

nal in your hand, it is hard to avoid at least scanning titles and maybe an abstract or two outside your research area. On the other hand, the great search engines of cyberspace allow us to unearth gems buried in some obscure journal. Rothman (chapter 19) argues for a "virtual central database" so that history does not repeat itself and overlook important papers. If we had this electronic database in the late 19th century, perhaps Mendel's work would not have been lost for a generation, although I wonder if his work would have been read and understood any faster.

My short review cannot do justice to the many other issues discussed in this book, many of which are quite removed from the everyday concerns of *L&O* readers. Lynch (chapter 8) points out that electronic publishing without any paper trail raises certain ethical and integrity questions. Kahin (chapter 17) discusses copyright issues, although I found a clearer explanation in Okerson (1996). Glancing through this book even superficially may give you a better feel for this and other issues facing publishers, not just readers. (Another collection of articles [Shaw and Moore 1996] is more focused on electronic publishing in science than Peek and Newby.) As a member of the society that publishes this journal, you should be concerned with all sides of issues in electronic publishing. A couple of authors in this collection predict the demise of the printed journal by 2025. Perhaps so. I suspect, however, we will have printed journals for some time to come, just as I occasionally get a letter or two on a scientific issue. Just like the 17th century.

David L. Kirchman

College of Marine Studies
University of Delaware
Lewes, Delaware 19958

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JØRGENSEN, B. B., AND K. RICHARDSON [EDS.]. 1996. **Eutrophication in coastal marine ecosystems**. American Geophysical Union, Coastal and Estuarine Studies 52, Washington, D.C. ISBN 0-87590-266-9. 273 p.

In the past three decades we have observed disturbing signs of change in the coastal waters of all the continents. One set of changes, including regional losses of seagrasses, expanded occurrences of hypoxia/anoxia, persistent blooms of harmful algae, and disruption of pelagic and benthic communities, is related to the anthropogenic enrichment of coastal waters that began to accelerate in the 1950s. Enrichment of the coastal zone with nitrogen and phosphorus is now a well-established fact and presents a compelling rationale for new scientific programs to assess global changes at the land-sea margin. Examples in the United States include the Land Margin Ecosystem Research program (of NSF), Coastal Ocean Processes program (NSF, NOAA, ONR), and the Ecology and Oceanography of Harmful Algal Blooms program (NSF, NOAA, USEPA, ONR). Multinational programs include LOICZ (Land–Ocean Interactions in the Coastal Zone, a core project of IGBP) and the proposed coastal module of GOOS (Global Ocean Observing System).

The growing concern about coastal eutrophication is analogous

to the intense effort directed at the problem of lake eutrophication in the 1960s and 1970s. This explosive growth is characteristic of a young scientific discipline. Scott Nixon (1995) reminds us that the concept of marine eutrophication "was unheard of until about 20 years ago." We are still in the early stages of intense observation, mostly as region-specific assessments, and are far from working through the complete puzzle of how coastal eutrophication works on a global scale. This book reflects the state of the science because it presents a comprehensive, region-specific assessment. The region of interest here is the Kattegat, the transition zone between the Baltic Sea and North Sea, one of "the best studied marine regions in the world and certainly one for some of the longest time series for biological data." This book is a product of the Marine Science Program, sponsored by the Danish Ministry of Environment and Energy from 1988 to 1994 following recurrent events of oxygen depletion in the Kattegat. The program was funded by the Danish Parliament to stimulate research on the ecological effects of eutrophication at a time when measures were adopted to reduce nitrogen and phosphorus inputs by 50 and 80%, respectively. The book was "designed as a general text," and the editors' goal was a synthesis of "how coastal marine ecosystems respond to eutrophication."

