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Book reviews

ROBERT FOX (ed.), **Centre and Periphery Revisited: The Structures of European Science, 1750–1914**. Revue de la Maison française: Oxford, 2003. Pp. 191. ISSN 1477-3082. No price given (paperback).
doi:10.1017/S0007087406217898

Power, Michel Foucault insisted, is at once a source of oppression and a source of inspiration. He contended that in documenting how power acts, the historian as archaeologist exposes past levels of existence, while the historian as genealogist drills countless boreholes in the chronological ground. There is, in the Foucaldian universe, a dialectic between broad structures (such as classicism and Romanticism) and the experience of individuals (for example, as émigrés, as factory workers, as homosexuals). History is a tissue of structural warp and individual woof. Ultimately one seeks to know what powers the loom, because power, as it creates discipline, is the origin of both subjugation and liberation. Wielding significant firepower, the state both disciplines subversion and patronizes creativity.

In his spirit as *tempestaire*, Foucault is present throughout this collection of diverse studies. Uniting many of them is the notion that people far from the intellectual action can discover new and valuable things or, failing that, at least construct a small simulacrum of higher learning by tapping local sources of wealth and authority. The architecture of the volume emphasizes this theme, with contributions from writers located at (and writing about) places not perhaps widely known as harbouring a vigorous tradition of modern science. The volume itself appears from what was once the intellectual centre of a great empire.

Foucaldian focus is apparent in Pietro Corsi's treatment of geology in nineteenth-century Italian Europe. He vigorously defends the study of organized communities of weak and inconsistent reasoners – here, a group of scientists whose contribution to European geological debates was minimal, bordering on the insignificant, but who remained convinced that they were not on the periphery at all, and who used a nod from foreign centres to obtain local goods and services (pp. 54–5). Institutional authority is central to Faidra Papanelopoulou's examination of the French understanding of thermodynamics in the nineteenth century, concentrating on the contrast between, on the one hand, the innovative provincial engineers Marc Séguin and Gustave-Adolphe Hirn – spiritual-minded thinkers who formulated a mechanical equivalent of heat in the context of industrial steam engines – and, on the other, Henri-Victor Regnault, a resolutely positivist Parisian mandarin who resisted theories, especially new ones.

A number of the contributions invite comparative reflection. Kostas Gavroglu contends that we should care more about how foreign ideas are appropriated by autochthonous cultures than about how they are transferred from the place of authority to a place of tutelage. The receiving end, he observes, modifies and extends a foreign idea, in part because the institutions and social mechanisms that take up the idea differ from those where the idea first emerged. Gavroglu uses this framework to discuss Greeks in the Ottoman Empire, who absorbed notions from the scientific revolution in the seventeenth and eighteenth centuries. His topic and his material suggest a fruitful comparison with writings by scholars of Enlightenment science in colonial Latin America, East Asia and especially the Islamic world, who for nearly twenty years have shown a similar methodological bent. Ana Simões, Ana Carneiro and Maria Paula Diogo evaluate the

Enlightenment Portuguese naturalist Correia da Serra, who pursued science and politics throughout Europe and the United States in a style evoking the Spanish natural philosopher Antonio de Ulloa. Hain Tankler surveys the university at Tartu, or Dorpat, in Estonia, from its reconstitution early in the nineteenth century up to 1918. The university was German-speaking for much of the nineteenth century, and a large portion of its faculty came from Germany. As a linguistic eccentric in the Russian Empire, the university seems not unlike its cousin to the north, the University of Helsinki, which was Swedish-speaking in a majoritarian Finnish society and which, though nominally self-governing, suffered continual impositions from the Russian imperial seat. Irina Gouzévitch and Dmitri Gouzévitch examine the missions to the mines of the Urals of French engineers Claude-Joseph Ferry and Frédéric Le Play in the first half of the nineteenth century. Oriented to commercial exploitation, the missions figure broadly in the diffusion of French engineers and engineering across Europe and beyond, from the New World to Asia and the breadth of Islam. Ferry and Le Play used the Russian experience in their publications, but the scientific results of their intervention seem less impressive than those of Roderick Impey Murchison's palaeontological voyage to the Urals in 1841, in the company of the French palaeontologist Edouard de Verneuil. Augustí Nieto-Galan reports on the network of chemist-dyers around the early nineteenth-century Catalan industrialist Jean-François Persoz, but a reader will sense the enormous distance separating Persoz from August Kekulé, a contemporary chemist installed at Ghent, another intellectually peripheral centre of textiles and dyeing.

It would be a mistake to conclude that, because scientific activity on the periphery is overwhelmingly channelled towards technological improvement and the exploitation of regional resources, peripherally situated people are necessarily hostile to talent in the exact sciences. Dorpat, for example, had notable strengths in astronomy, physics and mathematics. But the prosecution of the exact sciences does seem unable to remain independent of centralizing authority. In his contribution on Arcisse de Caumont, tireless defender of traditional provincial wisdom in France, Robert Fox points out that while field research – in botany, ornithology and many areas of prehistoric excavation – retained a large measure of autonomy, the experimental and mathematical sciences became confirmed as the almost exclusive preserve of those with posts in the *université*, the national research institutions, and the *grandes écoles* (p. 172). Whether freelance or civil servant, a scientist needed unusual strength of character to develop and extend sophisticated ideas while *enseveli en provence*, where the community of common interest was small and the resources, libraries, publication outlets and suppliers were thin. Omnibus peripheral gatherings, notably the Association française pour l'avancement des sciences, treated in Hélène Gispert's contribution, functioned as occasional showcases for local talent and popularization, although at least in the AFAS science seemed threatened with eclipse by industrial and commercial application. Benjamin Franklin's mission in Paris was a rare occasion when a peripheral pedigree, attesting to the natural genius of natural man, carried allure in the world of science. For the most part, people far from the centre have had to take care to shake the hayseed out of their hair when they address a broad scientific constituency.

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Mary Jo Nye (ed.), **The Cambridge History of Science. Volume 5: The Modern Physical and Mathematical Sciences**. Cambridge: Cambridge University Press, 2003. Pp. xxix + 678. ISBN 0-521-57199-5. £65.00, $95.00 (hardback).
doi:10.1017/S0007087406227894

This volume, the fifth in the Cambridge History of Science series, presents a collection of essays on the history of the physical sciences (broadly construed) during the nineteenth and twentieth

centuries. It consists of thirty-three chapters organized in six parts (for example, on discipline formation or atomic sciences in the twentieth century). Chapters vary greatly in scope and structure, but most focus on a single discipline or scientific community, such as astrophysics or geometry. The authors chosen represent some of the most eminent scholars in the field, and this volume is an impressive testament to the depth and breadth of current study of the history of the physical sciences. It will become the definitive reference work for the field.

The editor makes clear in her Introduction that she deliberately included a wide range of methodologies. The result is that we are given examples of some of the most important and influential approaches to the history of physics, such as Crosbie Smith's vigorous contextualist account of thermodynamics and Bruce Hunt's emphasis on scientific practice. Many of the authors include brief historiographic surveys of past work, and a diligent reader will come away with a broad appreciation of the varieties of history of science.

The sheer number of topics addressed is both staggering and heartening. Individual chapters examine the histories of various sub-disciplines of physics (radioactivity and nuclear physics, optics, energy and thermodynamics, electrical theory and practice, particle physics, plasma physics, solid-state physics and quantum theory) and chemistry (classification, chemical structure, quantum chemistry, polymer chemistry). Astronomy, astrophysics and cosmology each receive a chapter, as do geometry, statistics in physics and the development of mathematical schools and mathematical functions. 'Physical science' is given a big tent, and essays on geophysics and geology, computer science, environmental change, medical imaging and the relationship of the physical and life sciences also appear. This inclusive approach works very well, and is one of the major strengths of the book.

Additionally there is a series of excellent contributions on the relationship of the physical sciences to society and culture. Religion, gender, popularization, literature, war, ideology, language, visualization and industry are all considered in relation to physical science. A useful introduction to issues in the philosophy of physics is also included, although it feels somewhat disconnected from the rest of the book. These thematic chapters are all very well done, and give an accurate sense of the wider problems pursued by modern historians of science. A thorough index (which includes the names of referenced authors as well as historical figures and topics) makes finding specific information quick and straightforward.

There is some overlap among the contributions. For example, two chapters deal with very similar material on chemical terminology. The only major omission is the lack of a chapter on relativity. The theory appears in passing a handful of times (notably in Arthur I. Miller's essay on scientific visualization), but surely it is worthy of a chapter in its own right, based both on its impact on physics and on its representation in the historical literature. This gap is especially noticeable when much more esoteric subjects such as polymer chemistry receive entire chapters. Also, physical laboratories appear as secondary topics several times, but could have profitably received a dedicated chapter (especially given the large amount of attention material culture and lab practice have received in the scholarly literature).

Most chapters provide thorough references to the secondary literature on their subject, placed conveniently at the bottom of each page. Some authors include a variety of references to primary sources as well, which makes their essays extremely valuable for planning research projects or simply familiarizing oneself with the classic papers and books in a discipline. There are enough very well-documented chapters for those with less complete footnotes to stand out; it is frustrating to have comprehensive bibliographies for some subjects but not others. There is a similar unevenness in narrative scope and detail. Some chapters are written as genuine surveys while others make more nuanced, focused arguments about narrower topics. All are excellent, but the variety sometimes makes it challenging for a reader unfamiliar with the field to form a narrative arc for all of the disciplines discussed.

The very best chapters (of which Bruce Hunt's on electrical theory and practice and Olivier Darrigol's on quantum theory are exemplary) offer generous primary and secondary bibliographies, provide enough of a survey to give a clear narrative to a newcomer, and make clear the most important historiographic issues. Some authors, such as Jeff Hughes writing on radioactivity, make helpful suggestions for future research. These outstanding chapters will be valuable for historians and students of all kinds.

