History of Life, 4th Edition, Richard Cowen, 2004, Blackwell Publishing, Malden, 324 p. (Softcover, US $79.95) ISBN 1-4051-1756-7.

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At many universities, large survey classes in geology remain a staple offering with which students can fulfill a distribution requirement in the sciences. While such courses may result in an occasional geology major, they mostly serve to expose non-scientists (i.e., the soon-to-be general public) to a discipline of which they are, at best, vaguely aware. Within the genre, courses outlining the history of life are particularly attractive because they allow a great deal of flexibility to suit an instructor's interests and expertise. Moreover, the subject can be used to demonstrate how different scientific disciplines may be integrated in the pursuit of knowledge. Finally, biological history, when delivered as a seamless narrative, informs the lay public about its origins and relationship to the biological world and geological past.

Richard Cowen hits all of these nails on the head with the 4th edition of *History of Life.* Written for an introductory course Cowen has taught for over three decades at UC Davis, the book serves to delineate many critical events in the evolution of animals. Throughout, Cowen is careful to distinguish fact from interpretation, and explains how, in paleontology, a pecking order of more- to less-robust interpretations (the latter including guesses) exists. Cowen encourages the reader to analyze critically the interpretations that are offered for various observations. I like especially the integration of many chemical, biologic, paleontologic, and geologic principles within the narrative. As a result, the book deviates from a more standard format of having the first third cover principles while the latter two-thirds cover the subject at hand.

The integration across scientific disciplines is expressed especially well in the early chapters. For example, Chapter One outlines the primary hypotheses relevant to the origin of life. In doing so, it integrates mineralogy (clay minerals as templates for organic molecules), biochemistry (the polar structure of a lipid cell), and microbiology (lifestyles of various bacteria). Chapter Two introduces the basic concepts of taphonomy, stable isotope geochemistry, and geologic time while describing our knowledge of Archean and early Proterozoic life. Principles of cladistics, natural selection, and endosymbiotic theory are integrated into the narrative of the origin of eukaryotes and sexual reproduction presented in Chapter Three. The reader can pick virtually any chapter and find a great deal beyond a simple exposition of what organisms were on the planet during a particular interval of time.

Although Cowen has chosen to focus on the evolution of vertebrates for the sake of readers' familiarity, there is a great deal of information about invertebrate organisms. Some of this is for the obvious reason that any book with this title will discuss life that was on the planet during pre-vertebrate time. This history is continued in Chapters Four (evolution of metazoans, complete with Cowen's ideas for the importance of a slushball earth as a catalyst) and Five (events occurring between Vendian and Middle Cambrian time—the Ediacaran Fauna, first shelly faunas, Cambrian explosion, and Chengjiang and Burgess Shale faunas). Chapter Six is devoted to Phanerozoic diversity, Sepkoski's global faunas, and mass extinctions. An excellent discussion is given about the variety of mechanisms for mass extinction that have been proposed during the last 25 years.

The history of vertebrate life begins in Chapter Seven, and is recounted in the succeeding 14 chapters. Chapters 7–10 outline the major events in the Paleozoic history of vertebrate organisms. These include the origin of jaws, air breathing, and terrestrialization (all of which, in Cowen's narrative, are adaptations for becoming a better fish). The amniotic egg is introduced as a spaceship to convey embryos of aquatic organisms on land. The principles and development of thermoregulation in early reptiles is discussed at some length (with a refreshing re-analysis of the purpose of the sail borne by *Edaphosaurus* and *Dimetrodon*). Throughout this portion of the book, Cowen emphasizes that natural selection operates to produce solutions to various biological problems, rather than directing a march toward fully terrestrial animals.

