All Creatures Macro and Micro

Richard E. Lenski

Ecology, Volume 73, Issue 1 (Feb., 1992), 377-378.

REVIEWS

Ecology, 73(1), 1992, p. 377

Humic Substances

Allard, B., H. Borén, and A. Grimvall (eds.). 1991. **Humic substances in the aquatic and terrestrial environment.** Lecture Notes in Earth Sciences. Volume 33. Proceedings of an International Symposium, Linköping, Sweden, August 21–23, 1989. Springer-Verlag, New York. viii + 514 p. $72.00 (paper), ISBN: 0-387-53702-3 (acid-free paper).

Interest in the characteristics and properties of humic substances has increased dramatically in the past decade. This is due to a combination of improved methodology (e.g., the hydrophilic-hydrophobic separation scheme introduced by Leenheer and co-workers at the U.S. Geological Survey) and a growing awareness of the potential importance of humic substances in the speciation and mobility of trace metals, the solubility and bioavailability of many synthetic organic compounds, and the production of chloroform and other trihalomethanes upon chlorination of drinking water.

The purpose of the present volume is to disseminate papers presented at an international conference on humic substances held in Sweden in 1989. The meeting was a follow-up to an earlier meeting of Nordic scientists held in 1986. Attendance at the 1989 meeting was predominantly Scandinavian and European, and thus this volume exposes North American readers to the work of European researchers with whom they might not be familiar. As a volume in the *Lecture Notes in Earth Sciences* series, primary emphasis is placed on rapid dissemination, even if the manuscript is "unfinished or tentative." I found this to be a refreshing admission.

The book is divided into five sections corresponding to five sessions held in the original meeting. These include "Isolation, fractionation, and characterization"; "Biological and chemical transformation and degradation"; "Complex formation and interactions with solids"; "Biological activity"; and "Halogenation of humic substances." A total of 47 individual papers is presented. Noteworthy individual papers include a very detailed description of separation methodologies by Ronald Malcolm; a thought-provoking synthesis entitled "The contradictory biological behavior of humic substances in the aquatic environment," by Bob Petersen; and two papers detailing the biological effects of humic substances on root growth (Anders Grimvall et al.) and rates of accumulation of organic pollutants in freshwater invertebrates (Jussi Kukkonen).

Production quality is adequate but not outstanding. Most figures are of good quality, and I have already used several in class lectures. Others, however, suffer from the cramped and almost illegible scales generated by early versions of Lotus 1-2-3 and similar programs. The writing is generally lucid, but copy editing was somewhat lax, with typographical errors such as "trigging" for triggering and "specturm" for spectrum a fairly common occurrence.

For those working directly in the field of humic substances, this volume will be a useful reference. It also contains enough chapters of sufficient general interest to warrant inclusion in university libraries which maintain thorough collections in environmental science.

William H. McDowell

University of New Hampshire
Department of Natural Resources
James Hall
Durham, New Hampshire 03824

Ecology, 73(1), 1992, pp. 377–378

All Creatures Macro and Micro

Andrews, John H. 1991. **Comparative ecology of microorganisms and macroorganisms.** Brock/Springer Series in Contemporary Bioscience. Springer-Verlag, New York. xv + 302 p. $59.00, ISBN: 0-387-97439-3 (acid-free paper).

The field of microbial ecology has evolved largely independently of animal and plant ecology. John Andrews observes that, as a consequence, textbooks of general ecology usually mention microorganisms "only insofar as they relate to nutrient cycling or to macroorganisms" while microbial ecology is "typically reductionist in the extreme . . . and lacks the strong theoretical basis of macroecology." The goal of this book is to promote a broader synthesis that reflects the ecological similarities between micro- and macroorganisms while also acknowledging substantive differences. In pursuit of this goal, Andrews chooses to focus on properties of individual organisms—rather than on population dynamics or community structure—because the role of natural selection in shaping organisms provides a common denominator.

The first chapter of this book lays out Andrews' framework for comparing micro- and macroorganisms. The central premise is that all organisms must allocate finite resources to maintenance, growth, and reproduction, so that trade-offs between competing demands are inevitable. But given the diversity of life histories that exist among both micro- and macroorgan-

isms (including sexual versus clonal genealogies and unitary versus modular growth forms), a critical problem becomes one of defining the "individual" in which these compromises between competing demands must be achieved. Andrews settles on a definition that is based upon the life cycle of an organism rather than one that reflects physiological independence or genetic distinctiveness.

