by providing the conceptual tools and a unifying language for talking about and organizing a broader range of mathematical matters than the present set-theoretic foundation does.

Standard logical Foundations of mathematics (Harris capitalizes this to suggest imperial overreach) was the central focus of Philosophy of mathematics (ditto) for about the first half of the twentieth century. In the last quarter or so of the century, however, philosophy of mathematics (lowercase) has begun to take greater notice of mathematics as it is actually practiced by mathematicians. Harris terms this the philosophy of mathematical practice, and he clearly appreciates what has been accomplished here by Imre Lakatos, David Corfield, and others. Some see this new trend as turning away from Platonism in mathematics and toward postmodernism; not all readers will find this development as welcome as Harris does. Harris thinks philosophy/foundations of mathematics should not be so focused on truth or epistemology or on trying to construct the firm bedrock for grounding all of mathematics. Mathematics is a fully human activity done collectively under the elite leadership of those who have earned their charismatic stripes through successfully introducing and pursuing significant research programs. As such, it is a fallible and not fully rational enterprise, involving ethical motivations, conjectures, and intuitions about dimly perceived realities; disruptive shifts in focus and methodology; changing connections to what is considered central; and so on. Proof and rigor still have a place in confirming mathematical intuitions, but they should not be viewed as the essence or main task of mathematics.

MWA is not Harris's first attempt at answering "Why mathematics?": his twelve-page essay in the highly regarded *Princeton Companion to Mathematics* (2008) under this title introduced some of the same themes. *MWA* greatly expands these ideas within the context of a personal portrait of a working mathematician. And while *MWA* may not be a conventional apology for the existence of mathematics, it does explore why people do it, most pointedly in chapter 10. Mathematics, Harris says, is a free creative activity, subject only to certain social constraints as a tradition-based/tribal activity and (eventually) to the strictures of logical consistency and proof. It may lead to practical applications (one of the reasons why mathematicians should still be employed by universities), but mathematical research is best pursued as a "relaxed field"—for its own sake, unconstrained by utilitarian demands, akin to play. The clearest thing one can say about why mathematicians do mathematics is simply that they experience deep pleasure in uncovering abstract patterns and in solidifying intuitions about conceptual entities that intimate (are "avatars" of) still further realities to be explored. On this note, Harris's nonapology elaborates and refines Hardy's apology in the context of contemporary research mathematics.

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ORIGINS

A NEW HISTORY OF LIFE: The Radical New Discoveries about the Origins and Evolution of Life on Earth by Peter Ward and Joe Kirschvink. New York: Bloomsbury Press, 2015. 400 pages. Paperback; $10.97. ISBN: 160819907X.

A New History of Life is a natural history that stands out because of its large timescale (4.567 billion years, to be precise) and broad intended audience. Overall, it delivers on the promise of its title adjective, describing new findings and hypotheses connecting paleontology and geology, and offering genuine but grounded scientific speculation for future work. For the general reader, it provides a wealth of new information, but because its overall scientific narrative lacks momentum and internal connection, it may be most appropriate for a scientifically literate audience.

It is impressive to watch the authors address the central challenge of this genre, which I have faced myself in my writing for a general audience: How do you filter oceans of information and translate it into general terms? Ward and Kirschvink set up their filter by emphasizing physical evidence, and rocks and bones in particular. Their geological and paleontological emphasis gives this story a different tone and tempo than other natural histories that start with the Big Bang (physics) or the characteristics of life (biology). My own discipline, chemistry, is not as deeply integrated as a result—here, chemistry plays a role in dating the rocks and bones, and in transforming the environment, but the authors focus their attention on the change and flow of continents (and other aspects of geology) and body plans (developmental biology).

The flip side of the authors' emphasis is their de-emphasis. They deemphasize evidence from genetic clocks and other results from molecular biology, leading them to a chain of reasoning that is mostly geological in nature. For example, they favor a very late evolution of water photosynthesis. Personally, I trust the genetic clocks that show how many forms of photosynthesis, including water photosynthesis, evolved much earlier than Ward and Kirschvink allow. But this is a moot point—a few hundred million years one way or the other does not change the story much for the general reader.

