Biostratigraphy in Production and Development Geology

R.W. Jones and M.D. Simmons (Editors)
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Reviewed by T. Markham Puckett

Biostratigraphy in Petroleum and Development Geology presents 16 papers that, in general, focus on the applications and impact of biostratigraphy in the search for hydrocarbons. The intent of the book is to demonstrate that biostratigraphy can make good business sense. As stated (p. 21) by S. N. J. Payne et al. ("The role and value of 'high-impact biostratigraphy' in reservoir appraisal and development"), "Biostratigraphy undertaken from a business-driven perspective rather than out of quasi-academic interest or inertia, provides the potential for high-value, high-impact, but low-cost solutions [to reservoir-scale problems]." [I have to admit, though, that this sounds like "Scientist Meets the MBA."]

The volume results from the Petroleum Group Conference of the same title, which was held in Aberdeen in June of 1997. Industry scientists, both from major oil companies (particularly BP) and from the consulting sector, contributed most of the articles, in addition to contributions from a few academicians. Most of the articles, not surprisingly, resulted from studies of the Cretaceous and Paleogene turbidite deposits of the North Sea region, but case studies were also presented from the Euramerican Late Carboniferous, Miocene of Borneo, Miocene-Pliocene of Venezuela, Miocene of Nigeria, and Miocene of the Gulf of Mexico.

In general, the articles are well edited, with only the occasional typo or incomplete sentence, which I did not find to be too distracting. There are full-color, pull-out charts, plus a scattering of color cartoons and diagrams, numerous black and white figures of generally very good quality, and some nice photomicrographs. Only one figure contained writing too small to see without a microscope. Use of formal stratigraphic nomenclature was a bit inconsistent, though, even within particular articles (such as "late Miocene" and "Late Miocene" in the article by C. J. van der Zwan and W. A. Brugman). Somewhat more disturbing than inconsistent substage nomenclature (which can be confusing) is incorrect stage or epoch nomenclature (such as "late" Cretaceous). Overall, production of the volume is excellent.

The first article, contributed by BP geologists (see S. N. J. Payne et al., above), "was written to maintain the impetus of high-impact biostratigraphy, and is intended to keep geoscientists aware of the potential business impact that the many and varied strands of biostratigraphy can offer in the solution of reservoir problems" (p. 21). The article was a good introduction to the rest of the book, clearly casting out the "Old Model" of broad, and largely irrelevant, regional zonations in favor of

the "New Model" emphasizing high-resolution, reservoir-scale events to be integrated with other tools of reservoir description. The shiny image of the "New Model" (at least in management's bedazzled eyes) is buffed up by the use of such power terms as "high-impact biostratigraphy" and "bio-steering." I found it annoying, though, that these terms were not clearly defined at the beginning of the book. The concept of bio-steering, and discussions of particular cases, was one of most interesting parts of the book. In essence, the direction and progress of drilling is determined on site through the use of biostratigraphy, thus maximizing penetration of the reservoir sections. A main theme throughout the volume is the importance of using any sort of biosignal or combination of bioevents to correlate among wells to squeeze out the maximum information from the fossil content.

Most of the papers are well focused, particularly "Well-site biostratigraphy of Danish horizontal wells" (D. J. Shipp), "The Andrew Formation and 'biosteering'-different reservoirs, different approaches" (N. A. Holmes), "Biosignals from the EA Field, Nigeria" (C. J. van der Zwan and W. A. Brugman), and "Applied palaeontology: a critical stratigraphic tool in Gulf of Mexico exploration and exploitation" (B. J. O'Neill et al.). These papers clearly demonstrate the importance of biostratigraphy in the search for hydrocarbons, and they made for enjoyable and interesting reading. Several of the papers made use of the interesting work of R. W. Jones on benthic foraminiferal paleoecology, including his own contribution to the volume ("Forties Field (North Sea) revisited: a demonstration of the value of historical micropalaeontological data"). Jones' work formed the basis of the bio-steering programs employed in several of the drilling projects discussed in the volume. I cringed, though, when I saw comparisons being made to the coastal onlap charts of Haq et al. (1987). Besides the global charts being of dubious value, the general lack of high-resolution, cosmopolitan taxa in the reservoirs renders such comparisons speculative at best. The paper by S. Duxbury et al. ("Sequence stratigraphic subdivision of the Humber Group in the Outer Moray Firth area (UKCS, North Sea)") was, however, sheer drudgery. What the reader is supposed to get out of being dragged through the minutia of 20 stratigraphic sequences and 19 biostratigraphic zones is beyond me. The article by Armentrout et al. ("High-resolution sequence biostratigraphy of a lowstand prograding deltaic wedge: Oso Field (late Miocene), Nigeria") was unfocused, and included discussions of several topics, such as petrophysical data, seismic geometry, etc., that only detracted from the discussions of the biostratigraphic analyses and contributions. The use of sequence stratigraphic concepts in several of the articles was variable. For example, in the article by S. Duxbury et al., some of the sequences began (lower portion) with an "aggrading systems tract," but the meaning of that term was not clear, particularly how it relates to the more commonly understood lowstand systems tract, etc. The rare use of graphic correlation (which appears only in "Chalk palaeoenvironments and depositional model, Valhall-Hod fields, southern Norwegian North Sea," by P. J. Sikora et al.), particularly in conjunction with sequence stratigraphy, was surprising, because this combination of tools has proved to be quite effective in solving chronostratigraphic correlations.

In summary, *Biostratigraphy in Production and Development Geology* is an important contribution to the literature on the use of fossils in oil exploration. Most of

the articles are focused, well written, and clearly demonstrate the value of biostratigraphical data in the search for hydrocarbons. Some of the more salient contributions are: underscoring the use of all fossil information, even that restricted to small (i.e, field-scale) areas, in getting the most use out of the paleontological information; demonstrating the practicality of using fossil information in all phases of production and development geology; and presenting case histories where biostratigraphy has had a positive impact on the economics of oil exploration and development. The economic benefit of stable, coherent taxonomic schemes was emphasized, as was the understanding of the paleoecology of fossils, which are both important, practical points to be made to paleontology students. Anyone teaching biostratigraphy (or micropaleontology) at a university should be familiar with the text, and a couple of the articles should be required reading for the students. It should certainly be read by all oil company paleontologists and consultants, and by academicians working with oil companies. Lastly, it would make an excellent gift for managers--particularly if they hold MBAs.

