BOOK REVIEWS

The Pharmaceutical Industry: A Guide to Historical Records. L. Richmond, J. Stevenson, and A. Turton, Ed., Ashgate, Aldershot, England, 2003; ix + 561 pp, ISBN 0-754-63352-7, $99.95.

This Guide is one in a series of studies drawn from British business archives. It is based on a survey of various public and private records around the United Kingdom and was funded by The Wellcome Trust. It is obvious that a great deal of painstaking trawling through the identified sources took place in order to assemble such a wealth of detail. The Guide opens with three historical surveys: the first is an excellent review of the early development of the industry during the eighteenth and much of the nineteenth centuries, when it was based in retail pharmacy. The other two surveys—one on industrial developments since 1851, and one an overview of archival sources—are less inclusive.

The first two historical surveys include appropriate bibliographies. However, it is not correct that "in the inter-war period, legislation required that a qualified pharmacist should be in charge of the manufacturing and other departments in a business." Other professional qualifications were acceptable and indeed were more usual. Today, a high proportion of Qualified Persons are corporate members of the Royal Society of Chemistry. The surveys are followed by a useful chronology of pharmaceutical legislation (though it was the 1941 Pharmacy & Medicines Act that relaxed the regulations on the sale of agricultural and horticultural poisons, not the 1933 Pharmacy & Poisons Act).

There follow a select bibliography, a user's guide, and a glossary, leading into the main section of the book. In the glossary, the definition given for "patent medicine" has not applied for some time. Going back, say, some 70 years, medicines not declaring their compositions on the labels were subjected to a special excise tax, and a paper tax label had to be applied across the closure to show payment of this. Needless to say, most companies eventually decided to reveal at least the active ingredients in order to avoid liability to this tax and redesigned their labels accordingly. Today, of course, this labelling declaration is mandatory. Again, there is an implication under "surgeon" that medical practitioners in the UK are required to hold an M.D. In fact in the UK this is a post-qualification degree, based on research of appropriate standard, and is achieved by a small proportion of practitioners. The way to professional advancement is instead by the examinations of the relevant Royal Colleges that set and maintain high standards of professional achievement.

The main body of the Guide deals with the records actually found for pharmaceutical businesses, almost all in England. The criterion for selection appears to be merely the existence of historical records: businesses with just one pharmacy and no apparent other activity are intermingled alphabetically with internationally known companies. The rationale of mixing businesses of such diverse size and range of activities is not stated. Presumably detailed sub-classifications would be difficult because there is such an enormous variation and overlap in the volumes of manufacturing or wholesaling activity. On the other hand, the listing of minor collections of records in Appendix 1 could be more logical. Generally it is on a county basis, but some archives, particularly in Lancashire and Yorkshire, are listed by town or city, making it less convenient to determine where a particular record might be located.

The biggest weakness in the present edition is in the poor quality and paucity of information given for multi-national companies operating in the UK, particularly those whose headquarters are not in the UK. A number of archival references are really only secondary sources, such as general review articles by technical journalists. These give a flavor of the company and its background, but too often the underlying interviews were obviously with local junior staff who might not have been aware of the full background of the company and who would not have had access to actual historical records. So the story that comes across may instead be based on what is thought to be the traditional oral history of the company and in some cases is quite inaccurate or indeed misleading—a very close parallel with genealogical research!

Mergers, acquisitions, and disposals within this industry—and indeed in other industries—seem to be proceeding apace these days, even though it is questionable whether they do in fact yield an overall benefit. So any status report is necessarily out of date as soon as the ms. goes to the printer. It would have been a Herculean task to update the text repeatedly even to this stage. Thus the account of Glaxo in the main text finishes with the merger to form GlaxoWellcome in 1995, though one of the historical surveys does refer to the subsequent formation of GlaxoSmithKline early in 2000.

One of the biggest industry mergers of all time was the formation of Drug Inc in the USA in 1928, bringing together the interests of United Drug and Sterling Drug. The Guide does not mention this in the histories of any of the companies affected, though it does record that Jesse Boot sold his company (Boots Pure Drug Co. Ltd.) to United Drug in 1920. Among other companies operating in the UK at that time that were also controlled by Drug Inc were: Bristol-Myers (then part of United Drug) and Bayer Products Ltd., Chas. H. Phillips Chemical Co. Ltd., Proprietary Agencies Ltd., and Scott & Turner Ltd. (all part of Sterling Drug). Commercially, Drug Inc. was highly successful, despite the Depression, but in 1933 it was broken up on a voluntary basis and—as recorded in the Guide—the Boots shares were bought back and Boots was again a freestanding company.

There are some notable absentees. Roche Products (part of Hoffmann-La Roche, referred to en passant in one of the surveys) are not mentioned and a review of their archives (were they available) would surely have shown their acquisition of Nicholas Laboratories. The latter were best known for their marketing of Aspro, developed by them in Australia to meet World War I needs; it was the leading branded aspirin over-the-counter preparation in the UK for many years but was finally discontinued in 1997. Again, Amersham are not listed; their range of diagnostic and treatment products was expanded into high volume usage areas by their merger with Nycomed of Norway in 1997. In fact a Compendium of Data Sheets published by the Association of the British Pharmaceutical Industry around the time that this Guide was being prepared lists 133 companies, plus eight that are cross-referenced to associates or principals. However only 40 appear in the Guide, suggesting that appropriate records were not flagged for the balance. Again, some well-known companies such as E. Merck (Germany) and Merck, Sharp and Dohme (USA) appear only by passing mention in one of the surveys.

