science is, above all, a human enterprise, shaped by personalities, communities, and institutions, as well as ideas.

ROBERT FRIEDEL
Department of History, University of Maryland, College Park, MD 20742

Weatherwatchers

Meteorology in America, 1800–1870. JAMES RODGER FLEMING. Johns Hopkins University Press, Baltimore, MD, 1990. xxiv, 264 pp., illus. $52.

It has been hard for historians to take meteorology seriously. Those who study the history of physics, for instance, find weather science wanting in great men, mathematical rigor, and theoretical complexity. To them it has seemed the perfect example of the Baconian method, a would-be science with only masses of data to recommend it.

In this new book, James Fleming argues strongly otherwise, and in the process he provides us with a new appreciation of leading American meteorologists in the emerging stage of the discipline, as well as fresh insights into the relations of science and American culture.

Meteorology proved of more than usual interest to the European migrants to America because summers and winters were so much hotter and colder here. Many of them also assumed that as deforestation and tillage altered the landscape, the weather would be changed too, a notion that encouraged record-keeping activities. But it was the frequent occurrence of sudden, violent storms and, as Benjamin Franklin noted, their typically northeastward track that drew special attention to the study of meteorological phenomena in North America.

What stands out in the early phases of meteorological work in America is the dominant role of individuals—successive surgeons general concerned to discover the relation between climate and health; the head of the General Land Office who saw in the geographic dispersion of land agents a mechanism for collecting data about weather, flora, and fauna; William C. Redfield, a New York businessman passionately attached to his own theory of storms; James P. Espy, another storm theorist who artfully managed to make a career in meteorology out of a string of government appointments; and the Smithsonian's first Secretary, Joseph Henry, whose position made him a central figure in the development of weather study. Yet paradoxically, it was the ability of individuals like these to stimulate collective action that speeded the emergence of meteorology as a scientific discipline.

One of the interesting things Fleming demonstrates is the way theorizing energized data collection. The utility of a system of volunteer observers—widely scattered, properly equipped, and consistent in their methods of reporting—was obvious from the 18th century. The prevailing easterly movement of the weather clearly suggested that regularly collected data might yield predictability. But the impetus to the successful formation of such observational systems came from the debate over storm theory that boiled into public controversy in the 1830s. Redfield, who had a kinetic theory, Espy, with a thermal explanation of storms, and the University of Pennsylvania chemist Robert Hare, who believed they were caused by electrical effects, all strenuously competed—in the halls of Congress as well as in the public press—for the primacy of their views. Espy emerged the most adept in enlisting volunteer observers, first in a group organized by a joint committee on meteorology of the Franklin Institute and the American Philosophical Society, then later in a system coordinated at the Smithsonian, and consequently saw his views most widely accepted.

The controversy over storm theories proved vital both to the popularization of meteorology and to the professionalization of American science. Ministers, educators, farmers, and physicians working in the small rural communities of the country—on the periphery of the nation's intellectual life—could still feel connected to its center through their observations and reports. This broad popular base also clearly explains why American public support for meteorology was higher than in any European country. Furthermore, the application of telegraphy to weather reporting not only made possible simultaneous observation but brought weather forecasting into the realm of practical reality.

Years ago, Hunter Dupree observed that if American scientists were to secure professional careers of their own and gain international standing for their country's science, they had first to seize control of the American phenomena. That proved as true for meteorology as for botany. In the two decades before the Civil War, and primarily through the efforts of Espy and Henry, meteorologists worked out successful methods of data collection, revised their theoretical analysis, and created an institutional structure that essentially defined subsequent government policy.

Fleming's important contribution to our understanding of science during its formative period in America is to show the extent to which meteorology was shaped by cultural values. The idea of a democratic science to which anyone might contribute appealed to Americans, who increasingly supported it from the public purse. And the reasons for their support, Fleming points out, went beyond the obvious utility of weather prediction to encompass an interest in the theories as well as the processes of science.

BRUCE SINCLAIR
School of History, Technology and Society, Georgia Institute of Technology, Atlanta, GA 30332–0345

An Emergent Field

Fundamentals of Molecular Evolution. WEN-HSIUNG LI and DAN GRAUR. Sinauer, Sunderland, MA, 1991. xviii, 284 pp., illus. Paper, $22.95.

