correspondence.

[19]See Ian Hutchinson, *Monopolizing Knowledge* (Belmont, MA: Fias Publishing, 2011) for an insightful look at scientism in contemporary science and culture.

[20]See, for example, John Hedley Brooke, *Science and Religion: Some Historical Perspectives* (Cambridge: Cambridge University Press, 1991); Peter Harrison, *The Fall of Man and the Foundations of Science* (Cambridge: Cambridge University Press, 2007).

[21]Ronald L. Numbers, "Science without God: Natural Laws and Christian Beliefs," in *The Nature of Nature: Examining the Role of Naturalism in Science*, ed. Bruce L. Gordon and William A. Dembski (Wilmington, DE: ISI Books, 2011). Bishop's article, "God and Methodological Naturalism in the Scientific Revolution and Beyond," in this issue gives a more theologically rich treatment.

[22]William A. Dembski and Jonathan Witt, *Intelligent Design Uncensored* (Downers Grove, IL: InterVarsity Press, 2010), 23–4.

[23]Del Ratzsch, *Science and Its Limits: The Natural Sciences in Christian Perspective* (Downers Grove, IL: InterVarsity Press, 2000), 130.

[24]Stephen C. Meyer, *Signature in the Cell* (New York: HarperCollins, 2009), 434.

[25]Ibid.

[26]Nancey Murphy, "Phillip Johnson on Trial: A Critique of His Critique of Darwin," *Perspectives on Science and Christian Faith* 45, no. 1 (1993): 33.

[27]Meyer, *Signature in the Cell*, 556.

[28]Meyer has voiced exactly this kind of objection in the context of chemical evolution experiments. He argues that the very design of the experiments demonstrates the need for intelligence in generating functional nucleotide sequences. Stephen C. Meyer, "Response to Darrel Falk's

Review of *Signature in the Cell*," January 28, 2010, http://biologos.org/blog/response-to-darrel-falks-review-of-signature-in-the-cell. This reasoning is not uncommon. For example, we read on the Answers in Genesis website,

> What if a scientist could make a living organism by combining chemicals in a lab? It would only prove that intelligent actions can make life—not that life arose spontaneously billions of years ago." (Roger Patterson, "Evolution Exposed, Chapter 5: The Origin of Life," March 22, 2007, http://www.answersingenesis.org/articles/ee/origin-of-life)

[29]The Westminster Confession of Faith describes God's providential governance:

> God the great Creator of all things does uphold, direct, dispose, and govern all creatures, actions, and things, from the greatest even to the least, by His most wise and holy providence, according to His infallible foreknowledge, and the free and immutable counsel of His own will, to the praise of the glory of His wisdom, power, justice, goodness, and mercy. Although, in relation to the foreknowledge and decree of God, the first Cause, all things come to pass immutably, and infallibly; yet, by the same providence, He orders them to fall out, according to the nature of second causes, either necessarily, freely, or contingently. *God, in His ordinary providence, makes use of means, yet is free to work without, above, and against them, at His pleasure*. (*Westminster Confession of Faith*, 5.1–5.3)

[30]Sir Arthur Eddington, *The Philosophy of Physical Science*, 4th printing (East Lansing, MI: University of Michigan Press, 1958), 16.

[31]Dembski and Witt, *Intelligent Design Uncensored*, 112.

[32]Denis Alexander, *Creation or Evolution: Do We Have to Choose?* (Grand Rapids, MI: Monarch Books, 2008), 186–7.

[33]Robert C. Bishop, "Recovering the Doctrine of Creation: A Theological View of Science," The BioLogos Foundation, http://biologos.org/uploads/static-content/bishop_white_paper.pdf.

[34]Ibid.

[35]G. K. Chesterton, *Orthodoxy* (Whitefish, MT: Kessinger Publishing, 2004), 42.

[36]The predominant religion of America's teenagers has been described as "moralistic therapeutic deism." In this view, God created the world and wants us to be nice to each other. He only gets involved when we have a crisis, and he lets "good" people into heaven. Christian Smith and Melinda Lundquist Denton, *Soul Searching: The Religious and Spiritual Lives of American Teenagers* (New York: Oxford University Press, 2005).

[37]Michael Peterson, personal correspondence, May 4, 2011.

[38]According to Tim Keller,

> Sin isn't only doing bad things, it is more fundamentally making good things into ultimate things. Sin is building your life and meaning on anything, even a very good thing, more than on God. ("Talking about Idolatry in a Postmodern Age," The Gospel Coalition, April 1, 2007, http://thegospelcoalition.org/resources/a/Talking-About-Idolatry-in-a-Postmodern-Age)

[39]As a historical note, scientism and viewing science as a source of salvation did not originate with scientists but began in the late nineteenth century by people who were impressed by scientific progress. See James Turner, *Without God, Without Creed: The Origins of Unbelief in America* (Baltimore, MD: The Johns Hopkins University Press, 1985), chaps. 8–9.

[40]This argument and example are borrowed from de Vries, "Naturalism in the Natural Sciences: A Christian Perspective," 389.

[41]Ibid.

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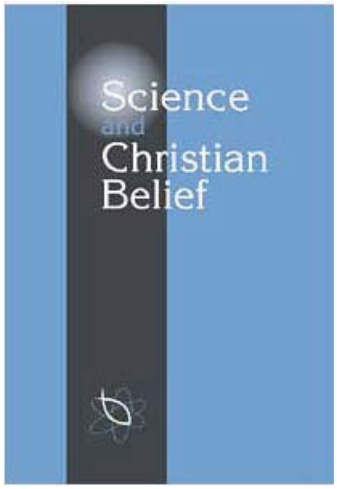

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Science and Technology in Service of the Poor: The Case of the Coconut

Walter L. Bradley

Walter L. Bradley

When I moved from Texas A&M University to Baylor University in 2002, my goal was to redirect my research activities from high-performance polymeric composite materials for the United States Air Force and NASA to something that would directly benefit the poor in developing countries. But what might this be? I started this journey of discovery by trying to determine the demographics of the poor in developing countries and learned that 80% of the 2.7 billion people who live on less than $2/day are poor farmers who have 2–5 acres of land.

Through John Pumwa, a former PhD student of mine at Texas A&M who was from Papua New Guinea, I learned that there were 11 million coconut farmer families around the world (see figure 1) who make $500/year selling the white coconut "meat" from the ~5,000 coconuts/year each family harvests for 10¢/coconut. These families live within ~20° of the equator where coconut trees grow and bear fruit (see figure 2).

Figure 1. Walter Bradley with a typical coconut farmer family.

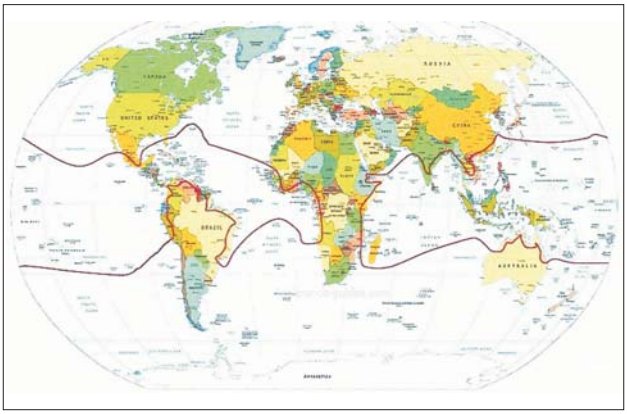

Figure 2. Regions inside the dark boundaries are locations where coconuts grow.

In this communication, I would like to share the details of my quest to make a difference in the lives of these farmers, both economically and spiritually.

Coconut Biodiesel for Sustainable, Worldwide Rural Electrification—The Impossible Dream

Pumwa took a one-year sabbatical leave from his position as department head of mechanical engineering at the University of Technology in Papua New Guinea to come to work with me at Baylor University in 2004. Our initial goal was to determine if we could make biodiesel from coconut oil to provide electricity in rural villages around the world, such as the one where he was born in Papua New Guinea. Vegetable

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oils including coconut oil must be converted into long-chain hydrocarbons (10–15 carbon atoms in length) to be utilized as fuel in diesel engines. The normal process to make this happen is called transesterification, and is typically done using methanol in a mixture of one part methanol to five parts vegetable oil. We were able to demonstrate that coconut oil can be used to make a wonderful biodiesel fuel (see figure 3) that created sweet-smelling exhaust fumes and reduced engine friction.

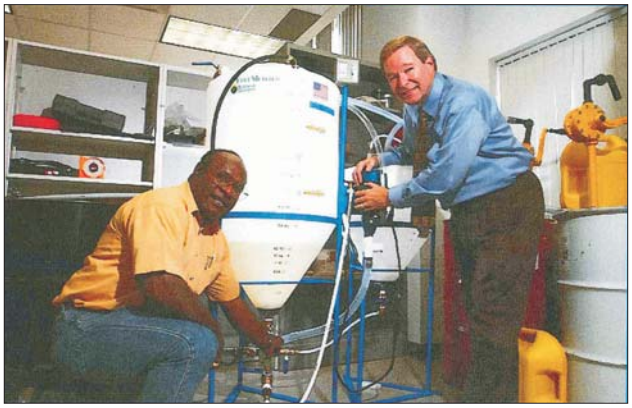

Figure 3. John Pumwa and Walter Bradley making their first batch of coconut oil biodiesel.

Unfortunately, methanol is not available in rural villages and rural villagers would not have money with which to purchase methanol, even if it were available.

Pumwa returned to Papua New Guinea while my research group at Baylor in 2005–2006 proceeded to explore a substitute for methanol in the transesterification step that villagers could make for themselves, namely, ethanol. With chemical stockroom-grade dry ethanol (essentially free of water), we made excellent biodiesel fuel from coconut oil. With 0.5 wt% water in the ethanol, we made acceptable biodiesel fuel from coconut oil. But with 1.0 wt% water in the ethanol, the transesterification process was poisoned, and we made soap instead. It is essentially impossible to make ethanol containing less than 1.0 wt% water in a rural village using a distillation still, so we had to abandon our "impossible dream" of providing sustainable rural electricity around the world. Any reader who is a chemist should ponder this challenging research project with its huge potential to benefit the poor in developing countries. How can biodiesel be made from vegetable oil using a chemical process that utilizes a chemical that villagers can create in a rural area?

Plan B—Creating Biocomposite Materials from Coconut Shell and Coconut Husks: The Possible Dream

Next we turned our attention to the 50 billion kilograms of agricultural waste created each year in the production of coconut oil. What unique combinations of physical properties might biomass in coconut husks and shells have that would not only be useful but would also have a competitive advantage in providing market opportunities and value for this abundant but poorly utilized agricultural waste?

There are currently relatively few markets for the coconut shell and husk. Consequently, the shell and husk are often burned as fuel or as agricultural waste (see figure 4), providing little or no economic benefit to the farmers. The goal of my research since 2006 has been to create polymeric composite materials that utilize coconut fiber (called coir) and coconut shell powder as functional fillers in polymers such as polypropylene, giving significantly enhanced value to the 50 billion kilograms of agricultural waste that is owned by poor coconut farmers.

Figure 4. Coconut husk in the Philippines, an abundant agricultural waste worldwide.

A cross section of a coconut is seen in figure 5, with the primary constituents being the husk that surrounds the coconut, the shell of the coconut, and the white coconut meat, usually called copra. The coconut husk consists of 50 wt% fiber called "coir" and 50 wt% pith, which is a fine, powdery biomass.

The Properties and Use of the Coconut Husk

What are the physical properties of the various constituent parts of the coconut husk and what commercial opportunities do these properties provide?

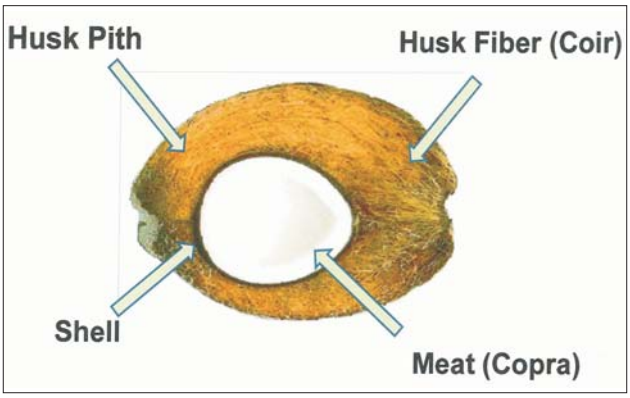

Figure 5. A cross section of a coconut husk and imbedded coconut shell.

The pith can absorb ten times its weight in water and is already widely used in horticultural applications. The function of the husk in nature is to absorb the impact energy from a 60–80-ft fall so that the seed, the coconut, is not broken. The husk must also protect the seed from fire and microbial attack. As a result, the coconut fiber has an unusually high elongation of 25–30% compared to most natural fibers with an elongation of only 1–3%. This gives excellent formability when it is used in nonwoven fabric composites.

The high lignin content of more than 35% makes the fiber resistant to microbial attack and difficult to burn. Natural fibers that are susceptible to microbial attack develop odor problems in service. The coir fiber has a remarkable structure (see figure 6) that gives it a very high stiffness-to-weight ratio, which reduces the cost per pound (it has a honeycomb-like core) and makes it particularly attractive for automotive applications. Finally, the coir fiber has a fiber diameter of ~200 μm, while most natural or synthetic fibers are ~50 μm in diameter. Flexural rigidity is proportional to the diameter.