Overall, this book functions very well for a graduate student or a scholar moving from another field looking for an introduction to the history of the physical sciences and its problems, or as a thorough reference for a specialist. It would be an excellent resource for a historian of science not familiar with the physical sciences who needs a quick introduction to a particular topic (such as for writing lectures for a survey class). It will be somewhat less useful for a general historian or interested layperson, for whom the variations in narrative detail may be somewhat confusing. Generalist readers may also be turned away by the lack of extensive discussions of relativity or the conceptual and philosophical issues raised by quantum mechanics (popular subjects among those with a passing interest in the history of physics). Nonetheless, this an excellent and impressive volume with a wealth of information on a large number of topics, and it fulfils a serious need. There is no comparable collection of essays and bibliographic information on the history of the physical sciences.

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LISA M. DOLLING, ARTHUR F. GIANELLI and GLENN N. STATILE (eds.), **The Tests of Time: Readings in the Development of Physical Theory**. Princeton and Oxford: Princeton University Press, 2003. Pp. xliii + 716. ISBN 0-691-09085-8. $25.95 (paperback).
doi:10.1017/S0007087406237890

The editors of this book state that its intended audiences are working scientists, laypersons with an interest in science and students in philosophy of science courses. Students of the history of science are not mentioned. It would thus be unfair for me to judge *The Tests of Time* as a contribution to scholarship or pedagogy in the history of science; yet that judgement is exactly what would presumably be most useful to *BJHS* readers. I propose to resolve this dilemma by asking how well the book helps a student understand some of the philosophical issues arising in the history of science – issues which, by my experience, indeed interest many students, if not professional historians of science.

So, following the editors' 'philosophical introduction', let us begin with the problem of 'the existence of theoretical entities'. The readings pertain to five theories: heliocentric astronomy, electromagnetic field theory, relativity, quantum mechanics and big-bang cosmology. For the first theory, the selections from Aristotle, Ptolemy, Copernicus, Kepler, Galileo and Newton do illustrate how those authors argued for or against the reality of the theoretical entity called 'the Earth's motion'. Surely that is one thing, if not the only thing, that students should learn about the history of early astronomy. There is also much valuable material pertaining to the reality of electromagnetic fields and ether, space and time, quantum jumps and the expansion of the universe.

The second philosophical issue is 'the problem of scientific discovery', by which the editors mean primarily the use of analogy in constructing theories. The book is less successful in elucidating this problem, in part because some of the interesting examples discussed in their Introduction do not appear in the readings. I would have preferred that they show the creative role of mathematics in introducing what they call 'the counterintuitive element contained in each of the theories' (p. xvi) and eventually, because the theories were empirically successful, in forcing

the adoption of new physical concepts. This would require, for example, printing Planck's 1900 paper, explaining how the method of combinatorial analysis led him to use discrete energy steps before he accepted physical quantization, rather than the retrospective account he published many years later.

The third philosophical problem is 'the evaluation of scientific theories'. Here the editors uncritically accept Popper's falsifiability criterion and his doctrine that scientists judge a theory by the success of its predictions. They seem oblivious not only to the extensive historical research on the reception of their five theories, which is quite relevant to the claim that scientists actually follow Popper's doctrine, but also to the current debate among their philosophical colleagues about the validity of the 'predictiveness thesis'. That thesis asserts that successful prediction of a previously unknown fact ('novel prediction') counts more, *ceteris paribus*, than the deduction of a known fact. That is not what happened in the case of general relativity; physicists gave as much weight to the deduction of the well-known advance of the perihelion of Mercury as to the previously unobserved bending of light by the Sun (see Einstein's own statement, p. 330). Although, as Eddington pointed out, the confirmation of the light-bending prediction 'has turned public attention towards the relativity theory' (p. 331), where is the evidence that it played a more important role in the evaluation of the theory by physicists?

A collection of writings on physical theories, chosen to illustrate or undermine a variety of philosophical claims about how science works, could be quite valuable for courses in the history as well as the philosophy of science. Such a book should probably have fewer original sources, more examples than descriptions of scientists theorizing, a philosophical introduction better coordinated with the readings, and notes on technical details (explaining, for instance, what is going on in that diagram of the 'Threefold motion of the Earth' on p. 65). *The Tests of Time*, although it does not fully achieve its announced goal, is at least a good starting point for future efforts.

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Hans Niels Jahnke (ed.), **A History of Analysis.** History of Mathematics, 24. Providence, RI: American Mathematical Society and London Mathematical Society, 2003. Pp. xi + 422. ISBN 0-8218-2623-9. $89.00 (hardback).
doi:10.1017/S0007087406247897

The word 'analysis', sorely overused in mathematics, refers here to a major branch often known as 'mathematical analysis'. It is concerned with the principles of the differential and integral calculus, and properties of mathematical functions (such as continuity) and of infinite series (such as convergence), the whole glued together by a theory of limits. This is the formulation made chiefly by A. L. Cauchy from the 1820s and enriched afterwards by many others, especially Karl Weierstrass; among the later elaborations, the set theory of Georg Cantor stands out.

Prior to Cauchy, the calculus, functions and series had all been studied, though without such a close alliance forged between them. Indeed, this book begins with a survey of aspects of ancient Greek mathematics that can be read in terms of analysis. Thereafter a dozen articles pick up the tale with some of the pre-calculus techniques of the early seventeenth century, pass on to the full calculus as invented independently by Isaac Newton and G. W. Leibniz in mid-century, and move steadily through the eighteenth century to Cauchy, Weierstrass and Cantor. Various later or allied theories are also handled: the calculus of variations, complex-variable analysis, measure theory and functional analysis (but very little on mathematical logic). Most of the account is concerned with the pure sides of analysis, but three articles consider applications or applicability, in some aspects of differential equations, mechanics and mathematical physics.

However, silence is unaccountably cast over the Middle Ages and the Renaissance, when Arab and then European scholars created some mathematics which, as with the Greeks (who on occasion were indeed the inspiration), can be interpreted in terms of mathematical analysis. Astronomy and mechanics, sometimes with trigonometry, provide the most important contexts.

Apart from this gaffe, the book gives a good impression. The authors are all established scholars on their respective topics, and their articles are graced by substantial bibliographies of primary and secondary literature. Uniform systems of citation and of organization into sections and subsections have been imposed, and the indexes of names and subjects are good – valuable features of an anthology. It resembles the type 'The Bloggs Companion to … ' popular these days, where the work and current understanding of some subject, or figure of the past, is appraised in detail in a volume put out by the Bloggs Publishing Company.

Such books often contain a general bibliography of the subject matter, but none is to be found here. One may have been intended, since a few bibliographies include 'Grattan-Guinness 1980' without further specification. This object is my edited collection *From the Calculus to Set Theory, 1630–1910: An Introductory History* (Princeton, 1980/2000). The two books complement each other nicely, for, as its subtitle indicates, mine is especially intended for beginners in this history, who can now pass on to the more substantial treatment given in the new volume.

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Marco Beretta, Paolo Galluzzi and Carlo Triarco (eds.), **Musa Musaei: Studies on Scientific Instruments and Collections in Honour of Mara Miniati**. Biblioteca di Nuncius Studi e Testi, XLIX. Firenze: Leo S. Olschki, 2003. Pp. viii + 486. ISBN 88-222-5238-1. €49.00 (paperback).
doi:10.1017/S0007087406257893

The Museum of Science in Florence has established itself as a model for scientific instrument studies and exhibitions. It is one of those rare institutions that attract both scholars and the general public. This is largely due to the efforts of Paolo Galluzzi, the director of the Istituto e Museo di Storia della Scienza, and Mara Miniati, the recently retired vice-director. As head curator of the museum and instrument collection from 1979, Miniati set the standard for what was then a new profession. She and the museum team created a welcoming environment for scholars, oversaw the renovation and creation of more exhibit space, published several fine catalogues, built a pioneering multimedia website, accommodated increasing numbers of visitors, undertook conservation projects and supported other museums throughout Europe. During this period, Miniati was on the editorial board of the institute's journal, *Annali* (which became *Nuncius*), and did her own research on science in Italy. A bibliography of Miniati's writings appears in the present book, a collection of papers dedicated to her and featuring the work of twenty-seven historians and museum colleagues. Writing in English, French and Italian, they cover a variety of topics: museum practice and management; specific collections and instruments; institutional histories; scientists and their use of instruments; instrument-makers; philosophical questions about instruments; and issues of practice in the history of science.

A number of articles deal with traditional topics and familiar early instruments, yet still demonstrate the never-ending wealth of new material generated from instrument collections. David King looks at a rather mysterious astrolabe from around 1300 (now housed at Oxford) to show the power of one artefact to elicit basic questions, revealing how little we know about craft centres, practice and transmission. Carlo Triarco examines the authenticity of the Florence museum's prized possessions, the Galileo telescopes, in a study that takes the reader to the heart

of the museum's identity. Thomas Settle takes us on a tour of the churches in Florence that carry large gnomons made by Danti. Willem Hackmann closely examines the eighteenth-century electrical instruments of John Wesley and John Read to solve questions about the earliest use of electrical machines in medicine. Filippo Camerota (Miniati's successor) describes fifteenth-century surveying and topographic instruments that were connected to the court of Cosimo I. Gerard Turner examines two Italian astrolabes, drawing lessons about production in particular Italian workshops, the commercial market for precision instruments, and astronomical practice in Renaissance Italy. Findings like this stem from examining hundreds of artefacts over the years, many of them at Florence. He fittingly concludes, 'the more closely one looks at instruments, the more questions arise' (p. 62).

