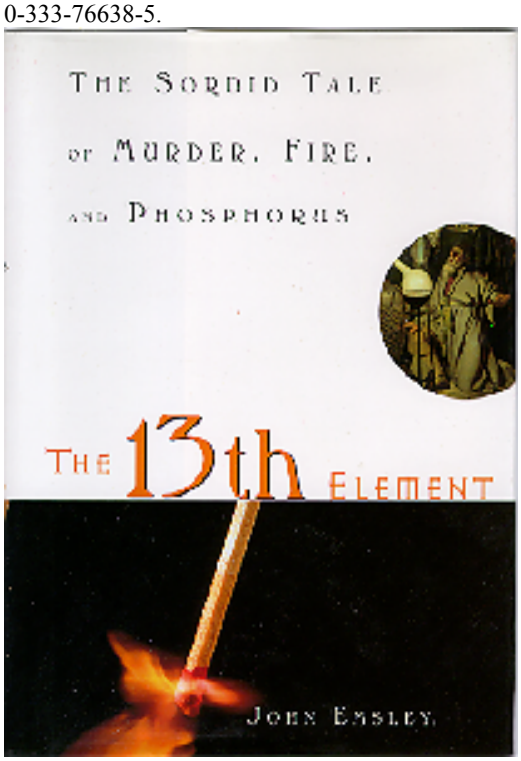
Media Reviews

The 13th Element: The Sordid Tale of Murder, Fire, and Phosphorus. By John Emsley. John Wiley & Sons: New York, Chichester, England, 2000; Illustrations. viii + 327 pp. 14.1 × 20.4 cm. $24.95 (USA); $38.95 (Canada). ISBN 0-471-39455-6; published in the UK as: **The Shocking History of Phosphorus: A Biography of the Devil's Element.** Macmillan Publishers, Ltd.: London, England, 2000. £12.99. ISBN 0-333-76638-5.



I first realized the importance of phosphorus when our biology teacher introduced us to the mnemonic acronym NCHSOP (New Central High School of Philadelphia) for the symbols of the primary elements of protoplasm—the stuff of life (Although my school was the second oldest public school in the United States, being antedated only by the Boston Latin School, it had just moved to a new building). In a modern, more sophisticated biochemical view, phosphorus is a key component of living things, being a constituent of DNA (deoxyribonucleic acid) and ATP (adenosine triphosphate). Also underscoring the central position of phosphorus in plant life is the triadic fertilizer formulation expressing the analytical percentage by weight of the three major nutrients familiar to all gardeners (N—total ammoniacal nitrogen; P—available phosphoric acid expressed as P_2O_5; and K—soluble potash expressed as K_2O).

Phosphorus was the thirteenth element to be discovered; it was preceded by the elements known to the ancients—carbon, sulfur, copper, silver, gold, iron, tin, mercury, and lead and the later discovered antimony, arsenic, and bismuth. John Emsley, the former longtime chemistry lecturer at the University of London, *New Scientist* magazine editor, and science writer in residence at Imperial College, London, now an award-winning freelance writer and science writer in residence at Imperial College, London (since 1997), has made use of triskadekaphobia (fear of the number thirteen) in his title to lend a sinister aspect to his "first biography" of this eerily luminescent element. His earlier books (e.g., *Molecules at an Exhibition: Portraits of Intriguing Materials in Everyday Life*, Kauffman, G. B.; Kauffman, L M. *The Chemical Educator* **1998**, **3**(6), S1430-4171(98)06266-2 (December 1, 1998), 3 pp., DOI 10.1007/s00897980266a) have received favorable reviews.

Emsley, whose most recent honors include the 1995 Rhône–Poulenc Prize for best science book of the year, the Royal Society of Chemistry tertiary chemical education award "for making chemistry popular to a wider public both nationally and internationally," is eminently qualified to write such a book, for he received his PhD degree in phosphorus chemistry (1963) from the University of Manchester. While collecting material for a book (Emsley, J.; Hall, D. *The Chemistry of Phosphorus*; Harper & Row: London, 1976), he encountered numerous human-interest stories unsuitable for an academic textbook but ideal for a popular-science article, which he wrote for the *New Scientist*. This led to a talk with demonstrations for the "Molecule Theatre," as part of a series of public lectures organized by Sir Bernard and Lady Miles. Emsley received many invitations to repeat the talk, which he transformed into a script for a radio program, "The Shocking History of Phosphorus" (the title for the British edition of the book under review). This program was broadcast on BBC Radio 4 in September, 1992 and won a Glaxo Award for popular science broadcasting and a Sony Award for memorable radio programs. During all these lectures and programs Emsley accumulated many of the phosphorus anecdotes that make this book, his seventh, so entertaining, engaging, and fascinating.

In an eminently readable account intended for the general reader, but suitable for the scientist as well, Emsley presents in 14 chapters the 300-year history of the element whose name is derived from the Greek words meaning "bringing light," with an emphasis on curious, bizarre, and horrific events and in the context of its multifaceted role in human history. He begins his account with Hamburg alchemist Hennig Brandt's 1669 isolation of phosphorus from urine (no mean feat; as an adolescent and later with my students I unsuccessfully tried to duplicate the procedure). Hoping that the substance might be the long-sought philosopher's stone, Brandt kept his discovery secret for half a dozen years. The toxic substance was soon touted as an aphrodisiac and a panacea for all sorts of "ills that flesh is heir to," especially mental conditions, and it appeared in 18th-century pharmacopoeias before it was considered "the "devil's element" that caused more curses than cures. Emsley continues his tale with a rich tableau of the activities of alchemists, apothecaries, scientists (including Robert Boyle), entrepreneurs, charlatans, and assorted picaresque characters, most of whom are brought to life in thumbnail sketches or more detailed portraits.

Emsley devotes three chapters to the phosphorus match, nicknamed the lucifer, immortalized in the line, "While you've a lucifer to light your fag" in the World War I song, "Pack up your Troubles." No less a thinker than the Victorian English philosopher Herbert Spencer praised it as "the greatest boon and blessing to come to mankind in the nineteenth century." However, in keeping with his goal to present both sides of the history of phosphorus—the good and the bad, the light and the

dark—Emsley considers in great detail the social, labor, and medical problems that became a concomitant of the match industry.

The women ("match girls") and children employed to manufacture matches, especially during Victorian times, endured dangerous and unbearable working conditions and eventually contracted phosphorus necrosis ("phossy jaw"), a painful, corrosive, and sometimes fatal disease that attacked the teeth and gums. Finally, the use of white phosphorus in match-making was outlawed by the Berne Convention of 1906, which was eventually signed by all nations except the United States. In Great Britain, the country to which Emsley devotes the most space in his stories, Parliament passed a law in 1908 that made phosphorus matches illegal after December 31, 1910. Emsley also discusses nonphosphorus friction matches, first manufactured by English surgeon and pharmacist John Walker in 1827, as well as safety matches.

In another chapter Emsley describes the horrors that civilians faced in World War II when attempts were made to destroy entire cities with phosphorus bombs. For example, he chronicles day by day the incendiary bombing, appropriately code-named "Operation Gomorrah" (July 24–August, 1943), of Hamburg—Germany's second largest city and largest seaport and ironically the home town of the element's discoverer. From one of the many "boxes" that Emsley scatters throughout his book to present data and information in an easily assimilated format, we learn that the Allies' raid resulted in the death of at least 37,000 persons and the destruction of an immense amount of property. He does not neglect more modern phosphorus weapons. Although dropping phosphorus bombs on civilians is not likely to occur again, he concludes that "no other substance can produce the dense smoke of phosphorus pentoxide….[and] phosphorus will continue to be part of the armoury of all armed forces in the foreseeable future."

In another chapter Emsley depicts the development of some of the most deadly poisons known—nerve gases including sarin, soman, tabun, and "the ultimate nerve gas" VX and their antidotes. He also discusses organophosphate insecticides (OPs). In the chapter titled "Murder" he describes a number of famous cases of poisoning carried out mostly by spouses and mostly in England, while in the chapter, "Fortunes from Phosphorus," he surveys its production from the 18th to 20th centuries. During the second half of the last century its peaceful use in making phosphates for detergents sent its production soaring to more than a million tons per year.

After detailing several disasters involving phosphorus, Emsley considers the phosphate cycle in nature that governs all life on earth. He also surveys the development of phosphate fertilizers, including "superphosphate" and "triple superphosphate," with an emphasis on the contributions of Justus Liebig, John Lawes, and Henry Gilbert. Concerning the importance of phosphorus he quotes Isaac Asimov: "We may be able to substitute nuclear power for coal, and plastics for wood, and yeast for meat, and friendliness for isolation—but for phosphorus there is neither substitute nor replacement."

