

BOOK REVIEWS

They went that-a-way

LOCKLEY, M. *Tracking dinosaurs*. 1991. Cambridge University Press. £27.50 hardback, £9.95 paperback. ISBN 0 521 39463 5, 0 521 42598 0.

Martin Lockley heads a group in Colorado called the Denver Dinosaur Trackers Research Group. They have a logo and, naturally, it is based on a stylised dinosaur footprint, but it also includes the motto “230,000,000 BC to 2000 AD”. This may strike you, as it did me, as a bit too American cute, but at least it shows that the Trackers are having fun with their footprints.

The way this book is written confirms this; easy to read and enthusiastic, it is also a good comprehensive review of dinosaur ichnology (trackway studies) from 1802 to 1990, with a special emphasis on recent discoveries.

I have to admit to a credulity problem with the “science” of palaeoichnology. David Attenborough worked with the Denver Trackers while filming the BBC series “Lost Worlds, Vanished Lives”; his contribution for this book’s blurb is “Sherlock Holmes himself could not deduce as much from a footprint as Lockley does . . .” and I’m afraid the unintended implication, that dinosaur trackers sometimes get close to fiction — maybe they deduce too much from the easily misinterpreted evidence of fossil prints — is about right. My greatest difficulty is with the application of binomial nomenclature to fossil footprints. This implies either that “species” within a footprint “genus” are somehow related genetically (but how can “form taxa”, created for particular shapes, sizes and stratigraphic ages of impressions in sediment, be related?) or that we know which animals made them (no-one has ever found a fossil footprint with its maker’s skeleton standing in it). Even the footprint taxonomists recognise that one track “species” could be made by one of a number of different dinosaurs, or that a *Tyrannosaurus* might produce several trackway taxa according to whether it was walking, running, sitting down or paddling at the beach.

To be fair, Lockley points out all the problems of footprint names and interpretation — good for him. The most likely pitfall for amateur dinosaur trackers (the professionals have fallen for it often enough) is that a dinosaur stomping across soft sediment produces footprints not only in the surface layer, but as a superimposed pile, increasingly wide and indistinct, in all the unconsolidated beds beneath. Find an “underprint” of a small dinosaur and you may think you have found a sauropod, or, like Roland Bird in 1944, interpret indistinct underprints as evidence of a sauropod swimming just out of its depth.

The chapter headings indicate the book’s broad and popular approach. Introductory sections provide basics for non-specialists, including a simple dinosaur family tree (monophyletic, and therefore perhaps not really “with it”), “how do we know a track was made by a dinosaur”, general track geometry (left or right, front or back, two legs or four) and principles of estimating

speed and size from an animal's tracks. The use of prints as evidence in the detective game of palaeoichnology is explained. Trackway fossilisation methods get a complete chapter; this is where we find out about underprints, why little dinosaur's prints seem rarer than brontosaurus', and also about natural casts and moulds (or "molds" — incidentally, the preparation of the British version from the original American text produces "ploughed" and "plowed" on the same page). "Discovery and documentation" begins to spread the subject rather more thinly and states the obvious, like the need to measure and map finds but perhaps to keep the locality secret, and fills half a page with a pie diagram showing that "dinosaur tracks are found in many natural and artificial terrains" (quarries and mines 26%, roadways 8%, fallen blocks 8%, etc., since you ask).

"A field guide" lists, with diagrams and photographs, the dozen or so best-known track genera in systematic order and gives the likely dinosaur makers whenever possible. Apparently there are a further 500 additional, but largely redundant, names in the literature for possible dinosaur tracks!

