BOOK REVIEWS

Chemistry at Oxford: A History from 1600 to 2005. R. J. P. Williams, J. S. Rowlinson, and A. Chapman, RSC Publishing, Cambridge, 2009, x + 291 pp, ISBN 978-0-85404-139-8, £54.95.

How does one review an encyclopedic volume covering 400 years of Oxford chemistry that after sporadic starts blossomed and flourished? How can I evaluate the story of a chemistry department that I have never seen, in a city in which I stayed only a few days to attend a Quaker Conference, and that over fifty years ago? I did live in an Oxford college and sensed some of its charms; and the TV series *Brideshead Revisited* gives something of its flavor.

The founder of history of science in America, George Sarton, recommended that reviewers read their book pretty fast, draft an outline review, and then modify it as they delve into the details. Well, this book could not be perused rapidly, or should I say, even a rapid perusal took me a long time. The only justification for agreeing to be the reviewer is that I spent ten years in England and received bachelor and doctoral degrees there before moving to the States. My alma mater was University College, London, where I completed both degrees in a total of four years, thanks to the pressures imposed by war conditions. There were no tutorials—the characteristic mark of an Oxford education. And unlike Oxford, we did have examinations before the final one that counted; in fact we had one at the beginning of each term, designed to spoil our vacations. Perhaps ours was a war-time aberration.

Of the book's three editors, the significant research of two of them, Williams and Rowlinson, is described in the book and there is a hint of the latter's contributions as a science historian. His skills in that field are made abundantly clear in his 2008 Edelstein lecture published earlier this year in this *Bulletin*. The third editor, Chapman, is the author of "England's Leonardo: Robert Hooke and the Seventeenth-Century Scientific Revolution." He does not appear in the Index of Names. Yet I may have missed mention of him. Charles Coulson also is not indexed, yet he appears in the book as a significant chemist *and* as a significant human being on pages 221, 244, and 258.

The book is divided into seven chapters, beginning with an outline by Williams. Then Chapman covers Oxford chemistry to 1700, including a welcome appreciation of recent research on the significance of alchemy; this is followed by Peter J. T. Morris on "The Eighteenth Century: Chemistry allied to Anatomy." Next comes Rowlinson's "Chemistry Comes of Age: The 19th Century;" and he also is the author of a brief but important chapter on chemists at war. Before the latter, Jack Morrrell covers 1912-1939, and Williams concludes the book with "Recent Times: 1945-2005: A School of World Renown." In spite of this chapter's title, a concluding section describes "Oxford Chemistry Today, 2008." There are appendices on laboratories and on finances, and "Notes on Oxford University." Morris's coverage of the 18th century startled me. He and I had co-edited the volume of Robert Woodward's papers, where his contribution was the explication of detailed ultramodern synthetic pathways. Fortunately for this book's editors, Morris's 1978 Part II thesis (see below) was on "Education of Chemists in the Eighteenth Century."

Covering a subject chronologically has its drawbacks, because many strands overlap the chapter boundaries. This becomes particularly aggravating in the last chapter of 80 pages, which is further subdivided into the periods 1945-1965, 1965-1980, and 1980-2005. Since a number of chemists remained loyal to Oxford for many years, there are constant cross references to prior and later sections. Three of the most significant chemistry professors with long Oxford tenure were Cyril Hinshelwood, Robert Robinson, and Nevil Sidgwick.

Robinson I had encountered twice in my career, first when I was a student of Christopher Ingold, and much later in connection with Woodward. In both cases the impression relayed to me of Robinson was negative. He had proposed an alternative description of electron movements in organic reactions, but Ingold's terminology won out. Oxford called Ingold's scheme the Ingoldsby legend. In Ingold circles it was rumored that, as a Nobel laureate, Robinson had blackballed Ingold, who never got a Nobel. And Robinson's proposed structures for penicillin and strychnine were proved wrong by Woodward. The present work gave me a much more balanced view. Robinson's natural-product researches clearly justified his Nobel, yet the authors also point out his limitations. He stayed with classical structure determination in spite of the huge new power that instruments might have given him.

What delighted me about Robinson as revealed in this book was the humanity of the man. He helped Fritz Arndt and Arnold Weissberger get out of Germany and sought new positions for them. He tried to find ways to aid several others, including Richard Wilstätter. To my great surprise, he successfully found funds to make possible Dorothy Crowfoot-Hodgkin's X-ray crystallographic work, in spite of his own lack of interest in instrumental methods

Robinson had been recruited from Manchester, and he was not alone. His predecessor William H. Perkin jr., and his successor E. R. H. Jones also came from that city, and they brought a most un-Oxonian mood with them. They consulted for industry and received funds from industry and saw no gulf between pure and applied science. They were looked down on as "tradesmen" (p 7-8) by the traditional Oxford academics, including some in chemistry. Perkin, who was president of the Chemical Society 1913-15, appealed to his colleagues in his second presidential address—during the war—not only to devote themselves to applied research, but to "cooperate with industry, however distasteful these practices might be to some Oxonian academics." (p 137)

The recurring theme of the book or, perhaps more aptly, the background noise of the book, is the extraordinarily chaotic arrangement in which chemists had to operate. In places it is called the tension between the bottom-up forces—control by the colleges—and the top-down force exerted by the University. The professors were appointed by the university; but their freedom to operate and exert their will was largely circumscribed by the independence of college appointees. There were Fellows appointed by colleges, and Demonstrators appointed by professors. Fellows were given research space within the organic, inorganic, or physical chemistry laboratories; and the university-appointed professors, even though they were heads of these laboratories, had no jurisdiction over them. Professors attempted, with more or less success, to convince colleges to appoint Fellows of the professors' liking. Nobel laureate Frederick Soddy was treated abominably and slowly moved into writing on social and economic problems and the social responsibility of scientists. He had been appalled by the horrors of World War I, forever symbolized for chemists by the senseless death of Henry Moseley. Rutherford famously called it "a striking example of the misuse of scientific talent." Moseley's image appears on page 119, the only photograph of a scientist in the book. Nevil Sidgwick had to wait endlessly for a laboratory specifically assigned to inorganic chemistry. Slowly the increasing cost of doing quality chemical research shifted control and influence towards the university.

