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Defining Darwin: Essays on the History and Philosophy of Evolutionary Biology

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fundamentally misleading assertion. Barnosky himself points out that he comes to this discussion not as a climatologist but as a paleoecologist. As such, we could forgive these mistakes if they were limited to a few misstated facts, even ones such as these that are so well known.

Barnosky wanders even further beyond his area of expertise and experience when he begins to discuss computer-based forecasts. He writes that "the nature of climate science is computer models and probability calculations," as if there really could be a science without empiricism—without direct observations and the development of methodologies which have allowed satellite remote sensing of sea ice cover and techniques to reconstruct climate and atmospheric chemistry far into the past. He refers specifically to a paper by Thomas and colleagues (2004) in *Nature*, which stated that 15 to 37 percent of species considered by those authors would be "committed to extinction" in the next several decades because of global warming. Barnosky writes that the authors of this paper used "state of the art climate modeling techniques," and then used species-area curves to forecast effects on biota. In fact, the modeling techniques used in that paper were a peculiar mixture of recent and old, as with the species-area curve. And, as 16 of us pointed out in a 2007 *BioScience* article, that particular analysis used questionable data and relied on species-area curves in a way that was readily open to criticism. Our article "Forecasting the Effects of Global Warming on Biodiversity" was an attempt to take an open and objective approach to the methods in use, and the authors included a wide variety of perspectives on global warming. In that article we pointed out a "Quaternary conundrum": Modern forecasting methods discussed in papers like Thomas and colleagues' suggested many extinctions in the near future, but, in contrast, major climate changes of the Quaternary resulted in few known extinctions around the world.

I mention these specific papers to show that Barnosky strays rapidly from his stated goal of finding a scientific answer to the overarching question about the effects of global warming. He has instead created—perhaps because he has reached far beyond his field and knowledge—a one-sided review that is not an independent, open presentation of all sides of the scientific debate. I wish that this book had asked some of the fundamental scientific questions often left aside in the global warming debate: The first is the meaning of nature's stability. Current forecasting methods use steady-state theoretical approaches for what are non-steady-state systems. Second, discussions like Barnosky's seem to fall into a peculiar biological contradiction. Since Darwin, we have known that adaptation to a changing environment is a plus, a necessity, for life to persist. Yet Barnosky's review of each observed change in the behavior and distribution of species, which he believes to be a response to global warming, is negative; he sees such change as a threat to species and a potential disappointment to we who seek what we saw as children and won't find in the future—or at least not where we first saw it.

A third fundamental error that many discussions of global warming commit, and one that appears throughout *Heatstroke*, is to list the many other causes of environmental degradation, state that rapid climate change on top of these must be bad, and thereby attribute many environmental problems to global warming. In the end, discussions like this one do not help a reader determine which of the many human-induced and undesirable environmental changes should take top priority. Having accepted at the outset that global warming is the fundamental disaster, despite his claimed desire to find a scientific answer, Barnosky is not open to such a question. Those who believe that human-induced global warming is inevitable and will have disastrous effects on much of life on Earth, on people, and on civilization will love this book; those who are skeptical will dislike it. What *Heatstroke* won't do is help a person who wants to know the best that science can offer in answer to Barnosky's leading question—whether global warming is or is not the incredibly disastrous crisis some have warned us it will be.

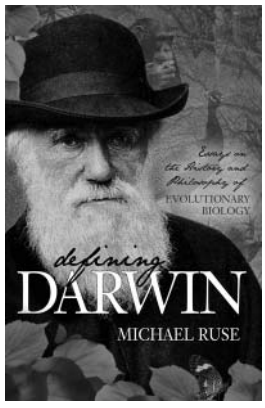
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A CLEVER RUSE

Defining Darwin: Essays on the History and Philosophy of Evolutionary Biology. Michael Ruse. Prometheus Press, 2009. 271 pp., illus. $26.98 (ISBN 9781591027256 cloth).

Michael Ruse is the Lucyle T. Werkmeister Professor of Philosophy and director of the history and philosophy of science program at Florida State University. He is the founding editor of the journal *Biology and Philosophy*, and is the author, coauthor, editor, or coeditor of some 38 books, beginning with *The Philosophy of Biology*, which appeared in 1973. Reading Ruse is always entertaining and frequently enlightening as well. His latest book, *Defining Darwin: Essays on the History and Philosophy of Evolutionary Biology*,



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is no exception. Ruse doesn't tell us who his intended audience is, but the book appears to be aimed at the interested nonspecialist who is encountering a semischolarly treatment of Darwinism for perhaps the first time. The essays in the book move along at a brisk clip, seldom tarrying to delve into any specific topic in great detail. The effect is to give the reader a broad overview of Darwinism from its seminal expression in the *Origin* to the latest debates, thereby whetting an appetite for more.

