MEGHAN GUINNEE, DEPARTMENT EDITOR

## PALEONTOLOGY

**Extinction: How Life on Earth Nearly Ended 250 Million Years Ago.** By Douglas H. Erwin. 2006. Princeton University Press. (ISBN 0691005249). 296 pp. Hardcover. $24.95.

This is a mystery story, a paleontological tale about what caused the most destructive of the six major extinctions in Earth's last 600 million years, namely the Permian or Permo-Triassic extinction, 250 million years ago. The Permian extinction, which actually consisted of two extinctions some 20 million years apart with the latest being the far greater, far overshadow the Cretaceous (or Cretaceous-Tertiary) extinction of 65 million years ago that led to the demise of the dinosaurs. During the Permian extinction about 95 percent of all living species died out—at least nine out of 10 species in the ocean, 82% of marine genera, fully half of all marine families, and, on land, plants and animals came closer to complete elimination than at any point since they first evolved. Biodiversity plunged from hundreds if not thousands of species at a single locality, with thousands of individuals, to only a dozen or so species.

The author is the world's foremost authority on the Permian extinction with more than 20 years experience studying Permian outcrops around the world, and most notably in China, Iran, northern Italy, Utah, and Texas. His long-sought goal is unraveling the mystery, the trigger that caused such a massive loss of life. He explores the several hypotheses about the cause of the Permian extinction and focuses on four: meteor or comet impact (such as was responsible for the Cretaceous); climatic destruction from massive volcanism in Siberia; the oceans becoming anoxic; and what he termed the *Murder on the Orient Express* in honor of the Agatha Christie mystery, where the solution was that *all* the suspects participated in the crime.

Following a succinct overview introductory chapter, Chapter 2 ("A Cacophony of Causes") outlines the possible causes in detail, citing, amongst other things, a brief accounting of the five other mass extinctions. Chapters 3 to 7 detail the existing evidence to evaluate each hypothesis. In Chapter 8 ("Denouement"), the several hypotheses are again evaluated and the author's conclusions are presented—to keep it a mystery, this reviewer will not divulge Erwin's conclusion. Chapters 9 and 10 discuss the long recovery following the mass extinction and its impact on the history of life. He notes that "... understanding the recovery after the extinction poses a far greater intellectual challenge ... and [has] attracted far less attention than the extinctions themselves."

Although the topic and the detailed analyses could make for a difficult read, the author's ease of communication, identifying his colleagues and dissidents, and occasional gibes and light-hearted asides provide a highly accessible and comprehensive account.

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## ECOLOGY

**How to Do Ecology: A Concise Handbook**. By Richard Karban and Mikaela Huntzinger. 2006. Princeton University Press. (ISBN 0691125775). 145 pp. Paperback. $16.95.

If you have been looking for the perfect gift for an undergraduate contemplating graduate school in ecology, or a beginning ecology graduate student, you have found it in this book. Short, with a conversational tone, this book is a wealth of information for beginning professionals. Reading this book is like eavesdropping on a finishing graduate student or professor taking a novice under her wing to explain what she has learned about surviving in this field, not the specifics of a particular system, but the broad view as to how to approach graduate school and research in general. However, finishing graduate students never have the time to do this (too busy finishing theses) and professors (especially at research institutions) often have less time. I constantly found myself thinking: "This is exactly what I tell my undergraduates who are doing research with me. ... I wish someone had told me this before graduate school." Of course, reading a book cannot take the place of actual experiences that drive home these messages. But this text is a good place to start, and a good reference to come back to early in graduate school when often frustrations and stumbling blocks abound. The main limitation of this book is that, other than undergraduates and graduate students in the first half of their Ph.D. thesis, the interested readership will be limited. It was fun for me to read it, as someone who has passed this stage and can agree with the words of advice, but I did not learn much new, nor will a general reader find much relevant information, except for ideas on how to design good experiments.

The book is organized into seven practical chapters, including: (1) picking a question, (2) posing a question/picking an approach, (3) using experiments to test hypotheses, (4) analyzing patterns and data, (5) working with other people (including suggestions on how to pick a graduate school), (6) communicating what you find (journal article writing, oral presentations, posters, and grant and research proposals), and (7) conclusions. The various chapters include basic statistical considerations for designing rigorous experiments: replication and the importance of unbiased sampling, blocking factors, power analysis (briefly), meta-analysis (briefly), and the issue of the scale of an experiment. They make the important (but rarely noted) distinction between statistical significance and biological significance. The major emphasis of the book is on creating rigorous manipulative experiments (from conception to publication), that reflects the current emphasis in the field of ecology.

The authors do a nice job of giving overarching suggestions and then following them up with specific examples that span a wide range of systems (snails, goose eggs, cicadas), although admittedly with a terrestrial bias. Brief, personal stories elucidating points are peppered throughout, clarifying issues and providing humorous touches (e.g., Karban's college girlfriend pestered him to forgo buying a red car because they were involved in more accidents—not realizing the confounding issue of the type of people who might be drawn to red cars). Karban and Huntzinger provide advice within the context of reality. For instance, they assert time spent observing organisms in the field is critical to develop intuition about the system, but recognize

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that other commitments limit these opportunities. Thus, they advise spending two days just observing before starting manipulative experiments and continued note-taking on natural variation during experiments for better results interpretation and refinement of future experiments.

