

Microbial Ecology of the Oceans

Second Edition

David L. Kirchman, Editor, John Wiley & Sons, Inc., 2008, 593 pages, ISBN 047004344X, Hardcover, \$100 US

REVIEWED BY LAWRENCE R. POMEROY

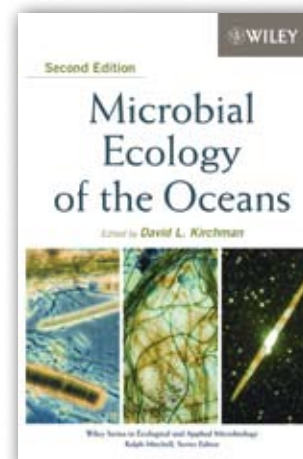
For much of the twentieth century, marine microbial ecology was considered to be a minor and relatively unimportant aspect of oceanography. A lack of appropriate methodology led microbiologists to believe that bacteria were not abundant or particularly active. That view began to change with the development of an improved method for counting marine bacteria (Hobbie et al., 1977), which showed them to be much more abundant than conventional methods had suggested. Research accelerated after publication of a method for measuring bacterial secondary production (Fuhrman and Azam, 1982) and of a sensitive method for measuring microbial respiration in the ocean (Williams and Jenkinson, 1982). Data gathered with these improved methods left no doubt that bacterial growth and respiration constituted a major carbon flux in the ocean.

Development of the field was then so rapid that textbooks and general overviews did not at first catch up. David Kirchman filled that void with the first edition of this book, published in 2000, consisting of a collection of critical reviews by experts in various aspects of marine microbial ecology. This second edition is a new and largely different book, with many chapters devoted to

what is now the third stage in the evolution of marine microbial ecology—the genomics revolution. Many marine Bacteria, Archaea, eukaryotic algae, and Protozoa have never been seen or cultured although, as several chapters tell us, their DNA has been isolated, digitally assembled, and interpreted. We know many attributes of these unseen organisms that we would not learn by actually seeing them under a microscope.

Advances in microbial ecology continue to be technology dependent. Many obvious questions have remained unanswered until very recently because methods did not exist for research on very small organisms that are highly dispersed in the sea. Much of that deficiency has now been redressed by a growing number of marine microbiologists who are following the lead of the pioneers cited above. Both editions of Kirchman's book are about concepts and data, but methods, and remaining problems with them, are thoughtfully discussed. What makes the second edition such a different book is the wealth of new information and insights achieved through advancements that have occurred in just one decade. That progress is, in part, a result of the new methodology of genomics, which is a minor element in the first edition and a major one in the second, not only in the chapter devoted explicitly to genomics but in many others as well.

In the second edition, "microbial" takes on its true meaning, with more chapters now devoted not only to bacteria but also to the picoeukaryotes,



both heterotrophic and autotrophic (i.e., protozoans and picophytoplankton). Several chapters discuss a potentially self-contained microbial food web with prokaryotic and eukaryotic autotrophs being consumed by heterotrophic protists, something that is conceptually significant for our understanding of the origins and fate of the ocean's photosynthesis. These developments are part of a more general shift from the mid-twentieth-century research focus on average rate processes of microbial communities to a focus on species, or phylotypes, and interactions at the species level. The authors of several chapters discuss interactions that we would call natural history if they were applied to macro-organisms, but at the microscopic level, questions of who eats whom include a focus on dissolved materials and biochemistry. The fact that we are capable of describing and understanding events at the level of marine microorganisms—not just at the birds and bees level—is perhaps one of the simplest and best metrics of the progress in microbial ecology.

Some of the chapters of the first edition have been revised for the second, but most are replaced, as Kirchman says in the preface, not because they are

obsolete but because little has changed in those areas, while new areas have developed. He therefore recommends owning and reading both editions. Indeed, that is necessary for a full overview of the field. Only in the first edition are there chapters on bacterial production, bacterial energetics and efficiency, food webs, top-down effects, and limiting inorganic nutrients.

