BOOK REVIEWS

■ General

Josep M. Camarasa; Antoni Roca Rosell (Editors). *Ciencia i tecnica als països catalans: Una aproximació biogràfica*. 2 volumes. 1,550 pp., illus., figs., bibls., indexes. Barcelona: Fundació Catalana de la Recerca, 1995.

This book collects forty-five biographies of scientists written by thirty-eight authors from the universities of North Catalunya (France) and South Catalunya (Spain). An approximate classification, using the categories of today's science, allows us to identify twelve people who worked in biology, seven in engineering and technology, seven in geology, five in mathematics, five in health studies, five in physics, two in architecture, and two in astronomy. Each biography includes pictures of the scientist and notes his workplace and the books or papers that he wrote. The particular contributions by each scientist to scientific developments in Catalunya are described. The criteria used to decide who should be included are the following: they lived between 1850 and the present and worked in the physical and mathematical sciences, chemistry, engineering, or natural history. Medical sciences were excluded because other works have treated these practitioners; nevertheless, as already noted, five biographies of people who worked in health studies are presented here.

Each biography describes the personal, family, and cultural environment of the scientist, noting his scientific education and whether he belonged to a specific school or tradition. Some examples are Antoni Cebrià Costa and Pius Font i Quer, who wrote the first studies on the flora of Catalunya; Marià de la Pau Graells, who worked in the Museum of Zoology; Odon de Buen, known as the father of Spanish oceanography; Ramon de Manjarrés, who worked in agricultural chemistry; Ildefons Cerdà, the first author of a modern theory of urbanism; Miquel Crusafont, of the School of Paleontology of Sabadell; and Jaume Comas and Eduard Fontseré, who established the first Catalunyan astronomical societies. Some of the scientists worked with European colleagues, and some wrote many books and papers besides those listed in their biographies.

For most of the period covered in the book, the history of science in Catalunya had no place

Albert Einstein in Poblet, Spain, in February 1923 before continuing on to Madrid (from Josep M. Camarasa and Antoni Roca Rosell, eds., Ciencia i tecnica als països catalans, *p. 32).*

in the universities. Only recently has the history of scientific work outside of Spain been recognized. Historically, Catalunya had not been a focus of scientific activity, but during those years researchers were quietly productive. In the last twenty-five years, however, there has been significant work in science, and now scientific research has been welcomed at the university level.

The book tries to be thematically coherent and understands the term "science" in the broad sense. It does not present science as a regular progression of discoveries and theories; rather, it considers scientific work in the context of its own time and shows its influence on subsequent ideas. The authors trace the development of scientific activities through the thoughts and ideas of the practitioners. Authors of earlier studies on some of the scientists included in the book have had difficulty in finding information about them and their work. In such cases the authors mention the incomplete nature of the secondary literature.

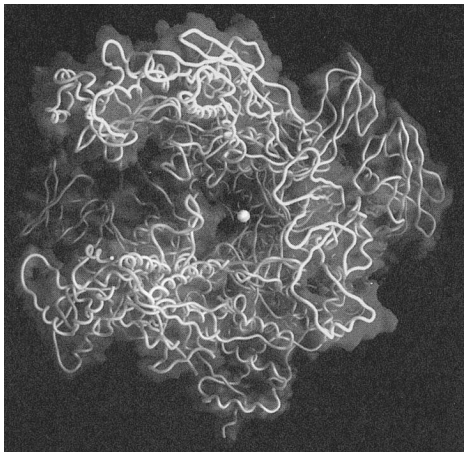
The book as a whole is a significant contribution to the history of science. It provides indispensable information about the history of science in Catalunya. The book is addressed to specialist researchers and also to those interested in the history of science or civilization. With its quotations of authorities, lists of names, and index of key words, it will be useful as a reference work in libraries devoted to science in Catalunya.

Though this is a major and laudable effort, it is a shame that no women are included among the scientists treated. I know how hard it can be to find information about their lives and their work. Still, I miss figures such as Montserrat Garriga, who worked in botany; Rosa Sensat, in pedagogy; Maria Capmany, in astronomy; and Ascensión Serret and Maria Capdevila, in mathematics.

NURIA SOLSONA PAIRÓ

Elizabeth Hanson. *Achievements: A Century of Science for the Benefit of Humankind*. Introduction by **Arnold J. Levine**. Epilogue by **David Rockefeller**. 156 pp., frontis., illus., index. New York: Rockefeller University Press, 2000.

Elizabeth Hanson, a historian and science writer at Rockefeller University, has written this short but intriguing commemorative volume on the centennial of the Rockefeller Institute for Medical Research, now Rockefeller University. This is not intended to be a detailed institutional history but, rather, provides a brief, informative overview of the history of the Rockefeller—its aims, its important discoveries, and the individuals within its walls. The book features lavish illustrations and makes good use of the holdings of the Rockefeller Archive Center.



The three-dimensional structure of cellular RNA polymerase, elaborated by Seth Darst (from Elizabeth Hanson, Achievements, *p. 140).*

Achievements is divided into four parts, each describing a major period during the Rockefeller's history. Each chapter is then further divided into two sections. The first is a historical essay that provides a general background for the chapter. The second section, a "closer look," consists of pictorial essays on a wide variety of subjects, including the Rockefeller's war work, contributions to public health, noteworthy persons and policies, and the relationship between the Rockefeller family's philanthropy and the institution that bears its name.

The first chapter contains a brief history of events leading up to the foundation of the Rockefeller Institute in 1901. On the advice of Frederick T. Gates, John D. Rockefeller looked into the funding of medical research for the benefit of mankind—particularly research into infectious disease. His decision became all the more personal with the death of his grandson from scarlet fever, a disease that was then untreatable. Under the guidance of Simon Flexner, the institute developed into a series of laboratories controlled by independent investigators able to conduct research without the burdens of teaching or publication pressures. The Rockefeller Hospital opened in 1910. Devoted to clinical research, the hospital functioned as a separate department of the institute, and the physicians researching there shared the same status as the other department heads.

The second chapter provides a more detailed description of Flexner's vision for the institute and biographical essays on the men he hired to fulfill those goals. During his directorship from 1903 to 1935, Flexner saw that the physical sciences were going to be increasingly important to medical research. Rufus Cole, director at the hospital, hired physicians as capable in the laboratory as at the bedside. The members of the institute pushed the boundaries between chemistry, physics, and biology and made fundamental discoveries in science and medicine, including the 1944 discovery by O. T. Avery and his lab that DNA was the carrier of genetic information. Indeed, Hanson argues that discoveries made at the Rockefeller were responsible for founding the field of cell biology.

The last half of the book concentrates mainly on institutional history. Part 3 covers the growth of the Rockefeller from institute to university. This section concentrates on the presidency of Detlev Bronk (1953–1968), under whom this transition occurred. Much less time is spent dealing with his successors, particularly the last three presidents: David Baltimore, Torsten Wiesel, and Arnold Levine. The final chapter is less historical and outlines the university's views and plans for the future.

The historical essays, although written in a clear and straightforward fashion, are by no means detailed and serve only as brief introductions. Those seeking a more complete and nuanced history of the institution and its discoveries will need to look elsewhere. However, *Achievements* provides a good general overview and serves as an excellent introduction to the Rockefeller. The pictorial essays in the "closer look" sections are particularly interesting and provide glimpses of less well known people, events, and activities at the Rockefeller. For example, the sections on support staff and instrument makers provide valuable insight into an often overlooked but vitally important facet of life at a research institute.

JUDITH FRIEDMAN

Guenter B. Risse. *Mending Bodies, Saving Souls: A History of Hospitals*. xx + 716 pp., frontis., illus., index. New York/Oxford: Oxford University Press, 1999.

In this extraordinary review of the long history of institutional care for the sick and dependent, Guenter Risse captures the dramatic social and technical changes that have transformed the hospital from a place of refuge and care for the soul into an institution focused primarily on the physical body of the inmate. The scope of this book is truly breathtaking in its ambition. It traces not only an immense expanse of time but also the entire Western tradition of human welfare, healing, and care. *Mending Bodies, Saving Souls* is an ambitious book that succeeds on many levels, although because of its very scope it also sometimes glosses over the issues it lays bare. In some ways this book is a much-needed addition to the specialized literature of recent years that has focused either on specific regions of the world or narrow periods of time. In some ways it is reminiscent of an older tradition of historical writing that saw continuity where it wasn't and direction where it shouldn't be.

Risse begins his book by tracing early Greek, Roman, and medieval Christian origins of the institutions we now call hospitals. The almshouse, the leper colony, pesthouses, lazarettos—rooted as they were in religious and secular needs and traditions—served as way stations for the dispossessed and displaced, homes for the dependent and sick, and places of refuge for the ostracized.

The book is perhaps the first to ground itself in the experience of the individual patient with the institution. Many of the chapters and subsections begin by recounting a brief, often telling, experience of someone who is about to be pulled into the nexus of health care and its institutions. We are provided with accounts of patients' experiences with the plague, leprosy, cholera, yellow fever, and a variety of other infectious diseases that swept through Europe and, later, the Americas at various moments in history. Sometimes using published accounts from medical journals, sometimes embellishing an extant patient hospital record, sometimes drawing on a biography or autobiography or letter, Risse breathes life into what could easily have been a dry account of changing medical practice and treatment. Especially useful is the way he embellishes the bare bones of the patient narrative to provide a social and historical context. His treatment of the case of Johann Duschau, a twenty-seven-year-old tailor in end-of-the-eighteenth-century Vienna, for example, relates the course of his fever, dry cough, and removal to the Krankenhaus (pp. 257–260). It also provides the mechanism through which we learn about the imperial history of Vienna, the size, shape, and conditions of housing for the poor, the attempt to consolidate power in the growing empire of Joseph II, and the charitable traditions that led to the hospital's founding. Elsewhere we learn of the origins of the Johns Hopkins Hospital through brief vignettes of Johns Hopkins himself

and John Shaw Billings, the well-known physician and Public Health Service officer who was the institution's architect. By constant reference to the personal, often fascinating, stories of patients, physicians, nurses, and politicians, Risse weaves a powerful narrative that captures the social relationships that were at the heart of the complex institutions he treats.

The narrative brings to light the extraordinary range of documentation that Risse commands. While many of the early portions of the book are built around secondary works detailing Greek, Roman, and medieval medicine, the later portions are suffused with original sources that have remained largely untouched to date. Stories from Mercy Hospital in Buffalo, for example, provide insights into the vast differences among the variety of voluntary institutions—sectarian and public, teaching and community, large and small—that today make up the hospital systems of Western nations.

A very real advantage of this book is its close attention to sources, specifically the way Risse pulls together a wide variety of material from Europe as well as the Western Hemisphere. There are few other serious works that try to span the continents and such a vast period of time, even in the weighty space of seven hundred pages. Yet the book's very ambition creates pitfalls that the reader must be aware of. Most important, it demands a story line and a narrative structure that sometimes feel forced: to link the history of the medieval pesthouse or leper colony with a twenty-first-century hospital, even cursorily, is problematic in light of the vast differences in circumstances, values, and historical settings. To see glimmers of "Frameworks for Early Medicalization" (p. 214) in Florence around 1500 forces a sense of progress and direction not really necessary for an informed reader. A basic problem that an ambitious book such as this has to face—spanning as it does the dramatically different experiences of European and American medicine, and political and popular culture—is how to develop a story line without imposing a structure and a direction that simply may not exist. How can one avoid teleological messages about "progress" and the inevitable improvement and evolution of early institutions into the modern medical center without losing an audience that demands signposts about where the story is going? How can we avoid language with too distinct a modern sound? Can we talk about "Church and Laity: Partnership in Hospital Care" with regard to Constantinople in 1140 (p. 117) or "Frameworks for Early Medicalization" in 1500 in Florence? Can we speak of the "St. John's Hospital: A Model for the World" (p. 148) when discussing a medieval institution? Are we in danger of reading into the historical narrative a continuity that isn't there?

This is an extraordinarily ambitious book that seeks to integrate an enormous literature. It succeeds on many levels, and even its limitations are a sign of its ambition and its scope.

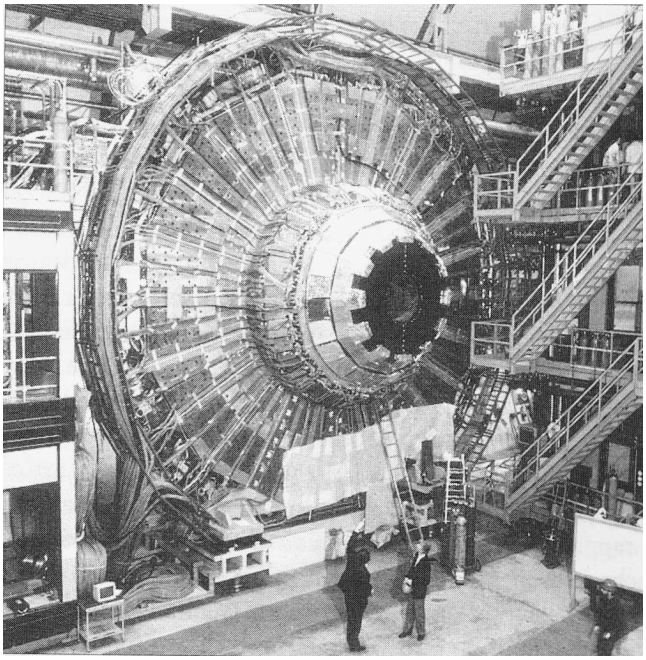
DAVID ROSNER

Marco Beretta. *Storia materiale della scienza: Dal libro ai laboratori.* (Biblioteca delle Scienze.) 329 pp., illus., index. Milan: Bruno Mondadori, 2002. €20.50 (paper).

A familiar figure on the campus after he stepped down as head of Caltech in 1945, the physicist Robert A. Millikan often joined the undergraduates for dinner in the various houses. On one occasion, according to a student who accompanied Millikan on these rounds, the aging scientist was asked what advice he had for the graduating class. "Set lofty sights," he replied. "You may fall short, but you will never exceed your goals."

Like Millikan, Marco Beretta, who teaches the history of science at the University of Bologna, thinks big. Many historians of science aim for a chronological reconstruction of the rise and fall of scientific theories, while others emphasize the biographical approach. Another way to study the practice of science is to examine the culture of the laboratory, including its scientific instruments. Building on these different schools of thought, Beretta lays out in *Storia materiale della scienza: Dal libro ai laboratori* what he calls a "material history" of scientific knowledge—of its actors, its applications, its influence, and its relationship to culture and society at large. He describes all these aspects of the scientific enterprise "in relation to the evolution of the material and ideological factors that were fundamental for scientific progress" (p. 3). Is it an ambitious book? Very.

Each factor in Beretta's story has its own chapter that examines its history from its beginnings—which (depending on the factor) could mean the Greek period, the Middle Ages, the Renaissance, or just a decade or so ago—by considering the salient events and people involved. The factors are chosen not because of their intrinsic importance but because they help the author to make his case and further his narrative. So we have chapters that recount the relationship of science to its communication, to art (think, for instance, of the importance of illustrations for early botanists), to religion, technology, industry, and war. Other chapters deal with the oper-



View of the Protosynchrotron in the CERN laboratory in Geneva, Switzerland (from Marco Beretta, Storia materiale della scienza, *p. 309).*

ational aspects of science, such as laboratories, museums, and conferences; others again with the organizational forms of the scientific community, such as academies, universities, disciplines, and science as a profession.

The common theme running through the book is the rise of science from a subordinate role, dependent on theology, philosophy, or technology, to its current autonomous and even hegemonic status. Because of this progression, the relationship between science and various other institutions, initially almost nonexistent, has evolved into symbiotic alliances. Beretta talks about politics and government: only during the Renaissance does nobility start to look to science for guidance and to enhance its prestige. During the French Revolution and under Napoleon scientists become technocrats, charged with applying the scientific method to the administration of the state (e.g., public hygiene programs). Industrial societies need scientists to seed technological achievements and regulate the availability of technical know-how through the system of patents. Finally, with World War II science and technology become indispensable to governments as a means of achieving military supremacy. Moreover, with this increasing political approval of the scientific enterprise come more funding, employment for scientists, and a means to increase the importance and influence of science within society.

Beretta is unsympathetic to unitary interpretations of science. For instance, while conceding that Galileo's trial and subsequent retraction had far-reaching consequences for the development of science and its relations with religion, he views it as an isolated episode in the history of religion's relative lack of interest in science. It might be an exaggeration, he says, to paint Galileo's tribulations as a piece in the pattern of the inevitable strife between science and religion, as some scholars (positivists, for example) have done.

Beretta writes in a clear and concise style; his examples and case studies are engaging and well chosen. There are interesting illustrations and reproductions in black and white, showing us how the modes and customs of science have evolved over the centuries. Although the book is typographically elegant, it is marred by many typos that, I hope, will be corrected in a second edition. *Storia materiale della scienza* is aimed at the general public and at scientists who are curious about how the practice of science today came

into being. What the reader will not find here is a discussion of scientific issues that dominate the news today—the debate in the United States between Christian fundamentalists and evolutionists, the rise of alternative medicine, animal rights, and fraud. Does this book fall short of its lofty goals? Yes; but it uses many rapid brush strokes to paint a large-scale canvas of the changing scientific landscape.

JUDITH R. GOODSTEIN

Joseph C. Hermanowicz. *The Stars Are Not Enough: Scientists—Their Passions and Professions*. xvi + 268 pp., figs., tables, apps., bibl., index. Chicago/London: University of Chicago Press, 1998. $45 (cloth); $15 (paper).

Careers in science begin at a young age, with an educational course that starts early and forms a progression of learning. Those who persist through graduate school and attain doctoral degrees often set their sights on work in scientific research—aspirations frequently envisioned since adolescence (see Mary Frank Fox and Paula Stephan, "Careers of Young Scientists: Preferences, Prospects, and Reality by Gender and Field," *Social Studies of Science,* 2001 *31:*109–122). *The Stars Are Not Enough,* by Joseph Hermanowicz, is about the eventual careers of such persons, "chasing dreams" over their life courses and within institutional settings.

With narratives from interviews conducted with sixty academic physicists, employed at six universities, who received their doctoral degrees at three different points in time (before 1970, 1970–1980, and after 1980), Hermanowicz explores the perspectives these scientists use to understand their careers and university settings. Key to his analyses are concepts of "time" and "place": the meanings and identities of selves and careers as they form and unfold over time and the universities that encourage or constrain "expectations" for success.

The university settings are characterized as three distinct social worlds: "elite" settings that place the highest premium on scientific research; "pluralist" settings with more balanced demands of research, teaching, and service, into which some eminent scientists are recruited; and "communitarian" settings with demands for "good citizenship" but without special arrangements to attract eminent scientists. These settings send different signals and cues for scientists' present and future senses of "self."

Core to the sense of self is ambition. Hermanowicz treats ambition not simply as an attribute of individual scientists but also as a characteristic situated in the universities in which they work. Ambition is, then, subject to fluctuation by time and place.

Compared to other occupations and professions, science and physics, particularly, are said to be driven by "imagined possibility." Careers are characterized as "open ended," with scientists not knowing what results their efforts will bring or when outcomes (findings, discoveries) will occur. In *The Stars Are Not Enough,* scientific careers are marked by a search for coherent meanings and a quest for recognition, with conceptions of success varying with the type of institutional setting (elite, pluralist, communitarian). Many—even most—of these scientists initially seek "greatness"; few achieve it; and, thus, scientists "chase dreams," both small and great.

The Stars Are Not Enough contributes to what we know about scientific careers through its life-course perspective—emphasis on the ways that professional identities of scientists emerge in different types of settings and unfold over time. This is enhanced through the analyses of narratives of cohorts (young, middle-aged, and older scientists) and the ways identities relate to age and maturation. It is important that the work addresses identities within institutional worlds, rather than as personalities of individuals outside of institutional contexts. This approach, in turn, enables consideration of ways that lives in science are profoundly shaped by the stratification of academic institutions.

At the same time, this work tends to generalize from physics to "science" and from the men it considers to "scientists." The initial quest for greatness in the narratives may be more characteristic of physics than of other scientific fields. Physics has an exceptionally high level of consensus about what constitute significant research questions, methods, and contributions. This may make physicists more prone than scientists in other fields to shared understandings of scientific impact. As Hermanowicz recognizes, consensus about physicists extends even to the wider public: Copernicus, Newton, and Einstein are perhaps the most widely known scientists.

Of substantial concern is that the work includes only four women among the sixty persons interviewed. Analyses of the narratives of women are set apart rather than integrated into the chapters. For women, the central narrative is the higher organizational standards to which they are held. Oversampling women for the interviews undertaken would have resulted in a larger number of women and provided a broader base for assessment of gender and careers and

the ways in which opportunities and constraints are shaped by institutional settings.

MARY FRANK FOX

Sanford Kwinter. *Architectures of Time: Towards a Theory of the Event in Modernist Culture*. xiii + 237 pp., illus., index. Cambridge, Mass.: MIT Press, 2001. $29.95 (cloth).

This book discusses changes in our understanding of time, although Sanford Kwinter prefers talk of changes in the epistemology, metaphysics, and ontology of time. It is often difficult to be sure what Kwinter is claiming because he frequently puts familiar terms in inverted commas. Occasionally he explains the special meaning he intends. For example: "By 'history' I understand the magical substratum through which events allegedly communicate with one another and in relation to which they are said to occur" (p. 36 n 3); this is not encouraging. The book ranges over many topics: aesthetics, architecture, literature, philosophy, physics, and more. Many works are cited and much terminology from various fields appears: phase space, fractals, nonlinear equations (which he thinks first appeared in physics in the nineteenth century), genetic algorithms (p. 13), illocutionary events (p. 14), transvaluation of all values (p. 35), and more. Kwinter offers such insights as that nothing new would occur without time (p. 8), that time permits distant objects to interact, and that modernity is characterized by the spatialization of time (p. 22). Bergson is a major supporting actor, but the star is Kafka, who is the subject of about half the text. I will focus on Kwinter's view of changing conceptions of time in physics.

Much of this discussion is in Chapter 3: "Physical Theory and Modernity: Einstein, Boccioni, Sant'Elia." Here physics flows into aesthetics as we move between Einstein's papers and Futurist manifestos. Einstein appears early, followed by discussion of the sculptor Boccioni, then back to Einstein, then to Sant'Elia. Much of the chapter concerns Sant'Elia's architectural drawings for projects that were never implemented. Kwinter attributes three hypotheses to Boccioni. One of these—universal motion—describes a cosmos "whose substance, conceived within time, is speed itself, ontologically pure and without substrate (the pure 'd' in dx/dt)" (p. 66); dx/dt is later described as a "differential equation" (p. 97). According to Kwinter, one main feature of special relativity is that it preserves the "Galilean principle of relativity," which holds that uniform motion of an inertial system "can be discerned only by referring to a point that lies outside the system" (p. 56). Later in the chapter we find a summary of the significance of special relativity, which "introduced the concept of relative inertial systems into physical theory, and in doing so replaced the absolute time and space of classical mechanics with the concept of the field. Though the laws of classical mechanics are valid within an inertial system, they do not apply to events occurring outside it. Thus local events seem to obey Newtonian principles, but they are always embedded in a larger fluid framework of space-time where events can only be related through the Lorentz transformation and not through a fixed or universal coordinate" (p. 67). As this and other passages indicate, Kwinter believes that physics was dominated by Newtonian absolute space and time—which he attributes to Descartes (p. 58), and which reigned unchallenged until the development of thermodynamics and electromagnetic theory in the nineteenth century (p. 58). He also identifies rejection of the absolute status of space and time with rejection of anything absolute (p. 36). But, in relativity, "what time lost in universality when it ceased to be absolute it gained in concreteness through its new association with space" (p. 67).

In the preface Kwinter tells us that, after some delays, he had decided not to publish the book because "I was no longer committed to its specific thesis" (p. viii) but that he changed his mind because of "a clear and emerging interest among designers and architects in the problem of time and its relation to form" (p. ix). Those who have a taste for literature in which every topic is vaguely related to every other topic via discussions in which key terms have idiosyncratic meanings may find value in this book. In my view, Kwinter should have followed his first impulse, leaving space a bit less cluttered and saving some of us some time.

HAROLD I. BROWN

Eric Jager. *The Book of the Heart*. xxii + 248 pp., illus., bibl., index. Chicago/London: University of Chicago Press, 2000. $32, £20.50.

Names of books, like the names of other commodities, are adjuncts of marketing and serve consumers as a guide to assessing products' relevance to their needs. The title *The Book of the Heart,* in my view, falls short of that requirement. The title may be more evocative in some academic and scholarly communities than to an uninformed reader, but it would have served Eric Jager better if it had a subtitle such as "A History of the Heart as a Metaphor in Western Thought and Literature."

Despite changes in ideas about the physiological functions of the heart as a seat of intelligence or emotion in early history, it has always been regarded as a vital part of existence. Sherwin Nuland, in *The Mysteries Within: A Surgeon Reflects on Medical Myths* (Simon & Schuster, 2000), expresses his awe at first seeing a beating and pulsating heart when he says: "In the ancient formulation of macrocosm and microcosm, the heart is the sun" (p. 163). This formulation expresses the power of the heart as a metaphor for a wide array of human emotions and conditions.

The author traces the use of the heart as a metaphor from its origins in classical Greek literature through the writings of St. Augustine, the work of the medieval scribes, the troubadours, and the Christian saints. One chapter is devoted to graphic representations of the "book of the heart." These sections take up more than three-fourths of the book, before Jager arrives at a consideration of the effect of Gutenberg and the introduction of a new technology on the metaphor. The book ends with a brief discussion of the changes in technologies of writing, from the classical scroll and the codex book to the use of the computer for the creation and storage of print. Like the other technological changes, digitization may have provided us with new metaphors, but it has not challenged the heart's supremacy as a metaphor for dealing with our emotional, spiritual, and moral sentiments or its role in expressions of faith, conviction, and compassion.

This book, I believe, will not engage the attention of many readers of *Isis.* I must, nevertheless, express my admiration for the author's erudition and scholarship, for which the bibliography provides ample evidence.

DAVID A. KRONICK

Leonard Mlodinow. *Euclid's Window: The Story of Geometry from Parallel Lines to Hyperspace*. xii + 306 pp., illus., figs., index. New York/London: Free Press, 2001. $26, Can $38.50.

The difficulties with this book start with its subtitle. It is not at all a history of geometry; for example, nothing is said about the development of perspective theory and connections with the arts. The theme appears to be the role of geometry in the development of mechanics and physics.

Even then, the lacunae are impressive. On the provability of the parallel postulate in Euclidean geometry, for example, nothing is said about the contributions of any Arabs, G. Saccheri, or J. H. Lambert, among others. The constructions of non-Euclidean geometries by J. Bolyai and N. I. Lobachevsky (Ch. 16) are treated too slightly to be understood. The contributions of "Georg Riemann" are covered (Ch. 19)—except for his crucial notion of intrinsicality; and his association of metric properties with the distribution of matter is attributed to W. K. Clifford (p. 154). Exclusions from the twentieth-century story include Hermann Weyl, a rather important figure in the exegesis of general relativity; and A. N. Whitehead, though mention is made of his logicist program for mathematics prosecuted with his "Oxford" collaborator Bertrand Russell (pp. 148–149). (However, Whitehead is also omitted from specialist studies, most recently J. J. Gray's edited volume *The Symbolic Universe* [Oxford, 1999].) Conflations include maps with charts in navigation (Ch. 8) and analytic with coordinate geometry concerning René Descartes (Ch. 11).

The level rises on later topics such as Henri Poincaré's hyperbolic geometry (Ch. 17) and the (super-) string theories of E. Witten and others, with efforts under way to unite relativity theory with quantum mechanics (Pt. 5). However, the reader may not grasp the reasons for the various dimensions in those theories.

The endnotes suggest a modest range for the author's reading of historical sources. Chestnuts in the text include Georg Cantor going mad because of Leopold Kronecker's attacks (p. 27), a fable that in any case is irrelevant to the history of geometry!

We are enjoying a wave of trivial pseudo-histories of mathematical topics, prompted by Ernest Zebrowski's *A History of the Circle* (Rutgers, 1999) and Robert Kaplan's *The Nothing That Is: A Natural History of Zero* (Allen Lane, 1999). May we look forward, say, to Fermat's last throw on probability theory or Newton's big apple on mechanics?

I. GRATTAN-GUINNESS

Albert Presas i Puig. *Praktische Geometrie und Kosmologie am Beispiel der Architektur.* (Algorismos: Studien zur Geschichte der Mathematik und Naturwissenschaften, 27.) 339 pp., illus., bibl. Munich: Institut für Geschichte der Naturwissenschaften, 1998. DM 29.80 (paper).

Rather than endorsing any specific number theory of proportions, Albert Presas i Puig traces the use of measurement and proportions from ancient Egyptian through Greek architecture and on through the constructions of Europe's Middle Ages. Although the importance of proportion underwent significant changes during this time pe-

riod, proportions and numbers remained the principles through which the harmony of creation could be recognized. These relationships of numbers were the basis of concepts such as harmony, cosmos, and order that were to dominate scientific thought in Europe for nearly two thousand years.

Crucial to ancient Egyptian architecture was the application of a set of rules that was used as a measure of artistic creation as well as a method of proportion. Although proportion was extremely important to the Egyptians' cosmology, the method was seen as a more practical one, as serving the larger purpose of building structures in relation to one another as well as pertaining to the gods' entire plan. The building process was not guided principally by aesthetic concerns. These proportions were obtained through the standardization of human body parts and also the grid, which allowed for the transference and reproduction of an image, no matter how complex or on how great a scale.

Puig emphasizes the example of Polykleitos, since this picture-carver of antiquity was among the earliest writers to concern himself with rhythm and symmetry. Polykleitos's applied procedures, Puig suggests, are fundamentally the same as those of the ancient Egyptians, but he based his measurement system on the smallest body part; other body parts were then reproduced in relation to the whole. Geometric methodology and progression remained important to Polykleitos, but his procedure, departing from the Egyptian grid, allowed him greater freedom in determining his initial size of unit.

In devoting a chapter to Anaximander, Puig wishes to explore more fully Anaximander's considerations of technology. However, he does not progress much further than the often-described rings of the sun, moon, and stars. Puig does make clear that it was Anaximander who introduced a principle of symmetry when he stated that the earth rested in the center of the cosmos. He also constructed his picture of the universe through fixed, determined proportions, as in architectural techniques—a major departure from the absolute sizes of Hesiod.

The theory of proportions expressed by the writer Vitruvius is the last in which the proportions of the human body appear. He set the proportions of the elements in relation to one another and established a basic unit, the diameter of a temple's column drum. Interestingly enough, this diameter was obtained with reference to the size of the human body, and these parts are still reflected in temple measurement. Symmetry also played an important role in Vitruvius's thinking: among other things, it was an attempt to set the microcosm in relation to the macrocosm. Vitruvius's proportioning and figures would later make possible an architecture that invites aesthetic and metaphysical regard.

Keeping Anaximander's strongly ordered and geometric worldview in mind, the Pythagoreans were the first to develop a global conception of the universe, assuming a relation between the cosmos and a fixed harmony of all things. Indeed, to these thinkers, the world was to be understood only when the number relationships on which it was based were made clear. So the Pythagoreans concerned themselves with the qualities of natural numbers. They ordered the most important elements of the universe and even assigned moral and aesthetic values to the mathematical relationships they constructed.

Reflecting on Plato's *Timaeus* leads Puig to the historical consideration of the relationship between building and cosmology. According to Plato, if the universe was created by a power resembling a master builder, then the visible world must be ordered in an intentional and planned way. Although the *Timaeus* does not explicitly address the idea of proportions, its discussion of geometric forms is most informative. All geometric figures, in the older tradition as well as in the newer Platonic one, are equal to one another, both physically and spatially. Plato also outlines how one constructs a geometric figure. Noteworthy here is that Plato understands that this figure is guided by an ideal definition.

With Roriczer and Pacioli, Puig provides two very different examples of the continued existence of proportions in Europe's Middle Ages. Roriczer, a master builder of the fifteenth century, focused on practical applications of geometry, not abstract geometrical theories. By this time geometry was seen as more of an "art" and was not only defined outside traditional categories but had become more visible. Roriczer's works are filled with drawings and are intended to be absorbed by a variety of learners, not just scholars. Pacioli's writings may not be as pedagogically oriented as those of Roriczer, but his treatise on architecture is still rooted *in* architecture. Pacioli was most interested in compiling mathematical and arithmetical knowledge, as well as finding new ways of explaining and utilizing that knowledge. His statements on proportions reflect those of Plato that proportions exist in every facet of life, not just numbers and sizes. His work also imparts a considerable religious interpretation.

ROBERT HAHN

Anouk Barberousse. *La physique face à la probabilité*. (Mathesis.) 210 pp., bibl., indexes. Paris: Librairie Philosophique J. Vrin, 2000.

What is probability? The question is not easy to answer, and it may even be doubted whether it makes sense at all. It is true that there is a well-defined mathematical theory of probability, characterized by the Kolmogorov axioms. But there exist many different interpretations of this probability theory: in terms of personal degrees of belief, (objective) support of a hypothesis by evidence, relative frequencies in an infinite series of repetitions of an experiment, propensities in a single run of an experiment, and so on. It is not so clear why one of these divergent meanings of the concept of probability should be given precedence over the others.

In the first part of *La physique face à la probabilité* Anouk Barberousse introduces some of the possible interpretations of probability and reviews, on an elementary level, the discussions surrounding them; she concludes by expressing a preference for the so-called modal frequency interpretation proposed by Bas van Fraassen. As she explains, the purpose of this part of the book is to prepare us for a study of the use that is made of probabilistic reasoning in statistical physics. Accordingly, Part 2 is devoted to an exposition of the basic principles of statistical mechanics; however, the conceptual machinery developed in Part 1 is not really put to use here or in the rest of the book. The approach in Part 2 is semihistorical: Barberousse discusses papers by James Clerk Maxwell and Ludwig Boltzmann from the 1860s and 1870s, with particular attention to the status of the statistical concepts employed. Originally, probabilistic reasoning entered through consideration of the relative numbers of molecules with particular properties in a macroscopic physical system consisting of an enormous number of such molecules. Later, the idea was introduced of considering an "ensemble" of physical systems—that is, an imaginary collection of copies of the one real system studied, all in the same macroscopic state but with differing microstates. In this case probability enters as a relative frequency in the ensemble; this way of applying probabilistic concepts found its culmination in the work of Josiah Willard Gibbs (1902).

The third and final part goes into contemporary issues in the foundations of statistical mechanics. The focus here is on two questions: how to justify the use of ensembles, given that we want to make predictions about the behavior of a single, really existing, system; and how to solve the well-known irreversibility paradoxes. With regard to the first problem, Barberousse mentions with approval the ideas of J. Lebowitz, according to which statistical mechanics is primarily concerned with those ensemble properties that hold with probability 1; in this way the gap between the study of the individual system and the ensemble is bridged. With regard to the irreversibility problems, she endorses Boltzmann's solution: irreversible behavior can be understood on the basis of specific initial conditions and the distinction between macroscopic and microscopic physical quantities. The dissenting views of Ilya Prigogine are briefly discussed and dismissed.

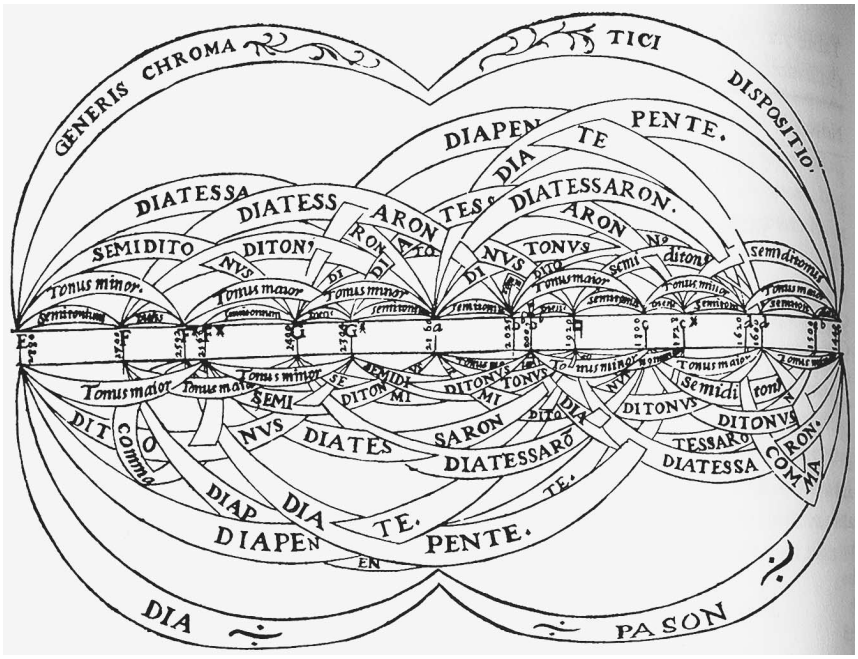
The style of the book is nontechnical: there are hardly any formulas. Of course, this makes it difficult to be precise in treating such a sophisticated and technical subject as the foundations of statistical mechanics. I fear that researchers who are well versed in the history and foundations of statistical physics will find nothing new in the book and will sometimes be dissatisfied with the cursory nature of the discussion. On the other hand, the lack of jargon and technicalities should make the book accessible to the nonspecialist. However, I have my doubts concerning this latter audience: I think that someone who has no prior knowledge of statistical mechanics will find it hard to get an adequate picture of the theory via this introduction. I think the book is best suited for those who already more or less know the physics and want to get an impression of the philosophical and foundational controversies surrounding the subject.

DENNIS DIEKS

Thomas Christensen (Editor). *The Cambridge History of Western Music Theory*. (Cambridge History of Music.) xxiv + 998 pp., illus., fig., tables, indexes. Cambridge: Cambridge University Press, 2002. $150 (cloth).

The *Cambridge History of Western Music Theory,* while not in fact a history, is nevertheless a substantial achievement. The book is a collection of thirty-one essays by highly regarded academic music theorists who range from assistant-professor juveniles to well-established tenured silverbacks. Perched somewhat unstably in the space between encyclopedia and hypertrophic journal issue, the book contains an abundance of fascinating material. Yet it is somewhat frustrating when considered *in toto.*

This frustration can be attributed to three sources. The first is organization. Many of the individual essays are broadly topical, tracing a



Relationships of notes for chromatic just-intonation printed in Franscisco Salinas, De musica libri septem *[1577] (from Thomas Christensen, ed.,* The Cambridge History of Western Music Theory, *p. 200).*

single theme ("Tuning and Temperament," "Music Theory and Mathematics," "Music and Rhetoric") through several centuries. Others treat the work of a specific eminent theorist (Rameau, Schenker) or a specific period ("Counterpoint Pedagogy in the Renaissance"). Still others ("Epistemologies of Music Theory") provide relatively nonhistorical treatment of a single metadisciplinary issue. The crisscrossing subject matter means that some important topics never get a full or thorough treatment, being consigned instead to scattered references throughout the book. Were a reader to be interested in Milton Babbitt, for example, he or she would need to consult Chapter 3 (for reflections on Babbitt's theoretical methodology), Chapter 10 (for brief remarks on Babbitt's mathematical orientation), Chapter 19 (for Babbitt's place in the history of twelve-tone theory), and Chapter 22 (for a discussion of Babbitt's rhythmic procedures). Chronological or encyclopedic organization might have been more useful in a collective work of this large scope.

The second problem is coverage. The book is somewhat brusque when it comes to twentieth-century topics. Particularly disappointing is the volume's near-total neglect of jazz. Jazz is undoubtedly one of the twentieth century's greatest contributions to the history of music, and it has opened numerous avenues of fruitful theoretical exploration. These include performance practice, particularly as regards the elusive rhythmic phenomenon of "swing"; improvisation, with its delicate balance between spontaneity and the use of conventional, overlearned patterns; and harmony, which in jazz derives equally from non-Western folk music and Western art composition. It is true that many of the important contributors to jazz theory are not academic theorists, but this is no reason to perpetuate the academy's long-standing disinheritance of jazz.

The third source of frustration pertains to style. As is to be expected in a volume of this type, the style and tone of the essays range widely. Some (such as John Covach's "Twelve-Tone Theory") are workmanlike contributions to the encyclopedia-entry genre; others (such as Nicolas Cook's "Epistemologies of Music Theory") feature the more controversial type of writing that makes for interesting journal essays. The best essays—including Brian Hyer's "Tonality," Patrick McCreless's "Music and Rhetoric," and

Scott Burnham's "Form"—manage to be authoritative and interesting at the same time. But one senses an ambivalence in the collection as a whole, which veers between personal and objective standpoints.

Despite these caveats, the work is an extremely valuable contribution to the history of Western music theory. Almost all of the essays are of high quality, and the scholarship is impeccable. Though there is probably no single reader who stands to benefit from all of the essays in the book, nearly every reader will find something of value herein. The book can serve both as a reference work and as a snapshot of current theoretical opinion. It belongs on the shelf of every scholar who has a serious interest in music theory and its development.

DMITRI TYMOCZKO

William Ewald. *From Kant to Hilbert: A Source Book in the Foundations of Mathematics*. 2 volumes. xviii + xvi + 1,340 + xxviii pp., bibl., index. Oxford: Clarendon Press, 1996. $300 (cloth).

This large collection of writings on the foundations of mathematics is organized chronologically. Exceeding the temporal limits of the title, it stretches from Bishop Berkeley to Bourbaki. It contains eighty-nine selections divided into twenty-eight groups: each group consists of related papers, generally by one writer, and each paper is introduced in a comment by William Ewald.

The foundations of mathematics is a field that has been cultivated by both mathematicians and philosophers. The main topics of inquiry are naturally common to both: the nature of mathematical objects, in particular the relation of mathematics to experience; the methodology of mathematical proof and the basis for belief in the certainty of mathematical theorems; the changing notion of rigor. It is well known that the attitudes of mathematicians toward the work of philosophers have often ranged from mistrust to lack of interest. This view is exemplified here by Gauss's dismissive comments about all philosophers, including Kant (see p. 293). With the exception of Berkeley, Kant, and Helmholtz, all of Ewald's selections are taken from the writings of mathematicians, quite often those of the very first rank.

The anthology opens with a group of excerpts from George Berkeley that are remarkable in their astute criticism of the foundations of infinitesimal calculus. The bishop had a point: his arguments started the protracted search for a rigorous basis of analysis that ended some 150 years later with the replacement of infinitesimal arguments by the systematic use of limits and the elucidation of the notion of the real number. This development is represented here by excerpts from Colin Maclaurin, Jean le Rond d'Alembert, Bernard Bolzano, and Richard Dedekind. The selections from Bolzano are particularly valuable, as his works are difficult to access and the extent of his research is not widely known.

The Kantian view of mathematics is represented by only twenty pages of the master himself, followed by ninety pages of Hermann von Helmholtz, a major figure in the revival of Kantianism.

Another line of inquiry with ancient roots is investigations into the role of the fifth postulate of Euclid. This work, which tied the logical question of the independence of axioms to the philosophical problem of the relation of geometry to empirical space, is represented here by less-known excerpts from J. H. Lambert and by famous remarks of C. F. Gauss extracted from his correspondence. Ewald's introduction to Lambert, a veritable essay on the history of the axiom of parallels, is particularly valuable.

The new era in geometry was started by the inaugural dissertation of Bernhard Riemann; it is included here in its entirety and is followed by various excerpts of a philosophical nature from Helmholtz. It may be noted that while Riemann's study opened a new field of mathematics, Helmholtz's writings did not much influence subsequent developments. Not so with Felix Klein; however, the selection from Klein in this collection centers on his more general views of mathematics rather than on the Erlangen program.

The widening of the concept of number, the gradual acceptance of negative and complex numbers, and the invention of quaternions is represented here by a brief selection from Gauss and a lengthy one from W. R. Hamilton. However, omission of the work of A. L. Cauchy results in an incomplete presentation. In 1821 Cauchy introduced the field of complex numbers as the set of "symbolic expressions," together with two algebraic operations on them. Since the equality of two "expressions" was defined as the simultaneous equality of their real and imaginary parts, there does not seem to be more than a linguistic difference between this definition and that as pairs of real numbers credited by Ewald to Hamilton. Moreover, in his investigations of integration in the complex plane, Cauchy explicitly considers integrals from $a + bi$ to $c + di$

as integrals along a plane curve from the point with coordinates (*a, b*) to the point (*c, d*) (see Cauchy's *Mémoire sur les intégrales définies prises entre des limites imaginaires* [1825]). When Hamilton's publications started appearing in 1833, both the nature of complex numbers and some principal theorems about functions of complex variable were already known to the most prominent mathematicians of the time. (This does not diminish the importance of Hamilton's discovery of quaternions—which, incidentally, are considerably more today than "a historical curiosity," as Ewald would have it [p. 362].)

