

ESSAY REVIEW

Essay review: horizontal chemistry

Peter J.T. Morris and Alan Rocke (gen. eds.), *A Cultural History of Chemistry* 6 vols.

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Introduction

In 1976 Raymond Williams commented, ‘Culture is one of the two or three most complicated words in the English language.’ Such implied difficulty has not prevented Bloomsbury Academic, since the 2000s, from publishing around forty series of their well-produced and generously illustrated Cultural Histories, with, according to their website, a further fifty in progress. Each series contains six volumes, each book covering, in theory, the same chronological period (antiquity, the Middle Ages, the Renaissance, the Enlightenment, the age of empire and the modern age), though there is some variation depending on precise topic. The idea is that one can use these books not only to read ‘horizontally’ about a subject across time, but also ‘vertically’ through different subjects in the same period – a idea made easier by the e-texts of the series on Bloomsbury’s website.

Topics currently covered by the series range from comedy and democracy to emotions and shopping. Science and engineering are notably absent from the list, though there are Cultural Histories devoted to animals, colour and medicine, which doubtless contain some history of science. There are no Cultural Histories, as yet, devoted to topics such as physics, biology, bridges, geology, mathematics and so on. So it is greatly to Bloomsbury’s credit that they have added chemistry, edited overall by Peter Morris and Alan Rocke, to their portfolio, a welcomed recognition that science is part of culture. The question usually asked of essay collections, about whether the sum of the book is greater than the individual contributions, is complicated by the verticality of the forty series. No attempt is made in this review to address that issue, but instead we concentrate on the horizontality of the six volumes.

Volume I: Marco Beretta, ed., *A Cultural History of Chemistry in Antiquity*

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This is an excellent, wide-ranging and much-welcomed cultural history of chemistry in the ancient world. The approach, as one would expect, is very much to place the practice and theory of ancient chemistry in its cultural context, looking at how chemistry was

done, its laboratory and institutional settings, its place in society and trade and how it was represented. We have chapters on theories and concepts, practice and experiment, laboratories and technology, culture and science, society and environment, trade and industry, learning and institutions, and art and representation. These are all written by Sydney Aufrere, Cale Johnson, Matteo Martelli and Marco Beretta, and follow an introduction written by Beretta. Each chapter has material on ancient Egypt from Aufrere, on ancient Mesopotamia from Johnson and on the Graeco-Roman world from Martelli, with a conclusion tying each chapter together from Beretta. This is an excellent arrangement for several reasons. As Beretta says in his introduction, it is too much to expect one scholar to have the philological skills required in four ancient languages to give an expert view on all of these cultures, especially given the three-thousand-year time span this volume deals with. I would add that studies of ancient science more generally, and in particular cross-cultural studies of ancient science, are hamstrung by the fact that experts in Egypt, Mesopotamia, Greece and Rome are usually in different departments and different faculties, and attend different conferences, and so simply do not interact with one another enough. This arrangement, then, is most welcome in encouraging the reader out of a monocultural approach to ancient chemistry and ancient science more generally.

My one concern here is that, as Beretta comments, this approach will generate a 'more homogeneous reconstruction' (p. 21). That is so, but perhaps at the cost of flattening out some of the differences between these cultures, which to some extent is my impression. A further advantage of this approach is that it circumvents the origins question, of when and where chemistry began or became a 'proper' science. This issue has loomed large in previous historiography, with scholars advocating one culture rather than another (usually the one they are expert in) with the highly definition-sensitive discussions generating more heat than light. Here there is a much more interesting and informative sense of collective interaction and progress without privileging one culture with a single 'origins' moment.

A perennial problem with the study of ancient chemistry is what should be included and what should be excluded. None of the languages of the cultures studied here had a subject name for chemistry, so we cannot simply appeal to 'what the ancients considered as chemistry' as our criterion. There has also been the question of what should be treated as chemistry and what should be treated as alchemy, with no historiographical consensus on the issue and again no contrast between chemistry and alchemy in the ancient world to appeal to. Indeed, it may be anachronistic to apply the later conception of alchemy to the ancient world and to seek to differentiate chemistry from alchemy there. In general, this book deals well with these issues. Wisely, it does not offer any rigid definitions but allows the practices and situations to speak for themselves and allows the readers to draw their own conclusions.