Other contributions engage broader themes. Jim Bennett takes us into two rooms of the Palazzo Vecchio (the first home of the Medici collection) to unravel the origins of the earliest museums. Anthony Turner describes the English maker John Dee and the complex relations in the sixteenth-century English court that, as he shows, furnish instructive comparisons with the Medici courts studied by Miniati. Paolo Brenni looks at the interactions between technology and science in the history of Volta hydrogen lighters, a fascinating yet forgotten piece of technology from the early 1800s. Giulio Barsanti addresses the limits of observation by looking at the practice and microscopes of the Enlightenment natural historian Lazzaro Spallanzani.

The success of museums of scientific instruments in Florence, Oxford and elsewhere in merging scholarship with public history raises questions in its own right. What should other museums do to attract a general audience? How might they draw more historians to their abundantly rich yet often sadly underused storerooms? Two papers touch on challenges at larger national museums for the history of science. Dominique Ferriot and Amparo Sebastián describe changes at the Conservatoire des arts et métiers in Paris (CNAM) and the Museo Nacional de Ciencia y Technologia in Madrid. The authors lay out their vision for the future, including plans for acquisitions, renovation of exhibit space, meeting storage challenges and increasing access for researchers. Robert Anderson, former director of the British Museum, contributes an article that puts these debates about museum reform into a refreshing historical context. He unearthed data collected by British authorities related to exhibitions and museums in Victorian England. We find in these fun facts (for instance, how many pickles the public consumed at the 1851 exhibition) that some of our current problems and solutions are not new at all. Related to this kind of historical introspection, the provenance of specific collections can be instructive as well. Marco Beretta describes the odyssey of Lavoisier's instruments and how their miraculous survival (now housed at the CNAM) exposes changing attitudes towards French patrimony and the value of material culture to historians of science.

In addition to the topics mentioned above, there are pieces on natural history, scientific illustration in the Enlightenment, philosophical questions about Galileo and the telescope, Roman technology and Italian geology. In some cases we see how a focus on instruments, even without reference to a specific collection or artefact, enriches the standard history. Peter de Clercq writes about the material culture of the Royal Society, describing instruments displayed at their soirées in the nineteenth century. Giorgio Strano brings long-lost instruments of Ptolemy back to life with data and textual evidence. William Shea writes about instruments and experiment in the seventeenth-century work of Blaise Pascal. Such examples, as with other contributions to *Musa Musaei*, reveal the diversity of approaches available for studying and presenting the history of instruments. Above all, the volume nicely reflects how important the museum at Florence has been, and will no doubt continue to be, as a space that stimulates original research and innovative museum practice.

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HESTER HIGTON, with contributions from SILKE ACKERMANN, RICHARD DUNN, KIYOSHI TAKADA and ANTHONY TURNER, **Sundials at Greenwich: A Catalogue of the Sundials, Horary Quadrants and Nocturnals in the National Maritime Museum, Greenwich**. Oxford and New York: Oxford University Press and National Maritime Museum, 2002. Pp. x + 463. ISBN 0-19-850877-8. £99.50 (hardback).
doi:10.1017/S000708740626789X

For all that the twentieth century saw increasing scholarly interest in the history of scientific instruments, a number of historians of science remained largely indifferent to this rich seam of evidence. A possible reason was the state of some collection catalogues, which had too often been put together, as John Heilbron once observed, 'unsystematically, as guides to temporary exhibits, accounts of notable items, or incomplete handlists' (in the edited collection *Making Instruments Count* (Aldershot, 1993), p. 3). No such complaint can be lodged against the catalogue under review.

It begins with an Introduction and four essays looking at aspects of instruments for telling the time. The Introduction summarizes the history of sundials before going on to describe the origins and scope of the sundial collection at the National Maritime Museum. The four essays provide various contexts for sundials: geographical context in Kiyoshi Takada's discussion of sundials of the Far East, technical context in Anthony Turner's description of the changing relationship between the sundial and the clock, the context of printed books on sundials outlined by Hester Higton, and the artistic context of the decorative arts explained by Richard Dunn. A further contextual chapter, on Islamic dials and quadrants, written by Silke Ackermann, precedes the section of the catalogue devoted to these instruments. These essays do not try to give the reader a comprehensive picture of the whole history of sundials – such a task would require another book just as large as this one – but instead serve as snapshots of the ways that scholars study sundials, sketching out frameworks within which to place the instruments in the catalogue that follows.

The catalogue itself includes all of the National Maritime Museum's instruments for telling the time by the sun, moon or stars, except astrolabes. In its organization the catalogue closely mirrors the museum's collections, so, for instance, the horary quadrants are in a section of their own since they are in a different part of the collection. In addition, the Islamic and Far Eastern dials are discussed in separate sections, since they do not fit so easily into the classification Higton uses for the European instruments. These objects – the majority of the collection – are organized according to the way that the dial works, with those that measure the sun's height above the horizon separated from those that measure its direction. The entries themselves are meticulously done, with almost a page devoted to each of 413 instruments. A typical entry identifies the instrument's type, origin and date, provenance, dimensions, materials, markings and signature. Full details of all the scales marked on the object are given. A 'features of interest' section deals with, for instance, decorative details, other similar instruments, uses, users or development. At the end are suggestions for further reading.

The amount of information packed into these pages makes this catalogue an essential resource for anyone studying the instruments in the National Maritime Museum's collections, as well as a valuable reference work for anyone studying similar objects in other collections. Indeed, thanks to the large number of photographs and colour plates, it is an interesting book just to look through, whether dreaming of one day having a collection this rich and varied, or browsing to find instruments with particular technical or decorative features.

It is not surprising to learn that a catalogue of this calibre took seven years to prepare. It was worth the time, for Higton and her co-authors have produced a work that will facilitate and encourage further interest in and study of the sundials, horary quadrants and nocturnals in the

National Maritime Museum's collections. While no assemblage of photographs and descriptions can substitute for first-hand examination of real instruments, this catalogue comes close.

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CAROLINE BICKS, **Midwiving Subjects in Shakespeare's England**. Women and Gender in the Early Modern World. Aldershot: Ashgate, 2003. Pp. xii + 212. ISBN 0-7546-0938-3. £40.00 (hardback).

doi:10.1017/S0007087406277896

Caroline Bicks's study of representations of birth in the early modern period is written from a predominantly literary-critical perspective. It is, therefore, more concerned with the social dimensions of popular beliefs about the various duties and powers of midwives and other birth attendants than it is with the history of midwifery per se. Whilst making accurate and analytical use of recent historical work on the work of midwives and the position of women – research by David Cressy, David Harley and Hilary Marland has been especially influential – Bicks draws substantially on literary sources to make her case that birth attendants participated 'not only in the cultural codes of *re*production, but in the act of cultural production itself' (p. 9, emphasis in original). Her central contention is that because of the midwife's role in establishing paternity, in naming a child and, even, in cases of doubt, in determining whether the baby was female or male, the early modern midwife can best be understood 'as a historian in her own right, who at times posed challenges to certain versions of personal histories, but who also produced origins that men and women often accepted as authentic. Whether or not midwives knew more, they could witness, conceal, touch and testify to things to which few men or women had authorized access' (p. 17).

As the title of her book suggests, a major source for her argument is plays by Shakespeare and some of his contemporaries. Substantial discussion is dedicated to *A Midsummer Night's Dream*, *The Winter's Tale*, *Othello*, *Macbeth* and *Pericles*; various other plays appear more briefly. Her title does her a disservice, however, in concealing the presence of her illuminating analyses of midwifery manuals, pamphlet literature, sermons and a range of other less familiar literary material. Quite a lot of these non-Shakespearean discussions in *Midwiving Subjects* also expand its chronological and geographical frame. For instance, she considers not only stories that circulated towards the end of Elizabeth I's reign about midwives supposedly being enlisted to destroy the queen's bastard children, but also the figure of the murderous Catholic midwife that emerged during the 1680s and the part played by midwifery metaphors in debates over the legitimacy of Cromwell's period of power. Bicks's use of midwifery manuals similarly extends beyond the long-popular *Birth of Mankind* (1540–1654) to include mid- and late seventeenth-century writings by Nicholas Culpeper, Elizabeth Cellier and William Sermon, as well as the earlier *Observations diverses* of the French author Louise Bourgeois.

Despite the book's title, too, *Midwiving Subjects* is not concerned solely with the figure of the midwife and her possible powers. There are also discussions of the role of other birth attendants, especially gossips, and much of Bicks's analysis is devoted to situating ideas about midwives, gossips and the mothers they aided in wider social frameworks. As a result, matters such as male sexual impotence, women's chastity, illegitimacy, the origins of birth anomalies and the disruptive threat of female gossip are all integral parts of the cultural picture that emerges through her discussions.

The main strengths of this book are those that characterize good work in Bicks's home discipline; the account is highly readable and carefully nuanced, drawing on a wide range of textual research, and making use of close linguistic analysis. Although it does not add to current

research on the professional practice or status of midwives, it does make excellent use of such research, and the evidence it amasses for the troubling and troubled status of midwives and gossips in early modern England should be welcomed by those working on the history of birth and reproduction.

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ROBERT D. HUERTA, **Giants of Delft. Johannes Vermeer and the Natural Philosophers: The Parallel Search for Knowledge during the Age of Discovery**. Lewisburg: Bucknell University Press and London: Associated University Presses, 2003. Pp. 156. ISBN 0-8387-5538-0. £39.50 (hardback).
doi:10.1017/S0007087406287892

This book opens uncharacteristically with a documented historical fact: Johannes Vermeer and Antoni van Leeuwenhoek were baptized just four days apart in October 1632 and they appear on the same page of the records of the New Church in Delft. Baptismal proximity may not seem a strong biographical basis for an account of sustained intellectual connection but it is more than is cited for the other relationships asserted in the book, whose author presents us with a web of connections he sees between a small group of scattered historical celebrities. The connections can be imaginative, even startling: 'I propose that van Eyck used oil technique itself as a kind of meta-instrument in much the same manner that Galileo used logico-rational calculations and the telescope to help him explicate earthly mechanics and heavenly arrangements' (p. 41).