The fact that, in spite of this confusing set-up, Oxford became a world class center for chemical research might find an explanation in Renaissance Italy. It has been argued that it was precisely the fragmentation of Italy into independent fiefdoms that led each to aim for supremacy, whereas Chinese science, having achieved so much in an autocratic, bureaucratic system was resting on its laurels. But it turns out that there are several ways to achieve excellence in science, and the book mentions the Cambridge MRC, Harvard, and the University of London.

One major innovation needs to be mentioned. In 1916 Perkin moved into the new organic chemistry laboratory, the Dyson Perrins. That same year he convinced the authorities to include a year of research in the undergraduate chemistry curriculum. It became known as Part II, and Perkin hoped he would thereby gather a cohort of Perkin-type researchers to follow in his footsteps, as he had done in Manchester. But it did not work out that way. The undergraduates came from the colleges and were controlled by the chemistry Fellows who were not Perkin appointees, so they tended to do their Part II research in the inorganic and physical laboratories.

What makes the book refreshing, and lifts it out of an endless descriptive mode of 400 years of changes, is the authors' willingness to make judgments: for instance, harsh criticism of the way Soddy was treated after being lured to Oxford and criticisms of Robinson for not using the newer instrumental techniques. They have also exercised humor. When Oxford tried unsuccessfully to change Prime Minister Margaret Thatcher's cuts in funds for universities—Thatcher, after all, was an Oxford chemistry graduate—the author comments "The lady's not for turning," by analogy with the Christopher Fry play "The Lady's not for Burning." It seems that Thatcher first used the phrase herself, not knowing where it came from. A speech writer had put it there. Thatcher never received an Oxford honorary doctorate.

Some time earlier, when funds were needed for a chemistry laboratory, the obvious source was the profits from Bible sales, although there was some objection that the sciences were an "ungodly subject to benefit from the sale of God's word."(p 94). The resulting laboratory, the "Abbot's Kitchen," attached to the new Museum in 1860, appears on the front cover. It is a square building with a rather squat octagonal spire in the center and four slender spires at the corners, which in fact were exhaust chimneys for noxious gases.

A word about the hurdles in the way of getting into Oxford. It took the usual time for women to enter those august halls. Knowledge of Greek was required for entrance until 1918, Latin until 1946. I took Latin all through high school just in case I ended up in Oxford or Cambridge. I have never regretted that exposure to the Latin tongue. Dissenters, Quakers, and others were long barred from Oxford and Cambridge because they would not assent to the Church of England's 39 articles. However, in 1831, in a burst of remarkable magnanimity, Oxford conferred honorary doctorates on four dissenters, John Dalton and Michael Faraday among them (p 88).

A final footnote: in its later years, Oxford chemistry kept clear of geology, biology, and medicine, even though chemistry had emerged from those fields. Biochemistry, whose emergence could not be avoided, ended up as a separate discipline outside the parameters of this book.

To produce this book was an ambitious undertaking and to do it in such perceptive detail was remarkable indeed. My guess is that no one will attempt to improve on it. Specialized studies on parts of the story no doubt will appear; one in fact was published last year: *The Dyson Perrins Laboratory and Oxford Organic Chemistry 1916-2004* by R. Curtis, C. Leith, J. Nall, and J. Jones (reviewed in this issue). *Theodor Benfey, Guilford College and The Chemical Heritage Foundation.*

The Dyson Perrins Laboratory and Oxford Organic Chemistry 1916 – 2004. Rachel Curtis, Catherine Leith, Joshua Nall, and John Jones. John Jones, Balliol College, Oxford, 2008, john.jones@balliol.ox.ac.uk, 134 pp, ISBN-978-0-9512569-4-7, £16.

England is a country where sentiment and tradition mean so very much. Organic chemistry is a discipline which builds upon and treasures its past. For both England and organic chemistry, the recent disappearance of the Dyson Perrins Laboratory, the home of organic chemistry at Oxford for 87 years, is a great loss. This was the place of Waynflete professors William Henry Perkin jr., Sir Robert Robinson, Sir Ewart Jones, and finally Sir Jack Baldwin, along with thousands of scholars and their achievements. The student roster included such eventual luminaries as Lord Todd, Sir John and Lady Cornforth, Arthur Birch, Michael Dewar, and Jeremy Knowles, among many, many others.

Today, the DP, as it was and is affectionately known, is a Historic Chemical Landmark by the Royal Society of Chemistry. A plaque on the old front door serves as witness of the DP's history and this worthy Landmark designation. The building is now mostly used by Oxford University's Geography Department, hardly aware of the research accomplishments attained therein over its nearly 90-year history and the scientific careers molded therein, including my own (my sabbatical during the 1983—1984 academic year).

Not only has the DP disappeared from Oxford University but so have its other *completely* independent chemistry laboratories. I am told by the book's senior author that the Inorganic Chemistry Laboratory (ICL) and the Physical Chemistry Laboratory (PCL, now called the PCTL) "are very much there and still semi-independent. The only real change is that there is an overall Chairman Professor."

Step across South Parks Road, and you will find Oxford's 17,000-sq. meter state-of-the-art Chemical Research Laboratory, which Her Majesty The Queen opened on February 20, 2004. The newly combined Department of Chemistry is under the active stewardship of Stephen G. Davies, current Waynflete Professor of Chemistry. A virtual tour of this facility can be found at http://www.chem.ox.ac.uk/oxfordtour/crl/# . Several of these videos, when the perspective is turned 180° away from the new facility, focus lengthwise on the old DP without even any notice of that fact: see, for example, http://www.chem.ox.ac.uk/oxfordtour/crl/movies/05.html.

Thanks to John H. Jones and three of his post-DP Part II students, an abbreviated yet memorable story of the DP has been documented in this glorious book. Just as great scientific discoveries are often made in several laboratories at the same time, books on the same or similar subjects also frequently appear somewhat simultaneously. [See the accompanying review by Theodor Benfey.] Jones, a Fellow of the Royal Historical Society, is himself no stranger to the DP. He received his degrees in chemistry (B.A., M.A. and D. Phil.) from Oxford University which was followed by 40 years as an official Fellow of Balliol, jointly with a University of Oxford lectureship..

