BOOK REVIEWS

The Pauling Catalogue, Oregon State University Libraries, Corvallis, OR, 2007, 6 vol., $ 125.

As Francis Bacon wrote some four hundred years ago "Some books are to be tasted, others to be swallowed, and some few to be chewed and digested." — Francis Bacon, English philosopher, essayist, statesman, and jurist, *Essays*.

This set of books certainly fits into the first category: to be tasted, not by a single nibble but by many, at different places, at random or systematically; both approaches will be rewarding. The collection is a complete catalogue of everything Pauling kept. Some people never throw anything away. In particular, they keep every scrap of paper. Pauling was one of these. From an early age he kept anything written that concerned him: manuscripts of publications, lecture notes, laboratory notebooks, research notes, letters received, copies of letters sent, newspaper clippings, photographs, all the other paraphernalia that turned up in the course of a long, active, creative life. Presumably he knew already as a young student that he was going to be important and that everything that concerned him would later, after his death, be of interest to historians and students of science. There is correspondence with hundreds of chemists, physicists, and biologists all over the world who left their mark on twentieth-century science, as well as with politicians and other public figures during World War II and the long cold war that followed. For the illustrations alone, nearly twelve hundred of them, anyone interested in Pauling's life should buy the catalogue. In Volume V there is a photograph of the five-year old Linus, already a person to be reckoned with—and it is clear that he was already aware of this (Photograph supplied by Oregon State University Libraries).

Apart from the illustrations and some introductory material by several authors, including an extensive year-by-year account by Robert Paradowski of the main events in Pauling's life from childhood onward—even earlier since his ancestry is also traced—the six volumes consist of lists: lists of the vast store of documents, more than a half million of them, held in the collection of *Ava Helen and Linus Pauling Papers* at Oregon State University Library. These lists make it possible for anyone to trace whether any particular document or set of documents exists in the collection and to identify it by a simple code. The individual volumes deal with the many facets of Pauling's life and his relationships with the world.

Volume 1 lists his correspondence, including postcards, with the outside world: scientists, politicians, public figures, everyone excepting family. This is followed by a complete list of his publications, not only scientific papers and books, but also popular articles, letters to the editor, and so on; then follows a list of manuscripts and typescripts of articles and of his many speeches delivered at various occasions through the years. It is interesting to see how the emphasis gradually changed from purely scientific topics towards political themes and health, although scientific topics still held his attention to the very end. Volume 1 continues with lists of manuscripts and typescripts of articles and speeches, together with relevant correspondence.

Volume II, the Science Section, lists material connected with Pauling's scientific work, divided into fifteen subsections, ranging from structural chemistry and quantum mechanics through the beginnings of what was

to become molecular biology, and including his work on numerous scientific advisory committees. Also included here are guidelines to the contents of Pauling's forty-six research notebooks, spanning the years from 1922 to 1994, fascinating material providing glimpses of how he approached scientific problems. An appendix to this volume contains extracts from Pauling's 1917 diary, begun during the time when he was preparing to enter Oregon Agricultural College without a high school diploma. He sometimes felt unequal to the task. He wrote: "I will not be able ... to do justice to the courses ... but it is too late to change now... so I will only do my best."

Volume III contains the Peace Section, consisting of material related to Pauling's work on behalf of world peace, including the famous 1957 petition to the United Nations, signed by more than 11,000 scientists, to stop the testing of atomic weapons. To modern sensibilities, it seems incredible that there could have been popular as well as official opposition to such a petition at a time when tons of radioactive material were being liberated every year into the atmosphere. But opposition there was: witness his encounter with the U. S. Senate Internal Security Sub-Committee (Volume IV). Eventually, Pauling's initiative led to the 1963 Partial Test Ban Treaty and to the award of the Nobel Peace Prize in the same year. In his long life, Pauling received many other honors and awards, far too many to mention here; they are all listed in Volume III, which also contains a section devoted to material relating to Linus's wife Ava Helen, a supporter and fellow activist from 1923 until her death in 1981, and manuscripts of articles and speeches, as well as correspondence with family and friends.

Volume IV contains material concerning various aspects of Pauling's life and career: academia, political issues, legal, business and financial, personal and family, and scrapbooks. In addition, it lists the contents of Pauling's personal safe, including intimate letters between Linus and Ava Helen, as well as other documents of a sensitive nature, such as correspondence relating to the Bomb Test Petition and other controversial matters. The personal safe also contains information about Pauling's scientific war work dealing with blood plasma substitutes and rocket propellants, much of it still marked "secret" on arrival at the Library and requiring belated official clearance.

Volume V lists extensive audiovisual material extending over several decades, from audio-cassette tapes to film reels, documenting public lectures, and radio and television interviews. It also contains information about more than 5,000 photographs of Pauling, his family, and friends. Finally, comes Volume VI. This lists newspaper clippings, magazine profiles, and journal articles concerning Pauling, and—surely one of the most interesting collections, at least for me—the catalogue of his personal library of more than 4,000 books, revealing the range of his reading. A library tells one a lot about its owner. Scanning through this list, one may feel rather like a visitor in the library of a famous personage, snooping through the shelves to infer something about the literary tastes and interests of one's host. One finds here, as expected, works on science, health, history, and politics; not much on music, art, and literature, neither classical nor modern; no Joyce, no Kafka, no Proust, but, perhaps surprisingly, T. S. Eliot, *Collected Poems 1909 - 1935*. Pauling evidently had a taste for detective stories—more than twenty volumes by Georges Simenon—and for crossword puzzle collections.

One can go on, picking raisins from a rich cake—six rich cakes containing many thousand raisins and plums. It must be made clear; the *Catalogue* is not a biography, far from it. For that the best offering is probably still Thomas Hager's 1995 *Force of Nature: The Life of Linus Pauling*, but it provides an immense amount of information about Linus Pauling and his times and will be the invaluable source of material for future biographies, especially those that will be written when we, the people who knew Pauling, listened to him, argued with him, and learned from him, have passed on. *Jack D. Dunitz, ETH-Zürich, Switzerland.*

Photograph: The five-year old Linus Pauling (with permission of the Oregon State University Library, Special Collections).

Lavoisier in Perspective. Marco Beretta, Ed., Deutsches Museum, Munich, 2005, hardcover, 207 pp, ISBN 3-924183-07-4, € 24.80.

