
Palaeoclimatology can with good conscience be called a new scientific discipline, one of the few whose roots do not go way back in the 19th century. Although it took on a wholly new life at the start of the 1970s, it is not yet being practised in very many countries nor is it published in very many languages, but it is none the less truly global in its range of tools, its context and its rate of advance, and the resulting harvest of new knowledge in just one quarter of a century has been amazing. Not surprisingly only a few scholars and science writers have, so far with variable success, tried their hand at summarizing and explaining the activities of this new and exciting science to a wider public. Only a few treatises and compendia have appeared for the benefit of undergraduates or post-graduate students and almost none for a broader academic public. This is rather astonishing, because its even younger offshoot, the prediction of the climate of the future, is treated familiarly by politicians the world over either as an enemy or reluctantly as a friend. A newcomer to the small group of those write about climate, past, present or future, is therefore to be warmly welcomed.

The book is a veritable compendium of the recent literature and since with sparse exceptions between 1920 and 1970 almost all publications can be labelled recent, this has generated an immense list of references covering 76 pages of fine print and a spectrum of subjects ranging from biological oceanography to solar–terrestrial relationships. There is also a commendable selection from the short but not negligible history of those who came before us, from the insights of T.C. Chamberlain onward. All the great are here, from Wally Broecker with seventeen papers to Harold Urey with two, but my modest random scan also pulled up quite a few papers that, although fairly labelled obscure or neglected, are more than just deserving. This vast collection predicts a raging tide of information and opinions, as indeed proves to be the case. After an introduction so enthusiastic about the wonders revealed in the last thirty-odd years that the examples may well be above the head of most of us, there are eight chapters packed with those challenging but at times disrupting references in parentheses: two on principles (Chapter 2, Principles of Palaeoclimatology and Chapter 3, Vital Effects) and six on diverse aspects of climatic change and its consequences.

The chapter on principles of palaeoclimatology astonishingly almost completely avoids the construction of what I tend to think of as essential, a foundation of how the climate works, in favour of many, many pages on stratigraphy, dating, chronology and other aspects of time-in-climate studies. Bits and pieces are added to this foundation in later chapters but in somewhat random order so that the reader wishing to emerge with a decent understanding of the dynamics of the global ocean and atmosphere is at times left to construct it himself.

The third chapter, entitled Vital Effects, is much longer than the preceding one and presents this theme at a length and to a depth that are unusual in palaeoclimatology. The author seems far more comfortably at home at here, his treatment is more assured and the material is interesting by itself, but much of the time the significance of this biological discourse in the context of the next six chapters is far from clear, while its length is at times excessive.

Four of the following six chapters focus on the various time-scales of climate change, beginning with change on an orbital time-scale (Chapter 4) and proceeding by way of the millennial (Chapter 5), centennial–decadal (Chapter 6) to the interannual time-scale (Chapter 7) where today the main research activity takes place. Using various time-scales as a lead theme is sensible, but done in reverse order from long to short and from least to best known as it is done here, violates two important didactic principles: that it is best to proceed from the familiar to the alien and that a sound foundation gains one the right to speculate. Besides, I found it at times rather confusing and it does not infrequently lead to a sudden ‘Ah, now I get what this was all about in chapter x’.

The book ends with two chapters on subjects not immediately related to the main theme that is so firmly anchored to time-scales. The first of the two discusses sea-level changes as consequences of climate-induced changes in the volume of water in the ocean and how those climatic oscillations are recorded as sea-level changes. Then, somewhat unexpectedly, it wanders off to inspect much older chapters of the history of sea-level change and raises new data, new theories and new questions. It brings up such issues as the embattled Exxon–Vail theory of long-term sea-level changes, but because it fails to delve deeply into the complex events of the remote past it remains the weakest of the chapters in terms of treatment and relevance.

The last chapter of the book addresses the late Pleistocene palaeo-atmosphere as seen through the records of the Greenland and Antarctic ice cores. It is well and interestingly done but presents much material that would have been more appropriate and much more helpful much earlier. It also brings the course in palaeoclimatology to a rather abrupt end, and a final chapter drawing together the various strands developed throughout the book into a clear, concise image of the climate of the last glacial–interglacial cycle would have been preferable.

How well does the author succeed in his intention to instruct his audience? He has chosen to inculcate the knowledge that precedes understanding with minimal coherent theory and mainly by a case-history approach that seems at times a bit extreme and all too often lacks clarity of purpose and context. Even the two chapters on principles use anecdotal cases more often than is good for a reasonably rigorous and orderly theoretical treatment of the principles of climate and ocean/atmospheric interaction on which all following chapters must rest. The first chapter must provide this education almost alone and does not, or not with minimally adequate rigour. The various texts mentioned (pp. 8–10) for supplementary reading are no remedy; time, attention span and retention of the readers are close to overloading by this dense package anyway and those more traditional treatises do not connect well with the structure of the book.

Especially in Chapter 2 the decision to defer dynamic aspects to later leads to pervasive difficulties which the
JONES, T. P. & ROWE, N. P. (eds) 1999. Getting the points across we wish to make. It is hard to say because the text swings from section to section and paragraph between an assumption of considerable expertise and a middle-school didactic stance. The extreme reliance on case histories and on references to an enormous number of publications to explain what the text does not say are to a significant degree unhelpful here and so, I fear, what the author has to say and says with erudition and passion may well fail to catch either of the two presumed potential readerships.

Throughout, the book seems reasonably free of error and bias and, considering the great range of information it covers, it is admirably correct and equally admirably comprehensive. But it is this very tide of information and description, together with the weakness of the theoretical foundation, that makes me wonder who will really benefit here without a massive case of palaeoclimatic indigestion. But then, there will be those who, like myself, will cherish it as an instructive although not wholly successful way of getting the points across we wish to make.

Tj. H. van Andel

This tome provides a timely addition to the palaeontological literature, which in the words of the editors, represents something of a ‘recipe book’ designed to provide investigators from graduate level onwards with written methodologies of both established and more recently introduced palaeobotanical preparatory and analytical techniques. Although their use of the culinary allusion is presumably not intended to cast the editors as the ‘Two Fat Ladies’ of the palaeobotanical world, they must be congratulated in achieving the miraculous by drawing together an international star cast of no less than 78 contributing sous-chefs (authors) who have contributed to 60 short papers which deal with an enormous range of techniques commonly applied to the location, collection, extraction, analysis and preservation of macro- to micro-fossil plant remains.

The volume is sensibly subdivided into ten thematic parts, each dealing with a different aspect of palaeobotanical investigation. These sections are clearly and logically organized, commencing with a series of papers summarizing a variety of collection and extraction techniques, closely followed by a further six papers which take the theme of the preparation and examination of surface morphological features. The third segment concerns itself with explaining techniques related to anatomical analyses of both plants and palynomorphs, whilst the fourth section deals with ultrastructural investigations of meso- to micro-scale plant fossils. Part 5 details geochemical techniques, some newly developed and some newly applied to plant remains. This section thus represents one of the most interesting in the volume: carbon stable isotope analysis, pyrolysis, chemolysis, $^{13}$C NMR, DNA sequencing and stable isotope analysis amongst the techniques covered. Conservation, use of databases and protocols are covered in Part 6, whilst Part 7 relates to experimental sedimentology, taphonomy and stratigraphy. The palaeoclimatological aspects of palaeobotany are drawn together in Part 8 with contributions on the employment of fossil leaf character states, palaeodendrology, stomatal density indices and nearest living relative comparisons; as is the case with Part 5, many of these techniques have been recently developed and the chapters thus provide extremely useful introductions. The volume concludes with a collection of chapters dealing with palaeoecological analyses and a final section describing the vagaries of international law as applied to the collection and movement of fossil specimens, a subject area all too frequently neglected in publications, and one with which all palaeontologists should be acquainted.

Bar a general section on multivariate statistical data processing, there are few subject areas that go without any form of mention in this comprehensive book, and although the sheer number of individual chapters has resulted in some contributions being of extreme brevity, the value of this volume as a first point of reference for any palaeobotanical investigator is self-evident. As the editors note, there are many ways to skin a cat and the readers of this volume are encouraged to utilize the techniques described as starting points for their own experimentation. Indeed, many of the techniques described within the nearly 400 pages will have applications in the field of palaeontology as a whole, and as such this publication will become a staple text for years to come. The editors have furnished us with some excellent recipes and detailed ingredients lists in this book, so it is now up to us to go back to our laboratories, don the aprons and start ‘cooking’!

Ian Harding


Readers who have encountered earlier editions of The New Solar System will need no reminding that since 1981, when the first edition was released, this has been the pre-eminent book to refer to for a well-presented and authoritative account of each element of the Solar System. The 1999 fourth edition is a welcome successor to the 1990 third edition. It includes a more mature view of the Neptune system than was previously possible, and incorporates much important information that was not available at the time of the third edition. This includes detailed radar mapping of Venus by Magellan, studies of Jupiter and its satellites by the Galileo probe and orbiter, and the discovery of the Edgeworth-Kuiper belt of icy planetimals in trans-
Neptunian space with all the implications this has for the dynamic evolution of the Solar System.

The new edition is longer than before, having gained separate chapters on Mercury, Venus, ‘Cometary Reservoirs’ and ‘Other Planetary systems’, and lost chapters on Voyager and ‘The Halley encounters’. The world-sized icy bodies at Jupiter and beyond now quite rightly receive six chapters in place of the previous three. The book is extensively illustrated throughout, in colour wherever appropriate. There are many glorious images of planetary surfaces, usually reproduced at sufficient size to do them justice.

The authors of each of the 28 chapters are well-known and well-chosen experts, who cover their subject matter in a nicely balanced fashion. The editors are to be congratulated on assembling such a highly readable and attractive text. This book should be in the library of any geoscience department where there is any pretense at seeing our own planet in comparison with its neighbours and in the context of its environment. It is written at a level that undergraduates should have no trouble understanding, and this will be welcomed by the professionals too, who will consult it for information outside their own specialisms.