The connectedness of the characters is based on their use of optical techniques of different sorts (mostly instrumentation), on their reliance on sustained and repeated observation and on their recognition that the mind is integral to the visual process – what the author calls 'mental lensing'. Other themes are the relationships between text and image, and the problem of how to represent the unfamiliar. The author has read a great many secondary sources and quotes from them frequently. If the cast of characters is small, the period they cover is worryingly long; the chapter titled 'Leeuwenhoek, Galileo, van Eyck and Vermeer' might extend from the late fourteenth to the early eighteenth centuries.

Suggested links become assumptions on which to build further connections. One outcome of this process is the reinterpretation of Vermeer's *The Art of Painting* as a homage to Christiaan Huygens; the personification of Clio is also Urania, her crown of laurel with its leaves at different angles to the viewer represents Huygens's solution to the changing telescopic appearance of Saturn, where the ring presents different views depending on the mutual orientation of the Earth and Saturn.

There has been much debate recently on the use of optical instruments in painting, and the importance of historians being detailed, precise, practical and realistic is now well recognized. Very general and speculative accounts are not likely to contribute to the debate at present. It may be that this book has a role in other disciplines but I cannot recommend it to historians of science.

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NICHOLAS HAMMOND (ed.), **The Cambridge Companion to Pascal**. Cambridge: Cambridge University Press, 2003. Pp. xvi + 287. ISBN 0-521-00611-2. £15.95, $23.00 (paperback).
doi:10.1017/S0007087406297899

There can be no doubt that the Cambridge Companions series serves a very useful purpose, both for students and for scholars who welcome a quick *entrée* into a topic with which they are not closely familiar. In the present case, however, the choice of topics for the various chapters seems to conform as much to the strengths and interests of the contributing Pascal scholars as it does to

a predetermined analytical scheme of the aspects of Pascal in need of discussion; overlaps are quite noticeable, and sometimes result in inconsistent treatments of similar issues.

Before addressing these points, however, the particular interest of the collection for readers of this journal should be remarked. At least four of the chapters are of direct concern to the historian of science: A. W. F. Edwards's 'Pascal's work on probability', Jon Elster's 'Pascal and decision theory', Daniel C. Fouke's 'Pascal's physics' (the longest piece in the book – the chapters average around twenty pages), and Desmond M. Clarke's 'Pascal's philosophy of science'. The first two are less impressive than the second two. Edwards's chapter concentrates on aspects of Pascal's mathematical work in a way that is not likely to be very illuminating to anyone who does not already know something of these matters (especially relating to Pascal's arithmetical triangle) or who is not familiar with modern mathematical notation in probability theory. Elster's chapter similarly provides a rather decontextualized exposition of Pascal's work, this time focusing explicitly on a subject matter that did not even exist in Pascal's time, namely decision theory, and attempting to assess the validity of Pascal's arguments.

By contrast, Fouke's and Clarke's essays do the work that a historian might expect. Fouke describes and explains Pascal's work in hydrostatics and pneumatics, laying out the issues, arguments and experiments that Pascal provided in his writings on those topics. Fouke relates Pascal's work appropriately to the views of his contemporaries and the controversies over the vacuum that gave Pascal's claims such contemporary significance. Clarke's chapter mostly discusses Pascal's methodological prescriptions, especially from *De l'Esprit géometrique* and the correspondence with Father Noël concerning the vacuum. In the present context, this division of labour has the rather odd consequence of implying (unintentionally) that Fouke's chapter on Pascal's physics had been concerned with a quite independent set of issues – this despite the fact that Clarke also briefly considers the Puy-de-Dôme experiment and related aspects of Pascal's work as bearing on the relationship between demonstrative certainty and experimental claims. Presumably the editorial intention is that Clarke's chapter be seen as building on Fouke's, but the effect is to encourage retrospective questions about the adequacy of the discussion in the previous chapter.

The effect is reinforced by the chapter that then follows Clarke's, Jean Khalfa's excellent essay on 'Pascal's theory of knowledge'. Khalfa investigates with enormous clarity and persuasiveness Pascal's ideas on knowledge in relation both to natural philosophy and especially to religious faith. Khalfa draws in particular on *De l'Esprit géometrique* and the *Pensées* to reveal the consistency and confluence between these two principal streams in Pascal's philosophy, showing how Pascal analyses formal demonstration (for which mathematics provided the model) in such a way as to argue that the fundamental premisses or principles on which deductive arguments are built must be known as true on the basis of something other than deductive reason. So far, so Aristotelian, but Pascal identifies in a positive way the faculty, or source, that serves to create one's sense of certainty regarding such principles: it is a form of intuitive knowledge associated with what Pascal calls the 'heart'. Thus the heart plays a role in mathematical proofs just as it does in matters of religious faith, and in that sense there is nothing in mathematics capable of creating greater certainty than in (heart-residing) religious faith. These matters of course also introduce issues of grace, discussed at length in other chapters of the present book, but Khalfa's essay serves to show the artificiality of attempting to partition a philosopher's work into discrete and independent units.

The collection concludes with a good bibliography, although the tendency in many of the essays (not all) to avoid discussion of the secondary literature compromises its practical value; for a beginner on Pascal, there may be a bemusing sense of having entered a conversation that has already been going on for some time. There is also a degree of inconsistency in the book's conventions, as to whether, for instance, quotes in French should be given with or without English

translations, whether titles should be cited in French or English, and whether there should be few footnotes or many. Nonetheless, there is certainly enough of interest in this book to make it worth the attention of the historian of science.

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OLIVER HOCHADEL, **Öffentliche Wissenschaft. Elektrizität in der deutschen Aufklärung**. Göttingen: Wallstein Verlag, 2003. Pp. 364. ISBN 3-89244-629-6. € 35.00 (paperback).
doi:10.1017/S0007087406307893

Groups and practices once considered to be marginal or even detrimental to the progress of science have been receiving increasing attention from historians for some time now. Research on the contributions of dilettanti, amateurs, scientific showmen and others has revealed much about the development and consolidation of scientific disciplines and practices. At the same time the public sphere has been identified as a space for negotiating both what is 'scientific' and what is 'knowledge'. A number of studies, notably those of Jan Golinski, Larry Stewart and Iwan Morus, have mapped the intense interactions between science, performance and the public, as well as between scientific practitioners with different claims to credibility. These studies have thrown new light on the role of presentation modes and public affirmation in the production of natural knowledge.

Oliver Hochadel's book on electricity in the German Enlightenment owes much to these precedents. Hochadel's is one of the first major studies on these 'margins of science' in Germany, where research has only recently expanded beyond academic science to consider non-academic actors, science popularization and the public. As such, the temptation to cover all questions already systematically developed in the British context is great. By concentrating on the provincial city of Augsburg, however, Hochadel is able to give depth as well as breadth to his analysis. Making judicious use of many previously unknown sources, he paints a vibrant and often amusing picture of science in the provinces. As a *Reichsstadt*, Enlightenment Augsburg was neither particularly politically suspicious nor in any other way especially remarkable. Boasting no university, academy or other typical Enlightenment institution, it was considered to be rather backward. Hochadel turns this deficit to his advantage, showing that the absence of academic and scientific institutions by no means diminished the variety of practitioners and intellectuals with a keen interest in natural research and in the blessings science could bestow on humanity.

David Bloor's symmetry principle provides Hochadel with a loose framework for a study that, as he makes clear from the outset, does not assume a hierarchy of legitimacy between scientist and amateur. Hochadel thus speaks broadly of 'scientific', rather than merely of 'research', practices. Indeed, in the early years of electrical science such differentiations had little meaning. The research object 'electricity' constituted itself gradually over a period of decades through the diverse practices of actors armed with very different forms of credibility. *Öffentliche Wissenschaft* traces the path from electricity as a phenomenon equally open to exploration and exploitation by anyone capable of manipulating it technically to electricity as an object legitimately investigated only by a scientific elite.

Hochadel concentrates on the producers of electrical knowledge and the different spaces and ways in which it was presented and performed, ranging from polite society to popular fairgrounds, from debates carried out in the local press and pamphlet wars to the instrument-maker's workshop. The heterogeneous practitioners, publics and spaces of performance are connected by the central themes of competition, competing interests and the establishment of credibility and authority in the interpretation of nature.

For practitioners, electrical expertise was both a commodity and a form of capital, a source of income and a means to increase social prestige. As Hochadel shows, competition for audiences for electrical 'amusements' and customers for electrical apparatus and cures motivated constant innovation in the study and demonstration of electrical phenomena. Audiences were actively integrated into this process of accumulating electrical knowledge; members of the public suggested new experiments, conducted their own with tabletop electrical machines and contributed to establishing or dismantling the credibility of electrical practitioners. While the logic of commodification stimulated variations in experiments and apparatus, the value of novelty in itself became a central battleground in the establishment of credibility.

Hochadel traces his double motif of competition and credibility, prestige and performance through micro-studies of the introduction of lightning rods in Augsburg, of debates on the conduct of experimental philosophy at local schools, of rivalries between indigenous and itinerant experimenters and of conflicts between instrument-makers and the natural philosophers who depended upon their expertise. The integration of electricity into natural philosophy hinged on the construction of a hierarchy privileging the self-proclaimed possessors of natural knowledge over those they deemed to be mere technical 'manipulators'.