In the chapter "Oh, Shit!" (Emsley favors attention-getting titles) he is concerned with the problems that phosphorus causes when human and animal sewage as well as phosphate food additives and detergents enter our environment. Eutrophication (from the Greek meaning "well nourished") refers to aquatic systems oversupplied with nutrients resulting in perpetual algal blooms that make them green, smelly, devoid of fish, and unfit for drinking or recreation. Although phosphates were first thought to be responsible for such environmental disasters, they were later vindicated. When used as fuel, chicken manure (hence the chapter title) with its high phosphate and high energy content can generate electricity and yields an ash containing as much as 25% phosphate.

In a final, intriguing chapter Emsley discusses alleged cases of spontaneous human combustion, which he calls "probably a myth" that he attributes to external sources of ignition and the "wick effect." After the recital of all the horrors that preceded it, his succinct four-page epilogue, "the Devil's Element," which summarizes the entire book, is refreshingly upbeat. He attributes all the damage and misery that elemental phosphorus has caused to its flammability and toxicity, but he concludes that the damage caused by the human exploitation of phosphates and other compounds is due to an entirely different set of properties. He claims that current regulations will ensure that only completely safe compounds will be allowed, and he predicts "a golden future" for the element.

A three-page appendix summarizes important numerical data on phosphorus and discusses its allotropes. A ten-page list of sources, arranged according to chapter and ranging from 1677 (Robert Boyle) to 1998, serves as a list of references and suggestions for further reading. A detailed index (11 double-column pages) facilitates location of material.

Emsley occasionally uses formulae but in deference to the general reader he writes equations in words. He possesses a felicitous, almost poetic way with words, and he makes chemistry come alive with vivid images such as "when we strip away [phosphorus'] protective cage of four oxygen atoms and expose the element itself, we release a tiger." A lapse in grammar, "The average person has in *their* body about 3.5 kg of calcium phosphate" (p. 257), is an exception rather the rule.

Although at times Emsley emphasizes the history of phosphorus as a Pandora's box, on the whole he presents a balanced blend of the element's positive and negative aspects in keeping with his longtime goal of extolling the benefits of chemistry in everyday life and dispelling the exaggerated fears about its environmental impact (chemophobia). I heartily recommend it to scientists and nonscientists alike. This modestly priced volume would make an ideal gift for a chemist friend.

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S1430-4171(02)03567-8, 10.1007/s00897020567a

Analytical Electrochemistry, Second Edition. By J. Wang, John Wiley & Sons: Chichester, England. £53.95. 207 pp. ISBN 0471-282272-3.

Analytical Electrochemistry covers the growth and development of electroanalytical chemistry over the past few years, with a significant emphasis on analytical aspects of the work rather than the more fundamental physical electrochemistry. The text is split into six easy-to-read and well-referenced chapters. Each chapter is complimented with worked examples and ten to twelve revision questions, which provide an excellent means for the self-teaching of electroanalytical protocols.

The introductory chapter provides an insight into the fundamental principles of interfacial electrochemistry,

including electron-transfer kinetics, mass-transport-controlled reactions, and an explanation of the processes occurring at the electrical double layer. The second chapter details the use of cyclic voltammetry and its use in the study of electrode reaction mechanisms, both in solution and adsorption processes. This chapter includes a detailed table that illustrates the various mechanisms that can occur and be observed using cyclic voltammetry; however, this would be more valuable if real-life examples of each reaction process were given in the table rather than being scattered through the text. The chapter then moves on to an enlightening and informative discussion of the coupling of electrochemistry with spectroscopy, surface-imaging techniques, and the quartz-crystal microbalance, and how combining these techniques can help to elucidate electrochemical processes.

After the first two chapters have given an insight into the fundamental basis of electrochemistry and how it can be utilized as a tool for understanding reaction kinetics, the third chapter introduces electroanalytical techniques in earnest, with the discussion of controlled-potential techniques. This gives rise to a brief but detailed review of all the various amperometric methodologies currently available to the analytical electrochemist.

Chapter 4 is perhaps the most useful chapter for the first-time experimentalist as it gives in-depth information on a range of classical electrode substrates and surface modifications currently available and an insight into where each can be applied. This, however, does seem to neglect some of the more recently utilized electrode materials. The book then moves on to discuss the use of potentiometry in electrochemical sensors. This section is well-written with a concise introduction to the principles of potentiometric measurements, followed by examples of its use in several ion-selective electrodes.

The final chapter consists of a succinct insight into the practical use of electrochemical sensors. The chapter is split into four main sections: electrochemical biosensing is discussed in the greatest depth, because of the range of techniques currently available in this important field of electrochemical sensing. Also included are sections on gas sensors, solid-state devices, and a brief mention of sensors capable of multiple applications. This chapter completes the text and thus brings the reader from the basics of electrochemistry in Chapter 1 up to present day research in the area of electroanalysis.

Overall the text is well-written and extremely informative, giving a concise overview of electroanalysis and the techniques available to the analytical community in general. It is a book which any chemist thinking of taking up the challenge of electroanalysis should read.

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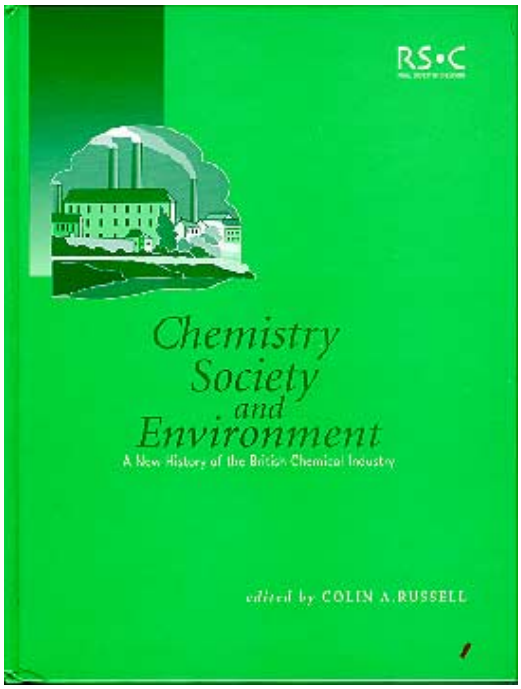
S1430-4171(02)03566-9, 10.1007/s00897020566a

Chemistry, Society and Environment: A New History of the British Chemical Industry. Edited by Colin A. Russell. The Royal Society of Chemistry: Cambridge, England, 2000; Illustrations. xvi + 372 pp. 14.1 × 20.4 cm. $120.00; £65.00. ISBN 0-85404-599-6.



During the past few years several book-length studies of various historical aspects of the European chemical industry have been published. From Kluwer Academic Publishers alone no fewer than three books have appeared—*Determinants in the Evolution of the European Chemical Industry, 1900-1939: New Technologies, Political Frameworks, Markets and Companies* (Travis, A. S.; Schröter, H. G.; Homberg, E.; Morris, P. J. T., eds., 1998); *The Chemical Industry in Europe, 1850-1914: Industrial Growth, Pollution, and Professionalization* (Homberg, E.; Travis, A. S.; Schröter, H. G., eds., 1998); and *The German Chemical Industry in the Twentieth Century* (Lesch, J. E., ed., 2000), Volumes 16, 17, and 18 in the "Chemists and Chemistry" series, respectively.

Similarly, a number of historical studies of the British chemical industry have been made, some dealing with the topic as a whole, and a greater number concentrating on individual companies. Although some focus on technical detail, economic issues, and the scientists and industrialists involved, few have tried to analyze the industry's effects on society as a whole. Also, many of these books, written before the current epidemic of chemophobia and general anti-science resentment, a time when the DuPont motto was "Better things for better living through chemistry," presented the industry as entirely benevolent and deserving of public support and encouragement. Another shortcoming of these earlier studies was the lack of serious analysis of the industry's impact on the environment, a term rarely used before the 1960s. Clearly, a serious, balanced, book-length study of the British chemical industry's effect on both society and the environment was sorely needed.

Colin A. Russell, Emeritus and Visiting Research Professor, Department of History of Science and Technology, the Open University, and Affiliated Research Scholar, Department of History and Philosophy of Science, University of Cambridge, has managed to combine successfully his religious beliefs with his interest in the history of science. He has expounded his goal of humanity's acting as God's steward in cherishing and preserving the environment in recent books such as *Science and Religious Belief: A Selection of Recent Historical Studies*

(Hodder & Stoughten) and The Earth, Humanity, and God: The Templeton Lectures (University College London Press; now Taylor & Francis). Thus he is the ideal scholar to have edited the "new" history under review here.