In 2003, the Deutsches Museum in Munich decided to celebrate its centennial by inducting the great French chemist, Antoine-Laurent Lavoisier, into its Ehrensaal, or Hall of Fame. A bust of Lavoisier was commissioned and placed in the hall among those of other great scientists, all of whom were (at that time) German. To further underscore the museum's earnest departure from nationalistic exclusivism, a group of international scholars (four German, four Italian, two French, and one each American, Japanese, and Canadian) were assembled under the able direction of Marco Beretta (University of Bologna) for a two-day symposium of which this collection of essays is a consequence.

As in almost any such collection, the styles, methodologies, subjects, and approaches of so many diverse authors make a summary evaluation difficult. Simplifying the task somewhat is the fact that presentations from each of the three sessions of the symposium were devoted to a common theme. The first session, for example, dealt with—to use the editor's words—"Lavoisier's experimentalism through his use of innovative instruments, such as the calorimeter and gasometer, and the theories which stood behind them." Three of the articles in this section follow precisely the conference theme, "Lavoisier in perspective," by not only analyzing Lavoisier's experiments on calorimetry, gasometry, and respiration physiology (spiroergometry) but by placing them in a larger historical framework that identifies Lavoisier as the founder of several significant lines of scientific research, some of them having to do not merely with chemistry but also with physics and physiology. In addition, Peter Heering of the Carl-von-Ossietzky University, Oldenburg, presented an interesting summary of a work in progress, the attempted replication (in so far as it is possible) of the calorimeter of Lavoisier and Laplace. The object of this exercise is to ascertain through historical reenactment of the original experiments details of specific conditions and procedures that the eighteenth-century experimenters failed to mention or were, perhaps, even unaware of. Results so far are only preliminary.

If there is one thing that nearly every historian of chemistry agrees upon, it is the oft-repeated view that the essential contribution of Lavoisier's chemistry was based upon a careful comparison of the weights of all the substances entering into chemical reactions to the weights of all the substances emerging from them—in C. C. Gillispie's words, "the spirit of accountancy raised to genius." In his symposium contribution, Jean-Pierre Poirier, an economist and recent biographer of Lavoisier, demonstrates convincingly that this "balance sheet method" pervaded nearly all aspects of Lavoisier's career, not only in chemistry (from almost before its very beginnings), but in his directorship of the Gunpowder Commission, his tax farming, his experimental agricultural work at Freschines, his presidency of the Board of Directors of the Discount Bank, etc. Poirier also attempts to trace (somewhat less convincingly, I think) the origin of Lavoisier's quantitative methodology to his precision-obsessed teacher of mathematics and astronomy at the College Mazarin, the Abbé Nicolas-Louis de la Caille.

As the divisions between the articles of this book are not manifest, Poirier's presentation could just as easily belong to the second session, devoted to "the strategies Lavoisier adopted in order to persuade his public of the validity of the new approach to chemistry." This section of the book is the least successful in coherently satisfying its avowed purpose. The papers range from a fascinating and well contextualized assessment (by Keiko Kawashima at the Nagoya Institute of Technology) of Madame Lavoisier's motivations in assisting her husband as translator of scientific works from the English, artist, and recorder in the laboratory to what amounts to a detailed catalogue (by Patrice Bret, General Secretary of the Lavoisier Committee) of Lavoisier's institutional affiliations (accompanied by charts). The first article, although excellent in itself, has only a remote association with Lavoisier's persuasive strategies, and the second, although clearly related to the dissemination of Lavoisier's influence, is more a like a reference work than a coherent historical essay.

In his article Ferdinando Abbri (University of Siena at Arezzo) attempts to widen the perspective of the Chemical Revolution by showing that it consisted of much more than a simple Anglo-French dialogue concerning pneumatics and that Lavoisier's complex relations to researchers of other nationalities, primarily German and Scandinavian, cannot be ignored. Abbri points especially to Lavoisier's connections to Georg Ernst Stahl (creator of the phlogiston theory), Johann Friedrich Meyer (whose theory of *acidum pingue* Lavoisier once found attractive), and finally to the great Swedish chemist, Carl Wilhelm Scheele, whose rival theories on fire and air Lavoisier confronted with a detailed and extensive critical analysis.

The final section of the book, devoted to the "image of Lavoisier in modern historiography, with particular attention to the Franco-German debate," consists of two papers which, taken together, provide an interesting comparison of the diverse uses (and abuses) that (primarily nineteenth century) German and French chemist/historians made of Lavoisier's image. According to Christoph Meinel (University of Regensburg), the German chemists endeavored to use Lavoisier to "define the boundaries of their discipline," and their assessments of his career were influenced by (among other things) nationalistic prejudices, the increasing preeminence of organic chemistry (where Lavoisier's new nomenclature was largely irrelevant), and the widespread notion that Lavoisier's major scientific contributions lay more in the realm of physics than in the realm of chemistry (in an era in which chemists were increasingly and understandably concerned about disciplinary autonomy). Mi Gyung Kim (North Carolina State University) presented what may be considered a companion to the preceding article. Although dealing with French historiography of the Chemical Revolution in general, she concentrates her attention primarily on the ways in which three of the most prominent nineteenth-century French chemists, Jean-Baptiste Dumas, Charles-Adolphe Wurtz, and Marcellin Berthelot, manipulated interpretations of Lavoisier's achievement to reflect favorably on their own careers.

Following this collection of scholarly articles, Marco Beretta and Andrea Scotti append a kind of tour of their extraordinary web site, the Panopticon.Lavoisier (http://moro.imss.fi.it/lavoisier/), at which they have assembled in one virtual location an enormous trove of primary and secondary sources concerning Lavoisier and the Chemical Revolution, including six volumes of Lavoisier's collected works, bibliographies of primary and secondary sources, digitized articles, chronologies, iconographies, and much more. Scholars will now be able to do much of their research without having to desert the comfort of their armchairs and without having to worry about bus schedules or library closing times.