In Our Worlds Alan Stern, himself a planetary scientist of some repute, has collected invited essays from eight leading ‘second generation’ planetary scientists. Each is an amalgam of personal anecdotes chronicling the authors’ entry into and pursuit of planetary science plus an account, in layperson’s language, of what is exciting about the particular planetary body (or bodies) in which they have ended up specializing. The book lacks the comprehensiveness of The New Solar System, because it covers only Mars and similes with dry valleys in Antarctica, Venus, the Moon, asteroids, comets, Io, Titan and Triton. However, the human interest factor is higher. I thoroughly enjoyed reading it, because it reminded me of why the planetary exploration game is worth it. To quote from Stern’s introduction: ‘Whoever it was that said that travel is broadening certainly had it right. Further the book was full of annoying type-setting errors, to such a level that about half-way through I gave up reading the text as a narrative altogether and simply followed the figures. This was no great loss, however, as the figures are excellent, being both clear and informative. My most serious criticism of the work is that, given the multidisciplinary aim, it seemed strange that the authors did not recruit someone with a complementary speciality onto their team. Whilst I have the greatest respect for the two authors, their coverage of the geophysics (my own area of speciality) was highly variable. The depth of the bulk and rare-earth geochemistry coverage also exhausted my enthusiasm for the subject!

In reviewing this book I tried to take myself back to my own Ph.D. days. During my studies I stumbled across the Open University Ocean Basins textbook, whose aims are similar to the one under discussion here. The OU book was a great revelation to me as it explained several of the emerging concepts on mid-ocean ridge structure (such as axial segmentation) and survey techniques (such as side-scan sonar), that I had been grappling with via the more conventional journal literature, in a straightforward way. Partly, the success of the OU book was its excellent coloured diagrams, often cleverly redrafted from the original, together with its readily digestible course-like structure. I doubt that the Juteau & Maury text would have inspired and enlightened me to the same level.

Jenny Collier

Reference


In 1997 the Geological Society of London and the Royal Society of Edinburgh held meetings to celebrate the bicentennial of two influential Scottish geologists: James Hutton and Charles Lyell. Hutton is noted particularly for his...
originality in taking a dynamic view of the world, with its unending cycles of uplift and denudation, driven constantly by subterranean heat that effected consolidation and melting of the products of erosion. The book reviewed here is a collection of contributions to the ‘Hutton Meeting’ held in Edinburgh (the papers from the ‘Lyell Meeting’ were published in 1998, in the Geological Society Special Publication no. 143).

The present volume begins and ends with articles on Hutton and his work. D. B. McIntyre sketches the political and intellectual background to Hutton’s life, but to get a view of the man and his times it is necessary to read his much fuller article in *Earth Sciences History* (1997). The last article, by D. R. Dean (who has published a major work on Hutton), is a critique of recent Hutton scholarship. Another article, by S. K. Monro & A. J. Crobie, has an attractive account of Hutton’s Edinburgh, but principally sets out the rationale behind the ‘Dynamic Earth’ exhibit in Edinburgh, which opened to the public in 1999. It is not my role to compare their educational aspirations with the actual experience of ‘Dynamic Earth’, although I would recommend any geologist to visit it, if only to feel what it is like to be drawn down into a subduction zone!

The most substantial part of the present volume is made up of six articles, each of which takes Hutton’s ideas as a starting-point and reviews aspects of ‘plutonism’ and the timeless evolution of the Earth. D. L. Anderson found a good quotation from Hutton’s writings to place at the head of his entertaining article, which is laced with Popperian philosophy and literary allusions. He uses Ockham’s Razor to cut away at the labile theories of mantle plumes, partly on the grounds of parsimony, and partly because they are incompatible with current theories of planetary accretion. P. J. Wyllie’s account of the history of experimental petrology begins with the work of Hutton’s friend James Hall, who, from about 1800, conducted controlled high-temperature, high-pressure experiments by melting rock-forming minerals in gun barrels (some of Hall’s samples survive even today in the collections of the British Geological Survey). Wyllie goes on to describe the development of experimental petrology in basalts, granites and carbonates. W. Schreyer extends the same theme with a lucid account of high-pressure experiments and their use in the recognition of rocks that have been metamorphosed at great depth. However, his penultimate paragraph causes me, in view of Anderson’s article, to wonder whether continental crust is really subducted down to depths of 2900 km?

For humans the most important part of the world is the biosphere. A. J. Watson’s readable review of the co-evolution of the Earth’s environment and life extends to interesting and sometimes controversial ideas such as the Anthropic Principle and the Gaia Hypothesis. He concludes that it is impossible to say how likely it is that there are other life forms outside the Solar System.

I was fascinated by U. B. Marvin’s 30-page review of the growth in the understanding of impacts from space and their acceptance as geological agents. As she points out, the study of geology and meteorites, each of which had developed separately for about two hundred years, have only recently been combined. Her article provides an excellent summary and includes what seems to me a balanced account of the controversies arising from the Alvarez hypothesis of the K–T boundary impact.

In the last review I, W. D. Dalziel takes as his text Hutton’s famous quote that, despite his study of the rocks, he could see ‘no vestiges of a beginning, no prospect of an end’ to the world. Dalziel finds that, even with modern geological knowledge, this still holds. He then extends his wide-ranging discourse to astronomical and cosmological theories in which beginnings are inferred and an end foreseen.

Altogether I found this a most interesting collection of articles. I had expected to see a more rounded picture of Hutton the man in this book, but otherwise the coverage is admirable. The reviews form a good starting-point for further reading, and every geologist will find matter of interest in them. My only slight complaint is that the index is not comprehensive enough, but in other ways book production is excellent and the effort that has gone into it has been well worth while.

Adrian Rushton


*Petroleum Geology of Northwest Europe* consists, as its full title proclaims, of the proceedings of the fifth conference on the petroleum geology of the North Sea. Held in 1998, this was one of a series of conferences organized variously by the Institute of Petroleum, the Institute of Geological Sciences, the Petroleum Exploration Society of Great Britain and the Geological Society. These conferences have resulted in the publications of proceedings in 1975, 1981, 1986 and 1993, of 501, 521, 1219, and 1537 pages respectively. The 1998 conference generated only 1398 pages, so the growth seems now to have peaked.

The first volume begins with an introduction by the editors. Fleet & Boldy note that the conference displayed three main themes. These are: 3D and 4D seismic studies, detailed sequence stratigraphic and high resolution biostratigraphic studies, and finally, modelling at both the basinal and reservoir scale. Essentially the proceedings describe petroleum exploitation in the mature province of the North Sea, and petroleum exploration in the frontiers of the distal continental shelves of the North Atlantic Ocean.

The pages are grouped in 11 parts, namely: Regional syntheses; Tectono-stratigraphic analyses and structural studies; Atlantic margin: offshore Norway to offshore Ireland (including western and northern Greenland, the Barents Sea, Labrador and Newfoundland); Atlantic margin: Faroe to Shetland; The Carboniferous of the Southern North Sea; Jurassic subtle traps; Chalk renaissance; High pressure/high temperature plays; Integrated field development and reservoir management; Reservoir studies; Applications of geophysical techniques; and finally, Basin modelling applications in reducing risk and maximizing reserves. Each part begins with an introductory review by one of the contributing authors. It is invidious to single out individual authors, but Underhill’s overview of the first part of the book includes speculation on the possible themes of the next North Sea conference. He predicts a total of six, five structural, and one sequence stratigraphic, with a structural angle. Time will tell.

A gradual increase in the number of pages is only one of many changes seen in the conference proceedings over the years. Sequence stratigraphy, which rose to maximum flooding surface level in the 1993 conference, appears now to have stabilized in the highstand systems tract phase. Similarly
source rock geochemistry seems to have waned somewhat, or at least to now be subsumed within basin modelling. The exponential rise in computing power has led to major improvements in imaging the geometry of petroleum reservoirs, and the distribution of fluids within them. The advent of 4D seismic now makes it possible to see how fluid contacts move as petroleum flows from the reservoir.

In the first symposium of 1975 most papers came from oil companies, several came from government surveys and consultants. Only one contribution came from a British university. Now the proportions are vastly different, with most of the papers contributed by academia and consultants. This reversal reflects the major change in the structure of the oil industry over the last quarter-century. Oil companies have ‘downsized’ their research facilities and contracted R & D out to universities and consultancies. Fortunately universities, faced with cuts in government funding, have seen the advantages of engaging in ‘trade’ through the vehicle of oil industry research contracts. These volumes testify to this metamorphosis.

*Petroleum Geology of Northwest Europe* is generally produced to the usual high standards of the Geological Society Publishing House, with many illustrations of seismic lines, well logs, maps, cross-sections, photographs and photomicrographs. There are, however, several lapses from the usual high standards. Sensitive readers may be frightened by the psychedelic-coloured figures in Cowan’s paper on the Sherwood Sandstone of the Irish Sea. This was caused by the corruption of digital files. An erratum, with the correct colouring, has been printed and distributed to all purchasers of the volume. There are occasional typos. Something odd happened, for instance, to the references on page 1397. But to comment on these minor blemishes seems as churlish as to comment on these minor blemishes seems as churlish as remarking on the ingrowing toenail of the Venus de Milo. *Petroleum Geology of Northwest Europe* is an essential reference work for all geoscientists concerned with the exploration and exploitation of petroleum from the continental shelves of the North Atlantic. Fleet & Boldy are to be congratulated for their Herculean editorial labours.