Although he had the final editorial responsibilities, Russell was aided by three other authors, who, like him, were members of the History of Chemistry Research Group in the Department of History of Science and Technology at the Open University—the late W. A. Campbell (also of the University of Newcastle-upon-Tyne), Noel G. Coley, and S. A. H. Wilmot (also of the University of Cambridge). Acting as a team, the four correlated their chapters by correspondence and meetings. However, because they realized that persons with a selective interest in the material might not wish to read through the entire book, they intentionally allowed a small amount of overlap between some chapters so that each essay is complete in itself.

An idea of the book's scope and breadth can be glimpsed from the titles, authors, and lengths of its 11 chapters:

1. "Records of the British Chemical Industry" (CAR) (12 pp., the shortest chapter)
2. "The Shape of the British Chemical Industry" (NGC) (28 pp.)
3. "Origins of the British Chemical Industry" (NGC) (31 pp.)
4. "The Alkali Industry" (WAC) (32 pp.)
5. "The Nitrogen Industry" (WAC) (26 pp.)
6. "The British Pharmaceutical Industry" (NGC) (24 pp.)
7. "General and Fine Inorganic Chemicals" (WAC) (40 pp.)
8. "The Organic Chemicals Industry to the First World War" (CAR) (42 pp.)
9. "The Age of Polymers and Petrochemicals (Industrial Organic Chemistry from 1914)" (CAR) (31 pp.)
10. "Metal Extraction and Refining" (CAR & SAHW) (48 pp., the longest chapter)
11. "Chemical Industry and the Quality of Life" (NGC & SAHW) (31 pp.)

Although the authors were all concerned with a number of fairly sensitive issues, they refrained from apologetics and tried to present as fair and objective an assessment of the entire history of the industry as possible. However, their "warts and all" picture of the industry results in a far better image than it currently "enjoys" with the general public. Since the four assumed that most readers would have some acquaintance with chemistry, they included chemical terminology, formulas, equations, and reaction schemes wherever appropriate.

Replete with 16 tables, 13 figures, and 147 illustrations—portraits, products, equipment, flow sheets, buildings, factories, advertisements, woodcuts, receipts, caricatures, plant workers, refineries, damage from pollution and explosion, means of transportation, aircraft, furnaces, bridges, and smelters, this volume is extensively documented with primary and secondary sources as recent as 1999. Indexes of persons (with dates of birth and death) (6 double-column pages) and subjects (16 double-column pages) facilitate location of material.

This volume will be of invaluable interest to historians of chemistry and of science, academic and industrial chemists, industrialists, politicians, science policy makers, and anyone concerned with the social and environmental impacts of the British chemical industry. To assess the effects of the industry on Britain now and in the future, such persons will require an understanding of what it has done in the past. For this purpose I recommend this authoritative, scholarly, but eminently readable history.

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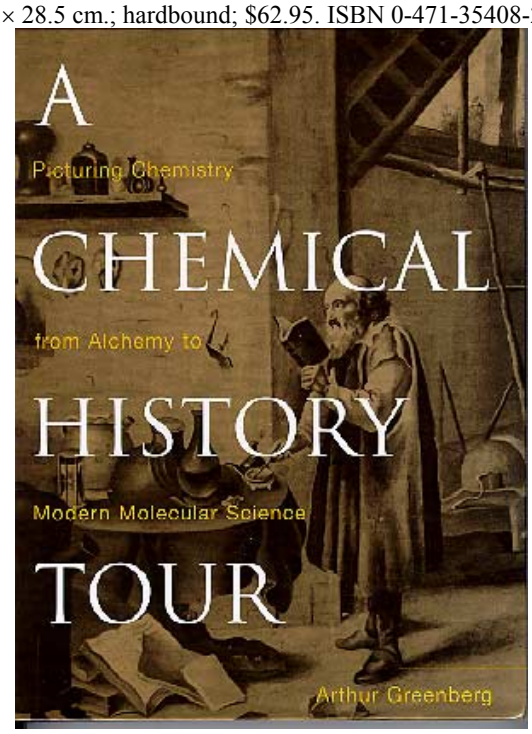
S1430-4171(02)03568-7, 10.1007/s00897030568a

A Chemical History Tour: Picturing Chemistry from Alchemy to Modern Molecular Science. By Arthur Greenberg. Wiley-Interscience; John Wiley & Sons: New York; Chichester, England, 2000. Illustrations. xviii + 312 pp. 21.1 × 28.5 cm.; hardbound; $62.95. ISBN 0-471-35408-2.



According to Arthur Greenberg, former Chairman of the Chemistry Department at the University of North Carolina-Charlotte and now Dean of the College of Engineering and Physical Sciences at the University of New Hampshire, his purpose in writing this beautiful, oversized volume was "to treat you to a light-hearted tour through selected highlights of chemical history" and "provide an entertaining and attractive, but informative resource for chemistry teachers, practicing professionals in science and medicine, as well as the lay public interested in science and appreciative of artwork and illustration." In my opinion he has admirably succeeded in fulfilling this goal.

Designed as a "picture book with sufficient text to explain details and context" and with its wide, generous margins, and fine paper, it is a work of art as well as of science. Greenberg's idea of using visual images to convey science and its history was inspired by another triumph of art and science, *Chemistry Imagined: Reflections on Science* (Smithsonian Institution Press: Washington, DC, 1993; reviewed by G. B. Kauffman and L. M. Kauffman, *J. Chem. Educ.* **1994**, *71*, A239-A240), for which Roald Hoffmann provided the text and Vivian Torrence provided the illustrations. A charter member of the Chemical Heritage Foundation's Bolton Society (named for chemical bibliographer Henry Carrington Bolton) and an inveterate antiquarian book collector, Greenberg states,

"Unless otherwise noted, the figures are from books or artwork in my own collection."

Intended for either browsing or reading in its entirety, Greenberg's tour begins with the early practical and mystical roots of chemistry and traces its evolution into a modern science in both pictures and words. He admits that his coverage of twentieth-century chemistry is relatively light because of the exponential explosion of scientific discoveries. However, he includes cutting-edge structural chemistry with the synthesis of nanoscopic polyhedra, recalling the Pythagoreans' view of the heavenly- or fifth element ("ether") postulated some two and a half millennia ago, and the use of the scanning tunneling microscope (STM) to view individual atoms. Although he has tried to recognize scientific contributions beyond those of Western culture, he attributes his weak coverage of early science in Chinese, Indian, African, Moslem, and other cultures to the lack of printed books.

The pictorial tour is divided into eight approximately chronological sections, which in turn are divided into 117 subsections:

1. "Practical Chemistry, Mining, and Metallurgy" (6 essays, 22 pp)
2. "Spiritual and Allegorical Alchemy" (13 essays, 41 pp)
3. "Iatrochemistry and Spagyricall Preparations" (3 essays, 10 pp., the shortest section)
4. "Chemistry Begins to Emerge as a Science" (26 essays, 60 pp., the longest section)
5. "Modern Chemistry is Born" (19 essays, 45 pp.)
6. "Chemistry Begins to Specialize and Helps Farming and Industry" (17 essays, 41 pp.)
7. "Teaching Chemistry to the Masses" (10 essays, 27 pp.)
8. "The Approach to Modern Views of Chemical Bonding" (23 essays, 53 pp.)

The book concludes with a one-page "Postscript" consisting of the images in three short poems by modern Irish poet Seamus Heaney, who received the 1995 Nobel Prize in Literature, that underscore a major theme of the book—the unity between matter, nature, and the human spirit.

Many of the vignettes bear ingenious, witty, whimsical, anachronistic, or quirky titles (for example, "Ratso Rizzo and the Poet Virgil as Transmuting Agents?;" "The Dream Team of Alchemy;" "A Tree Grows in Brussels;" "Black's Magic;" "Fire Air (Oxygen): Who Knew What and When Did They Know It?;" "Adams Opposes Atoms" (John Adams, the second U.S. President, "could not comprehend atoms."); "Why's the Nitrogen Atom Blue, Mommy?;" "Want a Great Chemical Theory? Just Let Kekulé Sleep on It;" "My Parents Went to Karlsruhe and All I Got Was This Lousy Tee-Shirt!;" "A Mid-Semester Night's Dream;" "It's the Atomic Number, Dmitry!;" and "Where Did We Dig Up the Mole?"). They range in length from half a page to 10 pages and are all linked to one or more figures except for the recipe for the Philosopher's Stone (pp 22-23).

Familiar and rare instruments, portraits, apparatus, textbooks, woodcuts, artwork, and a wide variety of other intriguing illustrations are included. Dates of birth and death are given for almost every one of the many persons who parade through the pages. The book is meticulously documented and cross-referenced; specific references as late as 1999 follow each essay, and Greenberg is scrupulous to a fault in specifically acknowledging assistance to numerous persons. Although his volume is intended for laypersons as well as scientists, he does not hesitate to use formulas and equations wherever appropriate. A detailed (12 double-column pages) index makes the book particularly user-friendly.