Despite some excellent and interesting essays, what we have in this book is, on the whole, a more-or-less typical collection of conference papers; and like most such papers, there is little in them that one could call earth-shakingly novel. With few exceptions, they tend to be fairly narrowly conceived, highly specialized, and of interest primarily to professionals in the field. *Prof. Jerry B. Gough, Department of History, Washington State University, Pullman, WA 99164.*

J. C. Poggendorff—Leben und Werk. Heiner Kaden and Benno Parthier, Ed., Wissenschaftliche Verlagsgesellschaft mbH, Stuttgart, 2005, 61 pp, ISBN 3-7776-1406-8, € 33.

"*Poggendorff,*" a byword for historians of science, is one that rolls easily and unconsciously off the tongue as do "*Beilstein*" for organic chemists and "*Gmelin*" for inorganic chemists. The complete title for the multivolume biographical-bibliographical work, coined by its founder J. C. Poggendorff, although fully descriptive of the contents, is virtually unknown:

Biographisch-literarisches Handwörterbuch zur Geschichte der exacten Wissenshaften enthaltend Nachweisungen über Lebensverhältnisse und Leistungen von Mathematikern, Astronomen, Physikern, Chemikern, Mineralogen, Geologen usw. aller Völker und Zeiten, Gesammelt von J. C. Poggendorff, Mitgleid der Akademie der Wissenschaften zu Berlin.

End of an Era

The occasion for the appearance of this current German publication, edited by Heiner Kaden, Sächsische Akademie der Wissenschaften zu Leipzig, and Benno Parthier, Deutsche Akademie der Naturforscher Leopoldina, Halle, is the remarkable milestone for this invaluable resource: publication of the last volumes and thus the discontinuation of the work, after141 years. The book consists of publication of a series of lectures presented in Leipzig in October, 2004 "..aus Anlass des Abschlusses eines

Jahrhundertwerkes" [on the occasion of the termination of a centuries-old work.]

After an explanatory introduction by the co-editors, there follow five presentations describing J. C. Poggendorff as scientist, editor, and biographer. The first, by the final editor of *Poggendorff,* Hans Wussing, covers the founding and continual growth and development of the reference work up to the final days. In the second lecture Martin Henke pays tribute to a generous benefactor, Berend Wilhelm Feddersen, whose financial support enhanced the publication of *Poggendorff* and guaranteed its continuation. Next, Gotthard Lerchner provides perspective for the publication of *Poggendorff* along with other contemporary German bibliographies and brings the audience up to the present time with the development of electronic data bases. Poggendorff the man is described both personally and professionally in the next two lectures by Heinz Penzlin and Heiner Kaden.

Although the attractive publication, part of an extensive series of treatises emanating from the Saxon Academy of Sciences in Leipzig, is only 61 pages in length, it provides a generous offering of fascinating information about J. C. Poggendorff the scientist and the conception and lasting legacy of *Poggendorff*. Only some of the highlights can be covered in this review. Readers would be rewarded by delving into more of the rich historical details.

Poggendorff the Scientist and Editor

Johann Christian Poggendorff (1796-1877), one of 14 children born in Hamburg, was educated privately and then became a pharmacist's assistant, where he continued to study independently by taking advantage of his supervisor's library. Moving to Berlin in 1820, he enrolled in the 10-year-old Friedrich-Wilhelms University, later to be renamed the Alexander von Humboldt University. Encouraged by his friend Friedlieb Ferdinand Runge (1795-1867), Poggendorff and Runge set up a laboratory in their shared living quarters, where they carried out scientific experiments. While attending lectures at the university, Poggendorff completed a self-directed study on "Physisch-chemische Untersuchungen zur näheren Kenntnis des Magnetismus der voltaischen Säule," which was published in *Isis von Oken* in 1821. This work—Physical-chemical Investigation of a Better Understanding of Magnetism in the Voltaic Pile—is often cited as the forerunner of measuring devices for minute electric currents.

Poggendorff was never examined for a degree at the university. He remained independent but professionally recognized, having been elected to the Königliche Akademie der Wissenschaften, Berlin in 1823. Particularly noteworthy is the awarding of the honorary "Doktordiplom" by F-W University in 1834, a tribute to his meritorious achievements in physics. First appointed as a professor without salary, Poggendorff was given an annual remuneration of 200 taler after 1842. He lectured at the university until the age of 78, primarily in the history of physics and chemistry. In exchange for an apartment, Poggendorff performed meteorological measurements in the academy's observatory, where Mitscherlich and Heinrich Rose also had laboratories. He became a life-long friend of the brothers Heinrich and Gustav Rose. He married the cousin of the wife of Heinrich Rose, and his daughter later married the son of Gustav Rose. In his lecture Penzlin includes a family tree covering five generations.

With the urging of Heinrich Rose, Poggendorff became the second editor of *Annalen der Physik und Chemie* in 1824 (the first being L. W. Gilbert) and moved the operation, which he continued until his death 52 years later, from Leipzig to Berlin. The highly respected periodical soon became known as the *Poggendorffsche Annalen*. His first volume contained publications by Berzelius and H. and G. Rose. Heinrich Rose published exclusively in Poggendorff's journal thereafter. Declining professorial offers at Gieβen and Leipzig, he opted to be independent as editor, science historian, and member of the Berlin faculty and the Berlin Academy.

Poggendorff, The "Handbook"

Poggendorff's early fascination with history of science and scientists may have originated from a work he coedited with Liebig, *Wörterbuch der Chemie*, published in 1836 by Vieweg, Braunschweig. Many notable chemists and physicists of the day—Gay Lussac, Magnus, Wöhler, Graham—contributed to the effort. By 1856 Poggendorff was working seriously on a collection of biographies of scientists (defined broadly, as is reflected in the full title of the handbook). The first two volumes (I and II), covering scientists in alphabetical order, was published by Verlag J. A. Barth in 1863. It contained 8,500 entries of scientists: birth, death, academic training, and a comprehensive list of publications, arranged by periodical source. Poggendorff had accumulated extensive material for supplemental volumes by the time of his death in 1877. The legacy was continued by a host of dedicated

editors and benefactors, with the result that additional volumes continued to appear, albeit irregularly [III, 1898; IV, 1904, V, 1925; VI, 1940 (4 parts)]. Material that had been gathered for subsequent volumes, beginning with 1932, was destroyed during WWII; but nevertheless Volume VIIa (in 5 parts), limited to German speaking scientists, appeared in 1951. This was followed by a bibliography of international scientists in Volume VIIb (8 parts) in 1971. Now with the completion of Volume VIII in somewhat abbreviated form (but still "A-Z"), the editorial board and publisher came to the painful conclusion that the project must come to an end. Historians of science need not despair, however, for Poggendorff survives in electronic form, with 28,000 entries! [See www.poggendorff.com]

