The Evidence for Evolution

Author: Nehm, Ross H.

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portions of the oceans), and to biodiversity in general after analyzing feedback from initial extinctions. In these chapters, some of the principal challenges that species will face in coping with climate change are superbly laid out. Many tropical species are unlikely to adjust to climate change solely by shifting their geographical distributions, for example. In some lowland areas of the tropics, certain species would need to migrate at a rate of 32 meters per day to keep ahead of the warming trend. Likewise, freshwater faunas often have no viable route through which to shift their natural range because of a lack of waterway connections to areas projected to have a suitable climate in the future.

The last two chapters of *Saving a Million Species* focus on conservation strategies for reducing extinction risks and provide an overview that urges us to proceed with actions that will reduce risk now, even if important aspects of that risk remain uncertain. The final chapter, written by Hannah, urges us to use incentive-based complements to regulation in order to reduce emissions, such as the Reduced Emissions from Deforestation and Degradation (REDD) program under the United Nations Framework Convention on Climate Change. He also encourages us to take action to preserve biodiversity by strengthening the network of corridors that connect reserves, so that species can more easily shift their geographical distributions in response to changes in climate.

With the understanding that it is impossible to address every line of evidence that is relevant to this topic in a single volume, I submit that there are arguably a few additions that would have improved the book further. A few of the chapters, such as "Extinction Risk at High Latitudes" (chapter 8), felt a bit thin, having useful content but too little detail. Given the excellent chapter on future risks to freshwater faunas (chapter 17), it would have been helpful to have a paleontological chapter with a focus on those groups of species (such as trees and freshwater fishes) that saw major extinction events during the Pleistocene, since these groups provide important insights into the synergies among climate changes, dispersal barriers, and habit loss (Schwartz et al. 2012). Finally, a greater focus on recent advances in reducing the risks of extinction would have been pleasing to read, although the constraints of an edited volume are certainly real and understandable.

This book is a tour de force overall and an excellent summary of the issues relating to extinction risk from climate change. Each chapter is well written and provides useful inroads to the relevant literature. Hannah has done an excellent job of inserting the right amount of overlap between contributions, and the result is a unified volume that reads like a book and not like a collection of chapters. But the book's greatest strength comes from its collection of ideas, perspectives, and reviews on this complex topic, resulting in the whole being much greater than the sum of its parts. *Saving a Million Species* provides a single reading source for anyone who wants to quickly get up to speed regarding the risks that changes in climate pose for species extinction. This book would serve well in a seminar at either the advanced undergraduate or graduate level. Edited volumes this useful are few and far between. I recommend *Saving a Million Species* to anyone interested in the conservation of biological diversity.

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DOV F. SAX

Dov F. Sax (dov.sax@gmail.com) is an assistant professor in the Department of Ecology and Evolutionary Biology at Brown University, in Providence, Rhode Island. His recent coauthored publication for the journal Ecology Letters *(2011 14: 1125–1133) is entitled "Analysis of climate paths reveals potential limitations on species range shifts."*

EVOLUTION: EVIDENCE AND ACCEPTANCE

The Evidence for Evolution. Alan R. Rogers. University of Chicago Press, 2011. 128 pp., illus. $18.00 (ISBN 9780226723822 paper).

Although scientists view evolution as an indisputable feature of the natural world, most Americans simply do not believe that it occurs, or they reject naturalistic explanations for biotic change. Empirical studies have revealed that students and teachers often know quite a bit about evolution but still do not accept it. This somewhat counterintuitive finding has been empirically corroborated and has led science educators to investigate this pattern in order to provide suggestions for effective evolution instruction (e.g., Rosengren et al. 2012). Within the lucid, compact, up-to-date, and highly readable pages of *The Evidence for Evolution*, author Alan R. Rogers takes an approach that most science educators have found inadequate: exclusively using logic, parsimony, and the force of evidence to precipitate conceptual change about evolutionary belief. Reactions from both supportive and dissenting readers to this nicely written text will depend on how much faith they place in the use of logic to challenge the worldviews of intelligent-design creationists.