Nine chapters are graced with numerous photographs, ten appendices, and many pages of thoughtful and fact-filled references. The chapters are organized chronologically by era, appropriately focused on the Professor of Organic Chemistry of that particular era. The first chapter, "Oxford Organic Chemistry before the Great War," sets the context for the entire book. The following chapters are: "The Foundation and Construction of the DP," two chapters dealing with Perkin and his era (1912 – 1929), three chapters to the decades of Robinson (1930 – 1954), one chapter to the Jones years (1955-1978), and one to the Baldwin Years (1978-2004). According to the senior author's preface:

> We have not set out to catalogue the people of the DP . . . an exhaustive survey would be a very turgid book indeed . . . There is not enough History in it, and too much Chemistry, for this book to conform to the conventional pattern of writing about the History of Science . . . because between disciplines was where I aimed. And it was an engaging exercise with which to conclude my career, the experimentally active part of which was spent entirely in the DP.

The authors fully meet their goals and provide the reader with a tremendously interesting and enjoyable experience as well. Jones further states that the book "contains no Philosophy at all." Here he is, most fortunately, entirely wrong. Apparently without intent or perhaps British understatement, the book is absolutely swarming with anecdotes, reflections, and judgments that individually are captivating and, in total, provide a deeply thoughtful reflection on the progress of organic chemistry, the nature of academic research at its best, and the peculiarities of human conduct that especially reside in the discipline's greatest thinkers and practitioners.

Benjamin Brodie the Younger was in the mid- to late 1800s, Oxford's first organic chemist. A member of Balliol College, Brodie's:

> ..laboratory is now part of the Balliol student bar. [He] was engrossed in the development of a highly original but abstruse 'chemical calculus' which sought to describe Chemistry using mathematical symbolism and operations, without atoms. . . . Interest in his calculus had faded away by the time he died, since when it has been in oblivion except as a challenge for philosophers of science.

In 1888 and in 1913, J. E. Marsh, another Balliol man,

> seems to have been the first to appreciate that the criterion for optical activity was simply that a whole structure should not be superimposable on its mirror image.

The eventual construction of what became Oxford's organic chemistry domain was accompanied by tension between Oxford's powers – its more than 20 autonomous colleges, the Dons, the autonomous Heads of Departments, and eventually the University administration, as is vividly described .

> It was and is a constantly evolving maelstrom of administrative complexity, which nobody of sound mind would ever have planned.

The DP's benefactor was Charles William Dyson Perrins, "grandson of William Henry Perrins, a pharmacist who had made the family's fortune by developing, in partnership with John Wheeley Lea, the recipe for the well-known piquant [Lee & Perrins] Worcestershire sauce."

Arriving just before World War I broke out, Perkin—along with N.V. Sidgwick—played a major role in organizing and advising research related to WWI needs, including a novel process for the preparation of acetone, work related to TNT and related explosives, and the preparation of both phenol, a precursor of picric acid, and in the preparation of phenol itself. In addition to superb science contributions to the war effort and in peacetime, Perkin's DP provided the first organic chemistry patent at Oxford, the first engagements with industry, the introduction of the Oxford D.Phil. in 1917, and a novel undergraduate degree regulation: the Chemistry Part II which required a fourth year devoted entirely to full-time research concluding with a dissertation and oral examination.

Perhaps Perkin's greatest legacy—surely, his greatest student and collaborator—was Sir Robert Robinson, who followed Perkin with the Professorship, first at Manchester and then the Waynflete at Oxford, to which he was elected "in almost indecent haste." Robinson dominated the DP (1930–1954) and British organic chemistry if not all of organic chemistry for over 25 years. His contributions in natural products including alkaloids, plant pigments, and steroids, were recognized with the Nobel Prize in 1947. "Many found him a difficult man to deal with. All held him in awe, and some in affection."

One highlight of Oxford chemistry during WWII was the invention of the Birch reduction, not named the Robinson reduction because the Professor chose to have nothing to do with the research—other than order Birch not to do it, a command that Birch failed to follow.

Oxford was one site of intense investigation of penicillin:

> The investigation of penicillin . . . was initiated in the Sir William Dunn School of Pathology in Oxford by Howard Florey in 1938 . . . Collaboration with Robinson, Wilson Baker, and then J.W. Cornforth in the nearby DP began in late 1942.

In fact, the β-lactam structure of penicillin was not unambiguously determined until after the end of the war—and even then, not accepted by Robinson, who held to his alternative thiazolidine-oxazolone structure The E. R. H. Jones era was initiated by strong support from Robinson though Jones did not respond in kind. Regarding the support, Robinson was in favor of his replacement who, like himself, had been the professor of organic chemistry in Manchester. The other likely candidate was the future Nobelist Derek H. R.Barton. Jones exhibited his own independence by denying the retired but not retiring Robinson to occupy a wing of DP.

The authors discuss perhaps Jones's most important accomplishment, the improvement and expansion of the DP's facilities and improvement in its condition. The interplay between the various stakeholders—the DP and its chief, the Waynflete Professor Jones; the University and its money; and the colleges and their autonomy—is described. To understand Oxford chemistry is to understand the changing dynamics of these interactions, affected substantially by the powerful personalities of the protagonists – and especially the personality and behavior of The Waynflete Professor.

Only three pages of text are dedicated to the 26-year period of the Baldwin era. Given that the rate of chemical research has increased dramatically with time (and the development of modern instrumentation and computer technology), the Baldwin era's absolute if not relative contributions to science exceeded any previous 26-year period in the DP's history. The authors, however, make it clear (in a note in the reference section to the last chapter) that

> This Chapter does not attempt to be much more than an epilogue to those it follows. Balanced history cannot be written without an interval for things to settle into place, and while the fact that most of the protagonists simplifies the fact-gathering, it inhibits the making of judgments. And no relevant files have aged enough to be open . . .

The Baldwin era and the Dyson Perrins Laboratory closed somewhat simultaneously in 2003 with the opening of The Chemical Research Laboratory, known as the CRL. To me, this just does not have the ring or appeal as the "DP." Perhaps in 70 years, or even sooner, it will.

This book has many virtues. It is an easy read, yet it covers the development and progress of organic chemistry for 150 years through the lens of Oxford, the Waynflete professors, and the DP. The numerous people and personalities are presented, almost in real life, by wonderful descriptions and aptly chosen photographs and illustrations, all lovingly presented by its authors.