In many ways it is a pity that China has been excluded from this volume. Looking at work in China and in India would make the volume much more comprehensive and give more of a sense that the early study of chemistry was more ubiquitous and took place outside the ancient Near East as well. This would have thrown a greater strain on the chapter structure (quadripartite rather than tripartite authors) and would have run against the theme of a trade in ideas and products between cultures as the Chinese and Mediterranean worlds were relatively isolated in this respect. Nevertheless, there would have been much to gain from such an approach. Studies of Chinese chemistry and alchemy are now much more numerous and more advanced than the introduction here would suggest and there are also important and interesting comparative studies.

I would question whether Chapter 2, on theories and concepts, is the right place in this volume, for as the authors readily admit, it was practice which was more important in the ancient world and the important advances were driven by practice rather than theory.

The same chapter titles and order are used throughout this series, which clearly has its advantages, as the series preface suggests, in making a diachronic reading of topics easier, even if it does in this case project a more modern preoccupation with theory anachronistically onto the ancients. One issue with Chapter 2 is that given the subsequent importance of Aristotle in the theory of both chemistry and alchemy, more ought to be said about his views – in particular the idea that the transmutation of the elements was an entirely natural phenomenon for Aristotle and indeed happened on a day-to-day basis. A multiplicity of views on the nature of matter persisted in the Greek world, and the chapter brings this out well but more detail on the nature of the elements for Aristotle and on how qualities and prime matter function would be very helpful for understanding many subsequent developments.

This volume is very well illustrated, in the senses that there are a good number of illustrations and they are well chosen. It is a pity, then, that some of them are not well reproduced, lacking contrast and clarity. The line-drawing illustrations are noticeably much better in these respects. The bibliography is excellent and extensive, though it might have been made more accessible and more useful by dividing it into Egyptian, Babylonian, Greek and bibliographic sections and/or by dividing it onto sections by chapters.

In any undertaking that attempts to deal with three thousand years and three separate cultures in one multi-authored book, it will always be possible to raise some quibbles about historiography or interpretation. Those I have raised here are relatively minor in relation to the ambition shown in this book and the general excellence of its execution. This book should be warmly welcomed as a starting point in the study of ancient chemistry and as an example that cross-cultural work on ancient science is indeed possible. I learnt a great deal from this book and I hope other readers will do so as well.

Volume 2: Charles Burnett and Sébastien Moureau, eds., *A Cultural History of Chemistry in the Middle Ages*

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As with the volume on chemistry in antiquity, this is an excellent, wide-ranging and much-welcomed cultural history of chemistry in the Middle Ages. The approach again is very much to place the practice and theory of ancient chemistry in its cultural context, looking at how chemistry was done, what its laboratory and institutional settings were, its place in society and trade and how it was represented. After the introduction from Sébastien Moureau, we have the set chapters for each volume in the series: Matteo Martelli, Sébastien Moureau and Jennifer Rampling writing on theories and concepts; Sébastien Moureau and Nicolas Thomas on practice and experiment; Nicolas Thomas and Sébastien Moureau on laboratories and technology; Regula Forster and Jean-Marc Mandosio with Antoine Calvet and Gabriele Ferrario on culture and science; Charles Burnet, Antoine Calvet and Justine Bayley on society and environment; Justine Bayley and Spike Bucklow on trade and industry; Regula Forster and Jean-Marc Mandosio with Antoine Calvet on learning and institutions; and Jennifer Rampling on art and representation. All of these chapters do a good job of placing the chemistry/alchemy of the time in its cultural context.

The non-expert reader might be concerned that the subtitles for each of the seven chapters refer to alchemy. Is this a history of alchemy or a history of chemistry?