The 12 chapters address many key elements of the problem, including atmospheric processes of nitrogen delivery, basic features of coastal hydrography and circulation, material fluxes in the water column and sediments, responses of the microbial, plant, and benthic macrofaunal communities, and the use of models as tools to integrate these elements. Individual chapters vary greatly in their quality and scope, ranging from mini-tutorials to detailed case studies. For me, the highlight of this book is the pair of chapters written by Bo Barker Jørgensen. The first is a superb review of the current state of knowledge about the structure and biogeochemical function of marine sediments, including microbial processes of element cycling (C, N, P, S, Mn, Fe, O), and a description of how these processes change with nutrient enrichment and hypoxia. Jørgensen's second chapter is an ideal companion, illustrating the general principles with results from an intensive study of Aarhus Bay in which the important processes and fluxes were measured over a 1.5-year period. The result of this study was a detailed dataset from which Jørgensen calculated annual budgets for the major elements. These chapters are excellent reviews for students and researchers who want to learn the fundamentals of marine sediment biogeochemistry.

This book is also valuable for the many general hypotheses about coastal eutrophication that are developed from observations in the Kattegat region. Examples include (1) There is no simple empirical rule that relates primary production to nutrient (N) loading across the spectrum of coastal ecosystem types (Borum), (2) Nutrient enrichment may not stimulate total system primary production. Its most important effect is to shift the autotrophic production from dominance by perennial macroalgae and seagrasses toward dominance by ephemeral macroalgae and phytoplankton (Borum), (3) Oxygen depletion is not related in a simple linear way to nutrient delivery. For example, the timing of nutrient inputs (pulsed vs. continuous) plays a critical role in the dynamics of mineralization processes and oxygen consumption (Kiørboe), (4) There is no simple empirical rule that relates macrobenthos production to primary production. Enhanced production of organic matter stimulates production of macrobenthos in deep waters, but it disrupts macrobenthos production in shallower stratified waters where eutrophication leads to oxygen depletion (Hagerman et al.), (5) Eutrophication preferentially stimulates sulfate reduction, which may become more important than oxygen for direct respiration of organic matter. Enrichment causes a shift toward anaerobic processes of mineralization (Jørgensen), (6) Coastal ecosystems have inherent large interannual variability, so management actions that reduce N and P loadings might not lead to immediate recovery toward the unenriched state (Riisgard et al.).

We do not yet have a broad empirical basis for predicting how nutrient reductions will lead to restoration, but estimates here suggest that recovery of oxygen concentration (Richardson) and eelgrass beds (Borum) may take decades after actions are taken to reduce nutrient loadings to Danish coastal waters. However, these estimates have large uncertainty because "the science of 'recovery biology' (i.e. how a system responds to a reduction in eutrophication) is not yet well established" (Richardson). This is perhaps the most important practical lesson for how we apply scientific understanding to protect coastal waters from the harmful consequences of enrichment. Our inability to predict the patterns of recovery is one consequence of a complex scientific discipline that is early in its development.

Although the title of this book suggests a general treatise, virtually all the results and lessons are from studies of Danish coastal waters. Efforts to integrate and compare results from other coastal ecosystems are limited, so it is difficult for readers to appreciate the global significance of the specific results presented here. For example, the editors could have included more comparison with results from Chesapeake Bay, another large coastal system that is strongly stratified in summer, enriched with N and P, and exhibits multiple symptoms of degradation. Smith et al. (1992) published a remarkably similar volume that described the physical, biogeochemical, and ecological aspects of eutrophication in Chesapeake Bay. Interested readers should compare these books to explore similarities and differences in the way in which eutrophication is expressed in these two well-studied, high-visibility coastal systems.

A general text would use results from other ecosystems to explore additional questions. For example, not all nutrient-rich coastal waters show clear symptoms of environmental degradation. How do physical processes constrain the expression of eutrophication? (Mombet [1992] offers one intriguing hypothesis.) How do top-down processes regulate the expression of eutrophication, especially in shallow marine waters where there is tight coupling between the production and consumption of phytoplankton biomass by benthic suspension-feeders? How do changes caused by nutrient enrichment interact with other human stressors, such as input of toxic contaminants or exotic species? Which combinations of forces promote blooms of harmful algal species? How does eutrophication affect fish recruitment? Answers to these complex questions will emerge as the science matures and moves from regional assessments to integrative, comparative analyses—the next step toward a global conceptual model of marine eutrophication.