The book consists of 10 essays on evolution-related topics, 5 of which have been previously published. The essays are grouped (very roughly) in chronological order, with sections of the book dealing with the *Origin of Species* (one essay), and then three essays each in sections examining "The Early Years" (essays on Kant and evolution, Darwinism and mechanism, and Alfred Russel Wallace), "The Middle Years" (essays on Spencer, Julian Huxley and G. G. Simpson, and evolution and the novel), and "The Later Years" (essays on evo-devo, Darwinian explanations of religion, and evolution as a religion). Each section is preceded by a brief note helpfully describing the essays in that section and pointing out the (sometimes subtle) thematic connections among them. As the subtitle of the book suggests, this is a work on the history and philosophy of evolutionary biology. What becomes clear as one reads the essays is that, for Ruse, the historical and philosophical issues are symbiotically related, with history providing a context for evaluating issues of philosophical significance and philosophical analysis highlighting the historical contexts requiring greater elucidation. Although on a number of occasions (see especially the essay on Huxley and Simpson) Ruse explicitly dons his historian's hat to make a particular point, then explicitly replaces it with his philosopher's cap to make a different point, for the most part the historical and philosophical claims work synergistically and provide mutual illumination.

The underlying theme of the essays and the question that animates them, Ruse tells us in the preface, is the big question of objectivity and subjectivity in science: "Is science about an objective reality and is the aim to describe and understand that reality as best one can, or is science a far more subjective enterprise, influenced by the culture of the day and as much a creation as an invention?" (p. 9). The answer that emerges in the pages of this book is, to a close approximation, "yes." One way to appreciate this point, Ruse suggests, is to consider the central role of metaphors in science, which provide a "middle way" between the objective and the subjective. As Ruse explains in his essay on "Darwinism and Mechanism":

> Science is objective, inasmuch as it is structured and guided by epistemic factors or values. It is beyond the individual or purely cultural because it aims to be predictive, consistent with other knowledge claims, internally coherent, unificatory, and simple. Yet science is in some way subjective, because we also structure and interpret it through our metaphors, things drawn from individual experience and the culture(s) within which science is produced. (p. 52)

The idea that organisms and their subsystems are "machines" is a case in point. According to Ruse, "Seeing nature's parts as machines, as mechanisms, as contrivances, is absolutely crucial for Darwin. Like a vampire before a virgin, the metaphor takes on new life" (p. 63). A key Darwinian research strategy is to think of organisms and their parts as if they were machines, and then to engage in reverse engineering to discover why they are as they are. One of Darwin's books, *On the Various Contrivances by which British and Foreign Orchids Are Fertilised by Insects* (1862), is a classic of this type of reasoning. The idea of organisms and their parts as machines was common in the intellectual milieu in which Darwin wrote, starting perhaps with the work of René Descartes in the 17th century, and finding its apogee in the natural theology of Archdeacon William Paley. Yet insofar as this metaphor leads the scientist to discover the true causes of natural phenomena, it produces objective knowledge. Scientific knowledge is thus both deeply influenced by the culture in which it is produced (the "subjective" element), and also objective in the sense of providing genuine insights into nature. The big question of objectivity and subjectivity in science is thereby neatly resolved—so long as one doesn't press it further.

As always, Ruse's prose is eminently readable. (The irreverent essay on the hapless and unfortunate Alfred Russel Wallace borders on the hilarious.) Many of the essays read as if they are informal lectures, and indeed Ruse tells us that all of the essays in the book were tried out in lecture halls. He writes as someone with a deep and intimate familiarity with all things Darwinian, permitting the narrative to carry the reader along with a sense of seeming effortlessness. Ruse's comments about Darwin's *Origin of Species* apply equally to the present work: "His warm and easy style makes it exceptionally easy to follow his thinking. Few will come away confused as to the points he is making" (p. 18). Ruse achieves this mellifluous effect by using broad brushstrokes to make his points rather than by delving deeply into his topics or by seriously wrangling with objections or counterarguments. One gets the sense that Ruse wants to keep the discussion moving. The result is jaunty readability at the cost of some precision, although given the presumed target audience for this book, this seems like a fair trade.