T. Markham Puckett
Department of Geology
The University of Alabama
7th Street, 202 Bevill Building
P.O. Box 870338
Tuscaloosa, AL 35487-0338

T. Markham Puckett is currently an Assistant Research Geologist in the Department of Geological Sciences at the University of Alabama. He received a B.S. in Biology and Geology at the University of Southern Mississippi, an M.S. in Geology at Mississippi State University, and a Ph.D. at the University of Alabama. Mark also worked at the Geological Survey of Alabama for 9 years. Mark's research has focused on the taxonomy, paleoecology, and biostratigraphy of ostracodes, particularly Upper Cretaceous ostracodes.

These studies, coupled with planktonic foraminiferal biostratigraphy, formed the basis for interpretations of the sequence stratigraphy of the Upper Cretaceous deposits of the Mississippi-Alabama region. Mark has also worked recently on petroleum systems modeling of Mesozoic strata in the northern Gulf of Mexico region.

Fossils, Fallacies, Foibles, and Fantasies: The Cradle of Life

by J. William Schopf
Princeton University Press, 1999, 359 p.
ISBN 0-691-00230-4, $29.95 U.S.

Reviewed by Eric Gaddos

"Though all the winds of doctrine were let loose to play upon the earth, so Truth be in the field."

-- John Milton, Aeropagitica

An advocate of deep-sea exploration and the protection of the marine environment was once quoted as asserting that we know more about the far side of the Moon than the bottom of the oceans. Paleontologists might claim with equal rigor that we know less about life on the Precambrian Earth than the seafloor: The fossil record of organisms visible to the unaided eye dwindles in the geologic record older than 545 million years ago and essentially vanishes in rocks only slightly more ancient. This Cheshire Cat behavior of the fossil record, a source of consternation of Charles Darwin, serves as the intellectual instigation for William Schopf's account of the dawning of the field of Precambrian paleobiology and his contribution as the co-discoverer of the oldest known fossils in the 3.5 billion year-old Apex rock formations of Australia. The twin themes are a scientific one; that life in the Precambrian, and particularly in the Archean eon (prior to 2.5 billion years ago) was almost exclusively microbiological, leaving commensurately micron-sized (read, difficult to find!) fossils; and a psychological one; that science is a human effort, and that in the interpretation of the fossil record our human imaginings, fears, schemes, and biases come into play. Schopf, whose meticulous work discovering ancient microbial fossils has helped extend our vision of life on Earth into the "deep time" of the Precambrian, tirelessly advocates the same care in the search for life on Mars.

The book reads more like a collection of essays rather than a seamless treatise, and I actually found the material more accessible as a result. With some exceptional cross-referencing, the chapters or groups of chapters could be read in a different desired orders. The style, too, makes for comfortable reading and Schopf's frequent exhortations (among them the liberal use of the exclamation point) convey his excitement about the field to the reader. In one chapter, he laments the delayed discovery that most stromatolite fossils are the remains of microbial mats – communities of microorganisms -- and attributes it to a lack of communication between the disciplines of the life and physical sciences. Schopf ably demonstrates his own interdisciplinary ability in this engaging book as he discusses topics ranging from the history of the discovery of Precambrian microfossils, theories on the origin of life, the evolution of metabolism, and the rise of eukaryotic, oxygen-respiring cells.

I personally enjoyed his description of the strategy for looking for very old rocks, for fossiliferous deposits within those formations, and for identifying candidate fossils within those deposits. His elaboration of the five criteria for determining bona fide ancient microfossils will be invaluable for those whose aspirations include searching for life on early Earth or Mars. His chapter on stromatolites is also well done, including his careful definition and description of how these fascinating formations form and bring us information about ancient microbial ecologies across billions of years of Earth history. Shopf shines in his enthusiasm and excitement, and there are rewarding instances of prose such as his analogy to the evolution of successive metabolic pathways as arising "like the ramparts of a medieval city…" The photographs of the fossils and geologic units are stunning, and it is unfortunate that they do not play a more central role in the book.

The manuscript could have withstood improvement in both style and accuracy. Schopf seems to be unsure of his audience, as the book hovers uncomfortably in a twilight zone between the educated layman, who can follow the logic but does not have the background to fill in the details, and the colleague in the field, who can supply the "missing mass" but who may find the logic overly simplistic. Another weakness of the book is the disconnect between the text and the figures and lack of identification of the sources of data. There is also a persistent background level of scientific inaccuracies or mistakes that, while not fatal, are just sufficient to be annoying. Examples include the use of "tiny bar magnets" as an analogy to the electric dipole of a water molecule, the use of "autotrophy" vs. "heterotrophy" in a more generalized way than the standard definition of carbon source, and the suggestion that a 5 km impactor could have boiled the away the world's oceans – planetary scientists typically quote a diameter closer to 200 km. Molecular microbiologists might disagree with the assertion that 3-5 times as many unknown species exist as are known; estimates of the fraction of bacterial species which remain uncultured (and thus uncharacterized) is 99-99.9%! There are also many instances where some facet of evolution is explained as though the theory were fact and not hypothesis and insufficient background information is given. Among these are the timing of the molecular machinery of life and its encapsulating micelle or membrane, the evolution of ferrodoxins (apparently based on the 1966 paper by Eck & Dayhoff), and the meaning of the absence of mitochondria in deep branching, "primitive" eukaryotes (some of which do turn out to have mitochondrial heat-shock proteins). Personal cultural digressions (a visit to Salvador Dali in Spain and a tour of a commercial stromatolite warehouse in China), while interesting in their own right, probably will only serve to distract the reader.

