

evolving cognitive organization as characteristic of the life sciences of the late 20th century. The implication is of course that the formation and execution of science policy, whether by legislatures, government agencies, review bodies of scientists, or charitable foundations, should take account of the way in which "problem domains" are created. The authors are writing, then, as aspiring professional commentators on both the sociology of knowledge and science policy. One of the problems with their book is that they seem to be trying to address two peer groups at once. Almost certainly any cancer researchers reading the book will find much of the epistemological discussion obscure and convoluted, which it need not have been.

The book begins with an account of the history of research on cell transformation in which three traditions are discussed—viral, bacterial, and molecular. I found the sketching here too rapid and much of the information about molecular biology irrelevant. The second chapter describes the search, through data on the growth of specialist literatures, for an area of investigation where the idea of confluence could be tested. Eventually such an area was located in the work on reverse transcriptase from 1970. One cannot help feeling that the authors' difficulty in finding such confluence casts some doubt on their model. At this point the program of interviews by means of which Studer and Chubin sought to check the generalizations taken from their quantitative data is introduced. Throughout the book the interview material is used in a helpful way, although it might have borne more interpretation and other, seemingly more suggestive material from the interviews goes unused. One footnote refers to a forthcoming commentary on this material, and it is to be hoped that this will soon appear. The third chapter is a discussion of the political debates over the structure and funding of cancer research in the United States, which covers ground already worked over by Strickland in *Science, Politics and Dread Disease*, Rettig in *The Cancer Crusade*, and others. This section provides some useful background information for those not familiar with the politics of cancer research, although it is generally undeveloped.

The fourth chapter is an intellectual history of the work on reverse transcriptase, and for my taste it does not say enough about the technical and conceptual aspects of the research. For a book that continually urges sociologists to consider the cognitive dimensions of sci-

entific work, rather than scientists' behavior and mere patterns of cocitation or coauthorship of articles, it tells us remarkably little about biological and biochemical concepts, theories, experiments, and methods.

These four chapters then, each with a different approach, can be balanced against the remaining two and the appendixes, which are largely given over to statistical studies of the structure and dynamics of research in the chosen problem domain. Although my own methodological sympathies would have lain with the earlier chapters, I found the quantitative chapters more interesting. From a four-year survey of the biomedical literature as represented in *Index Medicus*, Studer and Chubin extracted a set of 606 articles that relate to reverse transcriptase. They discuss the patterns of authorship and citation within them, describing, for example, how scientists seem to fit work on a new problem into their developing research careers, how some assemble large teams that seize upon new ideas and publish very rapidly. They suggest that researchers even in this mode of activity keep up their links with other areas of research and may redirect their interests should it make sense to do so. The suggestion is, then, that scientists' behavior and research strategies can be recovered from detailed analysis of the structure of publications around events of major technical or theoretical significance.

In chapter 6 Studer and Chubin take the discussion of cocitation a stage further and select a subset of highly cocited articles, which they call the cosmopolitan network. By treating this network in matrix terms—that is, by setting out in a two-dimensional array the number of times articles are cocited—one can produce quantitative representations of the clustering of the related articles. This technique, which they call "eigenstructure" research, is described in appendix C. It allowed them to identify seven clusters of articles, of which they discuss four in detail to display the relations of the work to other areas of research. The interpretation these authors give of these relations is that they display the coming together of technical, theoretical, and methodological concerns from disparate fields of endeavor. The postulation of this kind of relatedness in the life sciences leads them to stress that research proceeds through confluence rather than through crises and discontinuities. Their case is certainly persuasive in this instance, and it adds up to an impressive demonstration of what one can

do with citation studies if the interpretation is not pushed too far. What one is not told is whether the same conclusion might have been reached by reading all the articles in the cosmopolitan network and interviewing the scientists concerned.

In conclusion, although the argument and evidence seem thin in places and many of the issues raised are not adequately related to one another, the book represents a useful effort to combine a number of different approaches to a complex problem. I found it stimulating to read.

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## Nitrogen Processes

**Nitrogen Fixation.** Papers from a symposium, Madison, Wis., June 1978. WILLIAM E. NEWTON and WILLIAM H. ORME-JOHNSON, Eds. University Park Press, Baltimore, 1980. In two volumes. Vol. 1, *Free-Living Systems and Chemical Models*. xiv, 394 pp., illus. Vol. 2, *Symbiotic Associations and Cyanobacteria*. xiv, 326 pp., illus. \$39.50 each.

About 1.6 percent of world energy is being used to synthesize fertilizer. This has prompted biologists and agriculturists in recent years to devote increasing effort and talent to understanding, enhancing, and modifying biological nitrogen fixation, and their considerable success is summarized in these two volumes containing the proceedings of the seventh Harry F. Steenbock Symposium (the third Kettering Symposium). The volumes contain 42 contributions that consider seemingly all aspects of nitrogen fixation and several closely allied subjects. Together they provide the reader with an excellent overview of the state (as it existed two years ago) of this diverse, fast-moving field. The diversity of the coverage is illustrated by the major subdivisions: Global Nitrogen and Carbon Economy, Genetics and Physiology (of free-living bacteria), Nitrogenase and Cofactors, Chemical Models (of nitrogenase), Leguminous Associations, Nonleguminous Associations, and Cyanobacteria and their Associations.