The history of Mesozoic vertebrates comprises Chapters 11–16, and begins with a discussion of the Triassic takeover by diapsid reptiles. Principles of biomechanics and physiology are presented in a discussion of metabolism, respiration, and locomotion in Chapter 11. Cowen places this discussion in the context of the radiation of archosaurian reptiles in Late Triassic time. Dinosaurs (not including birds) are the subject of Chapter 12, in which the author again turns to the subject of thermoregulation and evidence for endothermy in dinosaurs. New data on the spectacular feathered dinosaurs from the Cretaceous of China are summarized in a section devoted to the origin of feathers. Flying vertebrates (and invertebrates) and the origin of flight are the subject of Chapter 13. Once again, biomechanics are integrated into the narrative, as are various ecological hypotheses for the evolution of flight. Chapter 14 is devoted to the large marine reptiles that dominated oceanic ecosystems during Mesozoic time, as well as the parallel evolution of land plants and organisms that serve as vectors for seed dispersal and pollination. Cowen combines these topics so the reader understands that marine and terrestrial ecosystems are connected. Land-plant evolution is thus implicated as a root (no pun intended) cause for the higher productivity suggested by the radiation of large fish-eating predators in Mesozoic seas. The origin of mammalian characteristics is presented in Chapter 15. Cowen is careful to point out that acute vision, hearing, and other mammalian characters, while successful today, did not allow Mesozoic mammals to compete with dinosaurs for open terrestrial ecospace. This discussion closes the chapter, and sets up the ecologic importance of the K/Pg extinction event, which is presented in Chapter 16.

The final chapters of the book are devoted to Cenozoic mammals. As with earlier chapters, Cowen integrates seamlessly a variety of associated topics. In Chapter 17, early Cenozoic mammals are presented along with discussion of the utility of molecular clocks and the organization of ecosystems into guilds. Chapter 18 essentially is devoted to biogeography and evolution, with examples drawn from mammalian faunas that radiated on continents that became separated as Gondwanaland broke apart. Various primate groups are the subjects of Chapter 19. This is the only chapter in the book that simply lists various groups of organisms and is accordingly, a bit dry. Human evolution is presented in Chapter 20, beginning with Australopithecenes and concluding with a discussion of evolution among modern humans. Vertebrate life during Pleistocene time is the subject of the final chapter. Cowen begins with a discussion of climate change and Milankovitch cycles. The effects of the ice age on terrestrial faunas are discussed for the Americas and Australia. Human-induced extinctions on islands and in North America are presented as the book draws to a close. Cowen uses the final section to make his case for ecosystem conservation, and reminds the reader that study of the history of life can be applied to modern ecological problems.

In general, the book is extremely well written and is presented as a narrative with a great many interrelated themes that are woven in and out. I found it very approachable, even though many pages are text-heavy. There are no color illustrations or photographs (save on the front and back covers) and the combination of austere line art and numerous cladograms and phylograms began to tire me as I entered the later chapters. There are a few confusing references to figures, and some typographical errors (for example, in Chapter 1, the reaction of H_2S and CO_2 driven by photosynthesis is given when the author is discussing the use of H_2O in the reaction). The limericks distributed sporadically in the margins are a nice touch, although the rhyming in some is a bit forced. Cowen has added symbols throughout the book to indicate web support for various topics. I found the website very dense and not particularly appealing visually; I am skeptical that the typical student would access it regularly unless required to do so. The site is a wonderful image resource, but I think a student might be more likely to pay close attention to a few representative color photographs in the book (then again, I did not grow up with access to the internet). Finally, each chapter ends with a very useful annotated bibliography. The reading lists provide ample starter material for a term project as well as resources for more in-depth information. The references are as up-to-date as possible given their publication in

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a textbook. I would not use this book for a survey course at Cornell College because our block plan affords different opportunities for learning. However, those of you teaching a large survey course on the History of Life over a semester or quarter should have a careful look at Cowen's latest version of his textbook—he has been tweaking and updating it for 15 years.

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Extinctions in the History of Life, Paul D. Taylor, 2004, Cambridge University Press, Cambridge, U.K., 191 p. (Hardcover, U.S. $70.00) ISBN: 0-521-84224-7.