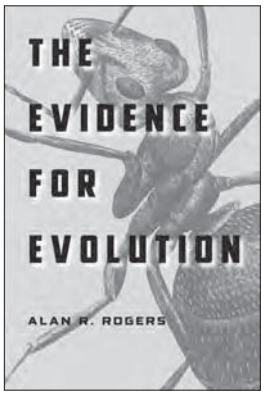
Two premises appear to frame this short book: Biology courses and textbooks are focused on evolutionary mechanisms at the expense of the evidence for evolution, which most people are not aware of, and once disbelievers of evolution are exposed to

the massive amount of evidence that exists, they will change their beliefs. I am not sure whether most biologists would agree with the first premise, given the increasingly elaborate coverage of evolution in textbooks. Indeed, having reviewed some of the best-selling introductory biology books (Nehm et al. 2009), I know that many topics that Rogers discusses are, in fact, covered in these texts. I am also doubtful as to whether science educators would agree with the second premise: Empirical studies have shown that learning more about evolution often fails to precipitate a meaningful belief change.

Within the 10 chapters that form the structure of *The Evidence for Evolution*, the choice of topics is excellent. Also noteworthy are the use of fresh empirical examples, the integration of phylogenetic trees, and the inclusion of paleontological patterns, radiometric dating, and genomic data. The evidence for evolution is vast, and choosing appropriate examples for a short book is no small task.

Writing about evolution can be quite challenging, given that many students and teachers view teleological factors as sufficient explanations for evolutionary change. It is important, therefore, to clarify what we mean when we use such language (Rector et al. 2012). At times, Rogers uses intentional or teleological language: "Every living thing must solve many engineering problems just to stay alive" (p. 34). Although biologists will understand what Rogers means, the same may not be true of novice readers. Individual organisms cannot willfully change the traits that they have (e.g., they cannot intentionally modify a phenotypic feature).

Language may also invoke ideas that are at odds with current scientific thinking, and although Rogers writes with precision and clarity, some exceptions are worth mentioning. Trait loss, for example, has been shown to be a particularly difficult concept for students and teachers to understand (Nehm and Ha 2011). When describing the loss of whale limbs ("Over the next few million years, whales relied less and less on their legs," p. 20, or "Hind limbs dwindled," p. 22), his language may be in greater alignment with common misconceptions about use and disuse than with natural selection. When writing about evolution, scientists need to be more cognizant of readers' potential interpretations of the language that we use.



One literary device employed throughout the text is the contrast of supernatural explanations (e.g., "Perhaps we sprang from the hand of God," p. 81) with naturalistic, evolutionary explanations. Although this approach makes the text engaging, it makes little sense from my perspective and has the potential to exacerbate readers' existing confusions about core ideas relating to the nature of science (NOS). Most students and teachers remain unaware of the ontological presuppositions that undergird the scientific process (e.g., methodological naturalism). By definition (e.g., from the National Academy of Sciences), science cannot speak to or evaluate the relative merits of supernatural explanations; no amount of evidence will ever be able to tip the scale in favor of a naturalistic explanation relative to a supernatural one or vice versa. It is not clear why Rogers takes this approach.

Students' and teachers' evolutionary acceptance levels are known to be related to their understanding of the NOS. Because many Americans are deeply confused about NOS concepts such as *observation*, *inference*, *testability*, *theory*, *law*, *model*, *proof*, *experiment*, and *hypothesis* (Lederman 2007), addressing NOS misconceptions has become *de rigueur* in evolution education. I was surprised, therefore, to find that *The Evidence for Evolution* does not discuss what *evidence* is or how the term is used in evolutionary science. More problematic is the somewhat careless use of NOS terms (e.g., "this experiment *proved* that," p. 12, emphasis added, and "we can also *see new species forming*," p. 16, emphasis added). In order to prevent the reinforcement of such NOS misconceptions (e.g., that scientific knowledge is certain because it is *proven*; or the conflation of *observation* and *inference*), the meanings of everyday and scientific terms must be carefully distinguished for readers.

To make the most of Rogers's important contribution, pairing *The Evidence for Evolution* with a textbook about the NOS (e.g., Espinoza 2012) is much more likely to achieve what the author admirably aspires to: an understanding, acceptance, and appreciation of evolutionary science. Facts, logic, and parsimony are unlikely, on their own, to affect most people's perceptions of the plausibility of evolution.

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ROSS H. NEHM

Ross H. Nehm (nehm.1@osu.edu) is an associate professor of science education and evolution, ecology, and organismal biology at The Ohio State University, in Columbus. His research on evolution education was recently highlighted in Thinking Evolutionarily: Evolution Education Across the Life Sciences *(National Academies Press, 2012).*

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