Because textbooks dealing specifically with modern marine microbial ecology have not yet been published, Kirchman's first edition appears to have found some use in graduate courses in oceanography and marine biology. Recognizing that application, the writers have included boxes throughout the second edition in which terminology is defined and

concepts explained in simple language. Those additions are only minimally helpful, and they do not make it a textbook. The book is highly detailed and somewhat redundant, owing to the many authors, and it is not organized in a helpful way for a student. Important subjects are covered only in the first edition, so the student needs to read most of the 1100 pages in the two books. Let us hope that the race is on to publish the first real textbook for marine microbial ecology. However, for the biological oceanographer, who already understands the jargon, this book and its predecessor are valuable, critical overviews of the state of marine microbial ecology. They are the best current analysis of a growing and important discipline.

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Oceans Past: Management Insights from the History of Marine Animal Populations

Edited by David J. Starkey, Poul Holm, and Michaela Barnard, Earthscan Research Editions, 2007, 223 pages, ISBN 978-1-84407-527-0, Hardcover, \$127.00.

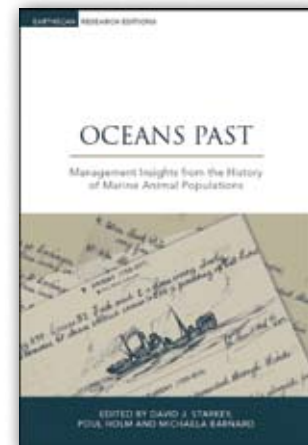
REVIEWED BY MICHAEL J. FOGARTY

History teaches us that men and nations behave wisely once they have exhausted all other alternatives.

—Abba Eban, Israeli Foreign Minister, London, 1970

If we could be transported back through time, would we recognize the structure of ocean ecosystems through the prism of their current state? What have we lost and to what degree might we be able to

restore their potential? Historical narratives and descriptions of both natural history and the abundance of marine animals paint a vivid (if fragmented) picture of ocean ecosystems that extend back over millennia. Centuries-old chronicles of early explorers traveling to the New World include numerous tales of the untold bounty of the seas. Historians recognize, however, that it is necessary to treat such descriptions with some care. Were some written to attract investors in fishing and trading enterprises, others to attract settlers to uncharted lands? The History of Marine Animal Populations (HMAP) project of the Census of Marine Life (CoML) program seeks to complement anecdotal reports and historical records with careful analysis of sources



such as logbooks of whaling and fishing vessels, tithing or tax archives, and the paleo-ecological record to provide more quantitative estimates of marine animal populations of the past. To establish appropriate restoration goals, it is essential to determine the ocean's potential productivity. This analysis would permit establishment of realistic baselines for comparison with existing

states of nature. Only then can we begin to assess whether appropriate goals are being set. The danger is in setting the bar too low by underestimating the production potential of the seas based on recent rather than historical levels.

Oceans Past: Management Insights from the History of Marine Animal Populations assembles ten case studies under the HMAP banner—five dealing with fish and invertebrate fisheries, three treating whale populations and whaling, one examining evidence for the origins of a now common intertidal species in North America, and one providing an international political context for the development of fishery management strategies in the mid twentieth century. In an informative and engaging introductory chapter, Jesse Ausubel lays out the context and rationale for CoML (and HMAP in particular). Editors David Starkey, Poul Holm, and Michaela Bernard then nicely introduce the themes and chapters to follow. Paul Waggoner aptly closes the volume with summary comments in his Afterword.

Although the volume deals with a diverse set of issues, the hallmark of each contribution is careful detective work, often involving multiple lines of evidence. Several general themes can be found in these pages, including the broad impact of human activities on marine ecosystems, the crucial role of human motivations and values in resource use and protection, and the relevance of patterns of expansion and contraction of populations and fisheries in space and time.

Unintended consequences of human activities in the ocean with important ecological effects include the introduction of nonnative species through

shipping. In her chapter, April Blakeslee traces the origins of the common periwinkle (*Littorina littorea*) in coastal regions of the Northwest Atlantic and convincingly argues it was introduced from Europe. Loren McClenachan shows that the rise and fall of the Florida sponge industry not only involved a clash of cultures and technologies but also precipitated a fundamental change in the dominance of microbial communities as the filtration role of sponges was adversely affected by overfishing; resulting disease outbreaks further degraded sponge fields and coral reef systems.