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Excepting perhaps the topic of dinosaurs, extinction is probably the biggest "ooh-aah" topic in paleontology, at least from an undergraduate student's perspective. The book, *Extinctions in the History of Life,* edited by Paul Taylor, is aimed specifically for that audience, and has an appropriate title for catching the aspiring geologist's attention and imagination. From the paleontologists' perspective, extinctions are a major topic of importance—not only have they shaped the history of life on Earth, and in the case of mass extinctions, are major events in the biosphere, but also extinctions and the data gleaned from them may have great importance to modern ecological crises.

The preface itself is a good opening for the rest of the book, and puts the subject matter in solemn perspective: that most of life on Earth is extinct if one includes the fossil species. Taylor goes on to point out the positive aspect of extinction, which is that the process of extinction is a major former of the pattern of life on Earth.

There are six chapters in the book, ranging from Precambrian microbial paleontology through macroinvertebrates and plants; no single chapter is dedicated to microfossils or vertebrates. Each chapter originates from an attendee of a symposium by the Center for the Study of Evolution and the Origin of Life (CSEOL) at the University of California, Los Angeles.

Chapter 1 is as it should be, a good overview of the topic and a strong introduction to the rest of the book. Taylor stresses the importance of extinctions in the history of life on Earth, and reviews the primary issues surrounding mass extinctions. The chapter also includes a short discussion of the history of thought behind extinctions, which is crucial not only for the understanding of the history itself, but also to set the stage for understanding the history of thought that culminates in current understanding of extinctions and extinction processes. Taylor also briefly touches on the modern extinction, mainly in numerical data, which can be sobering if the undergraduate reader understands what the numbers mean.

The second chapter is entitled "Extinctions in life's earliest history," but a more apt title might be "Lack of extinctions in life's earliest history." William Schopf summarizes some of his earlier published work in this chapter, comparing the almost monotonous record of microbial life in the Precambrian to the diversity—and diversity of evolutionary and extinction patterns—of Phanerozoic life. Although he treats in detail his theories of why Precambrian life is essentially static and unchanging compared to later biota, he neither mentions a major extinction in acritarchs nor the existence and obvious disappearance, or extinction, of Ediacaran biota near the end of the Precambrian. Furthermore, although he describes early microbial life, especially cyanobacteria, as essentially unchanging, modern work on bacterial DNA suggests that microbes indeed evolve more rapidly than Schopf proposes. As Schopf notes, we have no internal structures from these Precambrian microbes; thus, the microbial ecoscape of early life appears to be unchanging.

Scott Wing's third chapter is a discussion of mass extinctions in plants from several perspectives. Because many people reading the book likely study animals and/or microscopic organisms, or are undergraduate students introduced to mass extinctions from a historical geology class, Wing provides a novel perspective on mass extinctions. Wing deftly compares the effects of both temporal and spatial scales on interpreting patterns and causes of mass extinctions by presenting a general overview of global patterns at a coarse temporal scale, and then analyzes plant biodiversity issues at regional and local stratigraphic scales during four extinction events as recorded in animal fossils. This is an excellent discussion point for students; extinctions may exhibit different patterns at different scales, and mass extinctions are not spatially and temporally homogenous. In addition to the information provided in the chapter, Wing provides two appendices on basic information about plant clades and fossilization, which are useful for the student unfamiliar with paleobotany.

David Bottjer presents a short discussion on Permo–Triassic through early Jurassic mass extinctions in chapter 4. The main focus of the opening of the chapter is the extinction patterns in reef ecosystems through the Early Mesozoic, from which Bottjer quickly shifts to examining long-term ecological degradation and its causes. He suggests that major volcanism during the breakup of Pangaea, with its subsequent input of large amounts of carbon dioxide into the atmosphere, is the root cause of this long-term ecological crisis and resulting mass extinctions. The possibility of bolides as a culprit of mass extinctions is another idea that Bottjer raises, and he closes with the idea that if a bolide were to hit Earth during this present ecological crises, then a mass extinction likely would occur. However, according to many scientists, some of whom have written chapters in this book, a mass extinction already is occurring, and does not need an extraterrestrial impact to get it going.

