Applied Palaeontology

Palaeontology, the scientific study of fossils, has developed from a descriptive science to an analytical science used to interpret relationships between earth and life history. *Applied Palaeontology* covers all aspects of palaeontology, although its principal focus is on the applied. It adopts a holistic, integrated approach, highlighting the key role of palaeontology in the study of the evolving earth, life and environmental processes.

After an introduction to fossils and how they are classified, each of the principal fossil groups is dealt with in detail, covering their biology, morphology, classification, palaeobiology and biostratigraphy. The latter half of the book focuses on the applications of fossils in the interpretation of earth and life processes and environments, including the events that control biodiversity. It concludes with case histories of how our knowledge of fossils is applied, in industry and elsewhere.

This will be a valuable reference for anyone involved in the applications of palaeontology, including earth and life science students and academics, professionals in petroleum, minerals, mining and engineering industries, palaeontologists, geologists and environmental scientists.

ROBERT WYNN JONES gained his B.Sc. in geological sciences at the University of Birmingham in 1979 and his Ph.D. at the University College of Wales, Aberystwyth in 1982. Since then he has worked as a palaeontologist in the oil industry, including the last 20 years with BP. His work has involved analysis of micropalaeontological samples and interpretation and integration of micro- and macropalaeontological data. He has worked on rocks and fossils from Proterozoic to Pleistocene, from sedimentary basins all around the world.

Dr Jones also maintains an active interest in academic research, especially in the study of foraminiferal taxonomy, palaeobiology, biostratigraphy and historical micropalaeontology. This interest has resulted in over 60 publications to date, including five books. It has also resulted in an honorary scientific associateship at the Natural History Museum, London and an honorary research fellowship at University College London.

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Robert Wynn Jones

CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town,
Singapore, São Paulo, Delhi, Mexico City

Cambridge University Press
The Edinburgh Building, Cambridge CB2 8RU, UK

Published in the United States of America by
Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge.org/9781107407442

First published 2006
First paperback edition 2012

A catalogue record for this publication is available from the British Library

ISBN 978-0-521-84199-3 Hardback
ISBN 978-1-107-40744-2 Paperback

For my father, who unknowingly set me on a life-course when he showed me as a young boy a specimen of his favourite fossil, the brachiopod Rhynchonella . . .

To see a World in a grain of sand
And a Heaven in a wild flower
To hold Infinity in the palm of your hand
And Eternity in an hour.

William Blake, *Auguries of Innocence*

Gweled Nef ym mhlygion blodyn
Canfod Byd mewn un tywodyn
Dal mewn orig Dragwyddoldeb
Cau dy ddwrn am Anfeidroldeb.

A Welsh rendition of the above, by my great-grandfather, Thomas Gwynn Jones, *Caniadau*

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Preface

Mankind has always been fascinated by fossils, by their beauty and their mystery, their charm and their strangeness, their mute testimony to lives and worlds lost unimaginably long ago. In prehistoric times, our forebears not only collected fossils, but evidently treated them as valued artefacts, as indicated, for example, by the discovery of an ammonite at an Upper Palaeolithic burial site in Aveline's Hole in Burrington in the West Country (Rahtz, 1993), and numerous different types of fossil at Cro Magnon sites in the Vézère valley in the Périgord region of France, truly the birthplace of European civilisation (many of which are now displayed in the magnificent Museum of Prehistory in Les Eyzies). The habit persisted both in so-called primitive and so-called advanced societies through historical times (Mayor, 2000).

Palaeontology, that is, the scientific study of fossils, may be said to have originated at least as long ago as the sixteenth century (Thackray, in Briggs and Crowther, 1990), and, obviously, continues to be practised to the present day. The earliest written observations on fossils were made by the German Bauer, or Agricola, in his book *De natura fossilum*, and the earliest illustrations by the Swiss Gesner in his book *De rerum fossilium lapidum et gemmarum*, both of which date from the sixteenth century. The usage by these and other early observers of the term 'fossil', from the Latin *fodere*, meaning 'to dig', pertained to literally anything dug up from the ground or mined, including what we would now classify as minerals, crystals and gemstones. The earliest interpretations as to the nature of what we would now accept as fossils were made by the Danish anatomist Stensen, or Steno, working in the Medici court in Florence, in his publications dating from the latter part of the seventeenth century (Cutler, 2003). Steno applied Descartes' 'method of doubt' and his own deductive logic to demonstrate that the so-called *glossopetrae* or 'tongue stones' much valued in medieval Europe for their supposed medicinal properties were in fact not the tongues of snakes turned to stone by St Paul, as was the superstition, but the fossilised equivalents of the shark's teeth he was familiar with from his dissection work. Elsewhere in his writings, Steno established three important principles of stratigraphy, namely the 'principle of superposition', the 'principle of original horizontality' and the 'principle of lateral continuity', such that he is regarded by many as the true founder of that science. Incidentally, in later life, he renounced science for religion, and was made a saint by Pope John Paul II!