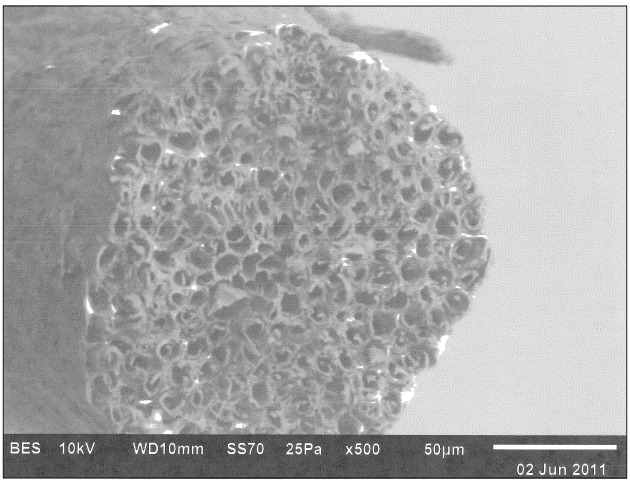

Figure 6. Cross section of a coconut fiber as seen in SEM showing a remarkable honeycomb-like structure.

Coir fiber can be blended with a synthetic "binder" fiber such as polypropylene or polyester and processed into a nonwoven fabric composite by carding and needle punching or by air-laid processing. The fabric composite can then be processed into parts such as door panels for automobiles, as seen in figure 7, or mattresses for beds, cushions for furniture, or many other applications.

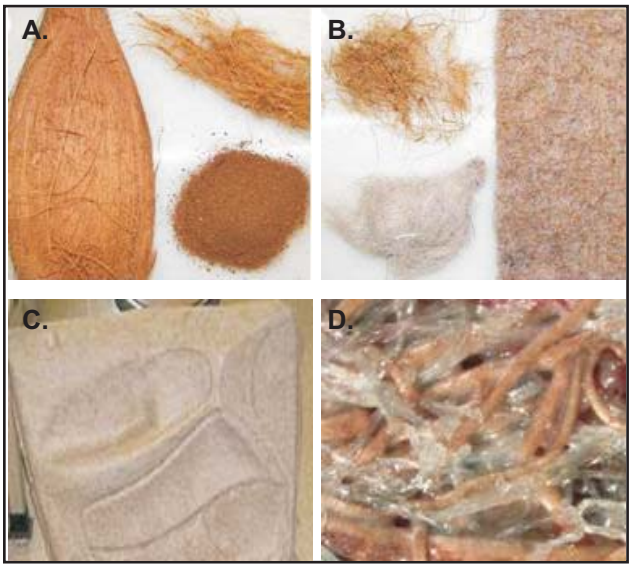

Figure 7. A. Coconut husk contains fiber and pith; **B.** Coconut fiber is blended with polypropylene fiber to make a felt; **C.** Automobile door panel made by heating felt and compression molding it; **D.** Felt after compression molding.

The high fiber elongation of coir, as compared to other natural fibers, provides excellent formability for production of parts by compression molding of nonwoven fabric composites that utilize coir, as seen in figure 8.

One part in the 2012 Ford Focus is manufactured using coir fiber in a nonwoven fabric composite. Ford Motors nominated this part of an automotive innovation award from the Society of Plastics Engineers in 2011, and it was selected as the first runner-up in its category of sustainable materials. Several major nonautomotive applications are at

various stages of development in collaboration with major companies.

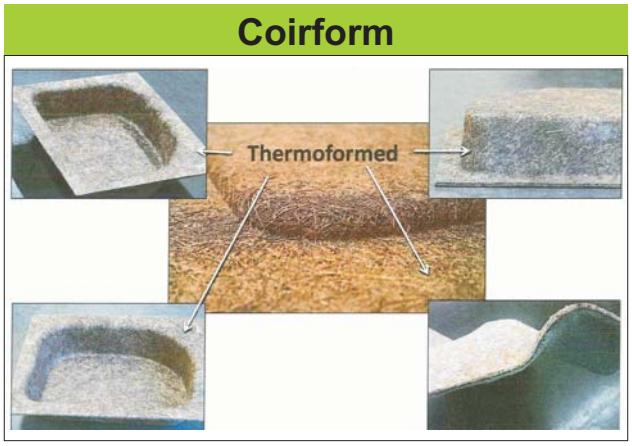

Figure 8. Excellent formability in compression molding of nonwoven fabric composites with 50 wt% coir.

The coir research and development work was made possible by two grants from the National Collegiate Inventors and Innovators Alliance (NCIIA) totaling $40,000 and subsequently by three National Science Foundation Small Business Innovation Research Grants totaling $1.1 million.

The Properties and Use of the Coconut Shell

What are the physical properties of the various constituent parts of the coconut shell and what commercial opportunities do these properties provide?

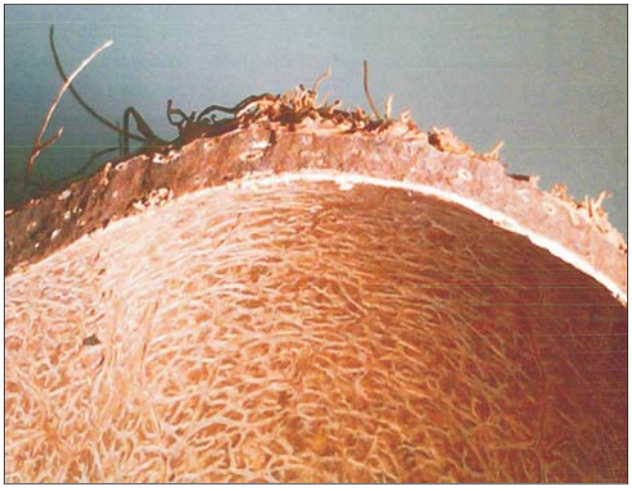

Figure 9. Coconut shell.

Coconut shell is extremely dense (1.2 g/cm^3 compared to most wood at 0.3–0.6 g/cm^3), which makes it very hard (four times harder than maple and ten times harder than pine). Its high lignin content makes it resistant to attack by microbes including mold, and also more difficult to burn.

The coconut shell can be processed into coconut shell powder (CSP) (see figure 10) and utilized as functional filler in plastics such as polypropylene to increase their hardness and stiffness. The coconut shell powder is eight times as hard as polypropylene and can easily double the stiffness of polypropylene when added at the level of 40 wt% as functional filler. It can be used in applications in which consumer goods are manufactured using injection molding, extrusion, or thermal forming (see figure 11).

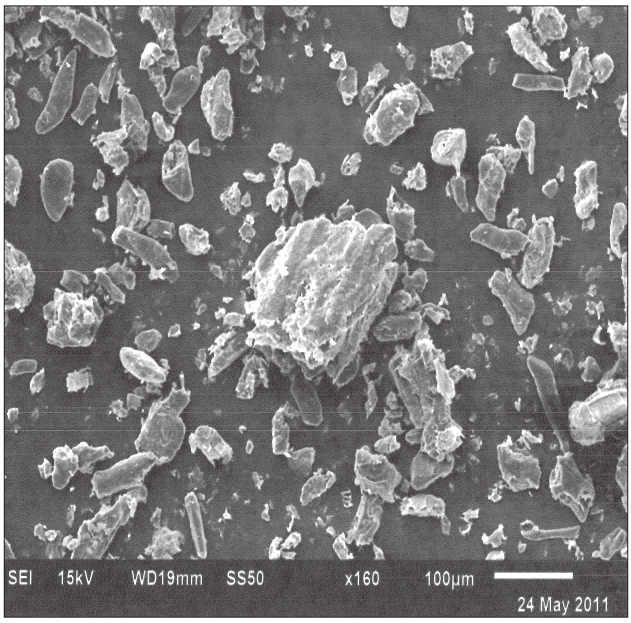

Figure 10. Coconut shell powder as seen in a scanning electron microscope.

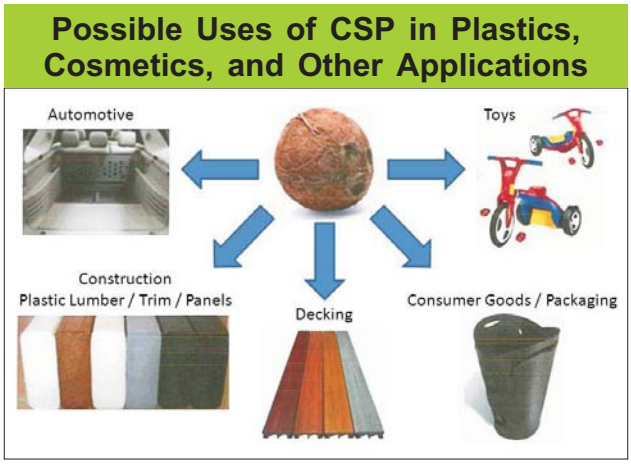

Figure 11. Examples of consumer goods that can be made from coconut shell powder (CSP).

Joint development projects with major manufacturing companies are already underway, with multiple products to be introduced in 2013 that utilize coconut shell powder as a functional filler in polypropylene.

Benefits to the Poor in Developing Countries

Production facilities have been purchased in Indonesia by Natural Composites Inc., the company that I founded in partnership with Christian friends who share my vision of helping poor people in developing countries in a for-profit company. This facility is capable of producing 10 million pounds of coconut shell powder per year and provides employment for ~100 people working in the plant. The employees are treated extremely well and are thankful to have a job to support their families. The number of employees should grow significantly over time as the use of coconut shell powder as a functional filler in polypropylene, and coir as a constituent in nonwoven fabric composites, expands. We also anticipate creating other production facilities in the Philippines, India, Sri Lanka, Brazil, and maybe in a country in the Caribbean.

We also plan to develop cooperatives with the coconut farmers so that we can buy coconut husks and shells from them directly. Currently, we buy from middlemen. Direct buying will allow us to provide more benefits to the coconut farmers and to build relationships with them. Rather than paying a premium for what is currently a very cheap commodity (even free in some cases), we will seek creative ways to benefit the farmers and their families, such as by providing vouchers for their children to go to nearby schools that would be created by concerned Christian businessmen and churches, or by providing fertilizer to help them double the yields of their coconut trees.

Concerning our employees and our coconut farmer suppliers, we plan to bless them by dealing with them in a Christ-like manner and, over time, by taking the opportunity to share the love of Christ with them.

Personal Postscript

When I moved from Texas A&M University to Baylor University in 2002, my goal was to redirect my research toward something that would directly help poor people in developing countries. I had no idea what that might be. God has led me on an amazing faith-stretching journey for which the past thirty years of my life were a preparation. The skills I developed and the friends I made prior to coming to Baylor have become the technical tools I needed and the partnerships I must have to be successful in this venture. It is very clear to me that "unless the Lord builds the house, those who build it labor in vain" (Ps. 127:1a).

When I was asked by ABC News in 2009 how I ever thought to use coconut husks to make automobile interior parts, they assumed that I would explain how I tirelessly tried every natural fiber and determined, by a process of elimination, that coir was the best. But God directed me to coir as he brought to my attention, through John Pumwa, the plight of the poor coconut farmers. Happily, their agricultural waste was pregnant with possibilities. The amazing band of brothers and sisters who have become part of this journey include former members of a young married couples Sunday School class that I taught twenty years ago, friends from a Christian businessmen's annual ski conference in Colorado over a period of ten years, and a whole host of students whom God brought to my classes, especially John Pumwa, the first student from Papua New Guinea to earn a PhD in engineering and whose parents were the first in his mountain village to accept Christ as their Savior many years ago.

Oddly enough, I was diagnosed with leukemia about the time I started this journey, with a life expectancy of three years. Here I am seven years later, living on "borrowed" time, doing perhaps the most important work of my life. When I was first diagnosed with leukemia, I prayed to God for fifteen more years, just as Hezekiah did, with the promise that I would try to be a better steward than he was with such a gift. This work is my down payment on that promise. Hopefully, God will grant me the privilege of seeing it come to full bloom. ✠

Environment

MAKING PEACE WITH THE LAND: God's Call to Reconcile with Creation by Fred Bahnson and Norman Wirzba. Downers Grove, IL: InterVarsity Press, 2012. 182 pages. Paperback; $15.00. ISBN: 978-0830834570.

This book is the seventh in the Resources for Reconciliation series published by the Duke Divinity School Center for Reconciliation and InterVarsity Press. As stated in the preface of this book, the purpose of this series is to address "what it means to pursue hope in areas of brokenness, including the family, the city, the poor, the disabled, racial and ethnic divisions, violent conflicts, and the environment." While the first six books in the series focus primarily on broken relationships among people, this book is centered upon the need to reestablish proper relationships between people and the land.

Each book in this series has two authors, one in the field of practice or grass roots experience and the other from a university setting with a background in theology. Fred Bahnson is a permaculture gardener, former director of Anathoth Community Garden in North Carolina, and a pioneer in church-supported agriculture. Norman Wirzba is a research professor of theology, ecology, and rural life at Duke Divinity School. He is the author of *Food and Faith*, *Living the Sabbath*, and *The Paradise of God*. In *Making Peace with the Land*, Bahnson wrote chapters two, four, and six, while Wirzba wrote chapters one, three, and five; so the chapters alternate between theology and practice.

One problem that this book addresses is the dream of the "abundant mirage." We in the United States have become so accustomed to an inexpensive, continuous supply of food that we have come to mistake this for reality, when it is actually an unsustainable dream that cannot endure past the oil age. This demand for inexpensive food is slowly but surely destroying life on our planet as well as the soil upon which life depends. One of the main causes of this problem is the separation of people from the land, which leads to "ecological amnesia." This separation takes two forms. First, many of us are physically separated from the land as far more people now live in cities than on farms. Today's forms of urban and suburban life make it likely that people will not appreciate where their food comes from or what processes have been used to make this inexpensive food available in abundance. The second form of separation is existential: the loss of practical, working relationships that can teach us about our dependence upon other creatures and the land and watersheds which support them.