Öffentliche Wissenschaft is an admirable and well-documented study of early electrical practices in Germany, and its careful and detailed micro-studies offer a rare glimpse into the heterogeneous and eclectic world of non-institutional scientific practices. One can only hope that it will soon be made available to an English-speaking audience.

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Alex Soojung-Kim Pang, **Empire and the Sun: Victorian Solar Eclipse Expeditions**. Writing Science. Stanford: Stanford University Press, 2002. Pp. xii + 196. ISBN 0-8047-3926-9. £16.95 (paperback).
doi:10.1017/S000708740631789X

In one of the most valuable contributions to the history of astronomy of the past few years, Alex Soojung-Kim Pang builds on several of his publications, including his prize-winning article 'The social event of the season: solar eclipse expeditions and Victorian culture' (*Isis* (1993) **84**, 252–77) to offer a concise yet comprehensive and insightful account of eclipse expeditions in the last four decades of the nineteenth century and of their scientific, cultural and political significance in Victorian Britain.

Instead of focusing on any single expedition, Pang sets out to characterize this particular form of scientific work by taking the reader through the major stages typically involved in such an undertaking, drawing examples from the various eclipse expeditions of this period. Thus the second chapter introduces the reader to the work and negotiations involved in planning and organizing an expedition, providing a vivid snapshot of the community and major figures of late nineteenth-century British astronomy. The third chapter, 'gently patterned' on Latourian methodology, follows the astronomers and their helpers in the field, detailing the challenges they encountered on their travels and in their attempts to work in sometimes precarious conditions. The fourth chapter examines the products of such expeditions, looking especially at the preparation by a range of actors of visual representations of the solar corona, including sketches, photographs and engravings for publication. The fifth chapter closes the volume with an analysis of the significance of eclipse expeditions for the British Empire, and conversely the expeditions' reliance on imperial infrastructures and resources.

There is no attempt here to evaluate the significance of the scientific results produced by these expeditions. Rather it is 'the emotional texture' and the experience of doing astronomical

work that Pang seeks to recover, through a careful reconstruction of the activities, both spectacular and mundane, of those involved. To this end he makes use of the copious and until now largely neglected body of documentation and artefacts left by officially sponsored expeditions, much of it held at the Royal Greenwich Observatory Archives at Cambridge University and the Royal Astronomical Society Archives. Adding further interest, he skilfully exploits his materials by the light of three major developments in contemporary historiography of science: science and technology studies, visual representation in science, and science and empire. Brief accounts of each appear in the Introduction and at several key points in the text. Discussions of, for instance, 'the amateur ideal' and the shift of values accompanying the move from sketching to photography in astronomical practice are thus expertly woven into the narrative, giving *Empire and the Sun* a high didactic value for courses introducing these historiographies. Its engaging and lively style makes it an equally attractive read as an introduction to the world of Victorian science and society. For a wide range of readers, then, the book is well positioned to stimulate interest in, and initiatives to develop, this approach to the history of astronomy.

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Ursula Klein, **Experiments, Models, Paper Tools: Cultures of Organic Chemistry in the Nineteenth Century**. Writing Science. Stanford: Stanford University Press, 2003. Pp. xi + 305. ISBN 0-8047-4359-2. £49.50 (hardback).
doi:10.1017/S0007087406327896

As Ursula Klein states in her Preface, her book is an enquiry into the various functions of sign systems such as chemical formulae and their manipulation on paper, coupled with a detailed historical analysis of chemical experiments and classificatory procedures deployed by chemists from the beginning of the nineteenth century until the early 1840s. She uses an interdisciplinary approach that is reflected in the organization of her book, but she also adopts an eclectic perspective in drawing on a variety of analytical resources, from the writings of Bachelard and Dagognet to Kuhn, Latour, Galison and Pickering. The result is an original contribution to the history of chemistry and a fascinating book.

Klein places her work in a tradition of scholarship focused on the laboratory sciences and the examination of how new experimental objects and inscriptions are formed and shaped. Her subject is the transformation of the 'pluricentred' culture of plant and animal chemistry, including physiology and the production of substances with pharmaceutical relevance, and the emergence of synthetic carbon chemistry, with special attention to the crucial role played by the chemical formulae and notation put forward by Berzelius. One of her central arguments is that chemists began applying chemical formulae not primarily to represent and illustrate preexisting knowledge but as 'paper tools' for creating order in the maze of organic chemistry. For Klein, scientists did not merely use paper and laboratory instruments in attempts to achieve preset goals; their application generated new goals, objects, inscriptions and concepts.

Following European chemists as they came, from the 1820s, to associate chemical formulae with experiment and classification, she reconstructs the process that led to the disintegration of the culture of plant and animal chemistry and the constitution of the experimental culture of carbon chemistry. Where the former dealt primarily with natural substances extracted from plant and animal tissues and the phenomena of life, the latter generated a wide range of artificial organic compounds. She compares the structural elements of both cultures to argue that the transformation of organic chemistry which took place from the late 1820s to the 1840s extended to the type of experiment done, the representational tools, the style of argumentation and

justification and the classification of organic compounds. She argues convincingly that this transformation changed the notion of organic matter. The meanings of 'organic' and the classification of organic substances before and after were, in her view, incommensurable.

In the course of a semiotic analysis of Berzelian formulae and a historical overview of their application, she compares them with the available alternatives at the time – ordinary language and Daltonian diagrams – and concludes that their 'graphic suggestiveness' and 'manoeuvrability' were preconditions for their use as paper tools from around the late 1820s. She turns next to an analysis of common structural elements in the cultures of plant and animal chemistry and of synthetic carbon chemistry, looking at the range of scientific objects, the reference and meaning of 'organic' matter or substance, the classification of organic substances and the kinds of experiment. In Klein's view, where the former assimilated these elements to natural history, pharmacy and the chemical arts, the latter was experimental.

Next she analyses the history of experiments carried out by European chemists, especially French and German, with alcohol and the so-called ethers between 1794 and 1820 – that is, before the application of chemical formulae. Around 1820, Klein shows, alcohols became central to research, with a dual function as model objects and paradigmatic achievements in the transformation of organic chemistry. Subsequently, she considers how the reactions of alcohols and derivatives were depicted, and in particular how Dumas and Boullay used Berzelian formulae in 1827 to build up a model of the chemical reactions underlying the preparation of ordinary ether. She then shows how Berzelian formulae were used in the construction of schemata of balancing the masses of reagents and products, and how these schemata enabled chemists to distinguish between independent, parallel and successive reactions originating from the initial reagents. According to Klein, the increasing use of Berzelian formulae, especially in the mathematical form of chemical equations, changed the style of chemical reasoning. In particular, the use of the formulae rendered the concept of affinity dispensable from the late 1820s until the 1850s, when it was revived with the introduction of the concept of valence.

Klein next addresses Dumas and Boullay's new mode of classifying organic substances, which assimilated the classification of organic substances to inorganic ones, before proceeding to exemplify the dialectics of paper and experimental tools and goals by showing how they led, around 1834, to an unintended scientific object – 'substitution'. She examines the formation of 'substitution' in the context of experimentation and modelling, showing how it originated from Berzelian formulae. After discussing the historical transformation process and recapitulating the applications of the formulae, she ends her book with an analysis of the limitations of the Latourian concept of 'chains of inscriptions', comparing paper tools with laboratory tools and instruments.

For all its inclusiveness, *Experiments, Models, Paper Tools* keeps inside the cognitive dimension of chemistry, seemingly for no dogmatic reason or matter of principle. Simply by the nature of her own object of enquiry and her methodological options, which combine historical, philosophical and semiotic analytical tools, Klein arrives at the conclusion that there was no research programme that could have purposely brought about the structural changes occurring in chemistry that she set out to explore, 'nor any account in terms of pre-existing intentions or interests, individual or social, [to] explain these transformations' (p. 226). Between the intrinsic interest of the topic and her approach, Klein's book is remarkable. Hers is a fine-grained reconstruction, which results in a fresh and innovative mode of analysing the internal dynamics of science and its shared cultures – an aspect which not long ago had become marginal to mainstream historiography of science. While not a book accessible to a popular readership, it is clearly presented, intellectually stimulating and a pleasure to read.

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THOMAS DIXON, **From Passions to Emotions: The Creation of a Secular Psychological Category**. Cambridge: Cambridge University Press, 2003. Pp. x + 287. ISBN 0-521-82729-9. £47.50, $60.00 (hardback).
doi:10.1017/S0007087406337892

This book is a most significant and most interesting contribution both to the history of psychology and to the study of relations between the modern scientific world view and religion. It is very clearly written, and non-specialists as well as specialists – scientists, philosophers and theologians, as well as historians – will find much to digest. If its main theme is taken to heart, it will substantially alter how writers refer to the history of what we loosely call the 'feelings'.

Thomas Dixon's very persuasive thesis is that the category of the 'emotions', as used in scientific psychology and everyday discourse, is modern and not equivalent to the ancient and Christian category of the 'passions'. Specifically, he argues, with precise textual detail, that common reference to the emotions in the modern sense came with the work of the Scottish philosopher Thomas Brown (whose lectures were published in 1820) and the spread, especially in the writings of Alexander Bain, Herbert Spencer and Charles Darwin, of a secular analysis of the feelings and even antagonism to religiously coloured concepts. Adding much to the plausibility of this claim, Dixon sets this period of change against the history of Christian description and judgement about the passions in Augustine and Aquinas and the multitude of crosscutting views about the passions, affections, feelings and sentiments in the eighteenth century. This leads into an account of 'the Scottish creation of "the emotions"' (p. 98) in Hume, Brown and Thomas Chalmers, whose work contrasted with a continuing discourse about the passions, or at least criticism of new approaches to the emotions, in a number of now little-known Christian or idealist writers in Britain and North America. The book then takes up William James's notorious 1884 theory of the emotions, which depicted them as epiphenomenal changes of consciousness following visceral events, to mark the high tide of separation of the emotions from the ancient passions.

