



---

## **Palaeobiogeography and Biodiversity Change: The Ordovician and Mesozoic-Cenozoic Radiations**

**reviewed by Bruce Lieberman**

by J.A. Crame and A.W. Owen (eds.)

Geological Society of London. Special Publication 194, 2002, 212 pp.

SBN: 1-86239-106-8, £65.00

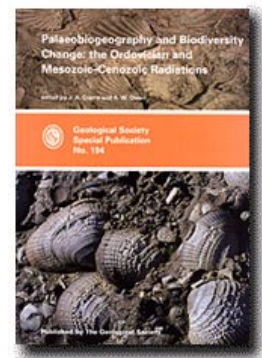
This book, in a series of fourteen articles, tackles the relevance and mechanisms underpinning life's twin peaks, these being the two upward jags in Sepkoski's diversity curve that correspond to the Ordovician radiation and the roughly post-Jurassic diversity march onward and upward. The various authors emphasize the role that biogeographic processes, especially tectonics and climate, may have played in generating each of these peaks. They also demonstrate the value of a paleontological perspective for understanding modern-day diversity. The book had as its genesis the 2001 Lyell meeting, co-sponsored by the Palaeontological Association, Geological Society of London, and British Micropalaeontological Society.

The first chapter, which follows a brief preface, is co-authored by the editors, and provides a fine introduction to the volume. Owen and Crame consider why there are two pulses of Phanerozoic diversification and also their similarities and differences. They recognize that both the early Ordovician and post-Jurassic worlds mark times of biotic provincialism, major continental breakup, and global tectonism, which raises the question of how each of these factors may have contributed to diversification. Jim Valentine and Tom Schopf were early advocates for the view that there was a link between continental dispersion and diversity. Arnie Miller has also stressed the link between orogenic activity and diversification, in the case of the Ordovician radiation. A link between continental

dispersion and diversity could emerge via vicariance and allopatric speciation, precipitated by the formation of geographic barriers as cratons became separated. Richard Bambach and especially Jack Sepkoski, by contrast, linked the twin bouts of diversification to the expansion of pre-existing ecological communities

or the appearance of new ones. The authors of the introduction, and most of the authors of the other chapters, side more closely with the view that earth history changes drive evolution. In the case of the Ordovician radiation, tectonics played a direct role by leading to biotic isolation. In the Cenozoic it seems that tectonic changes lead to climatic gradients, and both of these in turn increased biotic provincialism. Although I agree with these conclusions, this book will not settle the debate. Still, as Owen and Crame recognize, the chapters in this volume are an important introduction to these issues and hopefully will inspire future research into what role earth history episodes play relative to ecological processes in motivating macroevolutionary patterns and processes.

The remaining thirteen papers in this volume focus on various aspects of the Ordovician radia-



tion or the Mesozoic-Cenozoic diversity rise. Bassett, Popov, and Holmer, in the second chapter, focus on the nature of brachiopod faunas during the Ordovician radiation. They reach the important conclusion that many of the faunas and communities that comprise what is thought of as the Ordovician radiation fauna in fact evolved in the Middle Cambrian, but were confined to smaller regions and only later dispersed widely. Cope, in chapter four, reaches similar conclusions about the bivalve faunas of the Ordovician. In this respect, the Ordovician radiation may be analogous to other key episodes in the history of life, like the so-called Cambrian radiation and the Cenozoic radiation of mammals, each of which appears to have antecedent temporal roots. In the third chapter Harper and MacNiocaill focus on how continental fragmentation and subsequent immigration events by rhyconelliformean brachiopods contributed to the dynamics of the Ordovician radiation.

In chapter five Turvey reconstructs phylogenetic patterns in reedocalymenine trilobites and uses the phylogeny as a template to reconstruct biogeographic patterns by converting the phylogeny to an area cladogram. This is accomplished by substituting the taxon's area of occurrence for the species name. Four subclades are identified, each containing areas that span much of Gondwana. Although Turvey treats these patterns of area relationship as representing a faunal cline across Gondwana, the patterns may be more compatible with a biogeographic history of the group involving vicariance oscillating with episodes of range expansion facilitated by tectonic or climatic changes: what I refer to as geo-dispersal. An additional analysis that Turvey could have performed was to have optimized the geographic areas at the tips of the cladogram to the nodes, so he could explicitly identify episodes of vicariance and geo-dispersal.

Chapter six is a fine one by Smith, Donoghue, and Sansom that tracks the biogeographic context of vertebrate diversification during the Ordovician radiation. There are several useful cladograms mapping the evolution of various major vertebrate groups through time. Their phylogenetic analyses suggest that many vertebrate groups have an early evolutionary history that thus far has gone unsampled. They also recognize that early Paleozoic vertebrate paleobiogeography involves numerous episodes of vicariance followed by geo-dispersal.

Armstrong and Owen continue the theme of using vertebrates to understand the biogeography of the Ordovician by concentrating on the euconodonts. Finally, in chapter eight, Botting considers

the role that pyroclastic volcanism may have played in spurring Ordovician diversification.

The Mesozoic-Cenozoic chapters begin with Hart, Oxford, and Hudson's analysis of biogeographic patterns in planktonic forams. They recognize the important role sea-level rise played in facilitating biogeographic range expansion in planktonic forams, while Mesozoic continental fragmentation allowed oceanic stratification which in turn precipitated the diversification of depth stratified plankton. Aberhan considers biogeographic patterns in Early Jurassic bivalves. He examines whether bivalve faunal invasion followed extinction or caused extinction; this issue is difficult to test without phylogenies (which are lacking in Aberhan's study), a point he acknowledges.

Cantrill and Poole use their chapter to focus on Cretaceous Gondwanan plant floras. They again recognize the existence of what I would term widespread geo-dispersal, this time by angiosperms, which seems to be related to relaxing climatic gradients. Crame and Rose in chapter 12 focus on how Cenozoic paleogeography contributed to modern biodiversity gradients. They consider whether contemporary ecological processes or historical factors regulate regional diversity hot spots in the tropics. They make the convincing argument that tectonics played an important role in producing the Cenozoic diversity rise and also modern day diversity gradients by causing faunal isolation and speciation. Moreover, climatic changes, again driven by tectonic events, facilitated isolation and in turn also produced alternating climatic cycles which, via Elisabeth Vrba's Turnover Pulse Hypothesis, might lead to even more allopatric speciation.

In chapter 13 Markwick and Lupia focus on the value of paleontological databases for studying biodiversity in the fossil record. Chapter 14, by Markwick, comprises a case study to complement the theoretical perspective of chapter 13.

The book, although useful as is, would have benefited if there was a chapter by Tony Hallam, who has written so much of the important literature on Mesozoic biogeography. A chapter covering terrestrial vertebrate biogeography of the Mesozoic or Cenozoic would have also been useful. Finally, another concern I have with this book is the complete under-representation of any authors outside of Europe (and really most authors are from the United Kingdom). It is of course understandable that many of the authors should come from the UK, as the book evolved out of a Lyell meeting. Still, the fact that only one of the fourteen chapters has any authors currently working in North America (and he is a second author), while several North Americans

have research that focuses on the Ordovician and Cenozoic radiations, suggests an unfortunate omission. In spite of these criticisms, every university library should have this book.. It is also worthwhile for those paleontologists that are interested

in paleobiogeography or who study the nature and significance of the Sepkoski Phanerozoic diversity curve. Other paleontologists outside either of these research areas may still find the book to be a handy reference.