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# Oceanography

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## Oceanography and Marine Biology: An Introduction to Marine Science

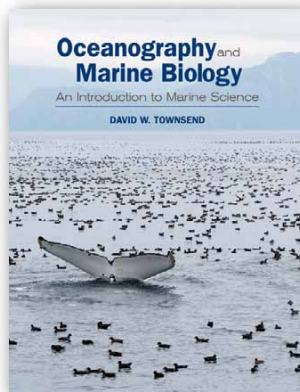
By David W. Townsend, 2012, Sinauer Associates Inc., 512 pages, ISBN 978-0-87893-602-1, \$139.95 US

REVIEWED BY LISA CAMPBELL

As Townsend states in his preface, the goal of this new textbook is “to preserve the basic disciplinary elements and their order of presentation found in most oceanography texts, but to include how it all relates to life in the sea.” He succeeds very well in providing balanced coverage as he leads students on an exploration of the physical, chemical, and geological fundamentals, and follows through with biological processes and organisms.

And, Townsend holds true to his promise of not skimping on the biology. Of the 512 pages (plus appendices) in this book, Chapters 7–15 (~ 50%) focus on biological topics. For comparison, in a typical introductory oceanography textbook (~ 500 pages), the first four chapters are devoted to geological origins and processes, one chapter to chemistry (and some overlook chemical oceanography), five chapters to physical processes (air-sea interactions, circulation, waves, tides, coastal processes), and the last three or four chapters to biology (~ 30%). Conversely, marine biology textbooks typically have one chapter on the seafloor and one chapter on chemical and physical properties, with the remainder on biological and ecological topics (80–90%). So, the very inclusive title (all three terms—oceanography, marine biology, and marine science) is appropriate, and courses with any of these titles could use this textbook.

The chapters in this book do follow



the “usual” outline of oceanography textbooks. In Chapter 1, aptly named “Early Foundations,” Townsend provides a historical overview of some of the major accomplishments by early explorers, and he addresses the questions of scale, navigation, and the technological developments enabling ocean exploration.

The next two chapters focus on geological concepts. Chapter 2 discusses the origins of Earth and its ocean and introduces concepts of geophysics and the origin of life on Earth. Chapter 3 continues the discussion of the formation of the ocean basins, traces the history of the evidence for plate tectonics, and concludes with some mention of the sediment types found on the seafloor.

Chapter 4 presents the chemical and physical properties of water and seawater. Coverage is equal to or better than some typical oceanography textbooks. In the next two chapters, focus turns to physical properties. Chapter 5, “Atmospheric Circulation and Ocean Currents,” discusses the driving forces of atmospheric circulation, the creation of winds, and the influence of the Coriolis force, the resulting surface currents, and thermohaline circulation. Chapter 6 focuses on the basics of waves and tides. I found these

chapters to be very clearly written, and they provide many descriptive examples that help to illustrate these principles.

In the second half of the book, the focus shifts to organisms and ecosystems. Chapter 7 introduces a number of processes related to biology: photosynthesis and respiration, nutrient cycles, food chains and food webs, and factors controlling distributions. Again, I found the explanations very clear and the figures useful. The next four chapters introduce the major groups of organisms. Instead of presenting the organisms following an ecosystem approach, as in many traditional oceanography textbooks, Townsend’s discussion follows a taxonomic outline, as seen in most marine biology textbooks. Chapter 8 covers the “Primary Producers,” including phytoplankton, macroalgae, and sea grasses. Images in this chapter are excellent. Chapter 9, “The Zooplankton,” describes the distributions and ecology of all the major groups; however, for the copepods, this chapter gives more detailed information on life cycles and ecological importance. The “microbial loop” is also discussed here. Chapter 10 presents “Marine Invertebrates,” featuring the taxonomic groups of the benthic invertebrates along with an overview of their ecology, followed by a brief overview of the nektonic invertebrates (cephalopod molluscs)—which, of course, includes an entry on the giant squid, *Architeuthis*.