Over the past four years alone, the major pharmaceutical companies have reported almost 1500 working relationships with small specialised research concerns—joint research programs, partnerships, and collaborative consortia. There do not appear to be any references to this kind of arrangement, perhaps because it has developed only during the last decade or so; but more likely because the specialist companies are not likely to appear in any archives other than their own, and usually they do not have direct sales.

The final sections list the various geographical archives ("minor collections") and the various public record collections. There are also full indexes by name, geographical location, subjects, and archives.

There are a number of misprints, some due to the evident unfamiliarity of the editors or the proofreaders with trade and brand names in the pharmaceutical industry. "Procter" (in Procter & Gamble) is misspelled, but this frequently happens; "Sterling" appears also as "Stirling" and both forms are indexed; Paludrine is also misspelled on one occasion, as is "Westminster" in the name of the eponymous university in the Foreword. There are also some incorrect attributions of products, particularly where they are assigned to contract manufacturers and packers.

The Guide has its limitations. For example, the current pace of mergers and acquisitions is such that companies mentioned in it may now be operating under quite different names, eg, there is no mention of Novartis, formed by the merger of Ciba-Geigy and Sandoz in 1996 (and they themselves are mentioned only in passing in one of the surveys). Some of the secondary references are unreliable. So any data culled from the Guide should be carefully crosschecked with their primary sources. Nevertheless, it is a useful starting point for information on the British pharmaceutical industry and so is a suitable addition to the specialist reference library. *John R. Gwilt, Northampton NN7 2NT, England*

The Last Sorcerers. The Path From Alchemy to the Periodic Table. Richard Morris, Joseph Henry Press, Washington, DC, 2003, xi + 282 pp., ISBN 0-309-08905-0, $24.95.

This is history of science as a pearl necklace, with individual biographies being strung together. The hidden assumption is that brilliance can be transferred from life to writing. Somehow, magically, portrayal of remarkable people becomes infused with their originality. We all know how mistaken this can be.

Let me submit as an example the seven pages Morris devotes to Joseph Priestley, who comes across as the epitome of the self-made man. His story reads like an outline for a television episode, very American, even very simplistic. Simplistic? Morris did away with all the elements in Priestley's life that did not jibe with his caricatural view of Priestley as arch-individualist, radical thinker and, yes, something of a crazy genius. This is a travesty of the historical truth. Priestley was not such a cardboard cutout, far from it. What about, for instance, the Lunar Society of which he was a member, jointly with Erasmus Darwin, Josiah Wedgwood, Mathew Boulton, James Keir, and James Watt? Surely, their emulation had something to do with their numerous achievements, such as Priestley's devising of soda water, and of the rubber eraser, Keir's arranging the mass production of soap, and their collective campaign against slavery. Theirs was fascinating group dynamics. Morris does not offer a single word on this.

Chapter 7 exemplifies the author's flippancy. Entitled "The Atom," it consists exclusively of a capsule biography of John Dalton. Its major tenet, viz., "When Dalton propounded his theory, chemistry was not yet a quantitative science" (p 130), makes light of one of Lavoisier's major inputs. We are told of Dalton's involvement as a Quaker in teaching; of his meeting John Gough; of his becoming a run-of-the-mill natural historian; of his being appointed to New College, Manchester; of his reading a paper on color blindness; of Dalton's experiments in pneumatic chemistry; of his cryptic announcement of atomic theory five years prior to formal publication; and of the public recognition which came to him in later years. Did atomic theory come to Dalton by divine visitation? There is not a word here on atomism during the seventeenth and eighteenth centuries; there is no mention of the problems Dalton's atomic theory strove to solve, nor any discussion whatsoever of the epistemic status of theory versus the empirical evidence at the beginning of the nineteenth century. The fascinating 1803-1808 lag time, which anticipates Darwin's own trepidation in coming out with the theory of evolution, is only mentioned in passing.

I can just hear the retort, "You should not take this book so seriously; after all it is only a popularization. What you are asked for is to evaluate its quality as light reading. Should it not, for instance, be recommended to students as additional reading ?" I contend that students find such books boring and devoid of interest. How can they identify with any of the loonies in such a gallery—Joseph Priestley, who preached a strange religion; John Dalton who never knew how to consort with females; Berzelius "living in a room that was also a storeroom for potatoes" (p 145); Cannizzaro who "heard that rebellion had again broken out in Sicily. He traveled there to participate but … he arrived too late. The 'red shirts' led by Guiseppe (sic) Garibaldi had already freed Sicily. It was at about this time that Cannizzaro received an invitation to attend the conference at Karlsruhe. Because there was no revolution to become involved in, he accepted at once." (p 152). "(Mendeleev) looked more like a Siberian shaman than a distinguished chemist." (p 158). "Einstein … expressed the opinion that if such a crazy theory (Bohr's) proved to be correct, then physics would be at an end; it would no longer be possible to do physics." (p 187).