It is generally assumed (admittedly with very few supporting data) that the global nitrogen cycle is balanced—that the quantity of nitrogen fixed is matched by the amount released to the atmosphere through denitrification and that almost all denitrification is biological,

mediated exclusively by prokaryotes. It is estimated that between 15 and 50 percent of nitrogen fertilizer is lost through denitrification before it becomes available to the plant. In a chapter that summarizes our present state of knowledge of this somewhat neglected process, W. J. Payne *et al.* point out, "Nitrogen fixation and incorporation into metabolism assure that the biological world stays ahead of nitrogen deficiency, but denitrification just as certainly assures that the margin is always slim."

Two chapters (by G. A. Peters *et al.* and S. N. Talley and D. W. Rains) discuss the physiology and agricultural uses of the  $N_2$ -fixing symbiotic association between a water fern, *Azolla*, and its cyanobacterial symbiont, *Anabaena*. This association (*Azolla pinnata*-*Anabaena*) has been domesticated for several centuries in Vietnam, where it is now grown as a fertilizer crop on over 40,000 hectares of fallow rice fields, providing sufficient nitrogen to produce 5 metric tons of grain per hectare. More recently (within the last three decades) cultivation of *Azolla* has been adopted in China, where *Azolla* now serves as the principal source of nitrogen for approximately 1,300,000 hectares of subtropical and temperate rice. Recent studies in California have shown that the *Azolla mexicana*-*Anabaena azollae* association excretes ammonia during growth. This source of nitrogen along with that contained in the biomass of the association seems to offer considerable promise for achieving the long hoped-for goal of supplying most of the requirements of a major cereal crop from biologically fixed nitrogen.

Advances in our understanding of the genetics and biochemistry of nitrogen fixation in the past several years have been remarkable, and the complexity of the system has been a surprise. At least 13 contiguous genes (*nif* genes) govern the process of nitrogen fixation by the free-living bacterium *Klebsiella pneumoniae*. These genes are transcribed in at least six distinct units. Modern techniques of microbial genetics—cloning, transposon mutagenesis, and deletion mutagenesis by induction of mu phage—have been effectively exploited in these studies.

*Nitrogen Fixation* is an important book for those engaged in research on this or related topics and for those who want to be up to date on this rapidly advancing field.

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## Books Received

**Advances in Cancer Research.** Vol. 31. George Klein and Sidney Weinhouse, Eds. Academic Press, New York, 1980. x, 332 pp. illus. \$35.

**Advances in Photochemistry.** Vol. 12. James N. Pitts, Jr., George S. Hammond, Klaus Gollnick, and Daniel Grosjean, Eds. Interscience (Wiley), New York, 1980. xvi, 360 pp., illus. \$42.50.

**Affine Sets and Affine Groups.** D. G. Northcott. Cambridge University Press, New York, 1980. x, 286 pp. Paper, \$22.50. London Mathematical Society Lecture Note Series, 39.

**Alcoholism.** A Practical Treatment Guide. Stanley E. Gitlow and Herbert S. Peyser, Eds. Grune and Stratton, New York, 1980. xvi, 288 pp. \$24.50.

**Background Math for a Computer World.** Ruth Ashley in consultation with Nancy B. Stern. Wiley, New York, ed. 2, 1980. xii, 308 pp. Paper, \$7.95.

**Basic Biochemistry.** Max E. Rafelson, Jr., James A. Hayashi, and Anatoly Bezkorovainy, Macmillan, New York; Collier Macmillan Canada, Toronto; and Baillière Tindal, London, ed. 4, 1980. x, 418 pp., illus. Paper, \$14.95.

**Biogeochemistry of Amino Acids.** Papers from a conference, Warrenton, Va., Oct. 1978. P. E. Hare, T. C. Hoering, and K. King, Jr., Eds. Wiley, New York, 1980. xviii, 558 pp., illus. \$56.

**Birds.** Readings from *Scientific American*. Introductions by Barry W. Wilson. Freeman, San Francisco, 1980. x, 276 pp., illus. Cloth, \$17.95; paper, \$8.95.

**The Brain.** Freeman, San Francisco, 1979. viii, 150 pp., illus. Paper, \$5.95. A *Scientific American* Book.

**Brain and Pituitary Peptides.** Papers from a symposium, Munich, June 1979. W. Wuttke, K. H. Voigt, and R.-R. Dries, Eds. Karger, Basel, 1980. viii, 238 pp., illus. \$64.

**Cholera and Related Diarrheas.** Molecular Aspects of a Global Health Problem. Papers from a symposium, Stockholm, Aug. 1978. Orjan Ouchterlony and Jan Holmgren, Eds. Karger, Basel, 1980. xii, 252 pp., illus. \$75.