Greenberg has a way with words, and the tone of the book is so decidedly light-hearted that it will appeal to everyone but the most hidebound reader. It abounds with rhetorical questions that draw the reader into the story. The volume is also full of satire, puns, and informal and colloquial speech, although his use of "snuck" (p 256) is carrying informality too far for my pedantic taste.

Greenberg modestly declares, "I am not a chemical historian," yet he displays a fantastically wide, multifaceted knowledge of chemistry and all manner of subjects. Although he states that "like any tour, [the book] is idiosyncratic in the highlights that it chooses to show the tourist," almost all of the theories and concepts that are a *sine qua non* of the usual introductory chemistry course are dealt with, thus making the book an ideal source of humorous anecdotes and tales for chemical educators who wish to enliven their lectures with supplementary, often humorous, material.

Considering the large number of persons and works cited, the number of errors, mostly in proper names, does not seem excessive. Some are "typos," e.g., sparse (not sparce)(p xi); Prelude (not Preclude)(p xv); Van (not Von) Helmont (p 159); Seuss (not Suess. Yes, even Dr. Seuss is included among the numerous popular, nonscientific authors cited) (pp 173, 310); H_2O (not H_20) (twice on p 175); and Benjamin (not Benjamen) Thompson (p 311). Others involve the omission of diacritical marks, e.g., André Ampère (p 176); André Dumas (p 176); Jöns Berzelius (pp 187, 188, 229, 302); and Frédéric Gerhardt (p 207). Consistent errors too frequent to be cited by page include Humphry (not Humphrey) Davy; Macmillan (not MacMillan); *Encyclopædia* (not *Encyclopedia*) *Britannica*; and omission of authors' names in the numerous articles cited in the *Dictionary of Scientific Biography*; the editor of which is also omitted.

Other errors include the following: Partington (James not John)(pp xvii, 308); A.D. should precede, not follow, the year (p 45); Sylvius (dele Boë not dela Boë) (pp 96, 310); Starkey (George not John) (pp 100, 310); Eilhard (not Eilhardt) Mitscherlich (pp 175, 307); Quaregna (not Quaregua) in Avogadro's title, but even Partington has this typographical error) (p 175); and Glenn T. Seaborg died on February 25, 1999 not March 1999 (p 283);

Also, it was Victor L. King not John Read who resolved the first coordination compound (p 252). In Greenberg's favor the article by Ivan Bernal, from which Greenberg obtained the information, contains the error; furthermore the first coordination compound to be resolved was the *cis*-amminehalobis(ethylenediamine)cobalt(III) salt not the corresponding *cis*-dinitro salt, for which the reference is given). Again, in Greenberg's favor, Karl Lehrs' admonition, "Immer Quellen lesen, daraus ergibt alles von selbst" (Always read sources, from which everything flows automatically), is often more honored in the breach than the observance.

In view of the large number of illustrations (164 numbered black and white plus eight color plates), most of which are full page, as well as the fine workmanship involved in producing this book, its modest price is both surprising and welcome. Professor Greenberg has put an immense amount of time and effort into this delightful book, and it shows. I highly recommend it to practicing chemists; chemical educators; bibliophiles and book collectors; anyone interested in chemistry, art, and culture; and even historians of chemistry

and of science. The author obviously had a lot of fun and enjoyed himself in writing it, and in reading it you'll experience the same feelings.

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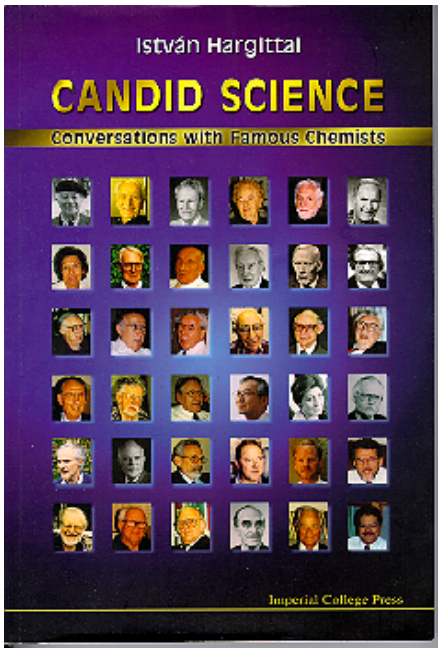
S1430-4171(02)03569-6, 10.1007/s00897020569a

Candid Science: Conversations with Famous Chemists. By István Hargittai; edited by Magdolna Hargittai. Imperial College Press: London, England, 2000; distributed by World Scientific Publishing Co.: Singapore; River Edge, NJ; London, England. Illustrations. xii + 516 pp.; 16.5 × 24.5 cm.; $78; £48; hardbound. ISBN 1-86094-151-6; $34.00; £21; paperback. ISBN 1-86094-228-8.



We have been Contributing Editor (GBK) of the History feature of *The Chemical Intelligencer*, Springer-Verlag's popular but unfortunately short-lived quarterly magazine for the culture of chemistry and related sciences, as well as authors (GBK and LMK) of interviews, reviews, and articles involving 14 of the 36 interviewed chemists whose portraits appear on the cover of *Candid Science: Conversations with Famous Chemists*. Thus, we have a personal as well as professional interest in István Hargittai's delightful collection of interviews, vignettes, and quotations.

During his six-year tenure (24 issues, 1995–2000) as Editor-in-Chief of *The Chemical Intelligencer*, Hargittai, sometimes with his wife Magdi, interviewed more than 120 eminent scientists, more than half of whom were Nobel laureates. A number of these interviews did not reach the pages of the magazine, and we hoped that these, along with the many that were published, could appear in print in a handier and more permanent form. Fortunately, the first of the four volumes of *Candid Scientists* (edited by Magdolna Hargittai) is now available and should be followed shortly by volumes subtitled *Conversations with Famous Biomedical Scientists, Conversations with Famous Physicists,* and *More Conversations with Famous Chemists*.

Hargittai seeks to uncover the stories behind the most important achievements in twentieth-century chemistry directly from some of their most eminent participants. They tell us about their lives, both personal and professional, childhoods (Yes, some had chemistry sets or home laboratories.), influences and career choices, aspirations, hardships and triumphs, philosophies, and, of course, their seminal discoveries. In most cases their human feelings shine through their words. Nobel laureates describe how the prize affected their lives, research, and careers. Most are modest and admit the role of luck in their good fortune. For example, 1999 Nobel laureate Ahmed H. Zewail states, "you have to be in the right place in the right time" (p 507).

A number of the conversations are laced with humor. For example, Elena G. Gal'pern, coauthor of the 1973 Russian article predicting the stable truncated icosahedral structure of C_{60}, told Hargittai, "I have two kittens and a dog and when I try to talk to them about fullerenes, they stare at me with great bewilderment" (p 331). Also, on p 263 we see a cartoon from the *Journal and Courier*, Lafayette, Indiana on October 20, 1979 after the announcement of the 1979 Nobel Prize. Herbert C. Brown is depicted sitting and reading the newspaper, while his wife asks, "Excuse me, Herbert, but would I be out of line in asking a Nobel Prize winner to take the garbage out?" In a letter to the editor of October 25, 1979 Brown responded, "I read your cartoon with a sinking feeling. Sarah has always brought the garbage out and cartoons such as you published can only create difficulties in an idyllic arrangement. You should understand that in our long, very happy marriage I have assumed total responsibility for the chemistry, and Sarah has assumed responsibility for everything else. Please, don't sow doubts in a wonderful cooperative arrangement." On the following page we see a cartoon by Brown's postdoc Hsiupu Daniel Lee titled "Sic transit gloria," in which the positions of the couple are reversed; Brown is taking out the garbage, while his wife is sitting reading the newspaper.

The subject matter discussed includes structural chemistry, medicinal chemistry, natural products, stereochemistry, theoretical and computational chemistry, inorganic chemistry, physical organic chemistry, NMR spectroscopy, kinetics and reaction mechanisms, early molecular mechanics, grants and research support, the increasing importance of instruments, the brain drain, and the politics of resonance theory and atmospheric chemistry. Almost a fifth of the book (95 pp) is devoted to one of the most fascinating discoveries of the second half of the twentieth century, the fullerenes.

Each interview is prefaced with a biographical sketch and includes one or more portraits, many photographed by Hargittai himself. The volume contains 167 illustrations of apparatus, pages of articles and books, medals, formal and informal group portraits, graphs, cartoons, models, commemorative postage stamps, and even an NMR image of 1991 Nobel laureate Richard R. Ernst's head and a drawing and painting by 1996 Nobel laureate Harold W. Kroto. Hargittai's questions are printed in italics and the much longer responses in Roman type. Structural formulas, equations, and reaction schemes are included when necessary. Eight of the interviewees are now deceased, underscoring the importance of such oral histories. The earliest born chemist is 1956 Nobel laureate Nikolai Nikolayevich Semenov (1896–1986), Hargittai's first conversation with a famous chemist (September 1965 for Radio Budapest), and the youngest interviewee is Robert L. Whetten (b. 1959).

