Complexity, Design, and Natural Selection

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Source: BioScience, 54(2) : 162-164

Published By: American Institute of Biological Sciences

URL: https://doi.org/10.1641/0006-3568(2004)054[0162:CDANS]2.0.CO;2

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Darwin and Design: Does Evolution Have a Purpose? Michael Ruse. Harvard University Press, Cambridge, MA, 2003. 371 pp. $29.95 (ISBN 067401023X cloth).

For a very long time, I have thought that Michael Ruse's best book was *The Darwinian Revolution: Science Red in Tooth and Claw* (University of Chicago Press, 2nd ed., 1999). Now I think that *Darwin and Design* has taken its place. Ruse's unifying themes in this book are design and complexity. He follows these twin notions from the ancient Greeks to Darwin's immediate predecessors and from Darwin himself and beyond to the present. Ruse makes this journey as painless as possible, in large part because of his delightful prose. He also strikes just the right balance between scholarship and comprehension: He knows all the technicalities of the literature that he summarizes, but he does not burden his reader with any of it unless absolutely necessary. I do not know whether Ruse wrote this book with scientists specifically in mind, but it is scientist friendly. Scientists should welcome an opportunity to get a rough idea of what philosophers, theologians, and other scientists and scholars have been trying to get at with respect to design and complexity for the past two thousand years.

Ruse sets out the response of each of his protagonists to three arguments: the argument to complexity, the argument from complexity, and the argument to design. Does the living world exhibit a level of complexity that seems to demand a special kind of explanation? If so, what conclusions can one derive from this complexity? Does it entail a supernatural designer?

Ruse divides his book into three largely chronological sections. First, he presents the various versions of teleology from the ancient Greeks to the Church fathers and such "modern" philosophers as David Hume, Immanuel Kant, and William Paley. Although Paley was nowhere near the philosopher that Hume and Kant were, he was the one who influenced Darwin most directly and extensively. Not infrequently in the history of thought, relatively unsophisticated authors have more impact on subsequent generations than do their more erudite colleagues. Darwin lived while the argument from complexity to design was at its height of popularity, set out time and again in a series of books termed the Bridgewater treatises. Darwin directed his one long argument in the *The Origin of Species* against Paley and the authors of the Bridgewater treatises. More sophisticated opponents would have to wait their turn. As Ruse puts it,

> Darwin accepted the argument to complexity: organic complexity was pervasive throughout the organic world and deserving of solution. He clearly interpreted this complexity as involving end-directed understanding—final cause. His goal, however, was to come up with a scientific explanation that could substitute for the argument to design, the argument to creative intelligence. Darwin proceeded by breaking down the argument to design into a scientific part and a nonscientific part, giving an answer (natural selection) to the scientific part, and then saying that the nonscientific part is really not his concern as a scientist. (p. 112)

According to the usual story, after some initial resistance from Darwin's more religiously biased contemporaries, Darwin's theory triumphed. But in fact the amazing thing about Darwin's theory was how unsuccessful it was. Before Darwin, a few natural historians had suggested that species evolve, but the mechanisms that they set out were not very convincing. When Darwin referred to "my theory," he meant his views about the processes that result in the evolution of species—chance variation and natural selection. After *Origin,* a fairly high percentage of scientists came to accept the idea that species evolve, but they were not all that enthusiastic about Darwin's mechanism. T. H. Huxley thought that evolution was more saltatory than Darwin supposed and did not think that natural selection was up to the task that Darwin had set it, while Asa Gray wanted to introduce a supernatural element into Darwin's theory.

To make matters worse, very few of the next generation carried on in the spirit of Darwin and Wallace, investigating the processes that lead to the evolution of species. Instead, they turned their attention to reconstructing phylogeny. Not until the end of the 19th century did a reasonably large number of biologists begin to investigate the evolutionary process itself, and they did so almost always as opponents of Darwin's theory. By now the story of the rediscovery of Mendel's laws at the turn of the century is overly familiar. I suspect that most biologists are puzzled when they read about the conflict between the Mendelians and Darwinians. How could the two groups of scientists not see that these two theories are compatible?

In any event, these disputes had one beneficial outcome: They forced biologists to start once again in earnest to work on understanding the evolutionary process itself. Under the leadership of Fisher, Haldane, and Wright, followed by Dobzhansky, Simpson, and Mayr, evolutionary theory was made more quantitative and testable. Ruse gives short but fair discussions of adaptationism, drift, the founder principle, mimicry, punctuated equilibria, levels of selection, game theory, kin selection, the comparative method, optimality models, and so on. He then turns to "formalist" critics. The contrast between form and function was

commonplace in Darwin's day. Platonists, primarily Continental Platonists, placed much more emphasis on forms than did their meat-and-potatoes English contemporaries. A role for forms in evolutionary theory has been resurrected in recent years.