Over the past quarter-century the wealth of information that has accumulated on the molecular structure and organization of genes and genomes has revealed processes of genetic change that were completely unanticipated and that have needed to be integrated into evolutionary theory. The field of molecular evolution, a synthesis of the disparate areas of molecular biology and evolutionary biology, has emerged to provide this integration. Courses in molecular evolution are beginning to appear in undergraduate curricula, and there is a real need for a concise yet authoritative elementary textbook on the subject. *Fundamentals of Molecular Evolution* fills that need admirably. It provides a lucid account of this rapidly expanding field and it is graced with an attractive design, a glossary, a good index, and well-chosen figures.

The book begins with the obligatory chapter reviewing the structure of DNA, the nature of the code, and the mechanisms of mutation. The next three chapters give an account of elementary population genetics and of the evolutionary inferences that follow from an analysis of patterns of nucleotide substitution in genes. Population genetics seeks to predict the trajectory of gene-frequency change over time, when various stochastic (gene-frequency drift) and deterministic (natural selection and mutation) forces are operating. The theory of population genetics has recently expanded to consider new problems posed by transposon evolution, the concerted evolution of multigene families, and the question of selfish DNA. In addition, population genetics has provided the statistical framework for the analysis of molecular evolutionary data. Thus, for example, methods for estimating numbers of gene substitutions and calculating genetic distances from gene sequence data are derived from population-genetic arguments. The molecular clock hypothesis, based on a population-genetic theorem, posits that neutral gene substitutions should occur at a rate equal to the mutation rate, which may be a linear function of time. This result provides a basis for the estimation of divergence times among major lineages in the absence of an adequate fossil record. Moreover, times of duplication of major gene functions (for instance, divergence times of members of the globin gene superfamily) can be estimated from sequence data.

The fifth chapter of the book develops the estimation of organismic relationships from molecular data. If genetic distance increases as a monotonic function of time then it should be possible to estimate the pattern (topology) of relationships from gene-sequence data (molecular phylogenies). This application of molecular data has given rise to a number of computational algorithms that can seem complicated and confusing to the novice. While molecular phylogenetics has reinvigorated the study of systematics in recent years, it has also yielded several contentious schools of thought on computational methodology. Molecular phylogenies are also providing an independent basis for the analysis of morphological evolution and for testing major issues like the hypothesis that mitochondria and chloroplasts had an endosymbiotic origin.

The remaining chapters deal with what might be called molecular phenomonology. For example, during the past quarter-century we have learned that eukaryotic genomes contain vast numbers of repeated DNA sequences whose functions are obscure; introns were discovered, as were overlapping genes; the molecular structure of transposable elements was documented; and these genetic entities were found to be ubiquitous in nature. In addition, retroviruses and their associated retrotransposons were described and their occasional horizontal transfer among species was documented. This wealth of empirical information has produced a kind of natural history of the genome. As with classical natural history, the natural history of the genome must be accounted for within a unified theoretical framework. The theory of evolution provides that framework. It is a testament to the power of evolutionary theory that it can easily accommodate observations that were not imagined a quarter of a century ago.

MICHAEL T. CLEGG
Department of Botany and Plant Sciences, University of California, Riverside, CA 92521

Reprints of Books Previously Reviewed

The Edge of Objectivity. An Essay in the History of Scientific Ideas. Charles Coulston Gillispie. Princeton University Press, Princeton, NJ, 1990. Paper, $14.95. *Reviewed* **131**, 1203 (1960).

Genome. The Story of the Most Astonishing Scientific Adventure of Our Time—The Attempt to Map All the Genes in the Human Body. Jerry E. Bishop and Michael Waldholz. Simon and Schuster, New York, 1991. Paper, $10.95. *Reviewed* **252**, 142 (1991).

Kadimakara. Extinct Vertebrates of Australia. P. V. Rich and G. F. van Tets, Eds. Princeton University Press, Princeton, NJ, 1990. *Reviewed* **236**, 1408 (1987).

Books Received

Acquired Aphasia. Martha Taylor Sarno, Ed. 2nd ed. Academic Press, San Diego, CA, 1991. xiv, 600 pp., illus. $55.

Advances in Theoretical Physics. Alan H. Luther, Ed. Pergamon, New York, 1990. viii, 256 pp., illus. $49.50. From a symposium, Copenhagen, June 1988.

Affinity Membranes. Their Chemistry and Performance in Adsorptive Separation Processes. Elias Klein. Wiley, New York, 1991. xii, 152 pp., illus. $70. A Wiley-Interscience Publication.

