

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)

THE CRATO FOSSIL BEDS OF BRAZIL

Window into an Ancient World

This beautifully illustrated volume describes the entire flora and fauna of the famous Lower Cretaceous Crato Formation of Brazil – one of the world's most important fossil deposits, exhibiting exceptional preservation. For the first time, the entire fossil assemblage is brought together in a single volume.

Chapters on the fauna cover a range of invertebrates including arachnids, crustaceans and an immense number of insect groups, while vertebrates are treated in chapters on fishes, anurans, lizards, turtles, crocodiles, pterosaurs and birds. A diverse flora is described in chapters on macrophytes ranging from ferns to some of the earliest angiosperms, including eudicots. Palynomorphs are also considered. Virtually all species are illustrated, many for the first time and some in full colour, while numerous interpretative drawings add to the scientific value of this work. Many new species and higher taxa are described. The fossil descriptions are supported by detailed explanations of the geological history of the deposit and its tectonic setting. Each chapter also contains a comprehensive bibliography.

Drawing on expertise from around the world and specimens from the most important museum collections, this book forms an essential reference for all researchers and enthusiasts with an interest in Mesozoic fossils, and will provide a springboard for further research.

DAVID MARTILL is a Reader in Palaeobiology in the School of Earth and Environmental Sciences at the University of Portsmouth, where his research interests include the palaeobiology of pterosaurs and exceptional preservation of fossil vertebrates. He is the author of several other books and has appeared in several television series including the BBC series *Walking with Dinosaurs*.

GÜNTER BECHLY is Curator for amber and fossil insects at the Staatliches Museum für Naturkunde in Stuttgart, Germany, where his research projects include the phylogenetic system of fossil and Recent damselflies and dragonflies. He has authored several books in German and English and has appeared in television series in Germany and Norway.

ROBERT LOVERIDGE is a Research Fellow in the School of Earth and Environmental Sciences at the University of Portsmouth. He is a biologist with interests in the use of artificial wetlands to treat wastewaters, environmental protection, and palaeontology (particularly palaeobotany). He has been involved in several other books and television projects, and is a skilled photographer, being responsible for many of the beautiful images in this book.

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)

THE CRATO FOSSIL BEDS OF BRAZIL

Window into an Ancient World

Edited by

DAVID M. MARTILL

University of Portsmouth

GÜNTER BECHLY

Staatliches Museum für Naturkunde, Stuttgart

ROBERT F. LOVERIDGE

University of Portsmouth



CAMBRIDGE
UNIVERSITY PRESS

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)

CAMBRIDGE UNIVERSITY PRESS

Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo

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/9780521858670

© Cambridge University Press 2007

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press.

First published 2007

Printed in the United Kingdom at the University Press, Cambridge

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

ISBN 978-0-521-85867-0 hardback

Cambridge University Press has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication, and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)

Contents

<i>Contributors</i>	<i>page</i> viii
<i>Preface</i>	xi
<i>Acknowledgements</i>	xiv
Part I The Crato Formation Konservat Lagerstätte	
1 Introduction to the Crato Formation <i>David M. Martill and Günter Bechly</i>	3
2 The geology of the Crato Formation <i>David M. Martill</i>	8
3 Stratigraphy of the Crato Formation <i>David M. Martill and Ulrich Heimhofer</i>	25
4 The sedimentology and depositional environment of the Crato Formation <i>Ulrich Heimhofer and David M. Martill</i>	44
5 Commercial exploitation of the Crato Formation <i>José Artur Ferreira Gomes de Andrade</i>	63
6 Preparation techniques for Crato Formation fossils <i>Michael Schwickert</i>	70
Part II The invertebrate fauna	
7 Taphonomy and preservation of Crato Formation arthropods <i>Federica Menon and David M. Martill</i>	79
8 Chilopoda: centipedes <i>David M. Martill</i>	97
9 Arachnida: spiders, scorpions and allies <i>Jason A. Dunlop, Federica Menon and Paul A. Selden</i>	103
10 Crustacea of the Crato Formation <i>Günter Schweigert, David M. Martill and Mark Williams</i>	133