This volume amply demonstrates the power of detailed analysis of fishing and whaling logs and archival voyage records to document spatial and temporal impacts of harvesting. Stefan Claesson demonstrates the power of new data-visualization tools applied to old sources, including maps of New England fishing grounds documented by government researchers at the close of the nineteenth century. The chapter by John Bannister and colleagues charts the global expansion and ultimate contraction of the sperm-whale fishery based on historical archives and whaling logs. Elizabeth Josephson and coauthors examine voyage records assembled by the pioneering oceanographer Matthew Fontaine Maury (who used vessel logs not only to map ocean currents but also to track whale migrations) to trace the rapid decline of the North Pacific right whale population as discrete whaling grounds were sequentially depleted. In their chapter, Tim Smith and colleagues nicely illustrate the need for and the value of critical analysis of whaling records in resolving an apparent paradox in the course of the sperm-whale fishery in the North Pacific.

UPCOMING BOOK REVIEWS

An Introduction to Ocean Turbulence by S.A. Thorpe, Cambridge University Press, 240 pages

Chasing Science at Sea: Racing Hurricanes, Stalking Sharks, and Living Undersea with Ocean Experts by Ellen Prager, University of Chicago Press, 200 pages

Chemical Oceanography and the Marine Carbon Cycle by Steven R. Emerson and John L. Hedges, Cambridge University Press, 453 pages

The Dynamics of Coastal Models by Clifford J. Hearn, Cambridge University Press, 488 pages

Essentials of Oceanography, Fifth Edition by Tom Garrison, Brooks/Cole Cengage Learning, 434 pages

Tides of History: Ocean Science and Her Majesty's Navy by Michael S. Reidy, University of Chicago Press, 392 pages

Inferences on population trajectories are not limited to logbook records. Glenn Jones shows how the information content of historical restaurant menus can be cleverly exploited to infer population change by examining carefully adjusted price information in relation to supply and demand. Julia Lajus reminds us that the field of historical ecology advanced in HMAP initiatives throughout the world has its roots in the developmental work of scientists in Russia and in Scandinavia who carefully sifted through historical sources to better understand changes in fishery resources in the mid nineteenth century.

Underlying every aspect of the human

appropriation of marine ecosystem goods and services are fundamental motivations and values. Just as conservation values held by different ethnic groups involved in the Florida sponge fishery recounted by McClanachan had important implications for sustainability, Matthew McKenzie shows that changes in values and, in particular, loss of a vital connection to the resource were at the heart of the destruction of river herring populations in Massachusetts. Subsistence fisheries providing ecosystem services that touched many aspects of daily life in colonial America were supplanted by a commodity-driven view of river herring as bait for fisheries for other species, and so a deep conservation

ethic was lost. Carmel Finley traces the development of the concept of maximum sustainable yield in the mid twentieth century and attributes its advancement by the United States to broader geopolitical motives.

The chapters in this volume illustrate different stages of development in the application of the HMAP research strategy, some establishing proof of concept with further work to follow, others providing more complete analyses of specific problems. The opportunities to be found in thorough analysis of historical information from very diverse sources are evident throughout. Although the reader does derive a good sense of relative changes in the marine

animal populations examined for the period of record, I think it is fair to say that management lessons to be extracted from these case studies are quite general and often implicit rather than explicit. The tasks of linking these historical reconstructions with contemporary estimates of abundance and of deriving more specific insights into marine resource management remain a challenge for future work.

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Climate Change A Multidisciplinary Approach (Second Edition)

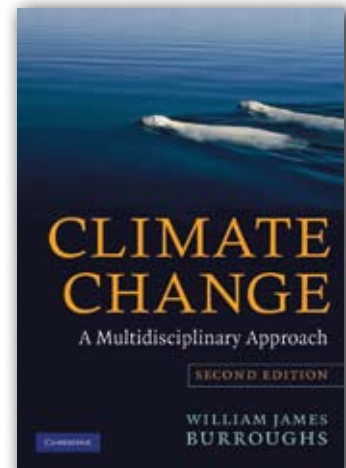
By William James Burroughs.
Cambridge University Press, 2007,
378 pages, ISBN 978-0-52169-033-1,
Softcover, \$55.00 US.

REVIEWED BY RAPHAEL WUST

Climate Change: A Multidisciplinary Approach (2nd Edition) is a thorough compilation of information concerning our current knowledge of climate changes and their implications for society. This book builds upon an earlier volume of the same name also written by William James Burroughs and published in 2001. Since the earlier publication, an enormous array of new information has come online, and the most critical data have been included in this new edition, such as new paleoclimate

data from the European Project for Ice Coring in Antarctica (EPICA) and the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC, 2007, available at <http://www.ipcc.ch/ipccreports/assessments-reports.htm>). The book's chapters have also been rearranged so that the new structure guides the reader through the most basic components of climate and weather to the complexity of statistical concepts and climate models and implications for society as a whole. As such, the book provides a concise understanding of the fundamentals of climate and climate change without confronting the reader with excessive formulas or mathematics.

