example of analysis of Bowen ratio or chamber data would have been a logical extention of the topics presented in earlier chapters.

This book has a number of attractive features that should be an example to other textbook writers. Each chapter has its own list of the symbols used in formulas presented in the chapter. Each chapter has an extensive bibliography. There are numerous well thought out and well drawn figures. There are numerical examples of most of the important concepts in each chapter. The SI system of units is used, indeed taught, throughout the book.

This is a well thought out and readable introductory textbook. The question that each potential user will have to answer for himself is whether to teach a course organized by his own inclinations using a number of texts that are more thorough in specific areas, or to use a single text with its own emphases. It is my opinion that students taught from this textbook, with sufficient laboratory and field sessions, will have an excellent foundation in experimental environmental biology.

CHARLES E. MURPHY, JR.
E. I. DU PONT DE NEMOURS & CO., INC.
Savannah River Laboratory
Aiken, South Carolina 29808

Ecology, 65(5), 1984, pp. 1703–1704

INTERACTING NUTRIENT CYCLES: A NEXT STEP

Bolin, Bert, and Robert B. Cook (eds.). 1983. **The major biogeochemical cycles and their interactions.** SCOPE 21. John Wiley and Sons, New York. xxi + 532 p. $74.95.

It will come as little surprise to those following nutrient cycling to find interactions of elemental cycles emerging as a major focus within the discipline. Both the terrestrial and aquatic literature have traditionally been dominated by questions centered on single cycles, but it is becoming increasingly evident that this focus can be short-sighted; nutrient cycles are often tightly linked, sometimes in subtle ways, and a thorough understanding of nutrient behavior in a given environment often will require an understanding of that nutrient's underlying relationships with others.

Largely in response to the perceptions that biogeochemical fluxes at small scales integrate to affect global processes, and that at these smaller scales elemental interactions may play key regulatory roles, SCOPE organized a workshop in Orsundsbro, Sweden in 1981, to directly address environmental interactions among C, N, S, and P. The present volume represents the most tangible result of this meeting. It is, as a whole, a remarkably even and well-integrated effort that brings together under a process-oriented umbrella researchers whose main interests span individual systems as disparate as the upper atmosphere, temperate grasslands, and deep-sea thermal vents.

Bolin and Cook have organized the book's 17 primary papers into subject areas that correspond broadly to the major global systems—atmospheric, terrestrial, aquatic and oceanic. These follow two introductory chapters, one a succinct, highly informative synthesis of the remainder of the book and the other a brief, almost sketchy review of the global cycles of C, N, S, and P. The first of these, by the editors plus Crutzen, Vitousek, Woodmansee, and Goldberg, provides an overview rarely encountered in edited volumes; it is valuable both as an introduction for the more casual reader and as a synthetic treatise for those who will read carefully many of the following papers.

The first of the two strictly atmospheric papers, Crutzen's chapter on homogeneous gas reactions, provides a needed and highly readable update on the role of C, N, and S gases—all biologically active—in atmospheric photochemistry. Crutzen concentrates on the way that these compounds (mainly CO, CH_4, NO_x, N_2O, NH_3, SO_2 and the reduced sulphur gases) interplay to maintain the distribution of tropospheric ozone, an essential determinant of atmospheric chemistry and crucial to surface radiation balances. He includes a shorter section on stratosphere chemistry that should be especially appreciated by biologists following the 15 yr N_2O saga. In the following chapter, Taylor, Baker, and Charlson model the other side of atmospheric chemistry, heterogeneous gas reactions—specifically the interactions of SO_2, NH_3, H_2SO_4, and CO_2 within condensed phases of aerosol particles and clouds. They emphasize in particular the importance of NH_3 as an accelerator of acid production in atmospheric water droplets; it's not generally appreciated that the geographic distribution of NH_3 may bear significantly on the intensity or distribution of acid precipitation, and Crutzen's point that major biotic fluxes of NH_3 are poorly understood, particularly with regard to vegetation interactions, is well taken in this regard. Cook in a later chapter on the impact of acid deposition on C, N, S, and P cycles notes that NH_3 fluxes may be among those affected by acid deposition, implying a potential feedback of the sort that has yet to be worked out.

Reiners' comprehensive chapter on transport processes—perhaps more aptly titled "mobilization, transport and deposition processes"—links phenomena as diverse as microbial mineralization and volcanic exhalations, and provides a fuller context for at least four papers that follow: Vitousek's discussion of how interactions among C, N, S, and P prior to and following deforestation will affect subsequent element mobilization, Richey's much-needed evaluation of global river fluxes of C, N, S, and P, and Liss' and Duce's chapters on air-sea exchanges of gases and aerosols, respectively.

Vitousek's brief analysis of the relationship between element ratios in forest litter and nutrient availability is further expanded by Melillo and Gosz, who also discuss the effects of plant nutrient status on ecosystem carbon flow, and consider the potential for enhanced carbon storage by the world's forests due to widespread low-level fertilization (from fossil fuel and tropical biomass combustion). They calculate that fertilization is likely to result in the additional storage of far less than the ca. 3×10^{15} g C needed to balance the global C

cycle, corroborating Houghton and Woodwell's conclusion that fertilization effects are likely to be minor in other biomes, as well. Houghton and Woodwell note that direct evidence of C storage is and will probably continue to be elusive, and point out that indirect evidence cited by some—in particular experiments showing enhanced primary productivity in response to CO_2 and low-level nutrient additions—has thus far failed to show that enhanced C fixation should not also be accompanied by accelerated C release via decomposition.