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)

vi

Contents

11	Insects of the Crato Formation	142
11.1	Introduction <i>Günter Bechly</i>	142
11.2	Apterygota: primarily wingless insects <i>Arnold H. Staniczek and Günter Bechly</i>	149
11.3	Persisting-type stem-group Ephemeroptera <i>Rainer Willmann</i>	154
11.4	Ephemeroptera: mayflies <i>Arnold H. Staniczek</i>	163
11.5	Odonata: damselflies and dragonflies <i>Günter Bechly</i>	184
11.6	Dermaptera: earwigs <i>Fabian Haas</i>	222
11.7	Mantodea: praying mantises <i>David A. Grimaldi</i>	234
11.8	‘Blattaria’: cockroaches and roachoids <i>Günter Bechly</i>	239
11.9	Isoptera: termites <i>Günter Bechly</i>	249
11.10	Chresmododea: fossil ‘water striders’ <i>Günter Bechly</i>	262
11.11	Orthoptera: grasshoppers, crickets, locusts and stick insects <i>Sam W. Heads and Rafael G. Martins-Neto</i>	265
11.12	Cicadomorpha: cicadas and relatives <i>Federica Menon, Sam W. Heads and Jacek Szwedo</i>	283
11.13	Fulgoromorpha: planthoppers <i>Jacek Szwedo</i>	297
11.14	Coleorrhyncha: moss bugs <i>Günter Bechly and Jacek Szwedo</i>	313
11.15	Heteroptera: bugs <i>Yuri A. Popov and Günter Bechly</i>	317
11.16	Neuropterida: snakeflies, dobsonflies and lacewings <i>Rafael G. Martins-Neto, Sam W. Heads and Günter Bechly</i>	328
11.17	Coleoptera: beetles <i>Karin Wolf-Schwenninger and Wolfgang Schawaller</i>	338
11.18	Hymenoptera: bees, wasps and ants <i>Till Osten</i>	350
11.19	Mecoptera: scorpionflies <i>Günter Bechly</i>	365

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)

<i>Contents</i>		vii
11.20	Diptera: true flies, gnats and crane flies <i>Jana Willkommen and David A. Grimaldi</i>	369
11.21	Trichoptera and Lepidoptera: caddisflies and butterflies <i>Günter Bechly</i>	387
Part III The vertebrate fauna		
12	The Crato Formation fish fauna <i>Paulo M. Brito</i>	429
13	Anurans of the Crato Formation <i>Maria Eduarda C. Leal, David M. Martill and Paulo M. Brito</i>	444
14	Turtles of the Crato Formation <i>Darren Naish</i>	452
15	Lizards of the Crato Formation <i>David M. Martill</i>	458
16	Crocodylians of the Crato Formation: evidence for enigmatic species <i>Eberhard 'Dino' Frey and Steven W. Salisbury</i>	463
17	Pterosaurs of the Crato Formation <i>David M. Unwin and David M. Martill</i>	475
18	Birds of the Crato Formation <i>Darren Naish, David M. Martill and Ian Merrick</i>	525
Part IV The flora		
19	The macrophyte flora of the Crato Formation <i>Barbara A. R. Mohr, Mary E. C. Bernardes-de-Oliveira and Robert F. Loveridge</i>	537
20	Spores and pollen from the Crato Formation: biostratigraphic and palaeoenvironmental implications <i>David J. Batten</i>	566
Part V Miscellanea		
21	Miscellaneous biota <i>David M. Martill</i>	577
	<i>Appendix: species list for the Crato Formation</i> <i>David M. Martill, Günter Bechly and Sam W. Heads</i>	582
	<i>Systematic index</i>	608

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)

Contributors

José Artur Ferreira Gomes de Andrade, Museo de Fosseis, Departamento Nacional de Produção Mineral, Praça de Sé, CEP 633.100 440, Crato, Ceará, Brazil

David J. Batten, School of Earth, Atmospheric and Environmental Sciences, University of Manchester, Oxford Road, Manchester M13 9PL, UK

Günter Bechly, Staatliches Museum für Naturkunde Stuttgart, Abteilung Paläontologie – Sektion Bernstein, Rosenstein 1, D-70191 Stuttgart, Germany

Mary E. C. Bernardes-de-Oliveira, Institute of Geosciences, University of Sao Paulo, Cidade Universitaria, Rua do Lago 562 CEP 05508–080, São Paulo, SP, Brazil

Paulo M. Brito, Departamento de Zoologia, Instituto de Biologia, Universidade do Estado do Rio de Janeiro, Rua São Francisco Xavier 524, Rio de Janeiro, 20559–900, Brazil.