One last element was necessary for the rigorous grounding of real analysis: the "arithmetization of continuum"—that is, a theory of real numbers. This task was achieved by Dedekind. He is represented here by a very solid selection that includes a complete translation of "Was sind und was sollen die Zahlen"; it is complemented by a brief selection from Leopold Kronecker, who held quite different ontological views.

A number of selections from the British mathematicians Duncan Gregory, Augustus De Morgan, Hamilton, and George Boole trace the rise of a new, more abstract conception of algebra. They are followed by essays on more general topics by J. J. Sylvester, W. K. Clifford, and Arthur Cayley. The last is most interesting, offering, as Ewald notes, "a masterly survey of the developments in nineteenth century mathematics as they appeared to one of its leading practitioners" (p. 542).

With the emergence of mathematical logic and of the set theory the philosophical inquiry changed its focus. The former is represented here by the complete text of Boole's "Mathematical Analysis of Logic." The development of set theory is represented by a substantial selection from Georg Cantor, by some selections from the work of French mathematicians (Emile E. Borel, René Baire, *et al.*), and by a later paper of Ernst Zermelo. The renewed discussion on infinity in mathematics is only lightly touched upon. For a presentation of more recent and more technical developments in mathematical logic, the reader should see Jean van Heijenoort's anthology *From Frege to Gödel* (Harvard, 1967).

The most prominent trends in the philosophy of mathematics in the twentieth century were David Hilbert's formalism and L. E. J. Brouwer's intuitionism; Ewald devotes substantial space to both. Indeed, all of Hilbert's published articles on the foundations of mathematics are now available either here or in van Heijenoort's anthology. Brouwer's ideas are also given a good deal of space, but it appears that they are easier to comprehend in the work of his followers. Here the reader can consult the anthology of Paul Benacerraf and Hilary Putnam, *Philosophy of Mathematics* (Prentice Hall, 1964).

There are two selections from G. H. Hardy. One gives a lucid exposition of the views of a professional mathematician on the philosophical controversies of the 1920s: logicism, intuitionism, and formalism. The second is a brief but definitive article on the famous controversy concerning an incomplete statement of Cauchy concerning the convergence of series of continuous functions. It will be particularly appreciated by mathematicians who are acquainted with the vaporous musings of some prominent present-day philosophers.

The last selection in the anthology is a brief article by Bourbaki describing their approach to mathematics, a development of ideas of Dedekind and Hilbert that attempts to present mathematics in terms of axiomatized structures.

There is no doubt that Ewald's anthology will be of great value to both historians of mathematics and philosophers interested in the foundations of mathematics. It covers the period preceding that treated by van Heijenoort and complements the purely mathematical collections of D. J. Struik (*A Source Book in Mathematics* [Harvard, 1969]) and D. E. Smith (*A Source Book in Mathematics* [Dover, 1959]). Many selections are made available in English for the first time, and many are from sources that are difficult to access. The chief merit of Ewald's collection is that he has selected appropriate excerpts—not an easy task in the case of more prolix writers (like Hamilton) or those who left many volumes of collected works (like Cayley, with fourteen volumes).

Each selection is preceded by an introduction containing, at a minimum, basic biographical facts and bibliographical references. Some of the longer introductions are valuable essays on particular topics or writers: besides the introductions already mentioned, I would single out the introduction to C. S. Peirce's life and work as well as the introductions to Bolzano, Hamilton, Gregory, and Zermelo.

A brief review is not the place for a reviewer to register his every disagreement with an author. Ewald himself lists some topics that had to be omitted to allow adequate treatment of those that are represented. It should be noted, however, that the collection is heavily skewed in the direction of English and German authors, omitting—with one exception—French mathematicians up to the time of Henri Poincaré. Thus its

picture of the search for the foundations of calculus is not complete.

Recently the publishers reissued this anthology in paperback at a more reasonable price ($85). This is fortunate, as the price of the original edition made this publication of formerly inaccessible material inaccessible for another reason—at least for most private purchasers.

ANTONI A. KOSINSKI

Peter Whitfield. *Astrology: A History*. 207 pp., illus., bibl., notes, index. London: British Library; New York: Harry N. Abrams, 2001. $35.

At first glance *Astrology: A History* looks like a sophisticated coffee-table book. Brilliantly illustrated with color pictures—some familiar and others quite fresh—this attractive volume will no doubt captivate an audience fascinated by astrology and lured in by the images of a wide range of books and manuscripts.

Surprise! Included is a very respectable text, even more impressive than the rich selection of illustrations. Peter Whitfield, an independent scholar in Britain, has produced a number of splendidly illustrated books, and here he offers an informative, nonpolemical account of the chameleon-like qualities of astrology that enabled it to evolve with the times and to be a serious part of intellectual history for two millennia. Whitfield is not concerned whether astrology is true. "True or false, the history of the subject is important and intriguing in its own right, as crossing the boundaries between science, philosophy, and religion. During the twentieth century, the century of science, astrology stubbornly resisted all the rational and scientific arguments against it, in a manner which reminds one of astrology's progress through the universities and courts of medieval Europe in the teeth of all the theological objections to it. The outstanding fact about astrology is that for centuries people *wanted* to believe it: they longed for it to be true, and around that longing they created an elaborate intellectual edifice" (p. 202).

Astrolabe used in astrological calculation (from Peter Whitfield, Astrology: A History, *p. 124).*

Whitfield has succeeded in presenting astrology not as an independent subject but in the context of the philosophical outlook of each successive period. As such he has achieved a synthesis that goes well beyond any other astrological history of which I am aware. In the hands of Ptolemy, astrology became a scientific topic; Whitfield argues this claim well. By the time of the Renaissance, "it was, as it had always been, a spacious philosophical structure, somewhere between a science and a religion, offering a unifying perspective on questions of cosmology and physics, medicine and biology, and above all on human destiny" (p. 165).

But by the late seventeenth century, William Lilly's very success as a popularizer/charlatan eventually proved fatal to the art. As science became empirical, astrology lost its place. The character of the astrologers themselves alienated serious thinkers, Whitfield writes. "Thus astrology suffered a process of social destruction as well as an intellectual one, and the importance of the first should not be underestimated" (p. 186).

Whitfield stumbles only very rarely, as when he confuses astronomical tables with ephemerides. If I were again offering a seminar on the history of astrology, I would surely adopt this book as a text, and such a peccadillo would offer a fine opportunity to discourse on the basic materials required by astrologers of all ages to conduct their analyses.

The presentation is enhanced by a generous series of sidebars that illuminate topics ranging from Shakespeare or Chaucer to Origen or the Black Death. I was, however, disappointed by the large illustration of "the lion of Commagene," the earliest horoscope in O. Neugebauer and H. B. Van Hoesen's *Greek Horoscopes* (American Philosophical Society, 1959), because it is totally textured with enlarged half-

tone dots—surely a better photograph is available. But this was the single exception in a dazzling selection of illustrations. More important, I was frustrated by the lack of identifications of many of the books and manuscripts shown; even though they generally carry the call numbers of the volumes in the British Library, they unfortunately rarely reveal the author or title.

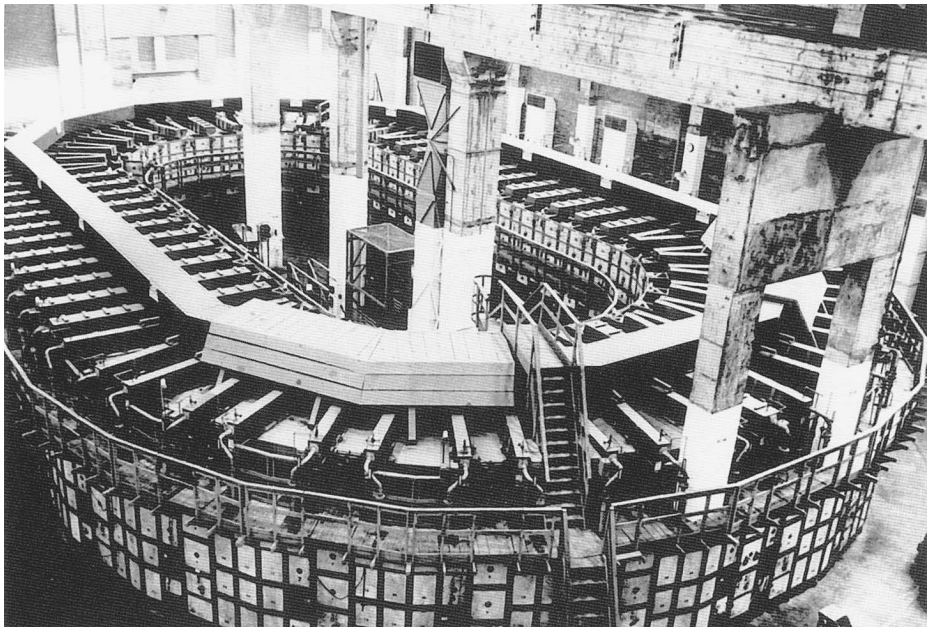
Altogether this is an impressive and elegant volume, surely the best history of astrology currently available.

OWEN GINGERICH

Michael A. Grayson (Editor). *Measuring Mass: From Positive Rays to Proteins*. x + 149 pp., illus., figs., index. Philadelphia: Chemical Heritage Press, 2002. $35 (cloth).

This carefully crafted volume can be described as a coffee-table book for mass spectroscopists. It is lavishly illustrated with many photographs and figures. At the bottom of each page of text there is a running summary of important events in physics in general and mass spectrometry in particular and, below that, of general historical events from 1895 to the present. The contributors are twelve eminent scientists from many fields, including chemistry, biology, biochemistry, pharmacology, molecular biology, protein therapy research, and health fields. However, the particular contributions of each of the twelve to the contents of the book remain unspecified. The coverage is largely descriptive. Mathematical expressions and chemical formulas are almost completely absent. Readers who are interested in a detailed technical description of mass spectrometry and its applications might refer to Frederick A. White and George M. Wood's excellent book *Mass Spectrometry: Applications in Science and Engineering* (Wiley, 1986).

The subject matter of the present book is divided into ten chapters. The first covers the important discoveries in the physical sciences in the nineteenth century and the first half of the twentieth century, culminating with the major developments in mass spectrometry during the Manhattan Project. The second chapter is devoted to the applications of mass spectrometry after World War II. It includes the work of Willard Libby, who in the late 1940s first measured ^{14}C in organic material by detecting its radioactive decay rather than by measuring its mass because of interference from the vastly more abundant ^{14}N. This problem was overcome in 1977 with the development of accelerator mass spectrom-



A Calutron "racetrack" at Oak Ridge, which produced enriched uranium for early atomic weapons (from Michael A. Grayson, ed., Measuring Mass, *p. 16).*

etry employing tandem Van de Graaff accelerators normally used in nuclear physics research. This important and relatively new branch of mass spectrometry encompasses the ultrasensitive detection of many long-lived radioactive isotopes in addition to ^{14}C and has many fascinating applications. It deserves much more extensive treatment than is provided by this book. Chapter 3 covers the applications of mass spectrometry in the petroleum industry. Chapter 4 is devoted to the fundamental physical and chemical processes involved in ion formation in samples to be mass analyzed. All mass spectrometers, of course, require an input of positive or, in some cases, negative ions. Chapter 5 is devoted to the biochemical applications of mass spectrometers—the study of living cells, both healthy and diseased. The labeling of large biological molecules with rare stable isotopes such ^{2}H, ^{13}C, and ^{15}N is an important aspect of this field of research.

Chapter 6 covers pharmaceutical applications of mass spectrometry. This is a particularly fascinating chapter, dealing with what may be the most important contribution made by mass spectrometry to mankind. Chapter 7 treats the use of mass spectrometry as an analytical tool to increase our knowledge of the earth, our solar system, and the entire universe. The eighth chapter concerns the application of mass spectrometry to environmental problems involving the distribution of potentially dangerous chemicals in soil, water, and air. In 1962 the ecologist Rachel Carson publicized the dangers of environmental pollution, and this led the U.S. government to create the Environmental Protection Agency in 1970. The regulations promulgated by this agency created a demand for new analytical techniques that were soon satisfied by various innovations in mass spectrometry. Chapter 9 relates the applications of mass spectrometry in the field of law and order, including the detection of performance-enhancing drugs in horse racing and other sports, drugs of abuse, and poisons. The final chapter is a brief summary of the community of mass spectrometrists. It describes the founding of the American Society for Mass Spectrometry, the awards that society has made for distinguished contributions to the field, and a list of its presidents from 1969 to the present. The book is very readable and entertaining; it should have wide appeal, especially to experts in the field but also to scientists in other fields and even to the general public.

HARRY E. GOVE

Martin Rees. *Our Cosmic Habitat*. 240 pp., illus. Princeton, N.J./Oxford: Princeton University Press, 2001. $22.50 (cloth).

During the past decade cosmology has become an increasingly experimental science in which the history of our universe since the first second of its existence is scientifically well established. Martin Rees, Royal Society Professor at Cambridge and Astronomer Royal of Great Britain, provides an overview of these developments and a proposed answer to Einstein's question, "Could God have made the world any differently?" The book is not a technical one, being based on Princeton's first Scribner Lectures, but it is rich in scientific detail and historic insight. The first half of the book is a very well presented overview of the present state of Big Bang cosmology, including the history of recent developments. In particular, Rees demonstrates that both for the existence of life on earth and for the current state of the observed universe the values of the constants of nature, the strength of its forces, and the parameters of the early cosmos must lie within a very narrow range.

Part 2, "The Beginning and the End," looks first at very recent experimental evidence pointing to a slight acceleration in the rate of our universe's expansion. The most likely cause is some "vacuum energy," but current theory predicts that, if such exists, it would produce a far too large effect. The other puzzle lies at the beginning of time, the first thousandth of a second of the universe's existence. The critical constraints are the proportions of matter and radiation, the cosmic expansion rate, how smooth the expansion is, and the fundamental properties of matter. Rees predicts that by 2010 cosmologists will know the nature of dark matter and vacuum pressure with sufficient precision to push the threshold of the well-established model cosmos well back from one millisecond but that they will not have solved the "deep question" of the origin of the Big Bang.

Rees writes, "We seek unified theories of the cosmos and microworld not because the rest of science (or even the rest of physics) depends on them, but because they deal with deep aspects of reality." In the concluding chapters he speculates on such aspects as possible answers to Einstein's question. First he recounts the history of early speculation about the stability of so-called constants of nature (e.g., Newton's G or the speed of light) over time. When the speculations arose no experimental means existed to test them, but subsequent advances in experimental technique have shown them to be constant on cosmic time scales. We currently lack laws of physics adequate to connect gravity and other forces of nature as needed to deal with the very early universe. Recently, however, physicists have

proposed that string theories involving more than three spatial dimensions can solve this problem, and Rees suggests that these theories will soon be experimentally testable. In fact, the February 2002 issue of *Physics Today* contains a long article suggesting experiments to test them at particle accelerators already under construction, lending further support to Rees's conjecture on testability. We must simply reserve judgment.

Having shown how special our cosmos is, Rees continues, "If our existence depends on a seemingly special cosmic recipe, how should we react to the apparent fine tuning?" Three possibilities occur to him: "Happenstance," "Providence of Design," and "A Special Universe Drawn from an Ensemble, or Multiverse." If by happenstance we found the unique set of theories that would yield the special cosmic recipe, he feels that we would still want to know why. Another interpretation he cites is that of John Polkinghorne, a Cambridge physics professor and theologian, who calls our cosmos "the creation of a Creator who wills that it should be so." Rees, however, favors a third way and elaborates the physics of multiverses, arguing for its being a scientific enterprise by showing how it may be tested and how other universes that have fundamental constants wholly unlike those in our universe may be possible within a multiverse. As he speculates in the preface, "Our entire universe is a fertile oasis within the multiverse."

This book's clarity of exposition, targeted to a broad readership, makes it a good introduction to a subject that challenges who we are and what the nature of our world is. It is neither a history nor a scientific monograph but an exciting insight into "our cosmic habitat" that deserves a wide readership among all who are curious about discoveries that might have an impact on our worldview as great as that of the Copernican Revolution.

JOHN L. MCKNIGHT

John M. Efron. *Medicine and the German Jews: A History*. viii + 343 pp., illus., index. New Haven, Conn./London: Yale University Press, 2001. $35.

The historic relationship between Jews and medicine has long been a source of self-respect, pride, and legend. John Efron's superb study, however, does not simply reconstruct a list of contributions Jewish physicians have offered to the field. Instead, this volume examines the complicated relationship between the Jews of Germany and medicine from the early modern period through the late 1930s. Interested in the impact medicine had on the construction of modern Jewish identity, as well as its historic place in German-Jewish culture, this cogent study contributes to extant scholarship concerning the embeddedness of science and medicine in culture.

Efron's periodization from the early seventeenth century until 1938 is ambitious, yet it allows him to chart over time the different ways in which Jews contributed as producers, consumers, and objects of attention within the German medical community. Large numbers of German Jews did not become professionally involved in the field of medicine before the eighteenth century. Restrictions on Jews at German Catholic and Protestant universities, the slow development of professional medicine there, and the belief that Jewish physicians desired to cause their non-Jewish patients harm prevented many Jews from becoming part of the German medical establishment. Furthermore, even when German Jews became physicians in certain communities, they experienced discrimination from Jewish communal authorities who worried that Jewish doctors threatened to undermine existing institutions, power structures, and ways of life.

Several historical phenomena transformed the relationship between Jews and medicine in the eighteenth and early nineteenth centuries, namely the rise of the German Jewish and non-Jewish middle classes, with their belief in change, education, and self-betterment (*Bildung*), the quest for political emancipation, and the Enlightenment. According to Efron, this period witnessed the rise of the "maskilic physician," a Jewish doctor who used the language of the Enlightenment to analyze Jewish society, criticize the physical condition and health of the Jewish people, advocate Judaism's reform, and aspire to positions of communal power. His presence helped to contribute to a paradox that would later characterize nineteenth- and early twentieth-century medical science: the simultaneous conviction on the part of Jewish and non-Jewish physicians that Jews represented ill health and that they were disproportionately healthy. Efron traces these concerns by analyzing the study of Jewish statistics, the interest in Jewish ritual behavior, and the published discourses on alleged Jewish pathologies, specifically the relationship between Jews, alcohol abuse, mental illness, and certain physical diseases.

Interestingly, Efron finds that the medical establishment witnessed two paradigm shifts. During the early twentieth century, Jewish psychiatrists changed in the ways in which they

imagined the Jewish mentally ill. During much of the nineteenth century, Jewish physicians—like the maskilic doctors before them—depicted Eastern European Jews as psychologically weak and Western European Jews as physically at risk. Over time, however, increasing numbers of Jewish psychiatrists characterized the Western European Jew as psychologically unstable and the Eastern European Jew as mentally sound. This shift took place as increasing numbers of Jewish physicians rejected the acculturatory sensibilities of their elders and embraced Zionism. The censure of Jewish physicians also changed. Eighteenth- and early nineteenth-century critics invoked anxieties over quackery to attack Jewish physicians. By the late 1800s, critics censured Jewish doctors for their presence in the medical establishment and questioned their motivations. Opponents now utilized concerns about sexuality, urbanization, and modernization to revive earlier charges that Jewish doctors wished to maltreat non-Jews.

As Efron makes clear, Germany was home to thousands of Jewish physicians, served as a medical leader in the international community, and acted as a national setting in which Jews and non-Jews used medicine and science to define Germanness and Jewishness. Yet his ambitious analysis sometimes leads him to assume a uniformity in Germany that may not have existed. This is particularly true for his examination of the pre-1871 period, before unification took place. Moreover, because his analysis focuses on pre-1848 and post-1871 moments, one is left wondering about the continuities and discontinuities that the relationship between Jews and medicine underwent during the so-called quieter years of 1850 to 1869.

This deftly written book advances our understanding of the interrelationship of science and medicine in culture. As an intellectual history, which utilizes mostly published materials, it leaves open possibilities for future cultural studies on similar themes. It is a rich and welcome contribution to the fields of medical and Jewish history.

ROBIN JUDD

Rudolf Schmitz. *Geschichte der Pharmazie*. Volume 1: *Von den Anfängen bis zum Ausgang des Mittelalters.* xvi + 836 pp., illus., apps., bibl., index. Eschborn: Govi-Verlag, 1998. DM 198.

This lengthy volume (the first of two projected; the author died in 1992) may prove to be one of the last single-author compactions of a very broad field (the history of pharmacy), a compaction relating several subfields into an attempted unified whole. Rudolf Schmitz was neither a pharmacist nor a physician in his early training, so that sometimes his presentations of specific drugstuffs and pharmacal techniques are rather vague, if not wobbly; on the other hand, Schmitz does what "universal historians" do—and does it well: one can see the interweaving of cultural with political history, the intermeshing of economics with social systems (especially in the last sections on Byzantium, the early Middle Ages, classical Islam, and the later Middle Ages in Europe [pp. 205–589]), much as ancient and medieval historians now commonly presume the influence of widespread trade as the economic underpinning of changes in particular societies.

Excellent are Schmitz's accounts of the later Roman Empire (in both politics and medical/pharmacal matters), Byzantium (albeit the treatment is too brief), and the Muslims on trade in drugs and spices, leading quite naturally into the so-called High Middle Ages and the early Renaissance: the volume ends with a clipped synopsis of how the "new disease" (syphilis) would affect the European states in the near future; the year 1493 is a fitting end to the book, which seeks to encapsulate as much ancient and medieval theory in medicine and pharmacy as possible, as well as how and why medicine and pharmacy remained wedded and dependent on botanicals, mineral drugs, and animal products well into the modern era. To be sure, one can discern the gradual separation of pharmacy from medicine in late medieval Italy and France, but again the specifics as drawn from legal texts do not lend clarity to the specific botany or pharmaceuticals used, as the law codes grant status, leaving "professional matters" (drugs, plants, primary teaching texts) to the practitioners. Moreover, by emphasizing what passes as "early German pharmacy" (pp. 84–92) as a fuzzy forerunner of German practices in the early Middle Ages (pp. 218–226) and in "Latin Europe" (pp. 293–589), Schmitz becomes more Eurocentric than perhaps he intended. One is surprised by this tendency, since there are short narratives on China (pp. 53–72) and Japan (pp. 74–83); the Chinese materials are rather fuller, given the large literature on this topic in modern German scholarship. It is to Schmitz's credit that he gives full credit to medical and pharmaceutical magic, alchemy, and the erstwhile "miracle tracts" in classical pagan, Christian, Byzantine, Arabic, and early modern (German) documents, but the extremely hazy notions of a German "Frau" in early times, coupled with "Druidic medicine and phar-

macy" (the latter within "The Celts" [pp. 89–92]), should have been excised by the literary executors of the unfinished manuscript.

Unlike in the classic German-language histories of pharmacy (e.g., Hermann Schelenz, *Geschichte der Pharmazie* [Berlin, 1904; rpt., Hildesheim, 1965]; and Julius Berendes, *Die Pharmacie bei den alten Kulturvölkern* [Halle, 1891; rpt., Hildesheim, 1989] and *Das Apothekenwesen* [Stuttgart, 1907; rpt., Hildesheim, 1967], this last with a "Vorwort" by Rudolf Schmitz himself), there are no specific references to texts and sources, excepting longer and shorter quotations, with the citation given within the main narrative. The reader is, thereby, presumed to know which primary sources and which modern scholars to pursue in the enormous bibliography (pp. 593–778 [almost five thousand references in Latinized Greek, Latin, the majority in German, followed by items in French, English, Spanish, and Italian]). Without expert guidance, the novitiate will know little about those texts and studies, and the scholar knows them all too well, so that the readership of this new *Geschichte* is left in doubt. It is unlikely that even graduate students would be willing to plow through five thousand titles in an attempt to narrow down a particular era or subject, although the very fulsome *Register* (pp. 781–836) somewhat mitigates this problem.

With a little digging, the prospective reader does find solid accounts of weights and measures and of the twisting nomenclatures of pharmacal substances in a multilingual literature that incorporates nonmedical, religious, and other technical tracts (viz., "Das Arzneimittel in der Literatur"; pp. 357–402); and perhaps the best section of Schmitz's huge assemblage is the controversial subject of "monastic medicine" in medieval times, particularly in the West (e.g., "Klöster als Pflanzstätten der Wissenschaft," beginning on p. 294). Unhappily, all of these treasures and many more are closed to those who do not command German, so that monolingual scientists, pharmacists, and doctors alike will not have access to the surfeit of early scientific riches scattered throughout this thick tome. Indeed, the modern reader must be reminded of the long shadows of Greco-Roman theory of the "balances" of elements, qualities, and humors, presumably first enunciated by Hippocratic Greek physicians and canonized by Galen of Pergamon (A.D. 129–after 210); those long shadows of almost dogmatic influence on later Roman, Byzantine, classical Arabic, and early modern European medicine and pharmacy now have a large literature, generally in English and French, followed by Italian and Spanish, with German works gradually growing fewer in number as the decades pass. It is sad to see such a fine example of the dying process of a "universal history" (inclusive rather than exclusive) relegated to a language that no longer gains the allegiance of science, let alone many of the humanities. It seems, therefore, that if a short version of this splendid book could be re-edited and translated into English (especially the portions on Greek, Roman, Byzantine, and classical Arabic medicine and pharmacy, including the marvelous tracts from Islamic Spain), it would function as a much-needed supplementary text for all current histories of pharmacy, which tend to be exclusive in their focus and devoted to more modern eras (Renaissance to the present), in which pharmacy definitely broke from medicine, becoming its own respected profession within the medical sciences. For those who have German (the vocabulary is not difficult, with the expected exceptions of technical terms), Schmitz's *Geschichte der Pharmazie* offers delicious insights even with "dipping" into sections of special interest; the volume as a whole ranks as a solid encyclopedia of the history of pharmacy from prehistory through the arrival of syphilis in Europe.

JOHN SCARBOROUGH

Robert Whitaker. *Mad in America: Bad Science, Bad Medicine, and the Enduring Mistreatment of the Mentally Ill.* 320 pp. Cambridge, Mass.: Perseus Publishing, 2002. $27 (cloth).

This history of psychiatry deliberately challenges the success story of the introduction of antipsychotic drugs in the 1950s, according to which individuals suffering from schizophrenia could lead normal lives again, thereby making deinstitutionalization feasible. To shed doubts on this account, Robert Whitaker starts out with observations made by the World Health Organisation that individuals suffering from schizophrenia in developing nations, where antipsychotic medications are generally not available, have higher recovery and lower relapse rates than patients treated with the most advanced medications in North America. Nevertheless, North American psychiatrists continue to prescribe antipsychotic drugs to many more patients and in much higher doses than their counterparts elsewhere in the Western world. *Mad in America* explores the historical reasons for this state of affairs and draws a number of rather discomforting conclusions. Rather than the well-being of mentally ill individuals, profits and the management of patient populations appear to have

been the central concerns of researchers and psychiatrists.

The first chapters deal with the heroic and often barbaric treatment methods of the eighteenth century and the somatic treatment methods developed during the first half of the twentieth century. The remainder and most interesting part of this study deals with the introduction of psychopharmacological treatments for schizophrenia, first offered in the United States in 1954 in the form of Thorazine. Whitaker relates how psychiatrists at that time described how Thorazine made mental patients emotionally detached and profoundly disinterested in their environment. They often mentioned the appearance of side effects that resembled the symptoms of Parkinson's disease. The following ten years saw a complete reversal of these opinions. In the 1960s Thorazine was praised for reducing apathy, improving motor activity, and making patients less indifferent. Whitaker explains this process as the outcome of a smart public relations campaign organized by a profit-driven pharmaceutical industry. Ghostwriting articles, manipulating the popular press, lobbying state legislatures, and organizing speakers' bureaus stacked with proponents of the new treatment methods were among the strategies employed. Unfavorable research reports were repressed, and psychiatrists who wanted to experiment with rehabilitation programs that did not rely on medications had difficulty obtaining funding. By quoting critical medical research, criticizing supportive articles, and relating the experiences of patients on psychopharmacological medications, Whitaker paints a profoundly disturbing picture. He speculates that most symptoms considered characteristic of schizophrenia today (high relapse rates, assaultive behavior, and social withdrawal) are outcomes of the medications used, not of the disease itself. In the case of schizophrenia, the treatment is much worse than the disease.

Whitaker's conclusions are well argued and at times convincing. He sketches how medical research and treatment have been shaped by the powerful pharmaceutical industry, which crafted unwarranted perceptions of antipsychotic medications. In this respect, he provides a welcome counternarrative to the standard positive accounts in the psychiatric and historical literature. However, some readers might be put off by the generalizations, the conspiratorial tone of the book, and the speculations about the effects of medications and the causes of schizophrenia. In these matters Whitaker often moves beyond the purview of the historian. That being said, this provocative study raises many troubling questions about the recent history of psychiatry in a challenging manner. It thereby puts a dent in the virtually unquestioned hegemony of biological psychiatry today.

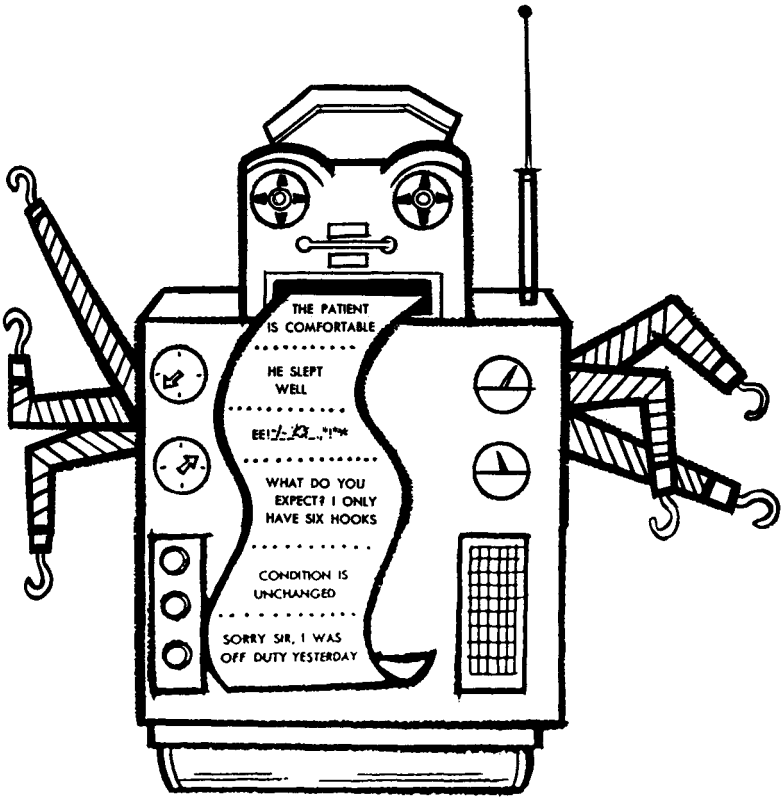
HANS POLS

Margarete Sandelowski. *Devices and Desires: Gender, Technology, and American Nursing*. (Studies in Social Medicine.) xx + 295 pp., illus., bibl., index. Chapel Hill/London: University of North Carolina Press, 2000. $45 (cloth); $19.95 (paper).

Histories of science and technology have typically portrayed "exceptional" women who succeeded within traditionally male professions, while ordinary women are conspicuously absent except as users of technology (particularly in the domestic sphere) or as victims of technology. Some feminists have perpetuated male norms regarding what constitutes important scientific work in their reticence to study female-dominated professions. Yet nursing offers an ideal context in which to examine the intersecting and reciprocal relationships between gender, work, science, and technology. Margarete Sandelowski's research begins to address this significant gap in the literature.

In *Devices and Desires* Sandelowski asks important questions about how technology has shaped the nature and definition of nursing practice, how nurses perceived and used new technologies, what choices were available, and how power, social relations, and divisions of labor between nurses, patients, and physicians were renegotiated based on new technologies (pp. 9–10). She points out that nurses have "always used a variety of tools, instruments, and machines" but seldom thought of them as technology (p. 1). On the basis of the centrality of material devices to nurses' work, she argues that devices both satisfied and thwarted nurses' professional desires.

Sandelowski begins with a discussion of theoretical issues (Ch. 2) and then moves on to analysis of the continuities and changes related to nurses' skilled observation of patients. She suggests that increased diagnostic technologies after World War II partially transformed nurses' work from being situated "behind the screens" at the beginning of the twentieth century to work that was situated "in front of the screens" by the end of the century. Nurses shifted from "hands-on" knowledge of their patients to "hands-off" knowledge generated by machines—but not without contesting and negotiating health-care terrain. Sandelowski examines their use of



Artist's conception of a "Nurse Robot" published in the American Journal of Nursing in 1963 *(from Margarete Sandelowski,* Devices and Desires, *p. 123).*

"unaided but trained senses" (Ch. 3), the "diagnostic revolution" (Ch. 4), increasing specialization and delegation (Ch. 5), and the specific technology of electronic fetal monitoring (Ch. 6) and then concludes with a discussion of current issues and debates around health-care technology (Ch. 7).

One valuable discussion involves the concept of "shared technology," as Sandelowski points out the difficulty of isolating medical technology exclusive to nursing. Nurses shared devices with untrained women. As she explains, "While women might arrange flowers, nurses cared for them as part of the management of the environment around the patient. Women might make beds, but nurses used beds to comfort and treat patients" (p. 45). Similarly, nurses shared specialty objects (such as thermometers, hypodermic syringes, and catheters) with physicians—typically becoming more familiar and more proficient with their use (p. 46). While these objects supported physicians' diagnosis and treatment, nurses transformed them as nursing technologies for the comfort and support of patients through illness experiences. For example, thermometer readings provided diagnostic information to physicians while also guiding nurses' decisions regarding bathing, feeding, and activity for patients.

The scope of this research is ambitious (ranging from 1873 to the twenty-first century), as is the diversity of analytical frameworks. Sandelowski includes excellent portrayals of what nurses did and still do at the bedside. There is, however, a thread of technological determinism that runs through the analysis, while the conclusions are universalized to all nurses. Sandelowski claims, for example, that there is "an increasing democratization of health care functions and access to technology" (p. 177) but without asking important questions about race, class, and ethnicity that would address "for which nurses" and "in which settings" democratization happened. That being said, *Devices*

and Desires does make a valuable contribution to the history of technology and the history of nursing.

CYNTHIA TOMAN

Douglas Starr. *Blood: An Epic History of Medicine and Commerce*. xvi + 446 pp., illus., index. New York: Alfred A. Knopf, 1998. $27.50, Can $39.50.

Historians shun epics as nature shuns vacuums. Yet epics tap into elements of humanity (or inhumanity) that appear, at least, to transcend transient particularities and reveal something more enduring. Perhaps this is why Douglas Starr's epic tale of blood—a subject deserving of such treatment, if ever there was one—has attracted such widespread attention. It has been released in paperback. It has inspired readers to write into the *Amazon.com* review section, exclaiming "It has ignited my interest in medical history generally"; "I couldn't put it down. . . . riveting . . . compelling . . . destined to become a classic." It has even merited translation into a four-hour documentary, produced jointly by PBS (U.S.) and Channel 4 (U.K.).

Starr gathers his larger story around a modern tragedy: the deaths of thousands of hemophilia sufferers, not from the disease, but from its treatment. This treatment, Factor VIII, was derived from large pools of donated blood, some of which had been contaminated with HIV. The tragedy was heightened by the fact that doctors eventually learned that the blood supply had been compromised and nonetheless encouraged patients to continue using Factor VIII. Starr opens with a scene from the subsequent French trial of some of these doctors. How, he asks, could all this have happened? To find his answer, he sets the story aside (a favored literary device here) and turns to history. Though he calls this "the" history of blood, it is in fact a history of the movement of blood in and out of bodies—be they persons or nations. Near his book's end he returns to the French trials, only to recount a denouement (the doctors were convicted but suffered little formal punishment) that reflects the larger ambiguities inherent in humanity's attempts to control so complex a fluid as blood.

The story unfolds in three parts. The first, "Blood Magic" (fifty pages), moves from antiquity to the seventeenth-century transfusion trials, through a side excursion on bloodletting, and into the "modern" era of transfusion. Part 2, "Blood Wars" (one hundred pages), moves from the 1920s through World War II, setting the stage for transfusion's widespread acceptance as well as for its future failures. Section 3, "Blood Money" (two hundred pages), sees plasmapheresis bring the United States (Starr calls it the "OPEC" of blood) into the heart of the story and traces the eventual national responses to the HIV-contaminated blood supply. Ultimately, he uncovers only relative degrees of failure. He concludes with an epilogue on blood in a "post-AIDS society."

Starr has thus devoted considerable attention to history, ostensibly to illuminate more recent events. Unfortunately, much of that history seems only a device to underscore the distance we have since traveled. Beyond numerous errors of fact, Starr makes serious errors of presentation and interpretation. His dismissals of bloodletting—"there was never any evidence that bloodletting did any good" (p. 17)—of humors as "vague," and of traditional clinical judgment as working "on impression" evince Starr's own inability to understand how disease and therapeutics were perceived before the mid-nineteenth century. His abrupt explanation of transfusion's fall from favor by that century's end exemplifies his tendency to oversimplify causality to the point of falsification. And then, there's his account of transfusion's twentieth-century rebirth. Here Starr's eye for a good story and his apparent unwillingness to consider physiology lead him astray. One night in 1908 the future Nobel Prize winner Alexis Carrel—then in New York—was brought a dying infant, her desperate doctors pleading that she would die without a transfusion. He transfused; she survived. (Carrel did not win the prize for transfusions, as one might assume from Starr's presentation [p. 36].) This begs an important question: Why, if blood had fallen from favor, should doctors have concluded that *this* patient—unlike thousands of others—could be saved only by blood? The truth is less glamorous. The Cleveland surgeon George Washington Crile had conducted extensive research on blood pressure and fluid loss in animals and had successfully transfused a patient (using Carrel's vessel attachment technique) a year before Carrel. His 1907 paper was widely known. There are similar problems with Starr's treatment (or lack thereof) of World War I and of Norman Bethune's work during the Spanish Civil War.

Many of the stories in *Blood* have been told before: by Richard Titmuss and Randy Shilts, to name two. Starr has, however, frequently returned to primary sources (both publications and interviews), spun his narratives artfully, and brought them together with an eye to a broader history. There are two lessons the historian

might teach those with the courage to write such epics. First, the past reveals more when approached on its own terms. Second, it is sometimes not the heroic events that alter the course of history. What Starr's success might teach historians is obvious.

KIM PELIS

John O. Baxter. *Dividing New Mexico's Waters, 1700–1912*. viii + 136 pp., illus., tables, bibl., index. Albuquerque: University of New Mexico Press, 1997. $24.95.

Technical water measurement concepts and scientific terminology had a role in the expropriation of the water rights established under Spanish and Mexican rule in New Mexico. John Baxter's slim history of water administration from the Spanish colonial period to New Mexico's statehood is, therefore, of interest to water scientists who are concerned about the social consequences of science. It also clarifies the water-allocation rules of the Spanish and Mexican governments. These are frequently referred to today as the source of the "doctrine of prior appropriations," often in ways that are contradictory to their spirit and intent.

As Baxter shows, water administration during both the Spanish colonial and Mexican eras focused on reconciliation of opposing interests rather than the enforcement of legal rules and property principles. While land and water frequently changed hands, there was no real market environment, and the emphasis was on access to resources rather than on the asset value of water. Prior appropriation was recognized more as a matter of equity than as the property rule enforced today.

Eighteenth-century New Mexican settlements were vulnerable to drought, flood, and Indian attack; continuous occupation was the exception rather than the rule. Hacendados driven off their lands by drought or massacre often returned to find their water being used by latecomers. Spanish and Mexican governors and alcaldes (local officials) encouraged claimants to work out mutually satisfactory arrangements; failing this, resolution by local officials was favored over resolution by the distant governor. The prior claims were generally recognized and confirmed, and adjustments were made to provide for the encroachers as well as could be. Rarely did decisions leave any party with no access to water, and rarely were disputes resolved definitively.

The coming of the railroads in 1878 brought two new influences: federal engineers and land speculators. Dispute resolution moved to the district courts, where Anglo lawyers and judges settled the water conflicts of Hispanic and Indian communities using unfamiliar principles, language, and technology. The incorporation act of 1887 gave large-scale irrigation ventures the right to enter private property and condemn any lands needed for right-of-way. Court decisions allocating water rights and rights-of-way to the emerging canal companies granted precise quantities of water rights in an environment where the total yield of a stream system was in fact unknown. This meant that substantial new rights were established in fully appropriated systems. While territorial law, including the 1907 water code, recognized established rights, the shift away from local dispute-resolution institutions and the measurement of water in unfamiliar and unrealistically precise terms put the original irrigation community at a disadvantage relative to the incoming speculators and developers. The simultaneous resolution of land-grant claims (not treated in this history) followed a similar pattern, with the result that title to much of the land and waters of New Mexico was lost by the region's original population. Some of the original titles remain, and the conflicts described here continue today, with some new characters—notably the Bureau of Reclamation, the Corps of Engineers, and a covey of endangered species.

This history is interesting on its own account and also provides insight into one aspect of the legal basis for prior appropriations. Finally, it is a valuable cautionary tale on how a neutral technical advance can have powerful equitable impacts.

CHRIS NUNN GARCIA

Giuseppe Olmi; Lucia Tongiorgi Tomasi; Attilio Zanca (Editors). *Natura-Cultura: L'interpretazione del mondo fisico nei testi e nelle immagini*. Preface by **Marc Fumaroli.** (Accademia Nazionale Virgiliana di Scienze Lettere e Arti, Miscellanea, 8.) (Based on papers presented at the Convegno Internazionale di Studi, October 5–8, 1996, Mantova.) xvi + 627 pp., illus., figs., tables, index. Florence: Leo Olschki, 2000.

In 1962 the art historian Eugenio Battisti published his successful and controversial *L'antirinascimento.* By exploring monsters, magic, automata, and emblems, he made a fundamental contribution to our view of the Renaissance as a multifaceted and ambiguous phenomenon. To celebrate Battisti's groundbreaking interdisciplinary work, the editors of this volume invited a wide range of scholars who

research the history of images or use images in their work—historians of science and art as well as scientists—to explore the relationship between words and images.

The editors' short introduction does not aim to offer a tight interpretative framework for the thirty-one chapters that follow, nor does Marc Fumaroli's preface on how the philosophical meaning of imitation changed in response to Cartesianism. Written in Italian, English, and French, the contributions cover topics ranging from the early sixteenth century to the present, though most fit into the period 1550–1800. The variety of approaches is truly remarkable. Unfortunately, some of the chapters do not go beyond very narrow reconstruction of how a certain organ, animal, or disease has been represented over the centuries and do not engage with any historically specific interpretations. Others are built around questions that historians of science would consider outdated and, for example, assess the "scientific value" of past images or examine earlier naturalists' anticipation of modern discoveries.

Yet there are chapters that readers of *Isis* will find stimulating. Peter Mason's discussion of the migration of images (found in his case on an English burial stone) is interestingly complemented by Jose Pardo Tomás's analysis of the production of Oviedo's work, one of the first in which European readers encountered the exotic nature of America. The authorship and function of one of the richest collections of early modern botanical drawings, the *Libri Picturati* in Cracow, is revealed by Claudia Swan's fascinating detective work. In his dossier on the relationships between Luigi Ferdinando Marsigli—soldier, diplomat, and founder of the Accademia delle Scienze of Bologna—and the various draftsmen and engravers who prepared the illustrations for his works, Giuseppe Olmi admirably reconstructs the complex process of transforming natural specimens or stretches of landscape into printed images. Roberto Paolo Ciardi's discussion of Michelangelo's anatomical representations of the living body is an important contribution to moving beyond the mere celebration of artists' and naturalists' "accuracy," with which some other chapters are satisfied.

Several authors write interestingly on the problem of how color was represented visually and verbally. By engaging with sources that are usually little explored—for example, technical literature on horses—Alberto Mugnaini offers a compelling investigation of sixteenth-century disagreements over the use of an expanding lexicon of colors and attempts to establish a taxonomy. Lucia Tongiorgi Tomasi's discussion of Ligozzi's "secrets" for achieving the renowned brightness of his colors reminds science historians of the rewards of taking research to the level of the "artisanal" and material production of the images. Renato Mazzolini analyzes how Marcello Malpighi's anatomical investigations of the skin, in particular the causes of its color, were received and expanded in the eighteenth-century debate on the origins of human races.

It is a pity that the contributions on contemporary issues, mainly on computer-generated medical images, are little more than clear expositions of the new techniques. In the end, while the book fulfills the editors' intention to encourage the dialogue between art and science historians, the presence of various absorbing chapters does not make up for the lack of a more coherent and focused editorial project.

SILVIA DE RENZI

Matthew H. Sommer. *Sex, Law, and Society in Late Imperial China*. (Law, Society, and Culture in China.) xx + 413 pp., illus., apps., bibl., index. Stanford, Calif.: Stanford University Press, 2000. $55.