The authors argue that today's churches are failing to address this problem because many Christians suffer from a "reconciliation deficit disorder." The source of this disorder is the belief that Jesus Christ came only to reconcile broken relationships between people and God or between people and people. But as the Apostle Paul writes in Col. 1:20, God has reconciled "all things" to himself through Jesus Christ; and again in 2 Cor. 5:19, God was in Christ reconciling the "world" to himself. On the basis of these and other passages of Scripture, Christians must come to realize that God desires all of creation—human and nonhuman, living and nonliving—to be reconciled with each other and with God. We were created not only for intimacy with God and with others but also for intimacy with the land.

How can the problems of the "abundant mirage" and "reconciliation deficit disorder" be solved? As far as the first problem is concerned, the book offers the solution of "regenerative agriculture" or "agroecology." The underlying idea is that the ecosystems in which we find ourselves are far more adept at growing things than we are. Making ourselves students of these ecosystems is what it means to serve and preserve the fertile soil that God has entrusted to our care (Gen. 2:15). This can be done by replacing monoculture agriculture with polycultures, through no-till farming and rotational grazing livestock systems, and with other types of regenerative agriculture such as permaculture, biodynamic agriculture, and agroforestry (p. 97). Several examples of organizations that are putting these methods into practice are described in the book. They include an agroforestry project called Sowing Seeds of Change in the Sahel region of Niger, a perennial, polyculture form of agriculture developed at the Land Institute in Salina, Kansas, and the Global Farm sponsored by the Educational Concerns for Hunger Organization (ECHO) based in southwestern Florida. The Urban Rooftop Garden developed at ECHO serves as a model for a movement that can provide food for the poor in cities around the world.

The authors also provide practical ways in which the second problem of "reconciliation deficit disorder" can be addressed. One suggestion involves converting our churches from places of consumption to places of food production. Examples include "church supported community gardens, permaculture parishes, transition churches, and apostolic farms that feed entire neighborhoods." In order to make this happen, seminaries need to train future pastors in the "agrarian arts, ecological literacy, and sunshine-powered living" (p. 109). Bahnson documents his own experiences with Anathoth Community Garden sponsored by a rural Methodist church in Cedar Grove, North Carolina, as

an example of how individual churches can become places of food production. Since gardening is a form of work that describes God's relationship to creation, participating with God in this work of gardening is something that Christians are encouraged to consider even in their own backyards.

As stated in the preface, the ministry of reconciliation is not reserved for experts. This book was written to equip all of God's people to be more faithful ambassadors of reconciliation in regard to the land. Study guide questions, along with notes and recommendations for further reading, are included at the end of the book to help accomplish this goal. Many Christians need to learn again how to live sacramentally in "God's garden." This book provides the biblical vision along with down-to-earth examples that can help to make this happen.

Reviewed by J. David Holland, Associate Professor of Biological Science, Benedictine University, Springfield, IL 62702.

ETHICS

AN INTRODUCTION TO EVOLUTIONARY ETHICS
by Scott M. James. Malden, MA: Wiley- Blackwell, 2011. 240 pages. Paperback; $34.95. ISBN: 9781405193962.

Scott M. James's book is a fine and helpful overview of many of the issues pertaining to evolutionary ethics. James does a good job not only in presenting the various positions, but he also does so in a fair and unbiased manner. This enables the reader to consider the positions and make up his or her own mind regarding them. The book is divided into twelve chapters and two major parts. The first part discusses the nature of moral psychology after Darwin and the second part considers the so-called fact-value divide ("Hume's guillotine") and how this does or does not affect the construction of a moral philosophy after Darwin.

In chapter 1, James presents the evidence for evolution and explains the meaning of natural selection. He points to several sources of potential misunderstandings of these concepts. James makes it clear that he rejects both genetic and environmental determinism, stating that a central issue for evolutionary ethics is moral responsibility.

Chapter 2 is an extensive discussion of altruism and why it is both a problem and a challenge to explain within a Darwinian framework. The central issue is why does altruistic behavior persist when we would expect a world of pure egoists? James discusses and explains inclusive fitness, reciprocal altruism, group selection, and the nature of Hamilton's Rule. He also furnishes an extensive discussion of the Prisoner's Dilemma, a fictionalized decision procedure based on contemporary game theory in which two individuals must determine whether to cooperate or defect in the light of the various cost-benefit pay-offs of each position. The dilemma highlights that cooperation delivers real benefits as long as others are willing to trust and play along.

In chapter 3, James furnishes us with a set of traits which make moral creatures moral. In addition, he traces an evolutionary story line in the emergence of our moral sense. He discusses what it means to say that natural selection does not necessarily have to select for what is intrinsically valuable. It can select for various intermediate goods (e.g., clear complexion, lustrous hair, full breasts) as a pathway to what is intrinsically valuable (female fertility). James suggests that the same holds true for morality. Our earliest ancestors did not have to calculate the long-term benefits of cooperative alliances (intrinsic good); they only had to resist the temptation, the pressure to refuse to cooperate (intermediate good).

> So the adaptive problem in need of solution was this: design individuals to establish and preserve cooperative alliances *despite* the temptation not to cooperate. (p. 59)

Natural selection, says James, shaped us into the sort of beings who can think morally, that is, creatures who will overcome their suspicions and commit themselves to certain cooperative arrangements. James suggests that religion, in the form of religious rituals, may have evolved *in tandem* with ethics because religion usually involves some sort of "signaling" (p. 61) to others of his or her fidelity to the values of the community (via dress, cleansing, ritual, ascetic practices, etc.), and hence his or her trustworthiness. Religion, thus, promotes group identity and cohesion.

Chapter 4 is dedicated to the subject of punishment—what happens to those individuals who violate various social prohibitions of the community. He discusses when people punish, why they punish, how punishment benefits the individual and the group, and how punishment is related to reputation and feelings of guilt. In order to do this, he examines several psychological studies employing games related to punishment (the Ultimatum Game, the Dictator Game, and the Public Goods Game). The importance of "tit-for-tat" as a possible candidate for how moral thinking got off the ground is also discussed.

Chapter 5 focuses first on the relation of feelings to the development of the moral mind. James then moves on to the question of whether morality is learned or

innate. Some argue that it is innate, that just as there is (à la Chomsky) a universal grammar, so also there is a universal moral sense. This, says James, would support the idea that morality is a product of evolutionary forces. Others doubt that this is so. Philosophers such as Jesse Prinz think that the diversity of moral codes and practices argues against this position. Prinz also thinks that children may have learned the moral rules that many take to be innate. James suggests that even if the position that morals are innate is vindicated, this does not, in itself, definitively show that morality is a product of evolution. He says that morality may be a side consequence of having bigger brains or it may have come into existence as a result of divine inspiration.

Chapter 6 begins the discussion about whether evolutionary ethics can bridge the supposed gap between facts and values first introduced by David Hume. Herbert Spencer contends that, in human beings, nature has evolved a moral sensibility that checks selfish conduct and leads to "'permanently peaceful' communities" (p. 125). Thus, the moral sensibility necessary to peaceful coexistence and the product of natural selection is identified as the good or "more evolved conduct," and the bad is the "relatively less evolved" conduct (p. 126). Hence, Spencer virtually identifies what is natural (how we came to be what we are) with the good (or how we *ought to be*). Spencer simply assumes that there is no gap between what is and what ought to be, or that if it exists, he has bridged it.

The problem of deriving an "ought" from an "is" is considered in chapter 7. James does a very good job of explaining the nature of Hume's claim and how it relates to evolutionary ethics, especially to the assumptions of Spencer as stated above. Hume's basic claim is that prescription cannot be derived from description, no matter how exhaustive such descriptions may be. Hume was arguing for the autonomy of moral theory, namely, that disciplines outside moral philosophy cannot offer any insight into the nature of morality. The fact/value split would, James maintains, check any sort of arguments in favor of social Darwinism where descriptions of nature (e.g., "survival of the fittest," "might makes right") should be taken as premises leading to a conclusion of how we ought to live.

Chapters 8 and 9 are rather technical considerations of the philosopher G. E. Moore's attempt to strengthen "Hume's Guillotine" (the fact/value divide) in order to make the divide absolutely unbridgeable (p. 143). James explains Moore's position in terms of what he calls the "open question test." We need not delve into the details of this discussion, but James claims to show that both Spencer and E. O. Wilson commit Moore's naturalistic fallacy in their implicit identification of what is natural with what is good (pp. 146–8). He considers the proposals of philosophers John Searle and James Rachels to cross the fact/value divide, along with several criticisms of their attempts.

The last three chapters (10–12) deal with the topic of evolutionary antirealism, the position that, after Darwin, morality cannot claim any mind-independent objectivity. According to Wilson and Michael Ruse, our belief in the objectivity of moral standards is simply a trick played on us by natural selection to get us to cooperate with each other. Our moral standards are nothing but the "*idiosyncratic* products of the genetic history of [our] species and as such were shaped by the particular regimes of natural selection" (p. 170).

James discusses briefly the work of Richard Joyce and Sharon Street. Both of them affirm and extend the work of Wilson and Ruse. Both Joyce and Street advocate suspension of belief in moral principles and a general agnosticism regarding what our moral duties are.

James proposes and discusses several options for the evolutionary realist, as well as objections to the various realist proposals. James is well aware that objectivity is tricky for those who maintain that natural selection has played an important role in the development of moral consciousness:

> If moral *realism* is to have a chance, then there needs to be a way of understanding, on the one hand, how natural selection played a critical role in shaping our moral minds and, on the other, how this can be reconciled with an account of moral facts that can sufficiently underwrite the distinctive character of moral judgment. (p. 208)

This is, indeed, a fair statement of the task of the evolutionary realist. Recommended for all undergraduate libraries in the sciences and humanities.

Reviewed by Lloyd W. J. Aultman-Moore, Professor of Philosophy, Waynesburg University, Waynesburg, PA 15370.

History of Science

AMERICAN GENESIS: The Evolution Controversies from Scopes to Creation Science by Jeffrey P. Moran. New York: Oxford University Press, 2012. 196 pages. Hardcover; $29.95. ISBN: 9780195183498.

In a 2012 speech, Georgia Congressman Paul Broun proclaimed that the world was only 9,000 years old and had been created in "six days as we know them." He also declared his opposition to evolution, describing it as "lies straight from the pit of Hell … to try to keep me and all the folks who were taught that from under-

standing that they need a savior" (Matt Pearce, "U.S. Rep. Paul Broun: Evolution a lie 'from the pit of hell,'" *Los Angeles Times*, 7 October 2012). These remarks drew national attention, in part because Broun is a physician and a member of the US House Committee on Science, Space and Technology, which oversees both NASA and the National Science Foundation.

Although some commentators expressed concern that national science policy was being made by someone who held such beliefs, Broun's views are consistent with the views of 40% of respondents in a 2010 Gallup poll (Doug Mataconis, "40% of Americans, Majority of Republicans, Reject Evolution," *Outside the Beltway*, 18 December 2010). It seems clear that one of the most technologically advanced countries in the world also remains one of the most religious and most opposed to Darwin's theory. This issue is often depicted simply as a conflict between science and faith, led by Christians who interpret the book of Genesis literally. Jeffrey P. Moran's examination of the history of American antievolutionism, however, shows that social forces "have intersected with the antievolution impulse in ways that shed light on modern American culture" (p. x). Using sources such as speeches, newspaper articles, and the research of prominent scientists and religious activists alike, Moran (a professor of history at the University of Kansas) explores how social forces and anxieties about changes in society shaped the various ways that Americans responded to Darwin in the early twentieth century and over the last fifty years.

Moran begins with a brief overview of the historical relationship between faith and science, arguing that for many centuries the two peacefully coexisted and even supported each other. Although natural selection posed a challenge to this relationship, many mainline religious leaders and upper-level educators in the United States initially embraced a notion of theistic evolution. By the 1925 Scopes trial, however, America had become a hotbed of antievolutionism due to unique national characteristics. The Protestant majority was hostile toward anything that contradicted a literalist interpretation of scripture, viewed antievolutionism in the context of broader cultural concerns, and used the democratic process to enact its concerns into law. After this introduction, Moran examines antievolutionism through the lenses of gender, geography, race, morality, and higher education. At each turn, he shows both how activists were motivated by these broader identity concerns, and how women, African Americans, southerners, religious leaders, and educators themselves were involved. Although the early chapters focus on the Scopes era, they also briefly describe how these issues persist into the present day.

As the 1920s brought an expansion of women's voting rights, public high school education, and cultural experimentation, religious conservatives saw antievolutionism as a way to cling to tradition, especially the notion of women as domestic defenders of morality. Ironically, the passage of the twentieth Amendment also empowered conservative women to take a more active role in the movement. Furthermore, the combative discourse of antievolutionism was shaped in part by Protestant male anxieties about the emasculating effects of modern society. Resistance to Darwin was also important for regional identity. While antievolutionism began in the North, southern activists used its ideas to assert a traditional, populist southern identity and to reject the values of their northern opponents, who, for their part, saw this as evidence that the South was backwards and intolerant. The racial lens of antievolutionism, Moran continues, also included a power struggle within the African American community between religious leaders and intellectuals. Both sides saw the issue in the context of racial uplift. While many ministers endorsed traditional values as a way to display black respectability, intellectuals viewed white southern antievolutionism as "part of a larger structure of white southern repression" and a fear that Darwin's notion of common human descent was a challenge to white supremacy (p. 81).

