Ecology and Applications of Benthic Foraminifera

In this volume John Murray investigates the ecological processes that control the distribution, abundance, and species diversity of benthic foraminifera in environments ranging from marsh to the deepest ocean. To interpret the fossil record it is necessary to have an understanding of the ecology of modern foraminifera and the processes operating after death leading to burial and fossilisation. This book presents the ecological background required to explain how fossil forms are used in dating rocks and reconstructing past environmental features including changes of sea level. It demonstrates how living foraminifera can be used to monitor modern-day environmental change.

Ecology and Applications of Benthic Foraminifera presents a comprehensive and global coverage of the subject using all the available literature. It is supported by a website hosting a large database of additional ecological information (www.cambridge.org/9780521828390) and will form an important reference for academic researchers and graduate students in Earth and Environmental Sciences.

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Contents

Preface

Why write another book on foraminiferal ecology when I have already previously written two (1973, 1991)? Writing those was stimulating because it brought together all the information currently available making it possible to see where progress had been made and where there were still gaps in knowledge. The same philosophy applies to this book. But the simple answer is that a vast amount of literature has appeared since 1991 and ideas have changed. Also, I know that my previous books are cited much more often than any of my papers. Two events encouraged me to undertake this major task. The 1991 book went out of print in the late 1990s but there continues to be a demand for it so the publishers re-introduced it in 2002 as a 'print-on-demand' edition. Also, I was invited to give a keynote lecture at the Forams 2002 meeting in Perth and while writing that the need for a new book became glaringly obvious. Another factor is that my circumstances have changed. I started research on foraminiferal ecology in 1959 and became an academic in 1962 so for 41 years research was carried alongside teaching ever increasing numbers of students, administration (including being head of a geology department for 14 years, and an exponential increase in bureaucracy over the last decade) and serving the scientific community on the councils of scientific societies and as editor. I started to write this book in 2003 during my final year of employment. I retired in September 2003 and since then I have had the advantage of more time for reading and research and freedom from most other duties.

My 1973 book was based on living distributions and I believe that worked well. However, in the 1991 book in addition to data on living I included data from dead and total (live plus dead) assemblages. I now think that was a mistake for ecological relationships can satisfactorily be based only on the distribution of live organisms. Foraminifera are sufficiently small that post-mortem transport and even reworking of tests from older deposits can

introduce distributional anomalies that go undetected if live and dead are not separated. Here I have based the ecological discussion solely on data on living (stained) forms. Geologists wish to know what differences arise between the living assemblages and the ones that become fossilised in the sediment. That is most easily addressed by studying the taphonomic processes that affect tests after the death of the organism and those are discussed in Chapter 9. Web Appendix 1 lists references on taxonomy, dead and total assemblages.

An additional aim has been to compile spreadsheets of data on living assemblages and to make them available to other workers and this is being done via the web. Published data from older literature have been entered into spreadsheets. Many authors have kindly responded to my request for electronic versions of their spreadsheets from recently published papers. One thing I soon realised when I started examining the published data tables is how many contain mistakes – particularly of totals not adding up to 100%. No doubt there are some mistakes in the tables presented here but I have tried to cross check everything as much as possible (web Tables WA-1 to WA-219). I have also used a standard set of generic and species names (web Appendix 2). With such a large amount of data, it has been difficult to know how to divide it into manageable portions. Whatever way divisions are introduced, there are always problems because the boundaries are artificial. I have followed the environmental route because it is already known that there are big differences between the major environments. Within specific environments, I have followed a geographical trail from north to south and then from the Atlantic to the Pacific and Indian oceans (see the website for extended versions of some distribution charts in Chapters 4 and 5). Coverage of the literature is up to early summer 2005.

The main focus of the book is on ecology and providing the essential database against which the fossil record can be compared. Because benthic foraminifera are strongly controlled by their environments, all applications of foraminiferal data must involve an understanding of their ecology. In Chapter 10 my aim has been to outline the methodology of the applications and to provide some case studies particularly from the Quaternary and Holocene. It is beyond the scope of the book to include a wealth of examples or to extend back into the Cenozoic or Mesozoic. Those are tasks for others to undertake in the future.

I have had great support from the foraminiferal community which I gratefully acknowledge. Everyone I asked for information, data or samples did their best to help: Elisabeth Alve (Norway), Joan Bernhard (USA), Martin Brasier (England), Alex Cearreta (Spain), Thomas Cronin (USA), Jean-Pierre Debenay (France), Henko de Stigter (The Netherlands), Paula Diz (Spain), Robin Edwards (England), Sue Goldstein (USA), Bruce Hayward (New Zealand), Silvia

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In addition, I have received great help from the Natural History Museum, London, for access to collections (Clive Jones) and libraries (John Whittaker). The National Oceanography Centre, Southampton, has kindly provided office space, technical support (Barry Marsh, Richard Pierce, Elaine Watson, Daphne Woods) and access to IT and library facilities.

Finally, it is a pleasure to record my gratitude to my father, William Murray, Elisabeth Alve and John Whittaker for their continued support and encouragement to write this book. Elisabeth and John have provided both stimulating discussion and valuable advice on structure and content. Juliette Topping has been immensely helpful with entering data into spreadsheets, checking citations of references, figures, tables, etc. Elisabeth and Juliette also read the entire draft and offered valuable comment. Small sections were also read by Ben Horton (USA), Marty Buzas (USA), Bob Jones (BP) and John Whittaker (UK). I also gratefully acknowledge a two-year Leverhulme Emeritus Fellowship in support of the research. I have thoroughly enjoyed writing this book and especially the luxury of doing so without carrying out a full-time job at the same time. I hope it will be useful to readers!

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