As the introduction explains well, it is actually a history of both as there was no real distinction made between chemistry and alchemy in these cultures in this period. This is slightly at odds with the first volume, on antiquity, which did characterize some processes as chemical and some as alchemical, but is undoubtedly the best approach to the Middle Ages. In relation to theories and concepts, some more might be done to explain Aristotle's theory of matter, which so often underpinned alchemical theory, and to emphasize that the transmutation of the elements was often seen as an entirely natural process. This would help clarify the relation of alchemy to (natural) magic and the other 'occult' sciences. The book generally does a very good job of emphasizing the breadth of alchemy and its relation to craft practices. The opening of Chapter 2 on practice and experiment runs slightly against this in stating that the main aim of alchemists was making gold and silver. Some evidence and/or argument is needed here as many would construe the aims much more broadly and would not be so happy to talk of a unified 'aim of alchemists' as opposed to the diverse views of individual alchemists. It is, then, interesting to see that the practices and experiments that the chapter discusses are not mainly to do with production of gold and silver! The point is important as the more broadly we construe the aims of alchemy the more interesting its relations to other disciplines and its cultural context become.

There are some problems with dates. 'The Middle Ages' is a rather nebulous term which could refer to something as broad as from antiquity to the Renaissance or as narrow as a century or two. We are given no specific dates that this volume covers, so presumably the range is 'antiquity' (the previous volume) to 'early modern' (the next volume), but then we have an absence of dates for the end of antiquity and the beginning of the early modern period as well. One might also have serious concerns as to whether it is proper to think of Arabic/Islamic cultures with reference to such a Eurocentric term as 'the Middle Ages', not least because the activities of Arabic/Islamic cultures may well pre-date and post-date the European Middle Ages, quite apart from any question of whether it is profitable to think of Arabic/Islamic cultures as in any way 'medieval'.

It is an even greater pity here than in relation to the volume on antiquity that East and South Asia have been excluded. Again, looking at work in China and India would make the volume much more comprehensive and give more of a sense that the study of chemistry in this period was more ubiquitous and took place outside Arabic/Islamic and European cultures as well. Again, this would have run against the theme of a trade in ideas and products between cultures, as the Chinese were relatively isolated in this respect, but to ignore China here is to ignore a large part of the global history of chemistry. In older accounts this might have been minimized to the discovery of gunpowder, but more recent work has shown that discoveries in metallurgy, distilling, medical chemistry, porcelain production and the exploitation of raw materials more generally were culturally important for the Chinese and ought to be recognized as being as historically important as their parallels in the West. Studies of Chinese chemistry/alchemy in this period are now much more numerous and more advanced than the introduction here would suggest.

As with the volume on antiquity, this volume is illustrated with a good number of well-chosen illustrations. Again, though, it is a pity that some of them are not well reproduced, lacking contrast and clarity. The line-drawing illustrations are again noticeably better in these respects. So too the bibliography is again excellent and extensive, though it might have been made more accessible and more useful by dividing it into European and Arabic/Islamic and bibliographic sections and/or by dividing it into sections by chapters.

In any undertaking attempting to deal with two separate but related cultures over a significant time span it will always be possible to raise some concerns about historiography or interpretation. Those I have raised here are relatively minor in relation to the

ambition shown in this book and the general excellence of its execution. This book should be warmly welcomed as a starting point in the cultural study of the chemistry of the Middle Ages. As with the volume on chemistry in antiquity, I learnt a great deal from this book and I hope other readers will do so as well.

Volume 3: Bruce T. Moran, ed., *A Cultural History of Chemistry in the Early Modern Age*

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The early modern age was characterized by multiple and competing forms of chemistry, illuminated clearly by the nine strong essays in the third volume of this series. Spanning the sixteenth and seventeenth centuries, the period embodied unprecedented social, religious and political changes, with intellectual developments and new cultural experiences becoming integrated into long-accepted theories and practices. The essays in this book focus primarily on developments within Europe, where new ideas spread rapidly thanks to the proliferation of printed books and increased international exploration.