Moran's fourth and fifth chapters focus on the last half-century of developments in antievolutionism. Darwin's theories triggered spiritual fears that the "disbelief in Genesis would ultimately undermine the faith that Jesus had come to earth once and was to come again to redeem mankind from sin" (p. 94), especially since science could also be used to discredit the biblical narrative of Jesus's life. The movement's resurgence during the 1960s was further spurred by Supreme Court rulings about religion in public schools. Many members of the next generation of antievolutionists embraced young-earth creationism or eventually intelligent design (ID), which emerged in the early 1990s as a movement that eschewed overtly religious attacks on evolution for a more science-centered approach. Antievolutionism also remains an issue in academia, the focus of Moran's final chapter. Through an examination of secondary sources, he debunks the common claim that higher education erodes the religious faith of college students, but he also affirms the equally frequent charge that scientists are less religious than other Americans. The antievolution controversy has had little impact on their work, except in the case of scholars at leading religious institutions, antireligious scholars such as Richard Dawkins, and organizations such as the National Center for Science Education. The battle continues to the present day, even in Moran's book.

Although *American Genesis* takes a clear stand against antievolutionism in all of its various forms, the book is also critical of secular scholars who use the debate to attack religion itself and of northerners who stereotyped the South during the Scopes trial. Moran also acknowledges that some engineers and scholars in the field of science and technology studies have rejected, or at least challenged, Darwin's ideas, thus refuting the common perception that all antievolutionists have substituted religion for legitimate scientific inquiry.

Overall, this is a profoundly even-handed book that seeks to explain a historical movement without merely attacking it or falling into the false equivalency trap of giving it equal footing with science. There are, however, some questions that remain unanswered. The book's short length and clear prose make it accessible to specialists, college students, and the general public, but it also leaves out a large portion of the twentieth century. Moran argues that antievolution activism was largely dormant in the years between the Scopes trial and the 1960s, but one is still left to wonder how events such as the Depression, World War II, and the Cold War affected it. Furthermore, at the same time that the movement regained momentum, ideas about race, gender, regionalism, and morality were being challenged through the Civil Rights Movement, feminism, the counterculture, the white southern shift to the Republican Party, and other major events. It would have been appropriate to ask if these historical moments affected antievolutionism, given that in Moran's argument, comparable events in earlier times clearly did.

Similarly, his discussion of the last twenty years is not as well contextualized as other chapters; the reader is left to wonder about the effect of the massive cultural changes of the 1990s and 2000s. Finally, the discussion of black Christianity focuses on Baptist and Methodist churches, but more could be said about the role of Pentecostalism, which was rapidly growing during that time. It rejected modernity even more fervently than other black churches, and was often disparaged by black scholars as the worst kind of superstition and cultish anti-intellectualism. These, however, are relatively minor concerns about an excellent book that sheds new light on the history of America's response to evolution, on common misconceptions about the issue, and on the segmented nature of American society itself.

Reviewed by David Brodnax Sr., Associate Professor of History, Trinity Christian College, Palos Heights, IL 60463.

Origins & Cosmology

EVOLUTION AND BELIEF: Confessions of a Religious Paleontologist by Robert J. Asher. New York: Cambridge University Press, 2012. xxiii + 300 pages. Hardcover; $24.99. ISBN: 9780521193832.

In *Evolution and Belief: Confessions of a Religious Paleontologist*, University of Cambridge paleontologist Robert Asher argues that evolution by natural selection is the major driving force that explains the diversification and interrelatedness of all life on Earth, while also contending that a proper understanding of evolution does not rule out the potential for a deity existing behind the natural process. Based on the title of the book, a reader might expect to find equal parts scientific discussion and theological exposition, with a healthy dose of integration between the two, but for the most part, the author does not venture very far from his scientific areas of expertise.

Asher is a respected paleontologist known for his research on the evolution of mammals, including work on endemic African groups and the reconstruction of interrelationships among mammals, using both fossil and molecular data. His expertise is clearly on display throughout the book, as he spends the vast majority of it making a case for the validity of evolution by natural selection. It is here that he is most successful. He discusses how evolutionary biology, while possessing a significant historical component, nonetheless operates on principles observable in the world today and is subject to testing just like any other branch of science. The theory of evolution by natural selection generates innumerable hypotheses that can be potentially falsified by observations from the natural world, and over several chapters, Asher illustrates specific predictions and observations involving character distributions in living organisms, the fossil record, development, and molecular biology.

This section of the book is outstanding, particularly the chapters with a paleontological focus. Topics include the evolutionary origin of mammalian middle ear bones from reptilian jaw bones, the mosaic accumulation of diagnostic features in the early relatives of modern elephants, the ever-growing fossil record documenting the transition made by early cetaceans (whales, dolphins, and porpoises) as they adapted to aquatic life from terrestrial ancestry, the use of DNA sequences to reconstruct the phylogenetic relationships of living organisms, and how the study of developmental pathways can provide insights into the evolution of biological complexity via natural selection. These examples (and others not mentioned here) are dis-

cussed in a manner that is scientifically accurate and thorough, yet still largely accessible to a nonscientist, and many cases are supplemented with helpful illustrations and photos. In addition, Asher makes a concerted effort to provide readers with the means to verify the claims he makes. The text is meticulously annotated with frequent endnotes and copious citations to the literature (including a bibliography of over 470 books and journal articles) for readers who wish to consult the original source material. He even provides step-by-step instructions for how to access DNA sequences using online repositories of such data and how to analyze it using open-source software. Throughout these chapters, Asher's enthusiasm for studying evolution and paleontology is abundantly clear.

However, for all that this book has to offer in terms of well-explained examples of compelling evidence for evolution and common descent, it lacks what I suspect many readers may have been hoping for—a novel, thought-provoking integration of a religious worldview with an evolutionary understanding of life on earth. Asher actually devotes comparatively little space in this book to discussing religious belief, and the "confessions" he makes therein are basically limited to the fact that he is religious and to the idea that he does not see any inherent contradiction between his work as a paleontologist and his belief in God. Throughout the book, Asher repeatedly argues this latter point by discussing the difference between *cause* and *agency*, which are often conflated with one another. He uses several different conceits to illustrate this, one of which involves Thomas Edison. An understanding of just how the filament in a light bulb emits photons has nothing to do with the existence of Edison (its inventor). Likewise, understanding *how* biological change occurs via evolution by natural selection (cause) says nothing about the potential *who* or *why* behind it (agency). Thus, evolution cannot rule out belief in God.

Asher makes it clear, however, that, at least for him, science and rationality do rule out belief in some things that are typically associated with orthodox Christianity. Asher was raised in a Presbyterian church in western New York by a Jewish father and a Christian mother. Currently, he often attends Anglican services in Cambridge, and because he still believes in God, he considers himself religious, going so far as to call himself a Christian. But even Asher admits that much of what he believes "disqualifies [him] as a theistic Christian by most evangelical standards" (p. 25). For example, he considers miracles (when defined as the temporary suspension of natural laws by a supernatural entity) to be irrational, including the virgin birth of Christ. He writes, "Everything that I understand about human biology indicates that [Jesus], too, had a biological father" (p. 25). He clearly contrasts himself with other religious scientists in this regard, quoting Francis Collins as an example of someone who holds that God can occasionally act in the natural world in ways that appear miraculous. Asher regards such beliefs as superstitious and calls them "incompatible with evolutionary biology or any other rational, data-oriented science" (p. 20). However, he sees his religious beliefs as compatible with evolution because he does not "base [his] religious faith on peculiar human myths about some extraterrestrial spirit breaking the laws of nature" (p. 26). Despite all of this, based on reasoning that he admits is nonscientific, Asher deems Christ and his father to be "inspired individuals" and Christianity to be "a legitimate account of the agency behind life" (p. 25).

I appreciate Asher's frankness in discussing some of his specific beliefs even though some key topics, such as Christ's resurrection, are notably absent, but I think they might make it more difficult for him to make his case for the compatibility of evolution and Christianity—at least for some readers. In the prologue, Asher writes that he hopes he can convince both Christian and atheistic skeptics that his belief in God and his work as a paleontologist are fully compatible. Christians who are opposed to evolution will undoubtedly use his particular beliefs about miracles and Christ as examples of how belief in evolution simply erodes away one's faith, while philosophical naturalists are unlikely to be convinced by a belief in God that, as Asher admits, is based on his own intuition and not on any scientific evidence. For those who already agree with Asher that evolutionary science and Christian faith are compatible in principle, they first must address the fact that Asher's particular religious faith might be very different from their own and that different aspects of his case for compatibility might be problematic for many Christians, including those who are open to evolutionary scenarios.

I think one could easily make the case that Asher presents more of a deistic perspective than a theistic or Christian point of view, but I hope that this will not prevent Christians who disagree with some of his personal beliefs from reading this book. Despite the fact that it offers relatively little in the way of how to integrate an evolutionary perspective of God's creation with an orthodox Christian worldview, *Evolution and Belief* does many things well. For readers interested in where evidence for evolution comes from, Asher's cases are impeccable and clearly written. For those seeking insights into philosophical aspects of evolution, his discussions of cause, agency, contingency, and the limits and nature of science provide a good deal of food for thought.

Finally, Asher reminds us that as humans, we have the unique and awe-inspiring privilege of studying and understanding the intricacies of the world around us. He concludes the book by noting, "This fact brings me to my knees every time" (p. 231). I cannot help but enthusiastically concur with this sentiment.

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CREATING LIFE IN THE LAB: How New Discoveries in Synthetic Biology Make a Case for the Creator by Fazale Rana. Grand Rapids, MI: Baker Books, 2011. 235 pages. Paperback; $17.99. ISBN: 9780801072093.

How did life begin? This book uses research efforts in synthetic biology to address this question and to support an intelligent design perspective on biological origins. A reader looking for detailed, current scientific examples to support an intelligent design argument will appreciate this book as an addition to the collection of books supporting this perspective. Readers who are unconvinced by intelligent design arguments will likely remain unconvinced after reading this book.

Rana begins his exploration of the question of life's origin by looking at the creation of artificial life forms, which he characterizes as a top-down approach. He presents the work of Craig Venter's research group as exemplifying this approach. Venter's group is attempting to define the minimal genome using a knock-out scheme, systematically eliminating all genes that are unnecessary for life from *Mycoplasma genitalium*. As Rana describes this work, he is very intentional about emphasizing the complexity of this simple cell. Then, in extraordinary detail, Rana lays out the biochemical steps necessary to add genes back to this minimal genome to create an artificial life form. The biochemical detail forms the basis for illustrating that the creation or transformation of life is an astonishingly arduous task—one that he argues cannot be accomplished without intelligence and design. By extension, he continues, original life could not have come into existence without similar intelligence and design. In this section, Rana weaves an irreducible complexity argument. He suggests that the biochemical and genetic complexity of *Mycoplasma genitalium* is of such intricacy that undirected processes could not give rise to even this simplest of life forms.

A bottom-up approach, described in the second section of this book, also asks how life began. Exemplified by Jack Szostak's work, a bottom-up approach starts with the raw materials for life and builds complexity. Szostak's group is attempting to form protocells by designing membrane-bound vesicles and working to incorporate nucleic acids and other metabolic components into these vesicles. Additionally, Szostak's group is working on artificial and reengineered enzymes. Other research groups are exploring methods of making the building blocks for RNA molecules and assembling them under prebiotic conditions. Rana also describes how experimental systems that attempt to mimic the geochemical reality of early Earth have been used in efforts to produce prebiotic materials. Rana provides current scientific details and offers scientific critiques of many of the bottom-up experimental approaches. Because scientists cannot go back in time and know with certainty the geochemical conditions of prebiotic Earth, he questions the relevance of the experiments. He expresses concern about energy sources and the presence of oxygen on Earth when life emerged. An irreducible complexity argument is raised in a brief discussion of restriction modification systems. Throughout his presentation of bottom-up experimental systems, he intentionally points out how carefully each experiment was designed by trained, intelligent scientists. Predictably, Rana concludes that these experimental systems point to an intelligent designer. He argues that the bottom-up experiments were as carefully designed by extensively trained and extraordinarily gifted scientists as were the top-down experimental systems. Then, he extrapolates from the necessity of intelligent scientists designing these bottom-up experiments to the necessity of an intelligent designer in the origin of life.

Rana writes as a knowledgeable, enthusiastic, and optimistic supporter of science. He argues throughout his book that advances in science, even advances in synthetic biology, can lead to outcomes that are beneficial for humanity. The science presented in this book is accurate and detailed. Readers looking for evidence to support intelligent design will find detail at a level sure to please. Nonscientist readers and scientists whose discipline is not biochemistry should find this book accessible; an appendix is provided for those who need a refresher course in basic biochemistry.

Quotes from Mary Shelley's *Frankenstein* begin each chapter and, along with pointed questions that emerge as he discusses various aspects of synthetic biology research, Rana touches on the important ethical issue of boundaries in science. These questions are often posed with an ominous tone that seems inconsistent with his general undertone of enthusiasm and optimism for scientific advances. I would have liked to have seen Rana explore this question in greater depth, but perhaps that is a project for another book. He also sets up an unnecessary creation vs. evolution dichotomy throughout this book that I wish he had avoided.