I recommend this book for anyone interested in coastal oceanography or ecology. Some chapters are excellent references for graduate-level instruction, and comparison with the parallel chapters in Smith et al. (1992) could be an effective teaching approach. Do not expect (as the title implies) a general treatise on this subject. Rather, this volume gives a comprehensive analysis of the problem from the perspective of Danish scientists who provide a model of how to do regional assessments of coastal eutrophication.

James E. Cloern

U.S. Geological Survey
Menlo Park, California 94025

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- SAND-JENSEN, K., AND O. PEDERSEN [EDS.]. 1997. **Freshwater biology, priorities and development in Danish research.** G. E. C. Gad, Copenhagen. ISBN 87-12-03135-6. 254 p.
- Danish limnologists have written a book marking the 100th anniversary of the Danish Freshwater Biological Laboratory (FBL). The first chapters (Sand-Jensen and Dall) recount the founding of the FBL by Carl Wesenberg-Lund on the shores of Lake Fure, near Copenhagen, in May 1897. Wesenberg-Lund, who is known as an early authority on planktonic invertebrates and for his studies of cyclomorphosis, was the force and inspiration behind the founding of Danish limnology. His comprehensive study of Lake Fure shows his commitment to the study of lakes as ecosystems, with full attention to the combination of physical, chemical, and biotic components in a manner reminiscent of Forel and Forbes. Wesenberg-Lund also directed Danish limnology toward comparative studies similar to those beginning concurrently in Wisconsin, and he broadened the base of limnology by enticing physical scientists to assist in developing ways of studying lake sediments. Danish limnology thus was blessed very early with a commitment to holism.
- The FBL was moved in 1911 to Hillerod near Frederiksborg Castle Lake, where it remained small but active through the 1950s. In the 1960s, the FBL expanded at a fast pace, culminating in an equilibrium scientific staff of 10 and a technical staff of 14, as well as an expansion of facilities and programmatic extension into streams and brackish waters.
- The introductory chapters of *Freshwater Biology* are followed by two chapters that describe and analyze 100-year records of change in the trophic state of Lake Fure (Sand-Jensen) and in the profundal fauna of Lake Esrom (Lindegaard et al.). Given that such extended records are exceedingly rare, these chapters are really quite interesting, and the authors have provided some provocative interpretation as well.
- The final nine chapters deal with topics that are currently of special interest at the FBL. These include community ecology of macrophytes, coastal eutrophication, modelling, bacteria and dissolved organic carbon in lakes, zooplankton studies, metabolic studies of benthos, water transport by aquatic plants, and the dependence of stream macroinvertebrates on riparian forest cover. All of these chapters are well written and have general appeal. Many are enriched by years or even decades of research. The chapters are not focused exclusively on Danish waters, but have more the flavor of review papers with special emphasis on Danish work by way of example. Many of the papers would stand alone as definitive reviews of their subjects, and the book as a whole makes a good foundation for a graduate seminar or supplementary reading for a limnology course.
- Freshwater Biology* reveals some characteristic features of Danish limnology. First is a commitment to understanding the distribution and diversity of organisms. The FBL can still claim the competence to deal with the systematics and life history of many of the groups of organisms that are important to aquatic ecosystems; this capability is much eroded elsewhere. Danish limnology also has a constant element of physiological ecology that can be traced back to Berg and Krogh. The limnological potential here is well illustrated by chapter 11 (Hamburger et al.), which explains how the mechanisms of oxygen distribution, time course of oxygen depletion, and interspecific variation in tolerance to oxygen depletion interact in determining the composition and distribution of the benthic fauna in lakes. Another thread is the study of sediments and sediment-water interactions. Zooplankton studies, which began with Wesenberg-Lund, are prominent, as shown in a chapter by Christoffersen and Bosselmann. Macrophytes also figure very im-