In sober and sometimes chilling detail, Matthew Sommer compares the Qing dynasty (1644–1911) legal codes with newly available archival case records on the subjects of "marriage, sex offences, family disputes." In doing so, he is able to show the continuities of legal philosophy with regard to sex, property, and family structure alongside the substantial practical changes demonstrated by the substatutes and actual cases.

The enduring principle of family relations was the protection of the patriarchal lineage. Neo-Confucian political philosophy was explicit about the link between family order and political stability: in sexual terms, this meant that intercourse should be governed by ritual. Marriage was contracted by the heads of families through matchmaker intermediaries: daughters and sons obeyed, and a wife owed her husband sexual service and absolute sexual loyalty, concepts couched in the same terms as the political fealty a subject owed his ruler. Female licentiousness was a threat to the social order, to the degree that widow remarriage was a crime if it occurred during the three-year mourning period. Widows who chose—or were wealthy enough—to remain chaste after the death of a husband or fiancé were eligible for canonization in the imperial chastity cult. Women who died resisting rape, or who committed suicide rather than succumb to

family pressures to remarry or be pimped in prostitution, might be similarly honored. There was no legal concept of a woman's consent to intercourse except in terms of the criminal behavior of "consensual illicit sex" (i.e., adultery or consensual prostitution), though inadequate displays of resistance to rape were often regarded (as in the West) as *de facto* consent.

For a woman who inherited property from her husband, maintaining the role of the chaste protector of her husband's property (for the lineage) gave a unique degree of independence and legal protection from avaricious in-laws. By contrast, the wives of poorer men found that chastity was a luxury they and their children could not afford.

The book centers on the reforms enacted during the Yongzheng Emperor's reign (1723–1735). Before these, prostitution was tolerated when confined to hereditary "music households," a legally debased group whose status often derived from punishment for political crimes. Afterward, all such debased status groups were elevated to commoner status, a move that made prostitution effectively illegal for all. Sommer characterizes this change in policy as one that made "every woman a wife." For the first time, commoners, servants, and even the offspring of former music/prostitute families became eligible for chaste widow status. He sees this as a logical extension of a growing tendency to extend Confucian standards of ritual and propriety to the mainly peasant population rather than as a sudden change. Still, it is hard to deny that these changes had unusually far-reaching consequences.

Also during the Qing dynasty, sodomy first appeared as a criminal offense. Here Sommer takes issue with other historians who view the new prohibition of consensual sodomy as an indicator of Qing homophobia. Sommer argues that it is the damage to the sodomized male's performance of familial gender roles that is the key issue, because of the powerful stigma associated only with *being penetrated.* As evidence, he demonstrates that virtually all sodomy cases involved older men penetrating youths. Magistrates found it hard to accept the idea of an older man being a victim of homosexual rape. Moreover, consensual sodomy appears in the legal record only when it was associated with more serious crimes such as murder. During the Qing, male numbers substantially exceeded those of women, causing widespread fear of the "rootless rascal," the marginalized male who could not afford a bride-price and was not invested in the social order. These "rootless rascals" were perceived as threats both to the chastity of women and to the gender performance of young men.

This meticulous scholarship demonstrates the imperial state's interest in the sexual choices of even the poor and status debased in late imperial China. Sommer promises more investigation of the state's reasons for this interest in his next work.

BRIDIE ANDREWS

■ Antiquity

Hermann Hunger; David Pingree. *Astral Sciences in Mesopotamia*. (Handbook of Oriental Studies: The Near and Middle East.) xviii + 303 pp., tables, app., bibl., index. Leiden: Brill, 1999. $112.

Cuneiform tablets excavated from Nineveh, Babylon, and other sites in Iraq have provided historians with a wealth of material for studying the astral sciences (astronomy and astrology) in ancient Mesopotamia. They have revealed an astronomical heritage stretching back to at least the early second millennium B.C., culminating in the development of an advanced mathematical astronomy during the latter half of the first millennium B.C., that had a major influence on the practice and development of astronomy in India and the Greco-Roman world. Indeed, it is no exaggeration to state that Mesopotamian astronomy was the foundation on which Greek and the whole of the subsequent Western astronomical tradition was based. Through the work of scholars over the past hundred years, large parts of the astromomical corpus are now understood, at least on a technical level. However, our understanding of the cuneiform astrological material is less well developed, since many more texts remain to be studied. As a result, only the first thirty-one pages of this three-hundred-page book are devoted to "omens"; Hermann Hunger and David Pingree refer the reader to the recent survey of Mesopotamian astrology by Ulla Koch-Westenholz for a more detailed study of what is currently known. The remainder of the book deals with "astronomy," although of course the distinction between the two is not sharp.

One of the challenges facing historians working on Mesopotamian science is the bibliographic nightmare of locating earlier work. There has been no natural home for publications on cuneiform astronomy. Articles are spread fairly evenly between Assyriology and history of science journals, together with a smaller number appearing in theology, history, or astronomy journals. But a significant number of important

essays have also appeared in a wide variety of *Festschriften* where one would not think to look. The situation for earlier publications, many of which are still highly useful, is even worse. For example, Franz Xavier Kugler's monumental *Sternkunde und Sterndienst in Babel,* published in three volumes plus supplements between 1909 and 1935, is a mine of information—but a mine without a map, where related issues are spread out, almost as if at random, throughout the various volumes. Perhaps the most useful aspect of *Astral Sciences in Mesopotamia* is therefore the wealth of bibliographical information it offers. For every text and topic, the authors provide a summary of all previous publications. Where two or more interpretations of a text have been proposed, they describe both but are not afraid to give their own opinion as to which interpretation they believe to be the more plausible. Of course, not everyone (myself included) will agree with every one of these opinions, but that does not detract from the book's usefulness.

The book is more than just a very useful critical bibliography, however. In discussing many texts and problems, the authors are also able to make significant new contributions toward their understanding. For example, their comparison of overlapping texts from the various different categories of nonmathematical astronomical texts illustrates that the relationship between these texts is not as simple as has often been thought.

Astral Sciences in Mesopotamia is not, nor is it intended to be, a "history of Babylonian astronomy." It is something far more useful: a true reference work for researchers studying astronomy in Mesopotamia. It will provide the starting point for all future researches in the field, allowing the reader quickly to find the essential basic information about any aspect of Mesopotamian astronomy, with references to all of the relevant publications. I, for one, refer to it almost every day.

J. M. STEELE

Shigehisa Kuriyama. *The Expressiveness of the Body and the Divergence of Greek and Chinese Medicine*. 340 pp., illus., apps., bibl., index. New York: Zone Books, 1999. $29.50.

In the several years since its appearance, Shigehisa Kuriyama's comparative study of Greek and Chinese medicine has become a landmark in several fields. Prior to the publication of this handsome Zone volume, Kuriyama's research on medical history appeared in somewhat obscure places: volumes edited by medical anthropologists and historians, a conference volume published in Japan, and an encyclopedia of the history of disease, among other venues. Many whose work stood to benefit were unaware of his original approach to scholarship on classical medical and cosmological sources. Now that *The Expressiveness of the Body* is out as a coherent monograph, however, it has quickly become an important presence in a number of fields. Classical historians of both Greek and Chinese medicine, historians of philosophy and science in East Asia, medical anthropologists, and scholars in the humanities who are generating a huge literature on the history of the human body have all had to sit up and take notice. It is Kuriyama's synthetic vision of the differing assumptions about embodiment, and their relationship to forms of systematic knowledge and writing, that now demands some form of address from all who are embarked on comparative historical studies.

The guiding problem of the book is stated simply at the outset: "The true structure and workings of the human body are, we casually assume, everywhere the same, a universal reality. But then we look into history, and our sense of reality wavers. . . . Accounts of the body in diverse medical traditions frequently appear to describe mutually alien, almost unrelated worlds" (p. 8). The question has been stated even more clearly in Kuriyama's earlier works: If the body is everywhere the same, how can there be a history of medicine? Given that history is concerned with variation through time and space, why are there such deep differences in forms of knowledge about the body? Kuriyama's answer, stated more clearly in this book than previously, is that "conceptions of the body owe as much to particular uses of the senses as to particular 'ways of thinking'" (p. 12).

Once these powerful questions have been posed as a frame for research, it is a novel style of reading sources—at least for medical historians—that constitutes perhaps the greatest contribution of this study. Kuriyama is able to read Hippocratic and Galenic texts, the *Huangdi Neijing* and the *Zuozhuan,* not so much for hidden meanings as for necessary assumptive structures about the body. By interrogating sources on such fundamental questions as the nature of touch and seeing, ways of experiencing blood and breath, new riches are revealed in canonical materials. Reading through these beautifully phrased explorations of alien ways of knowing and being, we begin to see at a deep level just how basic the problem of difference is to any scholarly undertaking.

The rhetorical force of this book works for

readers at all levels of sophistication. As an anthropologist working on Chinese medicine, I have found it theoretically and methodologically inspiring, while my undergraduate students and generalist friends have been excited by its experiential insights. Possibly historians of Greek medicine and Chinese science will find this study less detailed and esoteric than those they are accustomed to reading. But they can only benefit from taking Kuriyama's method and synthetic vision seriously.

Arguably *The Expressiveness of the Body* is less useful as a history of Greek than of Chinese medicine (though the force of the project is in the comparison), and the problematic literary vignette that opens the book is neither charming nor especially functional. But this is one of those books the appearance of which should be considered a genuine event. Everyone who sees value in comparison (and everyone who touches, sees, breathes, or bleeds) should read it.

JUDITH FARQUHAR

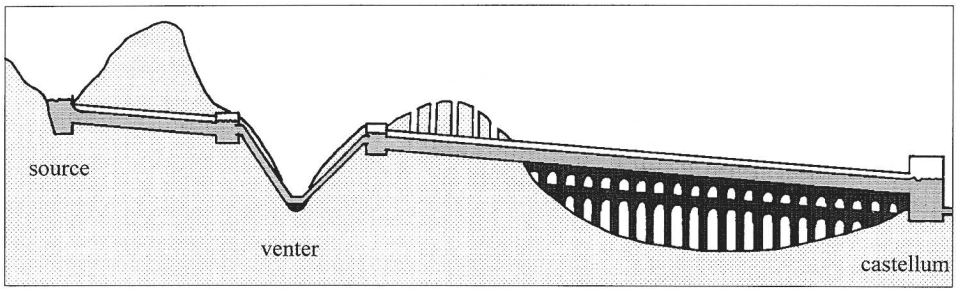
Gerda de Kleijn. *The Water Supply of Ancient Rome: City Area, Water, and Population*. v + 365 pp., maps, apps., bibl., index. Amsterdam: J. C. Gieben, 2001. $69 (cloth).

This book, which investigates "whether data derived from the water supply of ancient Rome might add to our understanding of the social fabric, the population size, and the extent of the *urbs*" (p. iv), begins with a survey of the city's eleven aqueducts, their technical functioning, the volume of water delivered, and the size of the city's population in the first century C.E. Gerda de Kleijn's review of Rome's aqueducts in Chapter 1, while sensible and well documented, is largely derivative and perhaps relies a bit too much on Vitruvius's *De architectura,* frequently regarded by students of Roman hydraulics as the Word of God; in this regard one important work to be added to the bibliography is D. R. Blackman and A. T. Hodge, *Frontinus' Legacy: Essays on Frontinus'* De aquis urbis Romae (Michigan, 2001).

Chapter 2 explores the old problem of converting Frontinus's *quinaria* measurements into modern equivalents, concluding that the depths and widths of aqueduct channels give better estimates of delivery and total water volume. De Kleijn also reviews the issue of ancient Rome's population, arguing that the increase in water supply under the principate in the first century C.E. does not necessarily constitute proof of the city's growth. Chapter 3 discusses the wide range of quality and different uses of aqueduct water.

Chapters 4 and 5 present the book's real contribution, a review of the administration of the *cura aquarum* and evidence of *fistulae* or aqueduct pipes. De Kleijn's lengthy discussion of pipe stamps is based on recent work by Christer Bruun and Werner Eck but goes beyond them in documenting the find-spots of *fistulae* with names in the genitive; these, she argues, are an important topographical tool in identifying property owners and the size of properties supplied by aqueduct water. Because these find-spots are concentrated in the northeastern parts of the city and its nearby surroundings, de Kleijn concludes that a green zone of gardens and estates on Rome's northern and eastern perimeter blocked expansion of the city into the *suburbium* in that area and influenced the growth of nonelite housing to the south, extending along the Via Appia.

This argument, while interesting, is not without its problems. As de Kleijn herself acknowledges (pp. 5–7), only some 4–5 percent of Rome's *fistulae* have survived, and we are reasonably sure of the find-spots for half of these,



Sketch of a large-scale Roman aqueduct supplying water from outlying sources to the city (from Gerda de Kleijn, The Water Supply of Ancient Rome, *p. 259).*

too small a sampling to inspire total confidence in any conclusions to be drawn. Her final chapter, on the fabric and extent of the ancient city, sensibly goes beyond *fistulae* to discuss literary evidence on who lived where in Rome. There are useful appendixes on the meaning of the terms "*urbs*" and "*suburbium,*" as well as "*domus*" and "*insula,*" not to mention maps of find-spots and listings of the *fistulae* cited.

In many respects de Kleijn advances our understanding of water distribution in ancient Rome, particularly in her documentation of the *fistulae* evidence. Her book is thoroughly researched, with an impressive bibliography, and her treatment of topics like Rome's population and the fabric of particular neighborhoods is balanced and well documented. Although she recognizes the value of Frontinus as a source on Rome's water supply (pp. 4–5), de Kleijn seems to discount his evidence for making sense of water distribution within the city (p. 30 n 89). Closer attention to Frontinus's statistics might have made a more convincing case for her reconstruction of the city's expansion. But hard work and careful study have gone into this book. Frontinus himself may have been shortchanged, but he would not, I think, be displeased.

HARRY B. EVANS

Árpád Szabó. *L'aube des mathématiques grecques*. Translated by **Michel Federspiel**. (Mathesis.) 367 pp., figs., bibl., indexes. Paris: Librairie Philosophique J. Vrin, 2000. Fr 280, €42.69.

This is the French translation of Árpád Szabó's *Die Entfaltung der griechischen Mathematik* (B. I. Wissenschaftsverlag, 1994), which attempts to describe the development of pre-Euclidean mathematics by using "external" evidence. Part 1 discusses the relation between early Greek astronomy, Euclid's geometry of the circle, and (supposedly) early trigonometry. Part 2 examines the origin of Euclid's theory of proportions in the theory of music. Part 3 explains the development of Pythagorean "geometry of areas" by referring to the discovery of incommensurable lines and the correlated notion of *dunamis.* In Part 4 the structure of Euclid's *Elements* is explained in the context of Eleatic philosophy. There are three appendixes, the first on the "mathematical passage" in Plato's *Theaetetus* (147d–148b), the second on the allusion in Aristotle's *Topics* to a pre-Eudoxean definition of proportion, and the third on the often-debated question of Greek "geometrical algebra."

Szabó puts much emphasis on the method he uses. Besides the already-mentioned resort to external evidence, he relies extensively on linguistic analyses, which are used sometimes to contextualize the use of ancient terms and sometimes as an index for conceptual development. Furthermore, Szabó makes extensive use of "plausible conjectures" when the textual evidence is defective or when he wants to organize it chronologically.

Those features were already present in Szabó's earlier works, especially *Anfänge der griechischen Mathematik* (Akademiai Kiado, 1969), which is the basis for the text reviewed here. The deficiencies of Szabó's results and method have already been discussed at length. In my view, one of the main problems lies in his eagerness to tell a tidy story about the early development of Greek mathematics. This story culminates, unsurprisingly, in Euclid's *Elements,* which Szabó sees as the "system of Greek mathematics" (p. 11). This historical approach is typical of Proclus, on whom Szabó relies—imprudently, given the many difficulties inherent in using such a late source (the same is true for his use of Ptolemy and late neo-Pythagorean authors).

I doubt that those who know Szabó's previous works will find anything new or convincing answers to earlier criticisms in this volume. Szabó either haughtily dismisses his critics by claiming that they have not understood him (p. 167) or further complicates his already intricate explanations.

Nevertheless, this text is as suggestive as Szabó's previous works. It reflects the warm personality of the author, who died in 2001. He was both a stimulating teacher and a challenging scholar, as is illustrated by the numerous reactions his conjectures have provoked. As such, I would recommend this volume as a good introduction to the historical issues of the period. Szabó's approach reveals the many difficulties implicit in any attempt to reconstruct the development of early Greek mathematics and raises a number of challenging questions worthy of consideration.

Michel Federspiel's translation is clear but not entirely faithful to the original. Besides some surprising changes and omissions ("*Entfaltung*" is turned into "*aube*" and "*Rechenoperationen*" into "*opérations*" on p. 131; "*Rückblick*" disappears on p. 166), many quotations in Greek have been added and words that Szabó only transliterates are given in Greek. This makes the original work less accessible and in at least one case changes Szabó's argument (p. 133). However, some of theses slips actually seem intended to

correct Szabó's most blatant mistakes ("*asummetron,*" wrongly translated by Szabó as "*unmeßbar,*" simply becomes "*incommensurable*" [p. 155]). The typesetting for quotations is not uniform throughout and certain key words are not italicized as in the original, an important omission given Szabó's concern for words. The final editing was very careless. In addition to the many typographical errors, the indexes contain so many errors that they are almost unusable; some bibliographical references are wrong as well.

ALAIN BERNARD

Sibylle Ihm. *Clavis Commentariorum der antiken medizinischen Texte*. vii + 268 pp., bibl., indexes. Leiden: Brill Academic Publishers, 2002. (Cloth.)

Sibylle Ihm has collected and organized the available information on ancient and medieval commentaries dealing with medical texts—the authors commented on are Hippocrates and Galen (Galen himself also commented on some other medical authors, but those commentaries are no longer extant). The *Clavis* itself is preceded by a more general introduction discussing the different commentary types included; Ihm has rightly decided to cast her net widely (p. 4) and includes works that contain line-by-line commentaries on a lemmatized text, works that are *called* commentaries, scholia, and summaries. The *Clavis* entries contain information on the author of the commentary (the basic organizational principle of the body of the *Clavis* is alphabetical), the title of the commentary, author of the work commented on, title of the work commented on, date of commentary/author, type of commentary, how much is extant, structure of the commentary, editions/translations, manuscripts, secondary literature, and other remarks. Ihm has not aspired to completeness in quoting secondary literature, but as far as I have been able to ascertain her references are certainly adequate as a starting point for further research.

In the last part of her introduction Ihm provides a short overview of the different periods she distinguishes. This section is a little disappointing; it has little to offer apart from a very rough periodization: Galen, the time after Galen, the time after the Alexandrian period (from the sixth century), and the school of Salerno and later (i.e., from the eleventh century)—this last period is not covered in the *Clavis.* The very general indications about Galen's conception of the work of a commentator are not very helpful but may be intended simply as an opening to discuss more generally the genre, purpose, and intentions of the commentaries. This type of work gets very little attention otherwise in this volume: for example, Glenn Most's edited volume *Commentaries/Kommentare* (Vandenhoeck & Ruprecht, 1999) is only mentioned in note 2 on page 3 and has not made it into the general bibliography. This is also the case for the other contributions mentioned on that page. This means that some of the more sophisticated theoretical and rhetorical approaches to the genre are ignored; see Ihm's remark (p. 14) on Galen's claim that good commentators should not become outright champions of the authors they are working on: she takes this as an unproblematic indication that some such "bad" commentaries existed. Of course, almost every ancient commentator, and certainly Galen himself, at times falls prey to such excesses of the principle of charity while loudly protesting that such would be bad practice—a rhetorical topos if ever there was one. However, given the restrictions the author has imposed on herself, the omission is understandable.

The *Clavis* itself is well laid out, is eminently usable, and seems generally reliable. Should one wish to find all commentaries to a certain work by Hippocrates or Galen, the indexes make these easy to locate.

This volume will prove a very valuable instrument, perhaps primarily for those who are interested in the more technical aspects of individual commentaries (text, local interpretation, state of the medical art), issues proper to the history of medicine. It is not primarily designed to promote research into the cultural or rhetorical functions of commentaries as such.

INEKE SLUITER

Jerry Stannard. *Pristina Medicamenta: Ancient and Medieval Medical Botany*. Edited by **Katherine E. Stannard** and **Richard Kay**. (Variorum Collected Studies Series.) xxii + 324 pp., frontis., illus., index. Brookfield, Vt.: Ashgate, 1999. $110.95.

Jerry Stannard. *Herbs and Herbalism in the Middle Ages and Renaissance*. Edited by **Katherine E. Stannard** and **Richard Kay**. (Variorum Collected Studies Series.) xvi + 342 pp., frontis., illus., tables, index. Brookfield, Vt.: Ashgate, 1999. $110.95.

In the four decades between 1953 and 1993, the late Jerry Stannard published 106 essays, articles, books, and encyclopedia entries. Thirty-five of these articles and essays, published between

1961 and 1985, are gathered in the two volumes under review, which are arranged chronologically according to their subjects. *Pristina Medicamenta* begins with an essay on "Hippocratic pharmacology" and continues through ancient Greek, Roman, and Byzantine pharmacology, ending with the Latin Middle Ages, including three essays on the botanical works of Albertus Magnus. *Herbs and Herbalism* begins with medieval European herbals and recipe literature, then turns to the sixteenth-century revival of ancient medical botany before ending with three studies of individual species: "moly," squill, and dill. Despite the inevitable repetition occasioned by the essays' having been written for different audiences at different times, the volumes, taken together, can be read as Stannard's history of ancient and medieval plant lore and use.

Stannard's greatest strength was as a creative, meticulous, and dogged researcher. The first thing that strikes the reader of these essays is their erudition. The notes refer to a wide range of primary and secondary sources, both well known and obscure, in print and in manuscript. The main focus of these articles is on plants themselves, traditions of knowledge about them, and their medical uses. Stannard does not neglect the social and cultural history of the ancient, medieval, and Renaissance worlds—he observes, for instance, that books on antidotes became important only in Hellenistic times, when poisoning was more widespread than earlier—but neither does he emphasize them. Some of the articles are largely synopses and commentaries on ancient and medieval sources, such as Aretaeus, Marcellus of Bordeaux, and Benedictus Crispus. Others offer accounts of important genres. In addition to being erudite, Stannard was a skilled botanist and pharmacist; not the least of the virtues of these essays is that he drew on his own practical experience to assess the skill and knowledge of his historical subjects.

Most of these essays address specific texts or corpora, from the Hippocratic corpus to the sixteenth-century works of Pier Andrea Mattioli. But a common theme runs through Stannard's work: the tension between, on the one hand, the rational empiricism of Hippocratic medicine and the firsthand knowledge embodied in folk tradition and, on the other hand, the irrationality and servile traditionalism of much late antique and medieval medical botany. We learn repeatedly that medieval botanists and pharmacological writers began to omit descriptions as they lost firsthand knowledge of plants, turning instead to fanciful etymologies and uncertain indications of provenance (some plants grew in India or Babylon, others in paradise!). The best herbalists were those who, like Albertus Magnus and Mattioli, combined an intimate knowledge of the tradition with broad experience of the natural world and a keen eye for detail, for "the heart and center of medieval herbalism was its empiricism" (*Pristina Medicamenta,* Essay 13, p. 376). The presence of magical and superstitious practices in the works of Albertus and other enlightened empiricists, Stannard insists, does not indicate that they believed such nonsense; instead, they felt obliged to report it because it was "worthy of inclusion." (The skeptical reader may be pardoned if he or she does not immediately understand the difference.) Most writers were not as talented and industrious as Albertus, of course, but this is no drawback for the historian. Plodding, derivative figures like Baptista Fiera, whose late fifteenth-century poem on the virtues of herbs Stannard examines, allow historians to establish the widespread everyday beliefs against which new movements in medicine and botany were directed.

Stannard thus displays a sensitivity to the complexity of the ancient and medieval traditions of medical botany and to how the fortunes of transmission have shaped our understanding of that tradition. The short article "Lost Botanical Writings of Antiquity" addresses the range of genres in which ancient writers, Greek and Roman, discussed plants and their uses. Many more books were written than survived, and the historian must take this fact into account when reconstructing the past. The history of medicine and the history of natural history have changed signficantly since Stannard wrote most of these essays; we are now more interested in the cultural uses and social organization of the study of nature and therapeutics than Stannard was. But these essays contain a range of material and interpretations that no historian of ancient, medieval, or Renaissance medicine and natural history can afford to ignore.

Some of these articles first appeared in journals that can be found in any good research library, such as *Isis, Sudhoffs Archiv,* and the *Bulletin of the History of Medicine.* But others were published in conference proceedings, *Festschriften,* commemorative volumes, and other hard-to-find places. Katherine Stannard, Richard Kay, and Ashgate Publishing have done historians of science and medicine a good service by bringing them together in these two volumes. Following Ashgate's normal practice for the Variorum series, the original pagination has been retained, allowing users to provide citations to the original articles. The price puts the volumes beyond the

reach of most individual scholars, but libraries with strong collections in the history of science and medicine will find them a welcome addition.

BRIAN W. OGILVIE

■ Middle Ages and Renaissance

Edward Grant. *God and Reason in the Middle Ages*. 398 pp., notes, bibl., index. New York: Cambridge University Press, 2001. $64.95 (cloth); $22.95 (paper).

Edward Grant's purpose in this volume is twofold: first, to describe how reason came to be the foundation of the medieval scholastic university tradition in logic, natural philosophy, and theology and to argue that these medieval developments served to initiate approaches to the natural world that eventually grew into modern science; and second, to explain how the Middle Ages subsequently received the popular image of antirational, barbarous, and unscientific. It would be impossible to summarize all the evidence he marshals in support of the first issue, but perhaps more important still is the observation that the fields he investigates go considerably beyond what one generally finds in surveys of medieval science. In setting up his analysis of medieval intellectual culture, Grant draws on issues like the Investiture Contest, the medieval study of law (although one might quibble with the stark contrast between customary and "rational" law), early theological literature, and the evolution of scholastic literatures. Historians outside the history of science tradition will find this an uncontroversial list of sources, but it is a refreshingly broad domain within general survey texts in the history of early science.

Chapters 4, 5, and 6 focus on the application of reason in the scholastic logical, natural philosophical, and theological traditions. Those familiar with Grant's previous work will find strong ties to those earlier sources, both in the theses pursued and in the evidence used to support them. Perhaps the most interesting and pedagogically useful aspect of the book is reserved for Chapter 7, where Grant turns to the second of his themes, the "assault on the middle ages." His view that the Age of Reason began in the Middle Ages invites a reperiodization of historical inquiry that sees the eighteenth century as more closely connected with the fourteenth than is generally acknowledged, a view recently articulated by Peter Raedts ("When Were the Middle Ages?" paper presented at the Nineteenth International Congress of Historical Sciences, Oslo, 6–13 August 2000). At the same time, Grant surveys the changing perceptions of the Middle Ages, starting from Renaissance humanists and Reformation theologians, whose proximity to medieval scholasticism might have permitted a more charitable assessment of the period but for their own parochial agendas, and ending with the Enlightenment, when historical distance from the Middle Ages and unfamiliarity with scholastic texts meant that eighteenth-century authors drew on a storehouse of medievalisms that bore little resemblance to the earlier period. Grant concludes the chapter with a survey of nineteenth-century historiography of the Middle Ages, Jeffrey Burton Russell's investigations of flat-earth theory, and modern popular perceptions of the barbaric Middle Ages, including citations of Dave Berry and Jack Kevorkian. These will undoubtedly prove useful in classrooms, where students may arrive with their own prior conceptions of the Middle Ages.

The pervasive application of reason in the Middle Ages constitutes for Grant a "culture of poking around" in which the scholastic *quaestio* serves as the central tool for the "irrepressible urge to probe into many things" (p. 356). Gone is Grant's earlier suggestion that *quaestiones* themselves served to atomize medieval knowledge of the natural world, effectively precluding the creation of a synthetic theory (Edward Grant, "Aristotelianism and the Longevity of the Medieval World View," *History of Science,* 1978, *16:*93–106, esp. p. 98 ff.). Instead, the application of reason to natural questions constitutes the heritage of the Western Middle Ages, to which modern scientists are heir, in spirit if not precise form.

There are central questions that many scholars will have about this book. Certainly one is the prominent role in the development of modern science that Grant assigns to Western culture. While he does not reserve rational techniques exclusively to Western society, in his view what distinguishes the West from other rational societies is "the self-consciousness with which [reason] was used, and the scope, intensity and duration of its application" (p. 9), and the institutionalization of reason in the universities. Both culturally and institutionally, recent scholarship has narrowed this perceived distinction between Western and non-Western science, and certainly Grant's book will produce some interesting future discussions. Inside and outside the classroom, it promises to be a useful catalyst for rethinking and debating a period often considered marginal.

STEVEN J. LIVESEY

Miguel A. Granada. *El umbral de la modernidad: Estudios sobre filosofía, religión y ciencia entre Petrarca y Descartes*. 513 pp., bibls., index. Barcelona: Herder, 2000. (Paper.)

This book is a compilation of studies, written by Miguel Granada over a fifteen-year period, that have appeared in different journals and collections. Each essay deals with philosophy, religion, and cosmology and their interaction during the Renaissance. The work consists of two parts: the first is a series of studies mainly on philosophical and religious matters, and the second treats cosmology. The introduction addresses historiographic questions and the concept of the Renaissance. Granada puts forward a unified concept of the Renaissance as "a vast intellectual movement that played a decisive role in the renewal of all fields of European culture (from literature and art to religion, philosophy, and science), based on its foundations in the humanist movement." He does not, however, fail to recognize elements of continuity with the Middle Ages and the difficulties involved in distinguishing the Renaissance from the preceding and later periods; moreover, he points out the conventional nature of the concept of the Renaissance and its relation to a set of values that might be called the distinguishing marks of the modern Western world.

Part 1 begins with an analysis of the fortune in the Renaissance of a passage from the sixth book of the *Aeneid* and provides an account of the humanist claim that poets are theologians who convey truths through images and allegories: Marsilius Ficinus considered these verses by Virgil to be an expression of Platonic cosmology. This is followed by a study of the efforts of and problems encountered by Ficinus and Giovanni Pico in reconciling pagan philosophical sources, the *prisca theologia,* with Christianity and by Leon Hebreo in reconciling them with Judaism. Granada explains that Ficinus and Pico believed that the obstacle to complete harmony was the impossibility of fully acknowledging the presence of the Trinity in pagan philosophy, an obstacle Leon Hebreo overcame by dissociating the Hebrew *Sapientia* from Christ. In Chapter 3 Granada compares Ficinus's view of the harmony between Christianity and the *prisca theologia,* his use of the latter to justify Christianity, and his lack of interest in skepticism with the hostility shown toward the Fician program by Savonarola and Gianfrancesco Pico de la Mirandola, a hostility exacerbated by these authors' interest in and use of classical skepticism and their negation of the human ability to attain truth through reason. Granada devotes a long chapter to another of the basic subjects of humanist philosophy—*dignitas hominis*—in which he chiefly addresses the figures of Ficinus, Pico, and Giordano Bruno. Granada explains how Bruno made fundamental changes to the concept of the "dignity and excellence of humanity" by eliminating the mediation of Christ between humanity and God (an essential point for Ficinus and Pico), rejecting the notion of original sin, and affirming the ascent of man and his direct communion with God by means of the infinite universe and the metamorphosis of humanity in God. In the following chapter Granada pursues his analysis of Bruno's ideas on "metamorphosis in God" by investigating the Erasmian subject of hunting as a folly or madness and the use of this metaphor by the Neapolitan philosopher in his scathing criticism of Christianity.

The second part opens with a chapter on Aristotelian cosmology originally written as an introduction to Aristotle's *De caelo.* With regard to the problem of celestial motion, Granada maintains that the "onto-theology" of the motionless mover–incorporeal divinity appears in *De caelo*—with, moreover, the plural nature that it has in *Peri philosophias* and in *Metaphysics* 12. In Chapter 2 he provides a brief overview and synthesis of pertinent literature about the basic subjects of the "cosmological revolution from Copernicus to Descartes." Written as an encyclopedia entry and hence aimed at a wide audience, this synthesis offers the general reader basic information on these complex matters, although it may not always satisfy experts. Chapter 3 of Part 2 is the longest in the book and one of the best. Entitled "Chronological Calculations, Cosmological News, and Eschatological Expectations," this study is in large part an analysis of the 1572 nova and the 1577 comet and the different ways they were interpreted by the many astronomers and philosophers who studied them. Granada demonstrates how most of these authors (including Tycho Brahe) associated these celestial novelties with eschatological prophecies or outlooks and upheld the principle of the heterogeneity of heaven and earth and celestial incorruptibility. From the Christian viewpoint, this principle was conducive to such celestial novelties being declared to be supernatural events arising from divine will and omnipotence and to God being considered as a free and absolute power. On the other hand, Giordano Bruno, who had carefully read the astronomical literature about the nova and the comet, rejected all these premises and gave a new interpretation of celestial novelties that was neither eschato-

logical nor Christian. The book ends with a chapter about the Baconian reformation of knowledge.

The book fulfills one of the author's aims well: it demonstrates the close relationship between philosophical, theological-religious, and astronomical-cosmological questions in the Renaissance, situating itself within the tradition of the history of ideas. Overall, the book makes an important contribution to our understanding of this crucial period "on the threshold of modern times."

VÍCTOR NAVARRO BROTÓNS

José Chabás; Bernard R. Goldstein. *Astronomy in the Iberian Peninsula: Abraham Zacut and the Transition from Manuscript to Print*. (Transactions of the American Philosophical Society, 90, Pt. 2.) xii + 196 pp., illus., tables, bibl., index. Philadelphia: American Philosophical Society, 2000.

The Jewish astronomer Abraham Zacut, who lived at the end of the Middle Ages, is well known to specialists of the Great Discoveries because of the role ascribed to him by Portuguese historians. According to these latter, it was Zacut's *Almanach perpetuum* that provided the discoverers of far lands with the scientific bases for astronomical navigation. In devoting an entire and densely documented book to Zacut's astronomical work, José Chabás and Bernard Goldstein have undertaken the task of re-evaluating his work: on the one hand, they eliminate the false reputation attributed to Zacut—that he was the father of astronomical navigation; on the other, they restore to Zacut the eminent position he held in the domain of planetary astronomy, the one domain in which he was truly competent, and on a high level.

It is regrettable, however, that Chabás and Goldstein limit themselves to a purely technical analysis of Zacut's astronomical work (tables and canons of tables, in Hebrew, in Latin, or in Spanish, transmitted both in manuscript and in printed form), without proposing an edition of any of his tables or of their canons. This gives their technical analysis a somewhat esoteric quality, depriving those who do not have access to Zacut's tables and canons of the possibility of confronting the actual subject under analysis. I should mention that the first printed version of the *Almanach* (1496) was reprinted in a facsimile edition in 1915, in Berne and Munich, within the collection *Histoire de la science noutique portugaise d l'époque des grandes decouveries;* this facsimile edition is certainly far easier to consult than the 1496 incunable (the 1915 facsimile edition appears not even to be mentioned in the book under review, unless it is referred to, erroneously, on p. 175, as having been published in Geneva in 1919).

Chabás and Goldstein easily prove that the contents of the *Almanach perpetuum* are founded on the Alphonsine Tables, of which the *Almanach* is but an elementary presentation (almanacs in the Middle Ages, it is worth mentioning, always provided the positions of the planets and not, as with the tables, only the means of their calculation). However, the fact that the *Almanach* is based on the Alphonsine Tables comes as no surprise at all, in view of the exclusive position these tables held at the end of the fifteenth century.

This said, one still needs to agree as to the definition and the contents of the Alphonsine Tables, instead of which, whilst in the process of rehabilitating Zacut, the authors of the present book simply continue to preach historical counter-truths, as if they were absolute ones. I demonstrated some ten years ago (in the *Journal of the History of Astronomy,* 1988, *19*:97–113) that what was being circulated, from Paris in 1320, as the Alphonsine Tables was *absolutely* incompatible with what we know of the astronomical work of King Alfonso of Castile, as contained in his *Libros del saber*. In reality, the only formal condition that would enable us to ascribe the origin of the so-called Alphonsine Tables to the king himself is a purely imaginary one, based on the idea that a thoroughly different work from that of the *Libros del saber* existed; however, we have no indication whatsoever that such a work existed. To therefore pretend that the Alphonsine Tables were written at the same time and in the same conditions under which the king's *Libros del saber* was elaborated is nothing short of misconception or imposture.

I realize that I have, over the past ten years, made no impact on either Chabás or Goldstein. They have every legitimate right to refuse my arguments, and for this I would harbor no bad feelings toward them. But should they not have at least tried to refute my argumentation? Instead of this, they have preferred to deliberately ignore it, and no mention is even made of it in their bibliography. This is unacceptable: the historian's trade is based on honesty, and any breach of this golden rule can only harm the reputation of the scholar taking such a risk.

In their refusal to accept the Parisian origin, Chabás and Goldstein are not dealing correctly with the sources of the history of astron-

omy. When the Alphonsine Tables were printed in 1483, the printer Ratdolt was manifestly happy simply to reproduce a manuscript he had at hand, one of the many manuscripts that were being used by practicing astronomers at the time. The goal of these astronomers was obviously to assemble all the tabular material they deemed a necessary part of the Alphonsine Tables, and their canons of course, but also an entire technical corpus that predated the Alphonsine Tables and was not a part of them. In 1984, when I did a critical edition of the Alphonsine Tables, and only of these tables, I made an inventory of the "membra adjecta" of the 1483 edition (the printer himself gave them this name) and I did research into their origin, which proved to be material coming from the Toledo Tables or those of al-Battani; this material was missing from the Alphonsine Tables and it had not been rendered out-of-date by the new astronomy. Therefore, even if this material appears in both the *Libros del saber* as well as in the *editio princeps* of the Alphonsine Tables, it obviously does not testify to any sort of continuity between the one work and the other, except if one is simply incompetent in matters of textual critique.

I sincerely regret that the same critical spirit, which deals with the role that Zacut played in the Great Discoveries movement, or with how the incunable edition of the *Almanach* found itself with a dedication that didn't at all concern it, was not applied to the far more fundamental question about Alphonsine astronomy itself. The discredit this is bound to shed on this outdated historiography unjustly risks placing this entire book in a poor light, though it merits a better fate.

EMMANUEL POULLE

Scott D. Westrem. *Broader Horizons: A Study of Johannes Witte de Hese's* Itinerarius *and Medieval Travel Narratives*. (Medieval Academy Books, 105.) xix + 359 pp., illus., figs., bibl., index. Cambridge, Mass.: Medieval Academy of America, 2001. $50 (cloth).

The *Itinerarius* of "Johannes Witte de Hese" is an early fifteenth-century narrative of an alleged journey, from Jerusalem to parts east, carried out by a priest from Utrecht. The original Latin survives in eight manuscripts and no fewer than eleven printed editions, the last dated 1565. Scott Westrem, in a work based on his dissertation, has provided us with an exhaustive study of the *Itinerarius* and its manuscript and printed traditions. His book includes editions of the original Latin and a Middle Dutch version, as well as his own translation of the Latin version into modern English (with some passages from the Middle Dutch also translated). Westrem situates the *Itinerarius* in its medieval context as well as providing extensive notes on sources and analogues of the incidents in the narrative, making surprisingly little use of critical or postcolonial theory. He points to many errors made by previous scholars trying to identify the author and concludes that the task is probably hopeless. Readers of *Isis* will presumably be more interested in the *Itinerarius*'s relevance to late medieval geographical and ethnographic knowledge than in its linguistic peculiarities or the complicated textual history Westrem carefully traces.

The *Itinerarius* is certainly no rival to the better-known medieval travel stories of Marco Polo and Sir John Mandeville. The book is short, its style undistinguished, and its narrative feeble. (Such was the mediocrity of the original narrative that subsequent texts tend to introduce improvements more than corruptions.) The writer's geographical knowledge blends biblical and classical tradition with knowledge of the accounts of travelers to the East during the Mongol period and previous legendary journeys like St. Brendan's. The writer is somewhat old-fashioned in identifying the Christian Emperor Prester John as the supreme ruler in the East and "Canisgrande," the great Khan, as a subordinate. One interesting aspect of the tale is that it is the first European account of a circumnavigation. The author matter-of-factly caps his description of his journeys ever further east with the claim that his route eventually returned him to Jerusalem.

Another interesting aspect of the text is the author's conflation of spatial and spiritual locations. He claims to have passed by the mountain at the peak of which was the earthly paradise and to have paused for three days and nights by the island of purgatory. He even asserts that he and his shipmates heard the cries of tortured souls and that he secured the release of three by performing masses. The true highlight of the narrative, however, is the elaborate description of the seven-story palace of Prester John in "Upper India" (the author shows no awareness of China) and the rites he carried out in honor of St. Thomas, the apostle of India, on his feast day. One of the many miracles noted is that Thomas's body dispenses the Eucharist and withholds it from unworthy communicants—a phenomenon the author claims to have witnessed himself.

Given the many fantastic and miraculous elements of the *Itinerarius*—very different from

the earlier narratives of Polo or William of Ruysbroeck—it is interesting to note that it was treated as an authority into the Age of Discovery. It was bound together with works of widely accepted factuality, such as chronicles and geographical treatises, until the seventeenth century. Westrem wisely avoids exaggerated claims for the *Itinerarius*'s influence or cultural importance, however, and points out that many commentators simply reproduced previous commentators' remarks rather than engaging freshly with the text.

Westrem's book includes a fine bibliography and index. It will be of interest principally to libraries and students of late medieval and early Renaissance travel narratives.

WILLIAM E. BURNS

Sydney Anglo. *The Martial Arts of Renaissance Europe*. xii + 384 pp., illus., bibl., index. New Haven, Conn./London: Yale University Press, 2000. $45.

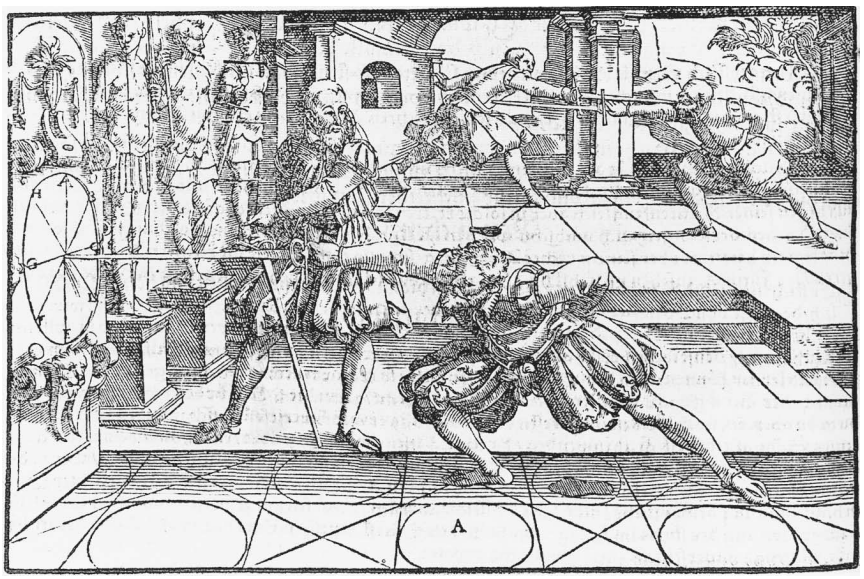
Readers of *Gulliver's Travels* may recall that the eponymous hero travels with a "hanger" always at his side. "Hanger" was the early eighteenth-century name for a small sword often worn by gentlemen for personal defense. Swift's casual description of Gulliver as armed is one of those little facts that speak volumes about changing gender roles and social expectations. Until the latter decades of the 1700s, any bourgeois male could freely carry a variety of weapons, usually swords or daggers, about his person, and he was expected to draw them at the slightest insult. Should he chance to kill anyone with those personal weapons, his case would be judged according to the gravity of the insult to his "honor." He was also expected to be at least minimally proficient in the proper use of whatever weapons he carried, as well as able to wrestle and to fight with his fists. This was the legacy of aristocratic maleness derived from medieval notions of knighthood.

Under such circumstances, it is hardly surprising that there is a vast literature dating from the fifteenth to the late seventeenth century devoted to all forms of personal combat: sword fighting, quarterstaves, daggers and knives, lances, wrestling, and bare-knuckle fistfights. Any scholar who has spent sufficient time in European rare book or manuscript collections will likely have noticed one or another of these works, for they are often profusely and beautifully illustrated, the sort of treasure that library staff delight in displaying under glass. This literature has at last found its scholar in Sydney Anglo, senior medievalist at the University of Wales and the author of *Spectacle, Pageantry, and Early Tudor Policy* (Oxford, 1997) and *Images of Tudor Kingship* (Seaby, 1992).