Editor Bruce Moran expertly assembled eight authors from varied scholarly backgrounds to offer a comprehensive view of early modern chemistry, and one that appropriately captures the state of the field today. Similar to the first two volumes in the series, this accessible primer begins with a thorough explanation of the theory and concepts (Lawrence M. Principe), followed by chapters on practice and experiment (Joel A. Klein) and laboratories and technology (Donna Bilak). Two essays follow that solidly reflect cultural history as a methodology, on culture and science (Andrew Sparling) and society and environment (William Eamon). The volume then concludes with three thoughtful deep dives into trade and industry (Tillmann Taape), learning and institutions (Margaret D. Garber), and art and representation (Elisabeth Berry Drago).

Moran's introductory essay stands out for convincingly and explicitly revealing the value of cultural history as a methodology for studying early modern chemistry. With a vivid description of early modern European societies experiencing population growth and using new plants and materials available to them for the first time, he expertly sets the context for the whole volume. Typical of cultural-history methodology more broadly, Moran provides insightful analyses on materiality, ranging from demonstrating how copperplate engravings allowed readers to visualize things they had never seen to introducing how exotic smells and tastes were now abundant in the marketplace thanks to raw goods imported by the East India Company. With its helpful overview of how wider economic structures, social norms and national boundaries shaped the development of chemistry while it was still a nascent field, this essay would make an excellent stand-alone piece to introduce the early modern period in an undergraduate or graduate course.

Terminology is a point of respectful contention across this volume. Terms such as *alchemia*, *chemia* and *chymia* were sometimes used interchangeably in this period and often had different meanings depending on regional context or specific circumstances. Accordingly, many authors in this collection (Principe, Klein, Bilak and Garber) have chosen to use the contemporary term 'chymistry' to refuse anachronistic modern distinctions between alchemy and chemistry. Other authors (Moran, Sparling, Eamon and Berry Drago) carefully use the terms 'alchemy' and 'chemistry' as appropriate to their arguments

(especially regarding alchemical caricatures), while another author (Taape) prefers the broader term 'chemical arts' (p. 142). Such thoughtful reflections on vocabulary are included in each essay, revealing that the boundaries for defining early modern chemistry are still contested. Yet although defining key terms reveals some differing opinions between these authors, they are united in arguing one central point: early modern chemistry comprised diverse practical and theoretical aspects and was not yet organized as a unified discipline.

Each chapter is well written and carefully researched, elaborating on the eight themes set for each volume in the series. Lawrence Principe provides an expert intellectual framework for understanding the theory and concepts of the period, thoroughly unpacking the developing and competing theories of material composition that underpinned early modern experiments, including metallic transmutation. Joel Klein and Donna Bilak's essays follow by showing how such contemporary theories played out in practice, both highlighting the importance of fire and furnaces, as well as the creation of analytical categories based on the senses. Andrew Sparling, William Eamon and Tillmann Taape illuminate how chemistry was present in the everyday lives of ordinary people, highlighting how practices like distillation created new medical treatments and how women and craftspeople used new ingredients in their practice. Margaret Garber illustrates how noble courts filled with ample resources were the ideal space for chemical experimentation, while universities slowly also began integrating and formalizing chemistry as part of their curriculum, especially in medicine. Elisabeth Berry Drago considers the line between fact and fiction in textual, printed and painted representations of alchemists, noting that scholars may recognize parodies in literature but are less discerning with paintings.

Each essay contains enough wider historical context to allow it to stand alone, and therefore enable it to be read 'horizontally' along with its corresponding chapters across the full series. However, this admirable goal uncomfortably competes with its other goal: to read each single volume 'vertically' from cover to cover. Series editors Peter Morris and Alan Rocke rightly acknowledge in their preface that 'in any multiauthor undertaking like this one readers will inevitably notice overlaps and repetitions' (p. xiii), but that issue is more pronounced in this anthology than in other multi-authored collections like it. This is likely both because the history of early modern chemistry is still a small field, and because some of the chapter themes used to provide continuity across the six volumes would be hard to disentangle from each other in the early modern period. If the editor of this volume were allowed more flexibility to choose his topics, one could reasonably assume that this issue would have been lessened.