**Cisplatin.** Current Status and New Developments. Papers from a symposium, Atlanta, Sept. 1979. Archie W. Prestayko, Stanley T. Crooke, and Stephen K. Carter, Eds. Academic Press, New York, 1980. xvi, 528 pp., illus. \$30.

**The Classical Thermodynamics of Deformable Materials.** A. G. McLellan. Cambridge University Press, New York, 1980. xviii, 338 pp., illus. \$62.50. Cambridge Monographs on Physics.

**The Current Status and Future of Academic Obstetrics.** Papers from a conference, Williamsburg, Va., June 1979. John Z. Bowers and Elizabeth F. Purcell, Eds. Josiah Macy, Jr. Foundation, New York, 1980 (distributor, Independent Publishers Group, New York). viii, 184 pp. Paper, \$4.

**Current Topics in Membranes and Transport.** Felix Bronner and Arnost Kleinzeller, Eds. Vol. 13, Cellular Mechanisms of Renal Tubular Ion Transport. Emile L. Boulpaep, Ed. Academic Press, New York, 1980. xxvi, 434 pp., illus. \$45.

**Decontamination and Decommissioning of Nuclear Facilities.** Proceedings of a meeting, Sun Valley, Idaho, Sept. 1979. Marilyn M. Osterhout, Ed. Plenum, New York, 1980. xvi, 804 pp., illus. \$75.

**Design and Memory.** Computer Programming in the 20th Century. Peter H. Huyck and Nellie W. Kremenak. McGraw-Hill, New York, 1980. viii, 152 pp. \$11.95.

**The Development of Sociomoral Knowledge.** A Cognitive-Structural Approach. Hugh Rosen. Columbia University Press, New York, 1980. xvi, 198 pp. Cloth, \$20; paper, \$10.

**Digital System Design with LSI Bid-Slice Logic.** Glenford J. Myers, Wiley-Interscience, New York, 1980. xiv, 338 pp., illus. \$28.50.

**Electric Power and the Future of the Pacific Northwest.** Kai N. Lee and Donna Lee Klemka with Marion E. Marts. University of Washington Press, Seattle, 1980. xvi, 332 pp., illus. \$16.95.

**Electronic Structure and Magnetism of Inorganic Compounds.** Vol. 6. A Review of the Recent Literature. P. Day, Senior Reporter. Chemical Society, London, 1980 (U.S. distributor, American Chemical Society, Washington, D.C.). x, 314 pp., illus. \$65.

**Encyclopedia of Common Natural Ingredients Used in Food, Drugs, and Cosmetics.** Albert Y. Leung. Wiley-Interscience, New York, 1980. xx, 410 pp. \$47.

**Energy.** From Opulence to Sufficiency. Jerrold H. Krenz. Praeger, New York, and Hemisphere, Washington, D.C., 1980. viii, 264 pp., illus. \$24.95.

**Engineering Applications of Correlation and Spectral Analysis.** Julius S. Bendat and Allan G. Piersol. Wiley-Interscience, New York, 1980. xvi, 302 pp., illus. \$29.95.

**The Entertainment Functions of Television.** Papers from a conference. Percy H. Tanenbaum, Ed. Erlbaum, Hillsdale, N.J., 1980. x, 262 pp. \$19.95.

**Freud.** The Man and the Cause. Ronald W. Clark. Random, New York, 1980. xiv, 654 pp. + plates. \$19.95.

**Friendship and Social Relations in Children.** Hugh C. Foot, Antony J. Chapman, and Jean R. Smith, Eds. Illustrations by Patty Inkley. Wiley, New York, 1980. x, 396 pp. \$42.50.

**From DNA to Protein.** The Transfer of Genetic Information. Maria Szekely. Halsted (Wiley), New York, 1980. viii, 284 pp., illus. \$35.95.

**Frontiers of Bioorganic Chemistry and Molecular Biology.** Proceedings of a symposium, Moscow and Tashkent, Soviet Union, Sept. 1978. S. N. Ananchenko, Ed. Pergamon, New York, 1980. x, 474 pp., illus. \$80.

**Fundamentals of Entomology and Plant Pathology.** Louis L. Pyenson. AVI Publishing Company, Westport, Conn., ed. 2, 1980. xx, 366 pp., illus. \$22.

**Gas Solubilities.** Widespread Applications. William Gerrard. Pergamon, New York, 1980. xxii, 498 pp., illus. \$67.50.

**The Genus *Penicillium* and Its Teleomorphic States *Eupenicillium* and *Talaromyces*.** John I. Pitt. Academic Press, New York, 1979. viii, 634 pp., illus. \$92.

**Gordon Childe.** Revolutions in Archaeology. Bruce G. Trigger. Columbia University Press, New York, 1980. 208 pp., illus. + plates. \$22.50.

**Ground Water.** Robert Bowen. Applied Science Publishers, London, and Halsted (Wiley), New York, 1980. xii, 228 pp., illus. \$44.95.

**Handbook of Environmental Health and Safety.** Principles and Practices. Herman Koren. Pergamon, New York, 1980. xx, 698 pp., illus. + appendix. Cloth, \$95; paper (in two volumes), \$51.

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