The arguments Rana presents for intelligent design theory rest primarily on the depth of scientific detail he provides. He holds to a definition of intelligent design theory that is consistent with the definition expressed by *Reasons To Believe*, which states that features of the universe and living things are best explained by the involvement of an intelligent creator. However, I was surprised at how often Rana slipped into a God-of-the-gaps argument in this book. In one form or another, he repeatedly asks the question, "Would this make God unnecessary?" This troubling slip into a God-of-the-gaps theology—placing God in areas where we lack understanding or, alternatively, using gaps in our knowledge as evidence for the existence of God—feels particularly dangerous in a book with as much scientific detail and optimism as this one. The optimism and detail leaves the reader with the impression that answers to many of the questions about life's origins are within reach of research science. As those answers emerge, the gaps narrow, making God, if God is placed in those gaps, less necessary. Similarly, as Rana explores synthetic biology, he slips into an irreducible complexity argument. This argument also risks making God less necessary as scientific knowledge leads to a more complete understanding of biological complexity. The God-of-the-gaps problem is not adequately addressed in this book.

I found the brightest piece of this book was the brief description Rana gave about his encounter with a scientist with whom he had strong disagreements on origin-of-life models. He describes a dialogue at a scientific meeting over the course of several days that was respectful and humble. In that spirit, this book can serve as a voice in an ongoing, respectful dialogue with the greater scientific community around the topic of biological origins.

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PHYSICS

LAKE VIEWS: This World and the Universe by Steven Weinberg. Cambridge, MA: The Belknap Press of Harvard University Press, 2011. 259 pages. Paperback; $18.95. ISBN: 9780674062306.

Lake Views is an engaging collection of essays by Nobel laureate physicist Steven Weinberg. As might be expected from a Nobel laureate who is an often sought-after speaker, Weinberg has provided us with a fascinating book that has many interesting rabbit trails. Most of the essays are lectures or articles published within the last decade, the latest of which appeared in 2008. Fortunately, he usually provides a few pre- and post-comments to bring each essay more up-to-date. The subjects range from discussions on physics to political advice, but all relate to science in some way. Rather than providing a chapter-by-chapter summary which would be somewhat unwieldy, I will first make some general comments about my impressions, mentioning a few chapters which piqued my interest, and then discuss three essays that focus more on science/religion issues that should be of particular interest to the readers of this review.

The essays reveal that Weinberg is Jewish, yet an atheist, though he seems to try very hard to be fair in discussing his religious perspectives, at least from his own point of view. In that sense, a Richard Dawkins he is not. He also appears to be reasonably aware of philosophical and historical issues pertaining to science, even though at times he seems to inflate what science actually can accomplish. He is, however, occasionally a little sloppy with his terms. For example, in his first essay, he lays out his idea of a "final" theory as one that is mathematically consistent and "governs" all of the seemingly arbitrary facts of physics that we observe, including "the deepest questions of cosmology." I find it curious that he uses the term "governs" in this context. After all, governing implies a governor, and who would that governor be? With God not an option for him, apparently Weinberg has the laws themselves or something material in mind.

In his second essay, Weinberg takes a "reluctant" excursion into the philosophy of science, in which he wrestles with such issues as what constitutes a more "fundamental" theory, and just how much science can explain. While his reference to many historical details of science makes this essay an enjoyable read, he occasionally makes surprisingly inaccurate statements. For example, he says that "the value of the proton mass is *entailed* by quantum chromodynamics," when, in fact, that theory contains an additional parameter that is not determined from within the theory but does determine the proton mass. He knows this full well; it is difficult to account for such an oversight.

Several of Weinberg's essays deal with political issues such as whether we should have a manned space program, and whether we should work harder to dismantle the world's nuclear weapons. On the former, Weinberg has a fairly strong opinion, that for the cost, so much more science could be done with robots. I find his reasoning quite convincing, but he also reluctantly admits that the public would hardly be enticed to fund such robotic expeditions without the glamour of manned spaceflights. Concerning nuclear weaponry, the thrust of his argument is that only the existence of the Russian nuclear arsenal offers a threat to the United

States from which we could not recover. Since anti-missile strategies cannot reliably avert the danger, he considers it imperative to negotiate arms reduction. On such a topic, it is interesting to hear from someone who is a consultant on such matters, and therefore has obviously spent much time thinking about the issues.

Just to mention a few other essays, I enjoyed his essay "Is the Universe a Computer?," a review of Stephen Wolfram's book, *A New Kind of Science*, in which Wolfram suggests that the fundamental laws of nature could arise from cellular automata. I enjoyed entering the world of Wolfram's computer experiments, touching on such topics as Gödel's theorem and Turing machines, while at the same time finding support for my suspicion that Wolfram claims a bit too much from his efforts. In referring to the simplicity of equations as compared with Wolfram's picture, Weinberg closes the essay by saying, "In the study of anything outside human affairs, including the study of complexity, it is only simplicity that can be interesting." The essays also include entries concerning scientific figures such as J. Robert Oppenheimer and Albert Einstein. In Weinberg's enjoyable reminiscing, he recounts Oppenheimer interrupting him in a talk he was giving, saying that he reminded him of himself at that age. Weinberg thanked Oppenheimer for the comparison, but Oppenheimer immediately responded, "It wasn't a compliment." Concerning Einstein, because of the recent discovery that the universe is accelerating in its expansion, it now appears that the general relativity equations need an additional term known as the cosmological constant. It is famously known that in search of a steady state theory, Einstein included such a term, but later considered it his greatest mistake. In an essay entitled "Einstein's Mistakes," Weinberg quips that "Einstein's real mistake was that he thought it was a mistake."

Finally, let me turn to three essays that explicitly deal with science/faith issues in some way. In all three, Weinberg expresses his atheism and the consequences thereof, but from different vantage points. An essay entitled "Living in the Multiverse" contains an interesting assessment of the relation of the multiverse theory to the anthropic principle (in support of fine tuning). There is an often-repeated claim against an anthropic principle, that perhaps our universe is just one of many possible ones that happens to have the right laws of nature. Support for this comes from the huge number of possible superstring theories (more than 10^{100}) out of which the universe could be "chosen." However, Weinberg recognizes that this is not enough; the probability of the ones viable for life has to be rather high for the argument to make sense. Thus he considers what criteria would be needed for assessing whether the "shape of the string landscape" supports a multiverse argument. Though it is evident that he thinks the conclusion warranted, it is also clear that he realizes that the argument is not completely convincing. In another humorous quip, he quotes Martin Rees as being confident enough in the conclusion to bet his dog's life on it and Andrei Linde confident enough to bet his own life on it, whereas Weinberg says that he is just confident enough "to bet the lives of both Andrei Linde and Martin Rees's dog."

In an essay entitled "A Deadly Certitude," a review of Richard Dawkins's book, *The God Delusion,* he generally agrees with Dawkins's thesis, and reveals a little more of his materialist prejudices. In a sentence as illustrative as any, while assessing one of Anselm's arguments, he says,

> The idea of an ultimate cause is deeply attractive, and indeed the dream of elementary particle physics is to find the final theory that we think lies at the root of all chains of explanation of what we see in nature. The trouble is that such a mathematical final theory would hardly be what anyone means by God. Who prays to quantum mechanics?

On the other hand, he takes Dawkins to task for targeting only Christians when Islam could be perhaps a much better target.

Weinberg's final essay in the volume is entitled "Without God." In this essay he makes the supposed observation that the more society embraces science, the less it continues to embrace religion. His premise is that insofar as science "explains" things, there is no longer a need for religion. While the premise may be disputed, Weinberg finds it inevitable that religion will eventually cease, and his real point is to ask the question, how will it be possible to live without God? His arguments contain a mixture of genuine insights, common misconceptions about science and religion, and unscientific speculation. It is nevertheless an interesting essay for peering into the thoughts of someone coming from his perspective and wrestling with such questions. Perhaps it is not surprising when he ends this essay with a comment that is strikingly similar to Jean Paul Sartre's existentialism:

> Living without God isn't easy. But its very difficulty offers one other consolation—that there is a certain honor, or perhaps just a grim satisfaction, in facing up to our condition without despair and without wishful thinking—with good humor, but without God.

Though Weinberg is evidently overconfident about his own assessment of the matter, it is nevertheless sobering to see the essay end in such resignation.

The book is a highly engaging and interesting read, and probably almost anyone of this readership would

find it enjoyable at some level and revealing in many ways. Particularly I recommend it for physicists who understand the theories he is describing, and also for those who enjoy reading about those theories. It goes without saying that reading such collections of essays should help us to engage with our scientific peers who have similar perspectives on the science and religion issue.

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Religion & Science

PARADISE LUST: Searching for the Garden of Eden by Brook Wilensky-Lanford. New York: Grove Press, 2011. xviii + 291 pages. Hardcover; $25.00. ISBN: 978-0802119803.

In this witty narrative, Wilensky-Lanford details the folly of literalism. In the beginning God created the Garden of Eden somewhere in the Persian Gulf, but on the other hand, it could have been at the North Pole, or underneath Cincinnati. We meet a variety of characters, some sincere and theologically savvy, others less so, as they search for a literal Eden. *Paradise Lust* explores the irrational things educated, intelligent people can literally *choose* to believe. A wider question is *why* the literal geography of Genesis 1–3 is so important to so many.

Wilensky-Lanford, a freelance editor and writer of essays, studied religion at Wesleyan and writing at Columbia. In this, her first book, she artfully ties together disciplines as diverse as history, archaeology, religion, science, and politics while exploring eccentric personalities.

The book's major contribution may be to provoke thought on how a few verses from Genesis can be used to support such disparate and sometimes absurd interpretations. Some exegetes intended to promote their unique theological perspective and others their unique geographical locality. Some were out for fame, some more clearly for fortune.

My attention was caught at the outset by William Warren, first president of Boston University, a professor of theology, and a Methodist minister. Published in 1895 and enduring eleven printings, *Paradise Found: The Cradle of the Human Race at the North Pole* rested on five hundred scholarly sources. Warren recognized that Eden was destroyed by the deluge; thus he placed it in a desolate region inaccessible due to changing climate. His version of concordism did at least further the cause of science by capturing public interest in funding Arctic exploration. Nevertheless, he was not deterred by the resulting evidence and retained his theory to the end.

More conventional in approach were Assyriologists Friedrich Delitzsch and Archibald Sayce, longtime friends and amicable competitors. Delitzsch, who placed Eden near Babylon, was friend of the Kaiser and son of biblical scholar Franz Delitzsch. Sayce, an Oxford professor who resided for years on a houseboat on the Nile, chose a more southerly spot near Eridu. They continued for decades to spar over the exact location until WWI truncated their friendship.

South of the areas suggested by Delitzsch and Sayce lies the city of Qurna. Wilensky-Lanford's fascinating historical account follows the region from Ottoman to British to Ba'ath rule and present desolation. John Calvin also placed Eden in this region. Others chose California, Ohio, Berlin, Mongolia, or Sri Lanka. Joseph Smith revealed that Eden had been in Independence, Missouri. Lena and William Sadler, an obstetrician and psychiatry professor respectively, were former Seventh-day Adventists disappointed with Ellen White's evolving revelations. Although the Sadlers debunked all other forms of psychic phenomena, they relied on revelations from extraterrestrials to produce *The Urantia Book*, which places Eden near Crete. Finally, in 1956, Eden was discovered in Florida by a politically conservative lawyer convinced the serpent was, in his words, "a Communist or a welfare-statist" (p. 171).

Juris Zarins, now retired from Southwest Missouri State University, conducted years of field research in Egypt and the Arabian Peninsula. He contends that Semitic languages arose in an Arabian nomadic setting during a period of changing climate. In an aside to his scholarly work, Zarins proposes that the garden story is based on the migrations around 5000 BC of these foraging nomads to Mesopotamia where agriculture already flourished. The resulting cultural upheaval led to an oral tradition taking the nomadic standpoint, which portrayed agriculturists as taking God's knowledge into their own hands to exploit the power of creation. As the Gulf continued to rise, the agriculturists were forced out of Eden. Using LANDSAT photos, archaeology, linguistics, and geology, he situates Eden underneath the present Persian Gulf. Wilensky-Lanford considers this the most credible garden theory, although it has not been embraced in academia as contemporary scholars show little interest in the geography of literal creation.

Iranian Azerbaijan is the location chosen by David Rohl, a musician, film producer, and founder of a journal dealing with Velikovskian chronology who has some partial graduate training in Egyptology. His Discovery Channel documentaries on biblical research are

widely popular, although his work lacks acceptance in the academic world. Another contemporary "biblical archaeologist" is Michael Sanders, founder of Mysteries of the Bible Research Foundation. According to his internet website, his scientific background is largely limited to research with parapsychologist J. B. Rhine. Sanders situates Eden in Turkey.

The author also devotes one chapter to American fundamentalism and contemporary evangelicalism, often conflating the two. For this chapter, she visited in Kentucky the Creation Museum associated with Answers in Genesis and Ken Ham. In spite of their "brazenness," she credits them for admitting that localization of Eden is incompatible with flood geology. Creationism is now a litmus test for evangelicals, and "either the brain secretes thought like bile, or God washes your mouth out with holy soap" (p. 205). An interview with Lee Meadows, teacher of science education at the University of Alabama, and input from Ron Numbers provide more moderate perspectives.

Wilensky-Lanford feels that the essential interest in locating Eden lies in our longing to undo the exile from paradise. It therefore represents the existential human quest "located both in the original past and in the idealized future" (p. 92). "That's the essential paradox of the search. Eden has to be erased in order for it to be Eden. A paradise isn't paradise until it's lost" (p. 253). It is an illustration of the varieties of religious experience.

Historical research is a strong point in this book, which is otherwise short on biblical, scientific, and archaeological detail with few sources in those areas. The author also fails to evaluate adequately the professional credentials of the modern theorists, although she alludes to their "Indiana Jones" quotients. And unfortunately there is no index. For the most part, the book is exceptionally well written; nevertheless the ample hyperbole and irony occasionally fall flat. All in all, however, I definitely recommend this book to ASAers looking for some fun reading. Members of the general public will also find it instructively amusing.