This is not the way to treat students. They need good, solid fare and there are two ways to go about it. One is to encourage them to research issues in science history and write short personal essays on them; an example would be "A Short History of the Chemical Stockroom." The other is for the instructor to serve as a guide and show the class, with all the needed depth, science in the making. It can be made as gripping as the narrative of a difficult, technical, and risky climb. No, to throw formulaic writing at students, replete with stereotypes, is not the right approach. How can it be ? To wallow in conventional wisdom is totally counterproductive, since scientific thinking—any thinking for that matter—and any life worth living go against the grain—not along the smooth, easy, and well-traveled route.

A major criticism I will level against Morris's book is its all-too-obvious ignorance of the status chemical science has now reached. Morris has not gone to the effort of finding out what chemists have been up to during the last half century. His perception of chemistry is hopelessly and totally out-of-date. He sees chemistry as exclusively analytical, with the mission of defining and isolating the elements from which matter is built. Not only is such a perception totally archaic, devoid of the major steps chemical science has taken since the 1950s; worse, it is a bore: how can it measure up, coming as it does after Primo Levi's The Periodic System; or, to mention a more recent title, also vastly superior to the book under review, Oliver Sacks's Uncle Tungsten, with the combined charms of the autobiography and of the author's strong personality?

I have to inveigh against the title. True, it is consonant with those of the previous Morris books; however, this time it is too much, too commercial, too demagogic. For a professional chemist in this day and age, being lumped together—even with honorable intentions and somewhat tongue-in-cheek—with witches and with the sorcerer's apprentice does not fly. Such stereotypes only feed public chemophobia.

One of the distinctive marks of American culture is its anti-elitism. There is a widespread allergy to unusual words, smacking of a classical European education. As Lawrence Levine writes in his book, Highbrow/Lowbrow. The Emergence of Cultural Hierarchy in America, Harvard University Press, Cambridge, MA, 1990:

If there is a tragedy in this development, it is not only that millions of Americans were now separated from exposure to such creators as Shakespeare, Beethoven, and Verdi, whom they had enjoyed in various formats for much of the nineteenth century, but also that the rigid cultural categories, once they were in place, made it so difficult for so long for so many to understand the value and importance of the popular art forms that were all around them. Too many of those who considered themselves educated and cultured lost for a significant period—and many have still not regained—their ability to discriminate independently, to sort things out for themselves and understand that simply because a form of expressive culture was widely accessible and highly popular it was not therefore necessarily devoid of any redeeming value or artistic merit.

Such perceptive comments bear on current popular presentations of science to the general public, which are typically productions by for-profit-organizations, disseminated predominantly by the printed word and by television. They play to the perceived tastes of the readers or of the viewers. They cater to selfish concerns for one's well-being, material comfort, and health. They turn science into a springboard for utopias, space operas. They regurgitate stereotyped accounts of human science and history. Popular presentations of this later, twentieth-century type, while drawing on the same distaste for intellectual-sounding language as their earlier counterparts, do not offer education to the public, only hedonistic time-killers.

As for books, "science" sections of bookshops in English language countries abound in short-lived titles covering not only an easy read, but also one totally unchallenging. The keyword here is the adverb "unthinkingly." The readership of such books, which sometimes turn into bestsellers, enjoys them, to some extent, because they sell an illusion of effortless increased knowledge. Thinking has become a dirty word. It is a solitary vice in the Orwellian, Newspeak world in which these nonbooks are written.

This has given us popular science writing at its formulaic worst, of personality-mongering and of scene-setting. Those are legacies from Henry Luce's instructions to his stable of writers for Time magazine. Why take issue with such stereotypes? Because, no more than appreciation of a painting by Vincent van Gogh is informed by the cutting-of-his-ear anecdote, can the throbbing pulse of science be perceived from such narratives. They dull the understanding. They are derivative and secondhand. They lack the familiarity that breeds admiration. They are ignorant, in the most crass sense. My main problem with such fast foods as The Last Sorcerers is that they kill the taste for gourmet fare. *Pierre Laszlo, P.O. Box 665, Pinehurst, NC 28370.*

Ernest Rutherford and the Explosion of Atoms. J. L. Heilbron, Oxford University Press, Oxford, 2003, 142 pp, ISBN 0-19-512378-6, $27.50.

At the beginning of the 19th century, John Dalton proposed that the world was composed of atoms with specific weights. These atoms, he argued, would explain observations that elements reacted in specific weight ratios. Even though there was no direct evidence that such discrete particles actually existed, his theory was utilized throughout the 1800s. Using atoms as models, scientists developed theories of organic chemistry, stereochemistry, crystallography, ionic and covalent bonding, and electrochemistry. The few who maintained that atoms did not exist admitted that they nevertheless were useful models, and the scientific community generally accepted the fact that chemistry behaved as if atoms existed. But since no one had ever seen an atom, some scientists could still gainsay their existence, even into the twentieth century. Ernst Mach denied them to his death in 1916.

Ernest Rutherford entered the scientific scene just as radioactivity was discovered in 1896 by Henri Becquerel of Paris. Born in 1871, Rutherford was raised on a flax farm in New Zealand. After his education in New Zealand, Rutherford arrived at Cambridge University in 1895. His first research involved hertzian (radio) waves, but he then moved on to the study of uranium rays with J. J. Thomson. In 1898 Rutherford took a post at McGill University, Montréal, Canada, while Marie and Pierre Curie in Paris were discovering polonium (1898) and radium (1899). This new phenomenon of radioactivity mystified the best minds, but Rutherford's brilliant mind and fertile imagination allowed him to view atoms not only as useful, but also as necessary, models to offer coherent explanations.