The fifth chapter is a very good and very well organized discussion of many potential causes of mass extinctions, which would be better suited as the second chapter in the book before the discussions presented by Schopf, Wing, and Bottjer. Paul Wignall introduces two major ideas to the reader: "proximate" and "ultimate" causes, which emphasize the difference between the trigger of global changes versus which of those global changes negatively impact the biosphere. In this chapter, Wignall introduces "numerous viable and competing mechanisms" (p. 147), but also stresses that there may not be one single cause, or one single paired cause-and-event type of situation. On a last note, Wignall also is occasionally and cleverly humorous in making a very important point; for instance, "Mr. Basalt" makes a surprising entrance.

The final chapter discusses the all-important aftermath of recovery following mass extinctions, which is as crucial to the history of life on Earth as the extinctions themselves. Furthermore, David Jablonski presents an appropriate tie-in to modern ecological crises and the impending mass extinction. In this chapter, he introduces three hypotheses: that mass extinctions are the scaling up of background extinctions, that mass extinctions are random events with no selectivity of taxa, and that mass extinctions create different selective processes than background extinctions. Although there is much treatment of the first two ideas in the published literature, the prior two hypotheses are not mentioned further in the chapter, but the third hypothesis is treated in depth, likely because it is the focus of Jablonski's own research. He presents many good arguments, and includes some of his data for support, but more importantly, he does call for more work to be done to investigate recovery patterns and their relevance to modern extinctions and subsequent recovery. Jablonski summarizes the chapter in "five lessons for the future of life on Earth." His emphasis on post-extinction recovery and the potential impact of extinction and recovery studies on modern ecological crisis is heartening, and an appropriate setting as the last chapter in the book.

One good feature in the book, from the undergraduate perspective, is the "further reading" section before the references of each chapter, and an 8-page glossary in the back. The glossary is exceptional in that it doesn't cover only extinction, or even paleontological, terms; some words defined in this book, although mentioned in historical geology texts, are not found in those same texts' glossaries. This is a useful feature if read by the undergraduate; indeed, the glossary and in many cases, the lists of supplemental readings, display the effort and

commitment that went into making this book accessible to undergraduates.

The major goal of the book is to "make accessible—at the undergraduate level—key findings and current debates concerning extinctions in the history of life. (p. xi)" The book indeed makes the information understandable for undergraduate students who have taken Historical Geology and perhaps another course on evolution or paleontology, but cannot be a stand-alone text of its own for a course on extinction. The chapters therein do not reflect entirely the key findings and current debates in paleobiology. One complaint about the book is that it is too short and contains too few viewpoints to fully encompass the diversity of ideas and thought within paleontology and paleoecology. Not only are some alternative hypotheses not treated (for example, the lack of a Frasnian–Fammenian mass-extinction event), and some extinctions (such as the Precambrian acritarch extinction) ignored, but, perhaps most importantly, the literature—and therefore the data, ideas, theories, and current biases—about extinction is constantly changing. Although this can be said of any field, recent articles and presentations have put some extinction processes and mass-extinction patterns in a new perspective. On a positive point, some authors do acknowledge that the field changes rapidly; Jablonski suggests some very important questions that, if answered, will alter the perspective of recovery processes, and—a very crucial point—Wignall cautions against the unquestioned acceptance of any "trendy subject in geology" (p. 144).

As for use as a text for a topical class on extinction, the book is very useful in that it shows the nature of competing views (for example, Wing's versus Wignall's take on terminal Cretaceous plant-extinction patterns) and viewpoints (stressing the importance of the extinction, versus the importance of the nature of evolution, per Schopf, or the importance of understanding recovery events, per Jablonski). In addition to supplementary material about the "Big 5" mass extinctions, students taking a class on extinction through time also would need added texts, likely from the primary literature, on alternative hypotheses not mentioned in the book, and recent work on extinction dynamics. An additional text on modern extinction and ecological crisis also would be useful, considering that very important, very likely mass extinction that is a current event in the reader's life. All of these texts combined with the book will provide excellent discussion material, not only on extinction patterns, processes, and recovery itself, but also on how any idea, whether idea, pattern, and cause, is not universally accepted by all scientists.