Whether readers will agree with all the points Ruse makes is another matter. Occasionally he makes claims plausible enough for readers who simply want to enjoy a good read, but that might raise eyebrows among those who have devoted their professional careers to understanding evolution and evolutionary biology. For example, he writes, "the chief feature of the organic world is its adaptive or organized complexity" (p. 21). To be sure, adaptation is certainly one of the chief features of the organic world that deserves our attention, but there are others as well—biological diversity, for

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example. What aspect of nature one chooses to privilege for explanatory purposes may seem insignificant, but it can have consequences for how one comes to understand the evolutionary process and for which problems one deems worthy of serious attention.

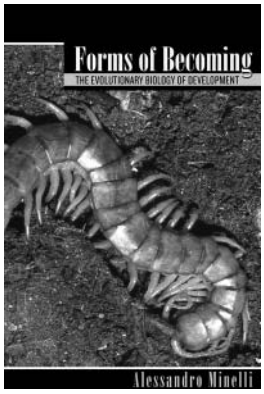
Likewise, many problems over which much ink has been spilt (e.g., whether evo-devo is in tension with an adaptationist view of evolution, how Darwinian and Christian worldviews can be reconciled, etc.) are dealt with in a fairly breezy manner; Ruse implies that he doesn't see what all the fuss is about (e.g., p. 216). Early in the book he writes: "Evolution is true and natural selection is its mechanism. No more, but certainly no less" (p. 26). This is shockingly simplistic (presumably deliberately so, since Ruse assuredly understands better than most how dauntingly complicated the issues really are). Ruse's energetic writing style and unbounded enthusiasm for an adaptationist interpretation of Darwin's theory can as easily convey to someone coming to these issues for the first time, or without much training in the history and philosophy of science, that most of the interesting problems arising in connection with Darwin's theory are pretty easy to solve with just a bit of historical investigation and philosophical analysis (hence the tongue-in-cheek title of this review). To achieve the breadth of historical sweep and concise take-home message he is seeking, Ruse has to skim the surface of many topics that could easily be subjects for sustained discussion. This is, however, a minor shortcoming that hardly begins to detract from the great value of this book. Its intended audience is likely to come away with a fresh understanding of Darwin's great theory, and with gratitude to Ruse for being such an engaging and convivial tour guide. *Defining Darwin* is a valuable contribution to the literature emerging from the bicentennial celebration of Darwin's birth. It deserves a wide readership.

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A MULTIFACETED VIEW OF EVO-DEVO

Forms of Becoming: The Evolutionary Biology of Development. Alessandro Minelli. Princeton University Press, 2009. 242 pp., illus. $27.95 (ISBN 9780691135687 cloth).

Inasmuch as Alessandro Minelli's goal with his latest book, *Forms of Becoming: The Evolutionary Biology of Development*, is to shake up conventional disciplinary-based thinking about the development and evolution of animal form, he succeeds. As in his first book, *The Development of Animal Form: Ontogeny, Morphology, and Evolution* (2003), Minelli engages the reader in considering animal form from unusual points of view by using examples from the development of a broad array of invertebrate taxa (e.g., sipunculids, nemerteans, centipedes) that may be unfamiliar to a comparative vertebrate biologist or model organism–based developmental biologist. These different views are enhanced by his use of thoughtful and creatively worded (translated from Italian) phrases.



One of the central questions posed by *Forms of Becoming* has to do with why some forms occur in nature while other imaginable forms never do. Thanks to molecular genetics, we understand that similarity of form is due to the high level of gene conservation across animals, but we don't really understand the basis of the differences. The example to which Minelli returns is that many centipede species of the genus *Scolopendra* have 21 segments, and many others have 23, but never has even a single individual with 22 segments been observed in any species. He views this general phenomenon, of phenotypes with "borders," as pointing to developmental rules or laws. Understanding the rules—that is, the developmental mechanics (rather than the set of involved genes)—will enable an understanding of the evolutionary basis for the observed differences and discontinuities in animal form. The analogy is made to the rules of chess: A knight can reach only certain squares by moving from its current position—and these moves are the variation upon which natural selection can act.

As in *The Development of Animal Form,* Minelli warns against finalism in developmental biology; that is, viewing the adult as the end goal of development. The traditional view of segments in adult annelids and arthropods, for example, is that they have been selected because of their usefulness in locomotion. Alternatively, he suggests that one should view segments as the result of a developmental process—a developmental logic that favors the serial repetition of structure. The fact that they are useful in locomotion, and thus are favored by natural selection, is not the primary reason that segments exist. As he says, "development has the first word and natural selection the second" (p. 204). Minelli also usefully reminds the reader that natural selection does not see the genes underlying the developmental mechanisms but rather the phenotypes that take shape throughout the whole of an organism's existence. Thus he warns that

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