There may be said to have been three, partially overlapping, areas or phases of subsequent palaeontological study: the descriptive; the synoptic; and the interpretive (Bowler, in Briggs and Crowther, 1990; Hoffman, in Briggs and Crowther, 1990; Thackray, in Briggs and Crowther, 1990; Valentine, in Briggs and Crowther, 1990; Jones, 1996). The emphasis through the three phases has shifted from the documentation of fossils to the analysis and interpretation of their relationship to evolving earth and life history and processes and environments, and their application to the elucidation thereof; from data acquistion and processing to interpretation and integration; from pure to applied. The descriptive phase began with the first descriptions of fossil species conforming to modern standards, made following the introduction of the binomial system for the naming of species by Linné, or Linnaeus, in the late eighteenth century. The synoptic phase has continued into the twenty-first century, with the establishment of higher-level taxonomic classification systems based on morphology and phylogeny, made following the publication of *On the Origin of Species by Means of Natural Selection* by Darwin (1859) in the late nineteenth century, and the advances in cladistics and molecular biology in the twentieth. The interpretive phase, ultimately resulting in the development of, and advances in, the applied sub-disciplines of palaeobiology and biostratigraphy, began with the establishment of the ordered succession of fossils in Great Britain, and the 'law of superposition' and the 'law of strata identified by organised fossils' by William ('Strata') Smith

in the late eighteenth and early nineteenth centuries (Torrens, 2003); and by the publication also by Smith of the first geological map of Great Britain, 'the map that changed the world' (Winchester, 2001). The first application of biostratigraphy in the oil industry was by the Pole Josef Grzybowski in the late nineteenth and early twentieth centuries (Czarniecki, in Kaminski *et al.*, 1993). At a time when (micro)palaeontology was essentially in a stage of synthesis, it was he who first used the discipline in an analytical fashion to solve geological problems encountered in the oilfields of the eastern Carpathians (those around the village of Potok being the oldest still in production anywhere in the world). His contribution to biostratigraphy and also to palaeobiology has long been recognised and justly acclaimed in his own country, but is sadly seldom acknowledged in the west.

In the future, applied (micro)palaeontology will continue to play a vital role in exploiting the world's discovered petroleum and other mineral resources, and in exploring for undiscovered reserves. In view of the growing concern about the environment, applications in environmental science, and outwith the exploitative industries, are also likely to come to the fore.

A significant number of textbooks have been written about palaeontology, most focusing on pure rather than applied aspects.

This book covers all aspects of palaeontology, although its principal focus is on the applied. It attempts to adopt a holistic, integrated approach, highlighting the key role of palaeontology in earth and life science. It treats palaeontology not as an end in itself, but as a means to an end – of understanding earth and life history and processes, and global change. Its theme may be said to be that of 'fossils as recorders and indicators of global change'.

The following quotation from Erwin Schrödinger's book *What Is Life?* serves as a disclaimer:

> A scientist is . . . usually expected not to write on any topic of which he is not a master. This is regarded as a matter of *noblesse oblige*. For the present purpose I beg to renounce the *noblesse*, if any, and to be freed of the ensuing obligation . . .

Acknowledgements

I would like to acknowledge Cambridge University Press, Longman/Pearson, Poyser/A. & C. Black, and John Wiley & Sons for providing permission to reproduce figures; separate acknowledgements are given as appropriate in the text. Every reasonable effort has been made to contact all other copyright holders in this regard. To any whose rights I may have unintentionally infringed I offer my unreserved apologies.

I would also like to acknowledge the assistance and professionalism of Sally Thomas, Emily Yossarian, Vince Higgs, J. Bottrill, Anna Hodson and Wendy Phillips of Cambridge University Press in seeing the project through from conception to publication.