This stark description does little justice to the range of historiographical issues at stake and the implications for the theory of the emotions. There has been little systematic history of the 'emotions' (which many authors equate with the 'passions') before this book, and this book provides a new and firm reference point. Modern studies have found it impossible to define 'emotion'; this book takes an alternative tack and supplies a lucid guide to the historically changing pattern of descriptions. At the heart of this historical description, and of the review of historiography, is a much-needed seriousness about the centrality, complexity and subtlety of interrelations between religion and psychology. There is no doubt that ignorance, indifference or antagonism to religion has marked the history of this field (though, if the author had taken a wider view of what the history of psychology is, he might not have felt the need to be so severe). Here we now have a model study that shows what is involved in overcoming this limitation. It also suggests concrete reversals of accepted views. Notably, Dixon argues that the modern, much-criticized view of the emotions being in conflict with reason is a view spread by secular, or at least non-Christian, authors and cannot be laid at the door of Christian writers who, early and late, envisaged the passions as events in the soul, in significant part involving the intellect.

The book succeeds in making its arguments so well by focusing down, often meticulously, on what a particular primary or secondary literature is saying and implying about the affective powers in soul and body. It therefore seems to me important to understand what structural decisions have been taken to achieve this focus and how this book relates to a wider literature on the history of psychology. Three dimensions immediately come to mind, which the book excludes but which, were they to be considered, would, it is at least arguable, affect the substance of the account. First, there is the question of the creation of 'psychology' itself as a category (the book

deliberately sidelines this and treats 'psychology' ahistorically). It is possible that this account of the origins of the 'emotions' as a category in fact proves a brilliant and central example of how 'psychology' itself became embedded in modern consciousness. Second, the book absolutely excludes any reference to the emotions as states of life in the modern world; thus the whole historiography that has tried to approach 'psychology', and states like 'emotion' too, as something formed in the living management of the modern world is put to one side. The question of the fictional representation of emotion as a source of 'emotion' is not raised. Third, though of course the author is well aware of the question, the account is about English-language usage and Anglo-American literature. But if the theme is the formation of a category, with putative status as the description of something 'natural', then, in the final analysis, lines must be opened to the difficult topic of the comparability and translatability of categories in other cultures. I rather think these three points open more than one can of worms; perhaps they have rightly been left alone in order to achieve the very valuable scholarship and persuasive clarity of this book. This is for debate.

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Paul White, **Thomas Huxley: Making the 'Man of Science'**. Cambridge Science Biographies. Cambridge: Cambridge University Press, 2003. Pp. xiv + 205. ISBN 0-521-64967-6. £16.99, $22.00 (paperback).
doi:10.1017/S0007087406347899

Although this study is part of the Cambridge Science Biographies series, it is much more than a biography of Thomas Huxley. It is a finely crafted and cogently argued account of the way that a particular cultural identity – the Victorian 'man of science' – was constructed through processes of negotiation and collaboration between naturalists such as Huxley and their families, colleagues, friends and adversaries. Through close readings of private correspondence, juxtaposed with carefully revisionist analyses of public pronouncements, Paul White has created a sensitive and multifaceted portrait of Huxley as, variously, aspiring professional, moralizing educationalist, high-culture demagogue, religious reformer and, finally, out-of-touch reactionary.

White's book opens and closes with reflections on how the identity of the 'man of science' differed both from the 'natural philosopher' of the eighteenth and early nineteenth centuries and from the 'scientist' of the twentieth century. The intervening chapters show how Huxley was involved in the production, from the 1840s to the 1890s, of this intermediate identity. The man of science, compared to the natural philosopher, was more concerned to establish specialist authority in a particular domain of natural knowledge, and to do so in a way that was dependent on neither wealth nor patronage. At the other end of the period, Huxley's rejection of the label 'scientist' is particularly informative for those of us who thought that the term was introduced by William Whewell in the 1830s. Whewell did indeed coin the term then, but it had not been widely adopted in Britain even by the 1890s. When asked by a journalist in 1894 whether he approved of the term 'scientist', Huxley dismissed it as a vulgar and unwelcome Americanism. The scientist derived his authority from a narrow technical specialism and mere utility, unlike the man of science who spoke from a much broader moral and cultural platform.

White builds up his portrait of Huxley the man of science in layers, through an examination of his major relationships – with his wife, his fellow men of science, educational reformers, clergymen and, finally, socialists and Salvation Army enthusiasts. The relationship between Huxley and his fiancée Henrietta Heathorn was a key factor in the shaping of his early career. In some ways they conformed to Victorian stereotypes, with Henrietta developing domestic, artistic and religious skills and sensibilities while Thomas struggled to establish himself as a public man of

action and ideas. In other ways, however, they went beyond these stereotypes. Henrietta emerges from this account as the more worldly and practical of the pair, especially during their extended engagement. Managing her sister's household in Australia, she wrote to the idealistic and romantic young Thomas in London, urging upon him the need to find remunerative employment.

Huxley's famous controversies with Richard Owen and Samuel Wilberforce in the 1850s and 1860s have sometimes been interpreted as evidence of a conflict between science and religion, or between professionalizing 'young Turks' and a resistant Anglican establishment. White views them, instead, as debates about gentlemanly conduct and integrity on the one hand, and about whether the museum or the laboratory was to be at the centre of biological knowledge on the other. A particular strength here is the treatment of Huxley's relationships with Owen and Charles Darwin. Although Huxley's meritocratic ideal of the man of science was exemplified much more clearly in the life and career of Owen than in that of the wealthy gentleman-naturalist Darwin, it was the latter whom Huxley championed in scientific matters, emphasizing his superior character and manners.

Huxley's friendship and intimate correspondence with the Anglican clergyman Charles Kingsley is also put to revisionist use, undermining any idea that Huxley was unremittingly hostile to religion. White is right that the 'new reformation' that Huxley envisaged, and his frequent use of religious language, should be taken largely at face value rather than treated as satirical. Huxley genuinely saw himself as a reformer rather than a destroyer of religion. White also reminds us that Huxley was an earnest and knowledgeable student of biblical languages, texts and criticism (as is evident in many of his essays as well as his extensive unpublished writings on the Hebrew scriptures); he even advocated the continued use of the Bible in schools as a vehicle for moral instruction. This revisionism can, perhaps, go too far, however. For all his earnest agnostic moralizing and his defence of the Bible as an elevating collection of historic documents, Huxley completely rejected the authority of the churches and of their traditions and doctrines. This, together with his insistence, in correspondence with Kingsley, that whatever unknown reality lay beneath the veil of phenomena was entirely impersonal, placed him quite firmly outside even the broadest of broad churches.

One of the most consistently developed aspects of White's portrait is the depiction of Huxley as a defender of high culture, even as an elitist. One part of this picture rests on Huxley's friendship with the poet, critic and inspector of schools Matthew Arnold. Huxley and Arnold reinforced each other's status and authority during the 1860s and 1870s, White argues, even while engaging in public disagreements about the relationship between scientific and literary culture. They were ultimately united in their defence of high culture against the forces of Dissenting philistinism, and in their arguments in favour of the reform of school and university curricula to include more scientific and literary subjects. The Huxley–Arnold alliance is interpreted here as part of an attempt not primarily to popularize or democratize knowledge, but rather to have science and literature both included within a dominant elite culture.

White ends his beautifully written and persuasive account of the meaning of Huxley's career by reflecting on the attitudes of his final years. Although Huxley had gladly offered paternalistic lectures to working men, through which elite knowledge was philanthropically distributed amongst the deserving poor, he had no enthusiasm for movements in the 1880s and 1890s which had their roots among members of the working class themselves. These movements included the rapidly expanding Salvation Army, under the leadership of General Booth. Booth's organization combined rowdy and charismatic Christian worship with practical schemes including soup kitchens, sleep shelters, cooperative farms and labour colonies. Huxley complained about the moral and intellectual evils of the kind of blind religious fanaticism on which he suspected this movement was based. The trade union leader Ben Tillet, however, was one of many to come to Booth's defence. Writing to *The Times* in 1890, Tillet asked why the proposals of a practical man

like Booth needed the approval of someone like Huxley – a theorist, a word-juggler, a mere 'scientist'. Huxley's lack of success in this final controversy of his career thus also signalled, White suggests, the beginning of the end for the 'man of science'.

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DAVID KNIGHT (ed.), **The Evolution Debate 1813–1870**. London and New York: Routledge in association with the Natural History Museum, 2003. Pp. 3748. ISBN 0-415-28922-X (set of nine volumes). £895.00 (hardback).
doi:10.1017/S0007087406357895

Publishers have long been aware that there is a demand from libraries for reprinted versions of classic texts. This set of eight facsimile reprints of works associated with the Darwinian revolution is clearly aimed at that market. David Knight has chosen the volumes to be reprinted and has written an introduction to the series (in the first volume), plus short introductions to each of the individual texts. The works reprinted are: Georges Cuvier, *Essay on the Theory of the Earth*; William Buckland, *Geology and Mineralogy* (his Bridgewater treatise, in two volumes); George Gosse, *Omphalos*; Charles Darwin, *On the Origin of Species* (first edition); Richard Owen, *Palaeontology*; T. H. Huxley, *Evidence as to Man's Place in Nature*; Charles Lyell, *Geological Evidences of the Antiquity of Man*; and A. R. Wallace, *Contributions to the Theory of Natural Selection*.