In one final paper in this symposium, B. Parthier provides tables of 19th-century members of Leopoldina-Akademie, Halle: one of physicists, 1791-1895, one of chemists, 1792-1895, and one of the seven presidents of the academy in that era. This offers insight into many of the scientists who were contemporaries of Poggendorff. *Paul R. Jones, University of Michigan.*

La Revolución Química. Entre la Historia y la Memoria (**Reviewer's translation:** *The Chemical Revolution. Between History and Memory*). Jose Ramón Bertomeu Sánchez and Antonio García Belmar, Publicacions de la Universitat de València, Valencia, 2006, 296 pp, ISBN: 978-84-370-6549-6. The book is published in Spanish.

The title of the latest collaboration between Profs. Bertomeu Sánchez and García Belmar (1) tacitly reveals the question that lies behind their account of the events of the chemical revolution: why is the chemical community's *memory* of the chemical revolution at odds with the *history* of the chemical revolution as has been described by academic historians? In seeking to answer this question, the authors weave a narrative that attempts to serve as a specific example of the tendency of disciplinary scientists to view the birth of their discipline as a heroic-mythical event (a genius creates chemistry from nothing) against the more nuanced and analytical descriptions of historians. In the particular example of chemistry, the question stated above could also be phrased as follows: why has the chemical community come to posses a *distorted* view of the historical events of the chemical revolution and still believes that chemistry started with the chemical revolution that Lavoisier alone marshaled? For the authors, the existence of these historical errors is a pleasantly convenient excuse to write a revision of the chemical revolution which, as a welcome side effect, might contradict the mistaken belief that there was no chemistry before Lavoisier, and that his revolutionary ideas were the result of his mind alone. Indeed, the bulk of the book does not address the reasons for the existence of misconstrued historical notions in the chemical community, as the question above remains suspended until the last chapter of the book. The remaining seven chapters take up a reexamination of the experiments that formed the chemical revolution, a description of the chemical community before and after the chemical revolution, and a compilation of the responses of the chemical community of the time to the experimental work of Lavoisier.

The richness of the historical period that is covered does not allow for an exhaustive treatment in the 250 pages that comprise the body of the narrative. Instead, choices have to be made, and the historical vignettes described by the authors were selected with the intention of eliminating the vision of the chemical revolution as an event that radiates exclusively from Lavoisier's discoveries (*memory* of the chemical community), to one that flows naturally from the early work of the alchemists and the phlogiston theory of Becher and Stahl (*history*), and where the agency of the discoveries is transferred from one sole genius to the plurality of the chemical community. As it is pointed out in the bibliography, there are few works that provide an account of the chemical revolution along the revisionist ideas stated above, and, as such, this is a welcome addition to the scholarly lit-

erature. Lesser known agents of the chemical revolution are emphasized throughout, thus enriching the canonical historical narrative. On the other hand, the examination of participants whose actions were mainly a reaction to the main events of the chemical revolution requires a vigorous connecting effort that avoids the disintegration of each part of the book into a disjointed collage of seemingly separate historical episodes. At this potential pitfall, the authors only partially succeed, given their tendency to dwell on areas that are somewhat tangential to the main thrust of their stated purpose. It is difficult to understand the relevance of the otherwise fascinating travails of the Spanish chemist Juan Manuel de Aréjula, during an epidemic of yellow fever in Spain in the early 1800s, to the mechanism by which historical concepts about the chemical revolution were formed and disseminated. A minor blemish along these lines is also the diluting excess of detail in the illustration of certain passages. This is only a slight problem because it originates from the obvious erudition of Bertomeu Sánchez and García Belmar, and, while distracting, it is also instructive.

The history is recreated in chronological order, starting with the status of chemistry right before Lavoisier's time (Chapter 1). The carefully detailed passages in this chapter ably accomplish the difficult task of acclimating the reader to the repertoire of chemical ideas and problems of the time: combustion and metal oxidation and phlogiston as its answer, the composition of salts, and the beginnings of "pneumatic chemistry," when air ceases to be an element and acquires a multilayered structure. The authors convincingly and meticulously reveal that the scientist working on problems related to the structure and reactivity of matter in the 18th century operated inside what cannot be called by any other name than a scientific discipline: theories were examined experimentally and critiqued by peers who had attained entry into the chemistry community through professional channels (medicine, metallurgy, pharmacy) or an emerging formal academic instruction.

Chapters 2 and 3 recount, among others, the experiments that led to the law of conservation of mass, the release of oxygen from the pyrolysis of mercury oxide, and the synthesis and analysis of water. The narrative of these two chapters recreates the frenzied seminal events of the 1770-1790s with such exceptional levels of vividness that the entire book is overshadowed by this accomplishment. An entire scientific community is brought to life; its interactions through letters, public lectures, personal contacts, and scientific publications are punctiliously presented and their effects on the revolutionary ideas of the time analyzed. The treatment of Lavoisier's work is quite exceptional as the authors' use of primary sources that analyze the laboratory notebooks of the French chemist enables them to present the thinking process of Lavoisier and the evolution of his own hypotheses in great detail. Reading about Lavoisier's doubts and uncertainties as he started to realize the inevitable transcendence of his experimental results—and how his data slowly undermined and eventually demolished the phlogiston artifice—brings to life the human dimension of an otherwise statuesque historical figure and helps to connect the contemporary scientific community with its own past. To be sure, a great deal of the trepidation that accompanies these historical events is in no small part due to the awareness these actors of the chemical revolution possessed about the consequences of their experiments. Lavoisier and his contemporaries knew there was a "before" and an "after," that they were living in an historical turning point; and they battled fiercely in order to ensure that their own notions (phlogiston or oxygen), as substantiated by experimentation, would survive. Lavoisier, Cavendish, and Priestley influenced each other through their work and engaged in intellectual, pugilistic reexaminations of their experimental data. Some of those encounters are described in the text and help to build the image of the chemical community as a multi-bodied entity, in which the most prominent characters are highly visible because of not only their inordinate intellect, but also because of their ability to stand on the shoulders of a creative and engaging community.

