The mechanisms of macroevolutionary change have long been a contentious issue. Palaeoecological evidence, presented in this book, shows that evolutionary processes visible in ecological time do not build up into macroevolutionary trends, contrary to Darwin's original thesis.

The author discusses how climatic oscillations on ice-age time-scales are paced by variations in the Earth's orbit, and have thus been a permanent feature of Earth history. There is, however, little evidence for macroevolutionary change in response to these climatic changes, suggesting that over geological time macroevolution does not occur as a result of accumulated short-term processes. These conclusions are used to construct a post-modern evolutionary synthesis in which evolution and ecology play an equal role.

Written by a leading palaeoecologist, this book will be of interest to researchers in both ecology and evolutionary biology.

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Evolution and Ecology: The Pace of Life

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All the business of war, and indeed all the business of life, is to endeavour to find out what you don't know by what you do; that's what I called "guessing what was at the other side of the hill" *Arthur Wellesley, Duke of Wellington, 1852, quoted by J.W. Croker (Jennings 1884, vol. 3, p. 274).*

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Preface

In July and August 1988 I spent time in Australia, partly on a study visit to the Australian National University, and partly attending a conference in Brisbane. After a conference field trip in northern Queensland, I had some time to spare in Cairns, and, as one does, took a day-trip snorkeling on the Great Barrier Reef. As the catamaran returned into Cairns, I noticed an osprey idly flying over. I had just spent much of the day watching fishes on the reef, and I had previously seen ospreys in northern Scotland, coastal Maine, and in the North American Great Lakes area (including, memorably, one flying over Exhibition Stadium, Toronto, during a ball game). I had long known that ospreys were cosmopolitan. The Cairns osprey reminded me of all of this. Whatever that bird was feeding on, whatever other organisms it interacted with, it had a different biotic environment, at least, from the Scottish or Canadian birds. I, like the rest of my generation, was brought up scientifically on the Neo-Darwinian paradigm, and had not thought too much about it in my day-to-day activities. But what, if anything, are ospreys 'adapted' to? This book is not about ospreys or their evolutionary history, but the Cairns bird has remained in my mind as a symbol for the relationships between organisms and their environments on ecological through evolutionary time-scales, including the crucial intermediate time-scales (10^4–10^5 years) typified by the Quaternary (the last 1.6 Myr).

The relationship between palaeoecology and ecology has been a topic of concern to many Quaternary workers for some time. This book was written partly as a result of a feeling of frustration that much of the ecological excitement of Quaternary events was not penetrating into mainstream ecological thinking, and partly as a result of realizing that these same events held considerable significance for processes of evolution, also untapped. The original scheme was for a book written jointly with Donald Walker on the subject of time in ecology. It evolved into this solo effort after a few years of little joint progress during which I developed the central theme of the book as it now is. Donald has been a significant source of support, ideas, and encouragement, particularly when I visited Canberra in 1988, and during the writing. His comments on an early draft convinced me to complete the thing. I am deeply indebted to him.

I began palaeoecological research under the supervision of John Birks, and I am very grateful to him for his continuing encouragement and discussion of the topics presented here, and many others, during and since those days. Many of the ideas in this book were initiated when I was an NSERC postdoctoral fellow working with Jim Ritchie while we were both in Toronto, and I thank him for his help and encouragement then and subsequently. It is an especial pleasure to thank Kathy Willis for her positive and helpful comments on several drafts, and for the many free and frank discussions that helped to shape the book. Janice Fuller allowed me to cite unpublished data from her thesis (Table 5.1) and, together with Jane Bunting, Alex Chepstow-Lusty, Simon Haberle, Susie Lumley, Maria Fernanda Sánchez Goñi, Julian Szeicz, Rebecca Teed, and Chronis Tzedakis, provided helpful discussions and made many suggestions for improvement. I also thank Nick Butterfield and Jim Ritchie for comments on a later draft, and Sylvia Peglar for allowing me to use Fig. 5.1. At CUP, I am grateful to Alan Crowden for his interest in the project, Barnaby Willitts for guiding it through the Press, and Sharon Erzinçlioğlu for carefully checking the text. John Birks and John Wiens made many helpful comments on behalf of CUP. Finally, but not least, I am grateful to Alison, Graham, and Hugh for their patience in the face of considerable neglect. If there is any merit in the book, they should all share the credit, but I alone take responsibility for omissions (it became impossible to include everything) and other failings.

The preparation of the text was greatly facilitated, and even made enjoyable, by Donald E. Knuth's wonderful type-setting program TEX, together with the macro package LATEX (by Leslie Lamport) and the bibliography program BIBTEX (by Oren Patashnik). I also gratefully acknowledge the provision of computing resources in the Department of Plant Sciences, University of Cambridge.

Keith Bennett
Cambridge
24 April 1996