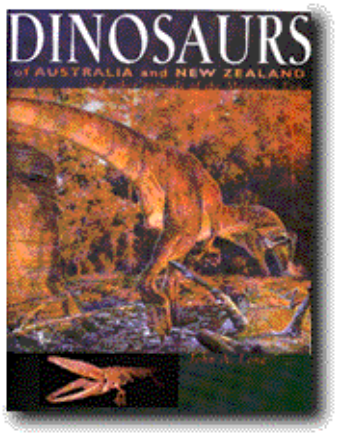
Schopf is at his peak in the final two chapters when he relates two (now, almost apocryphal) tales of fossil misinterpretation from the 17th and 18th centuries and suggests (barely implicitly) a modern version – the claims that there is chemical and physical evidence of past organisms in Allan Hills 84001, the meteorite from Mars. Schopf's vision of the human side of paleontology includes very human scientists that convince themselves of an erroneous interpretation of the fossil record either to satisfy the "politically correct" status quo or to achieve the noble but self-gratifying goal of a breakthrough in human knowledge. These are rel-

evant issues in the new media era of sound bites and science press conferences, of sophisticated models and simulations which blur our perception of what the evidence allows, i.e., what may have happened in the past, and what the evidence proves, versus what actually happened. Schopf's exhortations for careful work in the book make for important reading. I would have complemented this picture with anecdotes of scientists who did propose visionary but controversial theories against the "prevailing wisdom" and were later proven to be correct (the theory of plate tectonics comes to mind). Science advances not only by the many who incrementally advance our firm understanding of the facts, but also by a few who dare venture to the edge of our knowledge and suggest things that may be waiting to be discovered. The important thing, as Schopf reminds us in so many words, is to distinguish between the two.

Eric Gaidos

Eric Gaidos is a postdoctoral associate in the Astrobiology Group at the NASA Jet Propulsion Laboratory and a visitor in the Division of Geology and Planetary Science at the California Institute of Technology. His research interests include the early environments of Earth and Mars, microbial ecology, and molecular evolution.

Dinosaurs of Australia and New Zealand and Other Animals of the Mesozoic Era



by John A. Long
Harvard University Press, 1998, 188 pp.
ISBN: 0-647-20767-X, $39.99

Reviewed by Kathryn Hoppe

Among the multitude of books on fossils, this work stands out as one of the few that focuses on vertebrate fossils from Australia and New Zealand. This work contains a complete catalogue of the area's Mesozoic tetrapods (amphibians, reptiles, birds, and mammals), including specimens that consist of isolated bones as well as footprints and trackways. The text is illustrated throughout with full-color illustrations and photographs of not only the specimens discussed, but also many of the sites from which fossils were recovered. Anyone interested in the prehistoric life of Australia or New Zealand will find this book appealing. However, readers searching for an intriguing book about dinosaurs will likely be disappointed, in part because this region has yielded relatively few dinosaurs specimens (less than 20 species have been identified).

The book is divided into four sections, the first of which includes three chapters aimed primarily at readers without an extensive background in paleontology. The first two chapters provide an introduction to the major concepts needed to put fossils into context. Included are brief overviews of fossilization, geologic time, and plate tectonics, as well as a more detailed description of cladistics and the evolution of dinosaurs. The material is nicely written and well illustrated. General readers should find the subject matter easily accessible, although readers already familiar with the concepts discussed may prefer to skim ahead. The third chapter covers the history of vertebrate paleontology in Australia/New Zealand and provides a bridge into the rest of the book. Long has meticulously researched his subject matter and includes a detailed account of everyone who has contributed to the discovery or study of fossil vertebrates in this region. Professional paleontologists may find that this chapter serves as a useful reference tool, but the causal reader is likely to quickly bog down as many sections consist of little more than lists of people and/or institutions.

The remaining sections of the book are devoted to describing the fossils. Each section covers specimens of a given geologic time period (Triassic, Jurassic, or Cretaceous) and is organized taxonomically. In spite of the title of this work, the vast majority of specimens described are not dinosaurs, but rather amphibians and aquatic reptiles. A few specimens of pterosaurs, birds, and mammals have also been identified and are discussed. However, as most of the latter, as well as many of the dinosaurs species, are known only from isolated and/or fragmentary bones. there is often relatively little that can be said about them.

Descriptions of all specimens are presented in the same format. First, Long provides a detailed history of the discovery and study of each specimen, then he

describes its general physical characteristics. Each species is accompanied by photographs or diagrams of prepared specimens. Also included are summaries defining the synapomorphies of each species. This catalogue will serve as a valuable resource for researchers looking for detailed information on the occurrence or study of fossil vertebrates, as well anyone interested in trying to identify fossil specimens. However, the technical terms and terminology used in this section may be difficult for general readers to decipher. Additionally, relatively little information is presented on the paleobiology or paleoecology of these animals. It is thus often difficult to put specimens in context.

In summary, this book presents a detailed account of the tetrapod fauna and the work of vertebrate paleontologists from a region that has been largely overlooked by most publications. It fills a valuable role and will serve as a useful reference tool for paleontologists interested in the fossils of this region.

Kathryn Hoppe
Division of Ecosystem Sciences
151 Hilgard Hall MC # 3110
University of California Berkeley
Berkeley, CA 94720-3110

Kathryn Hoppe studies the chemistry of fossils in order to reconstruct the biology of extinct animals and the ecological relationships of ancient ecosystems. She has worked on fossil organisms ranging from Cretaceous clams (inoceramids) to late Pleistocene mammoths and mastodons. Recently she has also become involved in studies of how chemical tracers can be used to monitor the ecology of wild horses in the modern United States. She received her undergraduate degree from Washington University in St. Louis and has recently graduated with her doctorate from Princeton University. She is currently working as a researcher at the University of California in Berkeley.