Unfortunately, the narrative becomes quite muddled during the description of experimental details, procedures, and results because of the authors' inexplicable decision to employ in the narrative only the chemical nomenclature of the 1700s (i.e., oxygen = dephlogisticated air). Although a moderately useful glossary follows the book, this is no substitute for the use of modern chemical terminology either exclusively, or in concert with antiquated terminology. The authors accurately predict the controversial nature of their choice and defend it by suggesting the possibility that modern nomenclature would cloud the correct interpretation of the experiments and the ideas being pursued by the scientists of the time; perhaps, but the dual use of ancient and modern terms would have maintained the historical rigor without any of the problems of interpretation. Incidentally, there are no chemical equations in the entire book.

After the chapters describing the actual events of the chemical revolution, the rest of the text is devoted to illuminating how the ideas of the chemical revolution

were received in the European chemical community of the time. Chapter 4 in particular examines the development of devices for the dissemination of the new ideas, including the advent of scientific journals. The journals that are covered in the text and which were partially or exclusively devoted to chemistry include *Observations sur la Physique, sur l'Histoire Naturelle et sur ler Arts; Annales de Chemie* and *Journal de physique, de chemie et d'histoire naturelle*. The text focuses on *Annales* and *Journal*, and, in particular, the process of their founding, their role in the defense of a particular ideology (oxygen or phlogiston), and their underlying philosophy (conservative vs. adventurous).

The chemistry textbooks had to be rewritten after the chemical revolution. In this, Lavoisier took a personal stake; and, therefore, the influence of his chemistry textbook (*Traité élémentaire de chimie*) and his proposal for a new chemical nomenclature (*Méthode de nomenclature chimique*) are exposed to a critical eye. This analysis reveals the possible influence that older textbooks of Macquer and Baumé might have had on Lavoisier's own *Traité*, as well as aspects of the nomenclature work done by some of Lavoisier's predecessors (Macquer, Bergman, and Guyton de Morveau). As in the earlier chapters, this discussion succeeds at presenting Lavoisier as a transforming watershed of ideas and at detailing the historical peculiarities of the time: the authors' description of the idiosyncrasy of compound naming before publication of the *Méthode* is particularly revealing of the great challenges that one would face in characterizing matter when devoid of modern analytical instrumentation!

Chapters 5, 6, and 7 as a whole offer a cogent portrayal of the factors that influenced the manner in which the ideas of the chemical revolution were regarded by the European chemistry community of the early 19th century (partial or complete acceptance, rejection, or adjustment to one's own views). Chapters 5 and 6 dwell, respectively, on professional activity (specifically industry and medicine) and politics, whereas chapter 7 employs a mini biography of the Spanish chemist Juan Manuel de Aréjula to illustrate how the ideas of the chemical revolution flowed from its geographical epicenter (France) to a scientifically and geographically peripheral region (Spain). Professional activity and nationality were major determinants of the type of reaction to Lavoisier's ideas; for instance, while Swedish mineralogists acquiesced or simply ignored the fall of phlogiston (gases are not usually found among minerals and rocks), German academics were very eager to defend vigorously the theoretical construct of their German compatriot Stahl. The nomenclature proposals of the *Méthode* were not taken at face value, but were heavily edited according to the language and the culture of the national chemistry community (the direct translation of certain French terms would have had ludicrous meanings in the Spanish). In a phenomenon that is somewhat foreign to the modern international scientific community, the revolutionary agitation of the first half of the 19th century and the concurrent rise of nationalism did affect much of the behavior of the chemical community, especially because the chemical revolution prompted an interest in the creation of new academic spaces for chemistry instruction, which required that scientists enter the political arena. This is quite well exemplified in the life of Aréjula, an active revolutionary, who exiled himself in England after the restoration of the Spanish absolutist monarch Ferdinand VII in 1823. It is somewhat ironic that Lavoisier also served as a harbinger of prosecution when he was executed!

Finally, having fully explored the historical environment that impinged on the chemical community before, during and after the chemical revolution, in the last chapter of the book the authors move to address the question posed at the beginning of the text (why does the modern chemistry community have a distorted view of the chemical revolution?) (2) by compiling the origins of the historical misconceptions present in the chemical community. The authors present examples of the first historical accounts of the chemical revolution, as told by the contemporaries of Lavoisier and the generation directly thereafter. It is in these documents where the trouble begins, as they contain the premise that, briefly put, Lavoisier founded chemistry. This idea was easily propagated through time in commemorative speeches, and, more significantly, in chemistry textbooks, where the lack of space and the need to develop concepts according to pedagogy, not chronology, forced the simplification of historical detail. The final lines in the book reflect the authors' call for the establishment of spaces where the contrasting views of chemistry and history may be synchronized; this is done in the abstract and without concrete proposals.

The authors include a bibliography that not only precisely suggests where to go for further reading but also demarcates pretty well the scope of their own contribution. A website (www.uv.es/=Bertomeu/revquim) developed as an accompaniment to the book provides some quick reference background information on some of the main characters of the chemical revolution; parts of this site were incomplete as of 7/28/07.

In spite of the erudite and well articulated narrative that dominates the text, the book does possess some significant flaws. Some of these are simply factual (the stomach acid is said to be phosphoric acid (p 223) and the product of a chemical reaction is described as a "**mixture** of **pure** substances (p 120)") and some are derived from incomplete editing (there are some spelling mistakes and at least two passages (pp 159 and 179) where earlier parts of the book are erroneously referenced). However, the most significant problems are of a scholarly nature. In a number of instances concepts are quoted from other primary sources without referencing (the authors simply speak of the source as "other historians"); and, in at least three cases (pp 36, 40, and 169), this misallocation of credit occurs when the quote refers to ideas contrary to the authors' own. To be sure, some of these referencing problems are rectified in the bibliography, which also happens to contain a rather inappropriate statement: on p 268 the authors qualify one of the cited studies as questionable without bothering to recite the arguments that lead them to this judgment.