R. C. Selley


During the last quarter of the twentieth century about 100 books on dinosaurs were written by serious scholars (Lockley & Wright, 2000). Dean’s excellent biography of pioneer dinosaurologist Gideon Mantell helped bring the century to a close on a scholarly, historical note, chronicling the story of a man whose contribution is usually summarised, far too anecdotally, in a few paragraphs. Mantell it is best remembered, in most dinosaur books, for the discovery of *Iguanodon* remains, purportedly made by his wife Mary, in 1822, while he was busy visiting a patient. Dean reveals, however, that this ‘standard legend’ is not in agreement with ‘the evidence’ and that Mantell had noted saurian remains below the ‘Diluvium’ as early as 1817 and was collecting them by 1818. What emerges from Dean’s painstaking study of the Mantell diaries and archives is that by 1821, before the supposed discovery date ‘he already possessed a number of *Iguanodon* teeth’ (p. 71). At the time, however, these formed part of a miscellaneous collection of saurian remains that had yet to be identified. It behoves us, therefore, to look through the eyes of the early nineteenth century naturalist to try and understand how these discoveries challenged the anatomical knowledge of Mantell and his contemporaries, such as Cuvier, Lyell and Owen.

The evidence that ‘the standard legend’ is in need of revision will no doubt attract the attention of future generations of dinosaur textbook authors, and substantiate the repeated, but well-deserved, references to Dean’s scholarship which adorn the dust cover. However, Mantell is partly to blame for this historical inaccuracy, which is really of only minor interest in comparison with his interesting career.

Martin Lockley

**Reference**


Want to know the albedo of Uranus, the density of Saturn, the time of impact of fragment S of comet Shoemaker-Levy onto Jupiter, the early Babylonian name for Venus, or the mass of Mercury? Simply turn to Michael Bakich’s encyclopedic compilation to find the answers, which for your information are respectively 0.51, 0.69 g/cm³, 15.15 Universal Time on 21 July 1994, Nindarama, and 3.303 × 10²⁸ kg. And that is just for starters; in this book data pour out on escape velocities, atmospheric compositions, principal craters, moons, conjunctions between planets, orbital periods, magnetic properties, and yet more.

This volume, however, is more than simply a glorified telephone directory, and Bakich’s irrepressible enthusiasm carries the reader from numerous items of historical interest to scientific problems such as the origin and maintenance of planetary rings, most famously those of Saturn. In places the order of the text seems to be a bit jumbled and even repetitious, but it is difficult to imagine a more comprehensive and accessible compendium to our Solar System. The historical dimension is perhaps the leaven to numerous facts and figures. It is dealt with both by a series of potted lists (termed here ‘Historical tramlines’), which provide slightly disconnected and idiosyncratic overviews, as well as more extended reviews. These include the expected references to such giants of astronomy as Kepler and Galileo, as well as scientific campaigns such as the importance of proper observations of the transit of Venus across the Sun’s disc to allow an accurate calculation of the distance between the Earth and the Sun by parallax. Here, perhaps, Bakich assumes a little too much prior knowledge and the non-expert will have to pick up the threads of the argument for himself. Less well known was the race between Urbain LeVerrier in Paris and John Couch Adams in Cambridge, to discover Neptune. Bakich retells the story well, and like the various episodes in Galileo’s life and his brushes with authority (notably the Catholic Church but also, on a strictly commercial basis, the Senate of the Venetian Republic), the story of LeVerrier and Adams awakes recurrent chords of luck and priority in the scientific context. The discovery of Neptune, by a brilliant piece of prior calculation on anomalies in the orbit of Uranus, has been the subject of much hand-wringing, especially in England as Adams was pipped at the post by the French astronomer. Why, in particular, had the Astronomer Royal...
George Airy has been so dismissive, not even rising from his dinner to see Adams? But as shown here, the historian of science Allan Chapman provides plenty of reasons for taking a more balanced view of matters.

This then is a book by an enthusiast, who has done well to combine dry facts with human interest, and for the most part achieved a fair balance. If there is an obvious weakness, then it concerns the coverage of the moons. Some, notably the Earth’s daughter satellite and Triton, receive quite detailed attention, yet the Jovian satellites such as Europa and Io hardly receive a mention. A second edition would enthral us further with images of the frozen ice surface of Europa and the sulphur volcanoes of Io. The sections of ‘Interesting Facts’ are perhaps the most distracting component, although in general this is certainly a book for dipping into rather than being devoured cover to cover.

Michael Bakich has only not done a signal service by bringing together many data, reinforced by a wide range of illustrations, but in weaving a story of the history of Solar System astronomy, the recent triumphs of NASA, and the illustrations, but in weaving a story of the history of Solar System wonderfully diverse, but despite the extraor dinary images and discoveries the exploration of our nearest neighbours has only just begun.

Simon Conway Morris

Hopgood does not totally ignore key preoccupations of the modern structural geologist, such as strain partitioning and shear zones, but he effectively dismisses them in the first of his fundamental assumptions by saying that any deviations from regional penetrative deformation can be recognized and implicitly discarded. This would seem to limit the validity of the technique to terrains where no strain localization took place, but Hopgood maintains that characteristic sequences of fold sets can be recognized even where not every set is observed in every locality. Ultimately my reservations about this book could be countered by the fact that I have never taken up the author’s invitation to go out and do the truly painstaking work that will prove the methodology. I would still argue that fold sequence analysis is only one of many tools that need to be considered when deciphering the structure of basement, so this book has a use in illustrating some possible ways of dealing with complicated rocks in the field. Sadly the high price (presumably a reflection of the photographic content) will mean that the hardback version won’t find its way into the rucksacks of many research students heading into the field, which is where it would be most useful.

Simon Inger


This book is the fourth in the Cambridge Palaeobiology series which aims to provide a multidisciplinary approach to palaeontology. The first three volumes deal with either specific events in the history of a particular taxon (angiosperm origins and vertebrates) or a specific fauna (the Devonian Hunsrück Shale). This title is rather different; it deals with a process, post-mortem change and its role in understanding the fossil record, for the entire range of plant and animal taxa and from all geological eras (Precambrian to the present). Martin opens his preface with the charge that taphonomy is often ‘glibly treated’ and restricted to elementary palaeontology sessions ‘before the course moves on, presumably to more important things’. Later he suggests that the recent explosion in interest in taphonomy has meant that few have had time to assimilate the information. Certainly there is a certain over-familiarity of the weary diagrams of the fate of some hypothetical bi-valved organism during diagenesis (I have no idea who first drew it) and many undergraduates, where class sizes are high, are robbed of the experience of the wealth of different preservation styles (and the different information they convey) by studying uniform plaster casts.

Palaeontology journals these days publish a regular stream of papers which deal with disintegration of this or that taxon. Indeed, cognisance of this type of information is important in establishing (or at least acknowledging) information loss, or even gain, in a particular fauna or environment. However, such studies are often difficult to relate to one another or fail to establish the applicability of laboratory experiments to the real world. Thus this all-embracing contribution is particularly welcome.

Martin’s well-written text is comprehensive and clear. He draws examples from all quarters and the reference list provides over 1000 entries, most of which were published in the last two decades, underlining the increase in taphonomic
research and thus the timeliness of this book. Martin himself is a micropalaeontologist, specializing in foraminifera, and there is a rich source of information about their fate when they die and the information they provide, for example on the CCD, but the scope is much broader than that. Sometimes when one reads this sort of book, one gets the feeling that the author has only the most tenuous grasp over the details unrelated to their own interest, perhaps little better than the anxious reader. This is certainly not so here; Martin has done his homework well and he present information on plants, bivalves, worms, echinoderms and vertebrates with equal understanding and clarity. In the Preface, Martin hopes that he has shorn the equations, which are plentiful in Chapter 4 which deals with the effect of bioturbation on time-averaging, of ‘gobbledygook’ and I think he has succeeded.

The main areas covered by the book are a discussion of the pre-burial processes as they affect a range of taxa, dissolution and diagenesis, bioturbation, with its effects on time-averaging, specific case histories of well-known lagerstätten (Burgess Shale, Beecher’s trilobite bed, Mazon Creek) and, finally, a view of what he calls megabiases, changes, sometimes cyclical, in atmospheric and hydrosphere conditions which are likely to have affected taphonomy differently over geological time. He finishes his text with a set of rules, the last of which is a salutary reminder to all who would seek to practise taphonomic experiments. Whilst this is obviously possible for some environments, Martin reminds the reader that differences in timescale and parameters which are unfathomable or changeable, prevent extrapolation from the laboratory to the fossil record.

This book is a valuable asset to any library that seeks to serve students and researchers. Its interest should not be restricted to palaeobiologists; other earth and environmental scientists will also be interested, or at least they should be. Its price, particularly the paperback, provides excellent value for money in the highly priced book market. Not only is the book itself interesting and informative in a key (and expanding) field of palaeobiology but the springboard that it provides into the literature is invaluable.

Liz Harper


In 1992 Luis Dalla Salda and others of the University of La Plata in Argentina proposed that the continental masses of North and South America had collided along the western margin of South America in early Palaeozoic times. This revolutionary idea suggested that the Appalachian Mountains, which now terminate abruptly in the Gulf of Mexico, formerly continued into the Andes of southern South America. The reconstruction required Laurentia to be located in a position equivalent to the present-day South Pacific, with a Southern Iapetus Ocean between Laurentia and Gondwana. The traditional view, forming the basis of the Wilthan cycle, was that accordion-like opening and closing of the proto-Atlantic Ocean had produced the Appalachian and Caledonian orogenies. The new hypothesis requires a revolutionary review of early Palaeozoic geography, stratigraphy, palaeontology and tectonics. In an intriguing aside Ian Dalziel pointed out that the traditional reconstruction probably reflected the concentration of geologists on either side of the Atlantic as much as the geological facts.