From the invertebrate paleontologist's perspective, the cover contains not a picture of *Tyrannosaurus rex* gazing at an incoming, flaming bolide, but instead a repeated, tasteful sketch of a coiled ammonite, appropriate for a largely invertebrate-based perspective on extinction. As Jablonski points out in the final chapter, our understanding of extinctions and, more importantly, recovery, is just on the verge of asking the right questions and pursuing the right data, ultimately applicable to modern ecological crises before modern ecosystems go the way of the ammonite.

There are two major, troubling issues with the publication of the book. The first and very major concern is that many of the full page, rotated figures are upside down, noted on pages 20, 68, 72, 78, 104, 120, 161, and 166. Given the cost of this short, hardcover book at a $70.00 US value (the second negative issue with the publisher), one would expect the book to be pristine.

In short, the book meets its goal of presenting the material contained for the undergraduate reader, but could be more rounded in treating unrepresented fields of paleontology and other viewpoints and hypotheses. This problem may stem simply from the book being too short, with too few authors; perhaps more scientists with competing viewpoints would expand this book into an exceptional text. As is, the price is likely prohibitive for those professors concerned about book costs for students to use as a text. With the support of supplemental material, much of the writing in this book is useful for a topics class on extinction for undergraduates, to dispel the "ooh-ahh" of the topic and induce deep thought.

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Catastrophes and Lesser Calamities: The Causes of Mass Extinctions, Tony Hallam, 2004, Oxford University Press, New York, 274 p. (Hardcover, US $24.95) ISBN: 0-19-852497-8.

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Dateline Yucatan: Masters of the Mesozoic Massacred! Dino Demise! Massive Meteor Mayhem! Are We Next?!

Pretty much anyone who watches television, reads popular print articles, or surfs the web for a school project "knows" a gigantic meteorite struck Earth 65 million years ago and killed off all the dinosaurs. Some people even "know" that another meteor could strike Earth in the future, and that our own species would be among its victims. Quick! Make a movie—or two or three! E-mail your Congressional Representative: Protect Planet Earth!

Sensationalism sells, whether it is in movies, newspapers, politics, or your Historical Geology lecture. Don't get me wrong—I'm all for (almost) anything that will interest the general public, including my students, in science. The abysmal lack of understanding of the nature of science is all too evident among our neighbors, students, and politicians. If I can find that one hook to draw people into a discussion of how scientists "know" about Earth's past, I'm going to grab it. The problem, of course, is when all you get is the hook; the sexy science; the mile-wide-and-an-inch-deep science; the cool hypothesis-of-the-moment science. When it comes to extinction, alas, drama often trumps depth, and dinosaurs overshadow diatoms. Fortunately, there are exceptions . . .

Tony Hallam's *Catastrophes and Lesser Calamities* is a book for those willing to go beyond the hype of dinosaurs, bolides, and the terminal Cretaceous event and explore a thoughtful, balanced treatment of extinctions in general. True, this isn't a book for readers looking for an easy read or neat, absolute answers. It is a book that demands readers engage the brain; that they be willing to think and follow well-reasoned arguments. If they are so willing, not only will they learn something about mass extinction, but about the nature of scientific inquiry as well.