Jason A. Dunlop, Institut für Systematische Zoologie, Museum für Naturkunde der Humboldt-Universität, Invalidenstrasse 43, D-10115 Berlin, Germany

Eberhard ‘Dino’ Frey, Geowissenschaftliche Abteilung, Staatliches Museum für Naturkunde Karlsruhe, Erbprinzenstrasse 13, D-76133 Karlsruhe, Germany

David A. Grimaldi, Department of Entomology, American Museum of Natural History, New York, NY 10024, USA

Fabian Haas, Staatliches Museum für Naturkunde Stuttgart, Abteilung Entomologie, Rosenstein 1, D-70191 Stuttgart, Germany

Sam W. Heads, School of Earth and Environmental Sciences, University of Portsmouth, Burnaby Road, Portsmouth PO1 3QL, UK

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)

Contributors

ix

Ulrich Heimhofer, Ruhr-Universität Bochum, Institute for Geology, Mineralogy and Geophysics, Sedimentary and Isotope Geology, Universitätsstr. 150, D-44801 Bochum, Germany

Maria Eduarda C. Leal, Departamento de Zoologia, Instituto de Biologia, Universidade do Estado do Rio de Janeiro, Rua São Francisco Xavier 524, Rio de Janeiro, 20559-900, Brazil

Robert F. Loveridge, School of Earth and Environmental Sciences, University of Portsmouth, Burnaby Road, Portsmouth PO1 3QL, UK

David M. Martill, School of Earth and Environmental Sciences, University of Portsmouth, Burnaby Road, Portsmouth PO1 3QL, UK

Rafael G. Martins-Neto, Departamento Ciências Biológicas, Comportamento e Biologia Animal, Universidade Federal de Juiz de Fora, Campus Universitário, Martelos, 36036-900-Juiz de Fora, MG, Brazil

Federica Menon, School of Earth, Atmospheric and Environmental Sciences, University of Manchester, Oxford Road, Manchester M13 9PL, UK

Ian Merrick, School of Earth and Environmental Sciences, University of Portsmouth, Burnaby Road, Portsmouth PO1 3QL, UK

Barbara A. R. Mohr, Institut für Paläontologie, Museum für Naturkunde, Zentralinstitut der Humboldt-Universität zu Berlin, Invalidenstrasse 43, D-10115 Berlin, Germany

Darren Naish, School of Earth and Environmental Sciences, University of Portsmouth, Burnaby Road, Portsmouth PO1 3QL, UK

Till Osten, Abteilung Entomologie, Staatliches Museum für Naturkunde, Rosenstein 1, D-70191 Stuttgart, Germany

Yuri A. Popov, Paleontological Institute, Russian Academy of Sciences, Profsoyuznaya Str. 123, Moscow 117997, Russia

Steven W. Salisbury, School of Integrative Biology, The University of Queensland, Brisbane, Qld 4072, Australia

Wolfgang Schawaller, Staatliches Museum für Naturkunde Stuttgart, Abteilung Entomologie, Rosenstein 1, D-70191 Stuttgart, Germany

Günter Schweigert, Staatliches Museum für Naturkunde, Abteilung Paläontologie, Rosenstein 1, D-70191 Stuttgart, Germany

Michael Schwickert, Hebelstrasse 4, D-67734 Sulzbachtal, Germany

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)

x

Contributors

Paul A. Selden, Paleontological Institute, University of Kansas, Lindley Hall, 1475 Jayhawk Blvd, Lawrence, KS 66045, USA

Arnold H. Staniczek, Staatliches Museum für Naturkunde Stuttgart, Abteilung Entomologie, Rosenstein 1, D-70191 Stuttgart, Germany

Jacek Szwedo, Department of Systematics and Zoogeography, Museum and Institute of Zoology, Polish Academy of Sciences, Wilcza 64, 00-679 Warszawa, Poland