While this book is certainly just a launching point, it covers a wide range of topics that are relevant to the beginning ecologist and provides a nice list of references where the interested reader can get more (and more specific) information on various topics. Some techniques beyond the novice level arise (partial regression coefficients, goodness-of-fit tests), but mention of these are brief and further references are provided. While someone in the field for years might not learn a tremendous amount of new information from this book, it is a fast read and a good reminder of important principles often overlooked in the daily grind. I found a few gems that surprised me (e.g., losing measurement precision to get as large a sample size as possible is fine, the central limit theorem of probability will fix the sloppiness as long as the errors are unbiased), and the writing style and content is invigorating and encouraging, never boring. I think the authors have succeeded in their goal of providing a useful, concise handbook to performing ecological investigations.

I give this book 5 frogs for undergraduates and beginning graduate students interested in ecology; 3 frogs for a general scientific audience.

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# EVOLUTION

**The Evolving World.** By David P. Mindell. 2006. Harvard University Press. (ISBN 0674021916). 341 pp. Hardcover. $24.95.

Mindell's book presents the ubiquity of evolutionary theory in everyday life over six chapters. The first chapter details the history of science and its frequent collisions with popular culture. He recounts the histories of heliocentrism, germ theory of disease, and evolution. By providing the history of the first two, the reader is in a position to accept the history of the latter, evolution, as no different from any other scientific revolution.

Chapter 2, a la *The Origin of Species*, details the history of humans and selective breeding in domesticated plants and animals, and pathogens. Biogeographical maps suggesting the geographic origin of the species and the direction of spread are provided for each species discussed.

Chapter 3 covers the role of evolution in public health and medicine. He presents a mini-lesson in phylogeny describing the kinds of evidence used to construct the hypotheses of relatedness, and he shows their usefulness: "Accurate identification of closest known relatives for new pathogens enables initial hypotheses about the pathogen's basic life history, as these traits tend to be shared among close relatives. This includes identification of likely host species, their geographic distribution and favored habitats, as well as the pathogen's likely mechanisms of reproduction and transmission." (p. 98-99).

West Nile Virus, Ebola, Influenza A (responsible for the 1918 epidemic), HIV, and anthrax are discussed at length, accompanied by phylogenies. Each pathogen's phylogeny is a full page, and includes a line drawing of the pathogen, a world map indicating its point of origin, and factoids regarding its evolutionary history, adaptations, dispersal mechanism, recent evolution, and how best to minimize its presence in human populations.

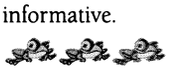
Virulence is described as varying with dispersal mechanisms. That is, a pathogen spread by human contact, such as AIDS, tends to be relatively less virulent then one dispersed by a vector such as malaria. Extremely virulent HIV strains are selected against, as they would die with their host before having a chance to spread to another host and reproduce. In contrast, virulent malaria is not a negative selecting agent, because mosquitoes carry the pathogen from host to host; the host does not have to be mobile, they can be confined to a bed. Thus, natural selection explains the differing evolutionary paths of these pathogens. This informs disease control strategies.

Other concepts discussed include antibiotic resistance, the role of microbes in chronic diseases and directed evolution of molecules–a process analogous to selective breeding. A "population" of DNA or RNA molecules is assessed for ability to synthesize a therapeutic protein. The best performing molecules are selected and nucleotides shuffled. Again the population is assessed, and again the best performers selected. This is repeated until a reliable level of protein production is reached.

Chapter 4 discusses the roles of phylogeny, biogeography, and molecular ecology in deciphering biodiversity and thus informing conservation practices. The fifth chapter seems to veer off course a bit. Here the metaphorical use of evolution in human culture is discussed. Religion and language have both evolved, but not by the same mechanisms as life has. Mindell goes to great pains to point how the two kinds of evolution can be analogous while emphasizing the differing mechanisms. The final chapter highlights the intersection of politics and justice with the application of evolutionary principles. The history of the intelligent design movement's efforts to gain a foothold in public schools is recounted. Several examples of the use of DNA evidence to convict or exonerate suspects are presented. Eugenics is described as a misinformed movement where inadequately understood scientific concepts were applied to a cultural phenomena leading to inevitable failure. He drives home the point that one cannot be selective regarding the realities of evolutionary theory and its applications. "Those who deny the tenets and findings of evolution, however, must also deny or ignore a large and growing body of applied evolutionary science." (p. 292).

While the intent of the book is noble, it is not clear who the intended audience is. If it is the general public, there is a likelihood the phylogenies and sentences like "Reversion to virulence is not an issue because the chimeric entity does not carry the full virulent pathogen genome, and contamination with other source pathogens is obviated because the construct" (p. 139), will be lost on them. However, the opening chapter recounting some history of science might be informative. On the other hand, if the intended audience is the biology major, then much of the book's content becomes redundant. For example, Chapter 2 is a recap of *The Origin of Species*, with which most biology majors are already familiar. Discussion of the development of vaccines, rapid evolution of viruses, and DNA evidence in court cases is also old news.

Mindell, a working scientist, should be applauded for this attempt to make evolutionary theory applications apparent. He observes that even if people don't realize the far reaching implications of evolutionary theory, they still benefit from it unwittingly. He compares that to not understanding the theories that explain how our cars work, yet we still benefit from using them. If the general public could assume this attitude toward evolutionary theory, continued progress in biological sciences is certainly assured. Secondary and college teachers of biology and biology majors will find parts of this book tedious and other parts astutely informative.



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