

metaphor. In *borealis* we get not only a color, but also a color that pulses across the sky. A bird we might hold in the palm of our hand suddenly fills the entire horizon, large as the universe itself. This, in miniature (but not in miniature at all!) is what good poetry can do.

By contrast, take these lines from Marilyn Gear Pilling's otherwise promising poem "Looking Out": "What happens when you spend time / on the edge / of such power, such beauty, such / possibility?" (p. 70). Notice the flatness of this passage, the lack of image or metaphor, the crowding in of abstractions. Do I, as a reader, feel power, or beauty, or possibility in these lines? I do not.

Fortunately, the barn-swallows by far outnumber the flightless abstractions in this rich array of poems. I suspect such a collection as this will inevitably be uneven. First, by limiting the contributors to those with a connection to a relatively small geographic area, and by further limiting the contributors to those with environmental awareness, the editors have narrowed the field. Suppose, for example, that in the early nineteenth century some enterprising anthologist had gathered a volume of poems about the Lake District. William Wordsworth would loom large, as would Samuel Taylor Coleridge and Robert Southey. But who else, really?

The second danger of such an anthology as this is its very environmental intent. Because environmentalists have a message. When Honey Novick ends her poem "Mushquoteh" by telling us that "Norway maple is a new metaphor / for decolonization" (p. 95), I want to say, save this for an academic essay. And when she writes, in "Oh, Mother Earth," that "Expediency lives in our hearts" (p. 50), I want to say, keep this for a sermon. I suggest that it is not the job of poems to preach or to pontificate, but to cast a magic spell.

Such a spell is beautifully cast by John Terpstra in "Giants":

They'd sit  
their giant hinds in a row along the top edge  
of the escarpment, and pick at the loose rock  
with their hands or their feet, then throw or skip  
the smoothest stones across the bay, to see who could  
land one  
on the sandstrip, three miles away ... (p. 57)

There is true imagination at work in the creation of such giants sitting atop the Niagara Escarpment, standing in for the land itself.

Also notable are the many richly sensuous poems about keeping and tilling the land. Take this elderly gardener in Adam Dickinson's "Beetroot":

Her fingers are asparagus stalks,  
stubbled and coiled cucumbers,

thick from years of having carried the charge  
of her burly, grandmotherly care,  
the pots of turnip  
that need lugging to the kitchen. (p. 179)

One of the unique features of this anthology is a series of interviews with each of the contributing poets. Each writer is asked to describe their relationship to the land, their spiritual grounding, and their motivation in writing poetry. And many are eloquent in their responses. Twelve of the poets are thoughtfully Christian, and thirteen more admit to the influence (for better or worse) of a Christian upbringing. There is also a rich ethnic diversity, with sixteen of non-European descent, six of these appropriately First Nations. And there are even some scientists in the mix! Bowen and Van Brenk have assembled a worthy crew to give witness to a worthy place—as worthy a place as any that lies unobserved on our very doorsteps. Perhaps poetry can indeed offer hope for environmental repair. Readers of *PSCF* will find this anthology a delightful supplement to the usual academic discussions on creation care.

*Reviewed by Paul Willis, emeritus professor of English, Westmont College, Santa Barbara, CA 93108.*

## EVOLUTIONARY THEORY

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**EVOLUTION "ON PURPOSE": Teleonomy in Living Systems** by Peter A. Corning, Stuart A. Kauffman, Denis Noble, James A. Shapiro, Richard I. Vane-Wright, and Addy Pross, eds., Vienna Series in Theoretical Biology, Gerd B. Müller, Thomas Pradeu, and Katrin Schäfer, eds. The MIT Press, 2023. 390 pages including index. Paperback; \$75.00. ISBN: 9780262546409.

This revolutionary and transformative book heralds a major paradigm shift in the science of biology and opens the door to an entirely new approach to understanding the science of life. Its core message is that while life follows the laws of chemistry and physics, it cannot be defined, described, or understood solely in terms of those laws. Most of the book's editors are pioneers in the demolition of the gene-centric, deterministic evolutionary concepts that have dominated the ideology of neo-Darwinism for many decades.