Besides the actual interviews, Hargittai includes additional entries: 1969 Nobel laureate Odd Hassel, "to whom I never posed questions in the way I did to the others, but my interactions with him made me think of him as one of my interviewees;" quotations (useful for lecture use by chemical educators) by Erwin Chargaff and 1995 Nobel laureate John W. Cornforth; a brief review of the minutes of a June 11–14, 1951 meeting in Moscow devoted to the denunciation of Pauling's resonance theory; a brief segment on Buckminster Fuller because of his conspicuous, if indirect, role in the fullerene story; early Russian work on metal–metal bonds; and a brief entry on Paul de Kruif "because his book *Microbe Hunters* was at least as important as the chemistry set in turning interested children's attention to chemistry for the generations that are so prominently represented among my interviewees."

Since Hargittai is a friendly fellow scientist rather than an investigative reporter, he never tries to deal with a problem with which the interviewees seem uncomfortable, and he tactfully asks them to ignore any of his questions that they do not wish to discuss. In return, they are often candid and frank in their responses to questions that he does ask. Hence the title of his book is most appropriate, as is its subtitle; actually, its contents are more candid informal conversations rather than formal interviews.

Thus several scientists discuss their differences with Sir Robert Robinson and Richard Bernstein. Al Cotton presents his side of the controversy during his candidacy for the 1985 American Chemical Society presidency. The campaign became a *cause célèbre* when he sent a letter to ACS members branding his opponent "a mediocre industrial chemist." He still maintains that this was "a precise description of him" but admits that he "shouldn't have coupled those two adjectives" (pp 241–242). Similarly, Eiji Osawa wishes that he had not published his 1970 article on C_{60} in the Japanese journal *Kagaku*, where it elicited no response from the international chemical community (p 313). Also, several of the main participants in the fullerene story reveal the presence of animosity and jealousy. Wolfgang Krätschmer tells that "it wouldn't have been a big problem to support [his former graduate student Konstantinos Fostiropoulos'] becoming a co-inventor [of C_{60}] if he had not blamed us for scientific robbery….He is somewhere in Germany, and his lawyers are pursuing the suit against the Max Planck Society, which is one of the patent holders" (p 402). In response to Hargittai's question as how to avoid controversies about priorities in discoveries, Rick Smalley suggests, "Keep a tape recorder running at all times [in the U.S. this ought to be called 'Nixon's Rule**']"** (p 372).

From the conversations we also learn many little known facts: Al Cotton was christened Frank Abbott (not Albert) Cotton (p 232). Richard R. Ernst suffered a nervous breakdown because of overwork in his native Switzerland, and he prefers the United States (p 303). Rick Smalley realized that something fundamentally new was being discovered "at about 1 a.m., Tuesday morning, September 10, 1985" (p 368). The wife of Wolfgang Krätschmer, who was the first to produce C_{60} in macroscopic quantities, came from Hatvan, which in Hungarian means sixty, and Buckminster Fuller was research professor at Southern Illinois University at *Carbon*dale (p 403). *Aerosol Age* published an interview with a person who speculated that 1995 Nobel laureates F. Sherwood Rowland and Mario J. Molina, who discovered the role of chlorofluorocarbons (CFCs) in depleting the ozone layer, were KGB agents intent of disorganizing American industry (p 462).

Because previous subscribers to *The Chemical Intelligencer* may be potential buyers of the first volume of *Candid Science*, here is an annotated list of its contents (CI, previously appeared in the same or modified form in *The Chemical Intelligencer*; *, Nobel laureate; †, deceased; F, female):

1. "Linus Pauling" (5 pp) CI * † (This was the very first article to appear in *The Chemical Intelligencer*)
2. "The Great Soviet Resonance Controversy" (6 pp)
3. "Erwin Chargaff" (15 pp) CI
4. "Quotable Chargaff" (9 pp)
5. "Frank H. Westheimer" (16 pp) CI
6. "Gertrude B. Elion" (18 pp) CI * † F
7. "Carl Djerassi" (20 pp) CI
8. "Paul J. Scheurer" (22 pp) CI
9. "Ayhan Ulubelen" (8 pp) CI F
10. "John W. Cornforth" (13 pp) CI *
11. "Quotable Cornforth" (3 pp) *
12. "Vladimir Prelog" (10 pp) CI * †
13. "Derek H. R. Barton" (10 pp) CI * †
14. "Odd Hassel" (6 pp) * †
15. "Michael J. S. Dewar" (14 pp) CI †
16. "John A. Pople" (12 pp) CI *
17. "Roald Hoffmann" (18 pp) CI *
18. "Kenichi Fukui" (12 pp) CI * †
19. "Milton Orchin" (8 pp)
20. "F. Albert Cotton" (16 pp) CI
21. "The Beginnings of Multiple Metal-Metal Bonds" (4 pp)
22. "Herbert C. Brown" (20 pp) CI *
23. "George A. Olah" (14 pp) *
24. "John D. Roberts" (10 pp) CI
25. "Richard R. Ernst" (14 pp) CI
26. "Eiji Osawa" (14 pp) CI
27. "Elena G. Gal'pern F and Ivan V. Stankevich" (10 pp) CI
28. "Harold W. Kroto" (26 pp, the longest piece) CI *
29. "The Fuller Connection" (4 pp) CI
30. "Richard E. Smalley" (12 pp) CI *
31. "Robert F. Curl" (14 pp) *
32. "Wolfgang Krätschmer" (16 pp) CI
33. "Robert L. Whetten" (12 pp)
34. "Philip E. Eaton" (6 pp)
35. "R. Stephen Berry" (14 pp)
36. "What Turned You to Chemistry?" (2 pp, the shortest piece)
37. Kenneth S. Pitzer" (10 pp) †
38. "F. Sherwood Rowland" (18 pp) * CI
39. "Nikolai N. Semenov" (10 pp) * †
40. "George Porter" (12 pp) *
41. "Ahmed H. Zewail" (20 pp) *

Only three of the scientists are women so, despite the increasing acceptance of women in academic, industrial, and governmental laboratories, further advances in the struggle against sexism are needed. An unusually high proportion of the interviewees (at least a dozen) are Jewish, so the issues of Judaism, the Holocaust, and anti-Semitism are discussed by several of them. However, it is a Moslem, Ahmed H. Zewail, who cogently makes the case for tolerance: "In academia, I have been aware of the Jewish tradition of scholarship. I know that Jewish families educate their children to these values and to reason. I think the majority of people could appreciate me

for what I was. Many of my friends are Jewish scientists, and they can value me as a scientist and as a human being" (pp 506–507).

Hargittai dedicated his volume, which is admirably suited for either complete reading or browsing, "to the coming generations of students, for whom much of the material presented here will be science history." According to 1967 Nobel laureate Baron George Porter of Luddenham, one of the interviewees, who also wrote the foreword, "This book will be enjoyed by all who have some interest in science and it will be of special value to the young people whom it may encourage to follow those, whose stories are told here." We heartily agree with his evaluation.

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S1430-4171(02)03570-7, 10.1007/s00897020570a

Chemistry Comes Alive!, Volume 2. Compiled by Jerrold J. Jacobsen and John W. Moore. Special Issue 21, 1998; CD-ROM for Macintosh and Windows; JCE Software, University of Wisconsin-Madison, 1101 University Ave., Madison, WI 53706-1396; Phone: (608) 262-5153 or (800) 991-5534; FAX: (608) 265-8094; e-mail: jcesoft@chem.wisc.edu; Prices/ Licensing (prices for non-U.S. are in parentheses): single user on a single machine, $60 ($80); additional single user copies, $45 ($65); libraries, single machine, $120 ($140); networks, up to 12 simultaneous users, $240 ($260); networks: up to 50 simultaneous users, $800 ($820); networks, more than 50 simultaneous users, contact JCE Software for a quote. Because *Chemistry Comes Alive!* is periodically updated, for the latest information on system requirements please access JCE Online: http://jchemed.chem.wisc.edu/JCESoft/Programs/CCA/CCA_system.html.

This disk is the second in a multivolume series of CD-ROMs featuring collections of pictures, computer-generated graphics and animations, explanations, and Apple QuickTime videos depicting chemical reactions that should stimulate the curiosity of students and motivate them to learn, thus bringing chemistry to life as the series title implies. The collections are divided into volumes on related topics generally included in a first-semester college or high school introductory chemistry course, as recommended for maximum usefulness by a group of chemical educators.