Chapter 11, “The Fishes,” presents the major physiological characteristics, life histories, and ecological features of three main groups of fishes. The chapter concludes with a short section on all the ichthyological topics that, because of space

constraints and the introductory nature of this textbook, had to be left out.

Next, Townsend returns to a more ecological discussion. Beyond benthic or pelagic ecosystems, Chapter 12 summarizes the features and processes of several of what he terms “more interesting marine environments,” including the intertidal zone, estuaries, salt marshes, mangrove forests, coral reefs, the deep sea, and hydrothermal vents. Chapter 13 discusses higher trophic levels—the reptiles, birds, and mammals. It provides details on the history of whaling and case studies of individual species.

The last two chapters deal with marine resources and human impacts on the ocean. In Chapter 14, “Fisheries and Aquaculture,” Townsend begins the discussion with trophodynamics and historical trends of commercial fisheries. He provides a good but very brief overview of the principles of fishery science, maximum sustainable yield, and the status of fisheries, and concludes with a discussion of aquaculture, including a brief mention of its limitations. Finally, Chapter 15, “Human Impacts,” discusses the issues of pollution and climate change. Pollution issues include the recent Deepwater Horizon explosion and subsequent oil spill.

The textbook also includes three appendices. Appendix A describes satellite remote sensing, including its history, types of data collected, and a good description of ways to overcome sampling limitations. Appendix B is an overview of El Niño and La Niña, and Appendix C describes deep-sea exploration from the bathysphere to DSV *Alvin*.

Of course, not all topics can be included in an introductory textbook. A detailed discussion of coastal processes,

which is usually included in oceanography textbooks, is omitted; the roles of bacteria are mentioned just briefly; viruses are mentioned just once and marine snow not at all. But overall, I found the coverage sufficient for an introductory oceanography or biological oceanography course.


The textbook is written in a very engaging style. Throughout, Townsend asks questions and then provides illustrative answers. For example, he asks “How salty is the sea?” and calculates the number of Morton’s salt containers that would be required to make seawater in a tub of freshwater. He explains how copepod filter feeding would be like “trying to catch a bubble in thick syrup by swiping at it with a fork” and that a more realistic understanding of particle selection is using “feeding appendages like canoe paddles.” In describing the competition for space between barnacles in the intertidal zone, he likens the warfare to “using their edges almost like shovels, [as] they cut beneath and dislodge.” He injects references sparingly, but does cite the primary literature (which appears in footnotes). This format is unusual for an undergraduate textbook, but instructors can use the footnotes to teach students how to reference the primary scientific literature and thus emphasize the importance of citing references.

The layout of the book is very nicely done as well. There is sufficient white space so the pages do not appear dense, and inserted text boxes with definitions or examples are clearly set out. The content of “boxes” includes additional information or reminders of concepts and principles, for example, how satellite altimetry is used to produce bathymetric maps, Beer’s Law, the bends

and deep diving marine mammals, or the Redfield ratio.

All figures, both photographs and graphics, are very sharp. The quality of the images of the plankton, in particular, is superior to that of other textbooks I have used. At the end of each chapter, there are several tools for students: a bulleted chapter summary, 10 or 11 discussion questions, and a list of references for further reading. Chapters do not contain lists of terms or lists of Web links (but I do not see these omissions as limitations).

An eBook version of this textbook is available through several commercial websites. They have options for offline reading and a tool for note taking and saving with the document. The quality of the text in the chapter I previewed was a bit blurry on my computer screen, but on zooming in, clarity improved. The images in the chapter I previewed were in color and good resolution.

In his Preface to the Student, Townsend asks “Why is the ocean important?” He points out that the unknown, the unusual fascinate most of us, and often it is just these things that compel us to investigate more. This textbook will serve as an excellent introduction for students because it does encompass more of the life that initially draws many students to the study of the ocean, but keeps the explanations grounded in understanding why things work the way they do, and to this end should provide the thoughtful student with ways to answer the question “Why is the ocean important?” 

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