The book is organized into 11 well-illustrated chapters that include numer-



ous black-and-white photographs and illustrations. Each chapter ends with a summary section and questions related to the individual chapter, most of which encourage deeper thinking. The first chapter is an introduction to the subject of climate change and its complexity. It also differentiates between climate and weather patterns and climate variability versus climate change. The introduction of the time scales and connections

among processes reveals what the reader will confront throughout the book: within our climate system, everything is interconnected, and hence climate analysis depends on how changes in various aspects of Earth's physical conditions and extraterrestrial influences combine over time.

Chapter 2 outlines the main energy factors of Earth's climate—the solar and terrestrial radiation and Earth's energy balance. This chapter covers the basics of the “greenhouse” effect on our globe and the importance of atmospheric composition for the absorption of radiation from both Sun and Earth. Throughout the book, difficulties and limitations of the heat budget, including heat transfers, are clearly outlined and discussed.

The third chapter describes heat distribution, and the elements of climate and their interaction on our planet. It outlines radiation balance and atmospheric and oceanic circulation patterns, including ocean-atmosphere interactions (e.g., ENSO, the El Niño-Southern Oscillation; the North Atlantic Oscillation; the Pacific Decadal Oscillation; thermohaline and meridional overturning circulations; and ITCZ, the Intertropical Convergence Zone). The chapter also describes some of the recent changes observed in ocean circulation patterns and their implications for future climate, such as the slowdown or the “switch off” of the Gulf Stream, and it discusses the current state of the computer models. The chapter's summary emphasizes the importance of understanding the complex links within our climate system and how these elements can be put in context with what is known about past climatic changes.

Chapter 4 illustrates how climate change is measured, beginning with

instrumental records from both land and ocean as well as the more recent satellite data. It presents Arctic and Antarctic sea ice extents, which are dysynchronous, and reminds us to be cautious about using a simplistic “greenhouse” model of our planet. The chapter also explores historical instrumental measurements and proxy records (e.g., tree rings, ice cores, pollen, corals).

Chapter 5 covers statistics and statistical analysis and how climate data can be used to determine climate variability and climate change. In a remarkably simple fashion, the author explains this complex topic, which is absolutely essential in understanding climate change. The chapter first covers the basics of statistics and statistical analysis, including time series, noise, variability and significance, filtering, and smoothing before discussing the important wavelet and multidimensional analyses.

The next four chapters form the heart of this book. They provide the reader with an overview of natural causes of climate changes (Chapter 6) over recent and geological time scales (Chapter 8) as well as human impacts on climate (Chapter 7) and consequences of climate change (Chapter 9). Topics addressed include agricultural consequences during the last few hundred years and recent economic impacts. An interesting discourse on the “hockey stick” debate (Chapter 8) reveals the challenge scientists face in using statistical analysis to reveal climate fluctuations.

The final two chapters cover climate models (Chapter 10) and climate change predictions (Chapter 11). They outline the last decade's progress in the ability of computational powers to simulate future scenarios without neglecting

some of the limitations that still exist in even the best atmosphere-ocean global circulation models (e.g., cloud formation, ENSO behavior, ITCZ). The final chapter concludes with mention of the Gaia hypothesis, and, more importantly, it wraps up with a stimulating comment that is a thread throughout the book: “By taking a wide view of our climate, we may reinforce a sense of wonderment for the immensity and complexity of the Earth's climate.”

Overall, this book is an excellent synthesis of current knowledge of the climate system and past and present climates. It provides solid background information and includes critical assessments of issues that remain incompletely understood. Burroughs also manages to introduce critical thinking with the question section at the end of each chapter. There, it is up to the reader to logically evaluate climate change issues presented daily by the media. This book will become an oft-cited reference for climate researchers and students, and should be essential reading for politicians and managers involved in issues of climate change. The book presents the basics surrounding climate change in a simple way while pointing out the complexity of climate-data collection, processing, and interpretation. Burroughs must be congratulated on this achievement. This new edition gives readers an up-to-date and appealing reference that provides a scholarly foundation for improving our understanding of climate change and its future economic and political implications.

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