Ernest Rutherford did not doubt the existence of atoms for a moment. He was the first to recognize natural transmutation of elements; he saw that the atom had a structure; he correctly proposed a positive nucleus concentrated at the core of the atom; he induced artificial transmutation of elements; he proposed a neutral particle, later discovered; and his model allowed others to develop the quantum description of the atom and the modern arrangement of the periodic table. Scientists who would later become famous in their own right flocked to his laboratory for training and collaboration, such as Niels Bohr (who first described the quantized atom), Otto Hahn (who discovered atomic fission), Frederick Soddy (who invented the term "isotope"), Henry Moseley (who discovered atomic numbers from his X-ray research), Georg von Hevesy (who discovered hafnium), James Chadwick (who discovered the neutron), and Hans Geiger (famed for his eponymous counting device). Rutherford was a giant in his field and was mourned at his premature death at the age of 66

Ernest Rutherford and the Explosion of Atoms by J. L. Heilbron is a delightful little book that blends Rutherford's research with the moving backdrop of the scientific community. Rutherford was a pioneer not only because of his brilliance; the British method of modeling was perfect for the advance of nuclear chemistry at this particular moment in history. The British were fond of explicit descriptive models to explain nature. Lord Kelvin said he could not reason "without making a visualizable picture" of the phenomenon he wanted to describe. J. J. Thomson of the Cavendish Laboratory at Cambridge was using the idea of charged corpuscles to explain cathode rays, and he proposed the atom was a dynamic, moving mixture of positive and negative charges. Scientists on the continent, by contrast, were not impressed by this "picture making." The Curies, for example, considered the British method as "childish, arbitrary, and English." The German chemist Wilhelm Ostwald, who did not believe in atoms, thundered, "Thou shalt not take unto thee any graven image or any likeness of anything." The Curies thought Rutherford's premature model making ran the risk of leading to nonsense (which it actually did sometimes, such as Rutherford's 1920 proposed structure of the nuclei as a conglomeration of alpha particles). Moseley, unaware that the French might "have a different way of doing things," was promptly educated when visited by Urbain from the Sorbonne in Paris, who was attempting to confirm the existence of a new element "celtium" in his rare earth mixture by Moseley's novel X-ray technique. After Urbain's visit Moseley confided to Rutherford that, whereas the British try to find models or analogies, the French "are quite content with laws." As Heilbron explains, "Rutherford knew this fact very well. The English method had helped him to outrun the Curies and Becquerel."

Heilbron traces Rutherford's research as he moved from Cambridge University as a student, then to McGill University, to the University of Manchester, and finally back to Cambridge. Under Thomson, Rutherford showed that ionizing radiation from uranium consisted of two main types, which he called alpha and beta "for simplicity." At McGill Rutherford found that thorium produced a gaseous radioactive product, which he called "emanation" (one of the isotopes of radon). He came to understand radioactive decay and developed the concept of "half-life;" with Soddy he developed the "transformation theory," which showed radioactivity was a nuclear property; and he showed alpha particles were positively charged. At Manchester Rutherford continued his study of alpha particles by showing they were helium nuclei and by conducting his classical experiments with the recoil of alpha particles on gold foil that showed atoms were mostly empty space and possessed a nucleus. At Cambridge, Rutherford studied the artificial transmutation of the elements by bombardment with energetic alpha particles; and as his fame grew he became heavily involved in the relationship between science and society. Heilbron completes Rutherford's contribution to society by devoting an entire chapter to World War I with its enormous impact on the nature of research and the direction of future investigations. Before the War, research was considered an individual activity, or perhaps a research effort by a small group under the command of one professor. After the War, research projects were mobilized, sometimes on a national scale. The relations between universities, technology, industry, and government intensified. Rutherford's role in this evolution of research was enormous, and he became the dominant force in British physics and a spokesman for British scientists.

Even though the "power of British pictorial physics and his own vivid imagination" allowed Rutherford to advance the watershed theories of the atom, his own weakness in mathematics prevented his moving beyond the basic models. Bohr, now in Copenhagen, was using Max Planck"s recent ideas to quantize the atom. Bohr's sophisticated model showed Rutherford's model was indeed "childish" by comparison. However, the original concepts paved the way for Bohr's atom, exemplifying that" one quality of a successful physical theory is that it points the way to its replacement."