The similarity of early Palaeozoic stratigraphy and fauna in the northwestern Argentinian Precordillerata (the mountain ranges east of the Andes) and eastern Laurentia was first recognized in the 1970s. Interpretations of terrane tectonics between the ancestral North and South American continents were introduced in the 1980s. Dalla Salda’s revolutionary plate reconstruction became the focus of intense international interest, culminating in a Penrose conference in San Juan in Argentina in 1995, and a 1996 IGCP symposium in Buenos Aires entitled ‘The Proto-Andean Margin of Gondwana’. The overall consensus of these meetings was that the Argentinian Precordillerata is a large allochthonous terrane detached from Laurentia and accreted to southwestern Gondwana during closure of the Southern Iapetus Ocean.

The book is produced to the usual high standards of the Geological Society. It consists predominantly of detailed papers on the early Palaeozoic geology of northwestern Argentina. An informative introductory paper by the editors provides a very useful summary of the geology of the region. The selection, presentation and editing of a collection of 17 papers, where many authors do not have English as their first language, is extremely good. The comprehensive index is particularly useful. The authors have focused well on the theme of the meeting and added useful material to the debate.

This book forms a valuable resource for researchers in South American and Andean geology. From the point of view of advanced undergraduate teaching the topic provides an excellent example of the evolution of an orogenic belt by terrane accretion. It also forms an intriguing case of the overthrow of conventional wisdom.

At a cost of £75 this book will probably not appear on many private bookshelves, but no university or geological research institute library should be without it.

C. M. Bell


The book comprises a selection of thirteen out of some 80 papers presented at the Fourth International Conference on Aeolian Research (ICAR 4) held in Oxford in 1998. Others of the 80 have been published elsewhere. Many of the papers presented at the conference were keynote reviews by world authorities on their specialities; it is these that form the bulk of this volume.

The first paper, a short ‘History of Desert Dune Studies over the last 100 years’, by Goudie, introduces the book and puts the succeeding research papers into perspective. Nickling & Neuman then bring us up to date with aeolian mechanics with their recent investigations of Terrane Tectonics and Sediment Transport over Desert Dunes. The following paper on ‘Geomorphology of Desert Sand Seas’, by Lancaster, emphasizes the importance and dating of past changes in climate and sea level in controlling the availability and rates of supply of sediment to sand seas. Dune size
seems to be a function of sediment supply and time, extending back tens of thousands of years, so that large dunes comprise the sediments of multiple generations of accumulation.

In ‘Coastal Dune Dynamics: problems and prospects’, Bauer & Sherman stress that because of the combined effects of wave erosion, sediment supply, moisture and vegetation, the morphology of coastal foredunes is distinctive in having the steepest slopes up-wind, the reverse of that seen in desert sand seas. Under ‘Coastal and Continental Dune Management into the Twenty-First Century’, Thomas discusses the need for management of what many city dwellers consider to be their natural holiday resort. Areally limited coastal dunes come under stress when, for example, holiday homes are built on them, and a consequent depletion of contained reservoirs of potable water puts their cover of vegetation at risk. Continental dunes, on the other hand, can comprise vast areas that now contain cities and linking networks of roads that need to be kept as free as possible from the natural hazards of drifting sand, whereas in other areas dunes may be reactivated because of increased agricultural activity.

‘Physics of Aeolian Movement emphasising changing of the aerodynamic roughness height by salting grains (Owen Effect)’: here, Gillette reviews the relatively slow development of the experimental and theoretical verification of the processes of aeolian sand movement that, via Raupach some ten years ago, stemmed from the mid-century work of R. A. Bagnold and, twenty years later, of P. R. Owen.

‘Wind Erosion on Agricultural Land’ is important not only to farmers because of land degradation, but also because it can cause widespread dust storms. In this chapter, Leys discusses the causes and effects as seen in particular in eastern Australia, and develops a strategy for avoiding such phenomena, and suggests areas for additional research for its better understanding.

Goudie’s second paper ‘Wind Erosional Landforms: Yardangs and Pans’ is a short description of the origins of these features. The former are clearly the result of wind abra- sion of rock surfaces softened by a variety of processes, while the latter apparently involve mostly the sediments of shallow, mildly evaporitic depressions whose surfaces were subjected to deflation.

‘Dust Transport and Deposition’ by McTainsh ranges from the global distribution of dust storms mainly in North Africa and Australia and their resulting deposits as continental loess and marine siltstone, to modern methods of measuring these deposits. The natural extension is into the next chapter, ‘Loess’, by Pye & Sherwin. They describe its origins in peri-glacial, peri-montane and peri-desert environments, give details of a variety of other characteristics and requirements for its formation.

Kocurek gives a thought-provoking chapter on ‘The Aeolian Rock Record’. He outlines the criteria for sand-sea construction, accumulation and preservation, each of which is controlled by three sets of governing rules, which he separates out as hypotheses involving: 1, the supply and availability of sediment and the transport capacity of the wind; 2, whether the aeolian systems were dry, wet or stabilizing; and 3, whether the sand sea was preserved by subsidence and burial or by a rising water table.

In discussing ‘Dune Palaeoenvironments’ Tchakerian confines himself to the Quaternary, and the criteria used for their reconstruction, from grain surfaces to global occurrences. The various sedimentary factors by which dune chronologies can be deduced leads naturally to the last chapter by Singhvi & Wintle, which explains the uses, strengths and limitations of ‘Luminescence Dating of Aeolian and Coastal Sand and Silt Deposits: applications and implications’. For sediments that have virtually no biota, this technique provides ages back to 300 ka or more, far beyond the 40–50 ka limit of radiocarbon dating, and has proved invaluable in helping to clarify climatic change over that time span. They present an outline of the technique together with some interesting examples of dating from around the world.

Not only is it an interesting book, it is also one that is stuffed with the latest ideas concerning aeolian activity, although marred slightly by some typographical errors. I certainly learned a lot from it and recommend it to all geographers and geologists concerned with aeolian sediments, from the specialist to the occasional seeker of information on the topic.

K. W. Glennie


When I was asked to review this book I must admit that I agreed with slight feelings of trepidation on hearing the title. I expected to open the cover and be drawn into a whirlpool of complicated statistical equations and methodologies. Having a limited knowledge of such things, I was however pleasantly surprised with the content and found that most of the chapters were methodically written, leading to a clearer understanding of the numerical/statistical content. Consisting of twelve papers, the volume encapsulates the majority of palaeontological disciplines and describes a number of numerical applications to solve some of the most commonly encountered problems.

In Chapter 1, Harper & Owen set out a thorough review of quantitative and morphometric methods, with a useful introduction into some of the historical development of numerical techniques. I personally found this chapter very useful and gained some particularly good references on principal component analysis and the expression of variation and temporal changes. They also thoughtfully provide a list of useful internet sites where relevant software may be obtained. In Chapter 2 Carlson tackles what I always consider a particularly difficult subject, phylogenetic systematics. She begins by discussing the basic principles of character analysis, leading onto detailed sections that supply the appropriate knowledge required to apply computer-based techniques to the problems involved.

The work described on computer-based serial sectioning in Chapter 3 provides some useful insight into the acquisition and application of 3D images. Herbert describes common problems encountered, with appropriate solutions, and describes how 3D images may be useful to the palaeontologist. There is also a stress on the need and room for improvement in the techniques, which will undoubtedly lead to increased use of computer-based reconstruction in the future. Hughes, in the following chapter, describes imaging methods in relation to overcoming the effects of deformation in fossils. He describes various statistical methods of overcoming deformation as an aid to correct diagnosis of taxa. He then describes the methods used to ‘retrodeform’ (redraw without deformation) utilizing advanced photocopiers and computer software.
Anyone familiar with Richard Dawkins’ work would find the next chapter stimulating. Swan guides us through various computer models that describe Raupian shell growth, accretionary growth, simulated growth of colonial organisms and morphological evolution. Computer code is supplied for most of the simulations (written in Q-basic), along with numerous illustrations of the outcomes of various algorithms.

In Chapter 6 Armstrong reviews the history and problematic nature of biostratigraphy. He goes on to review the principles and concepts of numerical biostratigraphy, although reserves one particular technique, graphical correlation, for more thorough examination, with a thorough description of methodology. There then follow two related chapters using palaeontological databases. The first, by Johnson & McCormick, looks at temporal and spatial distribution of organisms on a local scale. The paper discusses the construction of taxonomic databases and documents some numerical techniques for describing rates and modes of faunal change.

Benton, in the following chapter, describes the broader-scale testing of databases on a larger scale.

The following chapter by Etter on community analysis involves an extensive description of the methods involved in the field of palaeoecology. There is a particularly interesting section on the application of trophic analysis towards the end of the chapter. Smith’s chapter on multivariate techniques is a useful section where earlier-described techniques in the book can be seen ‘in action’ as Smith applies them to palaeoecological analysis. Two well-illustrated case studies are set out utilizing cluster analysis and PCA respectively.

In Chapter 11, Orr reviews quantitative approaches in technology, utilizing well-chosen case studies which the author feels are most appropriate for application and development in this burgeoning discipline. The final chapter describes seriation, a method used to identify spatial or temporal gradients in associations of absence–absence data. Ryan, Ryan & Harper present two methods that they claim are statistically more secure than those previously used.

**Numerical Palaebiology** is a well-illustrated and generally concise book. The provision of a CD with some of the compiled programs and examples may have been a useful addition. This book would be most appropriate for research students but could provide some useful knowledge to the undergraduate tackling a particularly difficult palaeontological project.