Another sticky point relates to the improper evaluation of the scientific concepts emanating from the chemical revolution with regard to their transcendence, eventual relevance, and utility. Whereas the authors are exceptionally qualified to recreate the historical setting of the chemical revolution and do present a satisfying narrative that could have helped redress the historical misconceptions of the chemical community, they seem woefully unable to evaluate satisfactorily the significance of the law of conservation of mass and the exceptional paradigm shift that the abolition of phlogiston represented. Indeed, these shortcomings could not only prevent this book from serving as the bridge between chemistry and history that the authors so persuasively argue for, but they could also overshadow what is a very carefully built work of dissemination of historical research.

For instance, in arguing that the chemical revolution was not the conflict between two different paradigms that Thomas Kuhn envisioned, the authors quote historical interpretations of the work of Lavoisier (p 237) which claim that the changes induced by the chemical revolution were limited to certain aspects of chemistry (combustion and oxidation), and that certain areas (plant chemistry) were almost entirely refractive to these changes. Indeed, not all the theoretical constructs that Lavoisier promulgated were entirely correct (his theory of acidity), or wholly relevant to all of chemistry (organic chemistry would not come of age until the end of the 19th century); but to quote these interpretations without the qualification that absolutely all of the studies of matter will end up relying on the primordial law (not theory, law!) of the conservation of mass, or the proviso that Lavoisier accurately demonstrated that combustion is a *combination* and not the *decomposition* that phlogiston predicted, simply smacks of scientific illiteracy. To make things worse, the text invariably emanates a certain insensitivity on the part of the authors towards the scientific method and to the realities of experimental science: the actual realization of mass conservation by Lavoisier is belittled (p 239) because it was not found in a deliberate manner, but rather discovered as a tool to rationalize certain experimental results. How else was this supposed to happen in an environment where, as the authors point out, quantitative analysis was seen as irrelevant? It almost seems as if part of the problem lies in the authors' conception of historical rigor as an imperative to give every faction of the chemical revolution an even hand, even if the scientific arguments indubitably and incontrovertibly tip the balance in favor of only one option. Under that light, it is easy to understand the authors' unremitting unwillingness to criticize Priestley's phlogiston as well as their tacit antagonism toward Lavoisier: Aldo Mieli is quoted as saying that it is very difficult to attribute a single original discovery to the French chemist. Of course, this depends on what is meant by "discovery."

In summary, "*The Chemical Revolution. Between History and Memory*" successfully defends the view of chemistry as an endeavor that was well developed before the chemical revolution, an event which, in turn, is compellingly conceptualized as a collaborative effort (especially in the areas of terminology development and dissemination of the new ideas), where Lavoisier served as a transformative watershed. On the other hand, what the authors are due in *history*, they lack in *science*, and, as such, a wildly passionate reader may extend the deficiencies of the book to the entire text and overlook the important historical scholarship that is the most welcome portion of this new work. *Gorka Peris, Postdoctoral Associate, Department of Chemistry, Yale University, New Haven, CT 06511.*

1. The CV of Prof. Bertomeu (University of Valencia, Spain) (http://www.uv.es/=bertomeu/pub/cv.htm, accessed 7/28/07) lists Prof. Belmar (University of Alicante, Spain) as a regular coauthor in published articles and at least one other book.

2. It must also be said that there are no sources cited in the text that document the modern chemistry community's understanding of the chemical revolution.

Chemistry, Medicine, and Crime: Mateu J.B. Orfila (1787-1853) and His Times. José Ramón Bertomeu-Sánchez and Agustí Nieto-Galan, Ed., Science History Publications, Sagamore Hill, MA, 2006, 331 pp, ISBN 0-88135-275-6, $52.

It was not clear to me for whom this book was written: the chemist or toxicologist who wanted to know more about some aspects of the historical development of the origins and spin-offs from their disciplines, or the professional historian of science. Some 11 different authors have contributed papers describing the early 19th-century development of toxicology and forensic medicine. The papers only glue lies in their connection to the Spanish chemist Mateu Orfila's role in the development of toxicology and forensic science. Although the diversity of authors' topics does not lead to a totally engaging narrative, there is much to be learned. It was of interest to me to learn more about how the success of chemical analysis in the "inorganic" world stimulated the experimental studies in the "organic" realm that led to the establishment of the discipline of medicinal chemistry. The development of toxicology was stimulated by the appearance of Mateu Orfila, Robert Christison, and other chemists who served as expert witnesses in place of physicians in a number of famous poisoning trials. Some of you analytical chemists might enjoy reading about the development of the Marsh test for the detection of arsenic, and consider whether you could qualify as an expert witness as to whether arsenic was present in sufficient quantities to confirm it as the poisoning agent. Many of the tests for poisons were often demonstrated on a variety of animals in Orfila's lectures on medicinal chemistry at the Paris Academy of Medicine. Orfila's main contributions to toxicology were summarized in his *Traité des poisons* (published in 1814) – which became one of the most popular and influential textbooks in the first half of the nineteenth century. *O. Bertrand Ramsay, Eastern Michigan University, Ypsilanti, MI.*

Chemistry, Decade by Decade. Arthur Greenberg, Infobase Publishing, New York, 2007, ISBN: 978-0-8160-5531-9, Hardcover, $49.50.

Chemistry, Decade by Decade is part of *Twentieth-Century Science*, a seven-volume set that summarizes achievements in several core areas of science, including biology, chemistry, earth science, marine science, physics, space, astronomy, and climate. Each volume contains an extensive glossary and a list of additional reading sources, as well as time lines, biographies of scientists in the different areas, and some background for the science that is described. The series is meant to correlate achievements in a particular science with events in history, developments in technology, and progress in related scientific fields. One of the stated goals of the series is to teach "new explorers of the world the benefits of making careful observations, of pursuing paths and ideas that others have neglected or have not ventured to tread, and of always questioning the world around them" (p xvii).

Greenberg states in the Introduction (p xxi) that the book is nonmathematical and, though geared for a general audience, would be best appreciated by those who have had some high school or college chemistry. He gives his area of expertise as organic chemistry, which is apparent in the preponderance of topics related to that subject. This is not to say, however, that other areas are neglected. The book includes material on all subsets of chemistry, as well as technology, manufacturing processes, related sciences such as biochemistry and genetics, and historical perspectives.

