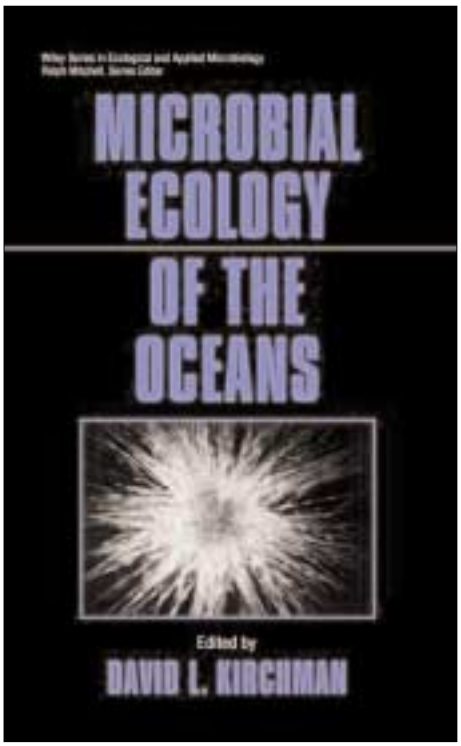
Book Review

A sea of microbes

Microbial Ecology of the Oceans
edited by David L. Kirchman
Wiley-Liss, 2000.
$139.00 hbk (ix + 542 pages)
ISBN 0 471 29993 6



Life on earth probably originated in the sea, and over the past 3.5–4 billion years, selection and evolution have produced a diverse and well-adapted marine microbial assemblage. Although the discovery of oceanic microorganisms dates back to 1677, with van Leeuwenhoek's path-finding discovery of 'little animalcules in rain, well, sea and snow water', the first ecological studies were not conducted for another 200 years, when A. Certes, B. Fischer, H. Russell and other pioneers posed the question 'Does the sea contain an autochthonous population of microorganisms?' In a thoughtful essay entitled 'Pasteur's dilemma – The road not taken', René Dubos contrasted the two fundamentally different subdisciplines of microbiology, namely pure-culture study and ecology. He concluded that 'the most creative processes emerge from the integration of complex systems, rather than from the analytic breakdown of their component parts', a call-to-arms for the ecological study of microorganisms.

This new book, *Microbial Ecology of the Oceans*, edited by David L. Kirchman, captures – perhaps for the first time – the excitement and importance of this intersection of oceanography, microbiology and ecology. The contributing authors list is a veritable who's who in the field today, none of whom fail to deliver an authoritative and thought-provoking account of their assigned topic. The chapters in this book are of more-or-less equal length and technical level, and each is organized with a very helpful summary of the key points and a largely up-to-date reference list. There is also an excellent user-friendly index. However, the quality of the graphics is spotty and I was somewhat disappointed by the lack of color plates and, especially, by the lack of photomicrographs (chapters by Dave Caron, Hans Paerl and Jon Zehr are notable exceptions). The microscope is still, in my opinion, the most important tool in microbiology. The publisher's website for this book (http://www.wiley.com/kirchman) could have been used to a much greater advantage for the display of supplementary materials. In my view, a few chapters seem out of place, given the full spectrum of topics presented. For example, I would have moved the Paul del Giorgio and Jonathan Cole chapter closer to the beginning, and would have placed Douglas Capone's review of the marine nitrogen (N) cycle ahead of the two more specialized chapters on nitrogen fixation (Hans Paerl and Jon Zehr) and nitrification (Bess Ward). However, these are mostly minor matters that do not distract from the very high intellectual quality of the individual contributions.

The book does, in my opinion, have a few omissions and other deficiencies. In this regard, it is imperative to emphasize that no single volume on this subject, no matter how carefully conceived and prepared, could be expected to cover the entire field adequately. Several companion volumes – perhaps even with identical titles – would need to be prepared to provide a full, detailed account of microbial ecology of the oceans. Nitrogen (N) is a key macronutrient for all living organisms and, in the marine environment, is usually considered to be the growth and production rate-limiting nutrient. Furthermore, the marine N cycle is largely sustained by microorganisms; it is therefore not surprising that ~20% of the book is devoted to N, including three complete chapters out of 15. Other essential macronutrients, such as phosphorus, and essential trace elements are not adequately covered. Also absent is information on sampling and subsampling the marine environment, physical–microbiological interactions, marine microbiological controls on greenhouse-gas production and the role of climate variability on the distribution and abundance of microorganisms in the sea. These are, in my opinion, key contemporary topics in microbiological oceanography. By my account, metazoans were not even mentioned until page 354, even though certain groups (e.g. larvaceans) can exert an important top-down grazer control on microbial populations. There are very few depth profiles, no time-series data and no basin or global scale plots of key microbiological parameters. Capone's chapter on the N-cycle is the exception in its presentation of conceptual paradigms, global patterns and even a paleoceanographical perspective. Finally, a primer of the key 'first principles' of oceanography, microbiology and ecology that form the foundation for the study of the microbial ecology of the oceans would have been helpful. If used as a textbook, then the course will need to be supplemented with additional reading materials.

