

tion (K. Kelts and K. J. Hsü); and radio-nuclide limnology (S. Krishnaswami and D. Lal)—contain a wealth of information that is simply not available in such concise form anywhere else. Aquatic chemistry is discussed in useful chapters on perturbations caused by humans (W. Stumm and P. Baccini) and chemical modeling of lakes (D. M. Imboden and A. Lerman). The book also treats heat budgets (R. A. Ragotzkie), stable isotopes (F. J. Pearson, Jr., and T. B. Coplen), and saline lakes (H. P. Eugster and L. A. Hardie). The chapter by Eugster and Hardie brings together in one place much of the elegant work that Eugster and his associates have done on highly saline lakes in Africa and North America.

Kelts and Hsü present a useful review of the numerous processes that control carbonate sedimentation in lakes. They have used their own data from Lake Zurich to illustrate most of the major points made in their discussion. This is particularly appropriate because Nipkow's classic work on paleolimnology and sedimentology was done on the varied sediments of that lake. Scanning electron micrographs of selected layers in sediment cores from the lake are used to give one an intimate view of the diatom frustules and minerals deposited through time.

Chemical perturbations by aquatic ecosystems resulting from human activities are examined by Stumm and Baccini in a notably synthetic chapter. The chapter begins with a discussion of the relationship between per capita energy consumption and eutrophication and goes on to deal with chemical speciation and the "emergent" properties of ecosystems. Some sections of the chapter are overly general, but the authors often indicate where particular caution in accepting some of the generalization is required. Many limnologists will be dismayed, however, by the uncritical approach Stumm and Baccini take to ecosystem ecology.

Jones and Bowser treat the mineralogy and related sediment chemistry of lakes in a long, scholarly chapter. They have made a special effort to organize and summarize the current literature in the field (over 230 references are cited). The chapter was written to interest students in the subject and to provide a basic guide to the study and interpretation of the chemical and mineralogical characteristics of sediments as well as to provide a good critical discussion of the relevant literature.

A disappointing chapter by G. T. Csady on water circulation and dispersal

mechanisms is largely a verbatim reprinting of two recent reviews by the same author. Despite an introduction to the fundamentals of this complex subject, which he attempts in a scant three pages, the latter part of the chapter will only be read by people who already have a good grasp of fluid dynamics. Moreover, the chapter deals only with selected aspects of the circulation of the Laurentian Great Lakes and thus many of the physical processes of interest to limnologists working on smaller bodies of water are completely ignored (vertical mixing and Langmuir circulation, for example). A good, readable book on this subject would certainly be a welcome contribution.

Most of the authors have produced chapters that fit nicely into the conceptual framework of the book. The figures and tables are generally excellent, though there is one that I found to be quite incomprehensible (figure 2 in chapter 3). There are some distracting spelling errors, and there are occasionally other errors, such as that Lake Victoria is now located in South Africa. But all in all the book is first-rate.

PETER KILHAM

*Division of Biological Sciences,  
University of Michigan,  
Ann Arbor 48109*

## Marine Ecology

**Upwelling Ecosystems.** Papers from a symposium, Kiel, Germany, Sept. 1975. R. BOJE and M. TOMCZAK, Eds. Springer-Verlag, New York, 1978. x, 304 pp., illus. Paper, \$27.

The editors of this symposium volume argue that upwelling ecosystems are significant because of their great biological productivity relative to other marine areas and because study of them over the past decade represents perhaps the best development of interdisciplinary cooperation in marine science.

This collection is for those already familiar with oceanography; the reader is abruptly thrust into the terminology (though not the mathematics) of the subject by way of an unsuccessful attempt to define the spatial scales of the phenomenon. Mathematical treatment of physical circulation appears only briefly in J. D. Thompson's discussion of mixing. Specific subjects are handled unevenly; for example, two papers dealing with phytoplankton studied on specific (but different) cruises are followed by a general summary of literature on types of zooplankton in upwelling areas.

In some respects, the editors' intentions are realized. The translation of planktonic production of upwelling regions into the diets of harvestable fish is discussed in two papers (one by D. H. Cushing, who has written often on this issue). There is a good representation of European work (though Russian studies, notably in the equatorial Pacific, are ignored), and, as has not always been the case in volumes on the subject, no particular team or geographical area dominates, though coastal systems receive the most emphasis. Diversity is enhanced by the inclusion of interesting attempts to evaluate the contribution to sediments of the organic remains of plankton stimulated by upwelling and a description of circulation in the Great Lakes. Perhaps of widest interest is a "biopolitical" paper by W. E. Wooster, who castigates researchers for not living up to their pious grant proposals in pursuing more diligently the practical consequences of upwelling.

There are some reports that are mildly interdisciplinary, such as one diagramming the relation between the distribution of the ciliate *Mesodinium* and the general pattern of physical circulation and a good (though brief) treatment of temporal patterns off Ghana. All too rare, however, are syntheses and attempts to state and resolve major issues. For example, T. E. Whitledge assesses the approximate importance of excretion by fish and zooplankton in supplying nutrients and compares these to supply by upwelling and other papers discuss bacteria, but a cooperative, interdisciplinary attempt at a nutrient or carbon budget is not presented. The relation between benthic biomass and food supply from overlying waters is discussed again, but there is little acknowledgment of the fact that many benthic organisms have mero-planktonic larvae that interact directly with the currents and the phytoplankton. Nor is it clearly pointed out that most upwelling areas have major currents flowing through them advecting plankton and nutrients from eutrophic (rich) to relatively oligotrophic (poor) areas.

These criticisms are easy to make and very difficult to obviate; further, it is arguable whether current trends in scientific management and publication will improve or aggravate matters. I would have been more stimulated by this book had the "ecosystem" in the title been better realized, or even delineated, in the contents.

MICHAEL M. MULLIN

*Institute of Marine Resources,  
University of California at San Diego,  
La Jolla 92093*