The book has several minor and one major weakness. The List of Illustrations that appears just after the Table of Contents contains full captions of the illustrations, which do not appear in the main body of the text. And there is no index. As the senior author says, "It is hoped that the extended Contents goes some way towards offsetting the lack of an Index; an electronically searchable version will in due course be made available." The book's major weakness is, indeed, related to its major strength. It is a story of Oxford and the DP. The chemistry is not placed into its appropriate worldwide context. But then, the authors specifically state that:

> our purpose [w]as simply to tell the story and highlight what seemed to me the most interesting and important Organic Chemistry worked out in Oxford . . .

For example, R. B. Woodward does not appear in the sections dealing with the structure determinations of either penicillin or strychnine. Woodward and Robinson held opposite views in the penicillin-structure debate, the younger being right, the established leader holding sway and resilient way beyond reasonableness. But then, Robinson was at the height of his powers, being just a few years from receipt of his Nobel, and Woodward was not even 30 (and two decades from his Nobel).

The book ends with a quote from the Oxonian Jeremy Knowles:

> Those of us who were brought up with the D.P.'s unique combination of smells, its extravagantly high ceilings, the staircase that millions of undergraduate feet could never wear away, the horrors of Room 33, and the open drains that made minor explosions in the teaching labs so much more interesting, will be nostalgic but not truly sorry. The Dyson Perrins has served Oxford well, but a bright new era begins. (J. Knowles, "The Dyson Perrins Laboratory at Oxford," *Org. Biomol. Chem.*, **2003**, *1*, 3625-3627.)

Well, there is another major weakness in this book. It is simply too short for my own appetite. And the same goes for the lifespan of the Dyson Perrins Laboratory. *Jeffrey I. Seeman, University of Richmond, Richmond, VA 23173.*

The Invention of Air: A Story of Science, Faith, Revolution, and the Birth of America. Steven Johnson, Riverhead Books, New York, 2008, xvi + 239 pp, ISBN 978-1-59448-852-8, $25.95.

First, what this book is not. It is not a standard biography of a great man. Steven Johnson is not interested in the usual "Life and Times of…" Nor is it a sophisticated analysis of the scientific discovery of oxygen. Johnson is interested in bigger game: understanding the interconnectedness of knowledge. He uses Joseph Priestley as the lever to explore this theme. As the subtitle suggests, Johnson strives to tell "A Story of Science, Faith, Revolution, and the Birth of America." (Curiously, or perhaps revealingly, Priestley's name does not appear in the book's title or subtitle).

Joseph Priestley was a man of many parts: famed scientist credited with discovering oxygen; controversial theologian who helped found the Unitarian Church; notorious – in some quarters – radical political theorist and supporter of the American and French Revolutions; and political activist who played an underappreciated role in early American politics (Priestley the émigré to the young Republic set a precedent of the scientist-exile repeated frequently in American history). A brilliant polymath, Priestley wrote over 500 books and pamphlets and spoke six languages fluently. He knew all the learned men of the age on both sides of the Atlantic: Boswell, Price, Wedgwood, Bolton, Erasmus Darwin (Charles's grandfather), and others in England; Franklin, Adams, Jefferson, and their cohorts of the Revolutionary generation in America.

Dissecting Priestley the natural philosopher allows Johnson to develop his "overarching moral:" that knowledge should not be compartmentalized nor left to the specialists. A subsidiary theme is that politics must be informed by the insights of science, a point often neglected in our recent history.

Johnson employs what he calls the "long zoom" connecting disciplines and knowledge to argue that Priestley's greatest scientific work was not the oxygen experiment of 1774 on "dephlogisticated air," but earlier experiments in which Priestley – with his good friend Franklin – observed that a flame in a glass cylinder in which a plant was placed continued to burn. The conclusion: plants release oxygen into the air. This process we call photosynthesis, a process in which plants also take in carbon dioxide. From this insight on oxygen and carbon dioxide Johnson is off and running on an "Intermezzo" set in the Carboniferous era 300 million years ago, in which vegetation grew to enormous sizes – club mosses reaching 130 feet in height, conifers sprouting three-foot long leaves – leading to an increase in the proportion of oxygen in the air which didn't last long; but all that vegetation eventually decayed, becoming the energy that fueled the Industrial Revolution (pioneered by some of Priestley's confidants) taking place in the country which sat on top of huge coal fields – "An Island of Coal" Johnson calls it – where Priestley did his initial experiments on oxygen. It *is* all connected, after all.

Johnson is fond of this kind of intellectual flight. Take, for instance, the role of coffee in Priestley's life and work. When the young Priestley first came to London he joined a coterie of natural philosophers who regularly met at the London Coffee House in the shadow of St. Paul's Cathedral (Johnson notes the irony of a group of heretics meeting a stone's throw from the shrine of England's establishment). The coffeehouse – which played a crucial role in 17^{th}- and 18^{th}-century England – provided Priestley with an interdisciplinary culture in which conversations touched on the latest scientific discoveries, the abuses of Parliament, and the fate of nonconformist religion.

This was a remarkably open information network whose members eagerly shared knowledge. (Johnson greatly admires Priestley for his "compulsive" sharing, both from discipline to discipline and among colleagues.) But coffee, Johnson also notes, is a stimulant that affects another kind of network, this one "neurochemical." Coffee became a popular European drink in the mid-16^{th} century, replacing beer and wine as the breakfast beverage. The switch from alcohol to coffee as the daytime drug of choice meant that Europe "emerged from its centuries-long bender" and entered the Age of the Enlightenment.

Caffeine fueled Priestley's extraordinarily productive eight-year period in the 1760s and 1770s. These were the years of his groundbreaking forays in chemistry, including the oxygen experiments and his discovery of soda water; his synthesizing of existing knowledge on electricity; and the writing of numerous books and pamphlets on religion, politics, and education. Such productivity suggests to Johnson a "streak of innovation" similar to Joe DiMaggio's 56-game game hitting streak in 1941.

That was the young Priestley. The elder Priestley lived the last decade of his life in rural Pennsylvania, alone with his books and his experiments. This most convivial of men, this sharer of information and knowledge finally had angered too many in England with his unorthodox religious views and his support of the French Revolution. A Birmingham mob burned his house in 1791, forcing Priestley to seek a haven in a more open-minded country.

