comfortable with the mathematical calculation of lifting forces, was off to Paris to make new demonstrations. There he encountered competition from a hydrogen-filled counterpart to his device (an alternative he and Joseph had considered but rejected because of the expense of procuring that gas) built by and popularly named for the physicist J.-A.-C. Charles. Etienne continued on his own projects, however, proceeding from a not very successful demonstration for the Academy to the launching of a rooster, a duck, and a sheep (Etienne's letter to his wife describing this flight is a marvelous addition to the literature) and finally, after several tethered trials (in one of which Etienne himself participated, one of many hitherto unknown details unearthed by Gillispie), to manned free flight. Throughout this period, and for several months thereafter, Etienne attempted to convert the fame of the "machine" to the profit of the paper mill in the form of a "Royal Manufactory" designation. Gillispie chronicles every effort of this provincial in the capital, shedding interesting light on the then-existing networks of communication and patterns of privilege. Unfortunately for the Montgolfiers, Etienne was unsuccessful in that quest, as also in the quest for large government monies to continue the development of the *aérostat* looking forward to its large-scale commercial use.

With those failures, Gillispie leaves the Montgolfiers temporarily in order briefly to pursue the beginnings of "barnstorming" with Jean-Pierre Blanchard and of the more serious business of aeronautical engineering in the ideas and designs of Jean-Baptiste Meusnier for achieving stabilization of altitude and control over locomotion and direction. He returns, in a last chapter, to finish their story largely in an exploration of the other outcomes of Joseph's preoccupation with problems of heat and mechanical work, looking at his efforts in building and employing both an internal combustion engine and a hydraulic ram. That section concludes with a study of the contributions of his nephew, Marc Seguin, to the science of thermodynamics, as well as the construction of both the first suspension bridge and the first railroad in France.

All of this is done not only with many new details but with frequent insights into social structures and personal motivations and occasional large generalizations on the nature of scientific research or the emergence of engineering out of tinkering. Moreover, Gillispie has an eye for the dramatic, a flair for characterization, and a command of both the English and the French languages that enable him to entrance while informing the reader. The whole is further enhanced by a large number of carefully chosen illustrations.

"Madame Blanchard rising above Turin in 1812." Jean-Pierre Blanchard, "the first of the barnstormers . . . put on numerous ascensions . . . before his death of natural causes in 1809. . . . His widow, the first woman to solo, assumed the mantle for another ten years and made sixty-seven flights before falling into Paris amid flames, victim of her practice of varying the spectacle by setting off fireworks from the gondola." [From *The Montgolfier Brothers and the Invention of Aviation*; U.S. Air Force Academy Gimbel Collection 1819]

Not that everything is positive. There is too great a use of such annoyingly trite transitions as "Readers may wish to know. . . ." And there are occasional oversights. Curiously, given his familiarity with the sources, Gillispie seems unaware of new petitions made to the Minister of the Interior by Etienne in 1798 and a resultant report in the First Class of the National Institute less than two months before his death in 1799. Moreover, I should have liked Gillispie to address the matter of Lalande's later claim that Montgolfier had promised to allow him to be the first man to ascend in his "machine." But these are cavils. Overall I find myself as enthusiastic as I expected from the sections on the beginnings of aviation in Gillispie's 1980 *Science and Polity in France at the End of the Old Regime*.

SEYMOUR L. CHAPIN
Department of History, California State University, Los Angeles 90032

Oxygen Biochemistry

Oxygenases and Oxygen Metabolism. A Symposium in Honor of Osamu Hayaishi. Hakone, Japan, Nov. 1981. MITSUHIRO NOZAKI, SHOZO YAMAMOTO, YUZURU ISHIMURA, MINOR J. COON, LARS ERNSTER, and RONALD W. ESTABROOK, Eds. Academic Press, New York, 1982. xxii, 664 pp., illus. $48.

This excellent book contains 76 papers presented at a symposium held in honor of Osamu Hayaishi on his 60th birthday. Hayaishi has had major influence on the course of the biochemical study of oxygen. His early work, which was partly carried out during a stay at the National Institutes of Health in the mid-1950's, was on catechol dioxygenase and was the first demonstration that the oxygen atoms from molecular oxygen could be incorporated into products. Previously, the generally accepted hypothesis, advanced at the turn of the century by Wieland, was that biological oxidations only involve the transfer of hydrogen atoms and that any oxygen incorporated into product was derived from water.

Hayaishi's discovery of dioxygenases was a milestone in biochemistry and the beginning of oxygenase chemistry. Howard Mason, who has a paper in this book, simultaneously discovered oxygenase activity in the phenolase system. His finding was the first demonstration of the splitting of the dioxygen molecule, with one atom being incorporated into an organic substrate and the other into water. This process was termed "mixed function oxidation" and, subsequently, "monooxygenation" or "hydroxylation."

In the ensuing years Hayaishi and his colleagues, many of whom have papers in the book, purified and characterized a large number of dioxygenases and monooxygenases and set the tone of research on this subject. Two major symposiums on oxygenases, one in 1966 and another in 1974, led to books edited by Hayaishi that are primary sources for students of oxygenase chemistry and oxygen metabolism.

The present book contains excellent papers on structures and mechanisms of the intradiol and extradiol catechol dioxygenases, enzymes originally discovered by Hayaishi. Genetic analysis, cloning, peptide and gene sequencing, and a large number of physical techniques are being employed to study the nature of these bacterial iron-containing enzymes. Toluene dioxygenase and putidamonooxin, multicomponent oxygenases involved in the degradation of unactivated aromatic compounds, are described. These enzymes are typical of a large number of such oxygenases found in soil bacteria.