Subsequent chapters address the mechanisms that generate heritable variation (Chapter 2); alternative modes and strategies for resource acquisition (Chapter 3); the ecological implications of differences in size, growth form, and life history (Chapters 4–6); and the responsiveness of organisms to environmental change (Chapter 7). Scattered among these chapters is a series of "case studies" in which the author describes features of the natural history of particular microorganisms which nicely illustrate basic ecological processes and are also of practical importance; the spread of antibiotic-resistant bacteria, for example, is used to illustrate natural selection in action.

Three major themes recur throughout this book. First, Andrews argues that the cost/benefit approach widely used to study trade-offs in plants and animals (e.g., specialist versus generalist, *r*-strategist versus *K*-strategist) can also be applied to microorganisms. Second, the most important difference between micro- and macroorganisms is the greater responsiveness of the former to environmental change, both physiologically (owing to the relationship between size and homeostatic capacity) and evolutionarily (owing to the relationship between size and generation time). Third, Andrews maintains that for many questions (e.g., the generality of senescence as a life history feature) the distinction between unitary and modular growth forms is more important than the distinction between micro- and macroorganisms.

How successful is this book? Given the gulf that presently separates microbial ecology from animal and plant ecology, Andrews' compelling statement of the need for a synthesis would have been cause enough for me to celebrate its publication. Beyond this, he fully achieves his stated goal of "presenting ecologically significant analogies between the biology of microorganisms and macroorganisms"; his framework for making comparisons, the organismal features he discusses, and the examples he uses to illustrate his arguments are well chosen.

My one concern is that Andrews may have tried to cover too much material in too little depth. Perhaps because he sought to make this book accessible to both microbial ecologists and plant and animal ecologists, the level of presentation tends to be somewhere between that of a textbook and a monograph. I fear that readers from both sides may react by acknowledging that, yes, there are some interesting similarities and differences between micro- and macroorganisms, and then leave it at that.

The "typically reductionist" microbial ecologist is never really confronted in this book with an explicit formulation of optimality theory and its potentially limiting assumptions. Rather, the reader is told in a just-so fashion that organisms can achieve an optimal balance between competing demands. The reader is similarly informed of the existence of phylogenetic constraints but is never actually shown how phylogenetic reconstruction can be used to distinguish, for example, convergent evolution from common ancestry. Had Andrews targeted microbial ecologists as his audience and expounded the basic elements of optimality theory and phylogenetic reconstruction accordingly, it would have been clearer that these theories may be used to generate testable alternative hypotheses. The reader interested in further discussion of these issues can consult recent review articles by G. A. Parker and J. Maynard Smith (1990. Optimality theory in evolutionary biology. *Nature* 348:27–33) and by P. H. Harvey and A. Purvis (1991. Comparative methods for explaining adaptations. *Nature* 351:619–624).

By the same token, had Andrews targeted the theoretically motivated "general" ecologist, he might have driven home more forcefully the utility of microorganisms for rigorously testing basic ecological principles. I do not see any reason to think that the comparative approach is any better suited to microorganisms than to macroorganisms; indeed, prior to the recent widespread use of molecular methods to determine phylogenetic relationships, microorganisms may have been less suited to this approach. The experimental approach, however, clearly is more feasible with microorganisms, owing to the relative ease with which their environments and genes can be manipulated as well as their larger populations and more rapid generations. Andrews agrees with this point, and in his conclusions (Chapter 8) he lays out an elegant program for progressing from correlative to experimental approaches to determine "whether a particular phenotypic trait is responsible for the competitive dominance of species A over species B." But, with the exception of a section on dietary specialization (pp. 88–97), I feel that evidence obtained from experimental manipulations of microorganisms tended to be neglected. For the reader interested in finding out more about experimental studies of adaptation that use microorganisms, I recommend three recent reviews, one focusing on a particular experimental system (Dykhuizen, D. E., and A. M. Dean. 1990. Enzyme activity and fitness: evolution in solution. *Trends in Ecology and Evolution* **5**:257–262) and two more general (Dykhuizen, D. E. 1990. Experimental studies of natural selection in bacteria. *Annual Reviews of Ecology and Systematics* **21**:373–398, and Young, J. P. W., and B. R. Levin. *In press.* Adaptation in bacteria: unanswered ecological and evolutionary questions about well-studied molecules. *In* R. J. Berry and T. Crawford, [eds.]. *Genes in ecology.* Symposia of the British Ecological Society, Blackwell, Oxford.)

In summary, John Andrews has succeeded admirably in building a bridge that is accessible to all ecologists. But those who take this journey may wish that some of the bridge's supporting elements had been anchored more deeply.

RICHARD E. LENSKI

MICHIGAN STATE UNIVERSITY
Center for Microbial Ecology
East Lansing, Michigan 48824