Fossil Plants and Spores: Modern Techniques

by T.P. Jones and N.P. Rowe
Geological Society of London, 1999, 196 p.
ISBN 1-86239-035-5, $125.00

Reviewed by Nan Crystal Arens

In *Fossil Plants and Spores: Modern Techniques,* Tim Jones and Nick Rowe have produced a self-described "recipe book" for the collection, extraction, preparation, and study of all sorts of plant-derived fossils. In a Herculean feat of organization, the editors corralled 78 contributors to write 60 bite-sized chapters (averaging 4-5 well-illustrated pages) that cover a nearly complete spectrum of paleobotanical and palynological techniques. The book is almost as dry as it sounds, but it serves the important purpose of compiling the collective technical wisdom of our field. As the editors note: "One of the aims of this volume was...to include information of the sort that you might get to hear about personally but not find in the literature," (p. 1). Codification of this oral tradition of technique and practice is this volume's most important contribution.

The book is divided into ten sections, each with a series of individually authored chapters. Part One begins with a discussion of how to locate and collect fossil plants and palynomorphs. This chapter concludes with the all-important contribution of toilet paper ("soft tissue" in this politely British volume) to paleobotany. This is followed by a series of chapters with detailed instructions on how to extract prizes of all sizes (micro-, meso- and macrofossils) from clastic or organic matrices. Part Two includes practical chapters on dégagement preparation, microscopy of various types of plant materials, and photography using both light and electron microscopes. Parts Three and Four contain chapters on the range of sectioning methods used in the study of anatomy and ultrastructure. Chapters cover the old stand-by acetate peel technique, thin and polished block sections, and microtechnique for the study of plant ultrastructure. (Thanks, Tom Taylor; I've always wondered how one got pollen grains to hold still for sectioning!) These chapters live up to the "recipe book" billing. They contain the fundamentals behind each technique, detailed instructions, and a list of materials. However, there are many ways to peel a coal ball and these details should not be considered canon. Most authors bring the spirit of experimentation--the hallmark of a good preparator--to their descriptions.

Part Five contains eight chapters outlining geochemical methods that can be applied to plant fossils. These provide an accessible and interesting introduction to these relatively new-fangled techniques. Pim van Bergen's discussion on how to collect, transport, and store plant fossil material for geochemical analysis is particularly helpful. However, the chapters on stable isotope analysis, pyrolysis and chemolysis, DNA extraction, and mineralogical and bulk geochemical analysis are more like menus than a cookbook. Although pragmatic technical details are included, there's

not enough here to let the novice begin PCR. Instead, these chapters give insight into the new data these techniques can bring to the study of fossil plants. This will undoubtedly inform researchers who are considering delving into these techniques. More importantly, the overviews will help readers of the technical literature understand the power and limitation of these methods. The final paragraph of John Marshall and Barbara Yule's chapter on spore color measurement also highlights the creativity that an ever-practical paleobotanist brings to technique: "The measurement of color with microspectrophotometers involves very specialist and...expensive equipment...However, one quantitative color measuring system which is widely available is that inherent in the software of most modern image analysis systems...Such image analysis equipment is readily available in most laboratories with the advantage of relatively low cost...Results from such a system...show that the simple measurement of G (green in the RGB scheme) provides a good relatively linear single color parameter" (p. 168).

Part Six is an unexpected, but important, section on databasing, curation, and nomenclature. Inexpensive, high-capacity computers and the Internet open a wide range of new questions and potential data sources for paleobotanists. As a field, we have fallen behind our colleagues in not fully applying these new technologies. Unfortunately, three short chapters barely scratch the surface, although I applaud the editors for opening the discussion. However, I was disappointed that phylogenetic approaches to nomenclature and systematics did not receive a word in this volume, particularly when several of contributors have pioneered phylogenetic systematics in paleobotany.

Parts Seven, Eight, and Nine present a sumptuous smorgasbord of methods ranging from sedimentology, taphonomy, and biostratigraphy, to the reconstruction of climate and ecology. Most of these chapters have a quantitative flavor and include discussions of how to interpret data, with illustration from real-world examples. Particular gems in these sections include Tom Phillips and Bill DiMichele's summary of the quantification of peat-forming communities using data from coal balls, Greg Retallack on paleosols, Geoffrey Creber and Jane Francis with an overview of tree ring analyses as applied to ancient wood, and David Beerling summarizing the use of stomatal indices for reconstructing paleo-pCO_2. I was a bit disappointed that neither chapter on biostratigraphy managed to open the black box of how biozones are objectively constructed. However, the authors did give an excellent summary of their application. But perhaps the best part of these sections was seeing ataxonomic climate reconstruction methods like CLAMP (Jack Wolfe and Bob Spicer's climate-leaf analysis multivariate program) described side-by-side with floristic and nearest-living-relative approaches. The authors of these chapters succeed in highlighting the strengths, limitation, and grounding assumptions of the methods, leaving the reader to evaluate the merit of each for herself.

Part Ten is yet another useful surprise: a summary of international regulations for the collection and transport of fossils. For the countries covered (I was particularly pleased to see China on the list), these summaries are invaluable. However, coverage is spotty. Mexico, Argentina, India, Russia, and the countries of eastern

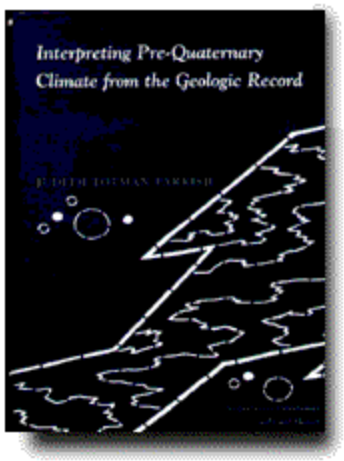
Africa are notable, fossil-rich, omissions. The book concludes with a comprehensive reference list (although I wish they had included references at the end of each article), an eclectic glossary, and a list of commonly used equipment and suppliers that will be useful for researchers embarking on a new technique.

To the editors' credit, it took some time to think of a technique or type of plant fossil not covered in this compact volume (phytoliths, the silica bodies found in the tissue of many plants, were not mentioned). The short-article format and good bibliography will make this book a must for the well-stocked library and highly recommended for research students. But don't wait! I suspect this volume will sell out before your rapid-setting epoxy resin cures.

Nan Crystal Arens
Department of Integrative Biology and U.C. Museum of Paleontology
University of California, Berkeley, CA. U.S.A.

