

Ready for Their Close-Up

Hans Sues

In the theater of Mesozoic terrestrial life, mammals have long been cast as bit players—mouse-sized, furry creatures leading furtive existences in the wings while dinosaurs chewed up the scenery. This traditional view may be questioned because mammals and dinosaurs were very different in terms of size and biology, and, aside from one occasionally feeding on the other, the two groups probably had relatively little direct interaction.

The Mesozoic fossil record of mammals represents more than two-thirds of the group's entire evolutionary history and shows that they, like their dinosaurian contemporaries, rapidly diversified soon after their first appearance in the Late Triassic. The first announcement, in 1824, of the presence of mammals in Mesozoic strata (Middle Jurassic Stonesfield slates in England) shocked most scientists because it challenged then-prevailing notions concerning the succession of life through geological time. Additional discoveries through the 1860s, most also in England, quickly established the existence of a diversity of Mesozoic mammals, and in 1871 Richard Owen provided the first detailed study of these finds (1). In the second half of the 19th century, collectors working for Othniel Charles Marsh at Yale recovered a wealth of Jurassic and Cretaceous mammalian fossils in the American West. In the 1920s, George Gaylord Simpson reviewed all known Mesozoic mammals and published two major monographs on the European and American specimens (2, 3).

Research in the field was rekindled in the 1940s, with discoveries of early Mesozoic mammals in Britain. The pace of exploration accelerated in the 1960s. Unlike in earlier years, when finds of mam-



Not just a dental record. The single specimen of *Jeholodens jenkinsi* is a nearly complete articulated skeleton and skull (from the Early Cretaceous of Liaoning Province, China). This eutriconodont probably weighed less than 30 g and fed mainly on insects and other invertebrates.

**Mammals from the Age of Dinosaurs
Origins, Evolution,
and Structure**

by Zofia Kielan-Jaworowska,
Richard L. Cifelli,
and Zhe-Xi Luo

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11918-6.

malian remains were usually an accidental by-product of the quest for dinosaurs, paleontologists now systematically searched for mammalian fossils, especially the durable and diagnostic teeth. New techniques for breaking down and screening sedimentary rocks made this effort more productive. At the same time, discoveries of scores of well-preserved skulls and postcranial remains in Late Cretaceous strata in the Gobi Desert of Mongolia by Polish-Mongolian expeditions led by Zofia Kielan-Jaworowska initiated major advances in our understanding of the skeletal morphology of several major

clades of Mesozoic mammals. In 1979, Jason Lillegraven, Kielan-Jaworowska, and William Clemens edited a comprehensive survey of the structure and diversity of Mesozoic mammals (4), but such was the pace of research that much of the volume quickly became outdated. The most significant development in recent years has been the discovery of exquisitely preserved skeletons of various Early Cretaceous mammals in the Yixian Formation of Liaoning Province (northeast China),

which have had a profound impact on our understanding of the origin and early evolution of marsupials and placentals.

Clearly mammals were a significant component of many Mesozoic terrestrial ecosystems. Yet their fossil record still remains sparse for much of the Mesozoic, and many issues remain unresolved. For example, the record is still too incomplete to test divergence dates for most of the principal lineages of placental mammals proposed by molecular evolutionary studies. Today the search for Mesozoic mammals continues worldwide, with almost every year bringing exciting new discoveries.

Mammals from the Age of Dinosaurs, written by Kielan-Jaworowska, Richard Cifelli, and Zhe-Xi Luo, represents a much needed, authoritative survey of Mesozoic mammalian diversity and evolution. The authors, leading investigators in the field, have produced a landmark study that provides a phylogenetic framework for future work on mammalian history. (Kudos to the publisher for

including the character-taxon matrix used for the parsimony analysis as an appendix to the text, rather than relegating it to an ephemeral Web site.)

They view the phylogenetic tree of Mesozoic mammals as a “bush” of lineages, with successive radiations throughout the era. This picture differs from the fundamental dichotomy between nontherian and therian mammals favored by many authors since the 1970s as well as from Simpson's earlier concept of Mammalia as a grade comprising several lineages with separate origins among nonmammalian cynodonts. The most radical aspect of the authors' phylogenetic hypothesis is the dual origin of tribosphenic (“reverse triangle”) molars, with a Southern Hemisphere clade (Australosphenida) that includes monotremes developing this type of cheek teeth independently from a Northern Hemisphere clade (Boreosphenida) that includes marsupials and placentals. Recently discovered Early Cretaceous fossils in Australia indicate that monotremes also developed the characteristic mammalian three-bone middle ear independently from therians.

