

BOOK REVIEWS

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STOERMER, E. F., AND J. P. SMOL. 1999. **The diatoms: Applications for the environmental and earth sciences.** Cambridge University Press. xii+469 p. US\$115. ISBN 0-521-58281-4.

Diatoms are ideal environmental indicators. The estimated 10^4 – 10^5 species are found throughout the world, from lakes and oceans to deserts and polar ice fields. Each has specific physiological requirements, and aggregations of species can thus be used to quantify environmental conditions. These assessments are often more meaningful than direct physicochemical measurements because they integrate environmental variation over time. Diatom cell walls are ornamented with intricate, taxonomically diagnostic patterns and preserve well in the sediments of depositional basins. These fossils permit quantification of past environmental conditions and evolutionary trajectories of species at a resolution unrivaled by most other fossilizing organisms.

For these reasons, diatoms are being widely used to solve a variety of basic and applied environmental problems. This has generated a great need to make the tools of diatom identification and application available to a wide audience. This timely book addresses this need, providing thorough reviews of the main subdisciplines of applied diatom research, explaining fundamental theory, techniques of practical application, and insights into where this research may lead. It is sufficiently critical and detailed to be useful to diatom specialists, and at the same time it is also accessible to those with a more peripheral knowledge of the field, such as environmental managers, ecologists, paleoecologists, oceanographers, and archaeologists.

In the introductory and final chapters the editors evaluate the past and future of diatom science. A recurring theme is their concern about whether taxonomic advancements can keep up with the recent surge in applied diatom research. When I began studying diatoms in 1989, 46 genera were commonly recognized in the North American freshwater flora; today 147 genera are accepted. Keeping abreast of these changes is not easy, yet the success of diatom-based assessments is largely dependent on taxonomic rigor. Unfortunately, basic taxonomic research suffers from a chronic lack of funding; in consequence, many applied projects have been done without appropriate taxonomic reference bases. An encouraging trend is that diatom researchers are increasingly using digital technology in identification protocols. Cooper (Chapter 16) asserts that establishment of digital databases that link photographs of species to taxonomic and ecological information should be an integral component of all diatom laboratories. These databases increase taxonomic consistency locally and, considering the potential of the Internet, may greatly enhance global consistency in the future.

Another important theme in the book is advancements in computer technology that facilitate better quantitative examinations of diatom data. Diatom data sets are usually multivariate, containing hundreds of species and dozens of environmental variables. Programs that condense these data are now widely available, providing precise estimates of environmental optima and tolerances of species,

which can then be incorporated into environmental prediction models. Many chapters describe statistical advancements that have improved diatom-based environmental health indices and paleoecological inference models. Most advocate a two-step procedure: (1) ordination to determine species–environment relationships, and (2) creation of an inference model to predict the value of important environmental variables from diatom assemblage composition. These models have been useful in a variety of applications, including hindcasting acidity, eutrophication, climate, and sea level change from diatom records in lake sediments. Although the presentation of these methods in several chapters may appear redundant, the authors offer unique views on their advantages and shortcomings. The book may have benefited by a single chapter reviewing the state of quantitative applications in diatom science, perhaps by a statistical ecologist familiar with advancements being made in the broader field of quantitative ecology. Future refinements of these quantitative methods will be particularly critical as these models begin to be implemented in management programs.

The extent to which diatom science is expanding circumglobally is amply demonstrated in the book. Douglas, and Smol (Chapter 10) and Spaulding, and McNight (Chapter 11) describe paleoecological research in polar regions, where lakes are especially sensitive to global climatic and other environmental changes. High resolution records from these and other studies (i.e., Lotter et al. Chapter 9) will provide essential data for Global Circulation Models that hindcast past or predict future climate change. At the other extreme, Johansen (Chapter 12) finds some of the same polar diatom taxa in aerial habitats and emphasizes the opportunities that these and other aerial diatoms afford for understanding the factors that limit diatom distributions.

In marine environments diatoms are particularly valuable in hindcasting sea-level change. Coastlines are among the most heavily populated regions in the world and are now threatened by global sea level rise. However, Sullivan (Chapter 15) and Cooper (Chapter 16) warn that although this is a critically important application of diatom science, diatoms of coastal areas have received much less taxonomic attention than other regions.

The book provides fascinating glimpses of less commonly recognized applications of diatoms including recounting prehistoric human activity, oil and gas exploration, and as evidence in criminal investigations. It also offers captivating accounts of injurious diatoms and insight into the importance of long-distance aerial transport in determining diatom distributions.

In conclusion, this book will be an invaluable resource for anyone with an interest in diatoms, particularly students, who will appreciate its thorough reviews and wealth of literature citations. Its synthesis of techniques, ideas, and viewpoints move diatom science strongly into the 21st century.

Evelyn E. Gaiser

Southeast Environmental Research Center
Florida International University
Miami, Florida 33199