to provoke a similar mix of reactions. I would say, however, that, despite its complexity and flexibility, ACT* is a more clearly specified theory than its precursors. It has evolved to the stage at which evasion of disconfirming evidence may not be an easy option. Furthermore, Anderson's stress on generality is something the field clearly needs. Perhaps it is premature or even impossible to develop a general theory of cognition, but we will never know unless someone is willing to give it a serious try. And in proposing specific mechanisms of inductive learning Anderson focuses attention on a topic now widely recognized as critical to gaining understanding of human intelligence.

Those familiar with Anderson's earlier monographs will find that, although his latest is not an easy book, it is clearly written and more concise than its predecessors. It deserves the attention of researchers in cognitive science.

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Microbial Habitats

Microbes in Their Natural Environments. Papers from a symposium, Conventry, England, April 1983. J. H. SLATER, R. WHITTENBURY, and J. W. T. WIMPENNY, Eds. Published for the Society for General Microbiology by Cambridge University Press, New York, 1983. x, 498 pp., illus. $67.50. Symposia of the Society for General Microbiology, 34.

This collection of 12 papers is the proceedings of the 34th symposium of the Society for General Microbiology. According to the editors, the book was intended to bring together a group of manuscripts that discuss "the reality of microbial life" in natural ecosystems. What constitutes ecological reality for the editors is unclear, but their actual goal appears to have been to assemble a group of papers on modern approaches to microbial ecology that emphasize mixtures of laboratory and field experimentation. Such approaches presumably are more likely to yield information that is relevant to natural ecological processes than are approaches that emphasize only field or only laboratory work. The editors have generally succeeded in assembling such a group of papers.

For example, the book contains an excellent paper by David C. White concerning methods for the analysis of microbial activities and biomass in situ. Topics examined include community composition status and the difficulty of applying analytical methods in situ without the introduction of artifacts. This paper should be required reading for all those who study microbes in situ.

Other particularly informative papers include one by Richard G. Burns and one by Darryl C. Reanney, Peter C. Gowland, and J. Howard Slater. The paper by Burns discusses enzyme-substrate interactions in soil, particularly interactions involving polysaccharases and proteinases. It is among the best reviews of this topic available. The paper by Reanney *et al.* presents a lucid discussion of genetic interactions among natural microbial populations. It contains valuable information regarding transfer mechanisms and how these may or may not function in natural ecosystems.

An interesting paper by J. Greg Zeikus discusses metabolic communication between biodegradative populations in nature. The paper contains 39 citations of Zeikus's work and is mostly a review of work performed in his laboratory during the past ten years. The review ranges over a variety of topics, concentrating on anaerobic degradation of biological polymers and methanogenesis in lake sediments. Discussions of mixed-population anaerobic food chains are interesting and useful updates of this very lively subject. One weakness in the paper is its oversimplification of what happens to the plant polymer lignin in anaerobic environments. The statement that "lignin and related high molecular weight aromatic polymers . . . are not significantly decomposed in anaerobic environments" is far from proven. It may turn out to be correct; however, one set of experiments from one environment (Lake Mendota sediments) is not a sufficient basis for such a sweeping generalization.

The quality of other papers in the book is variable but generally high. Topics discussed include spatially heterogeneous laboratory models and microcosms (Wimpenny, Lovitt, and Coombs), the relevance of pure culture studies to natural ecosystems (Tempest, Neijssel, and Zevenboom), mechanisms of microbial energy transduction and solute transport (Konings and Veldkamp), microbial adaptations toward survival in hostile environments (Dow, Whittenbury, and Carr), bacterial motility and taxes (Rowbury, Armitage, and King), microbes and their interactions with surfaces (Wardell, Brown, and Flannigan), the carbon cycle in aquatic ecosystems (Ormerod), and the challenges provided by nature to microbial survival in natural environments (Stewart).

This book should be useful for specialists in microbial ecology, particularly those of us who teach the subject to university students. It is a recommended acquisition for the libraries of most universities. The book provides a nice summary of some of the successes in this field.

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Plant Structures

Xylem Structure and the Ascent of Sap. MARTIN H. ZIMMERMANN. Springer-Verlag, New York, 1983. x, 143 pp., illus. $19.50. Springer Series in Wood Science.

The comparative morphology of wood provides us with a well-documented and dramatic evolutionary series. The invasion and occupation of land by higher plants were closely linked to the evolution of both a support and a water transport system, namely the xylem. Thus the vast majority of the land plants are aptly classified as the Tracheophyta. The cell walls of the xylem contain cellulose for strength, hemicellulose as a matrix, and lignin for rigidity. These cell wall constituents were fabricated into tube-like cells, that is, the tracheids. Support is provided by a tough, rigid wall of helically wound microfibrils of cellulose embedded in a matrix of hemicellulose and encrusted with lignin. For transport the tracheid is programmed to eliminate its cytoplasm at functional maturity, leaving a hollow center (lumen) to serve as a water conduit. Cell-to-cell transport is facilitated by interconnecting holes termed bordered pits. The borders and membranes of these pits are constructed in such a way that structural weakness due to the pitting is minimized. Tracheids in coniferous plants have perforated membranes that have thickened disks in the center that can fold over and seal off the pits under certain conditions.