It is also worth noting that although a volume on early modern chemistry would be incomplete without acknowledging the importance of intellectual elites such as Aristotle and Robert Boyle, the volume skews more heavily towards them than one might expect of a cultural-history anthology. There are some notable exceptions within the volume. In addition to Bruce Moran's piece, discussed in detail above, William Eamon takes the reader from vibrant Venetian marketplaces to the households of English gentlewomen, revealing how chemistry was integral to all aspects of early modern culture and society. Readers expecting a strong cultural-history methodology such as this will not find it present in each essay in this volume, which at times skews more heavily toward intellectual history. However, they may still expect to walk away with a clearer understanding of the prevalence and value of chemistry in early modern Europe, told by some of the strongest scholarly voices in the discipline today.

Volume 4: Matthew Daniel Eddy and Ursula Klein, eds., *A Cultural History of Chemistry in the Eighteenth Century*

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This volume is edited by Ursula Kline and Matthew Eddy, who provide an introduction entitled ‘The core concepts of cultural context of eighteenth-century chemistry’. They also contribute a chapter each, respectively ‘Theory and concepts’ and ‘Society and environment’. The other chapters are written by Victor Boantz (‘Practice and experiment’), Marco Berretta (‘Laboratories and technology’), Bernadette Bensaude-Vincent (‘Culture and science’), Leslie Tomory (‘Trade and industry’), John Powers (‘Learning and institutions’) and John Christie (‘Art and representation’).

As one might expect from these contributors and their titles, the essays in this volume reflect much of the recent historical thinking about eighteenth-century chemistry. For instance, most European countries are referenced at some point in the volume, though as one might expect most of the discussion is centred on France, the German-speaking states, England and Scotland, though Baretta does provide an extended discussion of Swedish laboratories. Whereas there is some discussion of patronage (e.g. Eddy, pp. 114–17), artisans and universities (especially by Powers, pp. 159–66), there is little overt general discussion of class and especially of the key role played by aristocracy and royalty (not the same thing) who had the wherewithal to support chemistry and chemists if they wished – think of Henry Cavendish, Joseph Priestley, Thomas Beddoes, Humphry Davy and others.

Gone from this volume is the notion of a self-proclaimed ‘chemical revolution’ created by Antoine Lavoisier and his circle. John Christie, for instance, discusses Wright of Derby’s painting *The Alchemist in Search of the Philosopher’s Stone* (1771) as illustrating that at least the visual representation of alchemy continued well into the century (pp. 183–5). Furthermore, the editors argue that the persistence of phlogiston theory post-Lavoisier shows how relatively straightforward it was to accommodate new chemical knowledge within the previous theoretical framework (p. 14). Chemistry in the eighteenth century thus comes to be seen as a gradually evolving science.

But beyond that, the century is portrayed as a key period in the transformation of chemistry in a number of regards. If we think of the state of al/chemical knowledge in 1700 and in 1800, it is clear that major change happened during the eighteenth century. These are tracked in each of the essays, providing vignettes of what might have promoted change, a good example being Beretta’s discussion of laboratories and apparatus. The outcome of all this is perhaps best summed up by Davy’s ‘Discourse introductory to a course of lectures on chemistry’ delivered in the recently founded, aristocratically run, Royal Institution in early 1802 discussed by Boantz at the end of his chapter (pp. 69–70). In his ‘Discourse’ Davy emphasized that chemistry ‘applies to most of the processes and operations of common life’, exemplifying this assertion by referring to, amongst other areas, agriculture (‘intimately connected with chemical science’), metallurgy (‘a branch of technical chemistry’), bleaching and dyeing (‘purely chemical’), tanning (‘chemical processes’), porcelain and glass (‘chemical arts’) and so on. Yet all of these practices had been in existence in 1700, indeed for centuries, if not millennia, before. Tomory methodically goes through how each of these processes changed during the century. From such specificity Boantz argues that the changing practices embodied in these arts ‘turned into analytical tools closely related to new notions of composition and chemical elements’ (p. 69).