Jon Roberts


There must be few readers of *Geological Magazine* who are likely to declare an interest in sociobiology, let alone bioeconomics. A glance at the subtitle of this provocative and stimulating book, however, will give the first hint that there are indeed topics discussed here that are relevant to anyone with a serious interest in biological evolution and its implications. At the heart of the matter is a contest, if not battle, between those who take a severely reductionist view of the evolutionary process as against those who espouse such concepts as ‘systems’ and ‘complexity’. The views of the former are encapsulated in such terminology as the ‘selfish gene’ and the yet more elusive concept of a cultural equivalent, the mental gene or meme. These ideas and their purported implications are promulgated with unwavering conviction, rhetoric and self-righteousness by such individuals as Daniel Dennett and Richard Dawkins. Opposed are those who take a more holistic, and I would suggest more subtle and arguably more intelligent, view. In this camp the atomistic world picture of Dennett and Dawkins, and their various camp-followers, is viewed not only as hopelessly simplistic, but from a scientific viewpoint is at best misleading and, even more seriously, from an ethical perspective might be potentially disastrous.

For the most part the sympathies of the contributors in this volume are very much with the second camp, although Michael Ghiselin takes a robust, self-assured and no-nonsense line that ends up ploughing a rather lonely furrow of the supreme rationalist who has no time for the sophistry (his words) of Dawkins. I suspect, however, he might have little patience with a number of the other contributors.

The highlight of this volume is the stimulating chapter by Eva Neumann-Held, with the provocative title ‘The gene is dead – Long live the gene’. In brief, she argues that to regard the gene in the customary atomistic fashion is simply wrong. In her opinion, and it is one that is highly persuasive, any concept of the gene only makes evolutionary sense when the overall context of its operation is defined and understood. This context, moreover, includes not only activities within the cell, but the external environment. Thus when we put the gene into this wider framework, it loses its reductionist persona as an almost homunculus-like object, but rather becomes effectively a process whereby the phenotype emerges in a complex (and potentially variable) context of co-definition and co-construction. And this is not all hand-waving. Neumann-Held supports her argument with specific and pertinent examples. With reference to the central processes of transcription whereby the polypeptides (the precursors of the proteins) are ‘read off’ the DNA strand, she shows how it is seriously misleading to regard the relevant segment of DNA as simply a template that can be divorced from the overall developmental context in which it finds itself. Equally upsetting to the atomistic view is the well-known, but strange, phenomenon of ‘split-genes’ whereby the lengths of DNA that actually act as code (the exons) are assembled after transcription, with a splicing that may not be a uniform process. In at least one example (bovine growth hormone) a segment of DNA that forms part of a coding region in one case has no function in the other. In other words the same protein is formed, although different parts of the DNA ‘segment’ are removed. Nor do the complications end there. As Neumann-Held goes on to report, there are yet more sophisticated examples of editing, where the DNA is effectively reduced to an alphabet that is drawn upon to build different structures from the same sequence. In one sense this is hardly surprising: DNA is the basic code, but the notion that it ‘builds’ birds’ nests, turtle migration patterns, let alone the Tate Gallery is naïve. Neumann-Held’s portrayal of the gene as effectively a process not only provides a cogent and scientifically reasoned escape from the dreary world of the reductionist, but also has more immediate, if not more important, implications. By rejecting the gene-as-particle notion it allows one to reject simplistic portrayals of ‘genes for something’, say homosexuality or schizophrenia. Either of these might have a genetic basis, and it is easy to see how the short cut of an argument leads to the fascination of genetic determinism. But not only is this erroneous because of the necessity, noted above, of knowing the context, but suggests that blanket assumptions of genetic risk as predisposition are much more
subtle than is presently assumed. The ethical implications of this should be obvious.

The chapter by Susan Oyama is also of particular interest, and provides an apt counterpoint to Neumann-Feld’s discussion. Although written in a style unfamiliar to evolutionary biologists, in which I include palaeobiologists, her text on how we define the boundaries of discussion has as its central theme what she terms ‘privileged genes’. Through five arguments she persuades the reader that the standard response of the genetic reductionist that ‘we knew that all along and/or it doesn’t matter anyway’ is unacceptable. Her chapter is laced with a not-so-gentle irony and is a stern reminder that the road to reductionism is neither strewn with roses nor offers any real explanation of the way the world is or even ought to be.

Other chapters have their own share of useful insights and thoughtfulness. Bruce Weber and David Depeu, for example, give a critique of the meme concept, as well as trenchant remarks on sociobiology. The hardest hitting comments, however, perhaps come from the editor Peter Koslowski. He identifies Dawkins’ world-picture as one of ‘genetic animism’ and concludes that his work is ‘the ultimate form of ontological nihilism’. His ideas, and Koslowski’s indictment, matter because the reduction of humanity on specious scientistic grounds to robots steered by blind genes across a meaningless landscape has political undercurrents that if exposed to the full light of day are deeply disturbing.

Simon Conway Morris


First published in 1992 with an A3 format, this new A4 edition of the ‘Geol. Soc. Atlas’, as it is generally known, is very welcome, as much for its affordability as its shelfability. The original edition might have been criticized for its unwieldy size but there are a few of the maps with detail which now need a magnifying glass to see clearly. However, this is not a serious complaint; the present edition will be a very welcome addition to any personal library.

The original work was the most expensive publishing venture ever undertaken by the Geological Society and, according to the editorial in the new edition, has now covered its costs, hence the new much cheaper edition. The 1992 edition involved 35 contributors, was a very complex venture and took a great deal of time and effort to compile. Like any such venture its production was at times excruciatingly slow, largely because of the tardiness of a few of the contributors (see the rather ‘sad’ editorial to the first edition). Most of the references are to the work of the late 1980s and before, so now they are 20 years old and a lot has happened in the intervening period.

The editors were well aware of this problem when the reprint became a possibility. They made a decision that ‘no amendments would be made to the maps or text’ in order to keep costs down, and instead provide a brief editorial which draws attention to the major scientific innovations of the intervening period. Certainly the alternative of allowing changes to the maps and text would have been daunting as it would have had to involve new authors.

WILLS, A Palaeogeographical Atlas of the British Isles and Adjacent Parts of Europe was published in 1951 and provided the original inspiration for the present Atlas. Stylistically, this evolutionary heritage is quite clear. Hopefully there will soon be a new generation of brave and tough young editors to pick up the challenge of chivvying their colleagues into producing a completely updated new edition. Judging by past difficulties, they should start planning now. Hopefully, the Geological Society will have more confidence in undertaking such important publishing ventures that no commercial publisher will consider these days unless they can be sure of guaranteed sales and profits. The Geological Society Publishing House has been providing an invaluable service to the geological community over the last decade or more and long may it continue to do so.

Douglas Palmer


If you pick a book at random from the biological sciences shelf of your favourite bookstore, you are likely to find your fingers grasping a freshly printed copy of How to run your PCR most effectively rather than an old and still unsold copy of How to follow Linnaeus’s footsteps respectfully. There is a widespread perception indeed that biological systematics has undergone such profound changes that nothing but cultural fossils may be found today in what used to be the taxonomic practice of the past. Let historians browse into those dusty pages crowded with species descriptions; our trade’s tools and goals have moved to quite more serious ground. The few fools still continuing with christening plants and animals with Latin or Latinized names remain better forever outside the precincts of acknowledged science. To be sure, there are also more informed and less presumptuous people who know and admit that a probably vast majority of Recent organisms are still awaiting description and, more importantly, that such a description may be worthwhile in our endeavour to understand the biosphere’s structure and functioning.

To be practitioners of less fashionable science means that prospective authors are not very motivated to submit proposals for up-to-date handbooks to potential publishers ready to anticipate mini-expedited publication schedules. It also means that the discipline’s standard may be in serious danger of declining, unless somebody is ready vigorously to reverse the trend.

Happily, Judith Winston (and Columbia University Press) courageously embarked on such a venture, producing an excellent book that fills a large and distinct gap in the current literature. Winston’s book is really about what the title anticipates: how to describe a new species, and how to re-describe an old one. To a large extent, this is a matter of nomenclature, zoological or botanical, but this new book is not just a companion to the current Codes. Neither is it a book-sized version of the Instructions for Authors of a journal specializing in animal or plant taxonomy, something Judith would have done well, based on her year-long service on the Scientific Publications Committee at the American Museum of Natural History. Instead, she offers a safe and exhaustive guided tour through a very large and well-selected sample of recent taxonomic literature, in the search for the best
examples to follow in each and every step of the taxonomist’s work, from his/her first acquaintance with the specimen to the final submission of the new species’ description to a specialized journal.

Following Linnaeus, one may wish to find for Judith Winston a place in the system of systematists. Taxonomically, she is a specialist of bryozoans. Methodologically, she is clearly Mayrian/Ashlockian. First, she founds her presentation, explicitly or not, on a basic distinction between microtaxonomy and macrotaxonomy: something operationally useful, and corresponding to firmly unshakeable attitudes, despite the recent and increasing theoretical assaults to the notion of species as some unique kind of taxon. Second, she keeps on using Ashlock’s (1971) term holophily, now disappeared from the cladistically imprinted mainstream literature of today. Indeed, Winston’s book documents the low degree of penetration of phylogenetic thinking into most practitioners of museum taxonomy and biodiversity research, which does not mean, however, that these taxonomists fail to offer sound precious contributions to our knowledge of Recent or extinct organisms.

Summing up: not too much theory, but a lot of good sense, in this book, and an astonishingly readable writing, despite the apparently dull and boring subject. Nothing to criticize? Well, the usual major shortcoming of an otherwise good book: the price, much too high for a handbook that should be on the personal shelf of thousands of taxonomists, and especially of those beginning their training in our old Linnaean discipline.

Alessandro Minelli


The plate tectonics revolution has changed our outlook on the physical history of the solid Earth more than anything else since the debates of Adam Gottlob Werner and James Hutton, but it has now arrived at a state of consolidation where patiently and inconspicuously (unless you are an insider) the foundations are being laid for, a, perhaps large, leap forward at some point in the future. In the meantime another revolution, slower, less audible and therefore less noticed, has been addressing equally grand but quite different aspects of the Earth. Born in the seventies of the last century, it tried its tools and wits in the eighties and began to really keep its promises in the nineties. Taking advantage of the images of the changing geography of continents and oceans furnished by its predecessor and the current explosion of interest in present and future climates of the world, it has already much increased our understanding of the working of the atmosphere, cryosphere and hydrosphere of the recent past. In so doing it has also set the stage for a new and more profound study of the surface history of the Earth and its role as the scene of the origin and evolution of life.