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THE BLACKWELL COMPANION TO SCIENCE AND CHRISTIANITY by James B. Stump and Alan G. Padgett, eds. Malden, MA: Wiley-Blackwell, 2012. xix + 644 pages. Hardcover; $199.95. ISBN: 9781444335712.

When thinking about the conversation between science and Christianity, many imagine hostility and antagonism. However, this book makes clear that this is not, nor has it characteristically been, the case. The 54 chapters (divided into eleven sections) compiled by James Stump and Alan Padgett represent a diverse spectrum of authors and demonstrate, for the most part, the mutually informing dialogue that exists across a range of disciplines between science and the Christian faith.

The book begins with five chapters devoted to a summary of the history of the debates between science and the Christian faith. Three of the five chapters focus on the impact of Charles Darwin and various theological and philosophical controversies surrounding evolution and a biblical understanding of creation. A fourth chapter summarizes an earlier controversy in the church concerning the scientific work of Galileo. The fifth chapter in the introductory section highlights the reconciliation of science and the Christian faith as represented by four women of the early modern period: Margaret Cavendish (1623–1673), Anne Conway (1631–1679), Aphra Behn (1640–1689), and Mary Astell (1666–1731).

Part Two is devoted to discerning appropriate methodological approaches befitting the objectives of science (to study and understand the natural world) and theology (to study and understand God's involvement in the world). The focus is to identify the goals, sources of authority, and methods for each discipline, recognizing their considerable differences. The conclusion is that each ought not to reduce the other to being inferior or unnecessary; both disciplines can benefit from the insights of the other.

Part Three evaluates the potential roles and pitfalls of natural theology. Focusing more than Part Two did on philosophical and logical implications, its chapters pose the questions: Can the existence of God be "proven" by exploring the natural world? Can the scientific exploration of the physical universe and its laws reveal a creator? The contention of four of the five contributing authors is that while the natural world does not definitively demonstrate the existence of God, it also does not cast a significant shadow of doubt. Therefore, it is reasonable to conclude that there may be a "Being" responsible for creation. The lone dissenter rejects this conclusion, judging that empirical arguments against God's existence (especially the widespread existence of evil) overwhelm the natural-theological arguments for God's existence.

The topic of Part Four is cosmology and physics. In this section the chapters are more diverse in content, ranging from the complexity of subatomic particles to the vastness of the universe. They offer multiple explanations for the role and activities of a creator in the origins and continuity of physical matter. Four of the five authors conclude that the evidence from their

field of study does not provide sufficient grounds to discount a divine being responsible for creating and sustaining the universe. However, to keep readers on their toes, the editors provide an opposing voice. One secular-humanistic author, while acknowledging that science is not about proving things, argues,

> Attempting to explain the natural world by appealing to God is, by scientific standards, not a very successful theory. The fact that we humans have been able to understand so much about how the natural world works … is a triumph of the human spirit, one of which we can all be justifiably proud. (p. 196)

Part Five, which contains seven articles on evolution, is the longest and most diversified of the sections (as a paleontologist, I appreciated this), spanning macroevolution to DNA formation and replication. Five of these chapters present arguments against both the evolution-denying fundamentalists who insist on a literal reading of the Bible and the atheistic belief in life-by-chance. They conclude that there is no conflict between a Christian theology of creation and observed biological processes. However, in arguing for essentially the same conclusion, these authors refute the proposals of their Christian colleagues while arguing for different, God-ordained processes. For example, chapter 23 makes the case for "intelligent design as … currently the best scientific explanation for the origin of biological information" (p. 280), whereas chapter 24 presents the pitfalls of ID and concludes that "design of organisms need not be attributed to the immediate agency of the Creator, but rather is the outcome of natural processes" (p. 282). Nevertheless, two chapters (22 and 27) were much less welcoming of a theological perspective. These chapters contend that Christian assumptions about the God-ordained process and results of evolution are not without inconsistencies and faulty logic, and therefore not reasonable explanations for life on Earth.

The middle third of the book include sections that examine the human sciences (psychology, sociology, and economics), Christian bioethics, metaphysical implications, and the mind. The first two chapters of Part Six challenge the ability of psychology to provide scientific evidence of a creator. The first takes a moderate view, suggesting that cognitive scientists have the potential to discover insights into human nature and thereby work with theologians to explain patterns in religious practices. The second argues more forcefully that psychology demonstrates the purely mechanical nature of humanity and thereby actually poses "deep problems" for the Christian faith (p. 342). The chapter on sociology provides a general overview of the domains in which sociologists have studied religion, while the chapter on economics suggests that a market economy reflects and builds Christian values.

The section on bioethics covers a cross section of contemporary issues, such as shaping human life at the molecular level, stem cell research, using technology to improve the human condition, and ecology and the environment. Each chapter reviews the various positions on the respective issue and offers constructive proposals for how Christians can move forward.

The chapters in the metaphysics section investigate the philosophical relationship between science and the Christian faith. Each essay notes that the dialogue between the two disciplines can be strained because of their different goals and methods. While making honest judgments concerning the challenges that science poses for traditional Christian beliefs about the world, these authors conclude that science does not render faith mute in the conversation.

Like the previous section, the chapters that evaluate how research on the human mind impacts our understanding of faith and religion note that there is an array of opinions on the mind-body relationship and what comprises "personhood." While each author varies on the spectrum as to whether present scientific research renders traditional Christian beliefs antiquated, they all conclude (contra the authors of two chapters in Part Six) that Christian perspectives are consistent with recent findings in this field of study.

The final two sections of the book give an opportunity for the other voice in the conversation, namely theology, to have its say on the relationship between science and the Christian faith. Part Ten opens with a chapter that discusses the differences in how science and theology provide theories through the gathering of "facts," noting that theology's task is much more difficult, because "God transcends us while we transcend the physical world. Often theology has to be content with circumscribing the domain in which truth must lie, without being able to offer a detailed map of the terrain" (p. 531). The following chapter evaluates and critiques science's "natural" explanations of the miracles described in the Bible. It offers a range of explanations for how God could demonstrate his reign without suspending or interfering with the observed laws of nature to accomplish a divine objective. This is followed by a chapter that suggests how modern science and theology can work together to gain a better understanding of the eschatological expectation of a new heaven and new earth (transformation by a radically new act of God, p. 544). The section ends where it began, with a discussion on the similarities and differences in the methodological approaches of science and

theology to the study of their respective topics—this time focusing on philosophical considerations rather than on practical tasks and concrete sources of evidence.

The final section of the book contains six essays highlighting twentieth-century theologians who have been influential in their contribution to the science-Christianity conversation, summarizing and evaluating their strengths and shortcomings. These include Pierre Teilhard de Chardin, Thomas Torrance, Arthur Peacock, Ian Barbour, Wolfhart Pannenberg, and John Polkinghorne.

This volume of the *Blackwell Companion* series is intended to contribute to the ongoing conversation about the relationship between science and religion. Each of the chapters provides an overview of contemporary scholarly work in an effort to introduce the reader to the important themes in this discussion (p. xiii). Unfortunately, some topics such as evolution are over-represented, whereas other scholarly topics of interest, such as ethics, sociology, and economics, are under-represented.

A majority of the articles were sympathetic to the complementary nature of the discussion. However, several of the topical sections also included chapters that contained opposing perspectives, for example, that there is no (and cannot be any) meaningful relationship between the sciences and religion. While this was, at first, a surprise in a book intended to foster a hopeful and productive conversation between the two, such less optimistic appraisals were, nevertheless, a welcome contribution. By expressing doubt (and, in some cases, outright rejection), these conflicting opinions challenge the reader not to become too comfortable with the notion that this is a friendly, mutually informing conversation. Those interested in participating in this dialogue must remain vigilant in their motives for engaging in the discussion, as well as vigilant in the logic they employ in finding points of resonance between the findings of modern science and Christian biblical interpretation and practice.

The target readership is intended to be a broadly academic but nonspecialist audience. For the most part, I found that the contributors were successful in making their respective essays readily accessible to a reader well informed on the larger themes of the debate. However, while admitting my lack of exposure to certain topics (I have a background in vertebrate paleontology, practical theology, and sociology), there were chapters—especially in Parts Eight and Nine on Metaphysical Implications and The Mind—that failed to engage me to the same extent as those in other sections. Admittedly, this may be due to my own interests as much as to the authors' recognition of the target audience and their ability to present their topic.

Overall, the book is geared toward those who are serious about a detailed exploration of the relationship between faith and religion. It is not recommended as an introduction to the topic as a whole. Other than the chapters in Parts One and Eleven, this collection, which is written at an advanced level, would be difficult reading for the nonexpert. It is best suited to those who have a command of at least one of the scientific disciplines highlighted in the book and have some familiarity with the significant issues that exist between that specific field and Christian theology. For those who have such a background, this book will be a valuable asset for orienting themselves in the broader conversation.

Reviewed by Neil Beavan, interim pastor of Edmonton Japanese Christian Church, Edmonton, AB. Neil is also a consultant who does paleontological environmental assessments.

GOD AND THE COSMOS: Divine Activity in Space, Time and History by Harry Lee Poe and Jimmy H. Davis. Downers Grove, IL: InterVarsity Press Academic, 2012. 292 pages, illustrations, indices. Paperback; $24.00. ISBN: 9780830839544.

One of the significant areas of concern across the spectrum of those interested in the science and faith conversation is the question of whether and how God acts in space and time. Poe and Davis, respectively theologian and chemist from Union University, tackle this subject in their fourth coauthored book in the area of science and Christianity, after *Science and Faith* (B&H Publishing, 2000), *Designer Universe* (B&H Publishing, 2002), and *Chance or Dance* (Templeton Press, 2008).

The first of the book's two parts is entitled "What kind of God interacts with the world?" It begins by pointing out that in the West the cultural situation of this question assumes the personal theistic perspective of the Abrahamic faiths. Broadening the focus, the authors examine in some detail how this question is considered from within the wide range of theological positions taken within each of the religions of Hinduism, Buddhism, Judaism, and Islam, before turning to Christianity. They argue that among world religions only Trinitarian Christian theology offers a full-orbed view of how God relates to the world: the Father ruling with authority and will, the Son incarnationally identifying with the world, and the Spirit holding reality together, tri-personally transcendent, immanent, and omnipresent.

Then follows a discussion of the powerful influence that philosophical traditions (Plato, Aristotle,

Descartes) had upon both pre- and post-Reformation Christian theology, including how the ideas of William Perkins led to new forms of Calvinism being articulated by both the Synod of Dort and the Westminster Assembly. Perkins's conception of the eternal decrees of God in election and reprobation led naturally to an effective deism, for his dichotomist thinking could only conceive of a God who governs created reality in uninvolved transcendent eternity *or* a world which unfolds of its own accord. In this vein, Darwin so accepted the Aristotelian immutability of forms that only two options occurred to him: "God either created all species immutably by a special act of creation or he was not involved in the development of life at all" (p. 88), and again, "either God had done everything or God has done nothing beyond setting the laws of nature in motion" (p. 233). Apparently in the church today, many remain in the "jaws of the Perkins dilemma" (p. 88), overemphasizing the model of God as King to the exclusion of other scriptural models and lacking even the breadth of Jesus's descriptions of the kingdom of God.

After a clear and concise description and rejection of process theology, the authors also briefly deal with the god-of-the-gaps notion, their critique suffering somewhat from a lack of definition of nature. Often "nature" means "created reality," but Poe and Davis usually locate humans as above nature and capable of changing it. This section also gives a too-simplistic distinction between science (the "how" questions) and metaphysics (the "why" questions), for science certainly does seek to explain and not just describe.

The transition to Part Two, "What kind of world allows God to interact?," is made by pointing out that laws of nature at one level (e.g., physical) are not "violated" or "suspended" but "mitigated" or "trumped" by us (e.g., mind operating on matter, genetic engineering), and conclude that "God is at least as free and able as humans to interact with the universe" (p. 137). The authors describe the world as open to influence from outside the world, citing the examples of quantum physics and chaos, including the "openness of DNA" (p. 245). They go into some detail on the big bang, development of stars and galaxies, and biological evolution, seeing behind these the agency of the Creator, as well as demonstrating that the claims that such emergence is evidence against a Creator are unscientifically metaphysical. As one of the authors is a chemist, I was disappointed that only examples from physics and biology, the two fields in some sense bracketing chemistry, were adduced. In fact, my recognition of a number of physics and astrophysics errors (e.g., the idea that stars formed first and then these grouped into galaxies, as well as inaccuracies on quantum physics and chaos [see below]) made me unsure about their treatment of biology.

The title of Part Two, and its various articulations, are problematic. The authors say that the recently discovered openness in creation "*create[s] corridors* though which God may … participate in the world" (p. 147), "God's activity is *facilitated by* [genetics]" (p. 180), "features of the universe … *provide the means* for God's operation in the universe" (p. 180, emphases added). Surely, as Creator, God does not depend upon the creation to *provide* means for his interaction with it, but in our scientific discoveries we can begin to *see* ways in which he engages.

The book ends with a creative section on human imagination as indispensable partner to empirical and rational forms of knowledge, tying together valuable "poetic" themes running throughout the book on human conceptions of reality, including well-placed critiques of the tendency of the modern mind to reduce both natural and spiritual reality to models thereof. They argue that imagination is not only the crucial starting point of scientific knowledge, later filtered by the scientific method, but that it also mediates human-divine interaction.