He craved a quiet life by then, but his political views soon got him into trouble in his adopted land. It took President Adams's personal intervention to prevent the government from prosecuting Priestley under the Alien and Sedition Laws. Fortunately, all ended well for Priestley, as Johnson notes. His good friend Thomas Jefferson was elected president in 1800, leading Priestley to note that only in old age was he privileged "to find myself in any degree of favour with the governor of the country in which I have lived." Jefferson's administration was "the best on the face of the earth." Jefferson returned the compliment, telling Priestley that "Yours is one of the few lives precious to mankind." *Judah Ginsberg, American Chemical Society, Washington, DC.*

The Language of Mineralogy—John Walker, Chemistry and the Edinburgh Medical School, 1750-1800. M. D. Eddy, Ashgate, Burlington, VT, 2008, xxii + 293 pp, ISBN 0754663329. $114.95.

The Scottish Enlightenment occurred within the context of universities, and yet historians have neglected this institutional framework. Matthew D. Eddy wishes to fill a lacuna in the historiography by stepping inside the Edinburgh classroom, as it were. He discovers that chemistry in the years between Boyle and Lavoisier—figures that dominated the literature—was distinctive and significant. John Walker (1730-1803), minister and professor of natural history, was no revolutionary, but representative of how scholars applied new chemistry in practice and disseminated methods and ideas throughout Europe. Eddy advances a number of important arguments: that the chemistry of fluids (saline) had more practical importance and interest among scholars in Walker's day than pneumatic chemistry of gases of Boyle or Lavoisier; that the language of chemistry and classification based on chemical composition was well underway before Lavoisier; and that early chemistry informed natural history, mineralogy, and geology before the systems of Hutton, Werner, or Linnaeus. 'Systems' were not always grand taxonomies and theories such as theirs, but oftentimes more empirically oriented classifications based on chemical composition, subject to repeated revision, and serving pedagogical and medical ends.

Eddy develops these arguments in five chapters, consulting sources such as lecture notes, syllabi, Walker's personal inventory of texts, his commonplace book, correspondence, and professional writings. The first chapter is a highly selective biography of Eddy's academic career that shows how well connected Walker became and extensive his teaching was. Chapter Two explains how Walker applied his knowledge of principle chemistry (based on the Becher-Stahl tradition), as taught him by William Cullen, to analyze the waters of Hartfell Spa in 1757. Salt production and balneology were two practical arenas in which early chemistry had marked impact. Walker concluded that the waters contained "two forms of iron, salt, sulphur, and a terrestrial principle" (p 75). Chapter Three jumps back to Walker's exposure to Cullen's chemistry and classification and Walker's academic development, professional network, and extensive mineral collecting. Chapter Four then provides a detailed explanation of Walker's mature mineralogical classification based largely on chemical composition (and secondarily on external or natural characteristics such as color and taste). Walker synthesized the work of numerous contemporaries: Joseph Black, Joseph Priestley, Cullen, and especially the Swedes, Johann Gottschalk Wallerius, Axel Frederik Cronstedt, and Torbern Olaf Bergman. Walker's classification system included nineteen classes subdivided into orders.

As an example, the metals: Class 19 were the six 'primary metals,' ordered according to durability, flexibility, and fixidity; Class 18 were 'secondary semimetals' ordered according to whether they were mineralized or 'calciformed'; and Class 17 were 'secondary mundicks' (pyrites) ordered also by mineralization or calciformation. Eddy provides the entire system in an appendix, along with comparisons to other, better known systems, such as those of Bergman, Linnaeus, Wallerius, and Cronstedt. Conspicuously absent is Abraham Werner, who did not use chemical composition as prominently as these other authors did, and who therefore held little interest for Walker.

The final chapter turns to geology, where chemical composition had greater influence than the historiography would suggest. Scholars have concentrated on theoretical controversies (especially the neptunism/vulcanism debate) and discovery of 'deep time,' but again, Eddy discovers more pedagogical concerns among Edinburgh faculty, including a Baconian methodology and aversion to theorization. Walker never discarded a Biblical conception of earth history (of some 5,000-6,000 years' duration), and never allowed for species change. The Creation and the Deluge were periods of intense chemical precipitations (rather than sedimentation or crystallization alone). Shying away from controversies, Walker never specified exact chronologies or developed a cosmology for his chemical conception. He remained committed to the chemistry of the earth and the necessity for classification based on chemical composition, spreading his ideas via scores of influential students. Hutton, one-time student of Walker's, and best known for promoting the vulcanist theory of rock formation, was better grounded in Edinburgh chemistry than we realize: in his important edition of Hutton's *Theory of the Earth* (1805), John Playfair excised many of the chemical descriptions that would expose Walker's influence on Hutton (p 197).

Eddy appeals for continued work on how principle chemistry impacted natural history, mineralogy, and geology by the mid 18th century. He is certain that future studies will better determine Walker's legacy among his students, physicians, surgeons, midwives, and other practitioners. I might suggest another avenue for improvement. Eddy should be praised for emphasizing the institutional context of the Scottish Enlightenment, for tying early chemistry firmly to other natural inquiries, and for lucidly explaining an early chemistry and taxonomy; but the reader leaves the book with the impression that Walker's work developed within a political and cultural vacuum. Eddy goes back and forth between his subject's wider context and his intellectual life, but these dual inquiries rarely intersect. Edinburgh University, the Republic of Letters, and Britain function as static units against which Eddy plots the internal dynamics of his main character's professional life. But were Edinburgh professors not politically motivated during these years of the Jacobite Rebellions? Walker was an expert on the Scottish Highlands, and Eddy notes that this interest included the culture and history of the people. Walker worked for the Board of Annexed Estates under King George III on Highland culture and religion (p 33). This suggests a far more complicated personality and career than that presented by Eddy. Numerous historians of natural history and mineralogy since Foucault's *The Order of Things*—Paula Findlan, Alix Cooper, Lisbet Koerner—have argued that power and politics motivated the collection and classification of natural objects, and it would be instructive to apply that sort of analysis for the Edinburgh chemist as he mediated London's control over the Highlands. Another related possibility is that Walker partook in the same early Romantic drive to preserve the dying Celtic culture of the Highlands that had driven the contemporary poet, James Macpherson, to 'discover' the Fingal epic in Gaelic. Walker visited Fingal's Cave on Staffa Island (named after the epic hero) and noted other mythological sites he saw during geological expeditions. Did chemistry, geology, and history all combine into a larger vision for Walker (as for Goethe)?