Since its beginning, the main thrust of what Nick Shackleton has called the ‘quiet revolution’ has been directed towards the climate and the atmosphere/ocean interaction of the Quaternary as the backdrop of the accelerating change from the climate of the recent past to that of the immediate future. It has so led to a strong growth in our understanding of the dynamics of the present climate and the development of important new tools; examples are the quantification of environmental data extracted from geological and palaeontological proxy records and the use of global circulation models to synthesize proxy data and test the ability of the models to simulate the climate dynamics instead of merely copying its global effects.

It was only natural that those new tools would soon be applied to some of the large climatic puzzles of the remote past, such as the curious fact that the current state of the world with its ice-covered polar regions is an unusual one occupying only a very small fraction of the history of the Earth for at least a billion years.

Why this is so, why the normal state of the world appears to be one of temperate conditions even at high latitude and an absence of polar ice caps is a challenging question, as is the question of what conditions prevailed on the super-continent Pangaea, so enormous and therefore so likely to be the stage of the grandest monsoon climate the world has ever seen. And so the quiet Quaternary revolution spawned an offspring interested in considering in depth those and other strange deviations of the more remote past from our accustomed present. Already in the late seventies a few climate modellers accepted this challenge under the curious, mildly sceptical gaze of palaeontologists and geologists. Not surprisingly, the new tools proved inadequate to this task; I remember a modelled Cretaceous with an equatorial ocean current system flowing from west to east and some Pangaean climates generated without benefit of an ocean because the memory of the computer was too small. Naturally, this presented the geological old guard, in whose hands the solid evidence rested, with a fine opportunity for a little satisfied sneering that was not really conducive to constructive collaboration. It also drove some irritated modellers to turn their backs on such down-to-earth matters and talk solely to each other about models produced in the lovely colours that entice one to believe in them. For a while a high wall seemed to be rising between modellers who know all, or at least more every day, about how the atmosphere and the ocean work, and those of us who, familiar with the record of the rocks, would like to understand it better; clearly an unhappy state of affairs.

All that is a while ago now, and on both sides curiosity, persistence and a strong desire to know the answers appear to be winning the day here and there in this difficult terrain. Still, some departments of earth science, and among them some of the most distinguished, remain blissfully ignorant of what is going on and how important it undoubtedly will turn out to be. However, within the last two years two major works have appeared that may well do a great deal to bridge that gap. The first was Judith Totman Parrish’s *Interpreting Pre-Quaternary Climate from the Geologic Record* (New York; Columbia University Press) that made the rock record much more accessible for application to modelling exercises, but also convincingly argued the essential nature of such applications. Now Huber, MacLeod & Wing’s book has completed the set by presenting, equally cogently and from many different angles, the value and state of the art of modelling the paleoclimate, with a much strengthened arsenal of modelling techniques and pervasive exploitation of geological proxies. Both are excellent works that should go a long way to bring about the co-operation of the two communities required to deal with rewriting the history of the Earth with quantitative methods and guided by an interest in and emphasis on past processes.

*Warm Climates in Earth History* counts many of the now very experienced pioneers of the study of past climates
BOOK REVIEWS


‘Granite magmatism represents a major contribution to crustal growth and recycling and, consequently, is one of the most important mechanisms to have contributed to the geochemical differentiation of the Earth’s crust since the Archean times’, so say the editors of this book. Their aim was to present an integrated approach to granite studies using geophysics, geochemistry, experimental petrology, structural geology, scale modelling and field geology. The book ‘was inspired by the international workshop’ on modern and classical techniques in granite studies held in the University of Huelva, Spain in 1997. Seventeen chapters in the book were written by 30 authors, and many chapters are review papers discussing the development and achievements using particular techniques, such as geophysical imaging and crystal size distribution (CSD). Others describe problem solving using a variety of techniques, e.g. structural, gravitational and geochemical, to interpret pluton emplacement and zonation. Very brief descriptions of the chapters are given below to give a flavour of the book.

Dingwell summarizes recent advances in the physical description of the rheology of granitic melts, particularly with reference to the work of the Bayreuth group since 1992. Alan Thompson in a typically erudite manner reviews processes governing time and length scales of various crustal melt mechanisms and looks at rates of melt extraction, ascent and emplacement. The geophysical aspects of the so-called ‘room problem’ are discussed and reviewed in some detail by Améglio and Vigneresse. Román Berdiel compares scale model experiments with the geometry of plutons. Trzebski, Lennox & Palmer and Cruden, Sjöström & Aaro use gravity data to study pluton shape and emplacement style. Patiño Douce in a carefully argued and interesting article concludes that nearly all magmas, and in particular ‘S’-type granites, have a non-trivial basaltic component. Cobbing looks at fracture control and the synplutonic acid and basic magmas, common in Cordilleran batholiths such as the Coastal Batholith of Peru. A more intimate mixing and mingling zone is described in detail by Menéndez & Ortega resulting in complicated hybridization. Hecht & Vigneresse, using ‘multi-disciplinary approaches combining classical and modern techniques’, conclude in a prolix manner that magma injection rate and continuity are important variables in pluton assembly. Fernández & Castro discuss the complex interplay between Newtonian and brittle behaviour of granitic magma during sequential magma batch intrusion, considering batholiths to have formed by episodic magma supply from feeder dykes. Higgins in an ideosyncratic study of megacryst growth considers Ostwald ripening and metasomatic transport to be important during very specific cooling histories.

Alonso, Carracedo & Aranguren look to crustal-scale shear zones as the main environment for large granitic intrusion, while Dietl considers stopping, dyking, downward among its authors; it is rich in content and very up-to-date, and its lists of references are a major resource by themselves. The first three chapters describe the current state of theory and methodology in pre-Quaternary palaeoclimatology and may well be its most valuable contribution. Paul Valdes presents a thoughtful analysis of which forcing factors are accessible to analysis when ‘instantaneous’ means at the very least tens of thousands of years. DeConto and others discuss where we are on the long path from simple energy balance models to as yet only dreamed-of coupling of atmospheric general circulation models with full-depth dynamic ocean models and where we shall shortly be. Crowley & Zachos complete this section with a discourse more directly oriented towards solving the warm-Earth problem by considering the meaning of past zonal temperature profiles.

Part II, looking at the not so distant past, builds on this as it presents case studies of the hot late Palaeocene and Eocene climate that interrupted the slow decline into the present Ice Age, probably so far the best documented case of a warm Earth, and looks at it from many angles. Bice and others, for instance, use for this purpose an advanced global ocean circulation model in conjunction with oxygen isotope and foraminiferal data that is a particularly clear example of the benefits of combining models with the relevant evidence. Others consider, for the same period, the potential impact of mountain building on the climate. A final discussion of the anomalous cool early Eocene reminds us that we are dealing with a very long time, longer than the entire present Ice Age, with plenty of room for deviations of the path from a greenhouse to an icehouse Earth.

Part III focuses on the long-known Mesozoic warm Earth and ranges from discussions of the palaeontological and geochemical constraints by way of a quite sophisticated synthesis of late Cretaceous ocean temperatures and land climates to an analysis of Jurassic vegetation and climate that presents a thoughtful analysis of which forcing factors are accessible to analysis when ‘instantaneous’ means at the very least tens of thousands of years. DeConto and others discuss where we are on the long path from simple energy balance models to as yet only dreamed-of coupling of atmospheric general circulation models with full-depth dynamic ocean models and where we shall shortly be. Crowley & Zachos complete this section with a discourse more directly oriented towards solving the warm-Earth problem by considering the meaning of past zonal temperature profiles.

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return flow and assimilation during emplacement of the Joshua Flat–Beer Creek pluton in California. The migmatite–deformation conjunction is discussed by Sawyer, Dombrowski & Collins and also by Mouri & Korsman.

So have the editors succeeded in their aim, showing that significant advances have been made by multidisciplinary studies? Well, yes and no. Much of the book is a review of published albeit often recent work (see above); the ‘reworking’ of melt in migmatites is a good example, and often relates very specifically to one technique or example. A sub-text I find difficult to accept the justification for is the implicit belief in hybridization at various depths as an important process in producing batholith-scale magmas (for example Patiño Douce). Cordilleran granites are not due to assimilation of quartzofeldspathic metasediments by basaltic melts at depth; basic field geology shows there is rarely mature quartzofeldspathic metasediment present at the appropriate depth.

In brief the book is good in reviewing aspects of granite geology (sensu lato), particularly with regard to shape and intrusion style of individual plutons; it does not really address the problem of the contribution of granite magmatism to crustal growth, and recycling. Physical and chemical contributions are good but very much biased to individual schools with little attempt to look over the whole subject. A holistic approach it is not. However the production, diagrams, etc., are good and clear, and it should be a good source book on part of the huge subject of ‘understanding granites’. It should be available in all libraries, but the list price of £70 will be too high for postgraduates and others unless they are members of affiliated organizations.

M. P. Atherton


Wherever people look for microbes in modern sediments, they find them. Microbial Sediments provides some fascinating and unlikely locations such as the ‘cold seeps’ of the oceans to the boiling springs of Wyoming and New Zealand. A wide range of topics is covered in 34 contributions beginning with recent sediments and ending with some thoughts on microbial life in the Archaean. The majority are short review articles but there is also some original work, for example the bacterial calcification experiments of Heike Knorr with its colourful micrographs, and the nice work on diatom preservation in carbonates by Barbara Winsborough.