The real meat of the book is in its middle sections, where the interpretation and significance of prints and trackways is discussed in detail, and where the reader's credulity about the value of trace fossils for elucidating individual and group behaviour, ecology and evolution is tested. The descriptions of the deductive processes used are fascinating, but is it right, for example, to use a rule of thumb which says that a walking dinosaur's stride is less than four times its foot length while a running dinosaur's stride is greater than four times its foot length without considering the effect of relative leg length (which implies that you have guessed what kind of dinosaur made the trackway) to interpret dinosaur behaviour? Estimates for dinosaur speeds using "formulae" like these range from 3 to 40 kph. Some trackways seem to indicate that their makers made an abrupt 90° turn — should we speculate that the animal was surprised by another dinosaur, or might careful examination show that two poorly-preserved tracks crossing at right angles merely give the impression of one animal changing direction? One famous trackway appears to show a herd of brontosaurus, adults surrounding and protecting juveniles (less ideologically sound trackers have proposed "males" surrounding "females" and juveniles because, of course, the boys are always bigger and braver!), being followed by a carnivorous dinosaur. But, as Lockley points out, this is speculation; what if the "hunter" came along 3 days after the brontosaurus? The trackway might look the same. What if the apparent herd structure is actually the result of regular use of a dinosaur path over several days by a few separate animals?

In "Ancient ecology" one of the main claimed contributions of trackways to dinosaur palaeontology is explained. A general observation is that dinosaur bones and trackways are rarely preserved together in the same stratum. Thus, gaps in our bone-derived knowledge of dinosaur ecology and evolution can be filled by print-derived information. Lockley grades track-bearing deposits from 1 (footprints are the only

evidence of dinosaurs) to 5 (footprints are unknown) to show their relative importance to palaeontological interpretation. This chapter is organised as a gazetteer of world footprint deposits: unfortunately it is America-biased, with claims like "the middle Jurassic is poorly known for dinosaur palaeontology" (what about England, Europe, North Africa and China?). Other palaeontological inferences are drawn from prints and trackways in further detailed chapters, before the Denver Trackers' own recent discovery and rediscovery of many "megatracksites" is described. It turns out that there are literally hundreds of square kilometres of bedding planes covered with dinosaur tracks in the western Rockies. Now that would be something worth seeing!

The book ends with "myths and misconceptions" (so Lockley is even-handed but seems to contradict some of what he has claimed earlier by so being), histories of the "dinosaur trackers" ancient and modern, and a "where next?" epilogue. There is a site by site guide, a good glossary and a well-organised "notes and bibliography" section which obviates the need for footnotes (good) but necessitates dodging to and fro to check what the superscript numbers mean. Design and typography are up to standard for an American publication at this price, but this is not a coffee-table production. Diagrams and decorative line illustrations are just adequate, and the 21 colour photographs are bound as a block at the middle; some of these are a bit like my old lecture slides, and some need to be turned upside down before they can be seen as footprint impressions because the light "falls the wrong way".

All in all this is a good introduction to dinosaur footprint studies aimed, I guess, at enthusiastic amateurs. It made me think about the potential of the Mercia Mudstone Group of the Midlands. There are dinosaur trackways in the upper Triassic of South Wales, and non-dinosaur tracks (*Chirotherium*) from Leicestershire and Nottinghamshire. So why not start looking locally, ready for the second edition?

John Martin

Breathing life into the earth sciences

WESTBROEK, P. *Life as a geological force*. 1991. W. W. Norton & Company, New York and London. £14.95 hardback, 240pp. ISBN 0 393 02932 8.

It's good to see life back in fashion. The plate tectonic revolution undoubtedly invigorated the earth sciences, but it also led many geologists to concentrate on physical and chemical processes and their role in shaping earth history, and consequently to neglect or negate the importance of palaeobiology. We are now, happily, emerging from that period, and the significance of life processes as part of the global system is now becoming generally recognised.

The wide realisation that the evolution of the earth and of life are inextricably linked is due in no small measure to James Lovelock's formulation of the Gaia hypothesis, in which the earth itself is regarded as behaving as a single living organism. To understand the earth we must study the development of the entire

earth/life system. Peter Westbroek, who heads the Geobiochemistry Research Group at the University of Leiden, is a prophet of this approach, and in this somewhat idiosyncratic book he sets out to convince readers of its importance.

The book is essentially a set of separate, but interlinked, essays dealing with different aspects of the topic. They are arranged under three headings: the geology of the planet earth; life, the missing link; life at the planetary scale. The message is clear: if we view this planet as a chemical factory we will never understand how it works. Geochemical models of the earth, according to Westbroek, are like Frankenstein monsters, assembled from bits left over from dead bodies in the hope that they will come alive.