This book is helpful because of the niche it fills. Most standard textbooks for chemistry courses in high school or early college years include some historical information. There are often sidebars in these texts that

focus on the biography of a scientist or on an event or historical period. This book supplements that kind of material, enabling the teacher or student to relate the subject matter to other scientific discoveries and to the times in which the discoveries were made. While most teachers would like to incorporate such related information into their curricula, it is often difficult to find sources that are concise and informative. The internet is a useful tool in such quests, but it is also helpful to have a printed list of interesting and related subjects from which to select. That is what this book supplies.

To see how this is so, it might be helpful to look at Greenberg's treatment of two representative subjects: steroids and the development of nuclear weapons. Greenberg traces the development of steroids in some detail. He begins with the early work in bile acids and cholesterol (p 65), continues with the identification and structural analysis of cholesterol and sex hormones (p 127), and concludes with the total synthesis of steroids (p 200). The section "Chemistry and the Manhattan Project" (pp 169-171) describes the beginning of the project as a response to early German discoveries in nuclear energy. The idea of nuclear weapons under the control of Hitler was so terrible, that U.S. government officials cooperated with scientists in the private sector to initiate work on the atomic bomb. The section details the science of purification of nuclear fuels and shows how those fuels were assembled to make nuclear weapons.

Especially in today's world where the sciences intertwine, where technology plays such a critical role, and where events are so much a product of history, it is important for students to be aware of the relevance of the subject matter to their world.

Each chapter in *Chemistry, Decade by Decade* reviews developments in a separate decade, starting with 1900–1910 and concluding with 1990–2000. The early chapters also summarize relevant information from previous centuries. Each chapter begins with a timeline of milestones for the decade to be studied. This is particularly helpful because the individual achievements are often unrelated, and it is useful to be able to put them in a concise historical perspective. The many sidebars in the book include topic summaries and biographical sketches of individual scientists. Typical sidebars include those on "The Bhopal Disaster" (p 334) and "The Origins of the Mole and Avogadro's Number" (p 63). The first addresses chemical accidents, particularly the accidental release of methyl isocyanate in Bhopal, India, which caused the deaths of over 2,000 people. The second describes various efforts to determine the value of Avogadro's number.

As the title suggests, *Chemistry, Decade by Decade* emphasizes time relationships. The book's timelines stress primarily chemistry-related events, but the body of the text includes many historical occurrences where chemistry played a part. For example, a section in Chapter 2, "World War I and Aftermath" (p 68) summarizes political events leading up to World War I and then traces the development of explosives and propellants, beginning with the Chinese invention of gunpowder in 1150. During World War I synthesis of cordite, a propellant used by the British, required acetone, which was in short supply at the time. A chemist, Chaim Weizmann, at the University of Manchester, developed a process to produce acetone. Rather than accept payment for his work, Weizmann, an ardent Zionist, pressed the British government for the Balfour Declaration, which supported the establishment of a Jewish state in Palestine. Weizmann eventually became the first president of Israel.

One of the most impressive features of the book is the scope of topics covered. A few general threads run throughout, including work on the periodic table and discovery of the elements, the environment, genetic engineering, instrumental analysis, and nanotechnology. For the most part, though, the various topics are diverse and generally unrelated, except for their place in history. Here is a sampling of subjects that suggests the range of material covered in the book: the Hubble Space telescope, the Murchison meteorite and the possibility of extraterrestrial amino acids, superconductors, the Manhattan Project, carbon dating, the double helix, polymers, transition elements, and pharmaceutical chemistry.

The titles of the individual sections within the chapters are well chosen, and the sections seem to be logically arranged. For example, a section on two-dimensional NMR spectroscopy is followed by one on applications of NMR to solids and to magnetic resonance imaging. *Chemistry, Decade by Decade* can function as a beginning reference book for these individual topics. Although some subjects are complex, Greenberg summarizes them concisely and makes them understandable. Many of the more difficult topics are in the author's area of expertise, organic chemistry (for example, proteins, organic mechanistic discoveries, and nanotechnology). In those areas, particularly, it would help the reader to have some initial familiarity with the subject.

Greenberg is true to his promise that his book would be math-free. There is a scattering of equations, but

they are dealt with mainly in a qualitative fashion. The many illustrations are relevant and helpful; they include schematic diagrams, illustrations of chemical structures, and pictures of mechanistic pathways. Each chapter ends with a list of resources for further reading, and the book itself concludes with a slightly longer list of the same type, one that includes books and websites. Also at the end of the book, there is a glossary of chemical terms and their definitions, a list of Nobel Prize winners in chemistry, and a very extensive index. *Mary L. Wise, Ann Arbor, MI.*

Michael Polanyi: Scientist and Philosopher. William Taussig Scott and Martin X. Moleski, S.J., Oxford University Press, New York, 2005, ISBN 9780195174335, 364 pp, $26.99.

The book provides a comprehensive biography of Michael Polanyi (1891-1976). Polanyi attained international stature as both a physical chemist and a philosopher. He was born in Budapest, Hungary. Following medical training and brief service as a doctor, he shifted his attention to the field of physical chemistry, carrying out important work on adsorption for his doctorate at the University of Budapest. Polanyi's scientific career blossomed in Berlin at the Kaiser-Wilhelm Institute for Fiber Chemistry (1920-1923) and Haber's Institute for Physical Chemistry and Electrochemistry (1923-1933).

Following the rise of totalitarianism in Central Europe, Polanyi moved to become Chair of Physical Chemistry at the University of Manchester in England in 1933. He continued with much of his research there, making important contributions in both experimental and theoretical areas in chemical kinetics. But increasingly (possibly motivated by observing the deteriorating situation in Europe) he became interested in economic issues and social science. In 1948 he took up a faculty position in Economics and Social Studies at Manchester. He ended his academic career as Merton Fellow at Oxford as a philosopher. He synthesized many of his thoughts and experiences into a personal and professional philosophy of epistemology and is known for several philosophical works, including *Personal Knowledge*.

From an early age, Polanyi's work was characterized by broad interests and a deep understanding of connections between intellectual endeavors. Largely unmentored in science, his insights are strikingly original. He possessed the great gift of being able to transmit his vision with great clarity, both in his science and his philosophy. A picture emerges of a man of restless intellect, never quite satisfied with what he had achieved and always moving on to pioneer new areas.