Anglo's approach is admirably academic, in contrast to the legion of stage actors and historical reenactors who simply want to mine this literature for information about "authentic techniques" of swordplay and fighting. (Whether Anglo gives enough technical detail to satisfy this undoubtedly large fraction of his potential readership is beyond my ability to assess.) There are larger issues at play here, and Anglo is sensitive to their subtleties. Martial arts manuals represent a form of "didactic" literature, designed to teach the beginner a skill and to cultivate the level of practice among those who already posses the skill. Yet fighting—like ballroom dancing—cannot really be learned except by personal instruction and supervised practice, as anyone can attest who has ever tried to learn the foxtrot or the tango from books containing pictures of all those footprints. What then is the purpose of a didactic treatise on a subject that can be taught only in a face-to-face context?

For Anglo, the answer to that question is highly contingent, and it varies from master to master and from age to age. For Fiore de' Liberi da Premariaccio, author of the early fifteenth-century *Flos duellarum,* the manuscript treatise was a means of recording best practice techniques and an aid to instruction, a point also made by Hans Thalhoffer's heavily illustrated mid-fifteenth-century *Fechtbuch* (also recently published for the first time in English by Mark Rector). On the other hand, for Camillo Agrippa in 1553, the point was to reveal the geometrical basis for swordfighting and wrestling; while for Geronimo Sánchez de Carranza, the treatise was to relate "mastery of the sword" to "primary causes"—a *philosophía de las armas,* as he put it in 1582. Agrippa was particularly favored by nineteenth-century historians of fencing as the "founder of proper method." Anglo represents a quantum leap over such outdated authorities as Egerton Castle precisely because of his open-mindedness to the heterogeneous purposes that didactic treatises can serve.

Another generic question dominates any discussion of this sort of literature: Was what we see in these pages "real"? This is also a surprisingly difficult question to answer, and one that requires a certain sophistication in its treatment. "Real" combat, if that is taken to mean battlefield encounters between enemies bent on inflicting serious bodily harm, was probably never a very pretty affair and may well have involved feints



Renaissance fencing school, illustrated in Meyer's martial arts handbook of 1600 (from Sydney Anglo, The Martial Arts of Renaissance Europe, *p. 89).*

and blows the marquis of Queensbury would have refused to countenance. Yet most forms of personal combat are also, at one time or another, practiced as "sports," and sport, by definition, implies rules and judgments as to what is and is not allowed between opponents. Over time, rules tend to proliferate, and the scope for creative improvisation becomes more restricted. What then is "real"—the brutality of face-to-face combat or the refinement of sport? The treatise literature on personal combat reflects these multilayered issues, and once again Anglo's handling of his subject is masterful.

This is a large book, not merely in format but in scope. The bibliography runs to sixteen double-column pages and includes virtually every printed treatise on personal combat published before 1750, as well as fifty-two manuscripts, most of them still unpublished. Clearly, this is a labor of love crafted over many years of careful research. Yale University Press is to be congratulated for including more than 180 black-and-white illustrations within the text and adding as well 28 color plates, drawn mainly from Emperor Maximilian's *Freydal,* Royal Armouries MS I.33, and the R. L. Scott Collection *Fecht und Ringerbuch.* I have seen the Royal Armouries manuscript, and I can attest to the fidelity of the color reproduction.

In sum, this is *the* book on fencing, swordplay, wrestling, jousting, and a host of other forms of personal combat from the late Middle Ages until the death of personal swordplay as a gentleman's birthright sometime in the mid-eighteenth century. Few readers of *Isis* are likely to have the opportunity to practice any of the skills Anglo's subjects discuss in such detail, but we should keep in mind that virtually all early modern scientists were also bourgeois gentlemen, and most of them could, in fact, handle a sword. They had been trained to do so as part of their education, and we cannot entirely overlook this aspect of their formation. For that reason, as well, we should welcome Sydney Anglo's latest contribution.

BERT HALL

John R. C. Martyn (Editor and Translator). *Pedro Nunes (1502–1578): His Lost Algebra and Other Discoveries*. (American University Studies, Ser. 9, 182.) viii + 158 pp., bibl., index. New York: Peter Lang, 1996. $35.95 (cloth).

The present work is a translation of and commentary on a few pieces of a codex, extant at the public library in Evora, Portugal, that the editor attributes to Pedro Nunes. The book presents a good deal of information, primarily concerning the cultural context of Nunes's activity as a mathematician. This important sixteenth-century

author deserves a series of studies on his life and work; certainly John R. C. Martyn, with his knowledge of Portuguese humanism, has succeeded in offering a rich picture of Nunes's world and providing new elements for his biography.

The main part of the book is a translation of the manuscript that Martyn believes is an early version of Nunes's algebra. The "other discoveries" announced by the title are a Church calendar and a few pages of religious notes, both transcribed from two manuscripts bound together with the algebra. To these texts Martyn adds many poems that have appeared in other collections he has edited. It is important to note, however, that the editor does not provide convincing proof that the manuscripts translated here are actually Nunes's work. The handwriting is attributed to Nunes only in passing and is not explicitly identified by Martyn in his commentary (see p. 11); the material descriptions of the manuscripts and the datings that appear in the original folios are not discussed in detail as part of the argument for the identification (see p. 14 and notes): the date appearing in the Church calendar—1533—is probably the time of Nunes's tutoring of the king's brothers in mathematics, which corroborates Martyn's thesis (the algebra manuscript should be from about 1535), but the other dates appearing in the manuscript codex (1544 and 1563) and the different handwritings it exhibits raise some serious doubts. So, when we approach what Martyn rightly considers the main piece—the algebra manuscript—we are left without satisfying evidence to convince us that these pages are actually by Nunes and not, for instance, the work of a diligent pupil of his who was simultaneously a student at the Coimbra Jesuit college (the manuscript is decorated with Jesuit symbols). In short, while it would be very satisfying to find the earlier manuscript version that Nunes himself refers to in the preface to the printed algebra, we cannot determine on the basis of Martyn's discussion alone whether the manuscript he presents is by Nunes and whether it is indeed the earlier version of the published book.

The size of the two algebras is obviously radically different: the manuscript consists of only 12 folios, while the book contains 341 folios. As to the content, Martyn's main argument in identifying the algebra manuscript as Nunes's first version of his book is a comparison between its distribution of topics and the table of contents of Nunes's 1567 book. It is true that if we compare the two tables of contents we see that they are roughly the same. However, there are some significant discrepancies that make the two texts quite different, and not only in terms of size: solution formulas for second-degree equations are simply stated at the end of the manuscript, while the book presents a long discussion of those formulas at the very beginning. Furthermore, Nunes gives extensive demonstrations for the solution formulas, the most complete justification in Euclidean terms offered in this period. Overall, the printed algebra is incomparably richer, not only because of the numerous examples and problems—which Martyn dismisses, a bit hastily, as "blackboard material"—but also in its treatment of "new" topics: besides the demonstrations already mentioned, it covers problems with several unknowns. The book refers explicitly to Girolamo Cardano's work (in the *Practica arithmeticae* of 1539 as well as the *Ars magna* of 1545); but we might expect that a manuscript from a specialist such as Nunes—even thirty years before 1567—would present at least the simple version of this part of algebra, which had been examined in works such as Luca Pacioli's *Summa* of 1494. Certainly Nunes's 1567 book was much appreciated in France—widely distributed and even translated into French—but it seems that the earlier version must have been interesting enough: Jacques Peletier referred to it, describing it as a manuscript in Portuguese, in his *Algèbre,* published in 1554. Peletier stated that he had not read the text; in any case, it is difficult to imagine that the algebraic content of the manuscript Martyn presents would have been relevant to him, for it is barely sufficient as a sketch of the main algebraic topics and contains no innovations—in either presentation or result—with respect to previous algebras. In fact, what appears to be a significant similarity between the manuscript and the book—the table of contents—is but the standard skeleton of every arithmetic book since the Middle Ages, the "algorism." For algebra, this meant the four operations of monomials in the simple and fractionary forms, the four operations with roots, the equations, and the rules for solving equations of the first and second degree.

Having consulted the algebraic manuscript and the Church calendar in photocopies (I wish to thank Maria Fatima Nunes, a historian of science at the University of Evora, for looking for the manuscript and then obtaining a photocopy and information about the library catalogue for me), I would be very interested in knowing more about the rest of the codex, particularly about the handwritings and datings of the various pieces: for instance, the two pieces I have seen are clearly in different handwritings. Furthermore, I

think Martyn does not offer evidence to support his attribution of the religious commentary to Nunes, an attribution that is crucial to the points he makes about Nunes's religious beliefs. Finally, in his introduction Martyn also attributes to Nunes a long rhetorical treatise, inspired by Hermogenes and not translated in this volume, that is part of the same codex; he suggests that facsimiles of the algebra manuscript and these rhetorical lectures should be published. I think it is an excellent idea, provided that readers are also given all the information available to evaluate the texts, including a description of the entire codex. This would enable them to assess Martyn's attributions of these manuscripts to Pedro Nunes. An updated bibliography of extant copies of the 1567 *Libro de algebra* would also be welcome.

GIOVANNA CIFOLETTI

Mònica Rius. *La Alquibla en al-Andalus y al-Magrib al-Aqṣà.* (Anuari de Filologia, Universitat de Barcelona, 21.) 357 + 61 pp., illus., figs., tables, bibl., index. Barcelona: Institut "Millás Vallicrosa" d'Història de la Ciència Àrab, 2000. (Paper.)

In 1933 George Sarton published in the pages of this journal (*20:*262–264) a "query" in which he expressed his amazement about the apparently incorrect orientation of medieval Islamic mosques, whose prayer niches should be directed toward Mecca. After all, he noted, Muslim scientists were able to compute the *qibla* accurately. A contemporary historian of Islamic architecture, Henri Terrasse, was unable to give a satisfying answer (*Isis,* 1935, *24:*109–110). Sarton would have been spellbound by the book under review.

The *qibla*—the sacred direction toward the Ka'ba in Mecca—has always been a matter of general concern in Islamic society. Above all, it is a complex legal issue, which has given rise to a substantial literature on the part of scholars of the sacred law. Since the determination of *qibla* can also be considered as a problem of mathematical geography, it was likewise a topic of utmost concern for Muslim astronomers, whose wide-ranging solutions have been subjected to intense scrutiny by historians of Islamic science during the past century, from the work of Carl Schoy to more recent writings by David A. King. Yet the pronouncements of jurists on the *qibla* have until recently received far less attention.

Mònica Rius has written the first book-length historical account of the *qibla* in a particular geographical and cultural setting—Muslim Spain and the Maghreb—in which the main focus of attention is the writings of legal scholars. The main figure in her inquiry is Abū 'Alī al-Maṣmūdī, a "Berber" who lived in Nafis (on the southern slopes of the Great Atlas) at the beginning of the fourteenth century; besides jurisprudence, this hitherto little known scholar was also highly knowledgeable in matters of geography, history, and folk astronomy. Rius's study includes an edition and translation of his informative treatise on the *qibla,* in which he quotes no fewer than sixty-five of his predecessors.

Chapter 3 surveys the religious and juridical foundations of the *qibla,* which, as the author convincingly argues, "was not a closed concept" (p. 257). In fact, the juridical notions of "valid"/"accepted" did not overlap with those of "exact"/"accurate." Legal scholars did differentiate between "accurate orientation" (*samt*) and "global direction" (*jiha*), the latter allowing for a generous margin of deviation from the *samt.* Some jurists even defined up to ten different types of *qiblas* with decreasing levels of certainty. Chapter 4 presents the archaeological evidence for the analysis of the orientation of mosques in Western Islamic lands, which is compared in Chapters 5 and 6 with the information revealed in textual sources. The relevant geographical and astronomical notions are introduced—somewhat too late, alas—at the end of the book.

The mathematical methods and instruments for determining the *qibla* were not accepted by legal scholars. This was not because of some fundamental conflict with the scientists, but mostly for pragmatic reasons: those scientific methods were inaccessible to most Muslims, for the Koran (22.78) insists that God "has imposed no difficulties on you in religion." In this respect, it is interesting to follow the argumentation of the famed astronomer and mathematician Ibn al-Bannā', a contemporary of al-Maṣmūdī living in Marrakesh, who was also a legal scholar. He maintained that the mathematical derivation of the *qibla* is flawed since the required geographical coordinates, especially the longitudes, cannot be known exactly (pp. 226–229), an opinion shared by some other legal scholars. Therefore, in practice, simple methods of folk astronomy were preferred: the *qibla* could be determined by means of the risings and settings of astronomical objects (sun, moon, stars, lunar mansions) or the orientation of the believer with respect to the polar star or particular winds.

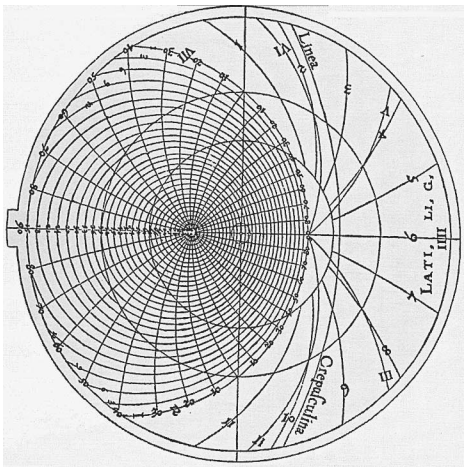
Rius's multifaceted approach to the fascinating topic of the *qibla* will be of interest to scholars in Islamic studies and historians of science.

FRANÇOIS CHARETTE

Georg Hartmann. *Hartmann's Practika: A Manual for Making Sundials and Astrolabes with the Compass and Rule*. Translated and edited by **John Lamprey**. 312 pp., illus., figs., bibl., index. Bellvue, Colo.: John Lamprey, 2002. $174.95.

Georg Hartmann lived from 1489 to 1564. As a young man he studied both mathematics and theology, becoming a Lutheran churchman. In 1518 he moved to Nuremberg to take up the post of vicar of St. Secaldue and, to supplement his income, established a workshop to make scientific instruments. For over forty years he designed and constructed the astrolabes, armillary spheres, sundials, globes, and quadrants that are now the pride of some of the world's most prestigious museums.

Hartmann must have felt a need to record exactly how he designed these instruments, for in the summers of 1518 and 1526–1528 he scribbled down in Low German a rough draft (illustrated with even rougher sketches) of his mathematical techniques. He never got around to refining this outline, and the paper (entitled *Collectanea mathematica praeprimis gnomonicam spectania*) eventually ended up in the Osterreichische Nationalbibliothek in Vienna as MS 12768. No publisher ever considered it, for to refine this raw material into a logical and understandable treatise would necessitate enormous effort and dedication. Hartmann is therefore truly fortunate that, after nearly five centuries, John Lamprey has undertaken this task (including a translation into English) as a labor of love. The work has taken him six years, but the result—concisely entitled *Hartmann's Practika*—is a credit to both author and editor/translator. Now we can discover at first hand how this master craftsman laid out his beautiful instruments.



Georg Hartmann's paper astrolabe component from a 1551 manuscript (from Hartmann's Practika, *trans. and ed. by John Lamprey, p. 298).*

Hartmann's method proves to have been entirely geometrical, utilizing the type of diagrammatic projection employed in a modern book by R. Newton Mayall and Margaret L. Mayall, *Sundials: How to Know, Use, and Make Them* (Branford, 1962). These and other contemporary authors do, however, improve clarity and conciseness by including tables of solar declinations and the like and using trigonometry where appropriate. It is not clear why Hartmann—a trained mathematician—felt constrained to stick so rigorously to projective geometry.

Lamprey has rearranged and edited Hartmann's draft into seven chapters ("books") according to the type of instrument described. Book 1 of the *Practika* deals with the basic "block" sundial in its various manifestations, calibrations, and numerations, Book 2 with the diptych dial, and Book 3 with the shepherd's dial. Book 4 is concerned with the layout of lines of declination, a complex and difficult matter in the absence of trigonometry. Book 5 returns to real but unusual items like the hemispherium and chalice dial, while Book 6 details the Nuremberg "Compast"—a portable dial incorporating a magnetic compass. Experience with the latter enabled Hartmann to note the varying deviation from true north, and according to the editor's introduction he independently discovered magnetic dip. The *Practika* concludes with what for many readers will be the most important section: Book 7, "Designing the Astrolabe."

Hartmann and Lamprey's comprehensive text is for the academic specialist in sixteenth-century gnomonics, not for someone wishing to make a sundial for the garden. Indeed, consulting the *Practika* will not enable anyone to make a dial suitable for an outdoor location, for it terminates with the production of a paper pattern. Hartmann, a master craftsman, appears embarrassed and almost ashamed of the manual ability and artistic skill on which his current reputation rests. Agreed, a craft requires a lot more than literary instruction; but Hartmann does not even explain how one transfers the paper pattern to a sheet of brass. This strict separation between mathematics and metalcraft is presumably in compliance with the notorious contempt and distrust between the academic and the "practical

man" that have plagued scientific and technological education right up to the present day.

ALLAN MILLS

Nancy G. Siraisi. *The Clock and the Mirror: Girolamo Cardano and Renaissance Medicine*. xiv + 362 pp., bibl., index. Princeton, N.J.: Princeton University Press, 1997. $49.50, £37.50 (cloth).

How many Renaissance historians does it take to do justice to one Renaissance Man?

Girolamo Cardano's *Opera omnia* fill ten volumes (and still leave out material). Two first-class intellectual historians, Nancy Siraisi and Anthony Grafton, have devoted a book apiece, several articles, and a jointly written essay to Cardano (1501–1576) and his work in medicine and astrology. The Centro Studi del Pensiero Filosofico del '500 e '600 has mounted an on-line database and has a major project under way to provide a complete critical edition (see http://www.cspf.mi.cnr.it/cardano/). The sheer bulk and range of Cardano's writing and the way this single figure encompasses so much of mid-sixteenth-century Italian life and thought easily justify this renewed interest in his work.

However, it is the expression of Cardano's own personality in his work that over the centuries has continued to attract readers and, to her own surprise, "caught" Siraisi (p. ix). His autobiography, written not long before his death, is still a good read; and throughout his life he enlivened his medical treatises—half of the *Opera omnia*—with stories about his contemporaries, his patients, his family, and his own health. We know what he ate, what he wore, how late he slept, and what he dreamed.

In his gambling (an addiction that led to the treatises on mathematics and probability for which Cardano is most famous), his professional career, and his personal life, Cardano was all too familiar with sudden reverses of fortune: at times, powerful patrons throughout Europe sought his services; at others, the hostility of colleagues or the Inquisition sent him into exile. The worst blow came from the fate of Cardano's beloved firstborn—executed for poisoning his wife. Small wonder, then, that so much of Cardano's intellectual curiosity was directed into the philosophical issues and the techniques of prognostication, whether by the stars, by portents, by natural magic, or by the symptoms of his patients.

Cardano made his living as a physician and professor of medicine. He studied at Pavia and Padua, taught at Pavia, Milan, and Bologna, and practiced his art in both major cities and small towns. An ardent student of the newly accessible classics of Greek medicine, he rated Hippocrates higher than Galen, although his training inevitably made him a Galenist despite his carping at Galen's errors. He was an early and enthusiastic advocate of Vesalius, praising his Hippocratic practicality, orderliness, and insistence on learning from experience. (Cardano also valued medieval Arab medical authorities for these qualities and chided his contemporaries for being put off by their barbaric language, "which was the calamity of the region or the age" [p. 48].) Siraisi makes it clear, however, that this taste for the straightforward vied with his much stronger fascination with *subtilitates.* His anxious desire to comprehend and control subtle, extraordinary, difficult-to-grasp, wondrous phenomena—natural and supernatural—underlay all his work.

Siraisi takes her title from Cardano's remark that the "studious man should always have at hand a clock and a mirror . . . to keep track of time . . . and to observe the changing condition of his body" (p. 3). For Cardano, the clock meant not only the daily pressures of time in human life but also the great sweep of history and the heavens. This self-absorbed yet detached physician was born on the brink of a half-millennium. It is his ultimate good fortune—and ours—that at the far end of those five centuries, another deeply learned scholar would hold up the mirror to his life, ideas, and world and give him the rich and sympathetic interpretation he deserves.

KAREN REEDS

Nicolás García Tapia. *Los veintiún libros de los ingenios y máquinas de Juanelo, atribuidos a Pedro Juan de Lastanosa*. Foreword by **Vicente Bielza de Ory**. (Colección Estudios y Monografias, 25.) 282 pp., illus. Zaragoza: Departamento de Educación y Cultura, 1997.

In 1984 a superb manuscript from the Spanish National Library in Madrid appeared in print under the title *Los veintiún libros de los ingenios y máquinas.* The manuscript is one of the most important works in sixteenth-century hydraulic engineering and a precursor of the eighteenth-century hydraulic literature. The name of Juanelo Turriano, the famous Italian engineer in the service of the Spanish Crown, appears on the cover of the manuscript. The edition, however, attributes the document to "Pseudo Juanelo Turriano" because the authorship is suspected to be spurious. The Spanish historian of technology in charge of the publication, the late José A.

García Diego, doubted Turriano's authorship and proposed an Aragonese origin of the manuscript. In the course of the ensuing debate, Nicolás García Tapia went a step further and identified, or so he claimed, the Aragonese Pedro Juan de Lastanosa as the proper author. But what began as a scholarly dispute in highly specialized articles had by that time reached a level of such acrimony that in 1996 García Tapia was, to his deepest regret (p. 16), not invited to participate in preparation of the new facsimile edition of the manuscript sponsored by the Foundation Juanelo Turriano (founded by García Diego). This prefatory note is important, because the attentive reader of García Tapia's *Los veintiún libros de los ingenios y máquinas* will hear echoes of these polemics. In fact, the dispute has shaped the argument of the book as well as its exposition. After long and patient research (p. 11), employing, as he assures the reader, a "strictly scientific methodology" (p. 12) as well as a "scientific procedure" (p. 13), García Tapia aspires to give a definitive answer as to the authorship of the manuscript under discussion. Though not writing a thematic work on the history of Spanish technology, he introduces at length and in great detail (and at times with considerable repetitiveness) the scientific, technological, and intellectual context of the court of Felipe II, where the treatise was written.

The book consists of four large sections and an epilogue: the first section is dedicated to the manuscript itself and its history. It is followed by a section on the humanism, science, and technology of the time, in which García Tapia also works out the profile of the author to be identified. This analysis constitutes the central part of the book, for it contains a detailed study of the content of the manuscript: the four elements (water, earth, air, fire), physics, mechanics, geometry, and the technical applications of hydraulic architecture (water conduction, aqueducts, mills, bridges, elevators, machines, etc.).

The third section is dedicated to the person of Pedro Juan de Lastanosa, who probably lived between 1527 and 1576. It is as much an intellectual and personal biography of Lastanosa as a detailed study of his scientific and technological endeavors. The final section deals with the history of the reception of the manuscript and its impact on the various scientific disciplines and on practical hydraulics of the time. García Tapia concludes that between 1564 and 1575, Lastanosa wrote a treatise on hydraulics, commissioned by Felipe II, that remained both unfinished and unsigned. Later, between 1585 and 1610, the text was revised; and then a copy (the only one extant) was made, probably for a publication that never materialized. Finally, between 1643 and 1647, a new, unsuccessful, attempt at publication was made, at which time Juanelo Turriano was mistakenly assumed to be the author. The volume under discussion is by no means a substitute for other publications on the issue by authors like David Goodmann, Víctor Navarro Brotons, Isabel Vicente Maroto, or, indeed, García Tapia himself, but it makes an excellent contribution to the determination of the technical and intellectual, as well as social, profile of a technical advisor to Felipe II, king of the most powerful empire at the time.

ALBERT PRESAS I PUIG

■ Early Modern (Seventeenth and Eighteenth Centuries)

Michael Windelspecht. *Groundbreaking Scientific Experiments, Inventions, and Discoveries of the Seventeenth Century*. xxi + 270 pp., illus., bibl., index. Westport, Conn./London: Greenwood Press, 2002. $69.95 (cloth).

We have recently seen the publication of a few works on the history of science designed for secondary school students. This is a welcome development and merits greater attention than it has hitherto received. In most science courses from high school through college, students are never given the opportunity to learn that the development of science is a complex process frequently involving contending hypotheses, that ideas and processes are affected by both scientific and nonscientific events outside a given research area, and that some ideas no longer part of contemporary science are worth learning about. Positivism reigns; this volume, unfortunately, is a prime example of it.

Moreover, the entry list is a strange mixture of specific experiments, inventions, and discoveries such as light speed, Boyle's law, magnetic declination, and hydrologic cycles, along with broad general topics such as optics, gases, magnetism, and meteorology. There are no general entries, however, on astronomy, mathematics, medicine, mechanics, navigation, or zoology. Several entries are devoted to individual planets, but there are none on force or mass.

The work is filled with contradictory, misleading expressions and a peculiar use of language. What are we to make of the apparently (unintentional?) teleological statement that Newton "held a key role in the evolution of seventeenth-century science" (p. 76) or the claim that he "was considered the driving force behind

the scientific revolution" (p. 210)? While indicating that Descartes was opposed to atomism, the author writes that in Descartes's vortex theory "all of the atoms of matter were basically in one continuous motion with one another" (p. 13). Hypotheses and experiments in Galileo's determination of the relationships between time and distance in falling bodies are confused (pp. 123–124). On page 15 Gasparo Berti "utilized air pumps to create vacuums at the top of tubes," a neat trick for someone who died in 1643, since on page 241 we are informed that the air pump was invented a few years after that. Newton's first law was not limited to bodies at rest (p. 77), nor was it a "restating of Galileo's principle of inertia" (p. 177).

The following are but a few of the numerous errors of fact and interpretation in the volume. Despite Michael Windelspecht's assertions, Ptolemy did not live in the second century B.C.E. (p. 166); Stonehenge is not an obelisk (p. 187); the pendulum clock did not signal "the beginning of the quantitative analysis of the solar system" (p. 190); Aristotle did not state that "nature abhors a vacuum" or that "a fifth compound [*sic*], ether, filled the spaces between the four elements" (pp. 15, 45, 241); Newton did not publish the manuscript of his *De motu* in 1684 (p. xxvii); Kepler did not notice "an eight-degree error" in his early attempts at Mars's orbit (p. 118); "for most of recorded time" there were five, not four known planets (p. 201). Kepler was not Tycho's student (pp. 117, 155), nor was Mersenne Galileo's (p. 188).

While the publisher is to be commended for undertaking a work on the history of science for high school students, the result is wholly inadequate. The approach is decidedly ahistorical—whiggery abounds; most topics are dealt with as forerunners—the choices of topics and their lengths make no sense, and there is a good deal of redundancy in the text. This is a work apparently drafted in great haste, without adequate attention even to the secondary sources cited. Few of the most appropriate works published in the past few years were consulted; some of the most egregious blunders could have been avoided by use, for example, of the *Dictionary of Scientific Biography*. Students and other members of the reading public deserve better.

WILBUR APPLEBAUM

Peter R. Anstey. *The Philosophy of Robert Boyle*. (Routledge Studies in Seventeenth-Century Philosophy, 5.) xvi + 231 pp., fig., apps., bibl., index. London/New York: Routledge, 2000. $90, Can $135.

This book presents itself as a philosophical study of Robert Boyle's thought. Peter Anstey's declared aim is to give a systematic account of Boyle's philosophy. This sounds like a difficult task, because Boyle was unsystematic, viewing systems as impediments to the advancement of experimental learning. Anstey seems to be aware of the difficulty involved in such an approach, though his remark that Boyle "is still marked by the scholastic heritage in that he sought to replace that system by another" (p. 6) is at odds with what Boyle wrote about philosophical systems. However, the difficulties to be anticipated in the systematic interpretation of Boyle's philosophy do not seem to worry Anstey, who claims to have found a solution: "the commentator has merely to be honest when inconsistencies occur" (p. 8). It is not clear how such an obvious caveat can help in making sense of Boyle's inconsistencies. A closer attention to the context of Boyle's works and to his polemical targets would help more.

The book is divided into two parts: the first part deals with Boyle's theory of qualities; the second explores his views of motion, place, laws of nature, and the mind/body interaction. Anstey investigates Boyle's distinction among qualities and proposes the following classification: mechanical (shape, size, motion, texture) and nonmechanical; the latter, in turn, are divided into manifest (hot, cold, wet, and dry), occult (magnetism and electricity), and, finally, sensible (color, taste, odor). Some interesting remarks on Boyle's theory of qualities can be found in Chapter 4. Anstey rightly maintains that for Boyle sensible qualities were not unreal (i.e., without ontological status over and above the mechanical properties of matter). What Boyle criticized was the scholastic view that they are ontologically distinct and independent of material substance. Anstey maintains that for Boyle sensible qualities are identical with powers, but powers are not identical with the mechanical affections of matter. Following current revisionist interpretations, he does not see Boyle's mechanical philosophy as implying a reduction of powers to the mechanical affections of matter. This interpretation would benefit from an analysis of Boyle's scientific investigations of qualities, but unfortunately Anstey fails to take them into account.

Part 2 deals with issues related to God and the mechanical universe. It is well known that for Boyle God maintains the universe by regulating the motions of its parts. The so-called laws of nature depend entirely on God's will. Anstey discusses Boyle's position on occasionalism and tries to assess whether he denied any causal ef-

ficacy to matter. Following Timothy Shanahan ("God and Nature in the Thought of Robert Boyle," *Journal of the History of Philosophy,* 1988, *26:*547–569), Anstey maintains that Boyle saw a *via media* between deism and occasionalism. He defines Boyle's view as "nomic occasionalism," stating that Boyle maintained that "while matter is causally efficacious in that it can transmit its motion in collisions; the nature of that transmission and the resultant motions are determined by the immanent activity of God" (p. 164). If the reader has the impression that this conclusion could help explain Boyle's complex views on the subject, Anstey then refers to a manuscript where Boyle seems "to be attracted by the occasionalism of certain neo-Cartesians" (p. 182)—which is at variance with his thesis. We are left without an explanation: "here is not the place to attempt to account for, or to reconcile Boyle's favourable attitude to occasionalism" (p. 182). The manuscript on occasionalism is published in the appendix, but without comment.

In conclusion, one must regret that in a philosophical study of Boyle there is no reference to his views of scientific method or to the relationship between reason and revelation, while large portions of the book deal with topics that are evidently marginal in Boyle's thought, such as the perception of sensible qualities (Ch. 3), natural and violent motions and the concept of inertial motion (Ch. 5), and the nature of place (Ch. 6).

ANTONIO CLERICUZIO

Rhonda Martens. *Kepler's Philosophy and the New Astronomy*. xiv + 201 pp., figs., tables, bibl., index. Princeton, N.J./Oxford: Princeton University Press, 2000. $37.50, £23.50.

This little book makes a big contribution not only to Kepler studies but to our understanding of early modern philosophy in general. Rhonda Martens examines the *Mysterium cosmographicum,* the *Apologia,* the *Astronomia nova,* the *Harmonice mundi,* and the *Epitome astronomiae Copernicanae.* She winnows out Kepler's underlying philosophical assumptions. In particular, she focuses on his use of the archetypes, how they functioned and why they were necessary. She shows how they were a constant feature in Kepler's work and how they evolved as his ideas developed and matured. She puts Kepler's thought in the context of four early modern trends—Aristotelianism, Neoplatonism, the mathematization of physics, and mechanics—and shows why Kepler's ability to assimilate them all is valuable for understanding natural philosophy in the seventeenth century.

Most interesting is how Martens presents the archetypes. She suggests that in the *Mysterium cosmographicum* they were the formal and final causes. This use of Aristotelian language is deliberate. Martens uncovers, as she titles Chapter 5, "The Aristotelian Kepler." She notes, "Despite Kepler's avowedly Platonic and Pythagorean sympathies, his physical astronomy fit well with Aristotle's directives in the *Posterior Analytics*" (p. 99). In a manner that not only improves our understanding of Kepler but should remind us that Aristotle's natural philosophy is not as simplistic as it is often portrayed, Martens shows how Kepler's combination of physics and mathematical astronomy was, in fact, compatible with Aristotle's thought. She points out that Aristotle accepted a deduction that proceeded from one discipline to another provided that they used the same basic principles and the appeal was to the higher discipline. For Kepler, the archetypes justified that appeal. Martens thus breaks new ground in disclosing how Kepler absorbed the Aristotelian natural philosophy of his day. She also shows that whereas the archetypal reasoning is "unscientific" to us, it could have made Kepler's ideas more appealing to his contemporaries. After all, it was the *Mysterium cosmographicum* that brought Kepler to the attention of Tycho Brahe.

Martens unfolds the evolution of the archetypes in Kepler's thinking. In the *Mysterium cosmographicum,* they were repositories for the concepts of simplicity, unity, and fruitfulness. He used these concepts to argue the superiority of the Copernican system, and he continually reverted to such concepts to judge his hypotheses. Martens suggests that the archetypes legitimated Kepler's use of physics in astronomy; in the *Apologia* "various objects and events studied by different disciplines are reflections of the same archetypes" (p. 68). Such ideas led Kepler to believe when working on the *Astronomia nova* that a simple geometrical measurement indicated a simple physical cause, so the absence of a discussion about archetypes does not mean that Kepler had temporarily abandoned them. Although Kepler overtly returns to the archetypes in the *Harmonice mundi,* Martens sees that his successes caused him to change some of his earlier ideas: the elliptical orbit forced him to reject his belief that geometry determined material form, thus limiting the effectiveness of his archetypes. Martens believes that Kepler continued to present his physical astronomy as an outgrowth of the archetypes in the *Epitome astron-*

omiae Copernicanae because he thought it would make his ideas more acceptable to his contemporaries. Nevertheless, she concludes that Kepler was increasingly disturbed by his observations and calculations that showed perturbations in the regularity of the orbits. It suggested that the physical universe did not conform to the archetypes, which destroyed his justification for the merger of physics and astronomy; it also brought the predictability of the motions into question.

Martens acknowledges that, with the exception of the *Apologia,* which was not available to his contemporaries, Kepler's philosophy is not easily discerned in his writings. Nevertheless, she suggests ways in which it influenced Mersenne, Descartes, and Leibniz. Martens has effectively shown that to understand Kepler, to understand how he influenced his times, and to understand how his times grappled with the issues he and other innovators were dealing with, it is necessary to look closely at his philosophy.

SHEILA J. RABIN

Brendan Dooley. *Morandi's Last Prophecy and the End of Renaissance Politics*. xiv + 238 pp., illus., figs., index. Princeton, N.J./Oxford: Princeton University Press, 2002. $36.50 (cloth).

This well-researched tour de force is a reconstruction of the life, times, trial, and apparent poisoning in prison of Oratio Morandi (ca. 1570–1630), who was the abbot of the Vallombrosan monastery of Santa Prassede in Rome before his arrest and trial. The result is a fascinating excursion that invites the reader to enter the cultural, political, social, and religious world of early seventeenth-century Italy, and particularly of Rome in the 1620s.

The study is based on the twenty-eight hundred pages of documents preserved from Morandi's trial. They reveal a monastery that under Morandi had become not only a noted library but also a lending library, complete with records of who had borrowed and used specific books. These circulation records serve as Brendan Dooley's main tool for peeking into the day-to-day exchange of ideas in Morandi's world. These book borrowings also served Morandi's personal goal of establishing contacts, access to power, and his own social advancement in political and church circles, which according to Dooley was the driving force of his life.

During his tenure as abbot Morandi created a very permissive regime in a wide range of areas: sexual practices, magic, cabala, numerology, medical advice and treatments, astrological predictions about political developments in the Thirty Years' War and about the reigning Barberini papacy of Urban VIII. In an era when there was as yet no clear distinction between astronomy and astrology, Morandi conceived of what we now think of as the "occult" as ultimately empirically based knowledge connected to the cycles of the universe. In May 1630 he overreached by predicting the imminent death of the pope, which led to his arrest and trial on charges of engaging in astrology, for his political and other objectionable writings, and for his collection of forbidden books. Potential embarrassments to important public figures were avoided when his death in prison conveniently ended the trial process.

In a six-page epilogue Dooley makes the suggestion—or, perhaps better, the conjecture—that Urban VIII's later and persistent anger toward Galileo, which started in 1632, was at least in part a carryover effect from his vehement hostility toward Morandi and astrology/astronomy two years earlier. Although this is an interesting surmise, it is not clear that the documents in either of the two cases give much identifiable support for this view.

RICHARD J. BLACKWELL

Maria Suutula. *Zur Geschichte der Naturzerstörung: Frau und Tier in der wissenschaftlichen Revolution*. (European Studies in the History of Science and Ideas, 7.) 272 pp., illus., bibls. Frankfurt/Berlin: Peter Lang, 1999. $42.95 (paper).

This book seeks to revise the history of the Scientific Revolution from an ecofeminist perspective. Maria Suutula intended neither to write a new history of ideas nor to explore new sources on the seventeenth century. Instead, she aims to criticize the scientific methodology developed in this period. Ecofeminism dislikes objectivity, empiricism, and value-free research. It advocates science in the interest of women, animals, and nature (whatever that is). Science should be founded in social practice and, most important, it should be ethical and done with due respect for life.

In addressing these issues, Suutula pays particular attention to the relation between religion and science, to scientific descriptions of sexuality, and to the use of animal experiments. She explores descriptions of "beastlike" human nature in contemporary philosophical thinking, discusses analogies of women and animals, and considers the shift in perspective from a divine nature to nature as a machine.

Many seventeenth-century philosophers and scientists get words in egdewise in the book's numerous quotations. However, since none of them is introduced, the reader gets no idea of the context of their work or of why they have been chosen. Like the compilation of quotations, the selection of images is tendentious. The drawing of a hairy woman from Ulyssis Aldrovandi (1642) is used as proof of the misogyny of science. Suutula finds that seventeenth-century philosophers and scientists demonized female sexuality. Quotations like "The man penetrates the secrets of nature" (p. 57) and "A dirty woman in bed is a sow" (p. 91) are meant to unmask scientists as women-haters. Suutula presumes that they undertook animal experiments because they found killing amusing and because the Christian religion justified what they were doing. In short: scientists in this period were barbarous, sadistic, and disrespectful of nature and its creatures.

To sum up, *Zur Geschichte der Naturzerstörung* is highly ideological. It does no good for the feminist movement in science history and offers no new insights into the Scientific Revolution. A last word about the publisher's work: Suutula is not a native German speaker, which should have been a reason for a careful editing of her book. However, as in the case of most books published by Peter Lang, no one besides the author has read the manuscript; the predictable result is that the German is very poor.

BARBARA ORLAND

Doreen Evenden. *The Midwives of Seventeenth-Century London*. (Cambridge History of Medicine.) xviii + 260 pp., illus., figs., tables, apps., bibl., index. New York: Cambridge University Press, 2000. $64.95.

Doreen Evenden's *The Midwives of Seventeenth-Century London* recovers some twelve hundred licensed midwives' names and offers previously unknown information explaining how women became midwives. The monograph details the careers and socioeconomic lives of about a hundred of these intriguing women. In its exploration of seventeenth-century midwifery and midwives, this book is a remarkable piece of historical sleuthing.

Evenden's primary goal is to counter the assumption that seventeenth-century urban midwives were "ignorant, incompetent, and poor" (p. 1). She shows that London's midwives were solidly trained under the guidance of older women as they prepared to be licensed by the Church of England. Evenden's insightful analysis of ecclesiastical licensing documents and parish and probate records proves that these women were widely successful, extremely capable, and highly regarded by mothers and that most of them belonged to the middle and upper classes. Her unabashed admiration for these long-lost women should lead others to appreciate seventeenth-century midwives' impressive record.

Evenden's project is fueled by an equally unabashed disdain for male practitioners; she explains that doctors had no routine business in the birth room since midwifery was only a "pseudo-medical area" (p. 176). Evenden criticizes historians who have suggested anything negative about seventeenth-century midwives, and she disagrees with those historical interpretations that propose that man-midwives' professional success arose from anything other than ambition and misogyny. She is, for instance, "in complete disagreement" (p. 203) with the central points of Adrian Wilson's well-respected *The Making of Man-Midwifery* (Harvard, 1995), which argues that eighteenth-century mothers were not coerced but willingly chose man-midwives and that man-midwives had some positive attributes.

Evenden convincingly argues that seventeenth-century mothers chose midwives and resisted the intrusions of instrument-wielding male surgeons. Yet she does not explicitly reveal why, once women did routinely call upon man-midwives in the eighteenth century, they were no longer making their own choices. Evenden simply states in her final footnote: "As a former registered nurse, mother, and historian, I make no apologies for presenting and evaluating the evidence as I have found it" (p. 203). A more source-based argument showing how historical actors made choices or were deluded would be illuminating here, as would a more nuanced approach to the relationship between midwives and mothers. Evenden presumes that women had only harmonious relations (pp. 87–105, 192), which makes some mothers' turn away from midwives in the eighteenth century puzzling.

Evenden identifies two institutional causes for this later transformation. First, London's ecclesiastical licensing system died out in the 1720s and, second, man-midwives established philanthropic lying-in hospitals for wives of the working poor from the late 1740s onward. Although both are very significant changes, neither fully explains how, by the 1750s, midwives were losing and man-midwives were winning an affluent, influential female clientele. In her epilogue on the eighteenth century, Evenden speculates about man-midwives' persistently nefarious motives that led to their successes. This chapter

would have benefited from incorporating the broader context of gender, sexual, family, urban, and medical relations, because changes in the home and in Enlightenment sensibilities about gender would offer additional, subtle explanations for how Evenden's admirable community of talented midwives lost status and business in the eighteenth century.

LISA FORMAN CODY

Matt Goldish. *Judaism in the Theology of Sir Isaac Newton*. (International Archives of the History of Ideas, 157.) xii + 244 pp., apps., bibl., index. Dordrecht/Boston: Kluwer Academic Publishers, 1998. $195.

Sir Isaac Newton bequeathed his papers to his niece, Katherine Conduitt, and they remained in the family home for 145 years. In 1872 they were transferred to the University of Cambridge, where they were catalogued by George Gabriel Stokes and a syndicate of other prominent scientists. When Newton's descendant, Lord Portsmouth, offered to donate the papers to Cambridge, the university happily accepted the manuscripts concerning mathematics and physics but returned those dealing with theology, alchemy, and chronology, which were judged to be of no scientific interest. Other institutions—Harvard, Yale, and the British Library, to name just three—also turned down the papers when they were offered in donation. Portsmouth couldn't give away Newton's spiritual and esoteric writings, which were considered an embarrassment and an affront to the legacy of Newton's scientific achievements. These unseemly texts were finally sold at auction by Sotheby's in 1936, eventually making their way to libraries and private collections around the world.

Students of Newton have always known that he wrote much about the Bible and Revelation and other such matters, of course, but felt they ought to ignore these interests because they obfuscate his important, rational scientific work. This attitude gave birth to a historiographical tradition that might be called "the two Newtons," one a scientific genius and avatar of Enlightenment (worthy of historical scrutiny), the other a primitive mystic (better ignored). Only in the past forty years have scholars begun to make serious use of Newton's theological and esoteric papers to try to understand his life and work more fully and to integrate the two Newtons. Frank Manuel published several books, beginning with *Isaac Newton: Historian* in 1963 and culminating with *Religion of Isaac Newton* in 1974, which took seriously Newton's nonscientific writings. Since then, owing to scholars like Betty Jo Teeter Dobbs, Richard Westfall, and Rob Iliffe and especially to the extraordinary labors of Richard Popkin and James Force, much detail has been added to Manuel's portrait of Newton's religious occupations and preoccupations. Now, a generation of younger scholars like Steven Snoebelin and Ayval Ramati are adding further refinements to our understanding of Newton, who today has come to seem a far more complicated and interesting figure than the champion of Enlightenment and surpassing rationalist he was earlier taken to be.

In *Judaism in the Theology of Sir Isaac Newton* Matt Goldish elaborates and complicates our picture of Newton further still. As Goldish describes, Newton saw in Jewish texts a valuable tool for understanding Scripture and its relations to nature. His library contained twenty-four volumes devoted to Judaism and many more books with large sections on Jewish history (for the sake of comparison, he owned fifty-two books on physics and optics), and he wrote about Judaism and cited Jewish sacred texts in many different contexts. He studied Hebrew and worked out Hebrew etymologies. He was fascinated by the prophets of ancient Israel and their prophecies and employed some rabbinic sources to interpret these. He studied intensively the Tabernacle and Holy Temple in Jerusalem. He took the Temple to be a Prytanaeum, a microcosm of the universe, and a key for understanding the Book of Revelations. Newton also saw the institutions of the Temple and synagogue as models of proper governance for the Church.

Goldish is careful also to describe the limits of Newton's interest in Judaism. He was incurious about the Jews living in his own day. He was uninfluenced by the philosophy of Maimonides, which was esteemed by contemporary Christian Hebraicists. He blithely rejected some Jewish apocryphal beliefs. He was sharply critical of Cabbala, which he took as a corrupting influence (perhaps, as Goldish speculates, in disparagement of Leibniz, who took a Cabbalistic emanational cosmogony very seriously indeed). "Newton's behavior was typical for his time," Goldish concludes, "using Jews and their literature in pragmatic and expedient ways. He was not so much a student of Jewish history and ideas as a consumer of them, picking what fit his needs and ignoring the rest" (p. 163).