David M. Unwin, Department of Museum Studies, University of Leicester, 105 Princess Road East, Leicester LE1 7LG, UK

Mark Williams, Department of Geology, University of Leicester, University Road, Leicester LE1 7RH, UK

Jana Willkommen, Staatliches Museum für Naturkunde Stuttgart, Abteilung Entomologie, Rosenstein 1, D-70191 Stuttgart, Germany

Rainer Willmann, Georg-August-Universität Göttingen, Abteilung Morphologie, Systematik und Evolutionsbiologie mit Zoologisches Museum, Berliner Strasse 28, D-37073 Göttingen, Germany

Karin Wolf-Schwenninger, Staatliches Museum für Naturkunde Stuttgart, Abteilung Entomologie, Rosenstein 1, D-70191 Stuttgart, Germany

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)

Preface

In the late 1830s Scottish botanist, surgeon and explorer George Gardner (1810–1849) made his way on horseback from the picturesque spring-line village of Brejo Grande towards the now palaeontologically famous town of Santana do Cariri on the flanks of the Chapada do Araripe. In his published diaries (Gardner, 1846) it is noted that parts of the track were naturally paved in a slabby limestone. Some of these exposures still exist, although this picturesque country track has recently been resurfaced. What Gardner didn't record was that these limestones contain a wealth of fossils, some of which are spectacularly preserved and the *raison d'être* for this book. Although primarily a botanist, Gardner had a keen interest in fossils and, just a few weeks earlier, he had been exploring outcrops where carbonate nodules contained three-dimensionally preserved fishes: the so-called Santana Formation fish nodules, often seen for sale in fossil shops around the world.

Gardner shipped many of the fish-bearing nodules back to Scotland where they formed the basis of studies by the famous ichthyologist Louis Agassiz (1807–1873; Agassiz, 1841, 1833–1844a, 1844b), but the fossils in the slabby limestones seemed to pass him by. Perhaps it was because few quarries excavated the stone at this time, houses then being constructed mainly of mud and sticks or, for the wealthier, bricks made in the traditional style using locally dug alluvial clays.

Even 20 years ago fossils from the Crato Formation were still hardly known. Description of the fossil fish *Dastilbe*, the commonest macrofossil in the Crato Formation, didn't occur until 1947, over 100 years after Gardner's first mention of the rocks (Silva Santos, 1947). Shortly after the description of the fish the first fossil insects from the limestones were described (Costa Lima, 1950), but serious palaeontological research did not commence until the 1980s when Brito (1984, 1987), Campos (1986), Kellner and Campos (1986) and Martins-Neto and Kellner (1988) described elements of the fauna and Duarte (1985) described the first floral remains.

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)

These announcements coincided with the commencement of a major increase in the commercial extraction of the Crato limestones or so-called *pedra de larje*. Today, specimens of *Dastilbe* can be purchased in fossil shops around the world or on the Internet, and the number of scientific papers describing Crato fossils is in the hundreds. From an initial faunal list of a single fish and an unnamed mayfly larva in the middle of the twentieth century, the faunal and floral list today includes over 100 insect species, nine species of fish and nearly a dozen arachnids. Turtles, lizards and even a bird are known, but among the vertebrates the formation is gaining prominence for the diversity and spectacular preservation of its pterosaurs.

The Crato Formation has the most diverse fossil assemblage for any non-marine Cretaceous locality in Gondwana, and perhaps Laurasia too. Museum collections around the world are full of new species of Crato insects, plants and even pterosaurs just waiting to be described. This book brings together the various components of the palaeobiota and attempts to describe the ancient environments represented by the formation. It is one of the clearest windows yet into the Mesozoic, and although its edges may still be misty, a picture of a Cretaceous low-latitude environment is becoming much, much clearer.