They have extremely diverse oxygenative capabilities and may provide one of the primary routes for oxygenation in bacteria. They all seem to employ two-iron, two-sulfur structures at the active site and also require ferrous ion to catalyze the oxygenations. It is curious that this active site can catalyze both mono- and dioxygenations. The bacterial enzymes have high turnover numbers and take part in reactions typical of P-450 systems, monooxygenases largely found in eukaryotes.

Other papers cover various heme proteins, including P-450, peroxidases, heme oxygenases, and indoleamine oxygenases. Bleomycin and its oxygenase activity on DNA are covered, as are regulation and mechanistic studies for the pterin-requiring phenylalanine monooxygenases.

This collection of timely, generally high-quality papers should be of interest to a broad audience of biochemists.

DAVID P. BALLOU
Department of Biological Chemistry, University of Michigan, Ann Arbor 48109

Mathematical Ecology

Stability of Biological Communities. YU. M. SVIREZHEV and D. O. LOGOFET. Translated from the Russian edition (Moscow, 1978) by Alexei Voinov. Mir, Moscow, 1983 (U.S. distributor, Imported Publications, Chicago). 320 pp., illus. $9.95.

Svirezhev and Logofet are, respectively, head of and researcher in the Mathematical Ecology Laboratory of the Computer Center of the U.S.S.R. Academy of Sciences. In this book, which is revised from the original 1978 Russian edition, they "attempt to convert ecological modeling from an art into a science based on powerful mathematical techniques developed lately and, in particular, on the well advanced stability theory for dynamic systems." The general layout and tone of the book are squarely in the idiom of Russian applied mathematics texts; to a monoglot like myself, casual inspection cannot distinguish the Russian edition from similar texts on fluid mechanics, astrophysics, or electrical engineering.

The book is useful as an encyclopedic collection of analytic results for the dynamical behavior of a variety of models for single populations, for species interacting as predators and prey or as competitors, and for "ecosystem" assemblies of species. The material is organized well and the translation is adequate (since much of the text is mathematics, the connective tissue of prose is less important than might otherwise be the case). The annotated bibliographies at the end of each of the nine chapters are helpful and fairly comprehensive up to 1977; after this they are very spotty. The authors' habit of reproducing large chunks of material, including figures, without acknowledgment (except in very general terms in the bibliography: "The reasoning in this section follows X") would be frowned on if practiced by an undergraduate at Princeton.

Although most of the book covers familar ground, there are some interesting studies previously published only in Russian. Sections 1.6 and 1.7 sketch results for the average lifetimes of populations affected by various kinds of random perturbations (a topic subsequently explored more thoroughly by Turelli). Section 3.10 outlines the way parametric resonances can be excited in predator-prey systems by random environmental variations. Chapter 5 contains some interesting ideas about communities with vertical structure and the stability properties of the consequent linear trophic chains (in both open and closed systems).

The material recapitulated in this book is useful to anyone planning an applied mathematics course and seeking good mathematical problems that bear some metaphorical relation to ecology. But as a step along the road toward transforming the modeling of real ecosystems from an art into a science I find the book unsatisfying in at least two ways.

First, the structure of, and predictions from, the models are related to data in the most perfunctory way, if at all. The entire book contains only five figures or tables with data (and only two of these are related in a concrete way to the model under discussion).

Second, too much attention is given to elegant mathematical results simply because they are elegant. Thus, for example, section 6.6 presents a detailed account of some nice tricks whereby contour integrals can be used to evaluate the minimum eigenvalue of a competition matrix. Although I yield to none in admiration of this result (it is mine), by 1978 it was clear that the model is, in several respects, too special to be generally useful; Svirezhev and Logofet cite some of the relevant works of criticism in their bibliography, but in the text they express no reservations about this or other mathematical models for limits to niche overlap. I think that an understanding of how an ecosystem works, and how it will respond to a specified disturbance, requires many kinds of carefully documented observations about natural history, and thoughtfully designed experiments in the field. Mathematical models can be useful in helping to form testable ideas about which of the myriad complications play an essential role and which do not. If these models lead to beautiful mathematics (as do "chaotic" difference equations), that is a pleasing fringe benefit. Simplicity and elegance cannot, however, serve as a guide to truth in ecology, as arguably they sometimes do in physics.

ROBERT M. MAY
Biology Department, Princeton University, Princeton, New Jersey 08544

Reprints of Books Previously Reviewed in *Science*

The Evolution of Culture in Animals. John Tyler Bonner. Princeton University Press, Princeton, N.J., 1983. Paper, $9.95. *Reviewed* **209**, 487 (1980).

The Foundations of Newton's Alchemy or "The Hunting of the Greene Lyon." Betty Jo Teeter Dobbs. Cambridge University Press, New York, 1983. Paper, $16.95. *Reviewed* **192**, 689 (1976).

Looking Far North. The Harriman Expedition to Alaska, 1899. William H. Goetzman and Kay Sloan. Princeton University Press, Princeton, N.J., 1983. Paper, $8.95. *Reviewed* **218**, 1109 (1982).

Polywater. Felix Franks. MIT Press, Cambridge, Mass., 1983. Paper, $5.95. *Reviewed* **213**, 1104 (1981).

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The Year of the Phoenix. Not a Novel. T. K. Mahadevan. World Without War Publications, Chicago, 1982. xvi, 200 pp. Paper, $5.