Michael Polanyi is perhaps best known today in scientific circles for his seminal contributions to chemical kinetics and to the field now known as reaction dynamics. This work, exploring the connection between phenomenological kinetics and molecular structure and motions, led to several pioneering insights into the nature of the transition state. It is in this area that Polanyi's son, John, received the Nobel Prize in Chemistry in 1986.

In addition, Polanyi carried out significant work in crystallography and structure analysis. One deep insight from this field was the concept of "edge dislocations" in material science, where mismatches in the atomic lattice manifest themselves as strains in the bulk. In the early 1920s Polanyi inferred from crystallographic measurements that species such as cellulose will have anomalously high molecular weights. This was a controversial conclusion before the covalent structure of macromolecules was fully accepted.

The first author of this biography, William Scott, was trained as a physicist. Later in his career he developed a strong interest in Polanyi's philosophical ideas and spent considerable time with his subject. According to the book's preface, Scott was responsible for assembling most of the biographical material. Scott passed away in 1999, leaving the work in unedited form. Martin

Moleski, a professional philosopher, took over Scott's work, shaped the narrative, and is responsible for the final version of the book.

The biography follows Polanyi's life and career with impressively documented detail. The authors had access to Polanyi's letters and talked extensively with many of his family and contemporaries. The book contains extensive notes, a comprehensive bibliography, and a good index. The story is told chronologically; Polanyi's trajectory from scientist to social scientist to philosopher is carefully mapped, and it is shown how his personal and professional experiences inform each step of his journey.

The book is well written, with a strong sense of the sweep of history as the story moves through dictatorship in Europe, two world wars, and the paranoia of the cold war. The latter part of the book reads particularly well, and seems (to this chemist reviewer) to have a good feel for the ideas and personalities shaping social science and philosophy in the period from about 1930 to 1976. Unfortunately, the earlier, more scientific portion of the book is slightly less satisfactory. Explanations of Polanyi's scientific achievements are undertaken but are sometimes clumsily worded and frequently not given in the language most chemists will be familiar with. In addition, there are numerous typographical errors (such as "8" instead of "∞" [several times], "van der Walls" rather than "van der Waals," "hydrogen bromine" rather than "hydrogen bromide," "C_{12}" rather than "Cl_2"). While these errors are themselves mostly minor distractions, they underline the fact that the narrative in the early part of the book lacks the insight into the "big picture" which characterizes the second half.

This is a shame. Physical chemistry in the early years of the twentieth century was an exciting emerging discipline, stimulated by the revolutionary ideas developing in physics. Polanyi was involved in many of the pivotal discoveries that shaped modern physical chemistry. Many of his insights were not fully appreciated in his time, and a critical reassessment of his contributions to the field is probably in order. A valuable complement to the scientific background given in this biography is Mary Jo Nye's essay "Laboratory Practice and the Physical Chemistry of Michael Polanyi" in F. L. Holmes, and T. H. Levere, Ed., *Instruments and Experimentation in the History of Chemistry*, MIT Press, Cambridge, MA, 2000. Her paper gives technical background for Polanyi's work in crystallography and places it expertly in scientific and historical context.

In conclusion, despite some slight weaknesses in the scientific writing, this biography presents an outstanding portrait of the life and career of Michael Polanyi and the times he lived through. It will be an invaluable reference work for those interested in this fascinating man. *Howard R. Mayne, University of New Hampshire*.

Chemical History. Reviews of the Recent Literature. C. A. Russell and G. K. Roberts, Ed., Royal Society of Chemistry, Cambridge, UK, 2005, hardcover, 229 pp, ISBN 0-85404-464-7, £59.95.

This collection of highlights from recent literature on chemical history, edited by C. A. Russell and G. K. Roberts, former editor of *Ambix*, is a sequel to Russell's earlier endeavor [C. A. Russell, Ed., *Recent Developments in the History of Chemistry*, Royal Society of Chemistry, London, 1985]. The title holds for all except a newly introduced chapter on physical organic chemistry, which covers literature from 1907 up to the time of this publication. With that exception, each chapter is intended as an update of literature published in each specific subject since 1985.

The introductory chapter, "Getting to Know History of Chemistry," is written by the two editors. They present a perspective on how the scholarly approach to the history of chemistry has changed in the last few decades. More work is being published by professional research chemists rather than historians of science. As the authors point out, this was the case in the mid-19th century, when eminent chemists such as Hermann Kopp created invaluable treatises on chemical history.

There follows a presentation of "Chemistry before 1800" (Chapter 2); then Chapters 3-8 cover, respectively, inorganic, organic, physical organic, physical, analytical, and medical chemistry and biochemistry. All are

written by other historians, except for the chapter on organic chemistry by Russell. The final Chapter 9 is titled "Instruments and Apparatus." One might have expected chapters devoted to industrial and environmental chemistry, inasmuch as these topics are prevalent in current scholarly work.

Unlike the case with the 1985 book, the authors have employed a computerized search program and note this approach allowed uncovering far more publications than would have been realized otherwise. It would be impossible to assess the comprehensiveness of these searches, without carrying out a parallel one; but omissions are inevitable. As an example, in the subsection on "Chemical Biographies" in Chapter 2 there is no mention of the long overdue biography of Wöhler [R. Keen, J. Büttner, Ed., *The Life and Work of Friedrich Wöhler* (1800-1882), Verlag Traugott Bautz, GmbH, Nordhausen, 2005]. While this is being singled out as an important citation, its omission may have been a matter of publication deadline. In Chapter 2 the editors acknowledge the drastic change in sources since publication of the earlier 1985 book, because of the advent of the internet. They justifiably raise the question of the reliability of material from secondary—and often—undocumented online sources. No specific mention is made of current periodicals where papers in the history of chemistry are most likely to appear.

Literature citations are provided at the end of each chapter. Their number is deceivingly large, however, because the authors duplicated identical references when they were cited more than once in the text. The Subject Index seems sparse for such a large collection of references. Entries in the name index are limited to those specifically mentioned in the text. An alphabetical listing of all the authors would have provided an invaluable bibliography for readers. This book, the manifestation of a massive, exacting undertaking, will serve as a dependable source for historians of chemistry in those areas that have been covered. *Paul R. Jones, University of Michigan.*