As Martin Zimmermann points out in this excellent monograph, the tracheid was so successful that few improvements were made for 300 million years. With the advent of the angiosperms a xylem appeared that had fiber tracheids for support (primarily) and vessels for transport. Each fusiform initial of the cambium produces a vessel element, and these vessel elements align themselves vertically, eliminate their protoplasts and end walls (at least partially), and form hollow vessels that in ring-porous

species may extend for many meters. Zimmermann stresses vessel length distribution rather than maximum or average vessel length and notes that the xylem generally contains more short vessels than long ones. Hydraulic conductivity varies with the fourth power of the radius of the vessel, and Zimmermann suggests that this parameter should be used in the functional comparison of xylem instead of the usually used vessel area or vessel number. Zimmermann provides thorough coverage of the applicability of the Hagen-Poiseuille equation to the xylem of various taxa and beginning with chapter 3 deals definitively with the cohesion theory for the ascent of sap. He does not spend much time evaluating competing hypotheses (for example, that put forth by Plumb and Bridgman, *Science* **176**, 1129 [1972]). He concludes with a chapter on the effects of pathology on water transport.

The references in the book are rich and mainstream, with good coverage of the older and European literature; citation of the wood science literature is somewhat lacking, however. Overall this volume is a fine and creative contribution that brings many heretofore disperse concepts into a coherent whole.

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Planetary Science

Physics of the Jovian Magnetosphere. A. J. DESSLER, Ed. Cambridge University Press, New York, 1983. xvi, 544 pp., illus. $29.50. Cambridge Planetary Science Series.

Books on the giant planets tend to be associated with the interpretative phase of major planetary missions and to have a lifetime on the order of the time until the mission's exciting data are superseded by the spectacular findings of the next mission. Thus the giant tome *Jupiter, The Giant Planet* that came out in 1975 in the wake of the Pioneer 10 and 11 missions has been replaced in the magnetosphere-plasma domain by the present volume, whose purview is the data collected by Voyager 1 and 2. Until the interpretative phase of the Galileo orbiter is reached, this volume will serve as the major reference work for researchers and students working in the field.

The book is tightly and rationally organized. It contains 12 papers, eight experimental and four theoretical. The experimental papers present the relevant Voyager data, the results of optical ultraviolet and radio remote sensing, and, in the paper on high-energy particles, the Pioneer 10 and 11 results. Results concerning the magnetic field, thermal plasma, and low-energy charged particles are presented clearly and discussed in depth by authors who were intimately involved with the experiments. A paper on the ionosphere by two Voyager ultraviolet experimenters insightfully compares the Pioneer and Voyager epochs and presents estimates of those ionospheric parameters, such as Pedersen conductivity, that play a basic role in magnetospheric dynamics.

A long paper by Brown, Pilcher, and Strobel, two ground-based optical spectroscopists and one member of the Voyager ultraviolet team, deals with the optical and ultraviolet remote sensing of the Io torus. The paper contains a great deal of "tutorial" material; the same space could have been better used for a more comprehensive and possibly fairer review of the contributions of many other workers, some of whom have been given rather short shrift in the paper. The involvement of a plasma physicist, if only as a consultant, would have done the paper good.

Chapters 7, 8, and 9 constitute a set. The first two chapters are reviews of the radio-astronomy and plasma-wave results, respectively, with the proper combination of authors from ground-based and Voyager groups. The last of the three chapters is the first of the theoretical papers, a review of the theories of radio emission by Goldstein and Goertz. The authors deal with the application of standard plasma-wave theory to the generation and propagation of electrostatic and electromagnetic waves in a magnetized plasma with, of course, Jupiter as the prime example. Of necessity this chapter depends on the following one, a discussion of magnetospheric models that, though to some extent presenting "the view from Rice," gives a fair picture of the generally sorry state of theory concerning the magnetosphere of a giant planet and the outstanding problems that remain to be confronted.

The final two papers deal with the fundamental questions concerning plasma physics that are raised by Jupiter. Vasyliunas deals creatively with the magnetohydrodynamic aspects of the plasma and magnetic-field regime, coupling his theoretical discussion with copious quantities of data gleaned from both the Pioneer and Voyager flybys. The result is an interesting and useful paper that does much more than simply review the published literature. Thorne, in the final paper, views the Jovian magnetosphere and its particle populations from the perspective of plasma kinetic theory. He discusses linear and nonlinear wave theory, including wave-particle interactions, diffusion resulting from the violation of the various adiabatic invariants, and the resonant-type processes that give rise to the broad range of Jovian magnetospheric plasma, particle, and radiation phenomena. Though there is some inevitable overlap between the paper and that of Goldstein and Goertz, the contents are sufficiently different to justify the inclusion of both papers. Thorne's paper is one of the book's highlights.

I can sum up by saying that this book is a useful and valuable research tool. It should be in the library of every researcher and student in the field. The editor is to be commended for bringing the book into being.

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