Westbroek is almost evangelical in promoting his view that the way forward in understanding the earth is through a melding of the sciences of geology and biology. Life is not a mere decoration on this planet, and it is not simply by chance that the oceans and atmosphere have remained in a sufficiently stable state to support life for most of earth history. Despite a constant increase in the energy output of the sun, a continual bombardment by meteorites and fluctuating internal dynamics, the Gaian system has maintained the narrow range of conditions necessary for life for 3.5 billion years. Westbroek even goes so far as to suggest that he would not be surprised if future research revealed that living things were essential for the maintenance of plate tectonics. Is he right? Read the book and judge for yourselves.

Richard J. Aldridge

Pros and cons of volcanoes

DECKER, R. W. and DECKER, B. B. *Mountains of fire (The nature of volcanoes)*. 1991. Cambridge University Press. £30.00 hardback, £10.95 paperback, 198pp. ISBN 0 521 32176 X, 0 521 31290 6.

For anyone interested in volcanoes and volcanic activity the writings of Robert and Barbara Decker must be well known. Of all the subject areas of geology that least need bringing to life, volcanoes must be at the top of the list, but the Deckers always manage to make this exciting topic appear even more fascinating. In this present book they have certainly not let us down. The book consists of fourteen chapters divided into three sections; Volcanic mountains, Volcanic rocks and Volcanic Risk and Reward. Each chapter commences with a case study, well illustrated with thoughtfully chosen diagrams and text figures. In addition, in the middle of the book, there are 27 magnificent colour plates illustrating various aspects of volcanic activity.

Generally the book has been produced with a lay audience in mind and, although there is a wealth of information and also well chosen examples to illustrate various points, I do fear that the attempt to keep the book simple, interesting and readable to the person with a passing interest in the subject has resulted, in places, in a loss of accuracy in the sense that the reader may well end up with some misconceptions here and there. For example on pages 66-67 the description of the

“Zone of partial melt” could well be misinterpreted as a localised zone just beneath volcanoes rather than the recognised more or less continuous zone in the earth’s interior. Chapter 2 “Volcanic Belts” has a subsection of Volcanoes and Plate Tectonics and here the great importance of the relationship between Plate Tectonics and Volcanism is not stressed. It should have been. Moreover we have to wait until Chapter 6 before we have any diagrams to help non-geologists understand a little more about plate movements. In Chapter 4, on the Life Stages of Volcanoes, I fail to understand why the submarine phases of eruption of a Hawaiian volcano are separated from the sub-aerial phases by a section on the history of Surtsey Volcano. The description of the life stages of the Hawaiian volcano on page 44 does not relate to the section of Mauna Loa on page 70 (Fig. 6.5) and no reference is made on page 44 to this text figure. In a chapter on Life Stages of a volcano it might well have been most appropriate to discuss the known cyclicity of certain volcanoes, of which Vesuvius is perhaps the best known and documented.

I have chosen just a few examples of where I think improvements in the organisation of the book could have been made; I could cite more. It may be that I am being hypercritical about what may be considered small issues, but I do feel more thought should have been addressed to the overall organisation of the text. I must also make comment about the quality of some of the black and white photographs used in the text figures. I have no doubt that the original photographs may have been good but the reproduction is not. On page 69, Fig. 6.3. is supposed to illustrate the variation in colour, from the light silica rich lower portion of the deposit to the darker, less siliceous top part. Good photographs of this particular feature show this very well, this reproduced photograph does not!