The authors devote the bulk of the volume to a comprehensive survey of Mesozoic mammalian diversity, one

The reviewer is at the National Museum of Natural History, Smithsonian Institution, MRC 106, Post Office Box 37012, Washington, DC 20013-7012, USA. E-mail: suesh@si.edu

grounded in the wealth of their own primary studies. For each major group of Mesozoic mammals, they offer a concise review of the group's anatomy and paleobiology, followed by a synopsis of all known genera (each of which is diagnosed and illustrated). This makes the book a particularly useful resource for specialist and novice alike because the primary literature on the subject (covered in a 52-page bibliography) is vast, multilingual, and widely scattered.

Like Simpson's classic studies, *Mammals from the Age of Dinosaurs* provides a solid foundation for the continuing quest to shed light on the extensive Mesozoic history of mammals, including the most distant roots of our own species.

References

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4. J. A. Lillegraven, Z. Kielan-Jaworowska, W. A. Clemens, Eds., *Mesozoic Mammals: The First Two-Thirds of Mammalian History* (Univ. California Press, Berkeley, CA, 1979).

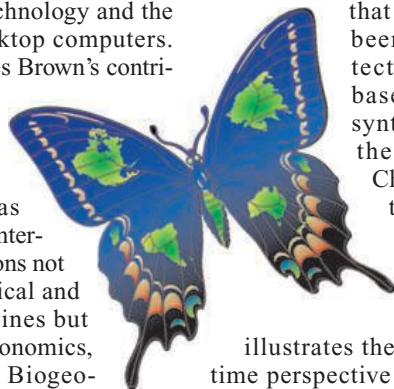
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ECOLOGY

Place Matters

Sahotra Sarkar

Biogeography has come a long way since the journeys of Humboldt and Wallace in the 19th century. Over the last three decades, the field has been revolutionized by the spread of geographic information systems (GIS) technology and the increasing power of desktop computers. Indeed, according to James Brown's contribution to *Frontiers of Biogeography*, the field only emerged as a recognizable subdiscipline during this period. It has become an international enterprise drawing on interactions not only with various biological and geographical subdisciplines but also with climatology, economics, geology, and sociology. Biogeography has also become central to the new discipline of conservation biology: without accurate relevant knowledge of biota localized to individual places,



The reviewer is in the Section of Integrative Biology and the Department of Philosophy, University of Texas at Austin, Austin, TX 78712-1180, USA. E-mail: sarkar@mail.utexas.edu

any conservation strategy is a shot in the dark. However, biogeographers and their collaborators, especially in academia, tend to be segregated into different departments and institutes. This volume is intended by its editors, Mark Lomolino and Lawrence Heaney, to play an integrative role by both summarizing the present state of the field and encouraging interdisciplinary interaction.

The volume's 18 chapters were developed from plenary papers presented at the inaugural meeting of the International Biogeography Society (January 2003 at Mesquite, Nevada). The authors include most of the major researchers in the field from North America and the United Kingdom, but the only other countries represented by contributors are Mexico and Chile. The new society's quest for international participation obviously has a way to go. The editors have divided the material among five sections that correspond to the field's major divisions: paleobiogeography, phylogeography and diversification, diversity gradients, marine biogeography, and conservation biogeography. Nearly all the papers focus on general principles rather than case studies (the chief exception being Heaney's chapter, which mainly concerns the Philippines). In addition, the contributors generally emphasize conceptual issues rather than technical detail. Both of these factors make the volume useful for introductory students.

The sections on paleogeography and phylogeography (the geographic distributions of genealogical lineages) complement each other well enough that they easily could have been merged. Using plate tectonics reconstructions based on 25 years of data synthesis and modeling in the PALEOMAP project, Christopher Scotese illustrates the changing global geography from the Early Triassic through to the current world.

Bruce Lieberman also illustrates the importance of a deep-time perspective in his consideration of range expansion, extinction, and biogeographic congruence. Brett Riddle and David Hafner explore the relevance of phylogeography to historical biogeography. These two sections also include contributions by Julio Betancourt on arid lands biogeography, Stephen Jackson on quaternary biogeography, and Christopher Humphries and Malte Ebach on cladistic

biogeography as well as Daniel Brooks's comparison of what he distinguishes as cladistic versus phylogenetic biogeography.