But Davy went further in his 'Discourse' when he asserted, 'How different is man informed through the beneficence of the Deity, by science and the arts!' Chemistry not only provided material benefits, but through its 'transcendental part' helped provide proper natural-philosophical knowledge. The eighteenth-century bases on which Davy constructed such ideas are discussed by Klein and Bensaude-Vincent. But Davy went further and argued that science in general and chemistry in particular also had a strong theological and political role in improving men. Christie picks up on this, while Eddy emphasizes it, especially Edmund Burke's spectacular denunciation, in the context of the French Revolution, of Joseph Priestley, his work and modern chemistry generally. The eighteenth century ended with chemistry viewed by much of the governing class as a politically and theologically suspect science with the potential to support revolution and sedition and to provide, through its inherent materialism, the basis for an attack on Christianity. One cannot get a much stronger link between culture and chemistry.

Volume 5: Peter J. Ramberg, ed., *A Cultural History of Chemistry in the Nineteenth Century*

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This volume, which tends to cover the long nineteenth century to 1914, is edited by Peter Ramberg, who provides an introduction entitled 'Creating modern chemistry' and co-authors a chapter, 'Culture and science,' with Agustí Nieto-Galan. The other chapters are by the late, much missed, Trevor Levere ('Theory and concepts'), Yoshiyuki Kikuchi ('Practice and experiment'), Amy Fisher ('Laboratories and technology'), Peter Reed ('Society and environment' and 'Institutions and learning'), Anthony S. Travis ('Trade and industry') and Joachim Schummer ('Art and representation'). The geographical coverage in this volume is diverse and includes what was not in the eighteenth-century volume apart from some discussion of Priestley's exile, namely chemistry and its institutions in North America. As the chapter titles suggest, recent historiographical trends are well represented, especially on the practical influence of chemical knowledge on industry, the environment and so on.

But more traditional concerns to the historian of chemistry are also represented, such as atomism and affinity, discussed by Levere in a valuable succinct summary. The problem here, of course, was that atomism was never fully accepted during the century, being opposed by many major figures, including, amongst others, Humphry Davy, Michael Faraday and later Wilhelm Ostwald and Ernst Mach. Indeed, atoms only really became accepted after J.J. Thomson's work showed that atoms were made up of smaller particles and were therefore no longer atoms in the classical sense of indivisible pieces of matter!

Davy appears a remarkable number of times throughout this volume, on a par with Jöns Jacob Berzelius, Robert Bunsen, Faraday, August Wilhelm von Hofmann, Antoine Lavoisier and Jacobus Henricus van 't Hoff, though with Justus von Liebig having the most references. Whether that is a reflection of their influence or merely shows where recent historical study has focused is for others to decide. But what Davy's appearance shows is a cultural continuity between eighteenth- and nineteenth-century chemistry, which is explored in the chapter by Nieto-Galan and Ramberg. Beginning with the lectures of Davy (which contributed to making chemistry a politically safe science) and Faraday, they move through the century to look at the links chemistry developed both with traditional areas, such as medicine, theology and ideology, and with new areas,

including astronomy, biology and literature. This last is the subject of Schummer's chapter which has as its subtitle 'The rise of the "mad scientist"'. It should be no surprise that Mary Shelley's novel *Frankenstein; or, The Modern Prometheus* (1818) figures prominently (pp. 223–5). What is surprising, however, is that the author appears unacquainted with the large and growing literature linking Romanticism with science, out of which *Frankenstein* emerged. Shelley, whose father William Godwin knew Davy well, clearly used the latter's chemical rhetoric in writing the novel and one of her characters had a strong resemblance to him. That lacuna seems to miss a major trick in a cultural history.