The present volume has a deliberate and acknowledged focus on heterotrophic bacteria in the upper euphotic zone, and on this promise the book delivers 110%. I personally think that it is a mistake to separate autotrophic and heterotrophic processes, and it is somewhat ironic that the book's cover is adorned by a N_2-fixing photoautotroph – *Trichodesmium*. The excellent chapter by Mary Ann Moran and Richard Zepp on UV and visible light effects on microorganisms and dissolved organic matter documents one area where autotrophy and heterotrophy cannot be divided. Furthermore, it is possible, even probable, that many open-ocean microorganisms are mixotrophic, deriving part of their energy from light and part from reduced organic or inorganic

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compounds. This, in my view, is the *pièce de résistance* of marine microbial ecology.

In the well-prepared introductory chapter, Kirchman and Peter J. le B. Williams review the most significant benchmarks in this discipline. It is remarkable how far and fast the field of marine microbiology has evolved since ZoBell's classic monograph[1], or even since the conceptualization of the microbial loop[2], but much still remains to be done. For example, our initial enthusiasm about the importance of the microbial food web as a subsidy to photosynthesis has been tempered by more realistic estimates of bacterial growth efficiencies (~15% vs >50%). However, it is still unclear whether heterotrophic bacteria represent an ecological 'link' or a carbon and energy 'sink', in the parlance of Larry Pomeroy. As Williams laments in his provocative chapter, our conceptual view of dissolved organic carbon dynamics is 'far from tidy'. Mass balance must be achieved, as there is no room for vitalism.

In summary, Captain Kirchman and his able crew have steered a very successful course of new discovery. The product is a wonderful and informative book that will serve as an invaluable resource for students and practitioners. It is a must for all professional biological oceanographers, marine microbiologists and other aquatic scientists.

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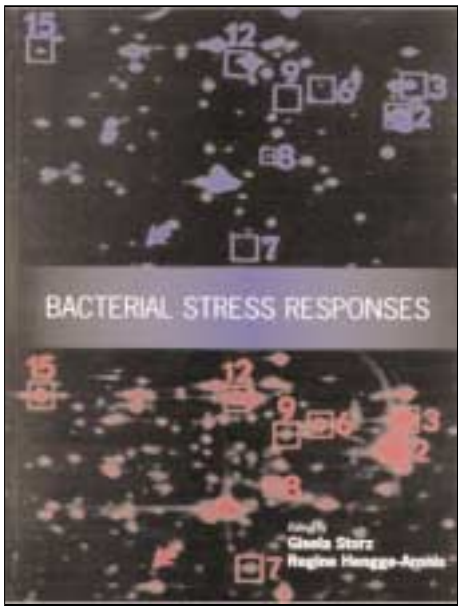
References

1 ZoBell, C.E. (1946) *Marine Microbiology: A Monograph on Hydrobacteriology*, Chronica Botanica Company, Waltham, Massachusetts
2 Pomeroy, L.R. (1974) The ocean's food web: a changing paradigm. *BioScience* 24, 499–504

Stressed out?

Bacterial Stress Responses
edited by Gisela Storz and
Regine Hengge-Aronis
ASM Press, 2000.
$109.95 (hbk) (xv + 485 pages)
ISBN 1 55581 192 2

Any change in lifestyle induces stress in us all. Bacteria are no exceptions to this in



the many diverse and changing habitats in which they live. Stress is very difficult to define in bacteriological terms, as can be seen by the collection of reviews brought together in *Bacterial Stress Responses*. Really, any environmental change that results in an adaptive response can be included. It is obvious that, within this nebulous field, great insights into the lives of bacteria have been gained in recent years. The editors have been able to cherry-pick topics, all of which are of specific yet general interest. There are five main themes: specific responses, general responses, pathogenicity, life in a stressful environment and applications.

Given the nature of research, many of the chapters are centred on *Escherichia coli*, but give a broader analysis of other organisms. All of the chapters are succinct, up-to-date reviews of individual topics and will be very useful as reference material. It is likely that most readers will turn straight to specific chapters and not read the volume as a whole. This will unfortunately result in some of the inter-relationships between topics being lost. In order to circumvent this, an overview of each theme, to set the scene and pull out common strands, would have been beneficial.

This volume is timely in the fact that perhaps this is the last moment when so many stress-related topics could be adequately covered in a single volume of this type. We are quickly moving into a new era, with the ability to look at whole-organism responses. This is, of course, based on advances such as the completion of entire genome sequences and the development of robust technologies to determine protein profiles and gene expression on a genome-wide basis. It would have been useful to have had more of an analysis of the available and emerging technologies, in one section, to enthuse readers of what is to come.

The solid understanding of physiology and molecular mechanisms in many areas portrayed in this book gives a firm basis on which to begin to elucidate complex systems. Common sense dictates that all aspects of the life of an organism are inter-related to allow it to coordinate the transduction of a myriad of environmental signals and make an appropriate response. In fact, a glance at the index shows how many components are mentioned in more than one chapter. From now on, as well as understanding specific facets of bacterial life, we have the possibility of beginning to build up a picture of the response of an organism as a whole. The current volume sets the scene and will be enjoyed by those interested in particular topics. Also, those who read the entire volume will find it extremely rewarding, as it gives an insight into the amazing complexity of responses available to bacteria.

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Book reviews

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