Heilbron's book is a delightful, readable book, enjoyable not only for scientists who may already be knowledgeable about Rutherford's science and life, but also for the layman. The book appeals to a wide audience because it works on several different levels. Thus, the author presents his provocative insight of British vs. Continental scientific philosophies (appealing to the scientist already familiar with scientific evolution in the early twentieth century), while he traces scientific events (useful to teachers and students), as he delivers an absorbing story of personalities (capturing the imagination of the nonscientist). The book seizes the attention of high school and college students because of its inclusion of episodes between Rutherford and Madame Curie, a name known to everybody. An aid to the teacher and student is the frequent inclusion of "boxes," which explain scientific experiments and theories for those who want more detail. These short essays include, for example, a brief description of J. J. Thomson"s original experiments leading to his ideas of the electron; a description of Rutherford's first experiments leading to his proposed decay chains or radioactive elements; Rutherford's original "childish" models of the atom; and a description of the principle of the cyclotron. The plentiful and descriptive figures include not only photographs of people, places, buildings, and events, but also reproductions of Rutherford's sketches of equipment and his handwritten theories and ideas. Since this book was written as a "portrait" (being one of the "Oxford Portraits in Science"), Heilbron intentionally avoids involved mathematical descriptions (such as treatment of radioactive half-life) and cuts short stories of various personalities. These omissions, however, do not detract from the book, since they inspire one to learn more about this unusual scientist.

If one reads Rutherford's original publications, one is struck by the uncanny ability with which he methodically performed an experiment, concluded precisely what could be learned from the experiment (and no more), and realized the implications of the experiment so that he could design the next perfect experiment. This is why he advanced so rapidly: a combination of common sense, vivid imagination, and scientific discipline—and how he rose from his lowly roots in rural New Zealand to become a Nobel Laureate, the world's leader in the investigation of radioactivity

Rutherford's death was announced to a somber crowd at an international meeting in Bologna, Italy, in 1937. He was buried in Westminster Abbey, near the remains of Isaac Newton, Lord Kelvin, and Charles Darwin. In the modern periodic table, directly below hafnium—which had been predicted and discovered in Bohr's laboratory in Copenhagen—lies element 104, rutherfordium. *James L. Marshall and Virginia L. Marshall, Department of Chemistry, University of North Texas, Denton TX 76203-5070.*

The Life and Work of J. L. W. Thudichum. T. L. Sourkes, Osler Library, McGill University, Montreal, 2003; x + 95 pp, $25.

This slim volume is not a cohesive nor comprehensive biography of the nineteenth-century medical chemist J. W. L. Thudichum, best known for his work on the chemistry of the brain. Rather, it is more a collection of brief essays on different aspects of Thudichum's life and work, as well as on individuals who influenced him (such as Justus Liebig and John Simon). The book does provide some useful biographical information about Thudichum, but fails to convey a satisfying portrait of the man or to place his contributions in adequate historical perspective. Those who are interested in Thudichum would be better served by consulting David Drabkin's dated but still valuable book, Thudichum, Chemist of the Brain (University of Pennsylvania Press, Philadelphia, 1958).

The volume reflects its origins. It originated as an essay prepared as the basis for an exhibit about Thudichum at the Osler Library on the centennial of his death in 2001. No doubt it served this purpose admirably. It was expanded into its present form, which, the author explains, "serves both as an exhibition catalogue and as a fresh biography of an important pioneer in biomedical research." While it succeeds in the former purpose, it is wanting, as noted above, in the latter purpose.

The illustrations, bibliography, and appendices add to the value of the work. This book should be on the shelves of libraries with collections in chemical and medical history, as it has some reference value. Few chemists or historians, however, other than those with a specific interest in Thudichum, are likely to find the book of much interest. *John Parascandola, Historical Consultant, 2617 Holman Avenue, Silver Spring, MD 20910.*

From Elements to Atoms: A History of Chemical Composition. Robert Siegfried, American Philosophical Society, Philadelphia, PA, 2002 (Transactions of the American Philosophical Society, 94, pt. 4), x + 278 pp, ISBN 0-87169-924-9, $24.

Chemical composition is such a fundamental concept in chemical thought that chemists probably don't think about it very much. At least not explicitly, though it's certainly implicit in much of what they do. The ideas of element, atom, compound, and definite composition fit together so seamlessly that it's difficult to imagine chemistry without them. But, of course, the nature of matter and its transformations were studied for centuries, either without these ideas at all or with versions of them that might be hard to recognize today.

Historians have apparently not thought much about composition either. The Introduction to Robert Siegfried's From Elements to Atoms opens with the sentence, "In spite of the fact that composition is the singular organizational basis of modern chemistry, its history before Dalton's atomic theory has never been written." Although Ida Freund took a historical approach in her 1904 classic, The Study of Chemical Composition: An Account of its Method and Historical Development, her goal was to write a chemistry book, not a history of composition.

As his subtitle indicates, Siegfried has written such a history. It traces the evolution of ideas about chemical composition from the centuries-long tradition of the metaphysical elements to the concept of simple material bodies, which are defined operationally. That is, it's the history of composition from the 17th-century interpretation of Aristotle's four elements to John Dalton's 19th-century atoms.

This book grew out of the course in the history of chemistry that Siegfried taught at the University of Wisconsin in the 1980s. By way of biographical prologue, he briefly outlines his journey from graduate student in the History of Science Department at Wisconsin in the late 1940s to faculty member in that same department by 1963. Luckily, for us—and apparently for him as well—he completed his Ph.D. degree in both the History of Science and Chemistry departments, and he seems to have kept one foot in each camp ever since. Thus, the author seems uniquely qualified to write this book.

In the Preface (pp. v-ix) and Introduction (pp. 1-23), Siegfried lays out the context for the book's fourteen chapters. As he tells us what material he's going to cover, how he's going to cover it and why, he candidly provides an overview of his own attitudes and biases about both chemistry and history. With his dual background, Siegfried has something significant to say about both.