Nan is Assistant Professor in Integrative Biology and Curator of Fossil Plants in the U.C. Museum of Paleontology. In previous incarnations she has been a science journalist and lover of Ordovician bryozoans. Her current research interests drift toward questions of plant community structure and diversity, particularly during moments of environmental change and disturbance in Earth's past. In her copious free time, Nan loves to walk in the forest, paint, quilt, and study theology. She lives in Oakland, California with her husband, David Kendrick, and two of the world's cutest Shetland Sheepdogs, Robbie and Zoey.

Interpreting Pre-Quaternary Climate from the Geologic Record



by Judith Totman Parrish
Columbia University Press, 1998, Perspectives in Paleobiology and Earth History Series, 338 p.
ISBN: 0-231-10206-2, $ 65.00

Reviewed by Wolfgang Kiessling

Paleoclimatology is a hot topic nowadays and books published in the field are numerous. Some 80 books on Paleoclimatology have appeared in the last 10 years alone covering all aspects of paleoclimatology. So what is the need for the issue of still another 338 pages?

Says Parrish: "Although I didn't set out to write a textbook, part of my motivation for tackling the job was that no textbook exists for the way I teach paleoclimatology at the University of Arizona. In writing the book, I assumed some knowledge of geology, especially sedimentary geology and paleontology, but tried to provide at least a few basics for each topic, so it can be used as a textbook in senior- and graduate-level classes."

Indeed, most of the recent books on paleoclimatology emphasize quite different topics. A quick recherché on Amazon.com shows that only 10 of the 146 titles are especially devoted to pre-Quaternary climates, and the majority of books deal with Holocene climate or climate prediction. Most books emphasizing pre-Quaternary climate trace the climatic evolution either of the whole Phanerozoic (Frakes et al., 1992) or of selected intervals (Vakhrameev, 1991; Prothero and Berggren, 1992; Allen et al., 1994). Although virtually all paleoclimate books devote a chapter to paleoclimatic indicators or compare paleoclimatic modeling results to geologic climate tracers, none really evaluates the value of paleoclimatic indicators in detail. From this point of view, Parrish's book is very timely as it clearly is the most comprehensive compilation on Phanerozoic paleoclimatic indicators to date.The structure of Parrish's book is very clear. An excellent introduction provides a guide to the volume and an overview of general principles behind all paleoclimatic indicators discussed in the book. Very helpful in this chapter is a table summarizing the parameters that define paleoclimate and their potential geologic indicators. The second chapter evaluates the paleoclimatic potential of fossils. Microfossils are discussed in some detail, but most of the discussion concerns isotopic geochemistry of foraminifera that would have deserved its own chapter. I was surprised to see that transfer functions are not discussed in more detail. A comparison is missing of paleoclimate data as derived from the different microfossil groups. A short discussion of the CLIMAP program - although concerning Quaternary climate - would have been useful to underline the great paleoclimatic potential of microfossils. The macrofossil discussion is very detailed for some groups (e.g. mollusks) but sketchy for other climatically sensitive groups, such as corals. A strength in this section is the short

introduction clearly summarizing the danger of circular reasoning in using macrofossils for paleoclimatic analysis as well as for paleogeographic studies. The third chapter is devoted to marine lithologic indicators of paleoclimate and provides a comprehensive and in places highly original overview. One example is the graphic summary of a reef database by Flügel and Flügel-Kahler (1992) to indicate the paleolatitudinal range of reefs through time and the paleoclimatic bearing of Phanerozoic reefs. The chapter on terrestrial and freshwater biotic indicators (chapter 3) is relatively short but contains all relevant information on the subject. It concentrates on plant macrofossils – reflecting their great potential in paleoclimatic analyses. The longest chapter in Parrish's book concerns the discussion of terrestrial and freshwater lithologic indicators (chapter 4). As I am personally not very familiar with continental deposits, this chapter was the most challenging to read and my view may best reflect the impression of a graduate student reading the book. Thanks to the frequent and clearly organized tables it was quite easy to get a quick overview of the discussed climate indicators. Each potential climatic indicator is introduced by a short summary providing useful definitions and an informative introduction. Although I occasionally got lost at a particular point, I always could acquire the major points and conclusions. The sixth chapter gives a short but excellent comparison of various paleoclimatic modeling approaches. The strengths and weaknesses of conceptual and numerical models are discussed in sufficient detail to allow the reader an evaluation of the different approaches. The final chapter gives a summary of some key indicators of past climate and an outlook of what can be achieved by combining various climatic tracers (integrative paleoclimatology). Although this chapter could have been organized more properly, the case studies are well selected and insightfully discussed.

Although the book is designed as a "sourcebook that provides an entry into the literature" it goes far beyond any comparable review on Phanerozoic climatic indicators. Every conceivable paleoclimatic indicator is introduced at the beginners level, but the discussion then quickly shifts into details that are hardly understood without fundamental knowledge in sedimentary geology, paleontology, and isotope geochemistry. To my taste, the general principles behind each paleoclimatic indicator are often not discussed in sufficient detail, and the sections move too quickly into excessive discussions of particular publications and case studies.

This affects the readability of Parris's book, but it also helps getting an insight into the discussions and controversies in the field. A deeper understanding is especially supported by the comprehensive reference list encompassing about 1500 citations. A glossary of the key paleoclimatic terms is lacking but would have been necessary considering the vast amount of terms floating around in the literature. I also missed a critical appraisal of published Phanerozoic climate curves (e.g. Frakes et al., 1992) by evaluation of the paleoclimatic indicators on which the curves are based. Parrish's book is richly illustrated throughout. All figures contain important information and were mostly adapted from high-quality reference sources. A significant drawback, however, is the quality of the illustrations. Many figures would have benefited from redrawing. The tables are excellent throughout: useful in all cases and commonly original.In summary, I cannot say that reading Parrish's book

is fun; it is work, sometimes even hard work, but work that pays back. The book is a must for everybody working on paleoclimatic interpretations in the widest sense, that is, almost every modern geoscientist.