The "African" Honey Bee. Marla Spivak, David J. C. Fletcher, and Michael D. Breed, Eds. Westview, Boulder, CO, 1991. viii, 435 pp., illus. $55. Westview Studies in Insect Biology.

AIDS-Related Psychotherapy. Mark G. Winiarski. Pergamon, New York, 1991. xii, 235 pp. $29.50. Pergamon General Psychology Series, 165.

Animal Species for Developmental Studies. Vol. 2, Vertebrates. T. A. Dettlaff *et al.*, Eds. Consultants Bureau (Plenum), New York, 1991. xiv, 453 pp., illus. $115. Translated from the Russian edition (Moscow, 1975) by G. G. Gause, Jr., and S. G. Vassetzky.

Archaeology Yesterday and Today. The Development of Archaeology in the Sciences and Humanities. Jaroslav Malina and Zdeněk Vašíček. Ed. Cambridge University Press, New York, 1991. xiv, 320 pp., illus. $65; paper, $18.95. Translated and edited by Marek Zvelebil.

The Astronomers. Companion Book to the PBS Television Series. Donald Goldsmith. St. Martin's, New York, 1991. xx, illus., + plates. $24.95.

Astronomy on the Personal Computer. O. Montenbruck and T. Pfleger. Springer-Verlag, New York, 1991. xii, 255 pp., illus., + diskette. $49.50. Translated from the German edition (Berlin, 1989) by S. Dunlop.

Atherosclerosis 2. Recent Progress in Atherosclerosis Research. K. T. Lee, Kogo Onodera, and Kenzo Tanaka, Eds. New York Academy of Sciences, New York, 1990. xiv, 589 pp., illus. Cloth or paper, $108. Annals of the New York Academy of Sciences, vol. 598. From a conference, Towada, Japan, Oct. 1989.

Atomic and Molecular Spectroscopy. Basic Aspects and Practical Applications. Sune Svanberg. Springer-Verlag, New York, 1991. xii, 405 pp., illus. $49. Springer Series on Atoms and Plasmas, vol. 6.

Bacterial Infections of Humans. Epidemiology and Control. Alfred S. Evans and Philip S. Brachman, Eds. Plenum, New York, 1991. xlii, 865 pp., illus. $89.50.

Balancing on the Brink of Extinction. The Endangered Species Act and Lessons for the Future. Kathryn A. Kohm, Ed. Island Press, Washington, DC, 1991. xii, 318 pp. $34.95; paper, $22.95.

Behavioral Measures of Neurotoxicity. Roger W. Russell, Pamela Ebert Flattau, and Andrew M. Pope, Eds. National Academy Press, Washington, DC, 1990. xvi, 432 pp., illus. $42.50. From a symposium, Canberra, Australia, Aug. 1988.

Better Trout Habitat. Guide to Stream Restoration and Management. Christopher J. Hunter. Tom Palmer, Ed. Illustrations by Ellen Meloy. xxx, 320 pp. $39.95; paper, $24.95.

Beyond Revolutions. On Becoming a Cybernetic Epistemologist. June Di Salvo. Vantage, New York, 1990. xlii, 148 pp., illus. $14.95.

Biochemistry, Molecular Biology, and Physiology of Phospholipase A_2 and Its Regulatory Factors. Anil B. Mukherjee, Ed. Plenum, New York, 1990. viii, 264 pp., illus. $69.50. Advances in Experimental Medicine and Biology, vol. 279. From a symposium, Bethesda, MD, Sept. 1989.

Biological Actions of Extracellular ATP. George R. Dubyak and Jeffrey S. Fedan, Eds. New York Academy of Sciences, New York, 1990. xii, 542 pp., illus. Cloth or paper, $125. Annals of the New York Academy of Sciences, vol. 603. From a conference, Philadelphia, PA, Nov. 1990.

Biological Feedback. Rene Thomas and Richard D'Ari. CRC Press, Boca Raton, FL, 1990. vi, 316 pp., illus. $149.95.

Biological Reactive Intermediate 4. Molecular and Cellular Effects and Their Impact on Human Health. Charlotte M. Witmer *et al.*, Eds. Plenum, New York, 1991. xviii, 894 pp., illus. $159.50. Advances in Experimental Medicine and Biology, vol. 283. From a symposium, Tucson, AZ, Jan. 1990.

Biomedical Ethics Reviews 1990. James M. Humber and Robert F. Almeder, Eds. Humana, Clifton, NJ, 1991. x, 257 pp. $39.50.