Volume 2 is divided into four chapters:

E/P Electronic Structure/Periodic Table
B Bonding
S/L Solids/Liquids
S Solutions

The topics and demonstrations (some of which can be considered under more than one topic—with an asterisk indicating the primary chapter assignment for the topic) are:

E/P* Relative Reactivity of Alkali Metals
E/P* Induction by Iron(II) of the Oxidation of Iodine by Dichromate
E/P* Colors of Elements in a Flame
E/P* B Curie Point of Nickel
E/P* B Paramagnetism: Compounds
E/P* S/L Paramagnetism: Oxidation States of Manganese
E/P B* Paramagnetism: Nitrogen and Oxygen
E/P* S/L Isotopes: Heavy Water Ice Cubes
E/P B* S/L Ferrofluid
B* S/L Floating Squares
B* S/L Plastic Sulfur
B* S/L Ice Bomb
B* S/L Viscosity of Liquids
B* S/L Hardness of Solid Substances
B* S/L Hardness of Solid Substances—Grinding
B* Ferrimagnetism
B* Ring Strain
B* **S** Like Dissolves Like: Demonstration
B* **S** Like Dissolves Like: Multimedia Experiments
E/P **S/L*** Piezoelectric Effect
B S/L* Sodium Chloride Crystal Cleavage
B S/L* Critical Point of Benzene
B S/L* Simulation of Dislocations in

Heat Treatment of a Metal Bobby Pin
B S/L* Heat Conduction by Diamond
B S/L* Thermochromism: Mercury(II) Iodide
B S/L* Memory Metal
S/L* Liquefaction of Carbon Dioxide
S/L* Boiling by Cooling
S/L* Superconductivity
S/L* Vapor Pressure: Drinking Bird
S/L* Vapor Pressure: Collapsing Balloon
S/L* Mercury Barometers
S/L* Big Barometer
S/L* Boyle's Law: J-Tube
S/L* Vapor Pressure: Using Barometers
S/L* Vapor Pressure: H-Bonding vs. Dipole-Dipole

Attraction
S/L* Vapor Pressure: Molecular Polarity
S/L* Vapor Pressure: Molecular Size
S/L* Vapor Pressure: Raoult's Law
S* Crystallization of Supersaturated Sodium

Acetate
S* Ammonia Fountain
S* Ammonia Fountains—Multiple
S* Conductimetric Titration
S* Canned Heat
S* Extraction of Acid with Base
S* Osmotic Pressure, Hydrostatic Pressure

The emphasis in the collection is on chemistry with reactions shown close-up (in only a few cases, where scale is important, are more than the demonstrators' hands shown). Each demonstration or reaction illustrates an important aspect of chemistry.

The disk is organized like a World Wide Web site to maximize its usefulness in the classroom, and accessing its contents via the web browsers should be a very easy and familiar process for most users. Correlation to a number of popular high school and college chemistry textbooks is provided, allowing the user to select the text used in class from a list and then move to each chapter to locate images that complement the content of the chapter.

Links are provided to *JCE Online,* where the user will find resources that complement the disk, including a consolidated index for all volumes of *CCA!* as they are developed,

instructional materials that utilize *CCA!,* and previews of all *CCA!* volumes. The viewer must install QuickTime to view the videos (played directly using MoviePlayer on the Macintosh or Media Player in Windows) and Chime for the molecular animations, both of which can be used as lecture aids. Images can be easily incorporated into multimedia presentations or lessons. The web browser's Bookmark function is an especially convenient way to organize material for lectures or student lessons. Sufficient written information about each video segment is provided to allow students to use the disk independently.

The starting point for accessing the program is the index page. Directions are given on how to access the index page from within an Internet browser. From this point the user can view the videos and animations in any order, either following the table of contents or going directly to the topics section where a particular topic and all the associated videos can be seen. A very useful aspect of the program is the cross-linking between topics and videos, much in the same way that a web page provides links.

The movies include voice-over narration, and the sound from the reaction is included whenever it is important. Several demonstrations are accompanied by computer-generated animations, which provide microscopic explanations of the observed macroscopic phenomena. Some demos consist of a comprehensive series of reactions that permit both the instructor and students to compare and contrast the behavior of similar reactions and to provide material that can be used in constructing tests. Frames diagramming the reaction can be found on the same page as the video.

The greatest strength of *Chemistry Comes Alive!* lies in the many reactions demonstrated that would be impractical or too dangerous to perform in the classroom. The reaction videos can be worked into lectures or class demonstrations and quickly shown to illustrate or reinforce information given during a lecture or lab. With increasing costs for reagents and equipment as well as the concern over liability to students and faculty, this CD-ROM is an excellent alternative to actually performing potentially dangerous experiments and cleaning up or disposing of reaction products. Admittedly, for students nothing can replace the thrill of observing or performing a highly exothermic reaction. However, in many situations the gains in being able to witness an energetic reaction hands-on do not outweigh the risks involved.

The contents of all *CCA!* CD-ROMs can be simultaneously browsed and searched by visiting the web site: http://jchemed.chem.wisc.edu/JCESoft.

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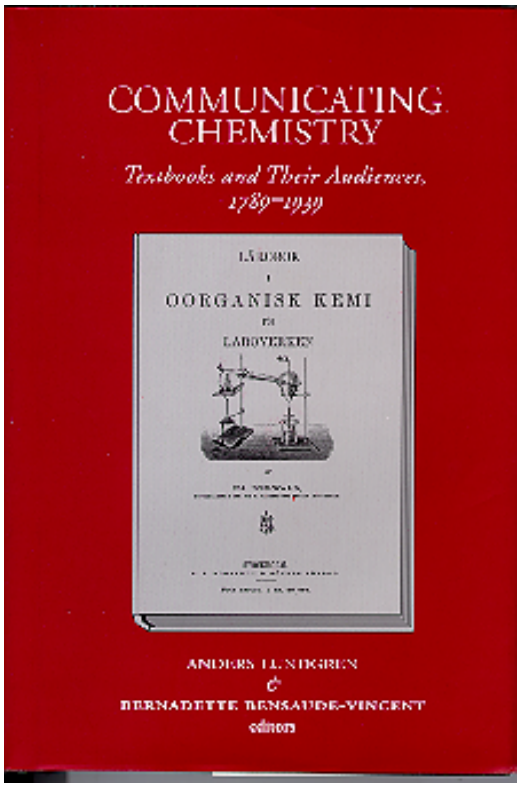
S1430-4171(02)03571-6, 10.1007/s00897020571a

Communicating Chemistry: Textbooks and Their Audiences, 1789-1939. Edited by Anders Lundgren and Bernadette Bensaude-Vincent. European Studies in Science History and the Arts, Vol. 3. Science History Publications/USA: A Division of Watson Publishing International: Canton, MA, 2000. vii + 465 pp., hardcover. 16.0 × 23.5 cm. $56.00. ISBN 0-88135-274-8.



The European Science Foundation (ESF) is an association of 62 major national funding agencies devoted to basic scientific research in physical and engineering sciences, life and environmental sciences, medical sciences, humanities, and social sciences in 21 countries. It acts as a catalyst for the development of science by bringing together leading scientists and funding agencies to debate, plan, and implement pan-European scientific and science policy initiatives.

In 1993 the ESF sponsored a scientific program on "The Evolution of Chemistry in Europe, 1789–1939," which explored the historical development of European chemistry from a variety of novel standpoints. This exploration occurred in the form of a series of workshops, in which leading scholars participated. These series dealt with the chemical profession; communication, texts, and laboratories; and chemical industry. Each workshop dealt with different time periods, and each resulted in one or more publications. To date no fewer than five publications have resulted from these workshops.

The first, "Strategies of Chemical Industrialization from Lavoisier to Bessemer," dealing with the application of science to industry during the period 1789–1850, the time of the First Industrial Revolution, was held in Liège, Belgium in 1994 [1, 2]. The second, concerned with the mutual relationship between science and industry during the period 1850–1914, corresponding approximately to the so-called Second Industrial Revolution, was held in Maastricht, The Netherlands on March 23–25, 1995 [3]. The third workshop, concerned with the period 1900–1939, especially the time between the two World Wars, was held in Strasbourg, France in October, 1996 [4]. A fourth workshop, which dealt with natural dyes, was held in Oxford, England [5].

A fifth workshop, dealing with textbooks, was held in Uppsala, Sweden in February, 1996 and resulted in this collection of 18 chapters by 18 historians of chemistry or science from 9 countries (four from France, three each from Spain and the United Kingdom, two each from Germany and

the United States, and one each from Greece, Hungary, Portugal, and Sweden) [6]. It is edited by Anders Lundgren, Associate Professor in History of Science and Ideas, Uppsala University, and Bernadette Bensaude-Vincent, Professor of History and Philosophy of Science, Université Paris X.