All of the preceding discussion prepares the stage for a return to a final treatment of complexity and design. Given all the improvements in contemporary evolutionary theory, how does the argument from design hold up? Ruse begins with nontheistic treatments of design: goal-directed system, functional organization, and human intentions. Then, in the last two chapters, he returns to the idea of God the designer. Here he must distinguish between the United States and the rest of the first-world nations. Only in the United States is the general public so opposed to Darwin's theory. By and large, our schools are not doing a good job of explaining evolutionary theory or the nature of science in general. According to the critics, unless one can see something with one's own eyes, it is "only a theory," and theories are the sorts of things that one can accept or reject as one pleases.

How do present-day creationists handle present-day evolutionary theory? In large measure, they don't. Instead, they use recent disputes over the evolutionary process to argue that even scientists reject Darwin's theory. In the main, they simply trot out 19th-century objections to parodies of 19th-century evolutionary theory. A case in point is the phrase "chance variation." When evolutionists say that variations occur by chance, they do not mean that they have no causes at all. The variations that function in the evolutionary process are "chance" only in the sense that they were not introduced for a purpose. They are caused—totally caused—but only by, say, an increase in temperature, not divine fiat. Evolutionary biology is totally naturalistic, as it must be if it is to count as science.

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A LAYPERSON'S GUIDE TO THE SOUTHERN OCEAN

The Complete Guide to Antarctic Wildlife: Birds and Marine Mammals of the Antarctic Continent and the Southern Ocean. Hadoram Shirihai. Illustrated by Brett Jarrett. Princeton University Press, Princeton, NJ, 2002. 512 pp., illus. $49.50 (ISBN 0691114145 cloth).

Hadoram Shirihai is a conservationist and birdwatcher best known for his works on Western Palearctic birds, and Brett Jarrett, the illustrator, is a wildlife artist. The twofold purpose of this book, *The Complete Guide to Antarctic Wildlife,* is to provide a detailed and accurate popular introduction to the Southern Ocean (broadly defined to include some islands that serve as tourist stops) and to serve as a field identification reference for the birds and marine mammals therein. The book is aimed at the layperson or keen birder with an interest in the Southern Ocean, and the author makes no apologies for not reading much of the scientific literature on the Southern Ocean. In other words, this book is not for researchers looking for a technical book.

The book is divided into three major sections: (1) an overview of the oceanography and ecology of the Southern Ocean and humans' exploration of it, (2) species accounts, and (3) descriptions of the islands and areas of the Antarctic. It closes with a short section on birding and marine mammal touring opportunities in the countries used as arrival and departure points for Antarctic tours.

The first section—the overview—is short; it makes up only about a tenth of the book. In those pages, Shirihai covers everything from geological history to oceanography, sea ice characteristics, oceanic food chains, conservation issues, a checklist of species, and the history of Antarctic exploration. Given that there are whole books devoted to each of these topics, the author tried to do too much in the allotted space. A problem throughout this section is that some technical terms are defined but others are not. For example, "Ekman transport" is presented without definition, but a few pages later, a full paragraph is devoted to the definition of convergence and divergence. If a layperson is supposed to know what Ekman transport is, I imagine that he or she would know what convergence and divergence are as well. I noted one error in this section: There is no illustration of a food chain on page 25, although one is cited in the text. (I think the author was referring to figure 4 on p. 27.) The readability of this section is impaired by the unfortunate decision to use "ad" for adult and "imm" for immature in the text, resulting in phrases like "but even as ads on foraging trips from the nest...." It is an annoying affectation.

The next section, on species accounts, makes up roughly two-thirds of the book. It is quite detailed. Although there are more species per plate than in other identification books, this section is nicely illustrated with photographs. I also liked the background colors on the plates, which gave a nice contrast to the illustrations. Moreover, the species accounts are nicely written to include information on vocalizations, ecology, and conservation status. The author's description of the current state of flux in albatross taxonomy is also well done, and the albatross section is particularly well illustrated with plates and photos. The marine mammal section is nicely done as well, and there are many handsome photos. I particularly appreciated the author's comments on what identification features can and cannot be expected to be seen at sea. I found only one identification error: On p. 74, two penguins, the Fiordland penguin and the Snares penguin, are misidentified. It is easily seen to be an error, because there is a photograph of a Fiordland penguin right next to the photograph with the erroneous identification.

The third section of the book, site descriptions of the islands and the Antarctic, will be of interest to any armchair adventurer. Most of us will never be lucky enough to travel to these areas (and many areas are off-limits to tourists), so it was

fun to read the different descriptions. However, there is still a problem with the level of expertise that is expected of the reader. In some passages, only Latin names for species are used in describing the flora. A professional botanist might understand these terms, but it is quite a stretch to think that a layperson will. Another problem with the section is that there are no legends for the maps. This means, for example, that the reader has no idea why the maps show different shades of green. I imagine they denote topography, but without a key, the colors are meaningless. In addition, some names on the maps are labeled in red rather than black, without explanation. I think the difference in color indicates that those areas are mentioned in the text, but again, without a key, the effect is puzzling rather than informative.