But Newton's avid "consumption" of Judaica matters more than it might at first seem. "Scholars like Scaliger, Bochart, Vossius and Newton," Goldish tells us, "thought that ancient authorities held the solutions to the problems facing Euro-

pean Christianity" in their day, and their interest in Judaism was part of their more general effort to recover the *prisca sapientia.* Newton's interest in Judaism, then, is one mark of the intellectual castings of early modern Europe, castings that produced the "fanatic erudition" of the age and that ultimately, in Goldish's telling, "contributed to the secularization of European thought because of their failure to deliver any concrete consensus of truth" (p. 164).

Judaism in the Theology of Sir Isaac Newton is a wonderful book. Goldish's grasp of the Judaic textual tradition is strong. So too is his command of the historiography of Newton, and the book is veined with generous and nicely opinionated references to past and contemporary scholarship. Goldish has also included as long appendixes fascinating and previously unpublished sections of the Newton manuscripts *Irenicum, Of the Church,* and *Of Prophecy.* All together, the book nicely illustrates the intellectual heterogeneity that marked Newton's work and, more generally, much of early modern religious and philosophical thought and natural philosophy. In so doing, it demonstrates yet again, and beautifully this time, that there are more things in heaven and earth than are dreamt of in our historiography.

NOAH J. EFRON

Marco Beretta. *Lavoisier: Die Revolution in der Chemie*. (Special issue of *Spektrum der Wissenschaft:* Biographie.) 106 pp., illus., figs. Milan: Le Scienze, 1998. DM 16.80, SFr 16.80, ÖS 135.

The work of Antoine-Laurent Lavoisier has always attracted special attention on both sides of the river Rhine. It has been of particular interest to German chemists and historians like Johann Friedrich Gmelin, Georg Kahlbaum, and, later, Max Speter, who never tired of evaluating the merits of Lavoisier's achievements. More recently, Johann Peter Prinz published a study of Lavoisier's and Armand Seguin's experiments on human respiration (*Die experimentelle Methode der ersten Gasstoffwechseluntersuchungen am ruhenden und quantifiziert belasteten Menschen [A.-L. Lavoisier and A. Seguin 1790]: Versuch einer kritischen Deutung* [Academia Verlag, 1992]). Despite all this attention, a German-language biography covering the full range of Lavoisier's activities has been lacking.

Thus this new volume will be very welcome. Marco Beretta presents a Lavoisier who is not confined to the mythical role of the enigmatic "chemical revolutionary"; we learn of the chemist's fields of interest beyond the academic arena. Though written for a broad public, this volume will also attract the attention of historians. It presents the latest research results on Lavoisier in a concise and well-thought-out form. Beretta portrays Lavoisier not only as the "leader" of the Chemical Revolution but also as an important financier, a respected economist, and an administrator in the final decades of the old regime. First published in the Italian *Le Scienze* in 1998, the text has now been translated into German by Michael Spang and published as a special issue of *Spektrum der Wissenschaft* (in the "Biographien" series).

Beretta guides the reader smoothly through the world of eighteenth-century science, following Lavoisier's development as a researcher step by step: his first encounters with chemistry, his work on the analysis and synthesis of gases, the oxygen theory, the reevaluation of the notion of the element, the adoption of the new chemical nomenclature, and the rejection of phlogiston. Beretta shows that the emergence of chemistry as a scientific discipline during the eighteenth century was closely tied to a rigorously quantitative mode of analysis and to the intention to provide a new basis for its technical language. The importance of Lavoisier's study of respiration for physiology is discussed, as is his search for a general theory explaining respiration, combustion, calcination, and chemical combinations. The reader will learn about Lavoisier's reflections on hygiene and public health that led him to study the physiological factors determining states of health or illness. The achievements of eighteenth-century chemistry are put in context, as Beretta considers its medical applications and extravagant offshoots such as Franz Anton Mesmer's magnetic fluid.

Lavoisier's scientific achievements are set against the background of political, economic, and institutional changes in Enlightenment France. Given his other responsibilities and interests, this biography is also a contribution to the history of economics: Lavoisier had important roles as a tax collector and investor in the "Ferme Générale," as director of the Gunpowder Administration, as administrator of the Discount Bank, and as commissioner of the National Treasury, to name a few.

Readers will appreciate this well-balanced and vivid account of the various facets of Lavoisier's extraordinary career. The volume is exciting to read and richly illustrated. As is common in nontechnical publications, there are no footnotes, and quotations are given without references. The

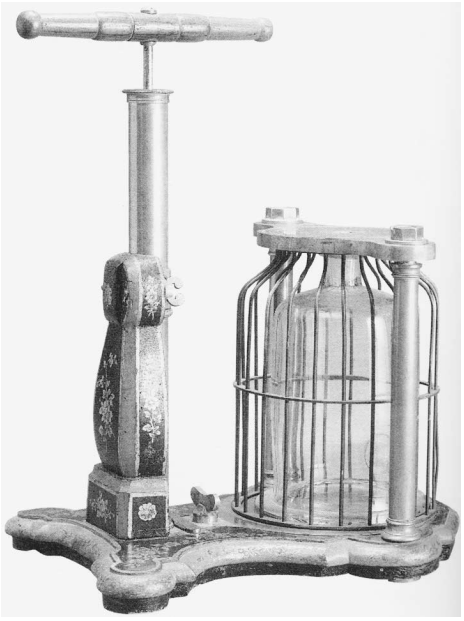
book includes a useful, though limited, bibliography for further reading.

ULRIKE FELL

Lewis Pyenson; Jean-François Gauvin (Editors). *The Art of Teaching Physics: The Eighteenth-Century Demonstration Apparatus of Jean Antoine Nollet*. xviii + 221 pp., illus., bibl., index. Sillery, Quebec: Septentrion, 2002. Can $54.95 (cloth).

This volume combines essays on the life and times of Jean Antoine Nollet with a photographic catalogue of the collection of Nollet-style physics demonstration equipment in the Stewart Museum in Montreal. An exhaustive bibliography of Nollet's publications, a limited inventory of apparatus in other collections, his catalogue of instruments of 1738, and excerpts from his correspondence (the latter two items in French) are also included.

Nollet, a poor French country boy, had been recruited for a clerical career and studied theology at Paris, receiving a bachelor's degree in 1724. Working as a tutor to the children of the clerk of court at the Hôtel-de-Ville, he set up a rudimentary physics laboratory and began to study the techniques of glass- and enamelworking. In 1728 he was ordained a deacon, but instead of progressing to the priesthood he joined the Société des Artes, becoming assistant to Charles François Dufay and René-Antoine de Réaumer. In 1734 he accompanied the former to England, began giving public lecture-demonstrations, and was elected to the Royal Society. Returning to France, he began to produce or supervise the construction of his own demonstration equipment, making additional copies for sale to defray the cost. The manufacture of demonstration apparatus quickly proved a profitable venture: Nollet had both academies and individuals, including Voltaire, as clients. In 1739 he was appointed to the Académie des Sciences. His subsequent career combined original research on liquids and electricity with lecturing to both public and private audiences, as well as a sequence of increasingly distinguished academic appointments.



Jean Antoine Nollet's vacuum pump apparatus with protective cage (from Lewis Pyenson and Jean-François Gauvin, eds., The Art of Teaching Physics, *p. 140).*

As a tutor to young children, public lecturer, entertainer at court, and frequent guest at the salons—and publishing instructional materials and scientific papers all the while—Nollet developed a reputation as one of the leading physicists in France while designing several hundred pieces of demonstration apparatus. A number of his designs are employed essentially unchanged in physics teaching today.

Issues of style and status were pivotal in Nollet's career. Though never ordained a priest, he consistently wore clerical garb and referred to himself as "abbé." He himself prepared the glasswork for some of his instruments—glassworking being a gentlemanly pursuit—while leaving the metal- and woodworking to employees when he could. Many of his instruments are ornamented with gold leaf to enhance their appeal to a genteel audience. The plates in his publications frequently show apparatus being used in refined settings. He encouraged women as well as men to participate in his electrostatic demonstrations—a process that might have raised eyebrows but for his clerical standing. Nollet avoided controversial issues until 1746, when his original theory of electrical "effluences et affluences" brought him into conflict with the French followers of Benjamin Franklin.

This book should prove a valuable reference for historians of physics and eighteenth-century science. It could also be read with profit by teachers of physics who want to gain some perspective on the relatively recent origins of the lecture-demonstrations that have become so typical in the field and their role in the public acceptance of physics as a genteel pursuit.

DONALD R. FRANCESCHETTI

Lisbet Koerner. *Linnaeus: Nature and Nation*. x + 298 pp., illus., figs., app., bibl., index. Cambridge, Mass./London: Harvard University Press, 1999. $39.95, €24.95.

Despite all the diligence and energy historians of science have invested to contextualize their topic, one of the key figures in the history of science, Carolus Linnaeus, has remained largely a cliché: the arch-systematist beset by the monomaniacal determination to reduce the living world to a timeless taxonomia. For those who want to get rid of this cliché, Lisbet Koerner's book offers a palatable antidote based on a wealth of published and unpublished sources, most of them in Swedish and thus hitherto inaccessible to most historians of science.

Koerner's starting point in providing this antidote is well chosen: from the beginning she makes it clear that she will treat Linnaeus from the perspective of the history of economics. Identifying a "cameralist's" concept of a "local modernity" striving for "rationalistically governed autarkies," conceptually intermediate between the "classical economist's" concept of an "ungoverned, yet self-regulating global modernity" and the "Romantic antimodernist's" concept of "custom-governed, local, traditional communities," Koerner promises to investigate the former as "it is fleshed out in the life and work of one of the eighteenth century's most famous naturalists, the Swedish botanist Carl Linnaeus" (p. 1). While this analytic scheme may seem overly simplistic, or even anachronistic, to some historians of economics—the footnotes reveal that it is largely based on pre-1970s secondary literature—it serves its purpose well as an Ariadne's thread through the vast and complex labyrinth of Linnaeana. Most notably, it allows Koerner to spell out the economic doctrine that motivated Linnaeus in his various scientific, medical, economic, and political engagements in a single sentence: "The idea was that science would create a miniaturized mercantile empire within the borders of the European state" (p. 188). Each page of her book provides evidence that this is indeed not a simplification but a sound historical generalization, at least in regard to the economics of Linnaeus and his promoters, collaborators, and students. Whether this brand of cameralism indeed "reappeared in new garb within the economic doctrines of anti-imperialist nationalisms" in the twentieth century (p. 189) may be a matter of debate. But the bridge thus spanned between Enlightenment economics and current discussions about globalization and its effects indicates that the "early instance of the confluence of science and governance" explored by Koerner's book merits more than mere historical interest.

The main body of the book is divided into eight chapters, each readable on its own, that follow a loose biographic and thematic order. The first and second chapters set out the local cultural framework that determined Linnaeus's self-image as a Lutheran and civil servant as well as his understanding of natural science as a "useful technology" rather than a "complex theory" (p. 55). This thesis is especially well corroborated in the long discussion Koerner devotes to binomial nomenclature, the innovation to which Linnaeus primarily owns his present fame and which, as Koerner convincingly shows, was developed "through his daily work practice rather than through a preconceived theory, and within a context of local economic problems" (p. 55). Chapter 3 turns to a decisive episode in Linnaeus's life, his 1732 Lapland journey, and describes it as part of the Swedish state's effort to colonize Lapland. Linnaeus's aim "to rationalize the traditional relations between Lapland's indigenous people and their ancestral lands" is interestingly explored for its inherent ambiguity. Chapters 4 and 5 then describe the overall framing theory of an "economy of nature" and the concomitant program for a science of "economics" that Linnaeus developed while engaging in university reform and the foundation of the Stockholm Academy of Sciences. In short, Koerner argues, all these activities were inspired by a conception of "economy" that "meant both a natural order and a new human science" (p. 95). Believing that "[nature] provided all the ingredients necessary for a complex and complete economy within each geographic area" (p. 109), Linnaeus advocated an economic education that, narrowly informed by his version of natural history, could develop the corresponding potentialities of the Swedish state territory. Chapters 6 and 7 then turn to the concrete "economic" projects Linnaeus and his students engaged in. These encompassed both attempts to find domestic substitutes for valuable import goods such as porcelain clay, dye-grasses, and medicinal herbs and "acclimatization" experiments to accustom exotic plants like tea, rice, and mulberry to the Scandinavian climate. Chapter 8 outlines the decline of Linnaeus's economic ideas in late eighteenth-century Sweden. The book concludes with a "Chronology of Linnaeus and Linnaeana," "Biographical References" giving short accounts of the people mentioned, and a well-organized index of subjects and names.

Koerner's account suffers from only one se-

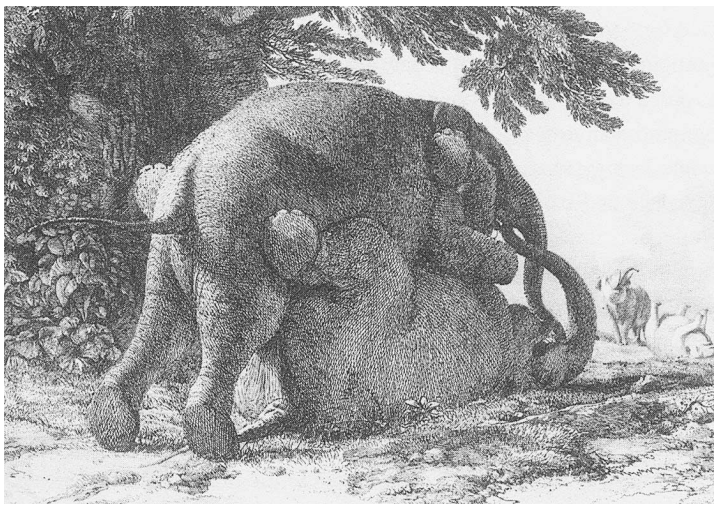
rious lacuna. Except for two brief sections—one on the reception of the *Systema naturae* (1735) in continental Europe (pp. 26–32) and one on Linnaeus's self-presentation as a "Lapp" during his stay in Holland from 1735 to 1738 (pp. 64–67)—Linnaeus's involvement in the international communication network of professional botanists is minimally treated. More attention to this side of the story, in combination with the mastery Koerner has gained over Linnaeus's economics, could have resulted in a fresh understanding of his taxonomic work beyond the received view that it derived from "a scholarly genealogy dominated by the Latin West's reception of Aristotle" (p. 32). Yet this lacuna can be excused by Koerner's explicit ambition "to locate Linnaeus within his culture, finding there a set of unexpected clues to his importance in the Enlightenment." And for this, her book will remain an invaluable standard reference.

STAFFAN MÜLLER-WILLE

Louise E. Robbins. *Elephant Slaves and Pampered Parrots: Exotic Animals in Eighteenth-Century Paris*. xiv + 349 pp., illus., notes, index. Baltimore: Johns Hopkins University Press, 2002. $48 (cloth).

This is a subtle and deeply rewarding study of the physical, metaphorical, and ideological presence of exotic animals in Paris in the eighteenth century. Louise Robbins is an immensely skilled writer who, in treating one of the most studied times and places in history, has told an often surprisingly new kind of story. Robbins simply sees things that many other people have missed. When she becomes our guide—which she quite literally and pleasantly does on occasion in this book—she has us settle into the rooms of a bird-seller, takes us out to the booths at the St. Germain, St. Laurent, and other fairs, finds us cheap tickets to the *combat d'animaux,* and explains how we might pack into a carriage for four hours to view the king's menagerie at Versailles. Robbins is comfortable in the streets. Of the area near the quai de la Mégisserie, for example, she writes: "Pet shops are still found there, and on Sunday mornings tourists and city pigeons gather around to gawk at the cages on the sidewalk" (p. 109). She is equally at home, however, with the likes of La Fontaine, Buffon, Jacques-Henri Bernardin de Saint-Pierre, and Rousseau. Her reading of Buffon, for example, reveals particularly well how apparent contradictions in his ideas about animals are perhaps best seen as characteristic of the period.

It is not a trivial task to make sense of this topic for a general audience (and general readers will find *Elephant Slaves and Pampered Parrots* a very enjoyable read) and still be able to provide the sort of rewarding analysis of materials demanded by scholars in the field. Thankfully, Robbins avoids offering classic bracketed intro-



Fanciful anthropomorphized depiction of elephant copulation in J. P. Houel's Histoire naturelle des deux éléphans mâle et femelle *[1803] (from Louise E. Robbins,* Elephant Slaves and Pampered Parrots, *p. 227).*

ductory lessons and instead offers a carefully interwoven narrative that combines a comprehensible and thoughtful account of social and political change with close studies of the presence of strange animals in the city. For example, in an exemplary chapter on the Parisian bird-selling guild (the use of which I would strongly encourage in courses addressing changes in early modern cities), Robbins has used virtually untapped guild records both to show the increasing presence and significance of imported birds in Paris as the eighteenth century progressed and to illuminate how political, economic, and social changes began to undermine the authority of guild structures. Similarly, in what is probably my favorite section of the book, she details frustrated efforts to obtain a pair of zebras for Louis XVI's menagerie at Versailles. As we follow the tribulations of a naval minister and a repeatedly disappointed and disappointing agent in the Cape Colony, we gain important insight into the limits of and stakes in royal power in the mid 1780s—and all of this, of course, in a section that is really (or maybe just also) about the remarkable status of zebras in the late eighteenth century.

More than anything else, what struck me again and again is how well Robbins keeps her history on the ground. In a time when rhetoric about animals is often far removed from the actual circumstances of their lives (then and now), Robbins consistently looks behind the paintings, behind the memoirs, behind the curtains, and behind the policies to try to get a sense of how exotic animals actually lived. About the new Jardin des Plantes, for example, she writes: "If the menagerie was conceived with starry eyes, it was born in gritty reality. . . . The menagerie developed higgledy-piggledy, in response to unplanned circumstances, and in a form quite different from that in the idealized memoirs and plans" (p. 220). This is a remarkable book that will be read and enjoyed as much by historians of science as by social, economic, and cultural historians.

NIGEL ROTHFELS

Leonard N. Rosenband. *Papermaking in Eighteenth-Century France: Management, Labor, and Revolution at the Montgolfier Mill, 1761–1805*. xvi + 210 pp., illus., tables, app., bibl., index. Baltimore: Johns Hopkins University Press, 2000. $39.95.

Thoroughly documented case studies on technological change are always very welcome. This is the case with Leonard N. Rosenband's history of papermaking in late eighteenth-century France. His study of the Montgolfiers' mill, at Vidalon-le-Haut in the Rhone Valley, illustrates the tension between the *ancien régime* policies of reform and promotion of the arts and the resistance of traditional craftsman to labor changes. Using the Archives Canson-Montgolfier, which are kept at the Archives Nationales in Paris, Rosenband manages to reconstruct minutely the everyday life of the papermaking mill and the conflict between masters—acting in the name of the owners—and skilled journeymen.

Under Nicolas Desmarest's official inspection and guidance, the Montgolfiers followed the path of other eighteenth-century entrepreneurs keen to promote technological change and innovation. Aware of foreign novelties, the Montgolfiers imported Dutch paper-beating machines for installation at Vidalon and tried to adapt rapidly to new state regulations on papermaking and quality control.

In the strike and lockout of 1781, however, dreams of applying science to the art of making paper—in Desmarest's view—dramatically clashed with the journeymen's self-styled law. The owners then took advantage of the crisis to destroy the journeymen's culture of work. In order to promote a more flexible labor culture in the mill, they hired a new generation of malleable employees. Moreover, new trends of mechanization after the French Revolution again challenged the old journeyman culture and the long-standing national tradition of high-quality luxury goods. In 1799, the introduction of Nicolas-Louis Robert's papermaking machine was another key step toward the end of a traditional skilled papermaking workforce, which lasted only until the 1820s.

Rosenband's account of these historical facts is precise and very illuminating. It sheds new light on the complex transition between craftsman and industrial culture in the late eighteenth century. It revisits the question of technology transfer from Holland to France (similar examples can be found in dyeing and calico-printing), enriches the discussion about the diverse kinds of division of labor—masters, journeymen, employees— and adds new examples of the challenges and attitudes toward new machinery.

Although the losers' version is often hard to reconstruct from archival material, more inputs on the journeymen's view of the conflict would have been of great interest in terms of a more symmetrical account. As a comparative framework, some additional thoughts on resistance to technological change in general, and on Luddism in

particular, might have been also useful—for instance, some of the papers included in Martin Bauer's edited volume *Resistance to New Technology* (Cambridge University Press, 1994).

Of course, these are only minor points. There is no doubt that this book is an excellent contribution. It adds another well-studied case to enlighten the debate on the nonlinear transition between craftsman guilds, *manufactures royales,* and the factory system (Maxine Berg). It will be of great interest for historians of science and technology as well as for economic and business historians.

AUGUSTÍ NIETO-GALAN

■ Modern (Nineteenth Century to 1950)

Nina Baym. *American Women of Letters and the Nineteenth-Century Sciences: Styles of Affiliation*. x + 272 pp., bibl., index. Piscataway, N.J.: Rutgers University Press, 2001. $60 (cloth).

Nina Baym's *American Women of Letters and the Nineteenth-Century Sciences: Styles of Affiliation* explores the varied ways in which women writers responded to the sciences in nineteenth-century America. Baym finds that few women writers on the sciences challenged either the premises of science or the assumption that scientific discovery was naturally a male province. Instead, she suggests that these writers outlined various "affiliations" between middle-class women and science in order to emphasize both what women could gain from science (connections to reason, progress, modernity) and what science could gain from women (a cadre of popularizers, appreciators, and consumers).

Working across many discourses, Baym finds a wide array of associations between women writers and science. As the author of popular botanical textbooks, Almira Phelps celebrated the role of scientific popularizer but ranked it below the masculine realm of original discovery. An advocate of old-fashioned classificatory botanizing, Phelps came to view the rise of a new plant biology and women's suffragism with analogous alarm. Sarah Hale promoted the scientific education of women in *Godey's Lady's Book* but believed that such education served purely to help women perform their domestic duties. Similarly, Catherine Beecher's domestic handbooks treated women as applied scientists of household life. In contrast, Susan Fenimore Cooper's mid-century nature writing presented science as a source of genteel entertainment for ladies, a mark of class distinction. (But by the century's final decades, Baym argues, both women's fiction and Cooper's revised editions reveal an ever-stronger norm aligning women not with science but with emotion, an alignment contributing to both the aestheticism of women's writing and the feminization of literature.)

Women could popularize, apply, and appreciate scientific knowledge, but could they generate it? Elizabeth Cary Agassiz aided her husband's work not just as an assistant in a scientific household but as Louis Agassiz's "publicist and ghostwriter," a literary professional (p. 98). Maria Mitchell discovered a comet yet presented her discovery as the product not of genius but of a methodical, collaborative science in which women could participate, while Emma Willard protested against a professionalized scientific establishment for discounting her theory that the lungs pumped the blood using steam power. At the end of the century, female physicians tended to affirm not their scientific acumen but their introduction of a nurturing feminine sensibility into medicine (a pattern defied by Mary Putnam Jacobi, who published many medical articles drawing on her clinical experience).

Some of Baym's most intriguing investigations move out from her focus on women's science writing *per se.* A chapter on Emily Dickinson argues for her scathing rejection of the pieties of natural theology and its blithe assurance of the compatibility of faith and science. And a final chapter explores both the increasing affiliation of women with the spirit in late nineteenth-century culture and the scientific claims of Mary Baker Eddy's Christian Science, Ellen White's Seventh-Day Adventism, and women spiritualist writers.

American Women of Letters and the Nineteenth-Century Sciences laudably avoids overschematization and reductiveness—with the result, however, that it sometimes seems too ready to proffer long catalogues, for instance of an author's use of scientific language. And occasionally there is an unaccountable slip. For example, the study's first paragraph claims that at the "beginning" of the century "the word *scientist* had yet to come into general use"—presumably because it had yet to be coined; a footnote sends us to William Whewell, whose use of the term is well known, yet the note inexplicably gives him credit for "the first use of the term *science*" (pp. 1, 211 n 2). But the volume clearly achieves its principal goal, offering analyses that outline the strategies women writers used to associate themselves with science in nineteenth-century America as well as the ideological and practical limitations to such styles of affiliation.

RICHARD MENKE

Hermann Grassmann. *Extension Theory*. Translated by **Lloyd C. Kannenberg**. (History of Mathematics Sources, 19.) 411 pp., frontis., figs., apps., indexes. Providence, R.I.: American Mathematical Society, 2000. $75 (paper).

In the history of mathematics and physics, Hermann Günther Grassmann (1809–1877) is known as one of the important mathematicians of the nineteenth century. While he developed, concurrently with William Rowan Hamilton, a new vectorial calculus, his contributions range from logic and foundations of mathematics to mechanics and electrodynamics. Even today his theories find new developments and applications. This is why it is so important to have easy access to his work.

It is a standard topic in the historiography, however, to deplore the belated reception of Grassmann's innovative theories. As recent analysis has shown, this belatedness is not as marked and dramatic as it is usually depicted (see Gert Schubring, "Introduction: Reflections on the Complex History of Grassmann's Reception," in *Hermann Günther Grassmann [1809–1877],* ed. Schubring [Kluwer, 1996], pp. ix–xxix, esp. p. x). There are problems inherent in Grassmann's work, however, that impede the easy reception of his concepts. Grassmann, a neohumanist scholar, also adopted the romantic strands of that school, rejecting traditional mathematical terminology based on Latin and French terms and replacing them with German terms created by himself. Moreover, as he established new foundational disciplines—namely, the extension theory—he constructed a semantics of his own based on this terminology; as the meaning of the terms was constituted by their interrelationships within his semantic system, Grassmann's theories seemed to present a rather hermetic kind of knowledge. It is evident, then, that understanding Grassmann's work constituted a difficult challenge even for German mathematicians and that every new generation had to face that challenge anew to appropriate its wisdom. As long as German was one of the major international languages for mathematics, it was conceivable that these obstacles might be overcome. They attained new dimensions, however, when German became less common in the international community. Translations were rare: only a few of Grassmann's articles were translated into English during the nineteenth century. The first translation of one of his books, the *Ausdehnungslehre* of 1844, was published in 1947 in Spanish. An English translation of this principal work had been in preparation by Lloyd C. Kannenberg since the 1980s; he eventually succeeded in getting it published in the wake of the 1994 sesquicentennial conference commemorating the first publication of the *Ausdehnungslehre* with the title *A New Branch of Mathematics* (Open Court, 1995). A French translation appeared in 1994.

Actually, Grassmann had developed two different versions of the *Ausdehnungslehre,* usually called A_1 and A_2: the A_2, a radically revised version, was published in 1862. Responding to criticisms of the A_1, Grassmann had abandoned its philosophical framework and attempted to give it a purely "Euclidean" form, thus conforming more closely to common standards of mathematical presentation. Since the A_2 also contained further developments of his theory, Kannenberg judged it to be Grassmann's "most mature" version.

Kannenberg has now prepared a translation of this second book, published in 2000 by the American Mathematical Society. Given the difficulties even native speakers have in understanding Grassmann's works, the complexity of the task of translating them was enormous. One must keep in mind that the terms Grassmann created not only carry a technical meaning but were loaded with philosophical and epistemological connotations. In each case, then, the translator faces the problem of finding an equivalent term that ideally carries the same range of meanings.

In fact, in his translation of the A_1 Kannenberg already pointed out that no unanimity can be achieved on the proper English equivalents even for such basic terms as "*Strecke*" (candidates being "stretch," "vector," and "displacement"—his own choice) or "*Verknüpfung*" ("connection," "join," and "conjunction"—his choice). Most of the scholarly publications on Grassmann in English use "connection" for "*Verknüpfung*" (the French translation uses "*liaison*"). Kannenberg adheres to "conjunction" in the A_2 translation as well. In the first translation he adopted an effective means for enabling the reader to compare the basic English terms he chose with the German originals: as part of the subject index, there is a concordance between the English and the German. For the A_2 translation Kannenberg inserted a separate concordance.

Even if a translation of Grassmann will not be able to convey the entire range of his meaning, a fair indicator of its level of sophistication is how far it enables the reader to grasp the essence of the ideas contained in the original. There are but a few particular terms where one can argue with the translator (besides "*Verknüpfung*" there is, for instance, "*Produktbildung,*" "formation of products," which he translates as "product struc-

ture"—in this instance the German original is not included in the concordance). In general, however, Kannenberg has succeeded in producing an English text that optimally corresponds to Grassmann's original and at the same time is well organized and eminently readable.

Besides presenting an excellent English version, Kannenberg's A_2 offers a significant textual achievement. Nowadays, the commonly used text of the A_2 is that published in 1896 as Volume 1, Part 2, of Grassmann's *Gesammelte Werke*. This 1896 text is not a reprint of the 1862 original, however, but an attempted "improvement": the editors rearranged some of the theorems, even interpolating new theorems of their own devising and replacing some of the proofs with versions of their own. After careful analysis, Kannenberg has restored the original text—while maintaining corrections of misprints and other unobjectionable improvements. An extended apparatus of notes permits comparison between the different versions. In a final chapter, Kannenberg briefly explains how to transpose Grassmann's concepts into modern terms and theories, in particular those of multilinear algebra.

Kannenberg's translation, then, is also a truly new edition of the A_2 that gives mathematicians, physicists, and historians effective access to Grassmann's original and important ideas.

GERT SCHUBRING

I. Grattan-Guinness. *The Search for Mathematical Roots, 1870–1940: Logics, Set Theories, and the Foundations of Mathematics from Cantor through Russell to Gödel*. xiv + 690 pp., illus., figs., tables, bibl., index. Princeton, N.J./Oxford: Princeton University Press, 2000.

Ivor Grattan-Guinness's uniformly interesting and valuable account of the interwoven development of logic and related fields of mathematics (set theory, algebra, and analysis) between 1870 and 1940 presents a significantly revised analysis of the history of the period. Standard twentieth-century accounts of the same period, and especially those focused primarily on analytic philosophy, often identified Gottlob Frege as its major figure, with all else forming a buildup to his work or part of the great outwash from it. Grattan-Guinness, by contrast, offers an alternative in which the primary feature is the logicism of Alfred North Whitehead and Bertrand Russell. There are several reasons for the shift. While Frege produced a version of the modern theory of quantification, his work had little influence at the time of its publication. Also, placing exclusive stress on Frege obscures the contributions of other important logicians working at the time—logicians such as Giuseppe Peano, who in turn did have more immediate influence. Changing the focus to Russell and logicism has the advantage of providing a convenient point at which the full scope and complexity of previous developments can be seen to converge.

While Grattan-Guinness identifies Russell's logicism as the *de facto* turning point in modern formal history, he does not seek to champion logicism itself as a defensible formal doctrine. As he lays out in detail, any hope of basing all of mathematics on pure logic foundered on Kurt Gödel's 1931 proof of the incompatibility of first-order consistency and completeness, which in turn led to a widespread reformulation of foundational problems, including the demise of logicism as it had been conceived earlier in the century.

In the process of following its main theme, Grattan-Guinness has produced a work that is detailed and encyclopedic. Among the most valuable contributions is a discussion of the (separate) mathematical backgrounds of "mathematicised logic"—that is, the algebraic logic of George Boole and Augustus De Morgan—and the later mathematical logic of Peano, Whitehead, Russell, and others. This is territory largely ignored in other histories, and its inclusion completes an otherwise partial picture.

Grattan-Guinness's delineation of various kinds of set theory, and particularly his analysis of Georg Cantor's *Mengenlehre* and its influence on Russell, is another welcome feature, as is his lengthy discussion of the contributions of Giuseppe Peano. All of this is in aid of shifting the focus of discussion toward the mathematical component of the history of the period and away from the primarily philosophical.

That shift will not please everyone. Confining the account of Frege to 20 pages in a 690-page book (while Russell receives two full chapters) invites charges of excess in the other direction, and Grattan-Guinness's attempt to isolate Frege historically in various ways is open to question. His claim, for instance, that C. S. Peirce, and not Frege, is responsible for the modern theory of quantification is a matter open to dispute: Peirce's version (though earlier) remains embedded in the algebraic context, while Frege introduced the first full version of the theory now in use. Such disputes are part of an ongoing discussion of a very complex area of inquiry (as is made evident in the flow chart on p. 570). Regardless of how the landscape is eventually settled (if it ever is), Grattan-Guinness's book is

important because it supplies what has been lacking: a full account of the period from a primarily mathematical perspective.

JAMES W. VAN EVRA

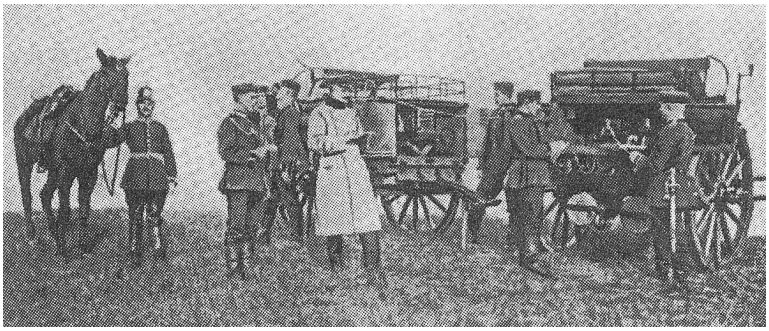
Florian Hars. *Ferdinand Braun, 1850–1918: Ein wilhelminischer Physiker*. 272 pp., illus., bibls., index. Berlin/Diepholz: GNT, 1999. €29.50.

This brief but cogent biography of one of the great unsung pioneers of electrical and electronic physics near the end of the nineteenth century purports to be a corrective to the sparse hagiography that surrounds the life and works of Guglielmo Marconi's most honored competitor. Ferdinand Braun (1850–1918) shared the 1909 Nobel Prize in physics with Marconi for making long-distance wireless telegraphy a reality. Braun also is generally recognized for his contributions through meticulous experimentation to the rectifier effect (1874), to the concept of free energy in thermoelectricity (1878), to the birth of the cathode-ray oscilloscope (1897), to indirectly coupled, tuned, and directed radio systems (1898–1902), and to the discoveries of semiconductor magnetic materials (1892–1899). Although Braun was a modest and energetic professor devoted to pure and applied physics in western Germany during the eras of Bismarck and Wilhelm II, he died while detained in the United States during patent litigations in World War I. Thus, proper appreciation of his life and works has been obscured by unfortunate circumstances.

Florian Hars herewith tries to amend that situation. His short biography of Braun is organized chronologically in only five chapters, contains only seven grainy photographs and about nine diagrams, and emphasizes social context more than technical aspects of Braun's work. Yet this contribution deserves an English edition or translation.

Ferdinand Braun was a quintessential experimentalist, not much interested in theoretical speculation, and he was a prototypical academic professor in Wilhelmine Germany over four decades. From 1870 until his death in Brooklyn on 20 April 1918, Braun's career spanned incredible years of progress in human understanding of physical nature. His role models included Faraday, Maxwell, Helmholtz, Hertz, and Röntgen. His contemporaries included Marconi, J. J. Thomson, H. A. Lorentz, Rutherford, Planck, and Einstein. His rivals included Marconi, of course, as well as Adolf Slaby, H. L. LeChâtelier, Nikola Tesla, A. S. Popov, Anton Overbeck, and Oliver Lodge. Braun was more a lover of experimental physics than a fighter for priorities and patents in electrical engineering. So his academic career in manipulating materials, measuring electrical oscillations, and analyzing electromagnetic properties of radiation was widely deemed exemplary for the exact sciences. And he was a beloved teacher, which perhaps compensated for his publishing only about 150 papers in all.

Born on 6 June 1850 in Fulda, a Lutheran among Catholics and the fifth son of a middle-class court clerk with seven children, young Ferdinand did well as a gymnasium student and so was sent to Marburg for a year before he chose to move to Berlin in 1869. There he flourished, especially under the tutelage of G. H. Quincke, a specialist in physical optics; he obtained his Ph.D. in the spring of 1872 under Helmholtz. Thereafter, he moved to Würzburg as Quincke's assistant, then on to Leipzig as a gymnasium



The Braun-Siemens military telegraph wagon in 1903 (from Florian Hars, Ferdinand Braun, 1850–1918, *p. 157).*

teacher, then back to Marburg for two years before being called to Strasbourg. Climbing the academic ladder, Braun next went to Karlsruhe in 1883 as a full professor, then to Tübingen in 1885 to revitalize a physics institute; finally, in 1895, he and his entourage were called back to Strasbourg in Alsace to replace Friedrich Kohlrausch at the most prestigious center for physics, apart from Berlin, in the German Empire. Braun's creative skills as an experimentalist had matured, and he was considered an excellent teacher, a demanding mentor, and a prolific inventor of laboratory apparatus and prototype instruments. His productivity increased throughout his two decades based in Strasbourg. His laboratory prospered, his honors increased, and his students multiplied—even as his interests led him farther afield. Once long-distance wireless telegraphy captured his full attention, Braun became embroiled in entrepreneurial, industrial, financial, and nationalistic competition beyond his ken. But he seems to have remained true to his core values and academic character despite all the intense rivalries—personal, professional, legal, and illegal—that quickly developed. Many layers of intrigue and interest surround and interact with Braun's later life. There is room for much more scholarship about these stories.

Until 1965 no full-scale biography of Braun existed, but then there appeared in German a lengthy study by Friedrich Kurylo. Walther Gerlach and Bern Dibner, among others, recognized the virtues of Kurylo's biography and encouraged the Braun family to translate, adapt, and contextualize that text for a wider audience. Charles Susskind finally and admirably performed this task: in 1981 the MIT Press issued *Ferdinand Braun: A Life of the Nobel Prize-winner and Inventor of the Cathode-Ray Oscilloscope.* This Kurylo/Susskind book remains the standard, lengthier, better-illustrated, and most accessible secondary source on Braun's life and work. But Florian Hars's book is a good supplement, based on Kurylo and Susskind's foundations but profiting from more archival and library resources as well as more recent scholarly literature in the history of science.

LOYD S. SWENSON, JR.

Massimiliano Badino. *L'espistemologia di Planck: Nel suo contesto stori*. (Consiglio Nazionale delle Ricerche, Centro di Studio sulla Filosofia Contemporanea, 78.) 318 pp., bibl. Naples: Edizione Scientifiche Italiane, 2000. L 48,000 (paper).

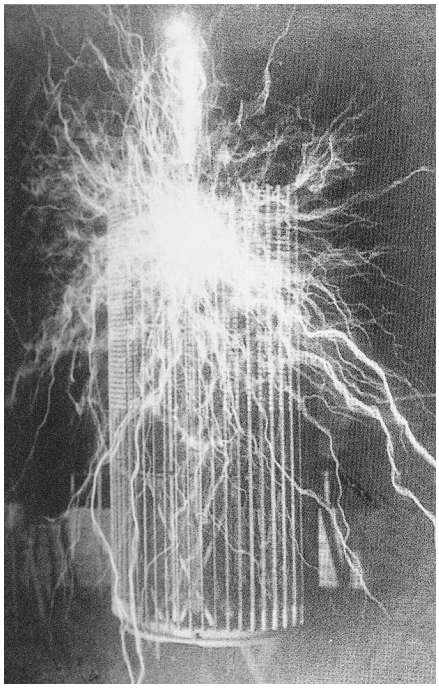
This book presents interesting and constructive insights into various aspects of the scientific and philosophical work of Max Planck. In chapters dealing with such topics as the mechanical theories and the related work of Ludwig Boltzmann, Planck's program is analyzed and described in detail. One focus is the role of the philosophy of science in Planck's work: he delivered some interesting public lectures in this field (e.g., on causality in physics, determinism and indeterminism, and religion and natural science). In this connection, I note that Massimiliano Badino has overlooked Hans Ertel's interesting essay "Causality, Teleology, and Freedom of Will as a Problem of Natural Sciences," which has been discussed in some detail by meteorologists and theoretical physicists (see the edition published by Wilfried Schröder [Druck & Verlag, 2000]). Planck's lectures in these fields, as well as on the development of his physical ideas and his philosophical reflections, do not constitute a "system" in history of science. (On the topic of philosophy, religion, and natural science Badino has also overlooked Schröder's *Naturwissenschaft und Religion* [Science Edition, 1999], which offers precise insights into the positions of Planck and Werner Heisenberg. With regard to discussions between Planck and Albert Einstein, he omits Hans-Jürgen Treder's "Meinungsstreit über Relativitätstheorie," *Spektrum,* 1976, *7:*24–25.) Planck moved more toward a "system" as the result of his thinking about certain problems while he was secretary of the Berlin Academy of Sciences and in the context of running discussions about modern physics since 1920.

Overall, Badino offers a fruitful look at Planck's work, and his very helpful bibliography may stimulate readers to look more closely at particular aspects of Planck's thought and writings.

WILFRIED SCHRÖDER

Margaret Cheney; Robert Uth. *Tesla: Master of Lightning*. xiv + 184 pp., illus., figs., bibls., index. New York: Barnes & Noble, 1999. $14.98.

Nikola Tesla was born in Croatia in 1856 and died in New York City in 1943. He lived in Yugoslavia, Prague, Budapest, and Paris during his youth and in the United States, mostly New York City, for all his adult years. What sets Tesla apart from so many other inventors is not only that his inventions were fundamental, but also that they spanned a great many separate fields. Tesla's creations are central to fluorescent lighting, alternating-current electrical power transmission, wireless communication, remote control,



Nikola Tesla's demonstration apparatus for electrical phenomena (from Margaret Cheney and Robert Uth, Tesla, *p. 87).*

robotics, the induction motor, steam turbines and pumps, tilt rotor, flying wing, and airplane designs, and even Star Wars technology.

Living in the Waldorf Astoria at the height of the Gay Nineties, Tesla hobnobbed with the social elite, including authors such as Mark Twain and Rudyard Kipling, the pianist Ignace Paderewski (who later became prime minister of Poland), the poet and Nazi apologist George Sylvester Viereck, the environmentalist John Muir, the architect Stanford White, the financiers John Jacob Astor, John Hays Hammond, and J. Pierpont Morgan, future presidents Teddy Roosevelt and Franklin Roosevelt, the scientists Wilhelm Roentgen, J. J. Thomson, Lord Kelvin, and Sir William Crookes, and such fellow inventors and industrialists as George Westinghouse, Thomas Edison, and Guglielmo Marconi. Tesla's closest friends were Robert Underwood Johnson, editor of the *Century Magazine,* and his wife Katharine.

What makes this picture book on Tesla's life so interesting is that Tesla himself was into what can only be called "camp." Although shy and reclusive, Tesla also displayed an incredible ability to capture the imagination of the public by presenting his electrical paraphernalia in astonishing pyrotechnic performances, appearing at such places as the Royal Academy of Science in London, the Chicago World's Fair of 1893, and Madison Square Garden in New York City. When he went to Colorado Springs to experiment on sending electrical impulses around the globe, he brought along his favorite photographer, Dickerson Alley, to record the events in photographs that still take one's breath away. Tesla could generate lightning bolts in excess of 60 feet; he could send hundreds of thousands of volts through his body to show the world that his new alternating current was safe; and, with Alley's help, he could produce multiple-image photographs to display all this in fantastic articles that appeared in all the electrical journals of the day, as well as in Johnson's *Century Magazine* and on the front page of newspapers such as the *World.*

Tesla: Master of Lightning captures many of these images in a very credible and almost understated fashion. Robert Uth, whose wife is a Yugoslav, was able to obtain some amazing photographs from the Tesla Museum in Belgrade, Serbia. Uth, who also used these images effectively to create a documentary on Tesla's life for PBS, further set his sights on uncovering little-known information in an attempt to do more than rehash stories already presented in such well-known biographies as John O'Niell's *Prodigal Genius* (Washburn, 1944) and Inez Hunt and Wanetta Draper's *Lighting in His Hand* (Omni, 1977). The Tesla Museum is an excellent resource for sharp images spanning Tesla's life from youth to old age. Also included in the book are pictures of Tesla's colleagues and friends, his laboratories in New York, wireless transmission stations in Colorado and Long Island, and many of his spectacular demonstrations and inventions. If any criticism were to be made, it would be that new works on Tesla are missing from the bibliography.

MARC J. SEIFER

Helmut Rechenberg; Gerald Wiemers (Editors). *Werner Heisenberg: Gutachten- und Prüfungsprotokolle für Promotionen und Habilitationen (1929–1942).* (Berliner Beiträge zur Geschichte der Naturwissenschaften und der Technik, 29.) 266 pp., illus., index. Berlin: ERS-Verlag, 2002. €27.50 (paper).

In the German education system, doctoral committee members submit written evaluations accepting or rejecting the candidate's dissertation.