Textbooks have suffered from a "bad press," at least in science studies. Widely regarded as boring, dogmatic, and conservative, they are considered useful only insofar as they provide a window on the "normal science" (in Thomas Kuhn's sense) of a given period. They do not deal with the creative moments in scientific innovation or the fascinating controversies through which scientific knowledge and progress evolve. Also, even among the channels of scientific communication, they are neither the most glamorous not the most successful means of transmitting information or enthusiasm.

The contributors to *Communicating Chemistry*, however, consider textbooks to be an interesting subject that deserves the attention of historians. They seek to place textbooks in their contexts, and they demonstrate how textbooks differ from other forms of chemical literature, under what conditions they became established as a genre and developed a specific rhetoric, and how their readers helped shape the profile of chemistry. The chapters and authors are:

1. "French Chemistry Textbooks, 1802–1852: New Books for New Readers and New Teaching Institutions" (37 pp), Antonio García Belmar and José Ramón Bertomeu Sánchez
2. "Spanish Chemistry Textbooks, 1788–1845: A Sketch of the Audience for Chemistry in Early Nineteenth-Century Spain" (33 pp), Antonio García Belmar and José Ramón Bertomeu Sánchez
3. "Theory and Practice in Swedish Chemical Textbooks during the Nineteenth Century: Some Thoughts from a Bibliographical Survey" (28 pp), Anders Lundgren
4. "Chemistry in Physics Textbooks, 1780–1820" (21 pp), Gunter Lind
5. "The Language of Experiment in Chemical Textbooks: Some Examples from Early Nineteenth-Century Britain" (24 pp), Brian Dolan
6. "From the Workshop into Print: Berthollet, Bancroft, and Textbooks on the Art of Dyeing in the Late Eighteenth Century" (22 pp), Agustí Nieto-Galan
7. "Communicating Chemistry: The Frontier between Popular Books and Textbooks in Britain during the First Half of the Nineteenth Century" (19 pp), David Knight
8. "Atomism in France: Chemical Textbooks and Dictionaries, 1810–1835" (25 pp), Catherine Kounelis
9. "Berzelius's Textbook: In Translation and Multiple Editions, as Seen Through His Correspondence" (22 pp), Marika Blondel-Mégrelis
10. "Three Rhetorical Constructions of the Chemistry of Water" (18 pp), Mercè Izquierdo
11. "From Teaching to Writing: Lecture Notes and Textbooks at the French École Polytechnique" (22 pp), Bernadette Bensaude-Vincent
12. "Dimitrii L. Mendeleev's *Principles of Chemistry* and the Periodic Law of the Elements" (15 pp, the shortest chapter), Nathan M. Brooks
13. "Chemistry for Women in Nineteenth-Century France" (15 pp), Natalie Pigeard
14. "The Chemistry of Everyday Life: Popular Chemical Writing in Germany, 1780–1939" (40 pp, the longest chapter), Barbara Orland
15. "Roles and Goals of Chemical Textbooks on the Periphery: The Hungarian Case" (29 pp), Gábor Palló
16. "From Student to Teacher: Linus Pauling and the Reformulation of the Principles of Chemistry in the 1930s" (18 pp), Mary Jo Nye
17. "One Face or Many? The Role of Textbooks in Building the New Discipline of Quantum Chemistry" (35 pp), Kostas Gavroglu and Ana Simões

In a masterly "Introduction: The Study of Chemical Textbooks" (18 pp), which was originally the concluding remarks of the workshop, John Hedley Brooke states,

> Textbooks can be more enthralling than their unglamorous image might suggest. The task of stabilizing a body of knowledge, when that knowledge is in a dynamic state, and the tendency in many textbooks to conceal the controversies that ultimately made them possible surely invite deeper analysis. To treat textbooks merely as a window on past theory is to short-change their authors, who were often responding to and endeavoring to reconcile, the demands of publishers on the one hand and of new institutional structures on the other.

Brooke summarizes the contents and conclusions of the individual chapters and thus gives an overview of the entire volume. He raises a number of questions and topics, which the contributors consider or answer in the chapters, which I have identified below by numbers in parentheses:

- What is a workable definition of a textbook? Has it changed with place and time? Can works of popularization and formal textbooks be clearly differentiated? (1, 5, 7, 13–15, 17).
- What are the characteristics of 19th-century textbooks? (1, 10).
- Are there hybrids of the various kinds of textbooks? (7, 15).
- How do textbooks distort the processes of scientific revolution in order to "normalize" scientific knowledge and emphasize its continuity and progressive accumulation? (14).
- What is the role of theory in textbooks, and do changes in meaning occur when theories are exported from one national context to another? (3, 8, 16).
- Does the elimination of controversy produce an artificial image of scientific objectivity? (16, 17).
- Do textbook authors who engage in research include their own participation in this making of science? (6, 7, 9).
- Does the study of textbooks shed light on political and institutional developments in different European countries? (2).
- Is the variety of texts related to the changing role of chemistry in primary and secondary education? (1, 7, 11, 14).
- Can textbooks contain explicit political ideology? (15).
- How does the content of chemistry textbooks reflect new degrees of specialization? (2, 3, 6).
- Why are some texts durable and deemed worthy of translation? (4, 8).
- Is there more to the process of translation of texts than mere translation itself? (3, 6, 7-9).
- To what extent do textbooks reflect pedagogic theory? (5, 7).
- What are the commercial aspects of textbooks? (1, 11).
- What is the readership of textbooks? (12, 15).
- What textbooks make extensive use of history? (2, 3, 7, 11, 12).
- What are the national and regional differences in textbooks and their audiences? (2–5, 7).

• How can textbooks reflect changing boundaries between disciplines, and how they were negotiated? (4, 11, 16, 17).

• In reorganizing material for didactic purposes have new insights been achieved by the textbook author? (The classic case provided by Mendeleev's discovery of the periodicity of the elements during the writing of his *Principles of Chemistry*) (12).

Unlike many multiauthor symposium-type volumes, which are often disparate collections, this book features closely integrated essays because during workshop sessions the contributors discussed precirculated drafts of the chapters to elicit connections and parallels as well as differences in chemistry textbooks in various countries. Replete with a nine-page (double-column) index of names (but not of subjects), this scrupulously documented (both references and notes to primary and secondary sources) volume, which the contributors consider only a beginning, will be of interest to historians of chemistry or science as well as chemists concerned with the historical development of their textbooks and their science.

References and Notes

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6. An ESF conference, organized as part of the Commission on the History of Modern Chemistry, formed in 1997, and titled "Between Physics and Biology: Chemical Sciences in the Twentieth Century," was held in Munich in 1999 and resulted in the collection, *Chemical Sciences in the 20th Century*; Reinhardt, Carsten, Ed.; Wiley-VCH: Weinheim, Germany, 2000. A related but independent conference, held on March 20–22, 1997 at the University of California, Berkeley, resulted in another collection, *The German Chemical Industry in the Twentieth Century*; Vol. 18; Lesch, J. E., Ed.; Chemists and Chemistry Series, Kluwer: Dordrecht, The Netherlands; Boston, MA; London, England, 2000 (For a review see Kauffman, G. B. *Angew. Chem., Int. Ed. Engl.* **2002,** *41,* 186–187).

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S1430-4171(02)03572-5, 10.1007/s00897020572a

Practical Chemistry for Schools & Colleges. Two CD-ROM set, 2000. £59.50 plus shipping. Order from: Viewtech Educational Media, 7-8 Falcons Gate, Northavon Business Centre, Dean Road, Yate, Bristol, BS37 5NH, England; telephone: 011-44-1454-858055; FAX: 011-44-1454-858056; e-mail: info@viewtech.co.uk; Web site: http://www.viewtech.co.uk.

This is the second interactive CD-ROM set produced by the RSC (Royal Society of Chemistry) for post-16 chemistry students (corresponding roughly to the last two years of U.S. high school) and teachers to support practical work in AS and A2 courses (In the equivalent of grade 11 typical UK students take five self-chosen "AS" courses. At the end of this grade they take exams in their AS subjects, then normally reduce the number of subjects studied in their final year to three or four. These subjects will be a subset of their AS subjects and are studied at the higher "A2" level for the final year in high school).

The discs were produced by the RSC on behalf of the Chemistry Video Consortium (Universities of Huddersfield, Hull, Leeds, Liverpool, Nottingham, Reading, Sheffield, Southampton, Ulster, and Wolverhampton; Imperial College, London; The Open University; and Sheffield Hallam University), c/o A. J. Rest, Dept. of Chemistry, University of Southampton, Southampton SO17 1BJ, UK; email: a.j.rest@soton.ac.uk: FAX: 011-44-23 8059 3781; http://www.soton.ac.uk/~chemweb/cvc.

