lated problem is Bromley's uncritical acceptance and portrayal of the concept of gardening in modern and ancient settings. Despite assertions, in no case has the collection of macrophytic material in burrow linings or the stimulation of microbial activity adjacent to burrows been shown to have energetic importance to the host. Until such an energetic link is demonstrated, gardening will remain a tantalizing, but unsupported notion. The final problem is the introduction of the concept of ichnoguilds. I don't think it will be possible to assign various trace fossil types to a given ethology with enough assurance to make this concept worthwhile.

There are many highlights of this book, although I discuss only a few. As mentioned previously, this book provides the first summary of the concept known as tiering, whereby different traces are produced at different depths within the sediment. This is a relatively novel concept in ichnology and its importance cannot be overstated. Bromley's discussion of tiering in chapters 6 and 11 and the ramifications of tiering in the fossilization potential of traces (chapter 7) admirably covers findings to date. My hope is that this exposé will stimulate benthic ecologists to look deeper into the sediments so that we may learn more about the deep-dwelling animals whose activities make up so much of the trace fossil record. There is also a good discussion of ichnofabrics (aka bioturbate textures) and their utility in core-based studies. Finally, through its focus on the biology of trace fossils, this book points out many of the overgeneralizations rampant in paleoichnology. For example, not all dwelling structures are made by suspension feeders, nor does complete bioturbation always result in complete homogenization of the sediment. These points are valuable and this book has many others worth discovering.

In summary, this book has much to offer both of the aforementioned audiences. For the student of modern animal-sediment relations, it is by far the most readable and up-to-date discussion of tracks, trails, and burrows and how they become trace fossils. There is a wealth of natural history information that would be of use to modelers. For the rock-based ichnologists, the book provides an update of progress since the early 1980s and makes the necessity of studying or at least reading about modern processes abundantly clear. The book should foster greater communication between the two groups and that in itself will be good. I recommend this book to anyone interested in animal-sediment relations in modern and ancient environments.

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References

CARNEY, R. S. 1981. Bioturbation and biodeposition, p. 357–399. *In* A. J. Boucot [ed.], Principles of benthic marine paleoecology. Academic.

EKDALE, A. A., R. G. BROMLEY, AND S. G. PEMBERTON. 1984. Ichnology: Trace fossils in sedimentology and stratigraphy. Soc. Econ. Paleontol. Mineral. Short Course 15.

FREY, R. W. [ED.]. 1975. The study of trace fossils. Springer.

LOPEZ, G., G. TAGHON, AND J. LEVINTON [EDS.] 1989. Ecology of marine deposit feeders. Springer.

MCCALL, P. L., AND M. J. S. TEVESZ [EDS.]. 1982. Animal-sediment relations. Plenum.

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CAPRIULO, G. M. [ED.]. 1990. **Ecology of marine protozoa.** Oxford University Press, New York. 366 p. $98.00. ISBN 0-19-504316-2.

Most workers in the aquatic sciences are aware of the explosive growth which the field of marine microbial ecology has undergone in the past 15 years. Studies on protistan ecology have been an integral part of this growth. In 1980, the NSF Biological Oceanography Section funded only three projects focusing on marine protozoa; in 1990, 19 such proposals were funded (from project titles supplied by M. R. Reeve). There is now a great deal of data on the activities and fates of heterotrophic protists—the subject of this timely book.

"Marine protozoa," as defined in this book, denotes forms that are either heterotrophic or mixotrophic. These are now known to be part of virtually every marine community from sea ice to hydrothermal vents. However, marine protists are far from a homogeneous group. Protistan guilds are usually composed of morphologically and phylogenetically diverse forms, while closely related species can have very different trophic roles. Summarizing the existing knowledge of marine protozoa would be an extremely useful but daunting task, and indeed *Ecology of marine protozoa* does not pretend to serve as a comprehensive review of the now considerable literature.

Instead, this multiauthored volume presents itself as a general overview of the ecology of marine protozoa (with the only overt omission being coverage of parasitic forms). The book is aimed at research scientists outside the field of microbial ecology and is also intended to serve as a text for advanced undergraduate or graduate students. The book contains much useful information but falls far short of providing a general summary.

The first chapter, by J. J. Lee and G. M. Capriulo, is entitled "An overview" and provides thumbnail sketches of the classification, morphology, and basic biology of the major groups of marine protists. P. L. Steinbeck and R. E. Casey wrote the second chapter on the ecology and paleoecology of Foraminifera and Radiolaria; it is a substantial part of the book (92 of 341 text pages). As the chapter title indicates, it is slanted toward the biology (which is mainly biogeography) of extinct forms. For this reader, who works on trophic relationships, the chapter was a very nice introduction to paleoceanography. The third chapter, by B. Zeitzschel, is titled "Zoogeography of marine

protozoa: An overview emphasizing distribution of planktonic forms"; however, a more accurate title would be "Marine biogeography: An overview emphasizing foraminifera, radiolarians, and tintinnids." Zeitzschel appears to have made a valiant attempt to differentiate his chapter by including a lot of material on general marine biogeography but, with the exception of a short section on tintinnids, much of the material presented on protists is drawn from the same sources as the preceding chapter!

The fourth chapter, "Feeding-related ecology of marine protozoa" is written by the editor of the book. This chapter contains many valuable tables summarizing what is known about marine protistan feeding, but some of them are not adequately referenced, making it difficult to find the source of the data. Readers should be aware that references to freshwater organisms are made without identification as such. This chapter would be much easier to use, as would some of the others, had the major headings and numerous subheadings been listed in the table of contents. Little or no general discussion will be found on mixotrophy, chemotaxis, or niche separation.

Protistan nutrition and growth (by J. J. Lee), nutrient regeneration (by D. A. Caron and J. C. Goldman), and respiration and metabolism (by D. A. Caron, J. C. Goldman, and T. Fenchel), are treated in three separate chapters. Although it might have been preferable to have a single chapter on protistan metabolism, there is surprisingly little overlap between these chapters, and the sections on nutrient regeneration, respiration, and metabolism are well-organized and provide fresh insights into old questions (size-specific nutrient regeneration rates).

In between the chapters on nutrition and nutrient regeneration is one entitled "Food quality and microzooplankton patchiness: An automata model" by H. A. Rubin and J. J. Lee. It is an interesting presentation of a model of ciliate populations in environments with foods of low and high nutritional values with various spatial distributions.

The last chapter is on symbiosis by F. J. R. Taylor. This topic is of enormous interest from both ecological as well as evolutionary perspectives and though the review is quite brief (14 p.), it does provide a good introduction to the literature (up to 1987).

The book ends with a glossary by A. J. Repak, followed by an incomplete index. The glossary will be valuable to many readers but does contain some cryptic comments. For example, "bacterivore: ingester of bacteria from a given environment; no indication of nutrient value." The index lists many, but certainly not all, of the organisms mentioned in the text and tables.

Given that some major ecological topics such as niche separation are barely mentioned and others are completely omitted (to the point where they do not even appear in the index, e.g. diversity, succession, competition), I think that readers seeking a general overview of marine protistan ecology would find either Anderson (1988) or Fenchel (1987) much more useful. However, for specific topics, some chapters give very good reviews, going beyond summarizing existing (up to early 1988) data and providing some original insights. Overall, I would hope that libraries will purchase this book as its does contain useful compendia, but I believe most individual researchers would find it to be of limited value.

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References

ANDERSON, R. O. 1988. Comparative protozoology. Springer.

FENCHEL, T. 1987. Ecology of protozoa. Science Tech.