D. M. Martill, G. Bechly and R. F. Loveridge 2007

References

- Agassiz, L. 1841. On the fossil fishes found by Mr Gardner in the Province of Ceará, in the north of Brazil. *Edinburgh New Philosophical Journal* **30**: 82–84.
- 1833–1844a. *Recherches sur les Poissons fossiles*, 5 vols. Neuchatel.
- 1844b. Sur quelques poissons fossiles du Brésil. *Compte Rendus Hebdomadaires des Seances des l'Académie des Sciences, Paris* **18**: 1007–1015.
- Brito, I. M. 1984. Nota preliminar sobre os insetos de Formação Santana, Cretáceo inferior da Chapada do Araripe, *Anais XXXIII Congresso Brasileiro de Geologia, Rio de Janeiro*: 530–535.
- 1987. Nota preliminar sobre uma nova efêmera do Cretáceo do Ceará (Insecta Ephemeroptera). *Anais do X Congresso Brasileiro Paleontologia, Rio de Janeiro* **2**: 593–597.
- Campos, D. R. B. 1986. Primeiro registro fossil de Scorpionidae na Chapada do Araripe (Cretáceo Inferior), Brasil. *Anais Academia brasileira, Ciencias* **58**: 135–137.
- Costa Lima, A. da 1950. Ninfa de efemerideo fossil do Ceará. *Anais Academia brasileira, Ciencias* **22**: 419–420.
- da Silva Santos, R. da 1947. Uma redescrição de *Dastilbe elongatus*, com algumas considerações sobre o genero *Dastilbe*. *D.G.M./D.N.P.M. Notas Preliminar, Estudos* **42**: 1–7.
- Duarte, L. 1985. Vegetais fósseis da Chapada do Araripe, Br. *Coletânea de Trabalhos Paleontológicos, Série Geologia, 27, Seção Paleontologia e Estratigrafia, 2, Brasília*: 557–563.

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)

Preface

xiii

Gardner, G. 1846. *Travels in the Interior of Brazil, Principally Through the Northern Provinces and the Gold and Diamond Districts During the Years 1836–1841*. London: Reeves Brothers.

Kellner, A. W. A. and Campos, D. de A. 1986. Primeira registro de amphibia (Anura) no Cretaceo Inferior da Bacia do Araripe, nordeste do Brasil. *Anais Academia brasileiro, Ciencias, Rio de Janeiro* **58**: 610.

Martins-Neto, R. G. and Kellner, A. W. A. 1988. Primeiro registro de pena na Formação Santana (Cretaceo Inferior), Bacia do Araripe, nordeste do Brasil. *Anais Academia brasileiro, Ciencias* **60**: 61–68.

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)

Acknowledgements

The editors would like to express their deepest thanks to all of the contributors to this book and to everyone who has facilitated its production. To those who made specimens in their care available for study and who have allowed authors to photograph material we are indebted: Drs A. Milner, C. Walker and S. Chapman (Natural History Museum, London, UK); Dr D. Frey (Karlsruhe, Germany); G. Koschny (Bad-Soden, Germany); Dr M. Ohl (Museum für Naturkunde, Berlin, Germany); Dr. S. Schmidt (Zoologische Staatssammlung, Munich, Germany); Mr and Mrs M. Schwickert (Sulzbachtal, Germany); Drs C. Forbes, S. Etchells-Butler and D. Norman (Sedgwick Museum, Cambridge, UK); Dr P. Wellnhofer (Bayerische Staatssammlung für Paläontologie und Geologie, Munich); Drs M. Manabe and Y. Tomida (National Science Museum, Tokyo, Japan); Dr S. Nabana (Iwaki Museum of Coal and Fossils, Iwaki, Japan); Drs Y. Hasegawa and Y. Takakua (Gunma Museum of Natural History, Gunma, Japan); Drs Y. Okazaki and Y. Yabumoto (City Museum of Natural History, Kita-Kyushu, Japan); Dr H. Taru (Prefectural Museum of Natural History, Kanagawa, Japan); Drs E. Gaffney and M. Norell (American Museum of Natural History, New York, USA); Drs Z. Dong, Z. Zhonghe and W. Xiaolin (Institute for Vertebrate Paleontology and Paleoanthropology, Beijing, China); Drs L. Junchang and J. Qiang (Geological Institute, Beijing, China); Dr G. Mayr (Senckenberg Museum, Frankfurt, Germany); Drs A. Herzog and A. Magno Feitosa Sales (Museo de Paleontologia, Santana do Cariri, Brazil); Drs A. Andrade and B. Filgueira (D.N.P.M., Crato, Brazil).

