

## References

1. P. A. Offit, *The Cutter Incident: How America's First Polio Vaccine Led to the Growing Vaccine Crisis* (Yale Univ. Press, New Haven, CT, 2005).
2. P. A. Offit, *Autism's False Prophets: Bad Science, Risky Medicine, and the Search for a Cure* (Columbia Univ. Press, New York, 2008).
3. P. A. Offit, *Deadly Choices: How the Anti-Vaccine Movement Threatens Us All* (Basic Books, New York, 2011).
4. A. P. Grollman, *Environ. Mol. Mutagen.* **54**, 1 (2013).
5. O. W. Holmes, *The Medical Profession in Massachusetts* (Wilson, Boston, 1869).

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## SCIENCE AND RELIGION

## When Prior Belief Trumps Scholarship

Charles R. Marshall

The power of scientific reasoning derives from the complex interplay between the desire to know, the ability to reason, and the ability to evaluate ideas with data. As scientists, we have learned how to make ideas dance with reality, and we expect them to be transformed in the process. We typically add to what we already know, often showing along the way that old ideas are incomplete or, occasionally, wrong. And so we collectively build an understanding of the world that is accurate, reliable, and useful.

In *Darwin's Doubt*, Stephen Meyer (who runs the Discovery Institute's Center for Science and Culture) also tries to build. He aims to construct the philosophical and scientific case for intelligent design. I am not a philosopher, so I will not attempt to evaluate his philosophical argument that in principle it might be possible to recognize the action of a designer in the history of life. But I am willing to evaluate his scientific case for the participation of such a designer. It centers on one of the most remarkable events in that history, the relatively rapid emergence of animal phyla in the Cambrian.

Meyer's scientific approach is negative. He argues that paleontologists are unable to explain the Cambrian explosion, thus opening the door to the possibility of a designer's intervention. This, despite his protest to the contrary, is a (sophisticated) "god of the

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**Scree slope site.** Walcott quarry in the Burgess Shale, which beautifully preserves soft-bodied animals from shortly after the Cambrian explosion.

gaps" approach, an approach that is problematic in part because future developments often provide solutions to once apparently difficult problems.

*Darwin's Doubt* begins with a very readable review of our knowledge of the Cambrian explosion. Despite its readability and a plethora of scholarly references, however, there are substantial omissions and misrepresentations. For example, Meyer completely omits mention of the Early Cambrian small shelly fossils and misunderstands the nuances of molecular phylogenetics, both of which cause him to exaggerate the apparent suddenness of the Cambrian explosion.

I like to read the arguments of those who hold fundamentally different views from my own in the hope of discovering weaknesses in my thinking. And so even after reading the flawed first part of his

book, I dared hope that Meyer might point the way to fundamental problems in the way we paleontologists think about the Cambrian explosion.

However, my hope soon dissipated into disappointment. His case against current scientific explanations of the relatively rapid appearance of the animal phyla rests on the claim that the origin of new animal body plans requires vast amounts of novel genetic information coupled with the unsubstantiated assertion that this new genetic information must include many new protein folds. In fact, our present understanding of morphogenesis indicates that new phyla were not made by new genes but largely emerged through the rewiring of the gene regulatory networks (GRNs) of already existing genes (*1*). Now Meyer does touch on this: He notes

that manipulation of such networks is typically lethal, thus dismissing their role in explaining the Cambrian explosion. But today's GRNs have been overlain with half a billion years of evolutionary innovation (which accounts for their resistance to modification), whereas GRNs at the time of the emergence of the phyla were not so encumbered. The reason for Meyer's idiosyncratic fixation with new protein folds is that one of his Discovery Institute colleagues has claimed that those are mathematically impossibly hard to evolve on the timescale of the Cambrian explosion.

As Meyer points out, he is not a biologist; so perhaps he could be excused for basing his scientific arguments on an outdated understanding of morphogenesis. But my disappointment runs deeper than that. It stems from Meyer's systematic failure of scholarship. For instance, while I was flattered to find him quote one of my own review papers (*2*)—although the quote is actually a chimera drawn from two very different parts of my review—he fails to even mention the review's (and many other papers') central point: that new genes did not drive the Cambrian explosion. His scholarship, where it matters most, is highly selective.

Meyer's book ends with a heart-warming story of his normally fearless son losing his orientation on the impressive scree slopes that cradle the Burgess Shale, the iconic symbol of the Cambrian explosion, and his need to look back to his father for security. I was puzzled: why the parable in a book ostensibly about philosophy and science? Then I realized that the book's subtext is to provide solace to those who feel their faith undermined by secular society and by science in particular. If the reviews on Amazon.com are any indication, it is achieving that goal. But when it comes to explaining the Cambrian explosion, *Darwin's Doubt* is compromised by Meyer's lack of scientific knowledge, his "god of the gaps" approach, and selective scholarship that appears driven by his deep belief in an explicit role of an intelligent designer in the history of life.

## References

1. D. H. Erwin, J. W. Valentine, *The Cambrian Explosion: The Construction of Animal Biodiversity* (Roberts and Company, Greenwood Village, CO, 2013); reviewed in (*3*).
2. C. R. Marshall, *Annu. Rev. Earth Planet. Sci.* **34**, 355 (2006).
3. C. J. Lowe, *Science* **340**, 1170 (2013).

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# Science

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Charles R. Marshall

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