The other key area linking chemistry with the broader culture was, of course, industry. Although there had been some links between chemistry and industry in the eighteenth century, during the following century these grew enormously, for instance in the German-speaking states. By the end of the century, German industry had come to dominate world production of chemicals, which is discussed, amongst other countries, by Travis (esp. pp. 177–9). One of the reasons why the German chemical industry was able to become so dominant was due to the number of chemists trained in German-speaking universities. This came about because before 1871 there was intense rivalry between states for their universities to have the best chemists as cultural ornaments. The states were prepared to pay for prestige, and some chemists, such as Bunsen and Liebig, took full advantage of this circumstance, building up large-scale teaching and research laboratories, which produced large numbers of students, many of whom went on to practise chemistry in academic and practical settings, including the chemical industry. Closely linked to the production of ever more chemists were developments, such as the building of laboratories, the making of novel chemical apparatus, model building, chemical communication and so on discussed by Kikuchi, by Fisher and by Reed in his chapter 'Learning and institutions'. These developments illustrate perhaps one of the weaknesses of confining each volume to a fairly rigid chronological period (presumably specified by the publishers) in that it is not made clear that the rise of the German chemical industry, especially through IG Farben, would have unimaginable consequences in the 1940s.

Chemical developments in the German states were imitated, to some extent, elsewhere – for example, the establishment in the mid-1840s of the Royal College of Chemistry in London, with one of Liebig's students, August Hofmann, as head (pp. 101–2). Like Bunsen and Liebig, Hofmann's institution produced many students, some of whom went into the British (and imperial) chemical industries. One of the consequences of the expansion of the chemical industry was its deleterious environmental impact. Legislation regulating the industry was enacted, a topic covered by Reed in 'Society and environment', using case studies from Britain and to a lesser extent from France and the United States (pp. 155–61).

Nineteenth-century chemistry is a huge subject. J.R. Partington, in his *History of Chemistry*, published in four substantial volumes during the 1960s, devoted most of volumes 3 and 4 to the eighteenth and nineteenth centuries. (Morris's and Roche's 'Series preface' reminds us that this Cultural History is the first multi-volume history of chemistry to appear since Partington.) Meanwhile, of W.H. Brock's 744-page *The Fontana History of Chemistry* (1992) just over two-fifths was devoted to the nineteenth century compared to the 271 pages in this Cultural History, forming a sixth of the series. Put differently, this and other volumes in *A Cultural History of Chemistry* do not seek to replicate, or even update, what has already been done, but rather to interpret the history of chemistry in the light of new insights about chemistry as a part of culture.

Volume 6: Peter J.T. Morris, ed., *A Cultural History of Chemistry in the Modern Age*

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The sixth volume of *A Cultural History of Chemistry*, which covers the development of this most ancient branch of natural science, brings the series right up to the present, whilst conveniently following the themes of the previous volumes. Thus readers can choose to focus on a single era, in this case 'the modern age', or use the last volume to explore the same topics across a longer time frame: from the theories and concepts of chemistry to its representation in art and wider society. Like the earlier volumes, it begins with a useful overview, designed at once for a specialist and for a wider readership. It is written by the editor of the volume, and co-editor of the series, Peter Morris, with an emphasis on the transformation of chemical knowledge and practice in its different institutional settings, and the instruments and materials associated with them. Although Morris does not articulate precisely how and why the culture of chemistry (defined in the preface as 'mixed constructs of social, intellectual, and material elements', p. xiii) was transformed in the modern era, there are hints as to some of the key aspects touched upon in subsequent chapters. These include the changing relationship between chemistry and neighbouring disciplines, especially physics, biology and engineering; major shifts in the dominant sites of chemistry (geographically and institutionally), and in the chemical profession, which has become increasingly diverse, in terms of both gender and ethnicity; the growing role of legislation (not only health and safety regulation, but also legislation to protect the environment); and the changing perceptions and representations of chemistry, which were influenced by the part played by chemists and chemicals in warfare, beginning with the First World War, often referred to as 'the chemists' war', as well as in a succession of environmental disasters.