The book suffers from many editing blunders, including words incorrectly spelled or used. These include "principle" (p. 60), "teaming" (p. 172), "breaking" (p. 175), "predications" (p. 193), "consensus" (p. 196), and "discreet" (p. 205). Many figures are quite unclear or incorrect (pp. 184, 185, 193, 286, 287). The authors' description of chaos, particularly on the logistic map (pp. 193f.), is so full of errors that the uninitiated reader must turn to other sources. They err in the physics and etymology of wave function collapse, writing,

> one does not necessarily get the same answer on each occasion that the measurement is made. This process is called collapse of the wave function since the Schrödinger equation does not predict how this solution is reached. (p. 186)

The term "collapse" is actually understood not as failure to predict, but as a transition from distributed wave function to single observed value. The phrase "not necessarily" misleads; in fact, the resulting answers follow a probability distribution and the chance of a duplicate measurement is vanishingly small. And the "s" in the 2s orbital indicates (spectroscopically) "sharp" transitions, not its "spherical" shape (p. 185).

Despite these and other errors, I highly recommend the book for its approach to a current topic. For me the most valuable aspects of the book are its in-depth

discussion of the enduring influence of the Perkins dichotomies in Protestant Christianity and its constructive critique of the modern western worldview, which has sidelined the epistemological value of imagination and poetry as if empiricism and reason are sufficient.

Reviewed by Arnold E. Sikkema, Professor of Physics, Trinity Western University, Langley, BC, Canada V2Y 1Y1.

GOOD NEWS FOR SCIENCE: Why Scientific Minds Need God by Davis A. Young. Oxford, MS: Malius Press, 2012. 349 pages. Paperback; $14.50. ISBN: 978-0982048610.

I am convinced that any member of the American Scientific Affiliation (ASA) could profitably read Davis Young's book, *Good News for Science*. However, Young (a retired geology professor) is writing to scientists and those interested in the sciences that are not Christians to persuade them that his worldview, that of a Christian, is powerful, true, and good news. Chapters 2 and 3 attack materialism, which includes agnosticism, atheism, or any other form of naturalism. Chapter 4 covers creation and the Creator. Chapter 5 argues that accepting the existence of a Creator gives meaning to the practice of science. Chapters 6 and 7 introduce the concepts of God's holiness, humanity's sinful nature, and justification for those who accept Jesus. Following this groundwork, Young then attempts to establish an evidential basis for creation (chapter 8), the Bible (chapter 9), and the life and resurrection of Jesus (chapter 10). In chapters 11 to 15 he argues that the Bible, Jesus, and the story of his resurrection are historically reliable accounts. In the final chapter, he encourages those who accept Jesus as their personal Savior to join a church, giving tips on how to choose one, and to join the ASA.

The book's clear purpose is to serve as an evangelistic witness to "scientific minds." As such, one could ask if his witness will be effective. Young writes in a conversational style. His style also includes raising several questions that could be asked about many of the topics. This may appeal to a mind that is comfortable with or enjoys questions. He also nuances several of his points, all of which may dispel the specter of dogmatism and could make reading the book easier for one prejudiced against Christianity. Moreover, he notes that "*the Bible was written in times and cultures that are very different from those of the modern western world*" (p. 162, emphasis is Young's). Young employs this principle of interpretation most effectively when he assures his readers that they can accept the scientific evidence for evolution, the Big Bang theory, and other consensus points in mainstream science, and still believe in the Bible. However, Young then labors to show that the Old Testament is historically reliable. This work would have been lessened if he had used the same principle of interpretation when it came to the Bible's recording of history.

So will it be an effective evangelistic tool? Will people accept his challenge to consider the historic orthodox Christian faith seriously? I suspect that unless the non-Christian reader has a fair amount of existentialist angst regarding his or her mortality, the book will fall on deaf ears. *Good News for Science* could be compared to *Among the Creationists* by Jason Rosenhouse. Rosenhouse claims to be an atheist but the reader comes away with a much different impression of a "materialist." Rosenhouse does not seem to be one who worries about Young's motivation: giving "genuine meaning to the universe or to humanity" (p. 47 of Young's book). On the other hand, Young's book is a great gift to give to a young Christian entering the study of science (perhaps in late high school or university). It provides enough material to support the reasonableness of a Christian worldview that also incorporates a scientific outlook. The book can also be used as a springboard for discussion among Christians who are interested in science. It would be interesting to see how many would argue over the historical reliability of certain accounts. Be that as it may, I enjoyed it and recommend it.

Reviewed by Bruce Buttler, Canadian University College, Lacombe, AB, Canada, T4L 1N9.

Science Education

WONDERS IN OUR WORLD: Insights from God's Two Books by Cheryl Touryan, Kenell Touryan, and Lara Touryan-Whelan. Littleton, CO: Family Foundations International, 2012. 108 pages, index. Paperback; no price indicated. ISBN: 9781881189640.

The back cover of the book states its purpose and structure succinctly:

> *Wonders in Our World* was written particularly for young people who are asking questions about the world around them as well as questions about meaning and purpose in life. The book weaves descriptions of natural phenomena together with biblical insights in a way that shows the complementarity of both aspects of reality—the physical world and the spiritual world. It is organized around three basic questions: Who is God? Who am I? and How Can I Follow Jesus? Each chapter includes suggestions for hands-on activities that help the lessons come alive as well as questions to foster discussion. This book explores God's Two Books, the Book of Nature and the Book of Scripture, looking at reality from both perspectives.

The authors of this book are all scientists. Kenell Touryan, whose name will be familiar to ASA members, has a PhD in mechanical and aerospace engineering. His wife Cheryl, who is the principal author, has a degree in anthropology, and their daughter Lara has a PhD in materials science.

The three basic questions—Who is God? Who am I? How Can I Follow Jesus?—constitute the three main divisions of the book. Each division is divided into chapters. For example, the division Who is God? has chapters on God the Designer, God the Creator, God is Spirit, God is Eternal, God is Three in One, God is Sovereign, God is Love/God is Just, God is Light, and God is Truth. Most chapters contain four sections: (1) Insights from God's Book—the Bible, (2) Insights from God's Book—the Physical World, (3) Insights gained from trying to integrate God's Two Books, and (4) Fun with Science, though this pattern is not followed in every chapter.

Wonders in Our World is well organized for its purpose. The basic questions are fundamental and the chapter topics are well chosen to answer them. The four-fold chapter format is also well conceived. The execution of the authors' plan, however, is spotty. Some of the "Insights from God's Book—the Bible" have no scriptural support. For example, the Bible incidents cited in the chapter entitled "I am Unique; I Belong," simply do not make the point of the chapter title, true as it may be. The science facts cited in "Insights from God's Book—the Physical World" are almost always interesting enough in their own right, but the sections attempting to integrate God's two books are sometimes forced. The "Fun with Science" sections often live up to their name: middle school teachers will want to try them with their students.

Some of the book is controversial. The authors devote a well-written section to showing that the earth is as old as geologists maintain. This will be welcome to those who lament the fact that most Bible-science books for young people are written from the viewpoint of creation in six 24-hour days. The chapter, "God is Sovereign," will raise a few eyebrows. The authors state that "God is at work in the world, but he is limited by the choices his people make" (p. 32). Also, Reformed or not, some will object to the statement, "When people long ago chose to reject God, he did not give up on them, but developed a plan whereby all people could come back into a relationship with him" (p. 31). One need not be a Calvinist to believe that the plan of salvation was not Plan B!

The book contains two patent scientific errors. In a footnote labeled (appropriately) "Science Trivia," the authors ask, "Who was the famous Russian scientist that set back the biological sciences in the Soviet Union by using the scientific method inappropriately?" The book answers, Levchenko. The correct answer is Lysenko. The more significant error is found on pp. 33–4. The authors correctly explain double-slit interference in light in terms of the wave properties of light, but then assert that a single slit does *not* yield an interference pattern. Single-slit diffraction patterns are studied in every good high school physics course.

A serious pedagogical failing of the book is that it often introduces technical terms and concepts without defining or explaining them. Middle school students, for whom the book seems to be intended, will not know terms like string theory, space-time continuum, closed system, RNA polymerase, stratosphere, nucleotide—and there are many more. The failure to define and explain such terms seems strange to me. The authors clearly made an effort to make their biblical material understandable to young people, avoiding theological language and going so far as to quote most of their Bible passages from an easy-to-read paraphrase, *The Message*.

I salute the authors for their good intentions, the overall plan of the work, and their creativity. Still, I cannot recommend this book as it presently stands. It needs revision. I do not expect the authors to change their theological approach, but they need to remove the scientific errors and render the technical language of the science sections age appropriate.

Reviewed by Robert Rogland, retired science teacher at Covenant High School, Tacoma, WA 98465.

Social Science

THE SCIENCES OF THE SOUL: The Early Modern Origins of Psychology by Fernando Vidal, translated by Saskia Brown. Chicago, IL: The University of Chicago Press, 2011. 440 pages, 3 halftones, 14 line drawings, 8 tables, 3 appendices, bibliography, index. Hardcover; $55.00. ISBN: 9780226855868.

In his 1908 textbook on psychology, Hermann Ebbinghaus stated that "psychology has a long past but only a short history." Most students of psychology have only been introduced to the short history that traditionally begins with Wilhelm Wundt's laboratory in Leipzig, Germany, in 1879. Fernando Vidal, in *The Sciences of the Soul* attempts to lay out the oft-neglected long past, arguing that this is where the fault lines developed that gave shape to our current conception of the discipline. The primary focus of the book is on the development of "psychological inquiry" during the

period from the sixteenth to the eighteenth centuries, especially examining the shift from the classic Aristotelian soul-form to the more modern soul-mind. The material in the nine chapters is extensively researched and well documented with footnotes.

In the early chapters, Vidal discusses the shift from *scientia de anima* to *psychologia* in the sixteenth century, which set the stage for the transition from an Aristotelian framework to a sense of the soul as that rational aspect of the human united to the body. He covers the distinction between a more metaphysically inclined pneumatology with its attendant religious/spiritual overtones and a "physics of the soul" with its emphasis on the soul's faculties.

In many ways, the core of Vidal's thesis is to be found in the chapter, "Psychology in the Age of Enlightenment." While noting the differences that existed among "French *philosophes*, Italian priests, Spanish Jesuits, or German and Scottish academics," Vidal comments on the commonality of the study of the interactions between the soul-body composite in humans both in psychology and in anthropology. Kant had argued for empirical psychology as an autonomous discipline in the university curriculum, and here is where the groundwork for just such an endeavor was being laid.

In the middle portion of the book (chapters 5, 6, 7, and 8), Vidal covers a wide range of topics including issues of historicity in the development of the discipline, Homeric and Hebraic psychology, and the manner in which the Paris and Yverdon *Encyclopédies* shaped the contours of the developing discipline. Vidal's scholarship is extensive on these topics and some readers, not familiar with the overall trends and major ideas from this time period, may find it difficult working through the mass of names and details. If one persists, however, the conclusion is rewarding. The *Encyclopédies*, and the Yverdon *Encyclopédie* in particular, link

> … knowledge of the soul to knowledge of the ultimate destination of the individual and humanity. Humans are obliged to perfect themselves because the Creator endowed them with perfectibility. By revealing how thought, appetites, and affects function, psychology assists man in fulfilling his higher purpose.

It is in this sense that the Enlightenment may be referred to as the "century of psychology."

Readers of this journal may well find the final chapter ("Psychology, the Body, and Personal Identity") the most interesting since it speaks to issues that continue to animate current discussions regarding the relationship of psychology and Christianity. Vidal argues that eighteenth-century psychology had become an empirical psychology, but not a materialist one. Metaphysical questions about the nature of the soul and its immortality were no longer addressed in psychological inquiry. What were addressed were the functions of the soul, and these could be known only in relation to its unity with the body. The emphasis was on soul-body unity, not duality. This had implications for notions of personal identity and even the place of the body in resurrection. Most importantly, these developments laid the groundwork for what Vidal refers to as the "cerebral subject," the notion that ontologically the brain is the person. Through nineteenth-century phrenology and then physiological psychology to current neuroscience, this has become a dominant theme in the discipline of psychology.

The book is well suited for graduate-level study in the history of psychology. Readers with a background in seventeenth- and eighteenth-century European thought will also find the book stimulating. Originally published in 2006, this English translation appeared in 2011. The book ends with a discussion of the "cerebral subject," a topic Vidal has pursued, including his excellent article, "Brainhood, Anthropological Figure of Modernity," *History of the Human Sciences* 22 (2009): 5–36.

Reviewed by Wayne D. Norman, Simpson University, 2211 College View Drive, Redding, CA 96003.

RELIGION IN HUMAN EVOLUTION: From the Paleolithic to the Axial Age by Robert N. Bellah. Cambridge, MA: Belknap Press of Harvard University Press, 2011. 606 pages, plus notes, and index. Hardcover; $39.95. ISBN: 9780674061439.

Robert Bellah, perhaps best known as the sociologist who authored the essay "Civil Religion in America" and the book *Habits of the Heart*, has done it again. In this magisterial work—with extended forays into child development, cognitive psychology, biological evolution, social evolution, and political history as well as evolution of religion—he forges a coherent and comprehensive understanding of religion's development in its biological, social, and political contexts. No wonder it takes over six hundred pages.

