

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

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## 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 ac-

tion 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.

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## 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 multi-gene 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