Thanks also to Dr Eberhard (Dino) Frey, Dr Yoshitaka Yabumoto, Mr Michael Schwickert, Carola Radke (MfN Berlin), Gabriela Drescher (SEM pictures; MfN Berlin) and Dr Raphael Martins-Neto for supplying photographs and Dr Karin Wolf-Schwenniger, Elke Siebert and Sarah Fielding for artwork. We are most grateful to Mr Bernd Schuster (Hünstetten, Germany), who provided numerous and excellent photos of fossil insects from coll. SMNS. Thanks to the team at Portsmouth University: Dr Mike Barker, Roger Pulley, Graham Spiller and Tai

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)*Acknowledgements*

xv

Wilson for logistical support; Derek Weights and Geoff Long for analyses; Tony Butcher kindly prepared palynological samples for David Batten. Judith Wohlrabe, Monja Knoll and Stig Walsh kindly translated a number of chapters. A number of people were kind enough to referee manuscripts and for this we especially thank Susan Evans, Catharina Rydin, Darren Naish, Lutz Kunzmann and several who wish to remain anonymous.

In Brazil tremendous support came from Dr Paulo Brito (Universidade Estadual, Rio de Janeiro), Dr Andre Herzog, Rector, Universidad Regional do Cariri (URCA) and Artur Andrade and Betimar Filgueiras of the Centro do Pesquisas da Chapada do Araripe (CPCA) of the DNPM's Crato office. Dr Jean C. Zamboni (Laboratório de Paleontologia, Departamento de Biologia, FFCL, USP, Campus de Ribeirão) kindly made laboratory facilities available to Dr Yuri Popov. Dr Peter Vršanský (Bratislava, Slovakia) is thanked for commenting on Dictyoptera, Umenocoleoidea and 'Blattodea'. Dr Paul Davis drew our attention to specimens in Japan, and Dino Frey, Natasha Bakhurina, Alex Kellner, Chris Bennett, Lü Jungchang, Zhou Zhonghe, Wang Xiaolin, M. Wilkinson and M. Witton are thanked for discussions on pterosaurs. Sam MacDonald (University of Manchester) kindly supplied CT scan images of Crato Orthoptera.

Thanks to Dr Jane Washington Evans, Dr Lorna Steel and Dr Phil Wilby for help in the field, Christian Neumann (Berlin) and Adriano Kury for advice on extant South American arachnids, Christian Neumann for curatorial assistance, Cal Welbourn for discussion regarding mites and Peter van Roy, Ricardo Pinto da Rocha and José Guadanucci for bringing other Crato material to our attention.

Financial support from the Leverhulme Trust; NERC; Institut für Paläontologie, Museum für Naturkunde, Humboldt Universität, Berlin; Department of Earth Sciences, Bristol University; School of Earth and Environmental Sciences, University of Portsmouth; Staatliches Museum für Naturkunde Stuttgart and the Royal Society are gratefully acknowledged.

Sympathy must be felt for Dr David Loydell (Portsmouth) who occupies an office next to David Martill: Dave, thanks for your tolerance.

Special mention goes to the numerous quarry workers who, while we were studying the strata, brought many wonderful fossils to our attention. In Nova Olinda we were made to feel at home thanks to the generosity of Maria Aurea and her extremely caring family and, in Jardim, we were made extremely welcome by Sr José Alvares Coutinho Junior and his family.

Special thanks also go to our production team at Cambridge University Press: Susan Francis for her encouragement, Helen Goldrein for juggling the contracts, freelance editor Nik Prowse for his copy-editing and Daniel Dunlavey for steering the book to publication.

Cambridge University Press

978-0-521-85867-0 - The Crato Fossil Beds of Brazil: Window into an Ancient World

Edited by David M. Martill, Gunter Bechly and Robert F. Loveridge

Frontmatter

[More information](#)

xvi

Acknowledgements

Finally, we must not forget the tolerance of our wives who, I am sure would have loved to have accompanied us, at least as far as the Brazilian coast, where we usually spent a day acclimatizing to the heat. Jill, Val and Maria Luise, we love you. And a big kiss too for Patricia Brito who made us so welcome in Rio de Janeiro.