I have given a few examples of the critical feelings I have about the general aspects of this book but I hope I am not misleading any readers into believing it is not a worthwhile publication. The book is, in fact, in most ways, an excellent text and for any person with an interest in volcanoes I thoroughly recommend it. Its virtues far outweigh the negative aspects I’ve commented on and the style is of the high quality we have come to expect from the Deckers. There are also many features which make the book much more worthwhile than the run of the mill texts on the subject. For example, I like the glossary where the Deckers have carefully reduced the technical jargon, which has had to be used, into very understandable language, and they are to be complimented on their selection of a sensibly long bibliography. What I find very pleasing and what makes most absorbing reading is the final section of the book on Volcanic Risk and Reward, which has brought together the extremely important aspects of volcanoes to man. This is an excellent concluding set of chapters to a book which will make good bedtime reading and, at the same time, provide a wealth of information on the subject. At the price of £10.95 (paperback) it is worth every penny!

Ian D. Sutton

Graptolite graphics

PALMER, D. and RICKARDS, R. B. (eds). *Graptolites: writing in the rocks*. 1991. Boydell and Brewer, Woodbridge, Suffolk. £39.50 hardback, xvi + 182pp., 138 plates. ISBN 0 85115 262 7.

At a time when there are so many academic and 'popular' books published on fossils it is hard to imagine that yet another publication series on palaeontology could find a niche in the market. Nevertheless with its novel and imaginative format, "Graptolites", the first in a new "Fossils Illustrated" Series from Boydell Press, can justifiably claim to have successfully done just that. It is a book I can recommend to all those interested in both the scientific aspects and the sheer beauty of fossils. This broad-ranging yet relatively concise review contains something for everyone — from the generalist eager to have a good introduction to this group of fossils, to the geologist/palaeontologist anxious to top up with more specialist knowledge or the latest ideas about graptolites.

The contents of the book covers the life, habits and geological uses of a very important group of large, Palaeozoic zooplankton, the graptolites. A quick dip into its pages soon dispels in a wonderfully immediate way the sometimes-expressed notion that this group of colonial hemichordates are ill-preserved and not especially interesting. "What can you see?", is an often-heard comment when those unfamiliar with the group first observe these "grey streaks" on rock slabs. Just what one can potentially "see" is spectacularly displayed in this book by no less than 138 magnificent plates which depict the morphology of graptolites and their closest living relatives, the petrobranches. Superb single graptolite specimens and bedding plane assemblages, ultrastructural details and growth stages, structurally distorted specimens and exceptionally well preserved isolated material recovered by acid preparation — it is a palaeontological feast of beautiful, quality photographs and SEM micrographs, most of which are published for the first time. The accompanying explanations thoughtfully guide the reader to the features of particular interest on each plate.

The text is authoritative: its 14 relatively short chapters are each written by relevant experts of 'Big G', members of the British and Irish Graptolite Group. Up-to-date, informative, and appealingly 'chatty' in style, there is plenty there for professional and layman alike. However, I do feel that, where appropriate, the occasional inclusion of a line diagram figure (there are virtually none) to accompany the text would have been helpful to the reader. "How did they live?"; "What was their sex life like?"; and "What use are they, anyway?" are just three of the entertaining questions (Chapter titles) that the authors address with obvious enthusiasm. By virtue of their biostratigraphical usage and potential, the value of graptolites has been appreciated by geologists throughout more than 150 years of study of the group. Surprisingly, there are still large question marks over the nature of the soft-parts and life habits of the animals themselves (the group became extinct in the Carboniferous); perhaps this is where we can expect to see major research efforts and advances in the immediate future. Having hooked the

reader on graptolites, the eight so-called appendices include pieces on the meaning of the technical terms applied to graptolites, the best places (both in Britain and world-wide) to collect specimens and which organisations, graptolitologists and sources of literature could be consulted in order to answer relevant problems and to find out more about the group. Particularly appropriate and much appreciated by this reader was the concluding section of the book, which gives pen-pictures of eight graptolite workers, from Joachim Barrande to Professors Bulman and Mu, whose contributions to the field are internationally recognised. Appropriately the volume is dedicated to the senior member of 'Big G', Nancy Kirk, whose work on graptolites, particularly her ideas on their mode of life and supposed 'automobile' capabilities, have often been so rewardingly controversial.

The second volume of "Fossils Illustrated", on trilobites, is shortly to be published. The efforts of the editors of "Graptolites", Douglas Palmer and Barrie Rickards, and the other 'friends of graptolites' have ensured that subsequent titles in the series have a hard act to follow. These long extinct animals really come alive in the book — oh those marvellous plates!