Aside from Eddy's selective gaze, there is the more technical matter of editorial oversight: the first half of the text suffers from occasional missing articles and prepositions. This being said, any historian interested in broadening his or her knowledge of Enlightenment-era classification and any historian of chemistry convinced that the period between Boyle and Lavoisier—when chemistry of fluids and principles dominated in practice—deserves more focused study will profit from Eddy's text and helpful appendices [On chemistry of fluids, see also A. M. Ross, *The Salt of the Earth: Natural Philosophy, Medicine, and Chymistry in England, 1650-1750*, Brill, Boston, MA, 2007.] *Warren Alexander Dym, Dibner History of Science Fellow [2009-2010] at the Huntington Library in Los Angeles, CA,.*

Making Scientific Instruments in the Industrial Revolution. A. D. Morrison-Low, Ashgate Publishing Ltd., Aldershot, Hampshire, England, 2007, 408 pp, ISBN 978-0-7546-5758-3, $99.95.

The author of this volume, A. D. Morrison-Low, is the Principal Curator of the Science Section of the National Museums of Scotland; and the book itself is in many ways a successor to an earlier volume by John Millburn titled *Adams of Fleet Street, Instrument Maker to King George III*, also published by Ashgate. Whereas Millburn gave a detailed portrait of an important late 18th-century instrument maker based in London, Morrison-Low seeks to extend our knowledge of the trade in Great Britain through the first half of the 19th century and to lesser-known instrument makers based in such cities as Birmingham, Liverpool, Manchester, and Sheffield.

This is primarily an economic study rather than a scientific study and, as such, is concerned largely with the nature, organization, and ownership of the instrument trade rather than with significant advances in instrument design. Drawing on a wide range of data sources made available as a result of the digitalization of governmental and city records, the author has assembled a truly impressive amount of information on a subject which one might have thought was permanently lost to history. She has effectively organized much of it by using tables and graphs, though one should also acknowledge some earlier compilations, such as the impressive *Handlist of Scientific Instrument-Maker's Trade Catalogues, 1600-1914*, assembled in 1990 by R. G. W. Anderson, J. Burnett, and B. Gee, also at the National Museums of Scotland.

Because of the book's emphasis, much of it is not of direct interest to the historian of chemistry since most of the output of the instrument makers being studied consisted of the limited production of microscopes, telescopes, surveying instruments, cameras, and other optical devices rather than chemical glassware and hardware. Nevertheless, this book is an important step toward the next logical stage in this process: a study of the rise of large centralized laboratory supply houses in the last half of the 19th century, such as J. W. Griffin & Sons and Townson & Mercer in Great Britain or J. W. Queen & Co. and Eimer & Amend in the United States, as well as the question of how much of the stock which these firms offered for sale was in fact supplied anonymously by the smaller family-owned businesses studied by Morrison-Low. *William B. Jensen, University of Cincinnati, Cincinnati, OH 45221-0172.*

Chronologie Chemie: Entdecker und Entdeckungen. Sieghard Neufeld, Wiley-VCH, Weinheim, 3rd ed., 2003, xi + 441 pp, ISBN 3-527-2424-4; *Från Lavoiser till Strindberg: Kemihistoriska föreläsningar*, Levi Tansjö. Berzelius Sällskapers: Lund, 2008, 293 pp, ISBN 978-91-971637-9-2; *Naissance de la chimie structurale.* Alain Dumon and Robert Luft, EDP Sciences, Les Ulis, 2008, 252 pp, ISBN 978-2-7598-0055-1.

Although it is perhaps too much these days to expect American historians of chemistry to read the monograph literature appearing in various foreign languages, they should at least make an effort to be aware of what titles have been published, as illustrated by the case of the three recent books listed above.

The first of these titles, *The Chronology of Chemistry*, by Siegard Neufeld is a much enlarged 3rd edition of a volume first published in 1976. The first edition chronicled important events in chemistry on a year by year basis from 1800 to 1970; the second edition, published in 1987, extended the chronicle to 1980; and the present edition now takes the survey to the year 2000. For each year the authors of significant papers are listed, followed in each case by a brief paragraph summarizing the importance of the work in question and a list of relevant literature citations. This is a genre of historical reference which has precedents in the German literature (Lippmann, 1921 and Walden, 1950) but no exact parallel in the English literature. In some ways it is a thankless task, as I am sure that many would dispute some of Neufeld's choices, especially for the last few decades. Many of the papers deal with the synthesis of specific compounds at the expense of those dealing with theoretical breakthroughs, and the restriction of the citations to papers in the journal literature overlooks the publication of many important books. Thus no mention is made of Pfaundler's paper (1867) on the application to the kinetic theory of gases to chemical reactions, nor of Horstmann's similar application of the entropy concept (1873), nor of Marcelin's introduction (1910) of the concept of free-energy of activation—all three of which represent key advances in chemical theory. Likewise Gillespie is mentioned for the year 1955 in connection with his later work on superacids, but not for his key review in 1957 with Nyholm which directly led to the formulation of the VSEPR model for predicting molecular geometry—a development which surely had a more significant impact on chemistry than did superacid solvent systems. Nevertheless, anyone who is contemplating the writing of a history of chemistry will want first to review Neufeld's choice of significant contributions.

The second title, *From Lavoisier to Strindberg*, reproduces 15 popular lectures or essays on various themes in the history of chemistry by the late Levi Tansjö (1929-2003). The subjects range from the origins of the law of energy conservation and the second law of thermodynamics to the work of such chemists as Gay-Lussac, Dulong, Ostwald, and Mendeleev. Not unexpectedly, many have a specific Swedish emphasis, including essays dealing with the work of Berzelius, Carl Mosander, Svante Arrhenius, and the alchemical fantasies of the Swedish playwright, August Strindberg. The book is beautifully produced with high quality photographs and paintings but is lacking an index.