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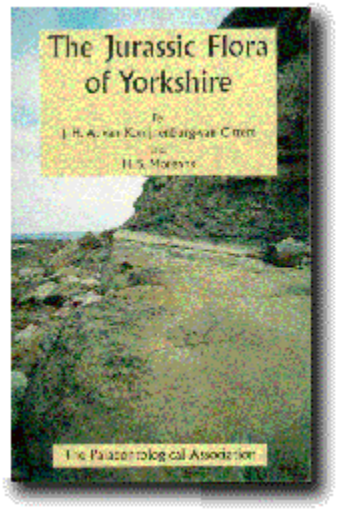
Wolfgang Kiessling

Wolfgang Kiessling is currently in a postdoc position at the Museum of Natural History in Berlin. He is working in the graduate research program "Evolutionary transformations and mass extinctions". Wolfgang's other major ongoing projects concern the paleogeographic distribution of reefs and their paleoclimatic significance and the paleoceanography of Mesozoic radiolarians.

The Jurassic Flora of Yorkshire

by J.H.A. van Konijnenburg-van Cittert and H.S. Morgans
Palaeontological Association, 1999, 134 p.
ISBN 0-901702-64-1; $24.00 U.S. or £ 12 U.K.



Reviewed by Richard Lupia

With each generation of paleobotanists, new tools, new methods, and new paradigms guide research. Now more than ever before, paleobotanists are conducting research and collecting data not only on plant anatomy and morphology, but also on the sedimentology, facies architecture, and stratigraphic context of the fossil deposits. All of this information, combined with the recognition and documentation of compositional variation on both small spatial and temporal scales, has permitted more accurate reconstructions of the paleoecology of the source vegetation. Although applied to new localities, "classic" localities often go un-restudied in light of the new paradigms, despite their importance.

The plant-bearing beds in the Middle Jurassic Ravenscar Group of Yorkshire have been investigated for more than a century and the 250+ species from over 600 beds have been described in numerous publications, notably in Harris' five volume set (Harris 1961, 1964, 1969, 1979; Harris et al. 1974). The authors of this field guide have selected four plant beds (Hasty Bank, Hayburn Wicke, Gristhorpe, and Scalby Ness) and provided descriptions, photographs, and keys to over 100 of the most commonly found species in these beds.

The text is concise, without flourish, but with enough detail to characterize and differentiate among the many taxa. Numerous line drawings are used to clarify morphological features described in the text and a glossary is provided for morphological terms employed in the descriptions (one exception is "falcate: curving forward" which otherwise is defined within the text). Without material in front of me, I usually find keys impossible to read, but those provided are simple and straightforward. The most important part of any guide to fossils is the photographs. The photographs are abundant, with most species illustrated by at least one image. The photographs are large enough and generally have sufficient contrast to show the necessary details clearly.

Errors in the text are extremely few—I counted only five. Two are related to figure referrals: *Osmundopsis sturii* is referred to in text as Text-Fig. 17C, but is 17D (p.41); and *Czekanowskia microphylla* is referred to in the text as Text-Fig.42C, but is 39C (p.107). The others are even more minor.

If there is great value to this guide beyond the taxonomic descriptions and images, and I believe there clearly is, it lies in the addition of detailed stratigraphic sections that describe the lithologies, sedimentary features, and facies interpretation

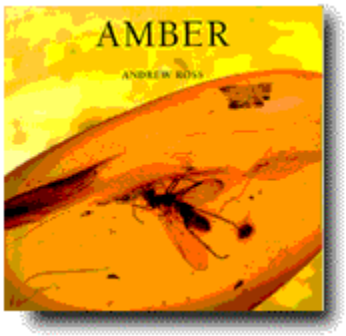
that provide important and often neglected context information for collectors – both amateur and professional. Anyone approaching these beds will be prepared for what they will encounter, not only in terms of the plants, but also the geology. The authors also provide a very informative table that describes the distribution and relative abundance of each plant species in each plant bed. Finally the authors conclude their guide with a discussion of the paleoecology of the Ravenscar Group and the Yorkshire plant fossil beds. The integration of plant distributions and facies characteristics to form a classification system of the deposits provides an informative synthesis of the nature and deposition of the original vegetation. In view of that synthesis, if there is one thing missing from this guide, it is illustrations of plant reconstructions. I realize that few have been completed, and I can hardly fault the authors for their absence, but I can wish it otherwise.

The authors are to be commended for compiling a clear and instructive introduction to the fossil floras of the Yorkshire Jurassic for collecting novices and veterans. Having completed this review, I am compelled to point out that I have never been to these localities. But with this guidebook, with the pictures, keys, maps, and stratigraphic sections it contains, I am sure that I could easily locate these plant beds and identify most of the fossils I collect. I hope one day to give this guide a true test.

Richard Lupia
Sam Noble Oklahoma Museum of Natural History, and School of Geology and Geophysics
The University of Oklahoma
201 Chautauqua Avenue
Norman, OK 73072

Richard Lupia earned a B.S. in Biology with a minor in Geology from University of Pennsylvania. He earned both a M.S. and Ph.D. in Evolutionary Biology from the University of Chicago. His research is directed at understanding the Cretaceous radiation of angiosperms (flowering plants) and the impact of that event on the composition, structure, and organization of terrestrial ecosystems.

Amber



by Andrew Ross
Harvard University Press, 1998, 73 p.
ISBN 0-674-01729-3, $12.95

Reviewed by Stephen Caine

Amber, the subject and title of the new book by Andrew Ross, has exploded into modern culture again, since that now famous film, which I'm sure needs no mention. In fact, as the author states in the preface of his book, it was due to the interest generated in the public by the film that he was given the job of cleaning, interpreting, and organizing the British Museum of Natural History's collection of Amber. Andrew is the Curator of Arthropods in the department of Palaeontology of that museum.

The book is full of lavish photographs and illustrated throughout. It takes us into the world of amber, starting with what amber actually is and describing the trees from which it comes, being followed up by the physical, chemical, and visual characteristics. The chapter entitled, 'Fake Amber,' tells of the substitutes that are used, what to look for, and tests that can be carried out to authenticate the amber. This chapter sent me off to scrutinize my own collection, planning all manner of revenge on anyone who had dared to trick me. Having checked my pieces, which I am happy to report, have all passed the tests; I return to the next few pages, which describe some of the uses of amber and the countries of origin.