Although the remaining sections are not quite as well integrated, they are more cohesive than those in a typical conference product. Several individual papers

stand out: Kaustuv Roy and collaborators attempt to quantify spatial patterns of biogeographic diversity using information on the function and morphology of organisms. This effort is intriguing because, while different measures of diversity are routinely used in biodiversity conservation planning, functional and morphological data are usually ignored in spite of their obvious relevance to the viability of the biota in any

particular area. Robert Whittaker explores the importance of spatial scale in processes that influence species richness from local sites to global patterns. Geerat Vermeij's interesting essay offers a marine perspective on island life. Despite its presence in the marine biogeography section, John Briggs's paper focuses on conservation, particularly of the East Indies Triangle—a major center of evolutionary radiation in the Indo-West Pacific. Julie Lockwood provides a useful summary of the effects of biological invasions on diversity patterns. Víctor Sánchez-Cordero and collaborators demonstrate how GIS-based modeling of niches can be integrated into conservation planning. Michael Rosenzweig's paper underscores the inability of island biogeography theory to guide conservation area network design while exploring the future use of general species-area relationships.

The book ends with a concise overview by Brown of biogeography's current state and future promise. He notes how recent developments have unexpectedly challenged many standard views of the 1980s, including the applicability of the equilibrium theory to islands, the preponderance of allopatric speciation, and high integration within communities. By and large, the papers are well written and endorse his conclusion that biogeography is presently in a state of flux, with few of the traditional certainties holding up under the scrutiny of new data and techniques. It is clear, however, that biogeography's crucial importance in efforts to conserve biodiversity makes it a subject of considerable contemporary significance. *Frontiers of Biogeography* successfully conveys some of the field's excitement.

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**Frontiers of
Biogeography**
New Directions in the
Geography of Nature
Mark V. Lomolino and
Lawrence R. Heaney, Eds.

Sinauer Associates, Sunderland, MA, 2004. 448 pp.
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\$49.95, £31.99. ISBN 0-87893-478-2.

Early mammals were significant and fast-evolving elements of the terrestrial biota for much of the Mesozoic, and they have played an increasingly important role in studies of paleoecology, faunal turnover, and historical biogeography. This book thoroughly covers all aspects of the anatomy, paleobiology, and systematics of early mammalian groups, in addition to the extant lineages with long history extending back into Mesozoic. Library of Congress Cataloging-in-Publication Data Kielan-Jaworowska, Zofia. Mammals from the age of dinosaurs : origins, evolution, and structure / Zofia Kielan-Jaworowska, Richard L. Cifelli, and Zhe-Xi Luo. p. cm. Includes bibliographical references and index. ISBN 0-231-11918-6 (cloth : acid-free paper) 1. Mammals, Fossil. He has actively explored fossil mammals and dinosaurs in China and in the United States and studied evolutionary morphology and phylogenetic relationships of early mammals and fossil whales. Product details. Item Weight : 3.74 pounds. I'm not qualified to say how good *Mammals From the Age of Dinosaurs* is as a reference work, but Dr. Kielan-Jaworowska and Dr. Luo I already know to be two of the world's leading authorities on Mesozoic mammals. (I know little about Dr. Cifelli.) Right now has to be the most exciting time in history for that specialty, with the astonishing discoveries of recent years. Sadly, this book was published before some of them, such as the discovery of *Volaticotherium*. Mesozoic mammals have come into their own as a rich source of information for evolutionary biology. Their record of episodic, successive radiations speaks to the pace and mode of evolution. Early mammals were small, but they provide key information on the morphological transformations that led to modern mammals, including our own lineage of Placentalia. Significant and fast-evolving elements of the terrestrial biota for much of the Mesozoic, early mammals have played an increasingly important role in studies of paleoecology, faunal turnover, and historical biogeography. The record of early mam... *Origins, Evolution and Structure*. This reflects well on the state of the subject, and especially so on the three authors of an extremely comprehensive book. All known genera at the time of publication are illustrated and discussed in a phylogenetic context, with the phylogeny presented in the last chapter shaping the structure of the rest of the volume. The format consists of (in addition to a foreword, preface, appendix, references, etc.) the following 15 chapters; 1: Introduction; 2: Distribution of Mesozoic Mammals in Space and Time; 3: Origin of Triassic mammals from the Middle Jurassic-Early Cretaceous and the possibility of non-monophyly of tribosphenic mammals is also noted as a paradigm shift. Early mammals were significant and fast-evolving elements of the terrestrial biota for much of the Mesozoic, and they have played an increasingly important role in studies of paleoecology, faunal turnover, and historical biogeography. This book thoroughly covers all aspects of the anatomy, paleobiology, and systematics of early mammalian groups, in addition to the extant lineages with long history extending back into Mesozoic. Numerous detailed maps and line drawings enhance the text. He has actively explored fossil mammals and dinosaurs in China and in the United States and studied evolutionary morphology and phylogenetic relationships of early mammals and fossil whales.