The third title, *The Birth of Structural Chemistry*, by Alain Dumond and Robert Luft purports to be a history of structural chemistry. However, the term "structural" is a bit vague and appears, by the authors' own reckoning, to include the history of valence, stereochemistry, the periodic table, and the electronic theory of bonding and reactivity. Though the authors have included an impressive bibliography of the primary chemical literature, they appear to be blissfully unaware that a vast secondary literature on the history of all of these subjects already exists. Thus no mention is made of the previous comprehensive histories of valence by Palmer and by Russell, nor of van Spronsen's well-known history of the periodic table, nor of the histories of stereochemistry by Ramsay and by Ramberg. The authors have also substituted newly drawn computer images for all of the original historical versions of the various tables, diagrams and structures which they discuss. Though this makes for a much more attractive book, it leaves the reader wondering just how much the originals have been both misleadingly simplified and subtly modernized. In addition, much that should be included under the rubric of "structural" is missing from this account, such as the packing models of Barlow and Pope, the rise of modern X-ray crystal analysis, and its role in verifying the postulates of classic stereochemistry. As is usual with most French publications, there is also no index. *William B. Jensen, University of Cincinnati.*

Das Dictionnaire de Chymie von Pierre Joseph Macquer (1718-1784). Katja Schmiederer, Wissenschaftliche Verlagsgesellschaft, Stuttgart, 2008, 395 pp, €27.

Probably the best known French chemist of his generation, Pierre Joseph Macquer was the author of a highly regarded textbook (1749-51), which he and other leading chemistry teachers employed in the third quarter of the eighteenth century to help build the reputation of the science as an independent scholarly discipline, and not a mere ancilla to pharmacy, medicine, and assaying. Perhaps even more influential in discipline-building than his textbook, however, was his *Dictionnaire de chymie* (1766), the first such modern dictionary, and a worthy early specialist work inspired by the great general project of Diderot and d'Alembert. Despite the fine contributions of such scholars as Willem Ahlers, William Smeaton, Roy Neville, Wilda Anderson, and Jonathan Simon, Macquer's overall work and influence have not been well studied—until now.

Originating as a revised doctoral dissertation at the University of Marburg (2006) under the direction of Fritz Krafft, Katja Schmiederer presents us a meticulous and finely crafted study that places Macquer's dictionary in the foreground. The author examines a total of fourteen editions of this work, including in this number not only the second French edition of 1778, but also multiple translations into English, German, Italian, and Danish. In this way she creates a chronological framework for her project that extends from 1766 until 1809. But her focus is not exclusively concentrated on the dictionary, nor even narrowly on Macquer's biography, as the subtitle of the book accurately advertises: *Die Originale und Übersetzungen [des Buches] als Spiegelbild der Entwicklung der Chemie und Pharmazie im letzten Drittel des 18. Jahrhunderts*. In particular, a principal theme of the author is the concern that Macquer and his translators had to fulfill the Enlightenment goal of national education (Volksbildung), independent of the influence of church or state, as well as the utilitarian pursuit of useful applications of the science. The latter tendency can be seen ever more prominently as one proceeds chronologically through the various editions and translations.

A lifelong follower of the phlogiston theory, Macquer also taught a modified version of the Aristotelian elements. But he also displayed the sort of critical, flexible, and empirical approach associated with the best Enlightenment scientists: he scorned the pretensions of the alchemists, and he paid careful attention—as can be seen by comparing the first and second French editions—to new evidence that appeared to conflict with phlogistic ideas or Greek element theory. After Macquer's death editors, such as the Englishman James Keir and the Germans J. G. Leonhardi, J. B. Richter, and S. F. Hermbstaedt, added much new material to the dictionary, the last-named adapting the whole work to the antiphlogistic system. Schmiederer argues that although Lavoisier's theory can be viewed as a scientific revolution in the Kuhnian sense, by following the development of Macquer's work through its various incarnations one can nevertheless discern a more gradual and continuous development, the antiphlogistic system thus emerging as "the result of the consistent development of phlogistic chemistry" (p 339).

The book is completed by excellent primary and secondary bibliographies and a usable name index. *Alan Rocke*, *Case Western Reserve University.*

What a Time I am Having. Vivien Perutz, Ed., Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 2009, xxix + 506 pp, ISBN 9780-0-87969-864-5, $39.

This extensive collection of Max Perutz's letters, amplified by brief biographical sketches and explanatory introductions to each chapter, serves as a highly informative complement to the Perutz biography by Georgina Ferry, *Max Perutz and the Secret of Life,* also published by Cold Spring Harbor Laboratory Press (2008). That book was reviewed in the previous issue of THIS JOURNAL (*Bull. Hist. Chem.,* **2009**, *34*, 69-71).

The editor (often times herself recipient of letters), daughter of Max Perutz, has been fortunate in having access to hundreds of letters Max penned to his wife and children, his sister, parents, personal friends, and many scientists over a period of about 70 years. While most are original in the form of collections of the recipients, sources also include copies found in his office files, his personal diaries, and numerous archives. Some of these memorabilia still in private hands will be deposited in the archive at Churchill College, Cambridge.

In her preface, Vivien describes her ambitious project, the myriad sources, and her decisions about what to include and to edit. An opening memoir of Max Perutz by the late David Blow provides a concise account of Perutz's life and accomplishments, all of which has been described in more detail in Ferry's biography. It is nevertheless helpful as an opening section and prepares the reader to proceed in "getting to know Max" the person. The editor has provided several features of great help in following Perutz/s story: a timeline of major events in Max's life; a list of the 80 correspondents, with brief biographical sketches; a list of the 100 illustrations; and archival repositories of the letters.

The book title is taken from the opening line of a letter Max wrote to his wife Gisela from the US in 1950. It conveys his enthusiasm for life in many forms, which is amply confirmed in his highly articulate writing, first in German (translated into English for this collection) and then gradually in English, as he lived out the major part of his life in England. The eight chapters are grouped by the decades of Max's life, from the 1930s to the 2000s. Each is prefaced with explanatory information about the highlights of that decade, and the editor has also provided useful and sometimes lengthy footnotes to amplify an issue or event.