The next part of the book moves into describing the inclusions found in the amber. Now we enter the part that most people relate to with this material and how the value of a piece of amber can be affected. Here, there is some beautiful photography of insects and plants with superb photos of arthropods. Of course, the book could not be complete without a section on DNA, which also includes a biogeography of the animals and plants. The final sections, which take up a good proportion of the book, are a number of keys to identifying arthropods, bugs, and winged insects. See Fig. 1 and Fig. 2 for examples. At this point I must say that I have a 13 year-old daughter, who is mad on bugs, insects, and microscope work; needless to say this book kept disappearing over the last few months and at times it was a fight to retrieve it to complete this review.

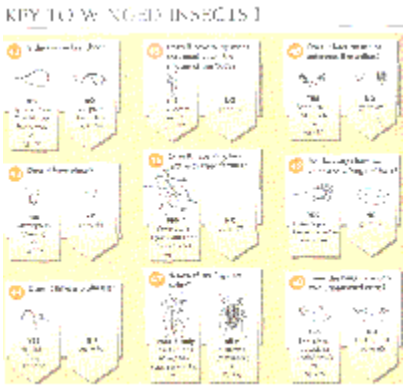


Figure 1.

In conclusion, I can say this is an enjoyable book and can be read by both older children and adults. It is an excellent reference book and will have uses in universities, school libraries, and museums. For me, and of course, speaking for my daughter, this is not one of those books you read then put on a shelf. With the many keys to identification, it can be used as a tool for years to come.

Figure 2.

Figure 1.

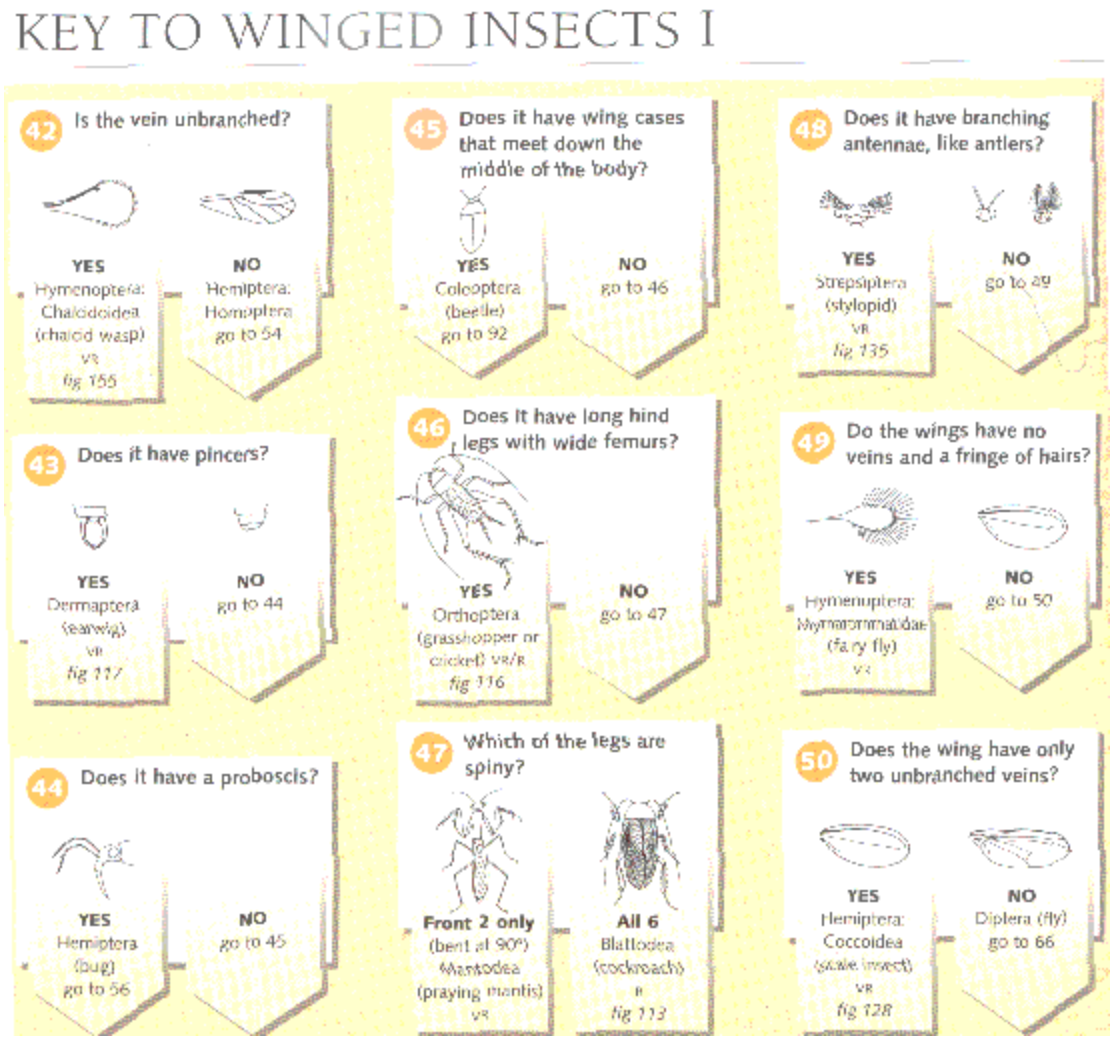
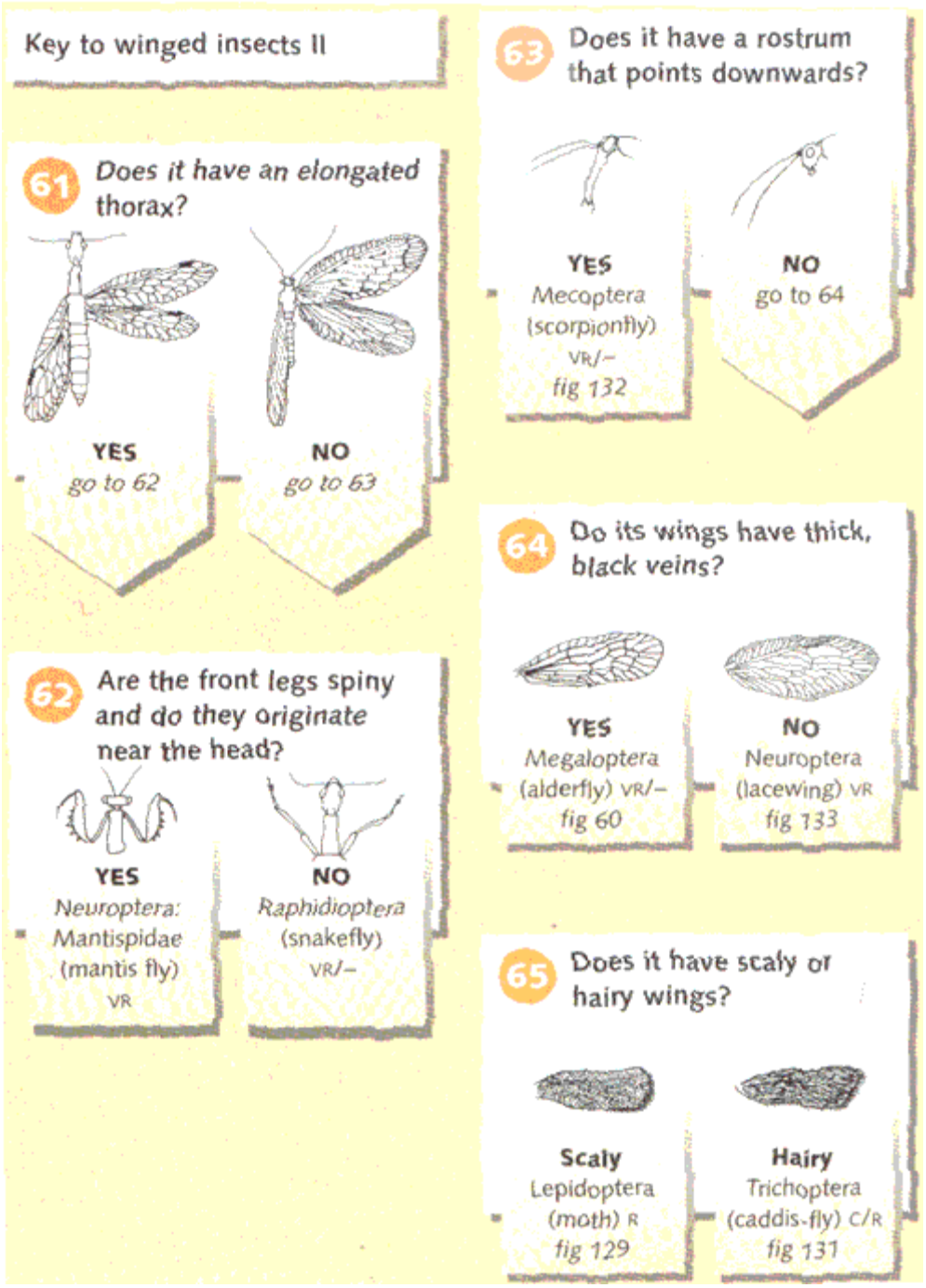