The comprehensive program contains 13 detailed video clips, accompanied by text, commentary, and a self-test, of the following standard practical techniques:

Disc 1
- "Assembling Apparatus"
- "Recrystallization"
- "Solvent Extraction"
- "Drying Samples"
- "Distillation"
- "Suction Filtration"

Disc 2
- "Doing a Titration"
- "Using a Burette"
- "Using a Pipette"
- "Gravity Filtration"
- "Refluxing"
- "Thin Layer Chromatography"
- "Making Up Solutions"

System Requirements: Pentium 200 MHz PC; 8× Speed CD-ROM; Windows 95, 98, or NT 4.0; 800 × 600 screen resolution; 64000 colors; sound card.

The submenus are accessed from the Main Menu, which is activated by moving the mouse cursor over the Menu graphic at the top left of the screen, from which the following menu choices are available:

Options: Text On, Text Size, Scrolling Text. The Learning Mode provides instant feedback on quiz questions. The Test Mode withholds quiz answers and provides only a final score.

Video: The upper menu shows video titles available for that disc. Print sends the video script to the default printer, which gives users instructions to follow, making certain that they perform the operations correctly—an application that is most useful in learning the particular technique.

Glossary: Words highlighted in red provide links to other glossary items.

Quiz: There are 10 True/False questions for each topic. Once selected, the answer cannot be changed. If the Learning Mode is selected (under Options), feedback is given. The Score Quiz calculates the results. In order to achieve a good score the user must know all the hazards and reasons for

performing each technique—a helpful guide for instructors wishing to learn how much attention their students have paid to the program.

Most of the videos are well arranged and explain each step in great detail. However, the more advanced techniques are located on the first disc, while the important basic techniques are located on the second one. Also, the "Drying Samples" video was confusing and difficult to understand when dealing with desiccators. Furthermore, the "Recrystallization" video fails to discuss the reasons for the technique although this information is provided on the other videos. Safety precautions and the reasons for them are thoroughly explained, and several videos even show what can happen if they are not correctly followed. The program is advantageous both in and out of the classroom or laboratory.

Preview material can be accessed on LearnNet, the RSC's education network, which provides direct access to teaching and learning resources across all age groups (http://www.chemsoc.org/networks/LearnNet). This site allows the viewer to download chapters from books, locate experiments to perform in lessons, browse through posters, watch video clips, play interactive educational games, access teaching resources from other organizations, and network with other teachers.

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S1430-4171(02)03573-4, 10.1007/s00897020573a

Sodium: A Spectacular Element. Cliff Schrader, Lee Marek, Mike Offutt, Tom Lehrer, Bob Lewis, and Greg Kimble. 37-minute VHS videocassette, Catalog No. AP5917, 1999. $30.00. Order from: Flinn Scientific, Inc., P. O. Box 219, Batavia, IL 60510; Telephone: (800) 452-1261; FAX: (630) 879-6962; email: flinn@flinnsci.com; Web site: www.flinnsci.com.

When former students return to visit, they invariably recall lecture demonstrations even though more than four decades have elapsed [1]. The exothermic reaction of metallic sodium with water is probably the most spectacular demonstration that is a *sine qua non* in introductory chemistry courses. Many chemists have attributed their career choice to spectacular reactions such as this one.

Like many of us "natriophiles," the late Cliff Schrader (whose obituary will appear in *The Chemical Educator*) of the University of Akron and longtime chemistry teacher at Dover High School in Ohio, had regularly demonstrated this reaction for his students over a period of decades [2]. In 1974 one of his former students, who had discontinued using the metal in a manufacturing process, offered him a 215-liter drum containing 34 five-kilogram cylinders of sodium, which would last him for several centuries at the rate at which he normally consumed it! Later that month, another former student, Greg Kimble, who managed a nearby strip mine, asked him how to raise the pH of the acidic mine pit water, which contained sulfurous and sulfuric acids, from 3–4 to 6–8 as required by the Ohio Environmental Protection Agency. Schrader simultaneously solved the problem and scaled up his usual demonstration [3]. By throwing large sticks of sodium into the mine pool he demonstrated not only a spectacular reaction but also a salutary environmental effect. For a decade this large-scale sodium reaction served as an annual last-day event in Schrader's high school chemistry class until his sodium supply was exhausted. Students competed for the honor of becoming a "sodium chukker"—someone able to throw the sodium stick far enough so that the class could observe the reaction from a safe distance.

In 1999 Schrader purchased 50 kilograms of sodium, hired a three-camera crew who videotaped its reaction with water at the mine pit and in the lecture hall, enlisted the aid of colleagues and students, added additional material, and directed and produced the videocassette under review here. He purchased permission to use songwriter, entertainer, and former Harvard University mathematics lecturer Tom Lehrer's song, "The Chemical Elements," sung to the tune of Gilbert and Sullivan's "I am the very model of a modern Major-General" from their operetta, "The Pirates of Penzance" [4]. This song, with a periodic table background and info on each element (symbol, atomic number, and atomic weight) in the foreground as it is mentioned, opens the video program. This is followed by singer, songwriter, and chemistry teacher Mike Offutt of Barrington High School, updating Lehrer by singing "the Chemical Element Name Game" accompanied by his electric guitar [5].

The program continues with demo master and Naperville North High School teacher Lee Marek of "Weird Science" and the David Letterman TV "Late Show" fame, discussing and demonstrating reactions of the alkali metals lithium, sodium, and potassium with water and of sodium with chlorine. He demonstrates the basic nature of solutions with phenolphthalein indicator. He asks students to participate, writes equations on the blackboard that he asks them to balance, uses a doll ("conductivity baby"), whose eyes light up in the presence of ions, and talks to the camera crew. He also attaches a pickle to electrodes and shows that the salt-laden cucumber completes the circuit (the "electric pickle"). Safety precautions are stringently taken throughout, and the demonstrators wear goggles and face shields.

The program then moves to the strip mine pit where the reaction of sodium is carried out on a much larger scale by "sodium chukkers," who repeat it again and again and again…followed by slow motion replays in the mode of an athletic game. Anyone who has showed a small child a trick only to be asked repeatedly, "Do it again!" will understand the urge to repeat this spectacular reaction to produce a bigger explosion, brighter conflagration, and louder bang. However, the 16 minutes (almost 44 percent of the program) devoted to the large scale reaction is excessive for all but the most ardent sodium aficionado.

The hallmark of the video is informality. The demonstrators wear T-shirts and use colloquialisms such as "cool" and "sucker." Marek sometimes makes mistakes in equations and slips of the tongue but then corrects himself. The sound is sometimes not of the highest quality, the sequences are sometimes disjointed, and the program could benefit from more judicious editing. The copy that we received was incorrectly titled "Sodium: A Spectacular Event." In short, the video resembles a live, unrehearsed C-Span TV program rather than a "slick" commercial TV production.

This entertaining but educational video makes a perfect introduction to a unit on the alkali metals, especially suitable for use by instructors in high schools and colleges with limited facilities, equipment, or financial resources. It is accompanied

by written materials that include teacher notes, lesson plans, background information, song lyrics, student viewer guides, equations to balance, problems to solve along with answers, and politically incorrect data sheet on "Woman" (symbol WO). It permits these fascinating and intriguing reactions to be shown to students safely as well as spectacularly.

References and Notes

1. Kauffman, G. B. Lecture Demonstrations: Science's Living Theater. In *1995 Yearbook of Science and the Future;* Encyclopædia Britannica: Chicago, Illinois, 1994; pp 220–240; Lecture Demonstrations, Past and Present. *Chem. Educator* **1996**, *1* (5), S1430-4171(96)05057-1 (December 12, 1996), 38 pp.; DOI 10.1007/s00897960057a.
2. Schrader, C. Dangerous Demonstrations Done Safely. *CHEM 13 NEWS* **1994**, *231* (May), 12; The Spectacular Sodium Reaction. **2000,** *285* (May), 22–23.
3. For detailed directions for both micro and macro versions see Kauffman, G. B.; Jackson, J. D. Sodium–Water Reactions. *J. Coll. Sci. Teaching* **1985,** *24,* 432; *CHEM 13 NEWS* **1994,** *231* (May), 13.
4. Songs by Tom Lehrer (His Lyrics, His Music, His So-called Voice, and His Piano), Reprise RS-6216, long-playing record.
5. For a review of additional science songs by Michael Offutt on audiocassettes, "Physics Songbag," "Chemistry Songbag," and "Science Songbag" (J. Weston Walch, Publisher: Portland, Maine, 1991, 1991, and 1995, respectively), see Kauffman, G. B. *J. Coll. Sci. Teaching* **1996,** *25,* 445.

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S1430-4171(02)03565-X, 10.1007/s00897020565a