He reminds us that there's something "magical" about chemical change. "Bodies disappear and new bodies with different qualities appear in their stead. . . . A piece of metal can be added to a clear, colorless liquid, the metal disappears, and a blue color appears. Based on direct experience alone there is no explanation available" (pp. 1-2).

Today we have elaborate theories to help us explain and understand the chemical changes we see, but how these connections between observation and understanding developed is not at all obvious. There have been attempts to explain and understand change (or the lack of it) since at least the time of Thales, but "chemical change is so magical in its character that these attempts remained in metaphysical rather than in experimental language and concepts well into modern times. Finally in the eighteenth century we see the slow and largely undeliberate transformation of implicit operational concepts of composition into explicit definitions and statements of principle" (p. 2).

Before beginning the story of that transformation, however, Siegfried outlines his own "historical perspective" (pp. 15-18). Of the two obligations of historians—"to do the past no injustice" and "to write intelligibly for [their] readers" (p. 16)—contemporary historians have done better with the former than with the latter, according to Siegfried. While historians have spent a great deal of time with the topics they write about, many of their readers haven't, so historians must convey their own understanding to their readers in terms that make that understanding available to the intended audience.

Siegfried has chosen to tell his story through the prism of modern chemical concepts. This may distress some readers, but it makes sense pedagogically, not only for his audience of undergraduate chemistry students, but also for professional chemists interested in the history of their craft and science. Here's his rationale. Just as scientific laws represent a reference against which "real" phenomena can be compared, modern concepts of chemistry also provide a reference for comparing past ideas of composition, many of which are now explicit and can be found implicitly in the thought and work of earlier chemical scientists. Indeed, Siegfried points out that by the mid 17th century, such practitioners were caught between "their operational familiarity with real, material bodies" and "some of the conceptual consequences of the metaphysical tradition they had inherited" (p. 3) not only from Aristotle's four elements, but also from the 16th-century tria prima (mercury, sulfur, and salt) of Paracelsus. Thus, Siegfried's story details how the metaphysical tradition eventually disappeared altogether and how ideas about chemical composition emerged gradually until Dalton's "atomic theory suddenly gave clarity to many discoveries and concepts that had accumulated in the previous century without having yet acquired coherence and unity" (p. 15).

Siegfried says that he chose this perspective of modern chemistry not to judge earlier ideas, but rather to try to understand them and to find more familiar modern ideas implicitly embedded in them. The author is not arguing for a Whiggish interpretation of history, but is instead pointing out "that a certain amount of such interpretation is unavoidable" (p. 17). In fact, he cautions against both Whiggish history and its opposite extreme, the idea that one is writing history "as it really happened." Before finishing the Introduction, I felt comfortable with an author who had obviously spent time not only in studying his subject, but also in thinking about how to present it to a particular audience. These opening pages convinced me that I was in the company of a trustworthy storyteller, and I was ready to be guided through the history of chemical composition as it developed between the constraints of what scientists knew at any particular time and of "what they knew for sure that wasn't so" (p. 22).

The book's tour of chemical composition covers a great deal of familiar and not-so-familiar territory, but the author's particular point of view frequently offers the opportunity to see even familiar material from a new perspective. The first nine chapters offer a detailed overview of the state of chemistry and chemical thought during the 150 years preceding Lavoisier. Siegfried does an excellent job in describing the 17th-century textbook tradition within the context of Paracelsan iatrochemistry and its later modifications. He also includes the history of the concept of a neutral salt, which, he argues, made possible the compositional nomenclature of the latter 18th century and which also represented "the most secure, the most explicitly empirical of all chemical knowledge" (p. 99) by 1750.

Chapters 5 ("An Historiographic Digression: Phlogiston") and 6 ("How Air Returned to Chemistry") interrupt the flow of the book's narrative. Although they seemed out of place as I read them, these chapters were interesting in and of themselves, and Siegfried brings both topics back into the main narrative in subsequent chapters. He argues that phlogiston was not a problem for 17th- and 18th-century chemists even though modern historians often present it as such. Phlogiston and combustion did not become problematic "until Lavoisier challenged the traditional view that combustion and calcinations were decomposition processes" (p. 102). Regardless of the validity of his argument—which I found persuasive—I will certainly approach discussions of phlogiston in the future differently as a result of having read this book.

In discussing the consolidation of 17th-century chemistry in the following century, Siegfried focuses on G.-F. Rouelle, whose chemical thought brought together the chemistry of Boerhaave's chemistry and the tradition of the French chymists discussed earlier in the book, as well as the concept of phlogiston. Both directly through his lectures and indirectly through the writings of his followers, Rouelle prepared the way for a resurgence of chemical interest in gases and "more than anyone else in mid-eighteenth century defined the chemistry that Lavoisier inherited and eventually replaced" (p. 133). After a brief overview of the relevant work of Joseph Black, Henry Cavendish, and Joseph Priestley, the last of whom finally elevated the concept of phlogiston "to a veritable chemical theory" (p. 161), the stage was finally set for Lavoisier.