KEY TO WINGED INSECTS I
42 Is the vein unbranched?
YES
Hymenoptera: Chalcidoidea (chalcid wasp)
VR
fig 155
NO
Hemiptera: Homoptera
go to 54
43 Does it have pincers?
YES
Dermaptera (earwig)
VR
fig 117
NO
go to 44
44 Does it have a proboscis?
YES
Hemiptera (bug)
go to 56
NO
go to 45
45 Does it have wing cases that meet down the middle of the body?
YES
Coleoptera (beetle)
go to 92
NO
go to 46
46 Does it have long hind legs with wide femurs?
YES
Orthoptera (grasshopper or cricket) VR/R
fig 116
NO
go to 47
47 Which of the legs are spiny?
Front 2 only
(bent at 90°)
Mantodea (praying mantis)
VR
All 6
Blattodea (cockroach)
R
fig 113
48 Does it have branching antennae, like antlers?
YES
Strepsiptera (stylopid)
VR
fig 135
NO
go to 49
49 Do the wings have no veins and a fringe of hairs?
YES
Hymenoptera: Mymarommatidae (fairy fly)
VR
NO
go to 50
50 Does the wing have only two unbranched veins?
YES
Hemiptera: Coccoidea (scale insect)
VR
fig 128
NO
Diptera (fly)
go to 66

Figure 2.


Key to winged insects II
61 Does it have an elongated thorax?
YES
go to 62
NO
go to 63
62 Are the front legs spiny and do they originate near the head?
YES
Neuroptera: Mantispidae (mantis fly) VR
NO
Raphidioptera (snakefly) VR/–
63 Does it have a rostrum that points downwards?
YES
Mecoptera (scorpionfly) VR/–
fig 132
NO
go to 64
64 Do its wings have thick, black veins?
YES
Megaloptera (alderfly) VR/–
fig 60
NO
Neuroptera (lacewing) VR
fig 133
65 Does it have scaly or hairy wings?
Scaly
Lepidoptera (moth) R
fig 129
Hairy
Trichoptera (caddis-fly) C/R
fig 131

Stephen Caine

Stephen has worked in the museum world for 25 years, covering all aspects of procedures from taxidermy, to exhibition designs, and model making. Over the same period, he has managed various museum supply companies and studios.

Now working from home, his main work consists of setting up palaeontology exhibitions for display at museums and exhibition centres. He is reconstructing the Elgin Reptiles into life-size models at present, which involves his other passion of sculpting.

His spare time is spent with his family, looking after their farm and going on fossil hunting trips with his wife and twin daughters. He is also deeply involved in the art world, specializing in palaeo-sculpture.