Camping with the Prince and Other Tales of Science in Africa. Thomas A. Bass. Penguin, New York, 1991. xvi, 304 pp. Paper, $9.95. Reprint, 1990 ed.

Cancer and Nutrition. Roslyn B. Alfin-Slater and David Kritchevsky, Eds. Plenum, New York, 1991. xvi, 491 pp., illus. $95. Human Nutrition. A Comprehensive Treatise, vol. 7.

Causes of Evolution. A Paleontological Perspective. Robert M. Ross and Warren D. Allmon, Eds. University of Chicago Press, Chicago, IL, 1991. xiv, 479 pp., illus. $65; paper, $24.95.

Covariant Operator Formalism of Gauge Theories and Quantum Gravity. N. Nakanishi and I. Ojima. World Scientific, Teaneck, NJ, 1990. xvi, 434 pp. $74; paper, $34. World Scientific Lecture Notes in Physics, vol. 27.

Crisis in the World's Fisheries. People, Problems, and Policies. James R. McGoodwin. Stanford University Press, Stanford, CA, 1991. xii, 235 pp., + plates. $35.

Cytokines. Basic Principles and Clinical Applications. S. Romagnani and A. K. Abbas, Eds. Raven, New York, 1990. xx, 370 pp., illus. $95. Serono Symposia Publications, vol. 68. From a symposium.

Design of Very High-Level Computer Language. A User-Oriented Approach. Melvin Klerer. J. Ranade, Ed. 2nd ed. McGraw-Hill, New York, 1991. xxii, 229 pp., illus. $49.95.

Handbook of Photon Interaction Coefficients in Radioisotope-Excited X-ray Fluorescence Analysis. O. S. Marenkov and N. I. Komyak. Nova, New York, 1990. 222 pp. $97. Translated from the Russian edition (Moscow, 1988).

Modular Deficits in Alzheimer-Type Dementia. Myrna F. Schwartz, Ed. MIT Press, Cambridge, MA, 1991. xviii, 346 pp., illus. $45. A Bradford Book. Issues in the Biology of Language and Cognition.

Negotiation Games. Applying Game Theory to Bargaining and Arbitration. Steven J. Brams. Routledge (Routledge, Chapman, and Hall), New York, 1991. xviii, 297 pp., illus. $49.50; paper, $15.95.

Supercollider 2. Michael McAshan, Ed. Plenum, New York, 1990. xviii, 840 pp., illus. $135. From a symposium, Miami Beach, FL, March 1990.

Synthesis of Lanthanide and Actinide Compounds. G. Meyer and L. R. Morss, Eds. Kluwer, Boston, MA, 1991. xvi, 367 pp., illus. $134. Topics in f-Element Chemistry, vol. 2.

Theory of Simple Liquids. Jean Pierre Hansen and Ian R. McDonald. 2nd ed. Academic Press, San Diego, CA, 1991. xii, 556 pp., illus. Paper, $24.50.

Torrey's Morphogenesis of the Vertebrates. Alan Feduccia and Edward McCrady. 5th ed. Wiley, New York, 1991. viii, 517 pp., illus. $54.95.

2.8 Angstroms. The Unifying Force of *G* and *c*. Kenneth G. Salem. Salem, Johnstown, PA, 1990. x, 123 pp., illus. Paper, $8.95.

Walking with the Great Apes. Jane Goodall, Dian Fossey, Birute Galdikas. Sy Montgomery. Houghton Mifflin, Boston, 1991. xx, 280 pp., illus. $19.95. A Peter Davison Book.

Ways of Thinking. The Limits of Rational Thought and Artificial Intelligence. Laszlo Mero. Viktor Meszaros, Transl. Ed. World Scientific, Teaneck, NJ, 1990. viii, 252 pp., illus. $48; paper, $24. Translated from the Hungarian edition by Anna C. Gosi-Greguss.

Weather from Above. America's Meteorological Satellites. Janice Hill. Smithsonian Institution Press, Washington, DC, 1991. x, 89 pp., illus. $19.95; paper, $9.95.

The Weird and Wondorous World of Patents. Robert O. Richardson. Sterling, New York, 1991. Paper, $9.95.

The Whole Earth Quiz Book. How Well Do You Know Your Planet? Bill Adler, Jr. Quill (Morrow), New York, 1991. 201 pp., illus. Paper, $6.95.

The World Treasury of Physics, Astronomy, and Mathematics. Timothy Ferris, Ed. Little, Brown, Boston, 1991. xvi, 859 pp., illus. $34.95.