In discussing the accomplishment of Lavoisier and the chemical revolution (Chapters 10-12), Siegfried most clearly presents familiar material from a fresh perspective. The chemical revolution is usually viewed in terms of the overthrow of phlogiston, but Siegfried argues that "little attention has been given to more fundamental consequences deriving from the operational concept of simple body" (p. 190), which was crucial to Lavoisier's Traité élémentaire de chimie. While his three guiding principles—the caloric model of gases, the role of oxygen in the release of caloric during combustion, and the role of oxygen as the principle of acidity—"were all quickly abandoned by nineteenth century chemists . . . [t]he concept of 'simple body' as the operational unit of composition became widely accepted" (p. 192). In fact, Siegfried cites the simple body as "the final step in the move toward the materialization of chemical composition that we have traced from the early seventeenth century" (p. 216).

Simple bodies, however, proved problematic as their number increased substantially in the years following Lavoisier. According to Siegfried, many chemists began to search for new order in the increasingly complex world of chemistry that evolved with the assimilation of the new chemistry of Lavoisier. The book's final chapter presents Dalton's atomic theory as the source of that new order despite its mixed reception by his contemporaries. The idea of relative atomic weights was not only of great practical value to chemists, but it also fit with the long-term movement toward a mathematical chemistry. At the same time, many chemists "either rejected the reality of atoms outright, or expressed great doubts that the weights being used bore any knowable relationship to the atoms themselves" (p. 258).

The fate of atoms in the 19th century, however, is not part of Siegfried's story. "Dalton's atomic theory must be seen as the climax of the history of chemical composition and terminates this story" (p. 262). Indeed, after only one more paragraph, the book ends, perhaps a little too abruptly. My first reaction upon finishing the book was that the book's opening sentence—the "history [of composition] before Dalton's atomic theory has never been written" (p. 1)—was no longer true. From Elements to Atoms presents just that story in a lucid and thought-provoking way for a reader with some knowledge of modern chemistry.

My own enjoyment in reading this book was punctured by very few distractions. Its physical appearance is perhaps a minor one. It's an oversized paperback (6 _" ¥ 10"), and its front cover has blue lettering on a mottled tan background, which reminded me of a generic burlap Windows wallpaper. Once the book is open, however (and the cover is no longer visible), it's a pleasure to hold and read. The typeface is easy on the eyes, and the binding allows the book to remain conveniently open by itself.

I found only a few typos. The sentence that continues from page 28 to the next page is clearly missing a few words, and "corporeal" is misspelled on page 34. Probably the greatest distraction was the number of times that Siegfried states, restates, and rephrases his goals and aims, as well as the book's themes, first in the Preface (pp. v, vi, ix), then in the Introduction (pp. 3, 12, 14-15, 15), and finally in Chapter 4 (p. 74). I could only surmise that he wanted to be sure that he was being completely explicit himself in telling the story of how implicit ideas about chemical composition gradually became explicit. But even this is a small distraction to the overall success of the book, which also, by the way, has an excellent bibliography of both primary and secondary sources.

I found it a fascinating book. Some of the material was familiar—though it can be quite pleasurable to revisit familiar places—but I also learned much that I didn't know, and Siegfried offered me a good deal to think about. From Elements to Atoms is a book that I will definitely keep on my bookshelf for reference and no doubt for re-reading as well. *Richard E. Rice, P.O. Box 1210, Florence, MT 59833-1210.*

The Ingredients. A Guided Tour of the Elements. Philip Ball, Oxford University Press, New York, 2002. xii + 228 pp, Cloth, ISBN 0-19-284100-9.

This book is a double delight. The reader, chemist or not, will be skillfully informed in readily comprehended language, with uncommon facts, connections, and insights, about the chemical elements. And this will be done with elegantly, charmingly constructed sentences and paragraphs. In trying to convey to potential readers the pleasure to be found here, there is a strong urge to quote extensively. For the moment, though, two examples: (1) "…the story of the elements is not simply a tale of a hundred or so different types of atom, each with its unique properties and idiosyncracies. It is a story about our cultural interactions with the nature and composition of nature." (2) "But only with the development of new ultra-sensitive techniques of chemical analysis have we become alerted to the complexity with which [the elements] are blended in the world, seasoning the oceans and the air with exquisite delicacy." Ball has a way of making a rather startling statement—"The [oxygen-rich] chemical composition of the air is not a precondition for life but the result of it." —and then supporting it with quiet exposition of the logic for it.

Besides a Preface, a page of Contents, a List of Figures, five pages of Notes, a page headed Further reading, and 13 pages of Index (which cites 80 modern elements), the book consists of seven chapters, ranging in length from 23 pages to 35 pages and whose titles strongly suggest their content:

1 Aristotle's Quartet: The Elements of Antiquity
2 Revolution: How Oxygen Changed the World
3 Gold: The Glorious and Accursed Element
4 The Eightfold Path: Organizing the Elements
5 The Atom Factories: Making New Elements
6 The Chemical Brothers: Why Isotopes are Useful
7 For All Practical Purposes: Technologies of the Elements

Every freshman chemistry text now in use likely includes reference to the four elements – earth, air, fire, and water – of the ancients, but how many, if any, lead to any understanding of why that list dominated thinking about elements from the 7th century BC into the 17th century AD? Chapter 1, which considers the social context (impact) of the elements and emphasizes processes of the mind in confronting the issue of elements as well as the reasonableness and evolution of the philosophy of element identification, does foster such understanding. It treats the puzzle of why several metals, known thousands of years BC in "impressively pure state," were not regarded as elements by Greek philosophers, whose viewpoints and influence extended into the 17th century AD, when experimentation finally began to power and guide the inquiry into elements. "In short, there is nothing obvious about the elements. [They] cannot be deduced by casual inspection of the world….[Aristotle's quartet] are not the elements of chemistry, but they say something resonant about how we interact with the world and about the effect that matter has on us."