I would like to acknowledge the many and varied contributions of my geology teacher at Penglais School, Aberystwyth, namely Huw Spencer-Lloyd; my palaeontology and stratigraphy lecturers at the University of Birmingham, namely George Bennison, Russell Coope, Tony Hallam, Frank Moseley and Isles Strachan; my micropalaeontology professors at the University College of Wales, Aberystwyth, namely Jo Haynes and Robin Whatley; and my colleagues at BP, the Natural History Museum, University College London and around the world, namely the late Geoff Adams, Jordi Agusti, Nigel Ainsworth, Peter Andrews, John Athersuch, Haydon Bailey, Fred Banner, Deryck Bayliss, Joan Bernhard, Ray Bernor, Ian Boomer, Paul Bown, Barry Carr-Brown, Mike Charnock, Kevin Cooper, Phil Copestake, Andy Currant, the late Remmert Daams, Jill Darrell, Paul Davis, Louis de Bonis, Mikael Fortelius, John Frampton, Liam Gallagher, Tony Gary, Philip Gingerich, Matt Hampton, Andy Henderson, Nick Holmes, Jerry Hooker, David Horne, Mike Howarth, Wyn Hughes, Jake Jacovides, Clive Jones, the late Garry Jones, Dave Jutson, Mike Kaminski, Paul Kenrick, Eduardo Koutsoukos, Johanna Kovar-Eder, Nadezda Krstic, David Loydell, Norm MacLeod, Paul Marshall, Sue Matthews, Sebastian Meier, Giles Miller, Alex Mitlehner, Bob Morley, Noel Morris, John Murray, Bonnie O'Brien, Hugh Owen, Bernard Owens, Simon Parfitt, Simon Payne, Pete Rawson, Jelle Reumer, Fred Rogl, Lorenzo Rook, Brian Rosen, Mike Simmons, David Siveter, Andrew Smith, Nikos Solounias, the late Charles Stainforth, Mike Stephenson, Jean-Pierre Suc, Jon Todd, Jan van der Made, Janice Weston, Greg Wahlman, John Whittaker, the late Peter Whybrow, Mark Williams, Brent Wilson and Jeremy Young; and the invaluable assistance of Keith Greenwood, Dave Johnson, Mike Larby, Ashley Lawrence, Pat Randell and Aubrey Thomas in the drawing office, and of Eddie Murphy in the library.

On a more personal note, I would like to acknowledge the inspiration provided by Carlene Anderson, Laurie Anderson, Joan Armatrading, Devendra Banhart, Bach, Bjork, Jussi Björling, Billy Bragg, Bruch, Michael Buble, Maria Callas, The Calling, Laura Cantrell, Enrico Caruso, Johnny Cash, Eva Cassidy, Nick Cave and the Bad Seeds, Chopin, The Clancy Brothers, The Clash, Jimmy Cliff, Holly Cole, Copland, Elvis Costello, Jamie Cullum, Victoria de los Angeles, Donizetti, Elgar, Marianne Faithfull, Kathleen Ferrier, Aretha Franklin, Franz Ferdinand, Marvin Gaye, Bebel Gilberto, Philip Glass, Tito Gobbi, David Gray, Patty Griffin, Jimi Hendrix, Billie Holliday, Ives, Etta James, Karl Jenkins, Norah Jones, Joy Division, Keane, The Kings of Leon, Ladysmith Black Mambazo, Leighton, Mendelssohn, Robert Merrill, Van Morrisson, Mozart, The Muse, Willie Nelson, Sinead O'Connor, Orff, Pärt, Dolly Parton, The Pogues, Elvis Presley, Otis Redding, Steve Reich and Beryl Korot, Damien Rice, Paul Robeson, Rutter, Ravi Shankar, Frank Sinatra, Mindy Smith, Patti Smith, Bruce Springsteen, Kristi Stassinopoulou, Joss Stone, Stravinsky, Jesse Sykes and the Sweet Hereafter, Takemitsu, Tallis, Tavener, Tchaikovsky, Phil Thornton, Juliet Turner, Vaughan Williams, Verdi, Anne Sofie von Otter, Tom Waits, Walton, Gillian Welch, Paul Weller, Hayley Westenra, Brian Wilson, and all the artistes on my many Gregorian chant and Russian Orthodox Church music CDs.

Finally, I would like to acknowledge not only the technological assistance but also the love, support and, above all, forbearance of my wife Heather, and my sons Wynn and Gethin, no longer small. I really have finished now.