If accepted, the candidate is subjected to graded final examinations in his or her major and minor fields. The successful candidates are then recommended to the dean for *Promotion* to doctoral status. Candidates for the *Habilitation* (the right to lecture at the university level) submit a more substantial dissertation, which is likewise evaluated in writing. If passed, the candidate offers a public test lecture, followed by a vote of the faculty on his or her admission to the profession.

At the University of Leipzig the record of these procedures for each candidate has been carefully preserved in official documents stored in the university archives. These records were accessible to Western researchers only under difficult circumstances before the collapse of the East German government and only to visitors to the archive thereafter. Thanks to Helmut Rechenberg, a historian of physics in Munich, and Gerald Wiemers, director of the archive, the portion of these records pertaining to the activities of the physics professor Werner Heisenberg as examiner and evaluator are now available in full, with helpful introductory commentary and appendixes.

Heisenberg was professor of theoretical physics in Leipzig from 1929 to 1942. During this period he wrote sixty-nine thesis evaluations and gave twenty-eight doctoral examinations in theoretical physics. Although there were a number of female physics students at the lower levels, all but one of the candidates, Hildegard Geest, was male. Fourteen of the doctoral candidates (not including Geest) were Heisenberg's own students. Four of these went on to habilitate under Heisenberg: Felix Bloch, Hans Euler, Erich Bagge, and Carl Friedrich von Weizsäcker. They wrote four of the five *Habilitation* theses that he reviewed.

These published files offer a wealth of information about each candidate and about the Heisenberg school of theoretical physics in general. Arranged in chronological order, each document provides the title of the dissertation, the names of those on the examining committee, the written evaluations by Heisenberg and by the first or second examiner, the topics Heisenberg covered in his examination of the doctoral candidates, and the grade given, often with a short comment. In addition, the candidates were required to provide for the record not only the date and place of their birth but also a short autobiography, usually giving religion, the full names and occupation of parents, and prior education. In a useful appendix, the editors present brief biographical sketches of the candidates, focusing on their careers after leaving the university. Thus we learn, for instance, of the careers of a number of foreign students, such as Ivan Supek (Yugoslavia), Edward Teller (Hungary), and Richard Iskraut (United States). Soon after graduation Hildegard Geest married the Leipzig associate physics professor August Karolus. In 1946 they moved to the University of Zurich, where she died in 1990.

As the editors point out, this collection is most valuable as a snapshot of the generation of German students who entered physics during or just before the rise of the Third Reich. Most of these students stemmed from upper middle-class families. The impact of the Third Reich and the onset of World War II is evident in the decline of graduates and in the course of their future careers. Yet, judging from these documents, the level of teaching and research in Leipzig remained remarkably high, extending from cosmic-ray physics and quantum field theory to the study of nuclear forces. Many of those not working on nuclear physics were subsequently drafted into the army, while others contributed to German wartime research on nuclear fission.

DAVID C. CASSIDY

Klaus Hentschel. *Mapping the Spectrum: Techniques of Visual Representation in Research and Teaching*. xiv + 562 pp., illus., figs., tables, apps., bibl., indexes. Oxford/New York: Oxford University Press, 2002. $125 (cloth).

Spectroscopy became central to physics, chemistry, and astronomy during the late nineteenth and early twentieth centuries. Klaus Hentschel investigates the development of this varied set of techniques from roughly 1860 to 1930 along two principal axes: interactions between spectroscopic research and changing printing technologies, and interactions between research and teaching. In doing so, Hentschel delves more deeply than most historians of science have done into the intricacies of the material culture of printing. Whether the mode of picturing and reproduction was steel engraving, lithography, or any of the variety of photomechanical reproduction techniques in play during the last half of the nineteenth century, spectroscopists always had to work hard to interpret spectral maps, even when the mapmakers purported to record directly from nature. Spectroscopists struggled over how best to work with the artisans who made their maps—engravers, lithographers, photographers—to convey not only spectral-line spacings but also relative intensities. Various visual languages (such as cross-hatching styles) were developed within each genre of print tech-

nology to distinguish intended signal from background.

A large portion of Hentschel's study contributes to the already-rich historical literature on the introduction of photography to scientific research, showing that despite the claims of photography's enthusiasts that the new techniques merely recorded how nature really was, a tremendous amount of subjective judgment remained. Photographs almost always needed to be retouched in order to show what the investigators believed to be most significant or relevant. Even more important, for several decades after photography entered spectroscopists' toolkit, the researchers still needed to work with engravers or lithographers to make "conventional" copies of their photographs, since it remained impossible to reproduce large numbers of copies of the early photographs for publications. As Hentschel is at pains to demonstrate, there was no linear progression in printing techniques that took spectral maps from the realm of Romantic individual-artistic modes of production to mechanical reproduction. Many modes coexisted, each seen at the time as having its own strengths and weaknesses.

Other questions of picturing were hotly contested for many decades. Should spectral maps be pictured in terms of wavelength or wave number (proportional to frequency)? How could numerical scales be appended to maps, and whose units of measure should be featured? Did glass prisms or the newer diffraction gratings introduce fewer distortions? Hentschel demonstrates the close affinities between spectroscopy and geographical mapmaking. Not only were many of the same artisans involved in both activities, but many of the same image-manipulation techniques were used: zooming in on interesting portions of the overall map for some purposes; condensing or distilling the map into its most distinctive, identifying *Gestalt* for others. Often the preferences for mapping style broke along disciplinary lines: physicists and instrument makers tended to favor zooming in on specific regions, so as to measure or calibrate absolute values for various wavelengths, while chemists tended to favor the distilled maps for getting the "feel" for a given element's spectrum quickly. Hentschel notes that before Niels Bohr's famous quantized model of the atom in 1913, most research on spectra was not tied closely to investigations of atomic structure. Many spectroscopists struggled to find patterns in the spectral lines, often contenting themselves with phenomenological and numerological relationships.

Learning to see the appropriate quantities in spectral maps was by no means an easy task. In fact, Hentschel argues, there was no single discipline of "spectroscopy" during the period under study but, rather, several distinct "spectroscopic domains," constellations of preferred instruments, mapping and reproduction techniques, and interpretive skills for producing and reading spectra. Experts as well as novices often found it quite difficult to read a spectral map produced according to the pictorial codes of a different domain. Hentschel devotes a lengthy chapter to the teaching and training of budding spectroscopists and finds the very interesting connection that most successful spectroscopists shared some background in the fine arts or technical drawing. Many of them, such as Johann Jakob Balmer, taught topics such as perspectival drawing and drew on these visual skills when interpreting spectra. Hentschel uses these interconnections to suggest (although not really to address in full) broader cross-cultural styles of visualization at the close of the nineteenth century.

This is an impressive book, based on a tremendous amount of original research. The effort to understand the social and technical worlds of nineteenth-century print techniques and their interplay with scientific research is admirable and unparalleled, though at times the reader might wish that the wealth of details had been better summarized or woven into the overall thesis.

DAVID KAISER

David Wright. *Translating Science: The Transmission of Western Chemistry into Late Imperial China, 1840–1900.* (Sinica Leidensia, 48.) xxvi + 558 pp., illus., figs., tables, apps., bibls., index. Leiden/Boston: Brill Academic Publishers, 2000.

This book gives a very good survey of the social and historical context in which the introduction of modern science and the translation of Western scientific and technical texts took place in nineteenth-century China. The lives and works of key characters, Chinese and Western, are well documented. Regarding John Fryer, for instance, this text is a valuable complement to the pioneering work by Adrian Arthur Bennett (*John Fryer: The Introduction of Western Science and Technology into Nineteenth-Century China* [Cambridge, Mass., 1967]). Even if the translation of the chemical language is not deeply analyzed, there is a vivid report of the process of translation of chemical terms, with many quotations from the various actors themselves.

A seminal paper should be added to the bibliography concerning the first chapter: J. Willard

Peterson, "Western Natural Philosophy Published in Late Ming China," *Proceedings of the American Philosophical Society,* 1973, *117:* 295–322. I regret that the period chosen does not allow the author to discuss fully the process of translating Western science into Chinese. We can read a very interesting tableau of the first step, but the reader may have the feeling that by the end of the nineteenth century what had been done was definitive. Actually, a crucial stage of the process of terminological creation occurred during the first thirty years of the twentieth century, when Japanese texts and textbooks of modern science were widely used by Chinese scientists as a source for their new terminology. In this respect, Chapter 10, "The survival of the fittest terms," which overlaps the nineteenth century to consider modern terminology, appear misleading. The choice of the author prevents an estimate of the role played by Japan in many ways. This very interesting question is just alluded to (pp. 227–228, 353–354, 400, 408, 425). If we look at the field of botany, for instance, the linguistic situation during the nineteenth century was similar to what is described for chemistry, but there was a dramatic change after 1900 due to the bulk of scientific terms in Chinese characters created in Japan, borrowed and still part of the modern vocabulary used today in China (Georges Métailié, "The Formation of Botanical Terminology: A Model or a Case Study?", in Michael Lackner, Iwo Amelung, and Joachim Kurtz, *New Terms for New Ideas: Western Knowledge and Lexical Change in Late Imperial China,* [Leiden, 2001], pp. 327–338). It seems that the part played by the Japanese chemical terminology may have been much more important than what is mentioned in the book. The statements (p. 353), "Japanese neologisms were often disliked in China," and "There was intense competition from the 1890's between native Chinese translated terms and terms borrowed via Japanese *kanji* [Chinese characters] into Chinese" (p. 353), followed by Table 13 (p. 354), which gives an example of three Japanese terms that have replaced late Qing Chinese terms and can now be found in modern Chinese terminology, seem to suggest the influence of what had been done in Japan. However, in Figure 33 (p. 364), which proposes "A genealogy of the modern Chinese nomenclature of the elements," Japan is just ignored. Except for these reservations, I consider this book as a fundamental work on the circumstances of the transmission of Western chemistry and some other sciences into late imperial China during the nineteenth century. It is a reference book with many pertinent footnotes, rich bibliographies (of Chinese, Japanese, and Western texts) and precious appendixes. Lastly, and not least, this scholarly book can also be read as a saga.

GEORGES MÉTAILIÉ

Dennis R. Dean. *Gideon Mantell and the Discovery of Dinosaurs*. xx + 290 pp., illus., fig., app., index. New York/Cambridge: Cambridge University Press, 1999. $69.95.

Winos frequently bed there. As a result, the Piccadilly entrance to the Burlington House premises of the Geological Society of London is today rarely unlocked. A shame: behind those closed doors are commemorated such pioneering giants of British geology as De La Beche, Greenough, Huxley, Lyell, Murchison, and Smith. There too hangs a portrait—artist unknown—of Gideon Algernon Mantell (1790–1852). That the fellows of the society no longer enter Burlington House past his portrait would, I suspect, be taken by Mantell as a personal slight. He was a touchy individual.

A physician by profession, Mantell practiced successively in Sussex at Lewes and Brighton and then in London at Clapham Common. But it was to geology that he pledged his soul. He became an authority on the Wealden strata, paleontological papers flowed from his pen, and he was the author of several popular expositions of his chosen science. Somewhere around 1820 he came into the possession of certain fossil remains—some of them the discoveries of his wife Mary Ann—of the large creature that he later termed *Iguanosaurus* and the world now knows as *Iguanodon.* It is with the dinosauria that Mantell's name is today chiefly associated; and when, on New Year's Eve 1853, there took place in the grounds of the Crystal Palace that famed banquet inside the Waterhouse Hawkins reconstruction of *Iguanodon,* Mantell's name was emblazoned above the guests alongside those of William Buckland, Baron Cuvier, and Richard Owen. Mantell became the Geological Society's second Wollaston Medallist, and in 1849 he and Edward Sabine were the two Royal Medallists of the Royal Society. Mantell stood among the scientific lions rampant of his day.

Literary memorials to Mantell have long existed. The posthumous seventh edition of his *Wonders of Geology* (1857) contains reprints of several of his obituary notices; T. G. Bonney shaped for him an obelisk in the *Dictionary of National Biography;* Sidney Spokes published a 263-page biography in 1927; an abridged ver-

sion of Mantell's diary of 1819–1852, edited by E. C. Curwen, was published in 1940; and in 1998 Dennis Dean gave us *Gideon Algernon Mantell: A Bibliography with Supplementary Essays.* It was Dean who reminded us that Mantell's elder son, Walter Baldock Currant Mantell (the present book bears a dedication to his memory), had emigrated to New Zealand and that in consequence there lies in Wellington's Alexander Tumbull Library a large quantity of manuscript material germane to his father. This material Dean has now extensively quarried in laying before us his comprehensive modern biography of Mantell.

Dean here presents us with a valuable addition to the historical literature of geology. Displaying all the footnoted scholarship we have learned to associate with this author, *Gideon Algernon Mantell and the Discovery of Dinosaurs* is a work that must take its place within any library—institutional or private—that aspires to reflect nineteenth-century progress in the earth sciences. That said, I found it difficult to warm to the book. I became somewhat weary of the author's repeated affirmation that he was now correcting the historical myths that others had allowed to pass for truth. Further, I craved to feel a breath of sympathetic humanity a-riffling through the pages. A full score is here, but at the rostrum maestro Dean fails to make the music live. He is content merely to serve as Mantell's clinical anatomist.

Despite his geological achievements, Mantell in essence is surely one of the more tragic figures in science. His struggles to achieve a good living in medicine were unsuccessful. He felt himself to be undervalued within the geological community. His petulance clouded his personal relationships. His wife left him. His family disintegrated. A spinal condition left him a pain-wracked slave to opium. He was so soured that when, near the close of his life, he was granted a royal pension of £100 per annum, he could only complain that it was "a miserable pittance from the Crown of the British Empire." Even in death he seems to attract misfortune. His spine, bequeathed for medical study, was destroyed by German bombs in 1941; and during 1991 his beloved *Iguanodon* was featured on a British postage stamp associated with the name of Sir Richard Owen, of whom, Huxley assures us, Mantell was the "arch-hater." Perhaps he was not the most adorable of men, but in closing Dean's volume I did find myself hoping that someday Mantell may find his warmhearted Boswell.

American scholars should note that from 1830 Mantell was in voluminous correspondence with Benjamin Silliman of Yale. British scholars, forgetful of "Satchmo," will be perplexed by Dean's advice (p. 7) that Mantell's birthplace—Lewes—is correctly pronounced "Louis."

GORDON H. HERRIES DAVIES

James E. Strick. *Sparks of Life: Darwinism and the Victorian Debates over Spontaneous Generation*. xiv + 283 pp., illus., apps., bibl., index. Cambridge, Mass./London: Harvard University Press, 2000. $45 (cloth).

Analyses of the controversies that emerged after Charles Darwin published *On the Origin of Species* invariably, and perhaps inevitably, focus on contemporary anxieties over apes and the extraordinary impact of the loss of the biblical creation story on nineteenth-century society. Only partly to do with Darwin, to be sure, this fundamental reshaping of human origins has rightly been discussed by a large number of scholars from a variety of disciplines. Nor have the other themes that redefine the now-canonical interactions of science and society been ignored. Yet it is always refreshing to see how much remains to be said, how high a proportion of the nineteenth-century biological sciences ran relatively independently from evolutionary theory while intersecting with it at various points, and how much can be achieved by a fresh perspective

Henry Charlton Bastian, combatant in the nineteenth-century spontaneous generation debates, around 1877 (from James E. Strick, Sparks of Life, *p. 63).*

or a new historiographical aim. Of these themes, one of the most significant must surely be views on the origin of life.

The German naturalist Heinrich Bronn was only one of several who asserted in the years immediately after the *Origin* that a theory of evolution must logically go hand in hand with the notion of spontaneous generation. Evolution by natural selection, he claimed, was methodologically incomplete as an explanation if it failed to account for the first origin of life and methodologically insecure if it introduced divine agency at that origination. Of course, he put his finger on a subject that Darwin deliberately avoided in print and discussed only briefly and reluctantly with a few friends in correspondence. The possibility of life originating from biologically inert chemicals (abiogenesis) or from organic starting materials (heterogenesis) was the big uncertainty lying at the heart of nature, and Darwin, as well as many others, was elusive on the issue. Bronn seems not to have believed in either the spontaneous generation of living matter or evolution, even though he translated Darwin's *Origin* into German in 1860 and had no particular religious ax to grind. But he saw the links. Both before and after the publication of Darwin's book, questions about the origin of life moved like a wildly spinning top across the intellectual world, outward from Louis Pasteur's and F. A. Pouchet's debates over what might constitute valid evidence for spontaneous generation and inward to high evolutionary proposals, taking momentum from both. The topic intrigued and tormented some of the finest minds of the period.

In focusing on spontaneous generation controversies in Britain from 1860 to 1880 James Strick therefore provides an exciting and significantly new slant on the mid-nineteenth-century biological sciences. Previous accounts of these debates have tended to emphasize the experimental data—its ambiguities and political and theological implications; this was most notable in Gerry Geison's and John Farley's early work on Pasteur and Pouchet, where it was argued that experiments alone could never have brought the problem to closure. Strick pushes this view further, taking the Darwinian debates in Britain as his frame, and shows how the unholy notion of spontaneous generation could perversely (once in a while) exist relatively peaceably alongside natural theology, as well as cause unexpected intellectual mayhem in the materialistic, godless, reformist world advocated by pro-Darwinians like Thomas Henry Huxley, John Tyndall, and others. Strick also adds considerably to Farley's pathbreaking *The Spontaneous Generation Controversy from Descartes to Oparin* (Johns Hopkins, 1977) by bringing into primary focus Henry Charlton Bastian, the brilliant young biologist who was groomed by Huxley to take a place in the Darwinian defense team and then cruelly dropped when he overstepped the boundaries dictated by the older man. Bastian deserves close attention, both for his work in this area, mostly delivered in *The Beginnings of Life* (1871), and for his temporary role as a member of the Darwinian set. Strick's account looks likely to be authoritative for a long while yet. Furthermore, there are welcome analyses of Tyndall's and E. Ray Lankester's notions about molecules, the germ theory, contagionism, and the later work of Pasteur in relation to spontaneous generation, all of which contribute materially to one of the most worthwhile new books of the decade to deal with this important period in nineteenth-century biology.

Much of Strick's account is given over to elucidating the subtle shades of opinion within the evolutionary mode of thought that were possible during his time span and the difficulties that accompanied the adoption of any one position. Did life originate just once? This was Darwin's opinion and, so it seems, the line taken by many of the other leading figures in the traditional story. Yet a single bout of spontaneous generation back in the mists of time could equally well be regarded as a creative act initiated by divine agency, the very force that many evolutionists wished to remove from nature. Or were single-celled organisms constantly emerging in their pools of sludge and replenishing the world of living matter? On the face of it, the latter position looked as if it ought to find most favor with evolutionists. Yet this too was fraught with epistemological worries over the nature of life, since most evolutionists believed that all living things reproduced by "germs," that life came from life, by analogy with all known organisms. Strick handles the mass of necessary detail here with panache, revealing the main figures of the British scientific landscape somewhat as the younger generation might have seen them. Richard Owen, Huxley, and Tyndall come over as bullies: wedded to their own doctrines, unwilling to let younger men perform solo, and at times fully prepared to murder their darlings in order to keep personal hegemonies to the fore. The social coterie of the X Club comes in for some clear-eyed reappraisal; and more practical intellectual affairs such as the cell theory, definitions of "molecules," and a number of conceptual revisions

implicated in rendering experimental materials "sterile" are reassessed in the light of this debate.

Sparks of Life is here and there rather complex reading, even for professional historians of science interested in what Darwin called "slime, snot or protoplasm," but Strick should be thoroughly admired for bringing such a significant area of nineteenth-century science back into notice and for the breadth of vision he found there.

JANET BROWNE

Ernst Mach. *Fundamentals of the Theory of Movement Perception*. Translated by **Laurence R. Young**, **Volker Henn**, and **Hansjörg Scherberger**. 191 pp., CD-ROM, figs., bibl., index. New York: Kluwer Academic Publishers, 2001. $85 (cloth).

Ernst Mach held the activity of science to be the pursuit of operative rules by which the observation of a single phenomenon would evince knowledge about all phenomena in the same class, regardless of the circumstances in which they were encountered in nature. In this way, science held out the hope that human beings could finally know the complex functional systems to which they were tied and finally act with certainty in such a world. A test of this view arose as a result of the "visual vertigo" Mach experienced on a train ride. As the train entered a sharp curve, the objects outside appeared to tilt away from the train on one side and toward it on the other. As Mach later explained in his *Popular Scientific Lectures:* "What had hitherto appeared to me perfectly natural, namely, the fact that we distinguish the vertical so perfectly and sharply from every other direction, now struck me as enigmatical" (quoted in *Fundamentals,* p. 136). This instance of visual vertigo—common to modern train passengers but new to Mach's age—threatened to disturb the sense in which objects were felt to be reliably "given" to subjective awareness. Mach set out his reaction to this disturbance in an experimental study of the effects of motion on sensation originally published in 1875 under the German title *Grundlinien der Lehre von den Bewegungsempfindungen.* This work has now been reprinted in a richly annotated bilingual edition translated by Laurence Young, Volker Henn, and Hansjörg Scherberger. The annotations appended by the translators supply contextual information about the science of Mach's day and references quoted by Mach in his study. The CD-ROM accompanying the book contains a range of additional historical sources and several essays by Henn and Young and other scholars. These additional materials represent a valuable resource in their own right.

In the *Fundamentals* Mach proposed the view that visual disorientation and related physical sensations could be explained as a rotational movement operating on the nerves of a part of the ear labyrinth. The extensive experiments set out in his study indicated that the skin, blood, connective tissue, and brain played a relatively minor role, whereas the ampullae of the semicircular canals of the ear labyrinth played a key role in responding to angular movement and acceleration. The ampullae were also responsible for the aftereffects of rotation experienced as giddiness. Mach's study therefore indicated the existence of a "final end organ" for motion sensation and thus lent further support to the view that human sensation could be explained in terms of a complete functional physiology of the human being.

This new translation of the *Fundamentals of the Theory of Movement Perception*—a preliminary study that directly anticipated Mach's major work *The Science of Mechanics: A Critical and Historical Account of Its Development* (1883)—is also a timely reminder of Mach's pivotal role in the emergence of empirical psychology at the end of the nineteenth century. In the rush to publicize the results of his experiments on movement sensation Mach's main rival, indeed, was Josef Breuer, who had come to the same conclusions with a similar set of experiments. Whereas Breuer was subsequently to colloborate with Freud and help launch what later became known as psychoanalysis, Mach embarked on a number of studies that were to ground a comprehensive theory of human sensation. Both Mach and Breuer were enlivened by the problem of Cartesian dualism dominating the Kantian revival in the late nineteenth century, but their work may also be read as a response to early technological modernism of the same period. In analyzing the sense of disorientation wrought by technological change (that fateful train ride!), Mach's work spawned a generation of literary and philosophical responses in turn-of-the-century Vienna—one of the greatest flowerings of the creative spirit in recent human history. In his concluding remarks to the 1875 study, Mach looked forward to an "age of quantitative psychology" where "we will understand the same basic processes which make up all psychological phenomena" and "which then can be enumerated relative to each other much like elementary processes" (p. 114). As Young, Henn, and Scherberger observe in the introduction,

Mach was prescient, for this age is in many ways now upon us.

TIM MEHIGAN

Stephen Jay Gould. *The Structure of Evolutionary Theory*. ix + 1,433 pp., illus., figs., bibl., index. Cambridge, Mass.: Harvard University Press, 2002. $39.95 (cloth).

Stephen Jay Gould published this very large book in March 2002. Two months later, he was dead from cancer at the too-young age of sixty. Although, as it happens, *The Structure of Evolutionary Theory* was not Gould's final book (that was a collection of essays), it is obvious that this book was intended to be his masterwork, that on which his reputation as a scientist was to be judged. For Gould was not only the most gifted popular science writer of his generation, but also a man with pretensions to serious scholarship. Most particularly, with fellow paleontologist Niles Eldredge, he was the author of the claim that the fossil record is not, as generally interpreted, a smooth, gradual process explicable by conventional Darwinism—natural selection promoting adaptation—but rather a more jerky affair with stops and starts. Famously, he and Eldredge put forward their theory of "punctuated equilibrium"; and although the book under review contains much more (very, very much more), it is this theory that is the keystone to Gould's mammoth-sized production.

I will not presume to suggest that readers of this journal have no interest in contemporary science. Even if you are interested only tangentially in modern thinking and achievements, I urge you to get this work and (if not to read it straight through) to dip into it judiciously, for there is much of great worth here, and as a guide to the way that today's evolutionists think it is surely destined to be a classic. But for readers of *Isis qua* historians of science, there is a more pressing reason to pick up *The Structure of Evolutionary Theory.* Gould was a thinker who believed that evolution pervades everything: in order to understand the present in the realm of ideas, no less than in the realm of organisms, one must dig back into the past and try to find out how things were then and how things then led to things now. He did this before, most particularly and successfully in his important *Ontogeny and Phylogeny* (Belknap, 1977), where he explored how past scientists dealt with the issues of paleontology and embryology and how this throws light on the way that we should treat such issues today. And he has done it again in this book.

In fact, all told, Gould offers us the equivalent of about five normal books, and of these the first two (about six hundred pages in total) are historical. Here we are offered a history—hardly a potted history—of evolutionary theory from the beginning to the present. There is much of value in these chapters—Gould was deeply read in the literature and obviously had pored over the original sources in many languages (from comments he made, it seems that he owned all of the original sources in the many languages). One rather regrets that this material was not prepared for independent publication, but one can see that this would not have suited Gould's purposes. He wanted to show that in opting for (what he would have called extreme) Darwinism, evolutionary biology had taken a wrong turn. With the history he presents establishing this fact, he himself is then ready to step into the breach with his own theory (of punctuated equilibrium) that would avoid the faults of the past and provide the answers of the future. In other words, like the works of other scientist/historians of evolutionary theory—notoriously Ernst Mayr—Gould's history was written to promote Gould's science and Gould's claim to an honored place in professional scientific history.

All history is of course written with an end in view. Otherwise it is just a collection of facts. But I have to say that Gould's aims do rather distort his material. His treatment of British adaptationists of the early part of the twentieth century (like R. A. Fisher) verges on the ludicrous, as their achievements are belittled and their motives impugned. (In Fisher's case, Gould's claims notwithstanding, there is certainly no conspiracy of silence about his eugenics, and indeed much effort has gone to show how Fisher's science survives despite his odd and somewhat repulsive views on race and class.) Gould's discussion is guided by his notorious metaphor that evolutionary thinking, in becoming more adaptationist, "hardened" (a process akin to the unfortunate degeneration of the arteries). Gould's facts are made to fit the metaphor, no matter what—rather like those unfortunate visitors who stopped off for the night at the B and B being run by Procrustes.

I liked Gould and admired him immensely. I was on the other side in many debates, and it never affected our relationship. I wish I could say nicer things about the history in *The Structure of Evolutionary Theory.* But the best way I can honor his memory is by being truthful. There

is much to commend this volume. I wish it were better than it is.

MICHAEL RUSE

Gerald Sullivan. *Margaret Mead, Gregory Bateson, and Highland Bali: Fieldwork Photographs of Bayung Gedé, 1936–1939*. x + 213 pp., frontis., illus., app., bibl., index. Chicago: University of Chicago Press, 1999. $45, £31.50.

This book consists of two essays on the fieldwork photographs taken by Gregory Bateson during his 1930s Bali expeditions with his wife Margaret Mead. Gerald Sullivan's first essay is a textual commentary on photography and ethnography; the second, a photo-essay, is an original compilation of selected photographs from Mead's and Bateson's photo archives, some previously unpublished. In both essays Sullivan concerns himself with the "problem of ethnographic writing," by which he means the fieldworker's conscious goal of objectively recording and writing about a culture. This book is a welcome addition to recent works on the photograph as evidence, most of which grapple with this question. Is the photograph an analogue of reality or is it an analogue of culture-bound visual experience?

Margaret Mead and Gregory Bateson were not the first anthropologists to photograph in the field, but their Balinese still photos and cinematography may well be the most famous examples both because of the "methodological and analytic importance" they assigned to the photographs as a means "for taking notes" and as direct, albeit interpreted, evidence of human behavior. Indeed, the most interesting narrative line of Sullivan's text, which relies heavily on the two fieldworkers' unpublished writings, documents the shifting status and methodological significance of the photograph, from the team's pre-expedition plans to their publication of *Balinese Character* (New York Academy of Sciences, 1942). It is clear that Bateson's training in the natural sciences and his theoretical concerns with the fieldworker's point of view sensitized him to the phenomenological difficulties of field recording. Mead and Bateson had originally intended to document only a small number of photographic sequences. In fact, they shot more than twenty-five thousand photos and thousands of feet of movies. The two fieldworkers improvised their methodology and altered their objectives as they went along, finding, for example, that Bateson's photographing could not always be synchronized with Mead's note taking. While they originally conceptualized the camera as a means to check their observational bias or their selectivity in isolating data to fit hypotheses, they came to understand Bateson's photo-documentation as a form of "note taking." As Sullivan points out, they saw almost none of what they had photographed until they returned to New York in 1939. Soon after viewing the images, they changed their publication plans: rather than a broad study of Balinese customs and behavior, they produced a book establishing the connections between Balinese child rearing and personality structure. At this point, Sullivan would argue, the photographs transformed from "notes" to "signs"—that is, they became part of the ethnographers' argument.

In his photo-essay Sullivan uses the Batesons' Balinese photo archive collection to survey the complex and overlapping social identities of the people of Bayung Gedé, along with the rich ceremonial life these villagers used to resolve and placate the spirit world. The camera, Sullivan argues, can record only what is visible, but much that is important to the Balinese—most notably their encounters with a sometimes-unpredictable spirit world—cannot be seen and therefore cannot be recorded on film. Mead, Bateson, and Sullivan have this in common: each ethnographer draws attention to what she or he wants viewers of photos to see. By juxtaposing his own textual commentary with archival photographs, Sullivan, himself an expert on Balinese culture, demonstrates how field photos originally conceptualized as equivalent to field notes can take on different meanings when reinterpreted into another ethnographer's texts. He notes that Mead and Bateson anticipated as much and that this understanding underlaid their effort to experiment with photography in the field.

VIRGINIA YANS-MCLAUGHLIN

Matthew J. Raphael. *Bill W. and Mr. Wilson: The Legend and Life of A.A.'s Cofounder*. xvi + 206 pp., index. Amherst: University of Massachusetts Press, 2000. $24.95.

In 1935 two drunks, Dr. Robert Holbrook Smith and William Griffith Wilson, met at the Mayflower Hotel in Akron, Ohio, to talk and keep each other sober. The encounter between the two, who later became known as Dr. Bob and Bill W., marked the founding of Alcoholics Anonymous (A.A.). An A.A. member, using the pseudonym "Matthew J. Raphael," tells the story of their encounter in the opening of his book *Bill W. and Mr. Wilson: The Legend and Life of A.A.'s Cofounder* before beginning his exploration of Bill W. His goal is to "rehumanize the

cult figure" and to recover "the unchurchly and often irreverent spirit of the A.A. fellowship during its apostolic era" (p. 14). Eschewing both the foundation myths of the organization and the analytical efforts of scholars seeking to understand A.A. as a movement, Raphael explores both Bill W.'s history and the movements and ideas that shaped his thinking.

The opening chapters of the book explore Bill's childhood, the beginning of his drinking career, and his heavy boozing during Prohibition and the Great Depression. Raphael's interpretation is heavily psychological; for example, he links Wilson the "alcohol adult" with the "lengthened shadow of the obsessive-compulsive child" (p. 27) and scatters similar forms of analysis throughout the book. The chapters move back and forth from biography to interpretations of Wilson's writings, and the author offers his own view of Wilson's drinking and downfall. Lois Wilson, Bill's wife, is also well profiled. Raphael recounts both her contributions to A.A. and her support of Bill, which continued despite his philandering.

A key theme for Raphael is the way Wilson developed his program of recovery by drawing from other groups, among them the Washington Temperance Society, a mutual assistance group founded in 1840, and the Oxford Group, an early twentieth-century religious movement that worked to change lives through self-reflection and surrender to God. The Oxford Group's six tenets, among them the taking of a moral inventory, the making of restitution, and reliance on a higher power, became the inspiration for A.A.'s Twelve Steps, as Raphael and other historians of A.A., including Dick B. and Ernie Kurtz, have pointed out. Wilson also drew from the ideas of William D. Silkworth, a physician at the Charles B. Towns Hospital, where the well-to-do dried out and were treated for narcotic addiction. Silkworth argued that alcoholism was both a physical allergy and a mental obsession. Another influence was the psychiatrist Carl Gustav Jung. Wilson's fascination with Jung's work led him to psychoanalysis in which he confronted his troubled childhood and his adult depression.

The final third of the book analyzes what Bill W. and Dr. Bob wrought. The author explores what members refer to as the Big Book, *Alcoholics Anonymous,* in which the twelve steps are laid out and one hundred men recount how they became sober. Although it would sell five million copies by the time A.A. turned fifty, the book initially met with hostility from many reviewers and unsold copies languished in the warehouse. The reviewer for the *Journal of the American Medical Association* noted that it was without scientific merit; in the *Journal of Nervous and Mental Diseases* it was dismissed as worthless, along with the alcoholics the book addressed.

While Raphael looks at the ideas of A.A., his book remains closely focused on Wilson's life both within A.A. and outside it. He details Wilson's later years, in which he experimented with LSD and became an advocate of niacin (vitamin B-3) therapy for alcoholism. His spiritual life and his flirtation with Catholicism are also explored.

As a biography, *Bill W. and Mr. Wilson* is entertaining, although perhaps laced with too much psychological speculation. Its contribution to the history of science is more limited. Because it focuses exclusively on Bill W. and on the movements and ideas that influenced his thinking, the reader gains few insights into how A.A. grew and why it has become so successful as a model "recovery movement." For this reason, I suspect that the primary audience for the book will be individuals who are interested in Bill W. They will appreciate Raphael's debunking of some of the myths regarding his life and work and his exploration of the movement that Bill W. and Dr. Bob helped to found.

JANET GOLDEN

Margaret Humphreys. *Malaria: Poverty, Race, and Public Health in the United States.* 196 pp., illus., notes, index. Baltimore, Md.: Johns Hopkins University Press, 2001. $41.50 (cloth).

While malaria continues to be a leading cause of death and disability worldwide, endemic malaria has disappeared in the United States. Margaret Humphreys's new book tries to disentangle the web of geographic, economic, and public policy factors to learn whether, and how, each might have contributed to its disappearance and what lessons might be gained for those countries where endemic malaria transmission continues. In the face of this ambitious goal, Humphreys's success is best measured not by the achievement of her aim but by her energetic efforts to reconstruct the history of malaria in the South and her cogent and compelling analysis of its twists and turns. And, perhaps most important, while she reads the scientific record expertly, her story is thoroughly integrated into the social history of the South. Thus, while many recent works in the history of medicine have contributed to a broader social history, there are fewer works like this

one, in which the line between scientific and social history is so nearly erased.

Humphreys does well in reviewing earlier work showing that malaria was active over much of colonial North America, powerfully contributing to the shape of settlement patterns from the Chesapeake Bay south to the Gulf of Mexico. Indeed, it has been argued that the intensity of malaria transmission in the Carolinas played a significant role in confirming reliance there on African rather than European agricultural laborers. And, as Erwin Ackerknecht showed in his classic *Malaria in the Upper Mississippi Valley, 1760–1900* (Johns Hopkins, 1945), the disease followed the path of settlers west into the Mississippi Valley and was probably responsible for much of the recurrent pattern of relatively brief settlement followed by another round of migration as local populations grew large enough to support sustained malarial transmission. But the bulk of Humphreys's work focuses on the twentieth-century history, especially the period from 1910 to 1940, the era of the so-called New South.

By the beginning of the Great Depression malaria had been an endemic disease of the South for over two hundred years. And yet, by the end of World War II malaria had been extinguished in the South. It is this period on which Humphreys focuses to understand how malaria was controlled—and where she offers her most interesting conclusions. Contrary to the nearly canonical teaching that it was DDT that eradicated malaria in the South, Humphreys notes that the widespread Public Health Service campaign to control mosquitoes through the use of DDT began after the prevalence rates of malaria had already fallen strikingly. Neither the great hydroelectric projects of the 1930s and prewar 1940s nor the large public works projects of the early New Deal contributed significantly to reducing malaria rates. In Humphreys's view, it was the Agricultural Adjustment Act (AAA) of 1933, which took thousands of acres of cropland out of production, that had the greatest hand in eradicating malaria in the South. Returning cropland to fallow would be expected to increase malaria rates in an endemic region, and, indeed, some rise in rates did occur when land was left unplanted. But the greatest effect of the AAA was to depopulate the land of the sharecropper families who lived and worked in the areas of highest endemicity and whose housing and nutrition were among the very poorest in the South. With fewer acres planted, and with government funds available to purchase tractors and mechanical cotton-harvesting equipment, owners ejected thousands from the land and, with them, a major host population for malaria. This was perhaps especially true in the Deep South, the region in which malaria was most entrenched and in which public efforts to control the disease were often the most limited. Thus, Humphreys contends, it was the unintended consequences of the AAA, and not programmatic efforts to eliminate the disease, that ultimately played the greatest role in its collapse.

Undoubtedly the arguments of this relatively brief book will deserve further, more detailed, examination, but with this work Humphreys again brings front and center the view that disease control is not merely a technical problem, which we can always expect will yield to the logic of technical solutions; rather, as Ackerknecht quotes an anonymous medical reviewer writing in 1828, "every book on malaria is also a book on political economy."

PAUL J. EDELSON

Michael French; Jim Phillips. *Cheated Not Poisoned? Food Regulation in the United Kingdom, 1875–1938*. viii + 213 pp., bibl., index. Manchester/New York: Manchester University Press, 2000. $69.95.

Cheated Not Poisoned? traces the development of British food regulation from the Sale of Food and Drugs Act (SFDA) of 1875, which made food inspection a mandatory duty of each local authority, to the Public Act of 1938. Michael French and Jim Phillips treat the topic in the context of models of the public regulation of commerce drawn mainly from cases in the Progressive Era United States. In some respects the British experience was quite different from the American. Although there were some remarkable scandals—notably the poisoning in the winter of 1900–1901 of roughly four thousand drinkers whose beer had been contaminated with arsenic contained in the sugar used to speed fermentation—food safety regulation does not appear to have become a broadly based reform movement in Britain during the period. Upton Sinclair's *Jungle* did make a splash, but it did not focus British attention on the horrors of the slaughterhouse, much less the compatibility of capitalism with food safety—but led simply to a wariness of American potted meat. There was no British analogue to Harvey Washington Wiley, crusading head of the U.S. Department of Agriculture's Bureau of Chemistry, no "poison squad" of youthful volunteers willing to discover the body's response to food additives. Regulatory policy was mainly worked out behind the

scenes by expert committees with varying proportions of analytical chemists, minor civil servants, medical academics, and representatives of trade organizations. The compromises they worked out were often ephemeral and minimal. More conspicuously than in America, regulatory capture was a prominent issue. Regulation became a means by which some competitors, chiefly domestic producers of high-quality products, could achieve a market advantage over competitors.

Concerned mainly with regulatory practice, French and Phillips give only passing attention to the emergence of food science. They take—probably rightly—a low opinion of the expertise offered to the committees—a mix of a priori platitude and anecdote—but do not review it in detail (p. 104). They do note the ongoing struggle and considerable professional achievement of the Society of Public Analysts, made up of those holding positions as analysts to local units of government under the SFDA. Competent (at least some of the time) to determine the composition of foods, the public analysts (or at least their leaders, Otto Hehner and Charles Cassal) did manage nevertheless to transcend technician status and pronounce as professionals on truth, beauty, and virtue—and even, despite the complaints of the medical profession, on toxicology as well.

This fine study should provide an excellent framework for further research by historians of science interested in professionalization and in the creation and regulation of expertise.

CHRISTOPHER HAMLIN

Nick Hopwood. *Embryos in Wax: Models from the Ziegler Studio*. ix + 206 pp., illus., notes, tables, bibl., index. Cambridge: University of Cambridge, 2002. £13.50 (paper).

Embryos in Wax is a remarkable contribution to the history of science in several respects. First, the topic of the study is quite out of the ordinary: scaled-up wax models of fetal development in animals and humans produced by the Ziegler studio between 1850 and 1936. We are all familiar with the shift in emphasis in the history of science from anatomizing revolutions in theory to studying scientific practice, but it is nevertheless suprising to find a book dedicated to one particular modeling practice. Here, then, there is relatively little discussion of embryological theory, with the focus resolutely on the lives and models of Adolf and Friedrich Ziegler—father and son. Indeed, when Nick Hopwood discusses the debate between Ernst Haeckel, arguing for recapitulation (ontogeny recapitulates phylogeny), and Wilhelm His, opposing this view, he shows how Adolf Ziegler ended up making models for anatomists on both sides of the debate.

Hopwood also is presenting the history of a family firm, arguing for its contribution to the science of anatomy. This adds an interesting new dimension to the "invisible technician," a popular figure in the new historiography of science. Hopwood suggests that the owners and employees producing the embryological models made very real, albeit largely unacknowledged (Friedrich Ziegler did eventually get an honorary doctorate from Freiburg University), contributions to embryological anatomy, while at the same time operating in an artisanal culture relatively independent of the anatomy departments they supplied. Thus, although universities were its primary clients, the Ziegler studio was not itself state supported, nor did it have any direct educational mission, which sets it apart from most scientific institutions that one encounters in the history of nineteenth-century science. By the time of Adolf Ziegler's retirement in 1883, the use of the microtome and a semiautomated method for constructing models by layers was already bringing modelers and anatomists into closer collaboration, heralding a golden era for wax embryological models at the end of the century. Indeed, we find His arguing for the essential complementarity between such wax models, graphic illustrations, and written descriptions.

In his introductory chapter Hopwood suggests that the lessons to be learned from this history are quite general, but one does get the impression that the only time the models passed from their role as pedagogical aids to tools for scientific discovery was this particular period at the end of the nineteenth century. In light of this particularity, it is difficult to assess how general the lessons drawn from this history might be. Nevertheless, it is important that the question of the place of three-dimensional models in science is posed, as the answer will no doubt prove very interesting for the history of science, the history of education, and other fields, such as the history of art. Indeed, one of the drawbacks of a relatively short book is that it does not permit the author to explore all the topics he does raise in sufficient depth—here, in particular, the relationship between the models of human embryos and views on motherhood at the turn of the century.

Finally, it is worth mentioning the quality of the book production and the fact that it is published by Cambridge University itself, and not by one of the university presses. *Embryos in Wax*

Friedrich Ziegler (foreground) in his wax model studio around 1912 (from Nick Hopwood, Embryos in Wax, *p. 89).*

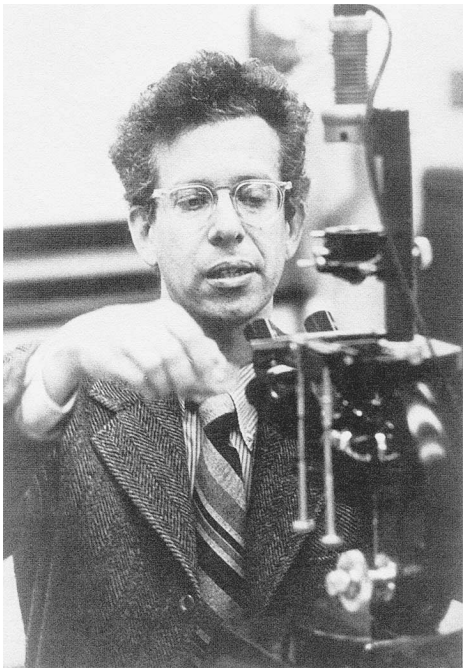
contains twenty-seven full-page color plates and about twice that number of high-quality black-and-white photographs (including a whole catalogue prepared by Friedrich Ziegler in 1912), and yet it sells for around $20 (£13.50). Although it no doubt required many hours of voluntary production labor and will not benefit from the advertising budgets of the university presses, this venture gives pause for thought about the margins involved in academic book publishing.

JONATHAN SIMON

Robert Oliver. *Making the Modern Medical School: The Wisconsin Stories*. ix + 156 pp., illus., index. Nantucket, Mass.: Science History Publications/USA, 2002. $24.95 (cloth).

Robert Oliver's history of the University of Wisconsin Medical School exemplifies the antidermatological approach to medical school history—warts and blemishes are left prominently in place. Discord, disappointment, and eccentricity fill this short volume's 150 pages, contrasting bizarrely with the general cheerfulness of its ornamental photographs. Throughout the work the author attempts to place the political history of the University of Wisconsin Medical School—and it is largely the political, or administrative, history that he offers—in the context of unceasing changes within the environments of science, medical education, and health-care financing. Oliver does this succinctly and intelligently, to the benefit of the Wisconsin alumnus, faculty member, or student who lacks much knowledge of the history of medicine and medical education in twentieth-century America and who picks up the book.