This section also has a wide variety of errors of fact. For example, Rothera Station is positioned in the wrong place on Adelaide Island (the map on p. 389); there is no Togerson Island at Palmer Station (it is *Torgersen* Island; p. 395); and the Transatlantic Mountains do not divide east and west Antarctica (the mountains are the *Transantarctic* Mountains; p. 470). There are many other errors in this section, including two mountains (or high points) that change height from the text to the map (in one case, the difference is 155 meters); a switch from the metric system to nonmetric units (miles) in one paragraph; and the statement that a treaty (signed in 1998) puts oil reserves off-limits until the mid-20th century (we are currently in the 21st century). Finally, Charles Wilkes was convicted in his court-martial; the court-martial was not "quashed," as claimed in the text.

The number of factual errors in the book invites suspicion about the accuracy of other information. Numerous grammatical errors mar the text as well. Some are clearly typographical (e.g., the lack of capitalization at the beginning of sentences), but others make me question how carefully the book was edited (e.g., using "affect" when the correct word was "effect"). Proofreading was poor in many places. Here are two examples: "to have come second was almost not have run" (p. 464) and "matters also did not go to plan" (p. 465). I eventually got tired of keeping track of such mistakes. This is not what I expect from a book with a Princeton University Press imprint. I talked to three other people about this book, and they all said the same thing: "The pictures are gorgeous." If you want a picture tour of the Southern Ocean, this is your book.

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THE PRICE OF RESISTANCE

Battling Resistance to Antibiotics and Pesticides: An Economic Approach. Ramanan Laxminarayan, ed. Resources for the Future, Washington, DC, 2003. 400 pp., illus. $65.00 (ISBN 1891853511 cloth).

I should state at the outset that, although the book in review is about the economics of battling evolved resistance to pesticides and antibiotics, I am a microbiologist and much more familiar with antibiotics than with pesticides. Furthermore, living in a country whose economy is handled by politicians with scant respect for rational analysis, I had not even realized that the economic approaches described here were possible.

Ramanan Laxminarayan, the editor of *Battling Resistance to Antibiotics and Pesticides,* is a fellow at the Washington, DC, think tank Resources for the Future and an expert on the intersection of economics and public health, especially resistance and the management of malaria. More than half of the book is devoted to pesticides. Most chapters deal with specific mathematical models borrowed from economic theory and applied, sometimes with modification, to resistance. Although I lack the mathematical background to evaluate the math critically, the book includes, intercalated among the mathematical chapters, critical discussions by biologists knowledge-

able about the modeling. These discussions offer clear explanations of the issues and allow the reader to compare models that approach similar problems in different ways. In sum, the reader gets a pretty good idea of the goals and the reach of each model, and the big picture is very interesting.

The models grapple with a very complex phenomenon. Dealing with multiple types of resistance, coselection, and non-Darwinian evolution, while also reckoning with the social forces that must be considered in combating antibiotic resistance, is an immense task. One revealing example contrasts two models, one of which seeks to incorporate the biological cost of resistance traits in the absence of selective pressure from antibiotics. Biological questions about this cost are far from resolved, and there is not yet enough evidence to establish its magnitude. But results from the models, when compared with the behavior of pathogens in the real world, can help researchers decide which model more closely resembles nature. Another model that shows itself to be particularly useful in understanding the treatment of infectious diseases comes, surprisingly enough, from highway traffic management. Mathematical modeling aside, the book is packed with data on the economic impact of resistance, data that are useful to keep in mind when discussing the real-world relevance of research on antibiotic resistance.

The part of the book that deals with pesticides centers on the strategies deployed to slow the pace at which bugs become resistant to *Bacillus thuringiensis* (Bt) toxin, which has been genetically engineered into many crops. The principal strategy—namely, scattering wild-type crops among crops containing the toxin—is discussed by authors advocating a variety of approaches. Using a comparable strategy for antibiotics would clearly be impractical and unethical: We could hardly deny access to antibiotics to some fraction of the population so that they could serve as reservoirs of susceptible bacteria. Nonetheless, it is widely believed that restrictions on the use of quinolone antibiotics in children have kept resistance to these drugs from spreading more rapidly than it has; in a sense, then, children may be serving as reservoirs of susceptibility to pathogens, much as wild-type crops are reservoirs of susceptibility to Bt toxin.

Resistance to antibiotics, and most likely to pesticides as well, is mainly a consequence of the abuse of these powerful weapons. Some antibiotics are prescribed for nonexistent illnesses, for example, or for conditions unlikely to be affected by them. Advocates of the rational use of antibiotics are increasingly trying to persuade physicians to refrain from prescribing antibiotics in such instances. But these advocates usually operate in an academic mode, delivering colorless talks and papers. They are competing against costly and aggressive

promotional campaigns designed by pharmaceutical companies to persuade physicians to prescribe as many antibiotics as possible in the short term. This policy runs counter to the best interests of society in a number of ways, yet companies pursue that policy because it seems to be profitable to do so. Although educational efforts are making some progress, pharmaceutical companies will continue to promote abuse unless biomedical scientists provide compelling evidence to corporations that it is better to keep antibiotics useful for a long time than to "burn" them fast in search of quick revenues. I do not believe that researchers can yet produce such compelling evidence, but after reading Laxminarayan's book, I know there are ways in which it might be attempted.

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NEW TITLES

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