In developing the book's overall argument, Bellah includes anthropological case studies from all over the world, past and present. Some of these are relatively short while others are actually small monographs that could stand on their own. He divides the social development of religion into three eras: tribal, archaic, and

axial. In his discussion of tribal religion, Bellah details the Kalapalo of central Brazil, the Walbiri of Australia, and the Navajo of the southern US. For the transition from tribal to archaic religions, Bellah gives the cases of the Pintupi of Australia, the Tikopia of the Solomon Islands, and the early populations of Hawai'i. As examples of full-blown archaic societies, he profiles the Uruk period of ancient Mesopotamia, the Old and New Kingdoms of ancient Egypt, and the Shang dynasty through the Western Zhou of ancient China. These already impressive case studies, however, are dwarfed by the *de facto* monographs about the axial religions that follow: the premonarchial tribes through post-exile prophets of Ancient Israel, highlighting Jeremiah; the early society through the downturn of Athens of Ancient Greece, highlighting Socrates and Plato; the fall of Western Zhou through the Warring States period of Ancient China, highlighting Confucius; and the Early Vedic period through the Mauryan dynasty of Ancient India, highlighting Siddhārtha Gautama, the Buddha. These twelve major and extended case studies, in which Bellah details the codevelopment of societal structures and religious practices, alone make the book worth reading. They are astonishing in depth of scholarship and clarity of narrative.

But this is not yet to address the more ambitious and overarching purpose of the book, namely, a narrative about how religion developed in the context of human evolution. Drawing on Clifford Geertz and Emile Durkheim, Bellah frames religion as a symbol system for making sense about a general order of existence that anchors long-lasting moods and motivations (p. xiv) and as a set of beliefs and practices that unite groups into a moral community around a sense of the sacred (p. 1). These point to the emergence of language as a condition for religion, as well as the intertwinement of cognition, emotionality, and social action. To outline religion's nature and development, Bellah's introductory chapter includes an extended foray into psychology, focusing particularly on three modes of representation in the development of young children: enactive, symbolic, and conceptual. These, Bellah argues, are recapitulations of the stages of religious development that he seeks to trace in human history—ritual, myth, and theology—which correspond roughly to the book's three sets of case studies—tribal, archaic, axial.

The most unusual and interesting part of the book is the chapter on religion and biological evolution. Here Bellah is most clearly going beyond the confines of social sciences. In his search for the origin of religion in biological and cultural evolution, he begins with the Big Bang and cosmological evolution, and then moves to an extended discussion of the emergence of life on earth, including single cellular and multicellular variants. His aim in this is to uncover the emergence of new capacities in the movement from simpler to more complex life forms, while simultaneously highlighting the conservation of core processes in that development. Bellah's assumption is that even as new capacities emerge, older ones continue, albeit in modified form. He is after uncovering what in our biological capacities might give rise to and support the emergence of ritual and symbolization, both of which are central to his idea of religion, even when they are seemingly eclipsed by cognition and theorizing. He traces their emergence in our anciently situated nurturing of our young, which perhaps began with the dinosaurs, is clear in birds, and is most evident in mammals. He thinks that emergence of parental care is "basic to the development of empathy and ethics … and ultimately religion among humans" (p. 70). But he also suggests that the phenomenon of play, which he argues could only emerge in a field somewhat protected from natural selection pressures (i.e., parental protection during relatively vulnerable early life), is also a precursor and precondition for the emergence of ritual, which is crucial for social bonding and community life. In turn, ritual continues as a central, conserved core of religion, even when it is seemingly eclipsed by myth (narrative and the symbolic) and later theology (the conceptual and theoretical).

Ritual, myth, and theology frame Bellah's story of how religion develops in human evolution. The three types of case studies—tribal, archaic, and axial—are meant to exemplify how religion develops from pure ritual (mimetic), to mythical, to theoretical. And in that development he seeks to show how core social actions and meaning are conserved (albeit transformed and submerged) in the transition to the new stage. The four ancient societies and figures that dominate the text—Israel (Jeremiah), Greece (Socrates), China (Confucius), and India (the Buddha)—each are meant to show religion's turn toward the universal, the theoretical, the critical. The axial turn, as he calls this, is a breakthrough in which religion is no longer only used to justify and maintain the unjust status quo of a hierarchical society, but instead it also transforms religion into an ethical and universal way of living, one critical of the inequalities of society, including critiques of the legitimation functions of official, court-tethered religions.

I am impressed with Bellah's ability to forge these various strands into a single narrative while maintaining a high standard of scholarly rigor. Rather than treating religion and science as two opposing forces that require harmonizing, he paints the sciences (natural and social) and religion as a seamless whole. If there is to be a criticism of the book, it is that, as a single scholar, Bellah cannot have equal command of every discipline and field upon which he draws. As a result, he does the next best thing of drawing on the central

and thus more conventional insights of the various fields: biological evolution, cognitive psychology, scholars of ancient India and ancient China, religious studies. Thus, it may well be that cutting-edge scholars in any (and perhaps all) of these fields might disagree with the research he is drawing from. Perhaps in biology the emergentists might find fault, in psychology the enactivists might quarrel, religious studies scholars might question the Buddha's existence, or argue for the invention of world religions during the romantic period, or even question whether there actually were axial turns. However, Bellah's genius is not that he goes to new and daring paradigms to make his case, but that he brings together the best of traditional scholarship into a new synthesis, telling a plausible story about how religion might have emerged in human biological and cultural evolution. In it, he resituates religion, away from being reactionary and outmoded, requiring eclipse, toward understanding religion as part and parcel of the warp and woof of being human.

Reviewed by Clarence W. Joldersma, Professor of Education, Calvin College, Grand Rapids, MI 49546. ✠

Letters

Evidence for an Earlier Nativity

James A. Nollet, "Astronomical and Historical Evidence for Dating the Nativity in 2 BC" (*PSCF* 64, no. 4 [2012]: 211–19), offers his reading of evidence to support the date of 2 BC for the Nativity. There are alternative readings of the available evidence.

The Census in Luke

According to Luke 2:1–3:

> In those days Caesar Augustus issued a decree that a census should be taken of the entire Roman world. (This was the first census that took place while Quirinius was governor of Syria.) And everyone went to his own town to register. (NIV)

But according to Josephus (*Antiquities* 18.1–2), Quirinius took the census in AD 6. During this census, Judas of Galilee caused a disturbance (Acts 5:37). According to Josephus (*War* 7.253), "Judas … induced multitudes of Jews to refuse to enroll themselves when Quirinius was sent as censor to Judaea."

The passage in Luke presents several serious problems. It is argued that

1. There is no evidence of a universal census taken at the same time in the Roman Empire.
2. A Roman census could not have been carried out during the reign of Herod, a client king.
3. Under a Roman census, Joseph and Mary would not have been required to travel to Bethlehem.
4. Josephus does not refer to a census during Herod's reign, but does refer to the noted census under Quirinius in AD 6 (*Antiquities* 17.355; 18.1–2, 26).
5. A census under Quirinius could not have been held under Herod, as Quirinius was not a governor until later.

To these objections, conservative scholars have responded:

1. Luke's language is hyperbolic. It is significant that Augustus initiated periodic empire-wide censuses in Italy and in the provinces, which were carried out in different ways at different times. Edict III from Cyrene in Libya refers to a census dated to 4 BC.
2. After 8 BC, Herod had fallen out of favor with Augustus, who no longer treated him as a "friend" (Josephus, *Antiquities* 16.290–3). It was therefore possible that the Romans required a new census.
3. Unlike the case in Egypt, in Syria (including Judea) women were to be enrolled also. A reference in Eusebius (*Ecclesiastical History* 3.20) records that Jesus's family at the time of Domitian possessed land in Bethlehem. The requirement for Joseph to return to his ancestral home in Bethlehem has been illustrated by an edict of G. Vibius, the prefect of Egypt (AD 104), which reads,

   > Because of the approaching census it is necessary for all those residing for any cause away from their own districts to prepare to return at once to their own governments, in order that they may complete the family administration of the enrolment …

   Another parallel is a document from Babatha, who was one of the Jews who fled during the Bar Kochba Revolt (AD 132–135). In 127 Babatha recorded that she traveled to declare her possessions before the Roman commander at Rabbath-Moab because "a census of Arabia was being held."
4. An earlier census may not have interested Josephus, as much as the more important census of AD 6, which started events which culminated in the great Jewish War, which was the focus of his histories.
5. Some have argued that the Greek term referring to Quirinius may not necessarily mean that he was the "governor" of Syria, but may refer to his role as an administrator in the area. However, attempts to appeal to a broken inscription that some have

ascribed to Quirinius governing iterum, that is, a second time in the area of Syria, prior to his well-attested term which began in AD 6, appear to be unconvincing. We also have a full list of governors of Syria; C. Sentius Saturninus was the governor between 10/9 and 7/6 BC, followed by P. Quinctilius Varus from 7/6 to 4 BC.

Though it is not the obvious meaning of the term, the Greek word *prōtē* translated "first," may have the sense of "prior" in a comparative sense, indicating that the census at the time of Jesus's birth was prior to the more famous census under Quirinius.

The Eclipse and Herod's Death

The author's contention that the eclipse in 4 BC was probably not the eclipse to date Herod's death, as it occurred late at night when most would be asleep, might seem, at first, a persuasive one, but it is a specious argument. Night watchmen could have observed such an eclipse.

For his purposes, the author cites the authoritative work on chronology by Jack Finegan, *Handbook of Biblical Chronology* (1998), but he ignores Finegan's charts (Tables 140 and 141), which clearly indicate that Herod's regnal years ended in 4 BC. In order to support a later death, the author has to resort to the possibility of antedating by Herod's successors.

The author cites (n. 31), an article from *Chronos, Kairos, and Christos II* edited by Jerry Vardaman. I was the co-editor with Professor Vardaman of *Chronos, Kairos, Christos: Nativity and Chronological Studies Presented to Jack Finegan* (Winona Lake, IN: Eisenbrauns, 1989) [hereafter cited as *CKC* I], to which Ernest Martin contributed a chapter, "The Nativity and Herod's Death." The consensus for that work dated Herod's death to 4 BC and was represented by Paul L. Maier, "The Date of the Nativity and the Chronology of Jesus' Life." See also Harold W. Hoehner, *Chronological Aspects of the Life of Christ* (Grand Rapids, MI: Zondervan, 1977).

The "Star" of Bethlehem

There have been innumerable suggestions as to the "star" of the Nativity (see my "The Magi Episode," *CKC* I, 15–39). Ernest Martin considered the star to be the planet Jupiter, as did Konradin Ferrari-D'Occhieppo, emeritus professor of astronomy at the University of Vienna, in his chapter, "The Star of the Magi and Babylonian Astronomy" (*CKC* I, 41–53). Jerry Vardaman, "Jesus' Life: A New Chronology" (*CKC* I, 55–82), on the basis of his identification of the star with Halley's comet, dated Jesus's birth to 12 BC!

More recently, two scholars have identified the star with a comet observed by the Chinese in 5 BC. See Colin Humphreys (Cambridge University), "The Star of Bethlehem—a Comet in 5 BC—and the Date of the Birth of Christ," *Quarterly Journal of the Royal Astronomical Society* 32 (1991): 389–407; see also James Sentell, BLOG_POSTedit20a.pdf (31 pages with data from the Jet Propulsion Lab). Among points with which I would disagree with Sentell is my persuasion that the Magi were Babylonian astrologers (see my *Persia and the Bible* [Grand Rapids, MI: Baker, 1990), chap. 13, "The Magi").

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Dating the Birth of Jesus from the Star of the Nativity

I read with interest the article by James A. Nollet entitled "Astronomical and Historical Evidence for Dating the Nativity in 2 BC" (*PSCF* 64, no. 4 [2012]: 211–19). The author goes into great detail discussing the available historical events regarding names of governors, two Roman censi, and lunar eclipses that occurred during the period 4–2 BC. Doing so, he tries to show that Herod died in 1 BC, or even AD 1, contra the commonly accepted date of 4 BC. If so, Christ's birth would have occurred within 3–2 BC.

There are a number of astronomical arguments regarding the nature of the star of Bethlehem during the period 5–2 BC. A few astronomers mention a "recurring nova" recorded by the Chinese in 5 BC, which then reappeared a year later, thus setting Christ's birth circa 4 BC. If, however, Christ's birth was in 3–2 BC, astronomical calculations would point to the star of Nativity as a conjunction of planets (not a nova, supernova, or a comet). As reported in *The Christmas Star* by John Mosley in 1988, and illustrated by Clay Frost (see msnbc.com, "That Christmas 'Star of Wonder' still leaves plenty to wonder about," http://msnbcmedia.msn.com/i/MSNBC/Components/Interactives/Technology_Science/Space/Star-of-Bethelehem/star.swf [click on image] updated 12/24/2012), it is said that there were nine major conjunctions that took place in the period from 3 BC to 2 BC.

But on August 12, 3 BC, there occurred a conjunction of Venus and Jupiter that would have had particular significance to astrologers who were also acquainted with the book of Daniel. It occurred between Venus and Jupiter in the constellation of Leo, near the star

Regulus. Leo was the tribal sign of Judah. Jupiter was the king planet for the Babylonians and the name for Regulus was Sharru the king. Also Venus, named Ishtar, was the chief Babylonian goddess associated with femininity. Could it be that the magi, who were observing the heavens and studying prophecy, observed this phenomenon in the East and associated it with the impending birth of a Jewish king in Judea? Note that they did not *follow* the star but rather told Herod that they had *seen* the star in the East (Matt. 2:2). This portion of the trip would have been based on a *natural* phenomenon (with the timing ordained by God; see Gal. 4:4).

However, the trip from Jerusalem to Bethlehem was clearly a *supernatural* phenomenon. The following of the *"star"* took place *only after the magi were willing* to travel to Bethlehem, away from the center of activities in obedience to what the scripture had predicted in Micah 5:2. This then led to a miracle, in response to their perseverance, when God specifically directs the magi to the exact location where the Christ child was (Matt. 2:9).

In any case, regardless of the precise timing of Jesus's birth, that included both natural events and a supernatural guidance, the wonderful miracle of the Nativity is the same.

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