Wisconsin's medical school was authorized by the state legislature in 1907 as a two-year college—students had to transfer elsewhere to complete their training—though it emerges in Oliver's narrative less as having been founded



The late Howard Temin, the only University of Wisconsin scientist to win the Nobel Prize while on the university faculty (from Robert Oliver, Making the Modern Medical School, *p. 138).*

and more as having stumbled fitfully into existence, entirely unwelcome to the physicians of Madison. They feared competition from university doctors (which equaled *government* doctors) within the relatively small college city: even attempts by the first dean, an honest and dedicated man named Charles Bardeen, to establish a student health clinic and physical diagnosis course proved threatening. In response, the young school hit upon the innovative expedient of sending its students to practitioners throughout the state for their introductory preceptorship in what is now called "clinical skills." In 1924 the school was finally able to establish its own center for clinical instruction, Wisconsin General Hospital, which was organized as a charity that would draw patients from throughout the state, lessening concerns of "town" practitioners in Madison. With its hospital, the medical school could expand to the full four-year program. As was probably true for most medical schools, meaningful interactions with other segments of the parent university were few, and for some time Wisconsin's College of Agriculture gained wider recognition than the medical school for medically related research productivity.

When the reader gets to the 1940s and Chapter 4 of *Making the Modern Medical School* ("The War of the Dean's Succession"), things really get bleak, as the narrative dwells from there until its end almost entirely on the school's improbable and hectic inability to secure stable leadership during the second half of the twentieth century. Oliver seems to have become entranced with his series of sordid stories documenting Wisconsin's difficulty in finding and nurturing an acceptable medical dean and other senior officers. Trying to make some sense of the successive calamities, the author does offer a plausible schema for understanding the changing attributes of medical school deanship. He points out the increasing complexity of the dean's job, the nuances of power balances within the medical school, and the virtues and costs of local loyalty and institutional inbreeding. It's a wretched story Oliver tells, but not, I suspect, an uncommon one: personality, idiosyncrasy, egomania, contention—and the whole scale of human fallibility—might well have played a larger part in the shaping of American medical colleges than would be suspected from Kenneth Ludmerer's comprehensive and synthetic volumes (*Learning to Heal* [Basic, 1985], *Time to Heal* [Oxford, 1999]). Recent scholarship on several of Philadelphia's medical schools would, regrettably, suggest this.

And yet there is a great deal more, and surely so at Wisconsin's medical school, which for many decades has been accorded high standing among its peers. Oliver's account does not, at least implicitly, purport to be anything approaching an adequate history of a medical school—or of any other sort of school, for that matter. (And perhaps explicitly: on page vii of his "Introduction" Oliver suggests that the book is really about "the American medical school," using Wisconsin "as a kind of historical laboratory.") Students appear rarely in his text (though attitudes toward women and minorities are discussed). Curriculum finds hardly a mention. The eventual achievement of wide recognition for research and other attainments, despite the endless strife, remains an unattended mystery. I can attest that no matter how chaotic or desperate the happenings in the administration wing of a medical school under stress may be, faculty and students, sometimes with quiet gallantry, return each day to classroom, clinic, and laboratory. This daily sustaining of the enterprise, in troubled times or tranquil, must form part of the story, even if it is sometimes a challenging component to document.

Making the Modern Medical School generally reads well, though in an effort to enliven the writing its author at times irksomely extends metaphors and figures of speech or strives unsuccessfully for dramatic flair. Relatively scant archival material is cited: does little exist for the University of Wisconsin Medical School, or was the author not granted access? For events since 1960 he relies almost entirely on interviews as primary sources; these are, of course, essential for institutional history, though they can be hazardous.

Histories of medical schools (and other institutions) will continue to appear, often called into being by an anniversary. This rather peculiar specimen about Wisconsin, a near-antithesis to the familiar celebratory photo collection, helps raise questions of what an institutional history should or can be and about how the genre can contribute to our understanding of science and medicine in relation to their often perplexing and unruly settings.

STEVEN J. PEITZMAN

Kees Gispen. *Poems in Steel: National Socialism and the Politics of Inventing from Weimar to Bonn.* xvi + 356 pp., figs., bibl., index. New York: Berghahn Books, 2002. $75 (cloth).

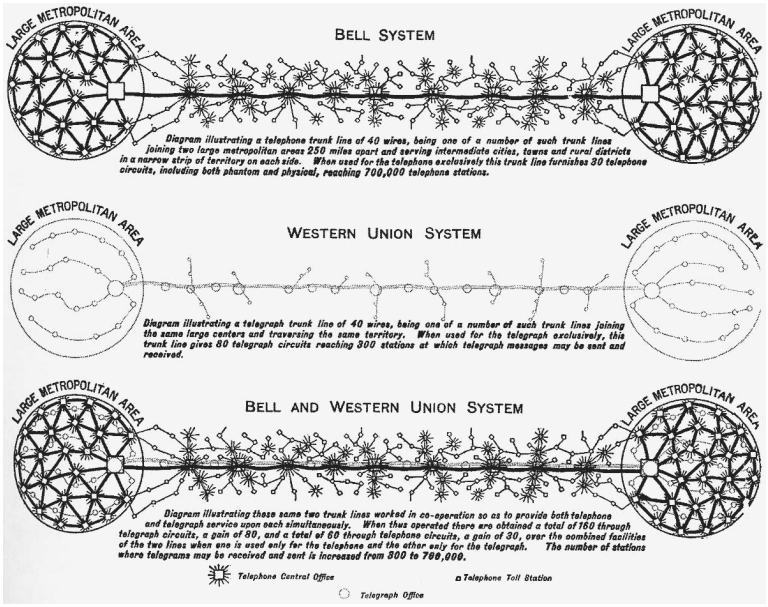
Amidst its pronouncements on political, racial, and other issues, Adolf Hitler's *Mein Kampf* also includes a few pages of significant comments about the creative potential of individuals and the inventor's role in society. According to Hitler, industrial capitalism threatened to stifle the spark of individual creativity and invention; once in power, the National Socialist regime restructured the patent system in ways that mirrored this philosophy. In *Poems in Steel,* Kees Gispen traces this and many other examples of the "politics of inventing" in Germany before, during, and after the Nazi years. The result is a sophisticated analysis of the interplay among inventors, engineering organizations, industrial firms, and governmental leaders that brings significance to a topic that could easily be overlooked.

Poems in Steel begins with the Patent Code of 1877, legislation that clearly favored the Second Reich's large industries. Indeed, the code diminished the achievements of individual and independent inventors to the point that the name of the inventor did not even appear on the patent application. Although certain engineering and chemical societies fought for inventors' rights, industrialists countered with the argument that inventions developed on company time were the property of the firm. Strains between inventors and industrialists increased through the 1920s, in concert with the broader polarization of society that eventually brought down the democratic Weimar government.

Gispen argues persuasively that inventors increasingly embraced language and ideological turf that the Nazis also had claimed: that the stifled elements in German society deserved emancipation, that economic planners needed to think in terms of autarky and protecting German national interests, and that there were distinctions between creative and destructive forms of capitalism. Thus many engineers applauded Hitler's 1933 seizure of power. Despite pressure from industrialists, the Nazi regime issued new patent codes and ordinances that firmly favored the rights of independent and employee inventors. Especially during World War II, Albert Speer and others instituted programs that encouraged German (not Jewish or foreign) employees to develop their inventive ideas and empowered the state rather than the firm with calculating a fair rate of compensation for creative inventors. Although these codes were stripped of racist language and Nazi ideology following 1945, their basic principles have remained in effect in the Federal Republic of Germany ever since.

In his analysis of these events, Gispen is more in tune with the issues of German historiography than many historians of German science and technology. He effectively turns the notion of Germany's "special path" on its head, for his focus is not the nation's alleged lack of bourgeois values but the Nazis' ability to play a role as the savior of the unprotected middle class. Likewise, Gispen also demonstrates that the politics of invention tempered the regime's purported ties to the business elite. And for those who like to think of 1945 as a "zero hour" that signaled a clear break from Germany's Nazi past, Gispen forcefully argues that "continuity" best describes a legacy of Nazi ties that could be found in the patent code and its administrators for a generation to come.

Gispen deftly handles the disturbing realities of his subject. Indeed, some of the same engineers who brutally employed slave labor and condoned the Holocaust also strove to develop fair and equitable compensation schemes for other inventors. Like historians of science who have looked beyond the simplistic dead end of "Aryan physics" to find significance in other aspects of Nazi scientific research, Gispen admits that the Nazi regime left a "positive legacy . . . in the politics of inventing" (p. 8). These revelations do not deny the fundamental barbarism



Plan for cooperative joint use of Bell telephone and Western Union telegraph lines in 1911 (from Gregory J. Downey, Telegraph Messenger Boys, *p. 141).*

of the Nazi regime, but they do provide a fresh perspective on the place that science and technology have held in the tumultuous German past. For these reasons and more, *Poems in Steel* deserves a wide audience that encompasses both historians of science and German historians.

MARK FINLAY

Gregory J. Downey. *Telegraph Messenger Boys: Labor, Technology, and Geography, 1850–1950*. xiv + 242 pp., illus., figs., tables. New York/London: Routledge, 2002. $23.95 (paper).

Gregory Downey's book, *Telegraph Messenger Boys,* addresses a much-neglected segment of the telegraph industry—the messengers who delivered telegrams to customers and who were largely responsible for creating, in the public mind, an image of the world's first telecommunications network. While most previous scholarship on the telegraph industry has dealt with the operators, technology, and corporate history of the business, Downey has taken a unique approach in focusing on what would be called "the last mile" in modern telecommunications terminology.

Downey's ten chapters cover the history, composition, and demographics of the telegraphic messenger service from the beginnings of the telegraph industry in the mid-nineteenth century to its post–World War II decline. His analysis focuses on the evolution of messenger service and the relationship between the Western Union Telegraph Company, the dominant company for most of the period covered, and the American District Telegraph Company (ADT), the first company to develop a large-scale urban message-delivery service. He also discusses the often-complex and symbiotic relationship between the privately owned telegraph companies and the United States Postal Service, which included elements of both competition and cooperation. The work of the telegraph messengers in delivering messages sometimes put them in direct competition with the mail carriers, but at other times the two services worked together cooperatively. While the Postal Service was sometimes used for delivery of telegrams, Western Union provided an early form of electronic mail delivery, Mailgrams, for the post office.

The term "geography" in the title is significant: while the electrical technology of the telegraph made it possible to transmit messages across the entire country, or even across the ocean, in a matter of minutes, telegrams still needed to be copied onto a paper form at the local telegraph office and delivered to the cus-

tomer. What Downey calls the "uneven geography" of the national telegraph network (p. 37) posed different challenges for message delivery in, for example, rural Iowa and urban New York City. He describes how the absorption of ADT's intracity message-delivery system into Western Union's intercity telegraph network played a key role in Western Union's expansion in the 1870s and its eventual domination of the industry.

While the level of detail is admirable, the editing is somewhat uneven and there are occasional lapses in accuracy—as, for example, when Western Union president William Orton delivers an opinion ten years posthumously (p. 83). And the author's conceptualization of the telegraph system as part of an "analog network" (p. 146), while appropriate in conveying the interconnectedness and generative capabilities of the postal, telephone, and telegraph networks, could be misleading if taken out of context. The telegraph system was, in fact, the earliest digital network, technically speaking, and the superior signal resolution capability of the telegraph's Morse coding system made it possible for the telegraph network to cross the oceans and connect the continents fully ninety years before the development of suitable amplifiers allowed the analog telephone system to accomplish the same feat.

The author concludes with some thoughts on the decline of the telegraph industry, which he attributes in part to its reliance on messenger delivery; he also discusses the evolution of messenger delivery service in the Internet age. All in all, Downey's book is a much-needed work that fills a large gap in the literature on the world's first telecommunications system and invites further scholarship on the subject.

THOMAS JEPSEN

Nigel Rothfels. *Savages and Beasts: The Birth of the Modern Zoo*. (Animals, History, Culture.) xii + 268 pp., illus., index. Baltimore: Johns Hopkins University Press, 2002. $34.95 (cloth).

The German animal dealer Carl Hagenbeck (1844–1913) is best remembered as a designer of early twentieth-century zoo exhibits that restrained animals behind moats and hedges rather than in cages with bars. Zoo professionals today often look back to Hagenbeck's "panoramas," as he called them, as the point of origin for the naturalistic style of exhibition that has become common in zoos in recent years.

Hagenbeck's displays, however, were only one product of an unusual enterprise that flourished in the late nineteenth century alongside the rapid international growth of other German businesses that also made use of the resources of Germany's colonies. Hagenbeck built his famous Tierpark outside Hamburg in 1907, at the end of his career. During the sixty years leading up to the opening of this zoo and animal holding facility, capturing and trading exotic animals—particularly African fauna—formed the core of the Hagenbeck business. The volume of wildlife that passed through Hagenbeck's hands conveys a sense of that business's scope: between the 1860s and the 1880s he sold a thousand lions, three hundred elephants, and hundreds of tigers, antelope, and camels. His financial success paralleled that of German traders in other natural resources such as guano, sugar, and coffee. As supply and demand for animals fluctuated, Hagenbeck turned to other means of making a profit, including organizing traveling anthropological "people shows," developing methods for training animals, and touring these trained animals in circuses.

Savages and Beasts is the first book-length history of the Hagenbeck company in English since Carl Hagenbeck's autobiography was translated in 1909. In this lucid and detailed account, Nigel Rothfels focuses on three aspects of the Hagenbeck enterprise—animal catching, showing people, and the displays at the Tierpark—and Hagenbeck's role as an interpreter of nature to the public in each of these realms. Hagenbeck's animal catchers, for example, wrote many popular books in which they portrayed their work as more humane than hunting. Central to the success of Hagenbeck's displays of people and animals, Rothfels argues, was his claim to authenticity in representing the natural world. In crude terms, authenticity meant that, compared with contemporary displays of indigenous peoples, Hagenbeck's shows were relatively unscripted. His animals, unlike in zoos of the period, were exhibited in groups, in settings with rocks and shrubbery. These efforts won Hagenbeck support in academic circles—for example, from anthropologists such as Rudolf Virchow—and they helped him craft an image of quality and integrity for his company. Just as important, these displays represented a natural world of order and happiness that appealed to the ticket-buying public.

Rothfels's project is to complicate two entrenched stories, the Hagenbeck company's century-long portrayal of its founder as a simple friend of animals and the tale of progress told by present-day zoo professionals who discount the efforts of their predecessors as amateurish. Rothfels situates the Hagenbeck story in the larger

history of zoological parks, arguing that it provides insight into present-day public ambivalence toward zoos and the stories about nature that they display.

Historians of science will wish that Rothfels had explored more deeply the notion of authenticity in representing nature and made more reference to the secondary literature on the popular display of nature and peoples at fairs and in museums and films. That said, Rothfels has made good use of the Hagenbeck company archives and of personal papers held by descendants of Hagenbeck's animal collectors. *Savages and Beasts* should appeal to the broad audience for which it is intended. The book is a welcome addition to the growing literature on the interpretation of nature and the relationship between humans and animals in Western culture.

ELIZABETH HANSON

■ Recent (1950–)

John Lukacs. *At the End of an Age*. x + 230 pp., table, index. New Haven, Conn./London: Yale University Press, 2002. $22.95 (cloth).

John Lukacs is a respected historian of twentieth-century politics and mass societies, especially of the World War II and the Cold War eras. Among his many books are also larger-scale reflections on historical change. *Historical Consciousness; or, The Remembered Past* (Harper & Row, 1968) is a history of history and of the evolution of historical consciousness, and *The Passing of the Modern Age* (Harper & Row, 1970) and *The End of the Twentieth Century and the End of the Modern Age* (Ticknor & Fields, 1993) advance his version of the thesis that the modern age is over. The book under review is a late-career, highly personal work that draws heavily on his previous books—indeed, quotes from them extensively. As such, I had hoped that, at the end of an age, it would be "the best of John Lukacs." Unfortunately, that is not the case. There are good moments, to be sure, but also disappointments and even irritations.

Chapter 1 recapitulates Lukacs's thesis that the modern age is over. For Lukacs the modern age is "the Bourgeois Age . . . the Age of the State; the Age of Money; the Age of Industry; the Age of the Cities; the Age of Privacy; the Age of the Family; the Age of Schooling; the Age of the Book; the Age of Representation; the Age of Science, and the age of an evolving historical consciousness" (p. 15)—all now in decline except for the last two. Chapter 2 asserts that we have entered a new phase of historical consciousness, that the general public now possesses a greater sense of history than ever before, as shown by the (alleged) fact that more people read historical materials than read novels. Indeed, Lukacs predicts that the novel is giving way to history as the dominant form of humanistic expression and therefore the dominant form of cultivated human expression. Chapter 3 challenges the value and cultural dominance of the scientific enterprise. Chapter 4 continues and illustrates this theme by discussing the limits of knowledge, objectivity, definitions, and mathematics and by defending contextualized (but not relativistic) claims over absolute claims. He cites little of the huge recent literature on these themes, however. In the final chapter Lukacs explains his claim that human beings are, in a sense, at the center of the universe. A reversal of the Copernican revolution (that harbinger of modern science) is the general idea. We need to appreciate that our fallibility makes everything we do human centered, writes Lukacs.

Lukacs is a self-described Burkean conservative—a reactionary rather than a conservative by today's political lights. As such, he is antiprogressive and a defender of traditional humanistic expression. Writing as a philosopher, I can certainly agree that strong defenses of the humanities and the arts are badly needed, given today's aggressive linkup of science and technology with corporate capitalism and consumerism. Unfortunately, his treatment of these matters is too ill informed to have any purchase on the unconverted.

In the introduction Lukacs characterizes his book as "an essay, without scientific or scholarly presumptions" (p. ix), but that does not stop him from rendering many self-assured, even harsh judgments, and his longest chapters are about science. Despite his central theme of the evolution of historical consciousness, he shows no appreciation for the revolution in consciousness within history of science. For example, he dismisses Thomas Kuhn, one of the principals in that transformation, with "Enough of this" (p. 103), partly on the basis of his own misquotations and gratuitous misinterpretations in which he confuses Kuhn's own position with the views of those whom Kuhn is attacking. Lukacs is equally dismissive of social history of science and, while denying that he is an idealist, favors something like intellectual history and biography that expresses the power of mind and free will over materialistic determinism. He vehemently rejects determinism as a "positivist" error while assuring us that Darwin was not original, since his achievement was "predictable" (p. 119)—in

fact, a "more or less predictable . . . result of the evolution of human consciousness (again: Science being part of history and not the other way around)" (p. 120). He cites William Whewell as a "biologist . . . forerunner" of Darwin (p. 91).

Lukacs writes as though historians of science are still engaged in hero worship, and he thinks it arrogant of scientists themselves even to seek laws of universal validity or to search for extraterrestrial life and intelligence. Yet he does not hesitate to assert that God-created human beings are the most complex creatures in the entire universe or to engage in hero worship of his own—for example, of Goethe and Cardinal Newman. His favorite humanists are obviously far more original than any scientist.

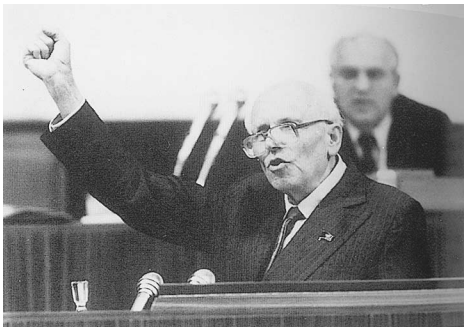
Curmudgeonly defenses of the humanities are surely welcome to this usually generous reviewer, but Lukacs's book does not succeed. We may be living in a postmodern age, but many general intellectual readers (and not only academics) will still prefer novel insight and evidence and argument, however critical, to repetition of one-sided assertions.

THOMAS NICKLES

Gennady Gorelik. *Andrei Sakharov: Nauka i Svoboda*. 512 pp., illus., bibl. Izhevsk: R&C Dynamics, 2000.

Richard Lourie. *Sakharov: A Biography*. xiv + 465 pp., illus., bibl., index. Hanover, N.H.: Brandeis University Press, 2002. $30 (cloth).

The cultural tradition of the intelligentsia—"the largest single Russian contribution to social change in the world," in Isaiah Berlin's words—may have ended with Andrei Dmitrievich Sakharov. For about 150 years Russian society bred a caste of intellectuals whose *raison d'être* was to revolt in idealistic pursuit of highly moral goals against the social order that ensured their own privileged status and existence. With their contribution, that order was broken twice during the last century. The first revolution undermined their position, yet the intelligentsia phenomenon managed to revive in later Soviet society. The second revolution, at the century's end, seems—at least for now—to have leveled their social condition more thoroughly into a "normal," "civilized," or "democratic" state of affairs, in which intellectuals en masse entertain higher principles insofar as this does not contradict the basic foundations of their own well-being.



Andrei Sakharov, Soviet physicist and activist, speaking at the First Congress of People's Deputies, with Mikhail Gorbachev in the background (from Gennady Gorelik, Andrei Sakharov, *p. 65).*

Born in 1921 and graduated from Moscow University's physics department in 1943, Sakharov belongs to the intelligentsia's Soviet generation. His studies in theoretical physics were interrupted in 1948 with the recruitment of his graduate advisor, Igor Tamm, to help the H-bomb effort. As members of the Tamm group, Sakharov and Vitaly Ginzburg made two crucial suggestions that helped the Soviet team to beat their American rivals in testing the first thermonuclear bomb in August 1953. That year Sakharov became the youngest scientist ever to be elected to full membership in the Soviet Academy of Sciences. Until 1968 he worked in a remote secret laboratory on the design and improvement of nuclear weapons. The recipient of a string of the highest government honors, he regretted the diversion from fundamental physics but found higher satisfaction in the feeling that the weapons work was morally important, contributing to the preservation of world peace, deterrence against the superior U.S. nuclear threat, and the prevention of further Hiroshimas and Nagasakis.

Starting with a 1958 article on the environmental dangers of radioactive fallout, Sakharov increasingly devoted his attention to social topics. His expertise helped bring about the 1963 Moscow treaty that banned all but underground nuclear tests. As the politicians did not always follow his other advice, Sakharov became more critical of the Soviet regime's failure to satisfy its own—and his—ideal image. Relying on the high social and moral standing of science in Soviet society, he applied his authority to issues beyond his direct professional expertise, petitioning the government to continue de-Stalinization and pleading on behalf of victims of political persecution. His move from reformist insider to open critic occurred around 1968, the time of

international rebellion against the Cold War order. While the death of Martin Luther King did not stop the movement toward civil rights in the United States, the Soviet regime managed with only limited repression to frustrate demands for further democratic reforms. As one of the leaders of the dissident movement, Sakharov continued to act and argue courageously in defense of legality and human rights. The struggle cost him many of his former privileges but was recognized internationally in 1975 by the Nobel Peace Prize. Hardest to bear, however, was the feeling of hopelessness: arrests and exiles of fellow dissidents were increasingly reducing the movement to defending the rights of the defenders themselves.

In early 1980 Sakharov's protest against Soviet intervention in Afghanistan's civil war prompted the government's decision to exile him to the city of Gorky, where he lived with his wife, inaccessible to foreign correspondents and other visitors except for occasional colleagues from the Physical Institute of the Academy of Sciences. Practically all expression of open opposition was silenced in the country, yet the feelings driven underground continued to spread. The accumulated energy broke loose after Mikhail Gorbachev came to power and resumed democratic reforms in the late 1980s. The changes from above came fifteen years too late, since in the meantime the intelligentsia had become irreparably alienated from the regime and its values. After returning from exile in late 1986, Sakharov became the moral leader of the growing democratic opposition to Communist Party rule. Facing a hundred-thousand-strong demonstration outside the Kremlin walls, Gorbachev finally agreed to satisfy Sakharov's call to remove from the constitution the article proclaiming the Communist Party "the guiding force of Soviet society." This crucial concession came two months after Sakharov's sudden death from heart failure in December 1989, at the time when he had started drafting a new constitution of the Union of Soviet Republics of Eurasia. The revolution driven by the intelligentsia proceeded much further on its own momentum, destroying the Soviet Union itself along with the society and culture that had allowed scientists and intellectuals to speak from a position of moral and political authority.

The two books under review are not exactly academic biographies: they aim at a much broader range of readers, though in rather different ways. Each succeeds admirably on its own terms; their strengths complement each other, and they provide extremely informative reading for professional historians as well. Richard Lourie, writing as an American journalist in the genre of political biography, gravitates toward explaining Sakharov's character in terms of his family upbringing, with roots leading back to the old Russian intelligentsia. His account is particularly impressive on the psychological side, empathizing with Sakharov's struggles and thoughts and paying close attention to his life in politics and as a family man. The author's attitudes and outlook are close to Sakharov's own at the end of his life, as expressed in his *Memoirs* (Knopf, 1990), which Lourie translated into English. Gennady Gorelik writes as a historian of science within the established Russian/Soviet tradition of science popularization. He sets Sakharov's biography in the historical context of Soviet physics and provides enlightening but nontechnical discussions of his contributions to both nuclear weapons design and fundamental theoretical physics. Placing less emphasis on the family tradition, he explains the formation of Sakharov's character largely through reference to the uninterrupted tradition of the Russian scientific intelligentsia. This too is traced to its prerevolutionary roots: through Tamm, Sakharov's teacher in life and science, to Leonid Mandelstam, Tamm's academic mentor and role model.

The books' weaknesses are related to their strengths. Lourie feels somewhat uncomfortable about his hero's long-held socialist mentality and ideals, which he mentions briefly but is afraid or unprepared to discuss seriously as an important cause of Sakharov's idealist rebellion against the Soviet political establishment. Gorelik takes for granted the view that science and scientists are natural sources of moral authority and allies of freedom, which, as a basic cornerstone of the intelligentsia's peculiar worldview, should belong to the explanandum rather than the explanans. Investigating these two additional aspects of Sakharov's beliefs and life story will bring us closer to understanding the specific phenomenon of the *Soviet* intelligentsia. However, this may require (or lead to) a new understanding of still-too-recent Soviet history and experience in general, the time for which may not yet have come.

ALEXEI KOJEVNIKOV

Tian Yu Cao (Editor). *Conceptual Foundations of Quantum Field Theory*. (Based on papers presented at the Center for Philosophy and History of Science, Boston University, 1–3 March 1996.) xx + 399 pp., illus., figs., indexes. Cambridge/New York: Cambridge University Press, 1999. $100.

This book is a collection of about thirty talks and discussions, enriched by some nice photographs, from a two-day symposium followed by a one-day workshop at Boston University in March 1996. The organizers, philosophers and historians, intended the meeting as an in-depth analysis of the foundations of quantum field theory, especially with respect to its philosophical implications.

In this respect the conference—at least so far as can be judged from the proceedings—was not a full success. The volume is dominated by contributions from illustrious physicists, both theoreticians and mathematicians, whose attitude is most clearly stated in the article by S. L. Glashow: "Most physicists are too much concerned with the phenomena they explore or the theories they build to worry about the logical foundations or historical origin of their discipline." Among the ten groups of articles, the headings of two may hint at questions outside physics: "Philosophers' Interest in Quantum Field Theory" and "The Ontology of Particles and Fields."

The rather restricted focus on physics does not mean that the volume does not contain interesting and, sometimes, deep articles. It offers a good survey—for example, in Steve Weinberg's "What Is Quantum Field Theory, and What Did We Think It Was?"—of the methods and the directions followed today to solve the mysteries of the particle spectrum and to understand the origin of the electroweak and strong gauge interactions as formalized in the standard model and of the attempts to reconcile the quantum methods for particles with the geometrical methods used in general relativity for space-time (i.e., to heal the old rift characterized by the attitudes of Einstein and Bohr). Yet there is a long way to go in the harmonization of space-time and matter concepts, as seen, for example, in Brice DeWitt's "Quantum Field Theory and Space-time—Formalism and Reality," which talks about a space-time–dependent Schrödinger wave function, possibly in a nonlinear equation, and its use for the "second quantization."

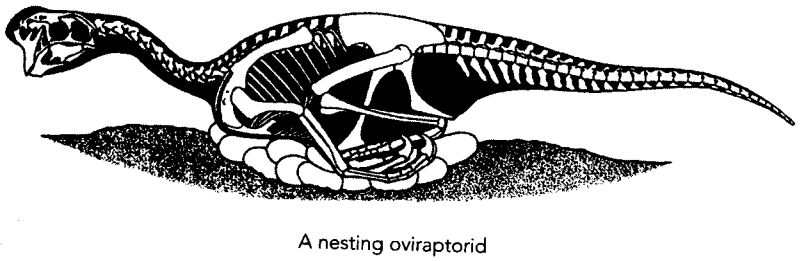
In most of the essays the reader is left to guess the philosophical and conceptual attitudes of the authors—if they hold any at all. They are buried in the jargon of the working physicist or mathematician. This is sometimes excessive—for example, in the renormalization group article by M. E. Fisher and the quantum geometry article by A. Ashtekar and J. Lewandowsky—a formalized language that, I'm sure, most philosophers and historians are not familiar with. Some participants seem to be unwilling or afraid to follow philosophical implications. For example, S. Treiman, in his role as chairman of a discussion session, mentions the relative ontology in the experimental interpretation of quantum mechanics and then begins the discussion with questions like: "Does relativistic QFT introduce really *distinctive* philosophical questions?" and, concerning "the question of virtual reality: Are real particles real when they are on the inside somewhere in a Feynman diagram? And what about quarks— . . . do they exist?" But then he stops: "I'll bite my tongue and try to stick to the commentator role." The ontology theme is taken up in the contribution by Fritz Rohrlich. Although—with D. J. Gross—one of the leading proponents makes a strong case for string theory, not omitting the encouraging whistling in the woods (that "we are living in revolutionary times"), his theme is not taken up and discussed in depth, pondered with respect to the strength or weakness of the philosophical and conceptual physical assumptions and prejudices it implies.

In other talks, string theory is mentioned only as a possibility or as the "only hope in town." Mathematical physicists often have a hard time explaining the relevance of their detailed work to phenomenologically oriented physicists, and even more to philosophers or historians. Nevertheless, A. Jaffe offers interesting comments connected with what he calls "Wigner's converse": "we marvel today at the unreasonable effectiveness of theoretical physics in mathematics."

HEINRICH SALLER

Michael Novacek. *Time Traveler: In Search of Dinosaurs and Ancient Mammals from Montana to Mongolia*. 352 pp., figs., notes, index. New York: Farrar, Strauss & Giroux, 2002. $26 (cloth).

The title of Nuala O'Faolain's memoir *Are You Somebody?* (New Island Books, 1996) came from a question once asked the author. As Michael Novacek confidently launches into his life story in *Time Traveler,* uninitiated readers might ask the same question. His nebulous flirtation with rock music aside, Novacek has had an extremely successful career as an influential vertebrate paleontologist, globe-trotter *extraordinaire,* and, most recently, Senior Vice President and Provost of Science at the American Museum of Natural History, overseer of the renovation and display of the most famous and inspiring vertebrate fossil collection in history. Novacek, a charming and unassuming man whose modesty



Nesting oviraptorid (from Michael Novacek, Time Traveler, *p. 301).*

belies his accomplishments, truly is "somebody."

What does he have to say? *Time Traveler* is really a collection of fieldwork stories. Most field paleontologists have a repertoire of strange tales, and Novacek is certainly no exception. The title of the book is a double entendre: professionally he is a time traveler, and the book is also a time traveler, spooling chronologically through his life. "Los Angeles," he writes in the opening paragraph, "is a particularly good place to become a paleontologist" (p. 3), and to judge from the empirical evidence—the number of accomplished paleontologists from L.A.—he is right. The stories go from there to all over the American West, Latin America, Yemen, and Mongolia. This makes for lots of rugged conditions, surreal experiences, and spectacular fossils.

Novacek appears not to be content just to write a book of good field stories, however, and he attempts throughout the book to weave in scientific themes. Here he is a bit less convincing: the themes—plate tectonics, biogeography, and, to a lesser extent, evolution—are lightly treated and not particularly memorable. Paleontology already has a reputation for typological approaches (Luis Alvarez famously characterized it as "stamp collecting"), and Novacek does not generate the same excitement for the great scientific questions that he does for fossil collecting. Ironically, in his own career he took on such questions directly and made important contributions.

Novacek is a deeply private man, and while there is surely more to him than his "personal attachment to rocks and bones" (p. 322), you won't find it here. Indeed, La Brea Woman (a fossil) gets far more attention than does his wife. Likewise, the individuals that we meet simply come and go as props in the stories, and, paralleling Novacek's personal revelations, individuals that are introduced later in the book are more two-dimensional than those that we meet earlier. Depths and shades of human emotion are not really plumbed in *Time Traveler.*

Most successful scientists are good writers, and Novacek is no exception. There are places where the writing approaches riveting, and these are most often found in the field stories. On the other hand, resplendent natural beauty tempts Novacek to wax poetic, but here (as for many of the rest of us) the result can be somewhat self-conscious and stilted.

"These recollections," Novacek writes, "are meant to show how a childhood of dinosaur dreams was transformed into a paleontological career" (p. 324). That being the case, this book ultimately takes its place alongside Roy Chapman Andrews's *All About Dinosaurs* (Random House, 1953) and Jack Horner's (and James Gorman's) *Digging Dinosaurs* (Workman, 1988) as inspiration for potential paleontologists. The best of such books should not be underrated; it takes considerable craft to portray the richness of the life of a field paleontologist. In this sense, Novacek may count himself successful; here is a book that will surely inspire more than one talented young student to pursue a career in paleontology. And this may turn out to be Novacek's most enduring accomplishment.

DAVID E. FASTOVSKY

Robert D. Ballard; Will Hively. *The Eternal Darkness: A Personal History of Deep-Sea Exploration*. xii + 388 pp., frontis., illus., figs., bibl., index. Princeton, N.J.: Princeton University Press, 2000. $29.95 (cloth).

Few scientists have received as much popular attention as the explorer and oceanographer Robert Ballard. His discoveries, using the Woods Hole Oceanographic Institution's submersible *Alvin* and its unmanned robotic vehicle *Jason,* of the *Titanic,* the *Bismarck,* and ancient Roman ships have received extensive media attention

worldwide. In this autobiographical account Ballard traces the history of deep-sea exploration, devoting over half the book to his own famous activities.

Ballard begins by discussing early deep-sea explorers. After briefly describing the underwater exploits of William Beebe, Jacques Piccard, and Jacques Costeau, he recounts efforts to deploy submersibles to find a sunken nuclear submarine, the USS *Thresher.* Ballard then turns to the use of *Alvin* and other submersibles by scientists. In the late 1950s, when suggestions of seafloor spreading fostered increased interest in bathymetry, scientists considered the possibility of making direct observations of the ocean floor. In the 1970s Ballard and others, working in submersibles, participated in the French-American Mid-Ocean Undersea Study (FAMOUS) that yielded dramatic photographic images of lava flows in the Mid-Ocean Ridge that "confirmed the theory of seafloor spreading, providing the first systematic documentation of a crust-making process that has global significance" (p. 153). Later work onboard *Alvin* resulted in a fundamentally new scientific discovery: hydrothermal vents and a community of organisms capable of existing by chemosynthesis. The book concludes with a section entitled "Detachment: Using Remote Controlled Vehicles to Gather and Distribute Underwater Data Electronically"; it describes a breakthrough that, according to Ballard, will enable underwater explorers to "leave the body behind" and make science more democratic (p. 310).

Ballard's study, although well written and replete with excellent photographs, holds little significance for historians of science. The historical overview of deep-sea exploration contains nothing that is original, and it is narrowly conceived and driven by a sense of triumphalism. More serious is the author's lack of attention to context. Developments in deep-sea exploration are not examined in relation to contemporary scientific, political, or economic concerns. Ballard offers only cursory treatments of bathymetry, seafloor mapping, and the revolution in plate tectonics and in some cases focuses on the work of *Alvin* and Woods Hole to the neglect of other scientists. Ballard and his colleagues may have been the first to see hydrothermal vents in 1977, but scientists from the Scripps Institution of Oceanography who participated in the *South Tow* expedition were interpreting temperature anomalies at the Galápagos Rift as due to hydrothermal vents in 1974 (as Naomi Oreskes has shown in her unpublished essay "From Hydrophones to Hydrothermal Vents").

Ballard's account also fails to recognize the profound importance of the military for oceanography and deep-sea exploration. He refers to the importance of military equipment for underwater investigations but never properly integrates the role of military preparedness and national security into the narrative. Since the early 1940s, military objectives and patronage have been central to virtually all work in oceanography. Oreskes's recent work has demonstrated that *Aluminaut* and *Alvin* were built to assess deep-sea sound surveillance systems for tracking Soviet submarines and underwater ballistic missiles. In 1964, when *Alvin* came on line, its first task was to ensure that a hydrophone system remained in proper working order. Projects FAMOUS and *South Tow* were not solely scientific investigations; they were designed to test new forms of Navy sonar. By suggesting that deep-sea exploration was an autonomous scientific activity, Ballard provides only one part of a much more complex story.

Nor does Ballard address problems associated with the visible scientist. He fails to explain his own shift from science to popular exploits in underwater archaeology, nor does he examine the consequences of popularization for the science and scientists involved, himself included. *The Eternal Darkness* may appeal to a general audience, but historians of science will be disappointed.

RONALD RAINGER

Mark L. Winston. *Travels in the Genetically Modified Zone*. viii + 280 pp., bibl., index. Cambridge, Mass./London: Harvard University Press, 2002. $27.95.

Mark Winston has provided an excellent book for those interested in the interactions of science and society. *Travels in the Genetically Modified Zone* is an astute commentary about genetically modified organisms, a subject desperately needing a nonadvocatory overview.

Travels begins with a discourse on seeds. Winston establishes a framework that presents modification of crop seeds as a foundation of modern agriculture. He also establishes that farming today is highly international in the development and trade of both inputs and harvested crops. It would be difficult to understand the squabble over genetically modified crops without understanding the centrality of modified seeds and international flows of goods and ideas.

In subsequent chapters, Winston recounts his interviews with and observations and readings of the major protagonists in the debate. He traveled

widely to meet with staff scientists in the seed companies, activists with environmental organizations, and regulators who knew that any decision they reached would result in litigation.

Winston's book is an enjoyable read because of his clear exposition of both the personalities of people involved and the biology of prominent cases. He captures the scientific enthusiasm of scientists working for the seed companies, which are increasingly parts of large companies originally focused on chemicals and pharmaceuticals. Equally well, he portrays the fervor with which international environmental organizations such as Greenpeace have attacked the development and use of genetically modified crops.

Different chapters also explain famous incidents of the campaigns. Winston leads us, for example, through StarLink corn from Aventis, the canola farmer Percy Schmeiser's legal defeat by Monsanto, the debated threats to the beautiful monarch butterfly from *Bt* corn, the plight of organic farmers who utterly reject genetically engineered seeds, and the fear of genetic contamination as a threat to the beauty and morals of rural England. These are all stories that have hit the daily newspapers and various scientific journals. What Winston does that is so valuable is explain each one coherently.

Winston also provides a brief overview of the legal landscape. He takes us from the 1930 Plant Protection Act to the 1970 Plant Variety Protection Act to the 1980 Supreme Court case *Diamond v. Chakrabarty.* These provided the basis for patenting genetically modified organisms in the United States. They also enabled the growth of an industry that later successfully lobbied the first President Bush to keep the United Nations convention on protection of biodiversity a "voluntary" agreement.

In the end, Winston reaches a clear but not terribly satisfying conclusion: the claims for both risks and benefits of genetic engineering have been exaggerated. He has a powerful and enduring faith that the truth lies somewhere in the center, not at the extremes. He provides a brief sketch of a sensible way to resolve many of the scientific dimensions of the genetic technology.

I believe that he is correct on scientific grounds to head for the middle, but the unsatisfying part of his conclusion pertains to morals and values. His book excellently portrays the moral dimensions of the arguments over genetic modification, so how can he expect those who object on moral grounds to agree to a solution based in scientific proceduralism? It is hard to imagine that fire-and-brimstone condemners of the technology will buy into his solution.

Despite my wish for a more nuanced conclusion, *Travels* will be of interest to scholars working on contemporary issues of science and society. Its style of providing references for each chapter but no footnotes for specific claims will annoy researchers seeking to extend the study. Its readability, however, makes it eminently suitable for undergraduate and graduate seminars in history of science and technology, science and society studies, and environmental studies.

JOHN H. PERKINS

Stanley Shostak. *Evolution of Sameness and Difference: Perspectives on the Human Genome Project*. xiv + 342 pp., tables, bibl., index. Amsterdam: Harwood Academic Publishers, 1999. (Cloth.)

Readers of *Isis* will likely find this a curious book. The subtitle is misleading as a guide to its contents, and only indirectly does the volume deal with the Human Genome Project (HGP). Generally it is a set of reflections indebted to Gilles Deleuze's *Difference and Repetition* (Columbia, 1994), and the general thesis of the work is to take issue with the predominance of models, metaphors, and theoretical claims that assume a fundamental identity or similarity of living forms and processes. In this respect the work conducts an often thinly veiled polemic against several biological orthodoxies, including neoselectionist evolution, the concept of homology, the assumptions of gene identity between different organisms, cladistics, and the assumptions of much of the theory of molecular biology. Stanley Shostak, an invertebrate embryologist and histologist, sets these arguments forth in five chapters. The first deals with the basic notions of sameness and difference in biology, using historical data, often problematically, to develop these points. Chapter 2 offers an analysis and critique of the "normal" science of contemporary molecular biology. This is extended to a critique of cladistics and its collaboration with molecular biology through the use of degrees of genomic difference to determine taxonomic relationship and, ultimately, evolutionary ancestry. Chapter 3 introduces alternative notions of difference in biology in opposition to these unifying claims of biological orthodoxy, using data from viral research, RNA differences, classification, and other data that illustrate the fundamental differences between living things. Chapter 4 continues this theme into a discussion of theories of exobiology and theories of the origins of life, sup-

plying an overview of the theory of the original "RNA" world and its alternatives. A final chapter then explores the alternatives of "evolution" and "devolution," with a defense of the latter as capturing the emergence of sameness from "redundant differences" in the nature of life (p. 237).

On the positive side, the book brings together a good deal of literature on a wide array of topics, from history of science to molecular genetics and contemporary debates on abiogenesis. As a professional biologist, the author moves easily through complex theoretical debates in genetics, molecular biology, and developmental embryology. The book also raises an important theoretical issue concerning the notion of "gene homologies" that forms a primary assumption of the work of the HGP that I find too little discussed. Unfortunately, the analysis does not attempt to situate these issues within a recognition of the alternative definitions of genes in transmission, populational, and developmental biology that could provide some more satisfactory solution to this issue.

The organizing theme of the book is a defense of "devolution," as distinguished from neoselectionist "evolution." The latter is interpreted as relying too heavily on the concepts of homology and sameness. Only by emphasizing the differences of living forms, from the level of whole organisms to that of their most elementary constituents, can some further advance in understanding be achieved. "Devolution" is proposed as a third alternative theory to neo-Darwinian selectionism, along with complexity theory and chaos theory.

If I did find several of the general points made in this book to have some theoretical merit, I found the arguments too polemical and overstated. Historians will be surprised at some of the claims. Cuvier is considered to be the author of the notion of unity of plan (p. 9); uniformitarianism is attributed to the "profoundly religious" Lyell (p. 17); Koch, Lister, and Pasteur are identified as "19th century mechanists" (p. 42). Such examples can be multiplied. Through the book runs an uncritical commitment to a Popperian falsificationist methodology in which the best science is assumed to progress by positing alternative falsifiable hypotheses, "devolution" forming a principle example.

PHILLIP R. SLOAN

James F. Crow; William F. Dove (Editors). *Perspectives on Genetics: Anecdotal, Historical, and Critical Commentaries, 1987–1998*. xiv + 723 pp., illus., figs., tables, bibls., indexes. Madison: University of Wisconsin Press, 2000. $19.95 (paper).

In Japan, people say "Furuki wo atatamete atarashiki wo shiru": by mulling over the past, one can discover a new idea. For this reason, history of science might be an important field even for scientists. But it needs to be done correctly—ideally, perhaps, in cooperation with scientists. This is not to say that historians of science should just give way to scientists and accept their "biases." It simply means that the gap between the highly technical language used by scientists and the standard language used by the general public often leads to much confusion and misunderstanding, and so historians need to make sure that the information they give the public is accurate.

One of the most important tasks for historians of recent science has been to translate between these two sets of languages. Yet because in the past such efforts have often gone in only one direction, with historians left to interpret highly technical scientific language on their own, the accuracy of historians' accounts of science has received serious criticisms from scientists. Scientists are often under extreme pressure to publish their work in a timely manner within their scientific communities, so some may not want to spend the extra time it would take to explain their "sophisticated" work to the public. There is, of course, a tradition for some senior scientists to write historical books on their own work for a general audience. The public should certainly appreciate these efforts. But such books are often criticized because historians of science—and even scientists themselves—think that the authors have a "bias" toward their subjects or that they are simply trying to promote their own work. Moreover, despite the authors' best efforts, these books are sometimes still too technical for the general public to understand.