David J. Siveter

A contentious collection

MÜLLER, D. W., MCKENZIE, J. A. and WEISSERT, H. (Eds) *Controversies in Modern Geology, Evolution of Geological Theories in Sedimentology, Earth History and Tectonics*. 1991. Academic Press Ltd., London. £44.00, hardback, 490pp. ISBN 0 12 510340 9.

The title of this book is rather misleading, as becomes immediately apparent when you read the foreword. Thus it does not attempt to be a general review of, or to provide an even coverage of, the whole field of recent controversies in sedimentology, earth history and tectonics. Instead it has been compiled from papers submitted at a symposium which was held in Zürich in 1989 in honour of Professor Ken Hsü's 60th birthday and in appreciation of his work. Thus the book is biased towards the work of Ken Hsü, his co-workers, colleagues and students.

Fortunately, he is a remarkable man who has built up a considerable reputation as an original and controversial thinker. He is particularly noted for stressing the importance of the rare event, as exemplified by his views on the Messinian salinity crisis and the catastrophic events at the Cretaceous — Tertiary Boundary. His background has embraced China, a period with the Shell Group in the USA and an academic period in Switzerland. His research interests cover an unusually wide spectrum, including geochemistry, tectonics, sedimentary sequences, facies models, dolomites, deep-sea and lacustrine environments, palaeoceanography, plankton, global biotic events, mass extinctions and evolution. Accordingly, the book covers a similarly wide spectrum of topics dealing with some ancient controversies as well as many that are still being vigorously argued.

The Introduction, Part I, Controversy and Geologic Theory, reviews some past and present controversies

and summarises the topics covered. It includes the following two relevant and eminently quotable sentences. 'Ingenious ideas to solve old puzzles are seldom received with gratitude by those who have much invested in their own solution and useless arguments are propagated to defend false pride' and 'Given enough time, the improbable becomes inevitable'. These ideas set the scene for the following 18 papers, which are grouped under four headings.

Part II, Geologic Events and Non-uniform Sedimentation, deals with the problem that specific sedimentary events vary in magnitude during different eras of earth history. Topics include the Messinian salinity crisis, stromatolites, dolomites, phosphates, and deep-sea depositional systems.

Part III, Paleoenvironment and Evolutionary Change, deals with rapid and multiple terrestrial and extra-terrestrially induced changes. Individual papers deal with the extinction of the Mammoth, the Paleogene glacial history of Antarctica, possible Cretaceous glacial interludes, and the periodicity of extinction.

Part IV, Sea-level History and Sedimentation, deals with the long-standing arguments regarding the relative importance of eustasy and tectonism. Topics include pelagic sedimentation, isolated carbonate platforms, intraplate stress-induced subsidence, and modelling sedimentary sequences.

Part V, Tectonics and Mountain Building, covers extension of the continental crust, the classification of fault rocks, Indosinides and eastern Paleotethys, the old controversy on the Glaurus Nappes, and the timing of orogenic events.

Part VI, the final section, lists the abstracts of eight talks that were delivered at the 1989 symposium. These cover back-arc basins, giant lakes, mass extinctions, cleavage, environmental geochemistry, oceanic plankton, and whether geology is an environmental science.

Readers who, like the reviewer, lack the breadth of knowledge and interests of Ken Hsü are nevertheless likely to find some papers of immediate interest to themselves. Furthermore, other papers on less familiar topics provide instant updates on fields which, with the current trend towards integration of different disciplines, may subsequently become highly relevant. A high proportion of the papers have been written by acknowledged international experts and provide concise, authoritative accounts of controversies in specific fields. The individual lists of references are also very useful and an Index is provided.

The text and most of the diagrams are clear and well set out. However, not all of the diagrams are equally legible and some have been reduced beyond the point of clarity. The price is comparable with that of other hardback geological books and potential readers may reasonably consider buying it for themselves. This book is not just of interest to the specialist and deserves a wide audience. It should certainly be recommended to your library!

William A. Read

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