and as much as 20,000 years near the base (because of the increased compaction). The upper 55 meters of core were analyzed separately at intervals of 25 centimeters. Paleoclimatic interpretation is based on the present geographic distribution of the 50 or so trees represented in the diagram, ranging from boreal conifers to subtropical types, with the climatic ranges expressed as a warmth index, calculated as the sum of the mean monthly temperatures. Interpretation is complicated by the fact that Lake Biwa is very large and is in a mountainous region that contributes pollen from various vegetation types up and down the mountains. Pollen diagrams for the entire 200 meters are subdivided into 19 pollen zones, but the individual pollen profiles zig-zag strongly, and some zones are represented by only a single count. Twelve cold intervals and ten temperate intervals are recognized, and a correlation is attempted with the ocean-sediment oxygen-isotope curve covering the last 500,000 years. The more detailed pollen diagram for the top 55 meters, with about 200 pollen counts subdivided into six zones, is more convincing, and a creditable correlation is made with the main paleoclimatic trends in other temperate regions. A mid-Holocene temperature maximum is recorded, as well as the last glacial maximum and the last interglacial.

The book closes with separate chapters on the stratigraphic distribution of diatoms, animal microfossils, organic geochemistry (hydrocarbons, aliphatic carboxylic acids, sterols, lipids, and humic compounds and kerogen), inorganic chemistry, and biochemical organic compounds (carbohydrates, protein and amino acids, and pigments). The strong correlation of organic carbon with diatom abundance and with chlorophyll derivatives and carotenoids suggests that diatoms are a principal contributor to organic carbon in the lake and that the trophic state has fluctuated over the 500,000-year history. The correlation of animal microfossils and green algae with the paleoclimatic phases inferred from the pollen diagrams is only suggestive. The diatom stratigraphy is clearly marked by five zones; correlation with climatic phases is not possible, but some of the zone boundaries are coincident with the levels of paleomagnetic events, for unknown reasons.

The Lake Biwa project is by far the most diversified and best-integrated paleolimnological project undertaken and fully published. The volumes that have appeared prior to the preparation of this summary book must have served the authors well, for the amount of cross-referencing from one type of investigation to another is impressive. Stratigraphic profiles of different microfossil or chemical components are interpreted with reference to the paleoclimatic sequence inferred from the pollen diagrams, or to the sedimentation history based on granulometry, or to the paleomagnetic stratigraphy. And most of the interpretations go back to the background information provided by studies of the modern physical, chemical, and biological characteristics of the lake and to the geology and biota of the area. Horie must be congratulated on the design and execution of such a massive interdisciplinary investigation, which should serve as a model for other comprehensive big-lake studies. The book itself is clearly written, with only a few quirks that go back to the Japanese language. The diagrams and maps are almost all clearly designed and drafted, and the book is easy to handle. Japanese work in limnology and paleolimnology is clearly to be followed with interest.

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Marine Ecology

Marine Ecological Processes. IVAN VALIELA. Springer-Verlag, New York, 1984. x, 547 pp., illus. $34. Springer Advanced Texts in Life Sciences.

Marine ecology, like other areas of ecology, is a diverse discipline that considers topics ranging from the molecular mechanisms of nutrient regeneration and the genetic diversity of populations to global geochemical cycles, adaptive radiation, and organic diversity. As such, it draws on disciplines as disparate as geochemistry, microbiology, genetics, and paleontology. It is not particularly surprising, then, that the worldviews of marine ecologists differ dramatically. This diversity of perspectives makes the objectives of this volume challenging and elusive. It is intended to serve as a beginning graduate or advanced undergraduate textbook and as a synthesis of current marine ecology. The author has brought together a vast body of information into a digestible whole, and considering the scope of the undertaking the result is fairly well balanced and up-to-date. The book reviews topics ranging from ecosystem-level processes, such as nutrient cycles and primary productivity patterns, to consumer and competitive effects on organism abundance and devotes attention to planktonic and fish populations as well as to a variety of benthic assemblages. In general, the volume succeeds as a textbook owing to its breadth and its summary of the literature but falls short as an innovative synthesis because its scope dictates a rather superficial treatment of most topics.

The subject is presented in five major sections based on functional levels of food-web organization. The first four sections deal with primary production, consumers, consumer interactions (competition), and decomposition processes, and the last examines the structure of marine communities. These topics are given approximately equal coverage, but the depth of coverage is uneven and the tone of the work as a whole conveys a systems view of marine ecology. In addition, though some efforts are made to tie divergent perspectives and topics together, these efforts are, in large part, unsuccessful.

The discussions of ecosystem-level processes dictating patterns of primary productivity, decompositional processes, and nutrient cycling, subjects close to the author's research interests, are particularly well done. The reviews of these subjects point out gaps in our current knowledge and highlight potential avenues for productive future research.