From some contributors we learn that the microbes are indispensable to sedimentation, providing templates for mineral nucleation, mucilage ‘traps’ for stabilization and even produce metabolites which help precipitate mineral components. Others are convinced that their microbes are passive components, exploiting favourable microenvironments offered by the sedimentation process. Whatever their views, the authors provide a broad range of arguments, some speculative, others well-founded, a few even dogmatic, to provide the reader with plenty of ammunition for debate.

The articles are mostly well written and organized. I liked those which provided direction for future work and a good conclusion though these were few in number. A few sit a little uncomfortably at the edge of the field but all are well illustrated and referenced. Readers should however note that none of the articles should be considered as comprehensive reviews. I noticed the omission of several well-known names and wondered if this was merely a need to conserve space or ignorance of their work. One of the problems for sedimentologists who delve into microbiology is literature. It seems that as far as the microbes are concerned, the knowledge base trails behind and few seem to appreciate how great the advances in molecular biology have been in the past decade. True, some contributors paid homage to these, but the editors might have considered a couple of articles from a few of the big molecular biology players in Europe and the United States.

The editors have done well to bring together so many respectable authors in this increasingly disparate field and for this they should be congratulated. The book is well worth reading, providing as it does plenty of ideas for new lines of research in the coming century.

Allan Pentecost


Bivalve and gastropod molluscs have long provided, and in many parts of the world continue to do so, a free source of protein-rich food to coastal peoples. Discarded shells may achieve further use as tools, currency and ornamentation. Archaeologists are able to study the diets of ancient people by examining middens, many of which achieve enormous sizes, and to understand aspects of social interaction and symbolism from other shell material that is found on archaeological sites. Interpretation of these deposits relies on an understanding both of the original biology of the shell-bearing animals and the changes that shell material undergoes after death. I have to admit that I had never really thought of the latter point; I had always imagined that taphonomy was largely practised by palaeontologists. However, there is an overlap; although the post-mortem destruction experienced by archaeological material is concentrated sub-aerially and in meteoric water, there is information that we can exchange.

This book has three major threads: the biology of the animals, taphonomy of shells, and the recognition of shell artefacts and patterns of shell exchange. It is naturally the first two of these which will be of most interest to geologists, but the third part is fascinating. I now know about the use of the gastropod shells in axes and how to use bone chemistry to assess the role of shell fish in the diet. I suspect, also, that the third section is the book’s real strength, for the biological and taphonomic parts are rather simplified and at times simply incorrect.

The basic account of molluscan biology is fair enough but betrays a lack of real understanding of the matter. Why, for example, in Table 1 are we confronted by a list of the names of families of gastropods and bivalves all randomly mixed up, rather than separated? Similarly, what appears at first sight to be scholarly discussion of shell structure (which is, after all, important in later discussions of taphonomy) is hopelessly confused and appears to convey more incorrect detail than fact (microstructural terms are muddled). Would-be palaeomalacologists will learn more about their beasts by reading any standard palaeontology or zoology text.

Similarly, the topic of post-mortem destruction is not...
particular well treated. Admittedly, Claassen is correct in her statement that palaeontologists know little about the decomposition of shell above the water table, but I am not too convinced that this book fills any voids. Sadly the account of taphonomy is based largely on a single publication, Kent’s Making Dead Oysters Talk, a publication from the Maryland Historical Trust. In actual fact there is a rich wealth of papers and other texts on the post-mortem destruction of shells, and interested parties (palaeontologists and archaeologists) would do well to start with Kidwell & Bosence’s chapter in Allison & Briggs’ book Taphonomy: Releasing Data Locked in the Fossil Record.

Quitmeyer gets into trouble for publishing his regression analyses for the meat content of Mercenaria mercenaria for a range of sizes of individuals from North Carolina. Claassen complains that using this formula as a predictor for animals she collected in subsequent years, consistently overestimated the flesh yield (but perhaps not to the extent stated). Why be surprised? Shells cannot shrink in poor years, but the tissue mass may well do. As a result it is inadvisable to try to use one year’s, or season’s, measurements against another’s. Besides, a quick run through Claassen’s data shows that there is tremendous variation with some larger animals yielding less meat than smaller ones. This is obviously entirely possible – a short person may weigh more than a taller on – but it does show that the variability makes this type of test (and accusation) unreachable.

This is a varied book and perhaps tries to cover too much, launching the author into what appears unfamiliar territory. The archaeological part of the book is extremely interesting, and I certainly learnt much by reading it. But geologists or palaeontologists hoping to learn anything about molluscan biology or taphonomy will be either disappointed or misled.

The rest of the book contains six papers on ‘Seismicity and Ground Motion’, some of which contain overviews of historical catalogues, but little concrete information. There follow ten papers on ‘Site Effects and Seismic Zonation’, six papers on ‘Structural Damage and Earthquake Resistant Design’ and eight papers on ‘Seismic Hazard and Risk’. The principal interest in these papers is likely to be that most are by Romanian authors and thus the work provides a useful source of names and literature for those concerned directly with those topics in Romania.

Liz Harper

Reference


This book is a collection of 31 papers delivered at a workshop in Bucharest in November 1997. It is a somewhat mixed bag, and will be of minor interest to most readers of this journal. The title is misleading in that the book is overwhelmingly concerned with details of earthquake engineering, risk and hazard evaluation, and local site assessment. These are undoubtedly important topics, particularly in Bucharest, which has been repeatedly damaged by large earthquakes. The tectonics of these extraordinary earthquakes, which occur at depths of 70–200 km within an almost-vertical slab-like zone that has no contemporary tectonic activity at the surface, is indeed very interesting. Such zones occur elsewhere in the continents, notably in the Hindu Kush and possibly also in Spain, and probably represent the final fate of minor ocean basins, such as the Caspian and Black Seas, that become trapped within continental collision zones. But there is only one paper in this book concerned with seismotectonics and that is rather light on real information, containing, for example, not a single fault plane solution and discussing mostly tomographic studies. The Vrancea earthquake zone has produced five destructive earthquakes of magnitude ($M_\text{w}$) greater than 6.3 since 1940, and three of these had $M_\text{w} > 7.2$. In fact, plane solutions are given for these major events, but only in the final short (and rather good) paper called ‘25 seconds for Bucharest’ which discusses possible Early Warning Systems for the capital city that utilize the delay time between the initial P wave arrival and the more destructive S waves for these relatively deep earthquakes. From the seismotectonic point of view, this book adds little to what is already known or published elsewhere.

The first three chapters (1, Interpreting evaporite texture; 2, Brine evolution and mineralogy; 3, Evaporite basins and their stratigraphic evolution) describe well-known aspects commonly dealt with in the sedimentological literature. Evaporites are classified as primary, secondary and tertiary, ‘secondary’ corresponding to diagenetic (including sabkha textures and mineralogies) and ‘tertiary’ to evaporites in the exhumation stage. Brine classification into marine and continental, and theories about evolution of marine brines (global change v. mixture with basinal brines), are explained. Special attention is given to brine movements in the diverse hydraulic regimes (from active phreatic to thermobaric) across a wide range of temperature and pressure. In the third chapter, the environments and conditions of evaporite development are described. Examples from the Recent, and from older environments with no equivalents in the Recent, are included. Also, different kinds of evaporitic basins and the importance of hydrology in their development are emphasized.

Evaporites. Their Evolution and Economics by J. Warren deals with very diverse aspects related to evaporites. Some have already been dealt with in similar previous books, others are a significant novelty.

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A second group of chapters (4, Indicators and effects of dissolution: ‘the evaporite that was’; 5, Salt tectonics; 7, Evaporites as a mineral resource) shows less-well-known aspects of evaporites. Breccias, karst features and other indicators of vanished evaporites (silicifications, calcitizations, residual accessory minerals, pseudomorphs) and their relationship with the hydraulic regime are discussed. The importance of evaporites in tectonics and diapirism, their relation with oil traps, in compressive and extensive environments, are not discussed. Finally, Chapter 7 is dedicated to the evaporite-derived raw materials, mostly to potash. Recent and older environments where sylvite and carnallite precipitated are reviewed, with the examples of Cretaceous evaporites from the Khorat Plateau (Indochina) and Devonian evaporites from the West Canadian Basin (including information about...
primary tapped brines) being the most extensively described.

The rest of the chapters (6, Meta-evaporites; 8, Evaporite–metal associations: lower temperature and diagenetic; 9, Evaporite–metal associations: brines, magma and metamorphism) are the more novel. Chapter 6 describes the changes in textures (progressive loss of primary textures) and crystallinity under anchimetamorphism, and also the processes that occur in more advanced metamorphic stages (recrystallization, fluid mobilization, dissolution, volatile loss, mineral neoformation). The last two chapters deal with metals and evaporites, including clear and enigmatic relationships in normal to magmatic conditions. Evaporite dissolution is considered as a main source of chlorine and sulphur ionic species, being a fundamental concern in metal solubilization, transport and precipitation depending on pH and redox conditions. Many kinds of ore accumulations (Kupferschiefer, Coro-Coro deposits, ‘freeze-dried’ evaporites from other planets) are described, the more detailed descriptions being those related to stratified brines from the Mediterranean and Red Sea, and cases of relationship between sedex deposits and evaporites.

One general observation about the book is that it does not seem homogenous in the treatment of each theme; some are much more developed than others. This is probably to be expected because it is the first time that so wide a spectrum of evaporite-related topics has been compiled. The same happens with the references which I feel could be more complete; perhaps the references could be completed in later editions of the book. Nevertheless, the book is certainly an important advance in the study of evaporites, since it is the first time that conditions of high pressure and temperature and ore-deposit formation have been considered in this kind of publication.

