to eat their more fleet presumptive prey, rather than to eat other animals or berries. Increased tooth wear in ungulates during this adaptive gap implies greater survival to old age and appears to clinch Bakker's argument. But one hopes that the silica content of food plants was constant over millions of years. Nonetheless, these authors dare to tread where others do not, and their papers may consequently prove to be among the most influential in this volume.

Finally, *Coevolution* is unusual in providing both predictive and critical overviews from both the community and phylogenetic perspectives. Geerat Vermeij notes that marine mutualisms are most frequent where nutrients are chronically limited, pointing the way toward productive tests of cost-benefit models of coevolution. Gordon Orians and Robert Paine find remarkably little evidence of community-wide coevolution. Terrestrial plants do show parallel morphological and physiological adaptations to the physical environment, but species diversities in similar environments in Chile and the United States are not convergent. Convergence of form and function is also independent of taxonomic representation in the marine realm; the closest Chilean equivalent of a dominant mussel of the Pacific Northwest is a tunicate. Nowhere is it more evident that we can predict only the general features of adaptation, not the details. Daniel Simberloff notes that most investigations of competition fail to test alternative hypotheses and consequently amount to confirmation by plausibility argument. This issue is contested (see *Science*, 12 and 19 August 1983), but ominously few competition studies actually do document the limiting shared resources required for competitive exclusion or character displacement. Tests with animals that eat foods that are hard to sample (such as birds that eat insects) are frustratingly equivocal. Perhaps direct tests will be more instructive with measurable resources, such as light, space, or mineral nutrients. Last, Charles Mitter and Daniel Brooks chart parallel evolution with the perspective that only comparative analysis can bring. They find clear evidence that some nematodes undergo parallel speciation with their hosts, but no evidence that insects consistently speciate with their food plants. The general message is that we must find ways of distinguishing diffuse coevolution from facultative adjustments of one organism to another, and more important we must discover how to predict when each will occur.

Overall, the editors and contributors should be proud of *Coevolution*. It lifts the discipline from anecdote and speculation and sets a thoroughly scholarly standard of criticism, explores the common ground of an enormously diverse set of phenomena, maps the path for significant future work, and takes a large step toward forging the synergism between theory and practice that fashions science out of a collection of phenomena and ideas. The book should be read in its entirety. It will mark a turning point in our understanding of some of the most fascinating processes in nature.

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Microfossils

Neogene Planktonic Foraminifera. A Phylogenetic Atlas. JAMES P. KENNETT and M. S. SRINIVASAN. Hutchinson Ross, Stroudsburg, Pa., 1983 (distributor, Van Nostrand Reinhold, New York). xviii, 265 pp., illus. $36.50.

Planktonic foraminifera are the most widely used fossils for paleoclimatic, paleoceanographic, and biostratigraphic interpretation of the last 150 million years of geologic history. They have made possible detailed correlation of marine sedimentary rocks worldwide, so that global climatic and oceanographic syntheses can be attempted for a variety of geologic times. They also have what is most likely the best documented fossil record of any animal group; it has tremendous potential in evolutionary and paleobiological studies. Such studies, however, have come slowly because workers on the group have largely been busy using them in geologic applications and because paleobiologists and evolutionists have been unaware of this potential. All these enterprises will be made much easier with the publication of this book.

Although planktonic foraminifera first evolved in the Jurassic and radiated in the Cretaceous, their evolutionary history is marked by three major extinction episodes—in the mid-Cretaceous, at the Cretaceous-Tertiary boundary, and near the Eocene-Oligocene boundary. This book deals with the genera and species that evolved in the 22 million years following the last extinction. The separation of the Neogene forms is thus quite natural.

The book is divided into two parts: a 15-page biostratigraphic section and a taxonomic section. In the first section are brief discussions of classification and of various biostratigraphic zonations. These are fairly standard treatments, but there is bound to be quibbling over details anyway.

In plankton biostratigraphy, the concept of stratigraphic "datums" has been widely and successfully used. A datum is either the first evolutionary appearance or the extinction of a taxon. The use of datums brings chills to dedicated biostratigraphers practicing on other groups where overlapping geologic ranges of species are regarded as the most, or only, reliable stratigraphic markers. Particularly galling will be the use of the last appearance of a species. How can you ever be sure your particular occurrence represents the last one worldwide? Ordinarily you cannot be sure, but in the very complete deep-sea sections usually dealt with by plankton people other means (paleomagnetism, radiometric dates, isotope stratigraphy, and comparison with other groups of fossil plankton) have empirically shown many datums to be isochronous. Such datums work in plankton biostratigraphy because plankton live in some of the most widespread environments on earth. The tropical water masses, for example, are very uniform compared with benthic environments, and they have been interconnected worldwide for most of the Mesozoic and Cenozoic. Water characteristics do vary, of course, but mostly in a north-south direction. Thus different zonations and datums have been recognized for tropical, transitional, and temperate waters, as shown in this book. Planktonic foraminifera work well in these waters, but because of low species diversity they are not so useful in subpolar and polar seas.