A New History of Life reads at the level of an undergraduate science text. Ward and Kirschvink recount

the back-and-forth narrative of scientific discovery and rebuttal as hypotheses are set forward and discarded. If the reader already understands how science works, these sections depict the drama of science in enjoyable detail. Sometimes the details seem superfluous, as when some sections list other scientists in the field but without enough detail to make them distinct characters. A surprising number of the images in the book depict scientists working in the field, but they do not convey much information to the nonspecialist.

The scientific detail is both an advantage and disadvantage. For example, the first chapter is all about geological nomenclature, which is too dry for a general reader. Throughout the book, the authors provide precise biological and geological terms for organisms and places, but a better description of these would make the story more relevant. A photo of a fossil skull is not clearly connected to the chapter around it, and lists of details on dinosaur names and the shapes of lagoon habitats provide detailed "dots" of data, but they do not seem connected.

At such points, the book becomes more like a required course assignment than the flowing story it could be. On page 80, the authors write, "We apologize for the complex chemistry necessary in the preceding section. But to get this story right requires complexity." If this statement had been placed before the section it described, the general reader would read that section differently—as it is, it amounts to locking the barn door after the horse is gone.

These narrative nits having been picked, this book is indeed new and interesting, both substantial and helpful for the prepared reader. In the chapters on the origin of life, the authors focus on the "RNA world" hypothesis, and include new findings that support this hypothesis, such as the nucleotide synthesis discovered half a decade ago by Sutherland and colleagues, but fail to cover recent experiments that point to "metabolism-first" explanations. The "new" hypothesis in this section is that life started on Mars, which is interesting and possible, but given the difficulties and distances, more speculative than other new proposals in the book.

Another "new" hypothesis the authors develop in several places is that major events such as the Cambrian explosion and particular extinctions were started by "true polar wander" events. One true polar wander event coincided with the Cambrian explosion, but my enthusiasm is tempered by the fact that there have been thirty or so of these events throughout history, which is a number large enough that the timing may be more coincidence than cause. A graph of the thirty events would have addressed my own skepticism but was not included.

The hypothesis I am most attracted to appears throughout the book, but may have been deemphasized by the authors because it is not all that "new." Ward and Kirschvink frequently allude to the power of oxygen, both at and after the Cambrian explosion. They connect oxygen to animal diversification and extinction more intimately than any other general text, and oxygen's influence is found in nearly every chapter. This is an exciting and intriguing thread to follow throughout the narrative, but it could have been emphasized more.

Curiously, in a section on dinosaur morphology, they downplay the power of oxygen. On page 266, they begin a paragraph with the statement, "No evolutionary history can ever be pinned on one factor." The paragraph ends, "Nevertheless, oxygen levels must have played a part." This apparent underselling of the organizing chemical power of oxygen brought to my mind the stories of how Einstein resisted the Big Bang because of its implication that the universe had a beginning. But, as is common for popular science, philosophical and theological implications are kept implicit.

Another major theme of this book that is powerful (but not really new) is the generative power of past extinction events. As Ward and Kirschvink put it, "Over and over, however, it really looks like a dominant theme in the history of life is that times of crisis promote new innovation." Many scientists from many fields, including myself, have converged on this finding, and it deserves to be repeated many times. What does that tell us about what kind of universe we call home?

The authors close the book by extrapolating the billion-year trends of change in carbon dioxide and oxygen levels into the distant future. This is an obituary for the future earth in which CO_2 runs slowly out of the atmosphere like air running out of a balloon.

In a book that tends to avoid large metaphors, this section stands out: "The fate of the nautilus is a metaphor for all animal life. Sooner or later evolution, competition, and the natural changing of our Earth and sun as they age will make any body plan obsolete." The authors describe a bleak future that gives the sense of the universe running down and flickering out, which is accurate as far as science goes, but philosophically and theologically truncated.

In summary, this book is an excellent example of recent evidence in the history of life, with special emphases on geology and paleontology. Anyone with an interest in those two sciences will find new ideas and directions in these pages. The most powerful conclusions—the emerging consensus on the driving role of oxygen and the creative power of even the most devastating extinctions—give a sense of the vitality of life and the

orderliness of creation that is somewhat at odds with the deflating final chapter. Here, new evidence is presented well, and its ultimate implications are left for the reader to ponder.