Correspondence from the 1930s is comprised mostly of letters to a young woman Max admired very much: Evelyn Baxter (later Evelyn Baxter Machin). Having saved all his letters, she returned them to Max when he was in his eighties. They provide personal accounts of his years as a chemistry student first in Vienna and then at Cambridge, the beginning of his life-long investigations on hemoglobin, and his adventures as an ardent skier and rock climber. Of Jewish origin but baptized as a Roman Catholic, Max deplored the political turmoil of the late 1930s, commenting on the *Anschluß* and concentration camps with utter disdain. In 1940, having completed his doctorate under W. L. Bragg, he was interned as an alien, as was his father. Letters to his parents and sister, first from England and then Canada, describe his frustration and anxiety about his future: when would he be released? Should he consider a position at Cal Tech in the US? With the intercession of Bragg, Max was released and able to return to Cambridge University in 1941, where he remained for the rest of his life; a loyal Anglophile, he never had to settle for a position in America, much to his relief. After he was married in 1942, the volume of his correspondence was magnified with often daily letters to Gisela, as well as frequent letters to her parents in Berlin. Because Gisela's "Berlin German" and his Austrian language were incompatible, they settled on English as their 'native tongue!" It was in this decade that Max initiated an association with the Rockefeller Foundation, which supported his research continously from that time on. With the founding of the Medical Research Council in 1947 his program was not only financed but recognized as a valid investigation into molecular structure of biological systems. It is remarkable how detailed descriptions of his slow but positive research results on hemoglobin were conveyed to his reading audience—wife, relatives, as well as to fellow scientists. How much the nonscientists comprehended the reports is problematic. His readers might have understood somewhat more clearly his account of war effort investigation of ice and later his project on glaciology, sponsored by the Royal Society. The love of the Alps must have been a compelling inspiration for these diversions from chemistry. His travels to the US and Canada are recorded for posterity in his personal diary, which the editor has reproduced.

The highlight of the 1950s was the substantial progress in working out the hemoglobin structure through the use of heavy atom markers and the first three-dimensional X-ray structure. He was named a fellow of the Royal Society in 1954. With growing recognition and respect for the structure work being carried out in Perutz's group, he received numerous invitations to lecture. A noteworthy trip was that in 1961 to give the Weizmann lectures in Israel, and he took the opportunity to plan an extensive trip to the Near East with his wife, children, and mother, well documented in a diary, portions of which are reproduced in the book. He is forthright in his observations, such as that about the contrasting impressions in Jerusalem. He found the Church of the Holy Sepulcher a "..shapeless and labyrinthine conglomerate of shabby chapels belonging to a multiplicity of different Christian sects..", while the Dome of the Rock "…was built in the 7^{th} century on a magnificent open site…and shows the great flowering of Islamic art at a time when Europe went through the Dark Ages." The awarding of the Nobel Prize in Chemistry to Perutz and John Kendrew, his former student and colleague, certainly constituted the apex of the 1960s. Once again he recorded the Stockholm ceremony and accompanying events with articulate candor, such that the reader has the sensation of experiencing the events first hand, rubbing shoulders with other Nobel laureates as well: Watson, Crick, and John Steinbeck. After years of managing in inadequate quarters, Perutz and his group were finally able to occupy the newly built MRC Laboratory, officially opened by Queen Elizabeth, in 1962. Refinements in the structure of hemoglobin continued steadily, and before the decade had ended, attention was being directed toward the mechanism of oxygen uptake and release, as well as the possible role of hemoglobin in diseases. Max, serving as the first chairman of the European Molecular Biological Organization (EMBO) beginning in 1963, was compelled to travel extensively in this capacity; and he provided details of these experiences as well.

In the 1970s Perutz traveled extensively on lecture tours, which are documented through his vivid descriptions. Much of his research progress—further refinements in the structure of hemoglobin and its role in oxygen transport—is outlined, sometimes with hand drawn sketches, primarily to his son Robin.

Upon his retirement as chairman of the Laboratory of Molecular Biology and with permission by the Medical Research Council, Max Perutz continued working in the laboratory as a research scientist. This had been his practice from the outset—to work with his own hands alongside his collaborators, and he maintained this routine until very shortly before his death in 2002. In the last two decades of his life, Max sustained his commitment to molecular biology, which was recognized in the form of several awards; but he branched out into studying the causes of afflictions such as Huntington's disease and AIDS. These new areas of interest are documented in great detail in the correspondence. He also became actively concerned with politics and wrote essays directed to a wider public than just scientists.

To be sure, this assemblage of personal letters serves as documentation of the scientific accomplishments of Perutz, a Nobel Prize winner who is less familiar to the general public than, say, Linus Pauling. But beyond this accomplishment, the editor has collected insight into Perutz the man—far more than scientist alone. He had deep interest in not only science but religion, history, and politics. Social issues such as contraception, genetic engineering, and human and religious rights are recurring themes in his correspondence. A voracious reader, he would often report in his letters whatever he was reading for pleasure at the time; books would span the horizon from early classics to *Catcher in the Rye*. Max was fluent in French and Italian and his (nearly) native language English, as well as his own native German. He was a sincere patron of art. architecture, the theater, and music: on one occasion, when snowbound in

Canada, he expressed his main concern—that he would fail to make it to Washington, DC the next day in time for the 'Philadelphia Philharmonic' concert. He provided clear descriptions of the design and architecture of sites he visited, such as the Washington capitol ("dignified but hideous"). As might be expected of a scientist with meticulous skills, he respected order and cleanliness, often giving a report on the condition of a hotel room or lobby. These traits could only be honed in a person with extremely keen powers of observation, so richly gifted was this man.

Qualities evident in this Renaissance man are: skill for organization, imagination, honesty, and a strong ethical sense. During the war he expressed shock at what he considered moral decline in the behavior of British citizens through public love making, rudeness, and drunkenness. Perutz had very high standards with regard to communication through lectures, scientific publications, not to mention correspondence. He is quoted as saying, "Presentation of a scientific discovery is, or at least should be, a work of art" (p 228). He was his own worst critic in evaluating his public lectures, sometimes reporting that one had gone badly—but also freely inclined to identify those that had gone well.

Perutz had keen insight in evaluating individuals; he selected his coworkers with great care and success. In dealing with scientists and pubic figures at all levels, he managed to maintain an objective perspective but was always sensitive to their feelings. Through it all, he maintained a sense of humor. While visiting Cambridge, MA in the US, where he lectured at both institutions, he reported to his wife that one of his functions "..was to tell people at Harvard what goes on at MIT and vice versa."

The editor and all the staff at Cold Harbor Spring Laboratory Press are to be commended for their remarkable success in bringing Max Perutz to life for those of us who did not have the good fortune to know him personally. *Paul R. Jones, University of Michigan*.