The book begins with an historical overview of the concept of extinction, then addresses the question of resolution in the record before moving on to a discussion of possible causes of mass extinction. I was especially pleased to see the resolution theme reinforced throughout the book; in my opinion, it is rarely dealt with adequately in popular publications. The vast expanse of even Phanerozoic time can be difficult for the non-geologist to grasp. We rarely include error estimates on our geologic time scales—an oversight that can create misconceptions among those not familiar with the processes by which geologists establish the timing of events in Earth's long history. Even when we do print error estimates, it is still not readily apparent to most casual readers that a seemingly small (1–2%) uncertainty in timing can work out to tens or hundreds of thousands of years. Hallam nicely explains features inherent in the (bio)stratigraphic record that must be understood if we are to recognize correctly the difference between a catastrophic (geologically sudden) decrease in diversity and a gradual dwindling of species. He shows the reader why five intervals in the Phanerozoic have been accepted as times of mass extinction, and several other intervals, such as the Devonian–Carboniferous and Paleocene–Eocene, are also of interest for their high rates of extinction.

Hallam devotes a chapter to each of five potential causes of mass extinction: bolide impact, sea-level changes, ocean anoxia, climate change, and volcanism. Each chapter provides a general introduction to the natural phenomenon in question and a description of how its effects can be recognized in the rock record. He then describes specific extinction events in both paleontological and geological detail, giving readers the opportunity to examine the evidence for a possible cause-effect relationship between the natural phenomenon and the extinction. Throughout these chapters, Hallam never hesitates to express his own opinions on the probable causes of extinction, but, commendably, he also presents other viewpoints and treats them fairly. He pulls together his discussion of various hypotheses in a pair of chapters that summarizes major points in the extinction debate and considers the evolutionary significance of mass extinctions.

The final chapter of the book is devoted to Hallam's perspective on

how humans influence extinction. He focuses his discussion on extinctions among large land mammals in the late Pleistocene and on late Pleistocene–Holocene extinctions in nearshore and continental shelf marine environments, concluding that three types of human activity cause extinction: overhunting/overfishing, introduction of nonnative species, and the destruction of habitat. The last few pages bring the reader into the present as Hallam describes the current status of Earth's ecosystem and his views on the potential consequences of rising extinction rates among the planet's biota.

The two appendices are worthy of mention. There is a chapter-by-chapter "Notes and suggestions for further reading" appendix for those who are intrigued enough by the book's topic to pursue the subject in more depth. This basically is a brief annotated bibliography of seminal papers from the primary literature of extinction research. There is also a nice Glossary, helpful for those readers unfamiliar with the terminology of our discipline.

Throughout the book, Hallam refers to the need to test ideas put forth by scientists. He gives numerous examples of ways extinction hypotheses have been tested, and how they were either supported or refuted based on those tests. There are one or two places where he neglects to explain how scientists reached a particular conclusion. For example, when noting Keller's and Stinnesbeck's review of sea-level changes across K–T boundary (work not cited in the bibliography, that I could find) and their conclusion that coarse clastic deposits around Gulf of Mexico are not the result of tsunamis generated by an impact event, rather "are more plausibly interpreted as deposits formed when sea-level was at its lowest" (p. 95), Hallam doesn't explain to his target audience (non-scientists) how this conclusion was reached. What is the evidence for how these sediments were deposited? How do we "know" a tsunami was unlikely to have produced these deposits? It would have been helpful to readers to have a bit more detail here. There are also a few problems with some illustrations. As an example, there appears to be a discrepancy between the text and caption for Figure 4.1 and the level of the Ir spike at Gubbio as drawn on the diagram. But, these are rare exceptions in the book. Overall, Hallam does a terrific job of letting readers see how scientists collect, evaluate, and interpret data.

The level of detail with which description and evidence are presented might be a bit intimidating for some non-scientists; this isn't "science lite." However, Hallam keeps jargon to a minimum; not always easy when dealing with the subtleties of geochemistry, biostratigraphy, and geochronology . . . just ask my students! His use of personal anecdotes and observations humanizes science and scientists, making the extinction story more accessible to the general public, and his clear and fluid writing style draws you into the process of scientific inquiry. This book involves the reader in the excitement—and sometimes frustration—of doing research into a fascinating and complex subject. And he even mentions diatoms.

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