In Chapter 2 Ball illuminates the significant role of physical experiments in the identification of an element and of the difficulty of scientists to accept the implication of their own data, to relinquish old, familiar ways of thinking. He cites and effectively uses the recent play Oxygen, by Roald Hoffman and Carl Djerassi. After an elegant account of the interlacing work of Lavoisier, Priestly, Scheele, and others, and their distinguishing views about what their experiments demonstrated, Ball states forthrightly, "It was Lavoisier who made oxygen an element." What a difference from writing, "It was Lavoisier who discovered oxygen"!

Chapter 3 opens with detailed accounts of two ancient legends—King Midas and Polymnestor—about the lure of gold and its tragic consequences. Then come a few other stories, more sketchily told, of long-ago happenings focused on gold and on to James Bond and Goldfinger. "And the crowning irony is that gold is that most useless of metals, prized like a fashion model for its ability to look beautiful and do nothing….It is gold's very uselessness, its inert and detached nature, that makes it so precious." Gold is contrasted with other, more useful metals, and the chemical basis for placer deposits and panning is described. Description of the color generation by nanometer-sized gold particles leads to a readily comprehended explanation of colloidal properties that would do a chemistry text proud and to the fascinating story of how two gold Nobel Prize medallions belonging to German physicists were, with the intervention of Niels Bohr and his colleague, Gyorgy de Hevesy, kept safe from confiscation during World War II. Finally the chemical inertness of gold is accounted for by an unintimidating description of bonding and antibonding,

Chapter 4 tells of the long evolution of the concept of atoms and of atomic structure. Names of famous chemists from the 18th century AD onward are numerous. The Periodic Table, first by groping inquiry, on to current electronic explanations, is the primary focus of the chapter. The chapter concludes with: "So that is why an element's location in the Periodic Table—its row and column—tells us a lot about its chemical behavior…The table is the best crib sheet a young aspiring chemist, sweating through a summertime exam, could wish for."

Chapter 5 begins with an account of the discovery of radioactivity and the growing appreciation of its implications for atomic structure. Discussion of atomic fission; the bomb; the discernment of the process for the sun's heat; cyclotronic generation of unnatural elements; and the description of barely over a century of amazing developments is replete with human terms, with names and points of view. Even the contemporary controversy over naming some of the manufactured elements is included.

"Chemical Brothers" is an inspired way of referring to isotopes (Chapter 6). The chapter begins with radioisotopes in fascinating, debate-settling applications to dating questions that involve people's long-held beliefs. Similar uses of stable isotopes (16O/18O, for example) and medical applications conclude the chapter.

The final chapter emphasizes iron in history, treating it almost as an icon. Ball moves easily from glass making into semiconductors with lucid, yet not technically overpowering, details of the semiconducting phenomenon, doping, and transistors. The platinum group metals and their roles in catalytic converters and cold fusion are highlighted. In discussion of the rare earths, Ball uses a readily-comprehended description of the experimental evidence: "…their presence was revealed by inspecting the 'bar code' of elemental emission lines in the glow produced when the material was heated." He tells of their use as phosphors for TVs. He concludes that "No cook could ever match the natural genius that brews such riches from simple ingredients."

This book may be annoying to those who prefer the presentation of chemistry to be cut and dried. But to those who enjoy the revelation and excitement of the human element in the development of chemistry, The Ingredients is a treasure box ready to be opened. A trendy project in some cities and universities encourages all residents to read the same book during a set period of time, with the hope that fruitful discussions and informed learning will result. I believe that this book would be a superb selection for such a project. Scientific illiteracy would most likely be diminished while appreciation of literature and perspective would be enhanced.

(This book is a companion volume to Ball's earlier book about molecules, Stories of the Invisible, Oxford University Press, Oxford, 2001.) *James G. Traynham, Department of Chemistry, Louisiana State University, 122 Highland Trace Drive, Baton Rouge, LA 70810-5061.*

Ladies in the Laboratory II. West European Women in Science, 1800-1900. Mary R. S. Creese, The Scarecrow Press, Inc., Lanham, MD and Oxford, 2004, 290 pp.

This hardcover updated version of the earlier (1998) edition contains all of the entries found in the earlier edition. The author has here included an Appendix to supplement the information in the 1998 softcover book. For an idea of the coverage and value of this survey, the reader is directed to the earlier review: *Bull. Hist. Chem.*, **2000**, *25*, 132-133. *Paul R. Jones, University of Michigan, Ann Arbor, MI 48109-1055.*

HIST ELECTION 2004 - CALL FOR NOMINATIONS

The following offices are up for election this fall:

- Chair-Elect
- Secretary/Treasurer
- Councilor (2 seats)
- Alternate Councilor (1)

Please send nominations, with contact information, to Vera V. Mainz, the Sec/Treas.

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