Knight's introductions are useful to set the scene for readers new to the topic, but too short to add much for specialists. The selection is worthy of some comment. It is comprehensive in the sense that it includes several major pre-Darwinian texts, the *Origin of Species* itself and some works by Darwin's followers. There are obvious omissions, but in some cases these are now available elsewhere, as in the case of Robert Chambers's *Vestiges of the Natural History of Creation*. The first edition of the *Origin* is already available in a facsimile reprint from Harvard University Press but, as Knight points out, that includes a modernized index, not the original one. Darwin's *Descent of Man* might have been a useful addition to the series. Personally, I would not have included Gosse's *Omphalos*, which is at best an interesting oddity with no real impact on the debate. But the Owen, the Huxley and the Lyell volumes are important texts not often reprinted.

One interesting feature of some of these reprints is that they are facsimiles of used copies, with the annotations included. Thus the *Origin* is the geologist Leonard Horner's copy, with some of his notes at the front. This edition also includes some facsimile pages of the *Origin* manuscript. Wallace's *Contributions* is his own copy, including his manuscript list of errata. Here also there are additions: the 1858 paper on natural selection with corrections which are presumably those Wallace would have made had he seen the proof, and a printed response to a French review of the book. Some of these additions are important and may be of interest to specialists, although purists might prefer their facsimiles cleanly printed.

This leads me to some general comments about the production and marketing of the series. To be frank, the quality of the reproduction is quite poor, and shockingly bad for some of the illustrations (although the fold-out geological section for the Buckland volume is better done). As Stephen Jay Gould once complained about one of my own books, if your xerox machine produced copies this poor you would send for the repairman. This is a pretty scandalous situation given the inflated price of the series, which may even be enough to put it out of reach of some libraries. As someone with a minor interest in the antiquarian book market, I have done a few quick price checks on these texts. If you gave me the best part of a thousand pounds and let me loose on the Internet, I could buy you original first or early editions of most of these books. A first edition of the *Origin* will obviously cost you silly money, the first editions of the Cuvier and the

Wallace are also pricey (although later editions are available), and the *Omphalos* is unobtainable. But books like the Buckland, the Huxley, the Lyell and the Owen are available for a couple of hundred dollars each even for the first editions. Given the choice, I'd sooner have the originals, although I have to concede that libraries might prefer the stout bindings of these facsimiles so they can put them onto open shelves.

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DIANA WYNDHAM, **Eugenics in Australia: Striving for National Fitness**. London: Diana Wyndham and the Galton Institute, 2003. Pp. 406. ISBN 0-9504066-7-8. £5.00 (paperback).
doi:10.1017/S0007087406367891

In recent decades numerous historians have investigated the history of eugenic movements beyond Germany, America and Britain. The result has been a series of startling revelations. Nations associated with benevolent social policies were responsible for tens of thousands of compulsory sterilizations. Countries with proud scientific traditions revered scientists who were guilty of accepting grossly simplified ideas about the roles of genes in behaviour. And dozens of ardently admired statesmen, educationalists, feminists, writers and social commentators have been implicated in pro-eugenic campaigns targeted at those unable to defend themselves. Diana Wyndham's *Eugenics in Australia* is an addition to this growing literature.

Wyndham's book explores the origins of eugenic ideas in Australia, beginning with the early days of settlement and, subsequently, the profound influence of social Darwinism upon Australian political and social thinkers. *Eugenics in Australia* highlights the eugenic assumptions that contributed to repressive policies aimed at the Aboriginal population, the raft of immigration restrictions passed in order to exclude non-Europeans, various initiatives designed to encourage the peopling of the nation's vast interior as a means of repelling an expected Japanese invasion, and attempts to legislate to prevent the propagation of the 'feebleminded'. Wyndham also reveals more subtle eugenic influences upon educational policy and debates over public health, contagious disease, sex education, population decline and birth control. And she charts the mixed fortunes of the leading Australian eugenicists and their societies into the period immediately after the Second World War.

Eugenics in Australia shows that eugenics appealed to a number of significant Australian scientists, doctors, psychologists, premiers and politicians. As elsewhere, the movement in Australia attracted statesmen in search of quick-fix solutions to hitherto intractable social problems, taxpayers and their advocates seeking to reduce the financial burden of caring for the seriously ill and the recidivist, progressive thinkers committed to the rational reform of society and its institutions, over-zealous biologists hooked on simplistic hereditarian rationales, and doctors wishing to lessen the suffering of patients and their families while augmenting their own social authority. But if the constituency of eugenics was broadly similar to that in other countries, local context led to a reconfiguration of the fears expressed in the writings of Francis Galton. The perceived dangers of the tropical climate, the presence of the Aboriginal population, the proximity of Asia, immigration on a massive scale, an intensely rapid process of urbanization – all lent distinctive hues to Australia's eugenic movements.

Just as in Britain, however, explicitly eugenic legislation failed to reach the statute books and, for all the earnest propagandizing of eugenics societies, a majority of people always considered eugenics to be impractical, offensive or misguided. Wyndham does a good job of demonstrating that Australia's eugenicists, although anything but cranks, always struggled to win mass support. Yet, drawing on the public sentiments of leading statesmen, Wyndham does show that the White Australia policy, enshrined in the 1901 Immigration Act, may well have been inspired in part

by fears of miscegenation. In this sense, the impact of eugenic thinking in Australia was very profound indeed.

Eugenics in Australia is unquestionably a useful book. Other scholars have trod much of this ground before, but Wyndham has brought together an impressive amount of primary research, and its 350 pages are packed full of detail. Anyone researching eugenics in Australia will find in this book important new material. My only serious criticism is that it sometimes has a rough-and-ready feel; some chapters lack continuity and the overall direction is obscured by the sheer weight of detail. A clearer organization would have improved the whole. But, as it stands, it remains a fine introduction and an excellent resource.

JOHN C. WALLER
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DEBORAH FITZGERALD, **Every Farm a Factory: The Industrial Ideal in American Agriculture**. Yale Agrarian Studies. New Haven and London: Yale University Press, 2003. Pp. xi+241. ISBN 0-300-08813-2. £35.00 (hardback).
doi:10.1017/S0007087406377898

Industrialized agriculture is very much on the political agenda. Whether it is food safety, environmental contamination from agrochemicals, or the Common Agricultural Policy, there is widespread public concern. How this form of agriculture emerged and why we have come to rely upon it is thus a major historical question and one central to this interesting and important new book.

Given the enormity of the phenomenon, Fitzgerald has chosen to concentrate upon what she regards as the first phase of industrial agriculture in the US: the growth of mechanization between 1918 and 1930. Although large-scale mechanization using steam-powered machines was first adopted in California from the mid-nineteenth century (by bankers who had bought large tracts of land), the process only began to take off during the First World War, when a shortage of male labour, price supports and the demand for food in Europe induced farmers to buy more land along with the new petrol-driven machines required to farm it. After the war, however, as price supports ended and demand declined, massive overproduction undermined prices, and one million US farms failed, reverting to the banks on which they had become dependent.

What happened at this point is not entirely clear. Fitzgerald says that the circumstances prompted a fundamental rethink by figures inside and outside agriculture about how agriculture ought best to be organized in future. (One imagines it also created an exceptional opportunity for investors.) In any event, the 1920s saw the rapid growth of what were then being called 'industrial' or 'factory' farms. Some of these consisted of a chain of farms owned and managed by a bank or other commercial entity, which instructed the managers who operated individual farms as to exactly what to do. A case in point was the Campbell Farming Corporation, a 100,000-acre wheat farm in Montana. Financed by enormous loans from New York bankers, it was the brainchild of Tom Campbell, an engineer passionately committed to the industrial ideal. Under his management, each of the Corporation's farms had dormitories for its workers, a central dining hall and its own machine shop to maintain the dozens of tractors and harvesters.

Apart from bankers and businessmen, however, which groups were keen on industrialization? As David Danbom noted several years ago in *The Resisted Revolution* (Ames, 1979) farmers themselves were unenthusiastic. Although Fitzgerald has relatively little to say about this group, her evidence tends to confirm the view. By the 1920s it was becoming obvious to both farmers and economists that as farm size increased and the number of farms decreased, rural schools were struggling to fill classrooms and small-town shopkeepers were losing customers. Remarkably, however, the US Department of Agriculture remained keen on factory farms, adhering to an

ideology that worshipped productivity while losing sight of profit (p. 31). While it seems odd that the USDA should have taken a line so different from most of the farming community, it raises an intriguing question: whose interests were actually served by the department?

This brings us to the third group Fitzgerald sees as championing industrialization: the agricultural colleges in each state. Her evidence, however, suggests a rather more complex picture. Experts in farm management, for example, were principally concerned with farmers' well-being, and much of the discussion among them centred upon questions of profitability, in evident contrast with the USDA. Considerable numbers of agricultural engineers also seem to have been at odds with the department. Although many of them were keen on Taylorism and the benefits of huge mechanized farms, various kinds of technical improvement were perfectly consistent with the family farm (for instance electrification and small engines), and some economists argued that there was no reason why most farms had to become large except in certain commodity areas like wheat. In addition, in a fierce debate from the early 1920s over the merits of tractors, quite a few engineers favoured horses, on several grounds – not the least being the absence of comparative studies!

By the late 1920s the profitability of huge farms was still not obvious. A US Chamber of Commerce report concluded that industrial farms were no more profitable than family farms, and Campbell's farm seems to have struggled financially for several years. Although Fitzgerald's book provides a vivid and valuable account of the 'how' of agricultural industrialization, therefore, it remains unclear why industrial farming had come to prevail by 1930.