The sections on consumers and competitive interactions are more conservative and less satisfying. Each of these topics is given a traditional mathematical treatment followed by discussions of the applicability of the models and selected empirical examples. In general, parts of the book dealing with pelagic interactions are quite well done and are much more complete than those dealing with benthic systems. An almost total lack of an evolutionary perspective in interpreting pattern in marine populations is a major shortcoming of the book and is very evident in the consideration of consumer and competitive interactions. As a result of the book's focus on proximate causes, the exciting body of current literature dealing with predator-prey coevolution is hardly considered. Similarly, new developments regarding the morphological correlates of competitive dominance among sessile organisms are missing, and the controversy over the importance of competition in natural systems is largely ignored. The role of mutualistic interactions in marine systems is mentioned only in passing.

The section dealing with the structure of marine communities covers a rich variety of topics including species diver-

sity, spatial and temporal heterogeneity, and succession. As with the parts of the book dealing with consumers and competitive interactions, a traditional approach is taken that stresses methodology and select case studies. The cases presented are all recent and generally well explained, but in contrast to the treatment of ecosystem-level processes the discussion of community-level processes is uninspiring. The current controversies concerning nonequilibrium communities, disturbance-maintained communities, and the application of island biogeography theory to marine communities are largely neglected.

In spite of these limitations readers are in most cases directed, in a bibliography over 70 pages long, to current literature reflecting a wide variety of perspectives on how marine systems are viewed. On balance, this book has much to offer as a textbook. As a comprehensive treatment of marine ecology at this level it really has no predecessors, and would-be marine ecologists would be well served by reading it. Its distinct systems ecology flavor will be less acceptable to some potential users than to others. Nonetheless, I expect that the book will find a grateful readership, particularly among biological oceanographers, and that its compilation of literature will be widely appreciated.

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Lichen Biology

Biology of Lichenized Fungi. JAMES D. LAWREY. Praeger, New York, 1984. x, 408 pp., illus. $39.95.

The some 25,000 known species of lichen-forming fungi and their algal partners constitute the classical textbook example of symbiosis. As the only fungi with "chloroplasts," the lichen-formers flourish where few other organisms can—on boulders above the timberline, on soil in burning deserts, on maritime cliffs sprayed with salt, even inside translucent rocks in Antarctica. Lichens are also epiphytes of higher plants in all parts of the world that we have not spoiled by air pollution (their sensitivity in this regard is even used as a measure of pollution). The fungus-alga relationships that coevolution has so finely tuned are still only sketchily known. Lichens, you might think, must consequently fascinate biologists to distraction—but they do not. They are generally considered to be too difficult taxonomically for field research and too intransigent for laboratory manipulation. To improve the lichens' scientific reputation is Lawrey's ambition in his admirable new book.

Lawrey draws upon a bibliography of more than 900 references, many from obscure and unlikely sources. A large percentage of the papers that he cites are not included in other recent surveys of lichenology. He summarizes the major points known about the lichen thallus (scanning electron microscopy reveals structures useful in refining taxonomies), asexual and sexual reproduction (yet not a single chromosome number is known), in vitro culture for experiments (hard, yes, but an increasing number of workers are succeeding), physiology (imagine daily photosynthetic cycles governed by the availability of *water*), secondary-product chemistry (hundreds of the compounds are unknown elsewhere in nature), growth and demography (what is an individual?), and ecology (are the many chemical races ecotypes or cryptospecies?).

Lawrey juxtaposes sets of data that we have not previously been forced to compare. Not content to leave it to us to formulate new hypotheses, he strews his text with tables bearing such titles as "Questions concerning the biological basis of lichen growth," making up lists of research projects, most of which are entirely feasible today. "This hypothesis needs to be tested experimentally" becomes the chorus that concludes one section after another. The book is an invitation—actually a challenge—to research.

In the chapter on the ecological significance of secondary products Lawrey is at his best, explaining the field of his own research. Although most lichens have only momentary periods of photosynthesis, they still spend vast sums of hard-won photosynthate to elaborate their bizarre extracellular secondary compounds. Lawrey explores the evidence that these substances have allelopathic effects on bryophytes and higher plants and act as deterrents against a wide range of invertebrate grazers. In all, the lichen is remarkably immune to micro- and macrobiological predators. This aspect of lichen ecology is in its infancy, but Lawrey is its chief researcher and most imaginative spokesman.

From an editorial perspective, the book is a botch. Most of the many photographs, which looked fine in the papers of their provenance, are now so overexposed as to be uninterpretable. The line drawings, which could have been made presentable with some reduction, are published at what must be original size and look hopelessly crude. An eye blind to the beauty of the printed page selected the typography. (Were copies with defective bindings intentionally used for review?) Scientific authors in search of a publisher might well want to consider what Praeger did to Lawrey.

The verso of the title page tells us that *Biology of the Lichenized Fungi* is printed on acid-free paper. This precaution was unnecessary. Long before time will be able to erode it, the book will be obsolete thanks to the broad range of research that it is certain to inspire.

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