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GUPTA, BARUN K. SEN [ED.]. 1999. **Modern foraminifera.** Kluwer Academic. xi + 371 p. US$185. ISBN 0-412-82430-2.

Foraminifera are a prolific group of protoctistans that secrete shells (commonly referred to as tests) of calcite, aragonite, opaline silica, organic matter, or foreign particles. For many researchers less familiar with these marine organisms, they are an ever-present component of shallow and deep-water benthic as well as neritic and oceanic planktonic communities. But for those who study these organisms, they represent an invaluable source of ecological, environmental, and climatic information about modern and past oceans. Although the observation and study of modern foraminifera can trace its ancestry back to Leeuwenhoek in 1700, it is only during the past 50 years or so that the biological and geological significance of modern lineages were truly appreciated. During the last 20 years there has been an explosion of publications about foraminifera from an amazing variety of disciplines: basic cell biology, algal symbiosis, biomineralization, biogeography, ecology, pollution, chemical oceanography, geochemistry, paleoceanography, and geology. This book summarizes contributions by leading researchers in these diverse fields. It is not just another text on the biology of foraminifera. Rather, Barun Sen Gupta has accomplished his objective to ''write an advanced text for university students that would also serve as a reference book for professionals.''

The book begins with a modified version of Loeblich and Tappan's (1987, 1992) taxonomic treatise. This brief yet comprehensive treatment (modern and fossil, benthic and planktonic) down to the Family level is a valuable overview of a complex subject. The biology of foraminifera has been covered in detail in previous texts on benthic (Lee and Anderson 1991) and planktonic (Hemleben et al. 1989) species; thus, the two general biology chapters in the present book can be brief. Nevertheless, the discussions of cell biology, trophic and feeding strategies, test morphogenesis and shell structure, and life cycles are informative and easy to read. They are also well referenced and contain numerous line drawings that are supported with light and electron micrographs. The focus here is on benthic species, but the discussions are broadly applicable to the group as a whole (Hemleben et al. [1989] is available if specific information on planktonic species is required).

The foundation of foraminiferal ecological studies is biogeography; the distribution of organisms, present and past; and the historical and ecological processes that cause these distributions. Biogeographic studies of this group have been extremely rewarding, resulting in some of the earliest reconstructions of climate change in the Earth's recent past (McIntyre et al. 1976). Two chapters in Gupta's book review the biogeography of benthic and planktonic foraminifera, providing both a historical overview of the literature and an examination of recent research linking morphologic variability (e.g., coiling direction and porosity) to environmental parameters such as temperature, salinity, and nutrients. Temporal (both seasonal and geological time scales) and spatial (micro- to mesoscale) distribution patterns are discussed from the context of modern speciation and ocean circulation. A third chapter reviews research on algal symbiosis in benthic and planktonic species, linking basic aspects of calcification, productivity, and photosynthesis with more novel studies on the effect of elevated ultraviolet radiation and greenhouse gas–induced changes in ocean chemistry. There is also a very readable chapter on data analysis methods, ranging from common regression analysis through cluster analysis, eigenvector techniques such as principal component analysis and factor analysis, to multidimensional scaling and discriminant function analysis.

Foraminifera are found in nearly every benthic environment, from coastal marshes to the abyssal plains of the deep ocean. Five chapters review the macro- and micro-scale distributions of these organisms, including discussions of specific habitats (e.g., salt marshes, coral reefs, sea grass beds) and the properties (e.g., carbon flux, oxygen concentration) that control the vertical distribution and abundance of species within the sediment and water column. These chapters are rich with data from up-to-date field studies and reprinted figures from the primary literature. Given the current interest in life in extreme environments, I found the information on foraminifera of oxygen-depleted and polluted environments particularly stimulating and ripe with future research ideas.

Paleoceanographers use the trace element and stable isotope composition of foraminifera shell calcite to reconstruct past oceanic temperatures, continental ice volume, salinity, productivity, ocean circulation change, nutrient concentration, and pH (to name only the more common applications). These data also provide some of the most compelling clues about the ecology (e.g., depth distribution, temperature tolerance, seasonality) and physiology (e.g., symbiosis, respiration) of extinct taxa. The final chapters in this book explore the environmental and physiological parameters that control $\delta^{18}O$ and $\delta^{13}C$ and trace elements such as Mg, Ba, Cd, Sr, F, $^{10}B/^{11}B$, U, V, Li, $^{87}Sr/^{86}Sr$, and $^{143}Nd/^{144}Nd$ in shell calcite. The figures and summary tables in this section of the book are very valuable, and I was particularly pleased to see a section devoted to new frontiers in trace element paleoceanography.

Unfortunately, the publisher has priced this book out of reach of most researchers. This is frustrating and a shame because the editor and contributing authors have done an outstanding job, and the book is worth reading and owning as a reference. Despite this marketing flaw, I strongly recommend it to anyone interested in the foraminifera.

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