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Philosophy & Theology

STATE OF AFFAIRS: The Science-Theology Controversy by Richard J. Coleman. Eugene, OR: Cascade Books, 2014. xii + 272 pages. Paperback; $32.00. ISBN: 9781625647016.

If the title of Richard Coleman's first book at this intersection, *Competing Truths: Theology and Science as Sibling Rivals* (Bloomsbury, 2001), highlighted the contrasts but worked toward synthesis, the main title of the present book, almost fifteen years later, suggests a *status quaestionis*, but actually urges that whatever synthesis might be previously either promoted or achieved is premature given the disparate methodologies. Perhaps this is in part because in the intervening period, Coleman's *Eden's Garden: Rethinking Sin and Evil in an Era of Scientific Promise* (Rowman & Littlefield, 2007) scrutinized the sciences from a theological vantage point and observed that scientific inquiry, no less than any other human venture, is not less susceptible to overreaching in its pursuit of inquiry and knowledge, and hence he has become much more sanguine and realistic about the scientific enterprise. *State of Affairs* thus suggests that while the value of science should not be underestimated, we ought not to overlook the differences between it and the theological disciplines.

Now Coleman is advocating neither the classical "conflict" thesis nor the two-truths or independence model of more recent provenance. Instead, he engages more specifically and most extensively with what he calls the movement of "new rapprochement" (NR) between theology and science represented in the last generation by the contributions of Ian Barbour, Arthur Peacocke, and John Polkinghorne, among others. Coleman's argument is that NR, while helpful in various respects, also has been too accommodating to science, its constraints and empirical methods, and thereby has both minimized theology's distinctiveness and subjected its work to scientific frameworks and presuppositions. Along this latter route, theology subordinates its task of clarifying the deposit of revelation to that of "keeping up with the sciences" (my colloquialism), so to speak, and thereby forgets its prophetic stance of readiness to confront critically the shortcomings inherent in all human undertakings.

Note that Coleman writes not as a scientist for scientists but as a theologian for his peers. From my own vantage point as a theologian looking to engage the sciences, I am grateful for this timely reminder about the differences between both endeavors. Yet insofar as the modern sciences are driven in principle by the quest for ever-expanding knowledge, they have threatened, if not dethroned, theology from her status during the medieval period as "queen of the sciences." Hence, if science can overreach, part of the question is whether theology has its own realm and, if such, is anything less than all-there-is. It should not be surprising that if the extent of science's reach is contested even among those working in that arena, the scope of theology—for example, whether it concerns the existential depth of the human experience or the eschatological horizon of the cosmos or the transcendent dimensions of the world, or any and everything at all!—might itself not be amenable to clear definition. The extent to which theologians disagree about these matters will incline them to engage with Coleman's thesis divergently.

In the end, what Coleman wants, charitably put, is for theologians to take a more appropriately disputational, even prophetic approach to the sciences, with such contesting and disrupting capacities understood as theology's gift to scientific inquiry. Yet as the scientific method is itself designed to continually question what we know, theologians do not have a corner on the disputational market. This is not to say that theologians ought not to pose hard questions to science, or even that theology might not make a difference in the scientific domain. It is to say that the stance recommended by Coleman might be less confrontational than intimated. Here the carefully developed proposals over the last two decades plus those of Robert John Russell—to whom Coleman refers in passing on a few occasions but does not engage in any depth—deserve to be carefully studied.

Coleman's constructive way forward is complicated on two fronts: first, by the long history of fundamentalist, creationist, and intelligent design voices that understand themselves as disputational interventions vis-à-vis the sciences; and second, by the fact that in the twenty-first century, Christian theology's voice in the religion-science interface is one among other religious traditions engaging and even challenging the sciences. So the question is how to promote a disputational stance that is constructive for the wider conversation (as opposed to being merely reactive as on the former trajectory) and that is distinctive in a pluralistic world (as opposed to being perceived as merely attempting to get a leg up in a crowded field). When understood diachronically and historically in light of the last millennium of Christian theology's love-hate relationship with the sciences, the question can be expanded: what kind of theology or theological method can be an appropriate "queen"—on the one hand, being bold and prophetic while on the