The "Phylogenetic Atlas" makes up the majority of the book. It contains careful diagnoses and nicely done scanning electron micrographs of 150 species in 33 genera and subgenera. These are the important species in the view of Kennett and Srinivasan. Synonyms are listed and cross-referenced in a taxonomic index. Phylogenies, shown for all species, are inferred from morphologic similarities and stratigraphic occurrences, but no reasons are usually given for making such evolutionary connections. Although there will be argument about some of these, the relationships are probably mostly correct, for the authors have been studying the Neogene successions for many years and have a good feel for them.

The atlas is the basis for all other work

of any sort on Neogene planktonic foraminifera. The book must lie within easy reach of a specialist's microscope. And it is designed to be used—plenty of room is left to insert notes and update material. This book will be a new starting point for planktonic foraminiferal studies, and no one will be able to work in Neogene biostratigraphy, paleoceanography, paleoclimatology, biogeography, or, one hopes, evolutionary studies without it.

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Fertilization

Mechanism and Control of Animal Fertilization. JOHN F. HARTMANN, Ed. Academic Press, New York, 1983. xii, 563 pp., illus. $69. Cell Biology.

Several excellent reviews on various aspects of fertilization have appeared in the past decade, but this book is the most complete work on the subject since the now classic two-volume treatise, *Fertilization*, edited by Charles B. Metz and Alberto Monroy, was published in 1967.

Has much progress been made in research on the mechanism of sperm-egg interaction and early embryogenesis since 1967? The answer is definitely affirmative. During the past 16 years, and especially in the last eight years, there has been an explosive expansion of our knowledge of the biochemistry and cell biology of gamete interaction and the activation of embryonic development. Today there are more researchers working on fertilization-related problems than at any time in the past. The major underlying reasons for this expansion are the development of microanalytical techniques of biochemistry and immunology that permit analysis of the small number of eggs obtainable from mice and other mammals and the great interest in the fertilization of human eggs in vitro.

The first four chapters deal with biochemistry and macromolecular synthesis during mammalian oogenesis (P. M. Wassarman), spermatogenesis (A. R. Bellvé and D. A. O'Brien), the egg zona pellucida (B. S. Dunbar), and the capacitation reactions of sperm (E. D. Clegg).

Although most basic discoveries of the mechanisms of animal fertilization have utilized the gametes of marine invertebrates such as the sea urchin, only two chapters are devoted to invertebrate fertilization. Chapter 5 (S. S. Shen) reviews the electrobiology of sea urchin and echiurid eggs, covering both the properties of the egg membrane and the roles of intracellular ion fluxes in the activation of embryonic development. This is a valuable contribution because the clarity of writing and organization make what some find a difficult subject easy to understand. Chapter 6 (A. C. Lopo) summarizes knowledge of sperm-egg attachment in sea urchins and other invertebrates such as decapods and ascidians. The emphasis is on the mechanism of induction of the acrosome reaction and the description of the proteins of the sperm plasma membrane, the acrosome granule, and the egg surface that mediate surface recognition between the gametes.

Chapter 7 (J. F. Hartmann) returns to mammals, describing the process of gamete interactions, especially the different types of sperm-egg adhesions observed in vitro. Although chapter 4 deals exclusively with sperm capacitation, chapters 7 and 10 go into some depth again on this subject, creating some overlap and redundancy. Chapter 8 (E. D. Schmell, B. J. Guylyas, and J. L. Hedrick) compares the surface alterations and blocks to polyspermy in eggs of sea urchins, frogs, and mammals. The roles of the structural proteins and enzymes of the egg cortical granules are considered in depth. This is an excellent comparative analysis of polyspermy prevention in these three animal groups. Chapter 9 (D. J. Wolgemuth) summarizes all available information on changes in gamete pronuclei and macromolecular syntheses known in eggs of the mouse, rat, hamster, rabbit, and human. The final two chapters, on gamete interactions in the female (H. D. M. Moore and J. M. Bedford) and sperm and egg transport in the female (J. W. Overstreet), would be the most interesting ones for clinicians entering into human in vitro fertilization.

The only negative features of the book are the dearth of illustrations in some chapters and the poor quality of reproduction of some micrographs. Two chapters on invertebrates do not go well with the nine on mammals; chapters on embryo transfer and human fertilization in vitro would have been better choices.

On balance this is a worthwhile book. The reference lists are up to date and extensive, and the index is fairly complete. The book will be an excellent reference source.

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