Recently, a new movement in evolutionary biology, sometimes called "The Third Wave," has emerged that questions some of the more basic tenets of the established theory. One of the milestones of this new movement was a meeting of the Royal Society in 2016, at which several leading biologists (including some of the editors and authors of *Evolution "On Purpose"*) discussed a series of possible alterations to the established theory of evolution by natural selection. These included concepts

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of niche construction, whereby creatures modify their environments leading to altered evolutionary scenarios, non-random mutations, and natural genetic engineering by organisms—that is, evolution by choice. These and several other novel mechanisms outside of the standard model of random gene mutations, followed by natural selection, were part of the new “extended evolutionary synthesis” (EES).

*Evolution “On Purpose,”* however, goes much further than the EES in challenging neo-Darwinian dogmas by strongly emphasizing that living organisms are not passive recipients of random genetic mutations but active participants in their own evolution. This has long been, and to some extent still is, considered scientific heresy by many biologists, but the data supporting it is convincing.

The book contains eighteen chapters, including an Introduction by the editors, and an excellent summary (chap. 2) by senior editor Peter Corning. The history of how biology became fixated on denying teleology to conform to the sciences of chemistry and physics is told expertly by Denis Noble and his brother Raymond Noble in chapter 12.

The following sample of chapter titles gives an indication of the major themes of the book: “Teleonomy in Evolution”; “Cellular Basis of Cognition in Evolution”; “Niche Construction ‘On Purpose’”; “Relational Agency”; “Mentally Driven Goal-Directed Behavior”; “Morphogenesis as a Teleonomic Process”; and “Agency, Teleonomy, Purpose, and Evolutionary Change in Plant Systems.”

The subject of biological agency (a term that was traditionally banned from biology) has been shown to play a crucial role in evolutionary processes. The details are covered in several chapters, which describe how living creatures can influence their own evolution through their interactions with the environment.

Each chapter provides a richly profound look into fundamental ideas of how life really works, with very little overlap between different chapters. One can feel the excitement of the authors as they journey into what was once forbidden territory marked with the signs of final causes and willful agency. I will briefly discuss a select set of chapters to give a sense of the book.

Chapter 3 by Baluška, Miller, and Reber describes how all of life, including single-celled organisms, plants, and, of course, those with primitive or advanced brains, can perform cognitive functions such as perception of their environments. Even a bacterium can remember, learn, and make decisions based on its cognition. Cognition leading to purposeful action also includes cooperative

interactions between organisms of the same or even different species, such as symbiosis. The authors emphasize that “evolutionary development is creative not only through either mutations, or natural selection but also—and mainly—through the linked cognitive activities and preferences of individual organisms” (p. 34).

James A. Shapiro, in chapter 15, discusses one important and critical mechanism by which organisms engineer themselves: the activity of transposons, or jumping genes. These mobile genetic elements, first discovered by Nobel laureate Barbara McClintock, are cellular tools for natural genetic engineering. To quote Shapiro:

... living organisms have the ability to rewrite and rewire their genomes when necessary. Rather than being the passive beneficiaries of random mutations and natural selection, all organisms play an active role in their own hereditary variation and evolution by activating transposable elements in response to ecological challenges. (p. 285)

Editor Stuart Kauffman is one of the most important pioneers in the emergent field of systems biology and the nature of complexity. Written with Andrea Roli, Kauffman’s chapter 8 summarizes several of his contributions over the decades. These include the role of autocatalytic small molecule sets as possible precursors to the transition from chemistry to life, the statistical mechanics of evolution, and the uniqueness of life, which leads to a “third transition in science” beyond both the Newtonian paradigm and quantum mechanics, stemming from the impossibility of predicting and describing with equations the future evolution of a biosphere.

In chapter 10, Michael Levin, a rising star in many areas of new biological research, discusses the mounting evidence for teleonomy in the morphogenesis of many forms of life, from worms to frogs to mammals. He demonstrates that the way in which animals tend to build (or rebuild) their bodies (morphogenesis) is not based on a rigid program of stepwise, pre-set genetically based instructions requiring a fixed starting point to get to final shape. Instead, worms, frogs, newts, and other organisms build their bodies toward a known goal, and they use all kinds of innovative methods to get there. In other words, it is the final answer to what should be the shape of a frog face (for example) that drives the process, no matter the initial state of the tadpole face. Teleonomy drives morphogenesis.

How all this purpose-driven activity is controlled, monitored, and corrected is as yet unknown, but it is operative even in the development of mammalian (including human) fetuses, where large groups of cells self-organize into the correct organs and tissues.