Perspectives on Genetics, edited by James F. Crow and William F. Dove, is unique in this context. It is a collection of essays originally published in the journal *Genetics* under the title "Perspectives: Anecdotal, Historical, and Critical Commentaries on Genetics." *Genetics* is the official journal of the Genetics Society of America, established in 1931. The society and the journal have created a wonderful common ground for geneticists in the United States and in many other countries. Yet among practicing geneticists and evolutionary biologists, *Genetics* has a reputation for being highly technical and mathematical. The "Perspectives" section, started in 1987, introduced fresh views into this

journal by expanding the common ground and adding historical depth.

Crow and Dove, distinguished U.S. geneticists, selected authors for the essays in this section of the journal in a sophisticated manner, taking their specialties into account. Variations among the authors are great—they range from young to senior, from geneticists to historians of science. The essays cover a broad range of issues in genetics: there are scholarly reviews, obituaries, historical essays, biographical essays, and anecdotal essays. For example, Joshua Lederberg's "Replica Plating and Indirect Selection of Bacterial Mutants" explains an important method he developed to test mechanisms of mutation in bacteria populations in depth. This method was later used by critics of the directed mutation hypothesis to produce a counterargument to it. The essay will be useful for young geneticists who have not had a chance to work on bacterial genetics. Since it is written in a concise manner for uninformed readers, it will also be useful for anyone who is interested in learning about a unique test for bacterial mutation mechanisms. Crow's "Twenty-five Years Ago in Genetics," an obituary for Motoo Kimura, is a subjective piece on one of his most successful students. Here, a subjective style effectively addresses readers who never met Kimura, helping them to learn about him almost at a personal level. Diane Paul's "H. J. Muller, Communism, and the Cold War" is a historical and biographical essay that shows readers the political side of this well-known Nobel laureate. There are many more biographical essays, some of which treat figures whose names will not be familiar to young geneticists and historians in the United States. The biographical sketch "Hitoshi Kihara, Japan's Pioneer Geneticist," by Crow, gives information not only on Kihara's life but also on the early development of cytogenetics in Japan. Thomas Nagylaki's "Gustave Malécot and the Transition from Classic to Modern Population Genetics" is outstanding for its precision. Even today, only a few population geneticists know and understand the details of Malécot's work, which was written in French and is highly mathematical. Nagylaki patiently explains Malécot's work at great length. Essays on genetic methodologies that changed the direction of the field are also important pieces. O. Smithies's "Early Days of Gel Electrophoresis," for example, vividly documents the excitement and confusion that surrounded the first uses of gel electrophoresis.

Perspectives on Genetics provides useful material for young geneticists who are not familiar with topics outside their specialties and for those who have never had a chance to interact with the leading geneticists of the first half of the twentieth century in order to learn about these topics. It is also a good reference book for historians of genetics and biology. In reading through the entire volume, historians will meet the history of genetics in great depth. Historians will find those essays by scientists an insiders' guide to these topics, they can then analyze them in their own way. Most important, this volume is a first step in encouraging scientists and historians to collaborate and attempt to write accessible and original essays for a broader audience. Such efforts should be promoted in the future.

TOMOKO Y. STEEN

David Healy. *The Creation of Psychopharmacology*. 469 pp., notes, index. Cambridge, Mass./ London: Harvard University Press, 2002. $39.95 (cloth).

Readers of David Healy's three-volume blockbuster, *The Psychopharmacologists* (Arnold/Oxford, 2000), will have plenty of confidence in his erudition, good judgment, and lucidity. His expositions of complex pharmacological issues are marvels of clarity. Some of the best accounts from the previous work are summarized and updated in this new book. Quite apart from their historical interest, many are excellent stories. A latter-day Shakespeare could readily find material here for an entire cycle of plays. The character and fate of Jean Delay, one of the discoverers of chlorpromazine (Thorazine), for example, offer a cautionary tale reminiscent of *Richard III.*

The Creation of Psychopharmacology is therefore welcome in that it makes fascinating subject matter more readily available. Its main purpose, however, is to argue a case that has important implications for us all, regardless of whether we are psychiatric professionals: namely, a case "for the possibility that marketing now determines culture" (p. 67). Healy suggests that a psychopharmaceutical complex has developed, perhaps analogous to the military-industrial complex so feared by liberals in the 1960s, that to some extent determines the psychiatric diseases that we recognize, the treatments that we approve, and the research agendas that we adopt. The argument depends on showing in convincing detail that theories, therapies, and areas of particular clinical concern have chopped and changed in a manner that often has had little to do with the scientific information available at the time. Sometimes promising ideas

or clinically appropriate findings drop suddenly out of sight, occasionally to pop up again years later, while inappropriate notions and practices can be found that have long outlived their sell-by dates. Moreover, as time has passed, it has become increasingly obvious that these phenomena may sometimes be driven by the marketing strategies of drug companies. Whereas in the 1950s and early 1960s there was a healthy reciprocity between psychiatrists and the pharmaceutical industry, it is now apparent that the marketing tail can wag the entire dog.

Healy goes on to suggest that companies have been enabled by a range of circumstances to hijack the randomized control trial, supposedly the gold standard by which the value of new therapies is judged, and use it to sell expensive alleged cures for a range of dubious "diseases." Many of these "cures" are probably less effective than older and cheaper drugs, albeit sometimes safer, while psychiatry has played its part by helping to label the merely nervous or deviant as ill and by failing to discriminate appropriately between genuine disease entities. All this is unlikely to be due to any uniquely pernicious qualities of the pharmaceutical industry, because analogous trends can be seen in connection with purely psychological treatments. An attempt is made in the final chapter to identify the underlying factors responsible; it is followed by a brief excursion into futurology that really belongs in a forthcoming book.

Whatever the validity of this indictment—and certainly many aspects of it are true, even if one might quibble about the details of some of the claims—the book performs two enormously useful functions. First, it provides a marvelous demonstration of how the course of an applied science can be determined far more by the whims of fashion, happenstance, and the marketplace than by scientific rationality. Second, it shows beyond reasonable doubt that clinical psychiatry and commercial pharmaceutics have become far too closely intertwined for the health of the former and probably, in the longer term, for that of the latter as well. There are many people who will not like this message. Let us hope that they will be unable to ignore or subvert it.

CHRIS NUNN

Bill Gunston; Yefim Gordon. *MiG Aircraft since 1937*. 288 pp., illus., app., index. Annapolis, Md.: Naval Institute Press, 1998. $59.95 (cloth).

The USSR's renowned Mikoyan Design Bureau, which for three generations turned out perhaps the most well-known series of fighter aircraft made anywhere in the world, was founded in 1939 by two young Soviet aeronautical engineers, Artyom Mikoyan and Mikhail Gurevich. The pair chose the three-letter "MiG" designation (a contraction of Mikoyan and Gurevich) as the name for their product line. Their choice was doubly inspired, in that by a stroke of coincidence the word *mig* in Russian stood for "instant" (for example, *v odin mig,* or "in a twinkling") and had long been commonly used to denote speed. In the decades that followed, their bureau progressively evolved into a close-knit entity in which senior management, the various design subgroups, and the flight-test staff came to interact almost as an extended family, with high morale and fierce pride in their organization's products. By the time of the bureau's fiftieth anniversary in 1989 these individuals, collectively known as *Mikoyanovtsy* (or *Migovtsy*), had achieved a place of rare stature in the Soviet aviation industry

In *MiG Aircraft since 1937,* the British military aviation popularizer Bill Gunston and the Russian aircraft photographer Yefim Gordon have produced a remarkable contribution to the literature on Soviet aircraft that clearly shows how the bureau rose to become synonymous with leading-edge fighter design in the USSR. True to its title, the book offers only a fleeting history of the bureau itself, and it devotes no attention whatever to the personalities, processes, and politics that figured so prominently in that history. Yet it presents a unique cornucopia of technical data, much of it hitherto unknown in the West, on the entire roster of MiG aircraft, from the MiG-3, the bureau's first mass-produced fighter of World War II vintage, through the MiG-29 and MiG-31 of the later Cold War years.

Gunston and Gordon provide especially abundant detail on the MiG-15 of Korean War fame, nicknamed the *samolyot soldat* ("soldier airplane") for its rare maintainability and ruggedness. That aircraft ushered the USSR into the jet age and vaulted the Mikoyan bureau into the preeminent position among Soviet fighter producers. The authors offer a similarly rich treatment of the subsequent series of MiG fighters, as well as an interesting look at the many hand-built, one-of-a-kind MiG prototypes never meant for production that were unique to the Soviet approach to fighter development.

With no overview or conclusion, the book is more an encyclopedia than a narrative and does not make for effortless reading by any stretch. Yet it is not really meant to be read cover to

cover so much as to be perused as a reference volume replete with good photography. Not only is it an exemplary treatment of the design, development, and flight testing of all Mikoyan aircraft; it offers in the course of that coverage a *de facto* survey of the bureau's leading engineers and test pilots and their various achievements from the most senior level down. In marked contrast to the assorted straphangers and Party hacks who dominated the Soviet political system, these quiet professionals showed every sign of being practical people with a high regard for their own abilities and a strong commitment to excellence—even, if it had to be so, within a political system that severely stifled their initiative and creativity.

Published in 1998, *MiG Aircraft since 1937* came off the press just too soon to capture in detail the unveiling and limited flight testing of the abortive "Article 1.42," the bureau's long-promised successor to the MiG-29 and the Soviet Union's planned answer to the U.S. Air Force's F/A-22. It also just preceded the bureau's decline in the wake of the USSR's collapse and its subsequent absorption by a succession of enterprises that retained the MiG name but little of the bureau's former élan. That said, Gunston and Gordon have produced a compendium with which the principals of the once-vibrant Mikoyan Design Bureau would be justly pleased. The authors offer no acknowledgments other than a passing note that they had access to bureau archival material. Clearly, however, they benefited from considerable help by knowledgeable members of the bureau's senior staff. Thanks in large part to that authoritative support, their book offers the most detailed and comprehensive compilation of MiG-related facts and anecdotes yet available in the West.

BENJAMIN S. LAMBETH

Joan Lisa Bromberg. *NASA and the Space Industry*. (New Series in NASA History.) x + 247 pp., illus., bibl., index. Baltimore, Md.: Johns Hopkins University Press, 1999. $38.50.

This is not a book for historians of science whose concern is the world of ideas; nor is it a book for students of the history of technology whose focus is on the process of discovery and fabrication. This is a study of political and economic interactions between large-scale bureaucracies and the role policy plays in these interactions. Joan Bromberg's book is best located in the scholarly traditions of political science, economic and business history, and organization theory. In the past few years I have been immersed in the study of large-scale bureaucratic institutions and have sampled much of the literature. *NASA and the Space Industry* shares many of the best qualities of the genre. Students of post–World War II science and technology policy in the United States will find it of great value. But they must be prepared to deal with a book that is not a traditional narrative.

Using primarily printed sources, the author surveys the ever-changing patterns of NASA's relations with its major industrial partners—Boeing, Lockheed Martin, and the like. The period covered is from the inception of NASA (1958) to the 1990s. This is a very complex story that involves a large and fluid cast of characters. The author thoughtfully supplies readers with a kind of scorecard (pp. 10–13) that identifies the industrial players (including name changes and mergers) as well as the components of NASA. Chronological divisions run from the founding of NASA to the *Challenger* disaster, the fall of the Soviet Union, and NASA's more recent focus on the space shuttle and space station.

What may trouble traditionalists most is the lack of a single thread or unifying factor of the sort found in biography or the study of scientific ideas or technological processes. But this is not that kind of history. The story twists, turns, moves forward and backward from point to point. At NASA, many projects were proposed, discussed, and discarded. Others were started and then dropped. A few, like the lunar landings and the space shuttle, were brought to fruition. How these aspects of the story play out is a key focus of the book.

The cast of characters is like that in a nineteenth-century novel: large, rich, and diverse. This adds to the interest of the study and, occasionally, to the reader's frustration. It is sometimes hard to keep all the players clearly in mind. Consider the key players: First there is NASA itself, with its internal tensions and rivalries in terms of departments, individuals, and the eight R&D centers scattered from Alabama and Ohio to California. Then there is the rest of the federal government. For NASA, this includes the Departments of Commerce, Transportation, and Defense, with its three (Army, Navy, and Air Force) warring factions, as well as the executive branch, which in addition to the office of the president includes the Office of Management and Budget, one of the least understood and most powerful agencies of the federal bureaucracy. Let us not forget the president's science advisor and the various interagency committees that report to the executive office. Then there is the aerospace industry, with old, established firms

and start-ups, all competing for NASA contracts, striving to influence NASA's decision-making process, and warring against each other or joining forces to achieve specific goals.

At the heart of this study is the story of how the space industry was created from the complex interactions of this huge cast of characters. NASA moved from a heroic Cold War bureaucracy that achieved John Kennedy's goal of a manned lunar landing in the 1960s to an agency pressured by the Reagan and first Bush administrations to privatize its operations by giving the private sector control over design and production of space hardware as well as ownership of the product. This went on against the background of emerging commercial uses of space. Satellites became functional and even profitable in such areas as navigation, communications, and remote sensing. Just how NASA nurtured and then negotiated control of these activities with the private sector is a key part of the story. But we are not allowed to forget that the process involved the executive branch and the Departments of Defense, Commerce, and Transportation as well. In this context, tensions between politics and policies are also part of the story, and it was often the case that policy signals got lost in the noise of bureaucratic infighting.

If one were to fault this work at all, it would be for the lack of a human dimension. People are mentioned, their activities chronicled, but we never get to know them as real human beings. But then, there were clear limits on what could and could not be done under the NASA contract that guided the author. For those who argue that there is not enough about the input of the scientific community, the response is simple. That was not a theme of this book. Indeed, it is another story altogether.

Bromberg is to be congratulated on her skillful navigation of that ever-changing and stormy bureaucratic process out of which emerged the space industry in the United States.

JOHN LANKFORD

Mary Ellen Bowden; Trudi Bellardo Hahn; Robert V. Williams (Editors). *Proceedings of the 1998 Conference on the History and Heritage of Science Information Systems*. Foreword by **Arnold Thackray.** (ASIS Monograph Series.) (Based on papers presented at the Conference on the History and Heritage of Science Information Systems, 23–25 October 1998, Pittsburgh.) xii + 291 pp., figs., illus., tables, bibls., index. Medford, N.J.: Information Today, 1999. $39.50.

Proceedings of the 1998 Conference on the History and Heritage of Science Information Systems shares the work of an interdisciplinary meeting that brought together both scholars and practitioners interested in the history of scientific information. Academics in library and information science, history and philosophy of science, and communications at work on the historical and sociological aspects of science information system development and use are joined by librarians and science information pioneers whose own histories include work with the many techniques and technologies discussed throughout the volume.

That the participants hail from several fields, and include both academics and practitioners, is one of the strengths of the collection. Many of the authors make special efforts to avoid jargon and internal disciplinary debates in favor of writing that can speak to a general reader. This clarity of presentation would be valuable in any scholarly effort, but it is especially useful here in turning a conference proceedings into a useful compendium of readings about an emerging field. Nonetheless, readers from the history of science and technology will recognize subtle allusions to ongoing debates within our discipline.

While the book does not offer the same level of theoretical coherence as a volume in a more developed subfield might, it is nonetheless well organized into several thematically consistent areas. These include "History and Historiography of Science Information Systems," "Information Retrieval in Science: The Technical Aspects," and "Science and Information: Some National Perspectives." Likely to be of special interest to historians of science and technology are the chapters detailing the history of the information and indexing systems that scholars in our field work with in our own research—for example, the Science Citation Index.

This book does its best work in showcasing the richness of an emerging subfield in several disciplines. With essays ranging from a study of classified scientific communication in the American federal government to the history of Japanese library science to a history of microfilm technology, this volume suggests to any scholar or student interested in scientific information systems that there is enormous capacity for original work to be done.

JENNIFER S. LIGHT

John Ziman (Editor). *Technological Innovation as an Evolutionary Process*. (On behalf of the Epistemology Group.) xviii + 379 pp., illus.,

figs., tables, bibl., index. Cambridge: Cambridge University Press, 2000. $64.95.

This collection of twenty-two papers by nineteen authors derives from a research program on the evolution of knowledge and invention undertaken by the "Epistemology Group" of London, directed by the noted scientist and science policy scholar John Ziman. The issues involved were debated in a series of seminars that began in 1994 and culminated in a workshop three years later. The result is an integrated (i.e., cross-referenced and nonduplicating) proceedings volume divided into five thematic sections: "Evolutionary Theory," "Innovation as Cultural Practice," "The Process of Invention," "The Institutionalization of Innovation," and "General Reflections on Technological Change."

As these themes indicate, crucial to the argument is an otherwise unanalyzed distinction, traceable to the economist Joseph Schumpeter's work from the early twentieth century, between invention—the creation of new artifacts or processes—and innovation—the economic development and exploitation of such artifacts or processes. As the volume's title emphasizes, the main interest here is innovation, not invention. But when evolution is described as the selective retention of variations, technical invention providing the variations among which various types of innovation "select" to produce technological change, then innovation becomes the more inclusive concept. The aim of the book as a whole is to articulate more clearly than before the multiple mechanisms of technological variation and, especially, selection—historical, cultural, sociological, economic—and their interactions. Although Charles Darwin began the *Origin of Species* (1859) with observations about how the artificial breeding of plants and animals leads to the evolution of new varieties, and numerous authors from Karl Marx on have attempted to turn the tables and use Darwin's theory of natural selection as a paradigm to explain technical change, this volume constitutes the most intensive effort to date. Yet the authors are perhaps even more at pains to note the manifold differences between organic and technological evolution—the most obvious being that with technology neither variation nor selection is blind in the same way that it is in the organic world—and thus the limitations of the paradigm.

Scholars from at least four different disciplines have attempted to utilize evolution as a framework to explain various dimensions of technological change: epistemologists, historians, sociologists, and economists. The present volume is in fact dedicated to the late evolutionary epistemologist Donald Campbell, although its interdisciplinary center of gravity is the work of historians and sociologists. Indeed, almost a third of the chapters constitute something like historical or sociological case studies on, for example, Europe versus Japan (Ch. 7), Gothic architecture (Ch. 9), Edison and the telephone (Ch. 11), bridge design and aeronautics (Ch. 13), education (Ch. 14), innovative enterprises (Ch. 19), and warfare (Ch. 20). Historians of technology such as Walter Vincenti (Ch. 13) and Edward Constant (Chs. 16 and 20) do much of the case study heavy lifting; historians of science and those who might deal more with the epistemic dimensions of technical change are conspicuous by their absence.

The interests of the editor (who authors or coauthors four chapters) permeate the book. Its extended attempt to explain the extent to which the social selection of technological variation is analogous to the natural selection of chance variations among organisms is undertaken not simply as an academic exercise but in order to improve social intelligence. Despite its limitations, "an evolutionary perspective—whether we call it an 'analogy,' a 'metaphor' or a 'model'—is clearly a very fruitful way of [posing] practical questions and suggests useful answers for designers, technology managers, policy makers and others in industry, government and academia" (p. 316). This interdisciplinary, cooperative analysis thus ultimately aims not just at scholarship but at the increase of practical intelligence.

There are three qualifiers to my generally positive assessment. One, the referencing system is unnecessarily clumsy. Of the 631 notes, all but three simply give names and dates that then must be looked up in the bibliography. A whole step in the reading process could have been eliminated by placing the relevant names and dates in parentheses in the text itself. Two, there are a few significant works on technological evolution that are not referenced, one of the most noteworthy being Gilbert Simondon's *Du mode d'existence des objets techniques* (Aubier, 1958). Third, the proceedings could have been measurably enhanced by a comprehensive bibliographical analysis of previous contributions to the topic.

CARL MITCHAM

Edward Teller; Judith Shoolery. *Memoirs: A Twentieth-Century Journey in Science and Politics*. xii + 640 pp., illus., app., index. Cam-

bridge, Mass.: Perseus Book Group, 2001. $35 (cloth).

Legend has it that at a conference one physicist told another: "If you've got a problem, Ed's got a bomb." Perhaps more than any other scientist, Edward Teller has been associated in the public mind with the dark force of modern science and technology as he aggressively pushed for various nuclear weapons programs, notably the hydrogen bomb and the Strategic Defense Initiative, during the second half of the twentieth century. While conservative politicians and military officials adored him as an icon during the Cold War, many of his physicist colleagues and other scholars condemned him for fueling the nuclear arms race and especially for testifying against J. Robert Oppenheimer in the latter's security clearance hearings in 1954. Now Teller tells his side of the story in a long-awaited memoir written with the assistance of Judith Shoolery, a book editor, now retired, at the Hoover Institution of Stanford University, where Teller is a senior research fellow. The book is highly readable and adds more detail about his version of the facts but, despite its bulk, reveals little beyond what we already know.

Teller opens the book with a detailed and at times moving description of his childhood and youth in Hungary, where his Jewish family suffered at the hands of the Communists who briefly gained power in 1919 and from prevalent anti-Semitism. In the 1920s Teller pursued chemistry at Karlsruhe Technical Institute in Germany on his father's advice but switched to theoretical physics, his true love, briefly at Munich (where he lost his right foot in a trolley accident) and eventually at Leipzig with Werner Heisenberg, who became a lifelong friend. Teller completed his thesis on the energy states of the hydrogen molecular ion, received his Ph.D. in 1930, and then headed for Göttingen as a research assistant to a physical chemist at the university. With the rise of the Nazi menace, he moved to several places in Europe—Rome, Copenhagen, and London—for long or short stays in the 1930s. Gregarious by nature, Teller made friends with many of the major figures in modern physics in this period. In 1935 he came to the United States as a professor of physics at George Washington University.

The rest of Teller's career is well known: he went to Los Alamos to work on the atomic bomb during World War II, left for the University of Chicago at its end, helped develop the H-bomb, lobbied successfully for the founding of Livermore (which became his new and final institutional home) as a second nuclear weapons laboratory in the early 1950s, testified against Oppenheimer, opposed the test-ban treaty, advocated antiballistic missiles in the 1960s and the Strategic Defense Initiative (Star Wars) in the 1980s. In the book Teller curiously minimizes his role in the test-ban and ABM controversies. On other matters, he largely confirms what has been reported in two previously published biographies based on interviews with him: *Energy and Conflict,* by Stanley Blumberg and Gwinn Owens (Putnam, 1976) and *Edward Teller,* by Blumberg and Louis Panos (Scribner's, 1990). For example, he traced his political differences with Oppenheimer to a conversation they had in 1942, when Oppenheimer reportedly said, in reference to the Manhattan Project, that "the time is coming when we will have to do things differently and resist the military." Teller was shocked and replied, "I don't think I would want to do that" (p. 163 in *Memoirs;* pp. 134–135 in *Energy and Conflict*). In the new book Teller explains further that "even today, I find the idea of civil disobedience in a democracy wrong" (p. 379). It's not clear whether he opposed and still objects to the civil rights movement for this reason.

ZUOYUE WANG

Samuel P. Hays. *A History of Environmental Politics since 1945.* ix + 256 pp., index. Pittsburgh: University of Pittsburgh Press, 2000. $19.95 (paper).

A fuller title for this book might add the phrase "in the United States, with special reference to the federal government." Since the 1950s Sam Hays has explored the terrain of U.S. environmental politics, and he knows it as well as anybody. Here he offers a capsule account of the last fifty-five years' worth, reviewing and updating matters that he explored at greater length in one of his landmark books (*Beauty, Health, and Permanence: Environmental Politics in the United States* [Cambridge, 1987]).

The scope is relentlessly domestic. Like most historians of the United States, Hays writes as if Canada and Mexico did not exist. Even acid rain is treated exclusively as a domestic political issue. The chronological scope is mainly 1945–1997, although Hays does cast a glance backward in time wherever appropriate.

After a brief chronological survey of environmental issues and politics in the United States from Amerindian times to the present (Ch. 2), Hays adopts a thematic approach in which the entire postwar era appears as a whole. Fourteen

short chapters take up various themes, from the politics of environmental technology to the management of policy implementation. Almost all of them focus on politics and policy at the federal level. The best, in my opinion, is his chapter on antienvironmental politics. He rightly notes that these forces are often ignored by environmental historians, which is absurd—but few except Hays have noticed.

At two points in particular Hays offers discussions that will be of interest to historians of science. The first of these is within the chapter on antienvironmentalism, where he discusses what he calls "the science wars," struggles by various factions to claim that the weight of science is on their side. Then, in Chapter 11, he assesses the emergence, evolution, and contribution of environmental science in general, remarking on its extraordinary growth. Curiously—to my mind—this discussion does not include global change science, which is surely among the larger components of environmental science, at least since the late 1980s.

His most interesting conclusions come in Chapter 15, on the results of U.S. environmental policy and politics. He judges the greatest successes to lie in nature conservation and the elimination of leaded gasoline, the greatest failures to be the unwillingness to confront population growth and consumption habits. Hays regards population growth as of fundamental importance in U.S. environmental history, but I do not think he makes a strong case for this notion. His treatment of population is slender (pp. 11–12, 16) and offers no data at all. In summarizing (p. 233) he mistakenly says that since 1945 the U.S. population has grown "equally rapidly" as the economy (if that were true, per capita income would be the same today as in 1945). His general conclusion, that the impact of environmental concern on U.S. politics has been "modest, selective, and incremental, rather than comprehensive" (p. 234), is about right; no one open to persuasion is likely to believe otherwise after reading the book.

A History of Environmental Politics since 1945 has no footnotes. Hays refers the reader to his 1987 book and to documents deposited in the Archives of Industrial Society at the University of Pittsburgh. But he does provide sixteen pages of annotated bibliography. The prose is clear and serviceable, not flashy. The book will not attract readers for its style, but it offers a considered, comprehensive account of its subject, with greater insight into the political process than any other book in the field.

J. R. McNeill

Christian C. Young. *In the Absence of Predators: Conservation and Controversy on the Kaibab Plateau*. 269 pp., illus., bibl., index. Lincoln/London: University of Nebraska Press, 2002. $49.95, £37.95 (cloth).

By the 1920s the Kaibab Plateau had become a textbook example for two sciences: geology, because of the Grand Canyon; and biology, because of its immense herd of mule deer. The two were, in fact, politically related, because in 1906 President Roosevelt had declared the entire plateau a game preserve, thus sparing the canyon from development. National park status did not arrive until 1919. Shortly thereafter the deer population seemed to explode, from perhaps four thousand to one hundred thousand, becoming the very paradigm of a wildlife "irruption." The swarm posed fundamental challenges both to conservation and to the sciences on which conservationists putatively based their policies. The Kaibab deer was, in brief, the spotted owl of its day.

What happened—or, more correctly, what the various agencies, scientists, and popular media thought happened and what they sought to make of it—is the subject of this important and thoughtful study. It isn't a pretty story. Everyone could agree that the swollen population of deer exceeded what the Kaibab's forage could support. But how this situation arose, what exactly it meant, whether it was in truth a crisis, and what one might do about it—on such matters there was little consensus. There was scant agreement even about how many deer there were, much less how many the Kaibab might support, and still less about how to massage a bouncing population in a landscape subject to wild climatic swings. Ecology, game management, the concept of carrying capacity, techniques for estimating populations—all seemed to promise science-based formulas for analysis, but they collapsed in the field, often proving to be little more than metaphors. Management fell to politics, itself deeply divided between the Forest Service and National Park Service, the Arizona Game Commission, the Biological Survey, the ranching and tourist industries, and environmental groups with their special access to popular media. The "facts" of the Kaibab deer proved as elusive as the herd.

Every group spun the events to its own purpose, resulting in a menagerie of political parables, ever-simplifying diagrams, and anecdotal numbers. Surely the deepest casualty, however, was the naive belief that science could solve the problem. It was never even clear that the "problem" was scientific. Rather, it was about val-

ues—aesthetics, ethics, economics—among which politics alone could decide. Eventually the deer herd declined. In 1970 Graeme Caughley published in *Ecology* a damning critique of the "Kaibab story," and with the deer no longer scouring imaginations as they browsed, the "problem" went away.

The strength of the book is that it lays out in grinding detail just how the situation evolved. Christian Young's style, with one declarative sentence following another, is ideal for conveying the numbing confusion that resulted as one inadequate survey succeeded another and one flawed idea stumbled after the next until an artificial clarity was imposed. Yet at times the text hovers close to the imitative fallacy, as though it must recapitulate (not simply explain) the state of misunderstanding. It needs an occasional Homeric period or Ciceronian peroration to make this muddle into a narrative. Just as the Kaibab story is about politics, not fact-based science, so its history is about art, not citation-based social science.

In the Absence of Predators deserves a wide audience. It challenges naive confessions of science and creeds of environmentalism much as the higher criticism did simple religious faith. Interestingly, what worked best on the Kaibab were annual winter counts undertaken by representatives of the major agencies. The numbers they tallied were suspect, but the camaraderie produced by working on a common problem helped make possible the political compromises on which regular management depended. That's not a bad model for historians.

STEPHEN J. PYNE

■ Sociology & Philosophy of Science

Miriam Solomon. *Social Empiricism*. xi + 189 pp., notes, refs., index. Cambridge, Mass.: MIT Press, 2001. $32 (cloth).

At some point in the intellectual history of scientific belief, we invented a space between traditional epistemology, which focuses on rationality, truth, and cognition, and conventional sociology of knowledge, which focuses on social, institutional, and historical contexts of knowledge. Theorists rushed in. As it now stands, social epistemology, as this new space has come to be known, counts among its members scholars who retain a primary interest in truth and its justification, those that are more concerned with the general social norms that influence the development of distinct patterns of belief, and those that concentrate on very particular influences on scientific knowledge production, such as feminism.

Miriam Solomon's *Social Empiricism* falls into the first category, although she is also influenced by feminist theories. She believes that, at best, truth in scientific theories can be known only in hindsight. Hence she sets out to develop a method by which empirical success in science, which she takes to be a central indicator of truth, can be both measured and normatively evaluated. To do this—and this is what will be of most interest and relevance to historians—Solomon suggests that philosophers apply what she calls "whig realism" to their interpretations of historical accounts of scientific change. Like whig history, whig realism evaluates past theories in terms of the present; however, in Solomon's social empiricist version of whiggism, there is a slight modification of the premise. In keeping with a naturalistic orientation to epistemology that values empirical investigation over theoretical constructs, past theories are evaluated according to the empirical success they enjoyed during the time that they existed; however, that success is explained from a whig perspective. For example, the success of a scientific theory that was once popular but that is now consigned to the scrap heap can be explained by the axiom that "there is some truth in the theory." In other words, even though theories from the past might have been wrong, if they were accompanied by significant and robust empirical success we can, because we have access to subsequent theorizing, see what it was that made them so compelling to earlier scientific communities.

Naturalized social epistemologies such as social empiricism aim to reconceptualize epistemology as an empirical discipline to be approached with the methods of natural science. To that end, Solomon advocates a form of multivariate analysis of theoretical change that is designed to measure the distribution of research effort in a scientific community. She uses written accounts of historical controversies as her raw data, mines them for factors that influence the direction of theory choice, extracts these factors and lists them, and then assigns a positive or negative value to them depending on whether they favor or disfavor a particular theory choice. In order not to reproduce the internal/external and cognitive/social dichotomies that characterize older epistemologies, Solomon separates influencing factors into what she calls empirical and nonempirical decision vectors. Empirical decision vectors cause preferences for theories with empirical success, while nonempirical decision vectors in-

clude all other reasons for choosing one theory over another. Typically, though not wholly, empirical decision vectors relate to data and nonempirical decision vectors relate to ideologies, psychologies, and values. If, when all has been plotted and added, the numbers indicate that empirical decision vectors have been distributed equitably between competing theories, and nonempirical decision vectors have been distributed equally, then it can be said that the scientific community has been ideally normative.

While *Social Empiricism* may be of crucial interest to other like-minded social epistemologists, it is unlikely that this quasi-quantitative method will be preferred by historians over well-argued, reflexive, rigorously documented, narrative interpretations of scientific change.

ANNE GATENSBY

Michel Dubois. *Introduction à la sociologie des sciences et des connaissances scientifiques*. x + 321 pp., tables, apps, indexes. Paris: Presses Universitaires de France, 1999. Fr 139 (paper).

In the English-speaking world, there are as yet no general introductions to the sociology of science. We find "advanced introductions" that concentrate on one approach, but no overall view from which one could measure the evolution of the field from, say, Émile Durkheim and Marcel Mauss's famous 1903 paper on primitive forms of classification to contemporary research in the sociology of scientific knowledge, including Max Scheler's and Karl Mannheim's philosophically oriented sociology of knowledge and Robert K. Merton's empirical analysis of scientific communities. It is no small paradox that such a textbook comes from a country in which the sociology of science is a specialty much less developed than in the Anglo-Saxon world. For obscure reasons, four introductions to the sociology of science were published in France between 1995 and 2000, despite the fact that few courses in this field are offered in the republic. Two are short (128 pages each), and two are more substantial (more than 300 pages).

Whatever the reasons for this editorial surge, the book under review offers a general introduction to the field. It is divided into five parts. The first is a chronological overview that briefly presents Durkheim, Hessen, Scheler, Merton, Kuhn, Barnes, Bloor, Collins, Knorr-Cetina, Latour, Lynch, Mulkay, Law, and Lemaine. It is surprising to note the absence of Mannheim, who should have been given more prominence than Scheler—not only because he will reappear in the 1970s in the context of the strong program but also because Merton's program starts with a detailed analysis of the limitations of Mannheimian sociology of knowledge.

Part 2 covers in more detail the sociology of scientific communities as seen through Merton's norms and T. S. Kuhn's paradigms, while Part 3 looks at social stratification, work organization, and networks. Part 4 is more philosophical and focuses on conventionalism, centering the analysis on Pierre Duhem's thesis while also discussing Karl Popper and Paul Feyerabend. Finally, Part 5 discusses problem choices in science and the emergence of specialties, as well as the social construction of facts.

Generally speaking, Michel Dubois's choices of topics reflect a fair presentation of the diverse traditions; he does not try to diminish the value of one to the profit of another, though I do perceive a bias against the constructivist school and a leaning toward a classical rationalism represented in France by the sociologist Raymond Boudon (who, by the way, receives too much credit here, for he never really contributed to the sociology of science). One virtue of the book is that it gives due credit to the role of Gerard Lemaine and Benjamin Matalon, who did important work in the 1970s and whose contributions have, curiously, been erased from the "Anglo-Saxon" view of the field since the 1980s. These details have some importance in light of the fact that textbooks are also a way of presenting an "official history" of the field to newcomers, who learn what we want them to know and remain ignorant of what is left out of the table of contents.

As a faithful disciple of Boudon, his thesis advisor, Dubois has difficulty understanding Pierre Bourdieu's theory of the scientific field, which, he says, is based on a "psychology of scientists." For Bourdieu, the so-called strategies and interests of actors are dictated by a practical sense (the habitus) that has nothing to do with psychology or with consciously calculating the odds of an event but more with a sense of play, like hitting or catching a ball in a baseball game. The weakest part of the book is certainly its tentative explanation of the success of the constructivist view of science. Following the lead of Boudon, Dubois suggests that this success can be explained simply by invoking general social factors like the fact that relativists' values are consonant with the dominant trend of modern societies—as if there were no good conceptual reasons for the success of relativism. The problem is that an explanation in terms of "values" is too simplistic, vague, and borders on the tautological. Though the social context obviously

must be taken into account, Dubois should at least have added that there are good "internal" (or cognitive) reasons for this success, like the fact that the constructivist/relativist approach has raised new questions that revitalized the way we look at the practice of science.

Despite these caveats, this work can serve as a useful textbook for an introductory course in sociology of science. But we must first hope that such courses will be offered more frequently in the French university system.

YVES GINGRAS

■ Reference Tools

Ilaria Porciani; Mauro Moretti (Editors). *L'università italiana: Bibliografia 1848–1914*. (Biblioteca di Bibliografia Italiana, 172.) x + 217 pp., indexes. Florence: Leo S. Olschki Editore, 2002. $26 (paper).

This book provides a list of bibliographical references regarding Italian universities from 1859 to 1914. It also includes an introduction by the editors, an author index, and a subject index. The period considered begins in 1859, the year in which the temporary governments of the old Italian states initiated new policies for universities in expectation of the creation of a unified national state, which would come into being in 1861. Significant items for the years from 1848 to 1858 are also included. The end of the period is marked by the beginning of World War I.

The list contains 4,423 items. They relate not only to the five "faculties" that during the period in question constituted the Italian university in the narrow sense (i.e., "giurisprudenza" [law], "medicina" [medicine], "lettere e filosofia" [humanities], "matematica e scienze naturali" [mathematics and natural sciences], and, until 1873, "teologia" [theology]), but also the so-called superior schools, which later became the nuclei of the new faculties of Italian universities. The items listed in this bibliography are generally books or articles that appeared in periodicals. The journals considered are of three kinds: significant periodicals focused on culture and politics, either from a general viewpoint, such as the *Rivista dei Comuni Italiani* [*Journal of Italian Towns*], or from a particular viewpoint, such as *La Civiltà Cattolica* [*Catholic Civilization*]; periodicals focused on specific scientific disciplines; and periodicals focused on the problems of the university.

All the references in the *Bibliografia* pertain to the debate on Italian university education in the period considered. Readers interested in the history of science will not generally find any indication of scientific texts written by university teachers or of the textbooks adopted for specific courses. On the other hand, they will find bibliographical indications of debates, comments, and news about courses. In fact, the principal aim of the volume is to provide a useful database for historians specifically interested in the Italian universities as institutions. Of course, the implications of the history of institutions for the histories of culture, education, and science are important, so the book will be useful for a larger number of scholars. In particular, the role of universities in the political and social development of the Italian national state after its constitution was very significant in many different aspects, including the development of the various disciplines, the creation and expansion of the ruling classes, and the tension between trends toward national unification and those toward local differentiation.

Two other books are closely connected to this one. The first, *L'università italiana: Repertorio di atti e provvedimenti ufficiali, 1959–1914,* by Ilaria Porciani (Olschki, 1992), includes references to official documents regarding Italian universities in the same period. The second, *L'istruzione universitaria (1859–1915),* by Gigliola Fioravanti, Mauro Moretti, and Porciani (Ministero per i Beni e le Attività Culturali, 2000), is the fifth in a series of books regarding the sources on the history of Italian education that are stored in the Archivio Centrale dello Stato. Unlike the *Bibliografia* and the *Repertorio* of official documents, *L'istruzione universitaria* does not include a list of sources but presents a selection of documents.

These three books, both individually and taken together, provide a useful tool for the study of significant events in the history of the Italian university system. Among numerous examples, we can consider the attempt at reform carried out by the physicist Carlo Matteucci when he became a senator and then, at the end of March 1862, a government minister. That attempt provoked a strong reaction in the academic community and largely failed. In the *Bibliografia* there are thirty-eight records regarding Matteucci in the years 1861–1867, including letters and reports that he wrote or that were written to him, speeches in Parliament, contributions to journals, and collections of writings. The first of these documents is the important "Relazione e progetto di legge per il riordinamento dell'istruzione superiore" ["Report and Draft Law for a New Organization of Higher Education"], presented in June 1861, a few months af-

ter the institution of the kingdom. The *Repertorio* notes sixteen items regarding Matteucci, including decrees, circulars, and the important law of 31 July 1862. References to Matteucci are also frequent in the documents presented in *L'istruzione universitaria.* For instance, a letter written in July 1862 by the mathematician Luigi Cremona, who would become a government minister in 1898, is very enlightening about the debate over Matteucci's policies toward universities.

This book was published in the series "Biblioteca di Bibliografia Italiana," which started in 1923 and now includes more than 150 books. This series documents a lasting interest in the history of books, and also of manuscripts, and the idea that accurate catalogues are very useful for this history.

The *Bibliografia* was put together in the cultural environment of Unistoria, a center for the study of the development of Italian universities founded in 1991. The first book published by the center, *L'università italiana tra Otto e Novecento: I modelli europei il caso italiano* [*Italian Universities between the Nineteenth and the Twentieth Century: The European Model and the Italian Case*] (Jovene, 1994), includes contributions by various authors, among them the editors of the *Bibliografia.* The essay by Porciani is focused on Matteucci's attempted reform, that by Moretti on another reform effort, about half a century later, by the "Royal Committee" chaired by the mathematician Ulisse Dini. The three books published by Unistoria to date are devoted to the study of the connections between the building of the Italian nation, the history of Italian universities, and the development of the various disciplines in Italy. They also carry out comparisons between the history of Italian universities in the period under consideration and the history of the universities of other European countries. For example, this last topic is treated in "Modelli di università nell'Ottocento Europeo: problemi di scienza e di potere" ["University Models in the European Nineteenth Century: Problems about Science and Power"], by Pierangelo Schiera, included in *L'università italiana tra Otto e Novecento.* An example of a direct application of the Unistoria approach to a specific discipline is Roberto Maiocchi's essay "Scienza e nascita dell'industria elettrica italiana" ["Science and the Birth of the Italian Electrical Industry"], published in *Università e scienza nazionale,* edited by Porciani (Jovene, 2001).

UMBERTO BARCARO

Clifford M. Nelson (Editor). *Records and History of the United States Geological Survey.* (USGS Circular 1179.) Reston, Va.: U.S. Geological Survey, 2000. CD-ROM. Free.

We all know how expensive and time consuming archival trips can be, especially if one is prospecting and not yet in sure possession of a scholarly mother lode. It is therefore very useful and economical to have an index of accessioned documents (in easily portable form) to peruse before arriving at the archive. Clifford Nelson of the U.S. Geological Survey has put together just such a useful tool for historians of science and technology and students of U.S. environmental history.

Circular 1179 is a CD-ROM that bundles together two previously prepared documents. The first is Reneé M. Jaussaud's inventory of the documents accessioned, by the end of 1997, into Record Group 57 (U.S. Geological Survey) at the National Archives and Records Administration's (NARA) Archives II facility in College Park, Maryland. (Materials in NARA's regional archives are not a part of the inventory.) The second is a reissue of USGS Circular 1050, Mary C. Rabbitt's *The United States Geological Survey, 1879–1989,* a pamphlet-sized (ca. 60 pages) reduction of her well-known history of the USGS, available here in both HTML and PDF formats (a copy of Adobe Acrobat 4.0 is included on the disk). The inventory of documents and the organizational chart of the survey are in PDF only.

This is a huge archive of material. The annotated index (by Jaussaud) runs to 679 pages. It begins with the records of the King, Powell, Hayden, and Wheeler surveys, moves on to the records of the USGS, 1879–1997 (mistitled in the index header as 1839–1997, but 1879 is clearly meant), and then presents the records of the Administrative Division, the Publications Division, the Engraving and Printing Division (dates of coverage differ for these different segments of the survey), the Geologic Division, the Mapping Division, the Water Resources Division, the Conservation Division, and the Alaska Branch.

The annotations are extremely helpful. How else would one know that the records of the USGS participation in Operation Plowshare (geared to the peaceful uses of nuclear energy), control of continental shelf oil drilling, and cooperation with the BIA (Bureau of Indian Affairs), the BLM (Bureau of Land Management), and many other agencies are all to be found in the records of the Conservation Division? Or that

the Mapping Division produced fifteen films about map-making, including *Global Concepts in Maps* (1947)? Or that correspondence on the very interesting subject of the disposal of nuclear waste between 1947 and 1974 is found in the Office of Radiohydrology subsection of the Water Resources Division?

The annotated part of the accession list, treated by document group and administrative division and subdivision, takes up the first 220 or so pages. The next 400-plus pages are an analytical index of the material's actual location, box by box, in a series of appendixes. Thus we have not only the annotated description but the exact location; so that it would be possible to preselect documents—all on the same topic, from widely separated subdivisions—before ever arriving at the archive. This is a wonderful achievement.

One warning: because a decision was made to add an introduction to the index of RG 57 with roman numerals (i–vi), the "go to page –" utility on the Acrobat Reader is thrown off consistently by 6 pages. Thus if you type "page 120" in the page field you will be sent to page 114 because the computer has counted pages i–vi as 1–6, so that the numerical entry "1–6" is read as "7–12," and so on. A distraction, but easily overcome.

I was astonished by the wealth of documents and by how far the Geological Survey's activities have penetrated natural resource management beyond the original survey charter of "minerals, lands, and geology for the common defense and general welfare." There seems to be no part of national life and economic development left untouched by the activities of the survey—and it is massively documented and readily available (now!) for study.

This CD-ROM is available *free* from USGS Information Services, Box 25286, Federal Center, Denver, Colorado 80225 (fax: 303-202-4693). The file number is 21-1179. Reneé Jaussaud and Clifford Nelson (and also Mary Rabbitt) deserve our thanks for this extraordinarily useful and promising research tool.

MOTT GREENE