The diverse national and disciplinary backgrounds of the authors allow for a diversity of perspectives and approaches, which extend beyond the usual focus on laboratory science and on the West. It leads to the argument put forward in Chapter 7 that a common global culture of chemistry developed in the twentieth century and that this 'benefited both from enhanced international communications as well as from the restructuring of international politics since the 1980s' (p. 174).

Chapter 4, written by Carsten Reinhardt, comes closest, in my view, to identifying key drivers, which helped to produce this common culture of chemistry in the modern era. He reflects on the origins and evolution of chemistry's central role in the 'range of scientific disciplines, technical fields, and society and culture' (p. 100). This role was linked to chemistry's dual identity as a science and an industry, to which a third was added at the end of the twentieth century: a source of 'chemicals', often thought of as hazardous substances that are harmful to public health and the environment. In the account that follows, which shifts from Germany to the United States, reflecting the broader geopolitical shift that took place mid-century, Reinhardt focuses on two key aspects: (1) the materials and (2) the methods provided by chemistry to neighbouring disciplines and technical areas, as well as to wider society. Reinhardt does not neglect the role of historical contingency, in particular chemistry's close involvement in the major conflicts of the twentieth century, the rise of consumerism during the Cold War, and last but not least the reputational damage done to chemistry by public-health and environmental disasters, often perceived to be due to chemists' close links to industry. Unsurprisingly, perhaps, Reinhardt's chapter ends on a somewhat negative note, highlighting the paradox that, partly owing to environmental problems, from the 1960s onwards 'the impact of chemistry ... was greatest

when it was not considered chemical' and that, by the end of the century, chemistry appears to have become a science that is 'trying to understand a world, although partially made by it, that is now out of its control' (pp. 120–1).

By Chapter 5, therefore, the volume appears to be hovering between pessimism and optimism with regard to the evolution of chemistry *in culture* (as much as of *chemical culture*, which are never truly distinguished from each other). By the end of Chapter 6, on change in the culture of the chemical industry between 1914 and 2019, Morris and Travis conclude that, in the not-so-distant future, the public may well have to decide whether the practical benefits of the chemical industry outweigh its environmental costs.

Hence, almost imperceptibly, the structure of the book moves from a focus on chemical theory to a focus on chemical practice and materials, and their – often negative – implications for the environment. This move in terms of the structure of the book is mirrored in a shift in emphasis, from inside chemistry (largely avoiding the pitfall of being 'internalist'), to outside. The last chapter, by Joachim Schummer on the representation of chemists and chemistry in art and the media, closes a loop that opened in the first with Mary Jo Nye's reflection on the atom in science and art as 'a thing of beauty', much like the creation of the painter or sculptor. Thus, in many ways, the volume reflects and respects recent trends in the history of chemistry, referred to in Chapter 2 as the 'geographical turn' (in that that new practices could acquire a different significance or have a different impact depending on the environment in which they were deployed).

However, I would have preferred the structure and central argument(s) to have been made more explicit, either in the introduction, or by dividing the volume into different parts, with short introductory sections linking them to what preceded and followed them. The volume could also have been clearer about what the culture of chemistry actually consisted in, and what the key drivers of change were. In particular, the role of two world wars and of the major geopolitical shifts that followed in their wake, as well as the gradual (if perhaps transient) dominance of democratic political regimes, could have been analysed in greater depth. For the heightened interest in public health and the environment, which is reflected in the volume, and can perhaps only be too readily taken for granted, was not only the product of crises and disasters. It was also linked to the global expansion and extension of democratic rights, which is touched upon, rather than discussed outright, in many of the chapters. Yet, upon reading the volume, it seems to have acted as a key driver in the cultural history of chemistry by making chemistry a source of materials for the many, rather than the few, with all the risks and pitfalls involved.