A major feature of this book is its diversity in subject matter and approach. While several chapters do cover similar general topics (especially agency, cognition, and teleonomy), the number of specific applications of these and other aspects of biological complexity is very large. For example, chapter 7 by Eva Jablonka and Simona Ginsburg looks at the evolution of purposeful behavior from unconscious teleonomy in lower animals to conscious expression of goals and desires by human beings. It covers an enormous field of psychological and neurological research.

I am not aware that any of the editors or authors are professing Christians – to my knowledge, none of them are active in international associations devoted to science and Christian faith. Modern movements to reform the dogma of neo-Darwinism are not (as some atheists have claimed) part of a Christian plot to undermine settled science. Every participant in this project affirms the reality of Darwinian evolution. Their purpose is to bring the theory up to date.

*Evolution “On Purpose”* is a useful resource for Christians invested in describing the harmony of science (biology in particular) with our faith. Given the major impact that it is likely to have, I expect that more books and articles aimed at the general public will be making appearances shortly.

*Reviewed by Sy Garte, editor-in-chief of God and Nature magazine, author of Beyond Evolution: How New Discoveries in the Science of Life Point to God, and visiting professor at Rutgers University, New Brunswick, NJ 08901.*

## HISTORY OF SCIENCE

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**THE REINVENTION OF SCIENCE: Slaying the Dragons of Dogma and Ignorance** by Bernard J. T. Jones, Vicent Martínez, and Virginia Trimble. World Scientific Publishing Europe, 2024. 492 pages. Paperback; \$48.00. ISBN: 9781800613607.

The “dragons” referred to in the title are the old ideas that are often hard to get rid of as new scientific data come along, in particular things that were invented out of ignorance but apparently thought to be real. This comes from ancient maps that occasionally showed dragons in regions where little or nothing was known. One well-known example is the old idea that everything was made of the elements Earth, Air, Fire, and Water. The dogma and ignorance referred to are scientific, not religious. The authors reveal little or nothing about their personal religious beliefs (if any) and do not push anti-Christian or more generally anti-religion views.

Bernard Jones, emeritus professor at Kapteyn Astronomical Institute of the University of Groningen,

has worked in a variety of areas of astronomy, especially cosmology. Vicent Martínez, professor of astronomy and astrophysics at the University of Valencia, is a cosmologist who earned his degree under Jones at Cambridge. Virginia Trimble, professor of physics at the University of California, Irvine, has worked in various areas of astronomy and has written many reviews of astronomical research.

The book contains nineteen chapters in 361 pages, followed by extensive notes containing references and expansions of the information in the main text, as well as indexes of people and of subjects. It is probably not suitable for use as a textbook, but various sections might be used in courses on history or philosophy of science. One does not need to be an astronomer or physicist to read and benefit from the book, but some knowledge of science is useful, and more specialized knowledge is helpful (though not essential) in a few places. Readers with an interest in history or philosophy of science would probably find it interesting and informative. Those who primarily want the bigger picture may want to skim over some details, but they should take time to enjoy at least some of the many stories of interesting characters and the fun historical tidbits.

The book begins with what the authors call the “most famous failed experiment.” In the 19th century, it was known that light behaved as a wave, and all waves anyone knew about required a medium to move in (e.g., water or air). Therefore, it was believed that light must travel in a medium, labeled as “ether,” that filled all of space. As Earth moves through the ether, one should measure a different speed of light depending on whether one is moving with, across, or against the current. In 1887, Michelson and Morley found that the speed of light was the same regardless of the direction of motion through the supposed ether. This was a serious strike against the ether hypothesis, as well as showing light waves were somehow different from other waves. Some major rethinking was required, leading to Einstein’s theory of relativity. It took some years for the ether dragon to die, and more years for relativity to become well accepted.

Another dragon that many readers of *PSCF* will likely recognize would be the “crystalline spheres” on which stars and planets supposedly rotated around Earth. These were part of the geocentric model of the Solar System that was replaced by the heliocentric model in the decades around 1600. As most readers are probably aware, Galileo’s observations (ca. 1610) played a major role in slaying the geocentric dragon and Kepler’s “laws” of planetary motion a bit later were based on the heliocentric model. It wasn’t until several decades after Galileo and Kepler that Newton’s laws of motion and of gravity were published (1687) to make more quantitative