Juan José Pueyo


This book represents the Proceedings of the 5th International Symposium on the Geochemistry of the Earth’s Surface, which was held in Reykjavik in August 1999. This publication consists of a wide range of short papers, grouped into following categories: 1, Geochemistry of terrestrial environmental change, and global geochemical cycles; 2, Chemical weathering and climate, river catchment studies; 3, Environmental geochemistry of the terrestrial environment and its effect on health; 4, Organic geochemistry; 5, Marine and sedimentary geochemistry; 6, Mineralogy, microbes and the chemistry of weathering; 7, Geochemical thermodynamics and weathering; 8, Geochemistry of crustal fluids and catastrophic events.

The papers are all less than four pages in length and are of variable quality. While the authors are to be commended on the speediness of this publication, one major criticism I would have of the volume is that the rush to press appears to have sacrificed a rigorous international reviewing process, with all the reviewers being from Icelandic institutions. I would personally have preferred to have seen a more thorough reviewing process and waited six months longer for the volume. It is fair to say that at ~£75 this is not a volume which one would personally buy; however, it would be a useful source of reference for a library, and not only for those universities and colleges with geology departments, but this volume would also be of use to environmental scientists.

Andrew C. Kerr


The editors provide us with a diatom tome of nearly 470 pages within which there are only three pictures and two diagrams illustrating the nominative organisms. Although this is probably not a record, the editors point out that the primary aim of this volume is not to provide a reference work on either the biology, ecology or taxonomy of diatoms. Instead, the book’s laudable aims are to produce a collation of digestible review chapters covering the uses and applications of diatoms in the areas of earth and environmental sciences. In these aims the book succeeds admirably, and the editors should be congratulated on having managed to draw together experts in so many fields of diatom research to contribute specialist chapters.

The editors sandwich the four main sections of the book with a short eight-page introduction to the diatoms, and a brief conclusion consisting of a four-page epilogue and a most helpful glossary of terminology. The use of diatoms as proxies for environmental change in flowing waters and lakes comprises the subject of Part II, the first and longest of the main sections of the book. The seven papers review the literature concerning how diatoms can be utilized in environmental assessment, and to monitor hydrologic and climatic change, biogeochemical silica depletion, surface water acidity, lake eutrophication, long-term environmental change and lake water-level change. Part III deals with diatoms found in extreme environments and how they can indicate environmental change in the Arctic and Antarctic; a short chapter on the often overlooked aerial diatoms rounds off this section of the book. Marine and estuarine environments form the subject of the section which follows, examining the role of diatoms in determining sea-level change, (paleo-) environmental change in estuaries, shallow coastal waters and marine palaeoceanography. Given the lengthy coverage of the applications of freshwater diatoms in Part II, it is to be regretted that marine diatoms are relegated to a chapter of a mere ten pages of text – especially strange given the burgeoning interest in laminated diatomaceous marine sediments. The final part of the book pulls together a mixed bag of ‘other applications’, which briefly assess the utility of diatoms in the fields of archaeology, hydrocarbon exploration, forensic science, diatomite deposits, toxic diatoms and atmospheric transport.

The editors state in their preface how easy it would have been to expand some of the individual chapters to the size of books, so they should be congratulated on having limited some of the larger chapters to a more manageable size. However, despite the comprehensive and readable chapters on the various applications of freshwater diatoms, and the undoubted importance of this field of research, one cannot help feeling that this section overly dominates the book. The one major omission from the compilation is the role of diatoms and diatom extrapolymeric substances in sediment binding and stabilization. Although the book will appeal to scientists in many disciplines, from physiologists and
environmental scientists to limnologists and oceanographers, the cover additionally touts the book to archaeologists and forensic scientists. Given that the sections dealing with these latter applications are extremely restricted, it is dubious how many such professionals would spend £70 for 14 archaeological and 6 forensic text pages respectively! Whilst this book will prove useful to the palaeogeomorphological community as an illustration of what can be done with Recent diatoms, the book highlights the relative lack of integration between those who work on modern and those who work on fossil diatom assemblages – a situation which contrasts with most other fields of protistology, such as dinoflagellate and foraminiferal research. It is stated that diatoms can be employed as catalysts, so let us hope that this fine book will act as a catalyst to draw together neontologists and palaeontologists in the future. 

Ian Harding


Active Tectonics and Alluvial Rivers deals with the interface between two great subsystems of the Earth: the deforming lithosphere and the eroding and depositing hydrosphere. In that sense the book is a noble and rich endeavour. Rivers (bedrock and alluvial) are uniquely rich in the number of possibilities that they offer for extracting information about the tectonic state of the deforming continental lithosphere, an exercise of great and immediate practical importance (earthquake studies, environmental engineering, etc). Thus alluvial rivers respond to what we may call 'tectonic forcing' by: downstream and lateral gradient changes; altering their courses; incising or aggrading to alter their gradients; changing their planform morphology and dimensions. Moreover, the traces of many of these changes may be found left in the geomorphological landscape in the form of knick-points, distinctive drainage patterns, deformed terraces, asymmetric channels, channel-belts and valleys. They also heavily imprint the stratigraphic record of basin architecture, specifically the 3D distribution of river channel sandbodies, alluvial fans and floodplain fines.

Senior author Schumm, doyen emeritus of the empirical school of North American geomorphology, will need no introduction to many readers of Geological Magazine. Dumont has been active in studies of Andean rivers and tectonics, whilst Holbrook provides expertise in the analysis of ancient fluvial systems. We see here the typical results of a Schumm-inspired study: the wide reading, easy movements between disciplines, ability to make simple general conclusions from carefully chosen field studies, use of simple experimental analogues, tentative applications to the stratigraphic record, links to problems of applied engineering and hydrology.

After a useful discussion of drainage patterns and tectonic landforms, the results of experimental studies into channel responses to measurable deformation are outlined, mostly work of Schumm's student Ouchi done in the eighties. Natural examples are then assembled from US locations, including a fascinating section on the Gulf Coast Plain. River behaviour across areas of unmeasured deformation are then featured from the 1990 thesis of Jorgenson, another Schumm student, followed by examples of rivers whose courses have been affected by lateral ground tilting. Finally the link between tectonics and fluvial sedimentation is discussed, with a final section on the uses of rivers in locating actively-deforming structures and the application of results to disciplines like hydrology, petroleum reservoirs, etc.

Verdicts? Pro: compact easy-to-read book; lots of examples; text logically arranged; quite up-to-date; good for cross-disciplinary checks and interactions; emphasis on richness and complexity of nature. Con: results on channel form exported from unscaled experiments and applied uncritically to nature; tectonic deformation patterns often inadequately documented and naively expressed; thesis figures needed redrawn like others; a rather 'bitty' impression at times.

Finally, many earth and environmental scientists interested in the space–time patterns of river erosion and sedimentation will find much to stimulate them in the case histories outlined in this book, for there are many future challenges to take up and develop. Hard-line tectonic and tectono-geomorphic modellers will not, but the reviewer suspects that this will be their loss, not Schumm et al.!

Mike Leeder


Microevolution is a respectable science. Changing gene frequencies within populations, DNA sequence data and many other pieces of evidence document the mechanisms by which evolution occurs in living organisms. Microevolution’s big brother, macroevolution, is regarded as less respectable – perhaps because the most ardent pursuers of a macroevolutionary view of life, namely palaeontologists, are regarded as ‘less rigorous’ by their test-tube-wielding molecular biologist peers. Unfortunately, macroevolution has been a place where people could make a name for themselves with some far-reaching, sometimes preposterous, scenario building that lived up to the unjustifiable (or at least untestable) ‘just-so story’ so reviled by many scientists. Despite this, macroevolutionary theories can offer a grand overview of the evolution of life on Earth, integrating abiotic and biotic data. The realization that major alterations to animal body plans can be accomplished with just a small amount of genetic tinkering (consider mutations in Hox genes, for example), the recognition that abiotic events (such as changes in ocean geochemistry and climate) can have a profound biological effect, and the continued phylogenetic and anatomical studies of palaeontologists and zoologists, are starting to filter through to biologists at large and are at least being synthesized, bringing macroevolutionary hypotheses a new lease of life. Perhaps macroevolution is coming in from the cold at last.

Carl Zimmer’s book is a ‘must read’ for anyone interested in macroevolution. Zimmer chooses to concentrate on two macroevolutionary events that have long puzzled zoologists and palaeontologists: the origin of tetrapods and the origin of whales. In each case, Zimmer gives an up-to-date account of the research in these areas, drawing on many interviews with the scientists involved, as well as the primary research literature and the presentation given at professional meetings.

The first half of the book deals with the origin of tetrapods, while the second half deals with the cetacean
question. In both cases, Zimmer reviews historical ideas on the origin of the group and in doing so provides a framework for the study of these subjects and for macroevolution in general. We are also introduced to aspects of the biology of the animals involved so that the intricacies of the arguments presented, and the ecological and evolutionary significance of these features, are clarified. Zimmer has marshalled an impressive amount of evidence in his account and provides lucid explanations for macroevolutionary phenomena as seemingly distant as homeotic mutations, atavisms, phylogenetic reconstruction (both molecular and morphological), exaptations, global climate change and correlated progression. Although Zimmer obviously prefers some ideas to others (notably he seems to support the morphologists’ view of whale relationships, rather than that of the molecular phylogenicists), the text is balanced and gives a good overview of the hypotheses, and personalities, in these two areas.

Zimmer has a very readable style – intelligent, but not overbearing, and with just enough technical language to keep even die-hard elitists happy. The chapters dealing with the evolution of the tetrapod limb were particularly well written, expressing the complexities of limb-bud formation and differentiation with clear, jargon-free prose. The numerous asides dealing with everything from the evolution of snakes to the fieldwork reminiscences of many of the scientists involved were absorbing and informative. I heartily recommend this book to anyone with an interest in evolution – it goes a long way to rehabilitating macroevolution and is a pleasure to read.

Paul M. Barrett