It is probably in part the relative wealth of process-level information available for grassland sulphur and phosphorus dynamics that results in the strength of the three chapters that examine C, N, S, and P interactions in these systems. Stewart, Cole, and Maynard's article, for example, provides especially valuable discussions of C and S and of C and P interactions in soils. McGill and Christie concentrate on stoichiometric relations among N, S, and P as they relate to mineralization processes. These authors' conclusions, that mechanisms controlling N, S, and P mineralization are element-specific and that the supply of organic substrate further controls the mineralization rate for each element separately, are fundamental for understanding the availability of nutrients to soil organisms, including plants. Hunt, Stewart, and Cole develop these relationships into a single integrated model by linking existing single-nutrient models via the concept of differential oxidations of elemental bond classes (e.g., C-C, C-S, C-O-P) as driven by substrate and nutrient requirements. It will be interesting to see the model validated.

This volume marks a first attempt to examine explicitly the major elemental interactions in a variety of globally-important systems. That some papers are more successful in this synthesis than others is to be expected, in part reflecting some spotty areas of conceptual development. Clearly, however, the overall intent is to stimulate at least as much as to inform, and that most papers implicitly raise many more questions than they address is ample evidence for the venture's success.

G. Philip Robertson
Departments of Microbiology and of
Crop and Soil Sciences
Michigan State University
East Lansing, Michigan 48824

Ecology, 65(5), 1984, p. 1704

Books and Monographs Received for Review

Through June 1984

Axelrod, Daniel I. 1983. New Pleistocene conifer records, coastal California. University of California Publications in Geological Sciences. Volume 127. University of California Press, Berkeley, California. xi + 108 p. $11.00 (paper).

Bailey, James A. 1984. Principles of wildlife management. John Wiley & Sons, New York. x + 373 p. $26.95.

Balcer, Mary D., Nancy L. Korda, and Stanley I. Dodson. 1984. Zooplankton of the Great Lakes: a guide to the identification and ecology of the common Crustacean species. The University of Wisconsin Press, Madison, Wisconsin. xi + 174 p. $35.00 (paper).

*Barnes, James R., and G. Wayne Minshall. 1983. Stream ecology: application and testing of general ecological theory. Plenum Press, New York. viii + 399 p. $55.00.

*Bell, William J., and Ring T. Cardé (eds.). 1984. Chemical ecology of insects. Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts. xvi + 524 p. $45.00 (cloth), $28.50 (paper).

Connell, Des W., and Gregory J. Miller. 1984. Chemistry and ecotoxicology of pollution. John Wiley & Sons, New York. xii + 444 p. $40.00.

Dasmann, Raymond F. 1984. Environmental conservation. Fifth Edition. John Wiley & Sons, New York. x + 486 p. $21.95 (paper).

Delcourt, Paul A., Hazel R. Delcourt, and Thompson Webb, III. 1984. Atlas of mapped distributions of dominance and modern pollen percentages for important tree taxa of eastern North America. AASP Contributions Series Number 14. American Association of Stratigraphic Palynologists Foundation, P.O. Box 819047, Dallas, Texas 75381. ii + 131 p. $9.00 (paper).

*Emlen, John Merritt. 1984. Population biology: the coevolution of population dynamics and behavior. Macmillan Publishing Company, New York. xii + 547 p.

*Fasham, M. J. R. (ed.). 1984. Flows of energy and materials in marine ecosystems: theory and practice. Plenum Press, New York. ix + 533 p. $110.00.

Gibson, J. H., James N. Galloway, Carl Schofield, William McFee, Robert Johnson, Sandy McCarley, Nancy Dise, and David Herzog. 1983. Rocky Mountain acidification study. Air Pollution and Acid Rain Report No. 17. FWS/OBS-40.17. Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C. 20240. xiii + 137 p. (paper).

Godron, Michel. 1984. Écologie de la végétation terrestre. Masson, New York. 196 p. (paper).

Krebs, J. R., and N. B. Davies (eds.). 1984. Behavioural ecology: an evolutionary approach. Second Edition. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts. xi + 493 p. $42.00 (cloth), $25.00 (paper).

Lincoln, R. J., G. A. Boxshall, and P. F. Clark. 1982. A dictionary of ecology, evolution and systematics. First Paperback Edition. Cambridge University Press, New York. viii + 298 p. $19.95 (paper).

Olson, J. S., J. A. Watts, and L. J. Allison. 1983. Carbon in live vegetation of major world ecosystems. Environmental Sciences Division Publication No. 1997. Oak Ridge National Laboratory, Oak Ridge, Tennessee. Available as ORNL-5862 from the National Technical Information Service, 4285 Port Royal Road, Springfield, Virginia 22161. xiii + 164 p. (paper).

Strong, Douglas H. 1984. Tahoe: an environmental history. University of Nebraska Press, Lincoln, Nebraska. xviii + 252 p. $16.95.

*Sutton, S. L., T. C. Whitmore, and A. C. Chadwick (eds.). 1983. Tropical rain forest: ecology and management. Special Publication Number 2 of the British Ecological Society. Blackwell Scientific Publications, Boston, Massachusetts. xiii + 498 p. $57.00.

* In review.