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STEVEN B. KARCH, **A History of Cocaine: The Mystery of Coca Java and the Kew Plant**. London: Royal Society of Medicine Press, 2003. Pp. xi + 224. ISBN 1-85315-547-0. £24.95, $39.95 (paperback).
doi:10.1017/S0007087406387894

'One gains the impression that coca cultivation has passed its zenith and … will decline', wrote the German science teacher Theodor Walger in 1917 at the end of his doctoral dissertation, one of several contemporary texts on coca and cocaine transcribed in this volume (p. 157). Rarely can a prediction have been more thoroughly refuted by subsequent events. The main value of this book is perhaps in demonstrating how, well into the twentieth century, coca and cocaine were viewed as part of the solution by scientific and medical practitioners. It does this notwithstanding Karch's own agenda. For Karch, a physician and drugs advisor to the US government, the documents demonstrate why efforts to bring about crop substitution, crop suppression, better control of drug production and sales or more international cooperation in the fight against drugs are bound to fail. He never quite allows coca to be on a par with other exotic consumables, in spite of many past comparisons with coffee and a similarly mixed reception among Europeans. Initially attacked by Spanish *conquistadores* for its importance in heretical Inca religious ceremonies, coca later earned praise for its ability to facilitate tireless labour on a minimum of food (just like coffee). Three hundred and fifty years later, Harvey Wiley, the head of the FDA, worried that Coca-Cola contained too much caffeine and too little cocaine. After cocaine's isolation late in the nineteenth century, Karch claims, many 'felt that the actions of caffeine and cocaine were nearly equivalent' (p. 170). Since coca played such a different role in consumption policies, social relations and economics in the past, it is surprising that Karch never acknowledges the perception of coca and cocaine as problems to be a consequence of a more recent politics of consumption.

The history of coca and cocaine is dominated by treatments such as Joseph A. Gagliano's *Coca Prohibition in Peru* (Tucson and London, 1994) or, indeed, Karch's earlier *A Brief History of*

Cocaine (London, 1998). This literature is unable to escape the categories crafted by twentieth-century drug policies, especially the 1980s' 'war against drugs'. For more youthful readers, this was the war that preceded the war against terror, and with similar results. Karch notes that the combined budget against drugs made available to US law-enforcers is truly a drop in the bucket, a sum that South American drug cartels could lose almost without noticing. Scholars of different political persuasions have reproached the US for resorting to dangerous herbicides to eradicate an increasingly herbicide-resistant coca 'infestation'. While more orthodox commentators have written of an epidemic of addiction, and of the 'grooming' of Latin American street children as drugs vendors, some also point to the positive outcomes of the drug economy in terms of diverting Western resources for the benefit of underdeveloped nations.

In this turmoil of accusations, corruption, mayhem and dismay it is intriguing to find such different understandings of cocaine and coca at the start of the last century. The transcribed texts document a sudden flowering of pharmaceutical interest in cocaine between the 1880s and the 1910s after Carl Koller, at the University of Vienna, demonstrated its properties as a local anaesthetic. All are concerned with coca's taxonomy, geographic distribution, cultivation and commerce, and many propose technological improvements in the harvesting and processing of the leaves or the extraction and purification of cocaine. That the first consortium of drugs companies formed to exploit this new medicament is interpreted by Karch as the first 'drug cartel' shows, however, that there is no level historical playing field for a substance like cocaine.

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Lesley Richmond, Julie Stevenson and Alison Turton (eds.), **The Pharmaceutical Industry: A Guide to Historical Records**. Aldershot: Ashgate, 2003. Pp. ix + 561. ISBN 0-7546-3352-7. £55.00 (hardback).
doi:10.1017/S0007087406397890

When Colin Russell and I produced our *Archives of the British Chemical Industry, 1750–1914: A Handlist* (Faringdon, 1988), some professional archivists were rather reserved about this invasion of their territory by interlopers they clearly perceived – with some justice – to be amateurs. As I started to put the guide together, I tried to tackle three presentational issues: how each record should be structured, how the record-holders should be recorded and how the collections themselves should be listed. From the relatively few examples available at the time, I developed a layout based, in part, on L. A. Ritchie's *British Shipbuilding Records: A Guide to Historical Records* (London, 1980). I am glad to see that the volume under review, produced by professional archivists, has followed my structure in almost every detail, including the indices. The major exception is the listing of the record-holders' addresses under each entry rather than at the end – a debatable improvement. Although it has similarities to our volume, the present volume is a better product in many respects. It is longer and covers a broader timespan (with hindsight, we made a mistake stopping at 1914). The guide to minor collections, which we did in a very limited manner, is here extensive. Institutions and societies have also been covered more thoroughly. There is a series of essays on the history of the pharmaceutical industry and the use of archives. Prefacing the listings, these are useful if not really essential. The bibliography is impressive, covering theses as well as standard histories of the industry. Although more expensive than our paperback, this well-produced hardback volume remains good value.

Turning to the individual entries, it has to be acknowledged that our two guides have worked largely from the same listings produced by the Business Archives Council (BAC), although I also contacted and visited individual archives. I gather from the Acknowledgements that a similar project was funded for the pharmaceutical industry by the Wellcome Trust and directed by

Professor Derek Oddy between 1995 and 1997 (it would have been good to learn more about this project). We deliberately ignored 'a multitude of pharmacists', accepting that they could be properly covered only by another volume such as the present one, but we did set out to cover the larger-scale pharmaceutical industry. The two guides appear to have about twenty-one entries in common, one of which (William Bailey and Sons) comes under 'minor collections' in the volume under review. For any given entry, the details of the listing are similar, but are also usually more detailed in the present volume, though this increased detail also makes the entries harder to read (I felt it was better for the researcher to acquire the detailed handlist from the record-holders or the BAC, once they had determined the potential value of the holdings from my relatively brief description). The company histories also tend to be rather longer. There are doubtless companies here that we missed, either because the archives have come to light since 1984 or because they are entirely post-1914 (for instance AstraZeneca). The compilers of the present volume have also uncovered new sources for companies we did cover; for instance, in the case of Allen and Hanbury, they have noted five sets of records whereas we recorded only two.

A good guide to the records of the pharmaceutical industry, this volume will be of considerable value to historians of the pharmaceutical and chemical industries. One wonders, however, if the compilers have really taken the best route forward. If I were to resume the chemical industries project today, I would be thinking in terms of using the web, which would allow me to improve records already 'published' and add new records as they became available. Even more importantly, in many cases it would be possible to provide links to record offices and other archives, where further up-to-date information would be available. Will this volume be one of the last conventional guides to business archives?

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ROGER D. LAUNIUS and JANET R. DALEY BEDNAREK (eds.), **Reconsidering a Century of Flight**. Chapel Hill and London: University of North Carolina Press, 2003. Pp. xii + 300. ISBN 0-8078-5488-3. £14.95, $19.95 (paperback).
doi:10.1017/S0007087406407895

This is an American book, presenting a largely American view of the first century of aviation. All of the authors, save Hans-Joachim Braun, are Americans. Most of the essays first appeared at a symposium held at North Carolina State University in 2001 anticipating the centenary of the Wright brothers' first flight. The meeting was sponsored jointly by North Carolina's First Flight Centennial Commission and First Flight Centennial Foundation.

Perhaps this should indeed be an American book. Aviation technology is arguably the quintessential American technology. Rival claims to the contrary, atmospheric flight was an American invention. The United States dominated this technology in its military, commercial and private forms throughout most of the twentieth century. In fact, something of a watershed event occurred in 2003, when the European Airbus took more world market share than Boeing in the prestigious commercial airliner market. That achievement looms predictably large in Braun's account of Europe's perspective, where he also emphasizes that region's contributions in the First World War and aerodynamics between the world wars.

But beyond the Americanness of flight, this book lacks a theme. Several authors attend to the title of the 2001 conference – 'They Taught the World To Fly: The Wright Brothers and the Age of Flight'. The Wrights figure prominently in at least four of the twelve essays, but Charles Lindbergh gets almost as much coverage. David Cortwright argues that 'the emergence of commercial aviation as a reliable form of mass transportation for people and cargo was the single most important development in the history of flight in America' (p. 220), but the assertion offers

no standard by which commercial aviation might be measured in comparison to military aviation, let alone private aviation, which accounts for 95% of civil aircraft in the United States.

In lieu of a theme, the editors identify four categories into which the twelve essays fit reasonably well. The categories are 'innovation and the technology of flight', 'civil aeronautics and government policy', 'aerial warfare' and 'aviation and the American imagination'. In their Introduction the editors note that 'progress' is a theme 'suggested but not developed in a focused way by these essays' (p. 10). They might have added that it is a vexed issue, which John Staudenmaier and others have warned historians of technology to approach with great caution. Claims of technological progress always raise the question of 'progress for whom'. In the marketplace, at least, progress usually entails winners and losers.

Still, on the evidence of this book, ideas of progress fit tolerably well with an emphasis on technology, less well with emphases on government policy, war and the imagination. All three authors in the technology section, including co-editor Roger Launius, use the term. Roger E. Bilstein, described by the editors as 'the dean of serious aerospace history' (pp. 6–7), invokes it repeatedly in his synthetic overview of the technology of aviation. Launius uses it in explaining the role of government support for aeronautical research. And Braun employs it to explain European contributions. The most emphatic invocation of progress appears in John Morrow's 'Brave men flying: the Wright brothers and military aviation in World War I'. Amidst colourful stories of romance and carnage above the battlefields of Europe, Morrow notes that 'the aircraft manufacturers ... evolved with the industry, or were left behind by aviation *progress*. The rapid *progress* of aeronautics left the Wright brothers in its wake, and by 1917 their most significant participation in aviation was a patent suit that may well have delayed the *progress* of the American aircraft industry' (pp. 178–9; emphases added). This passage is arresting on several grounds. First, it humanizes the Wrights by noting that not all their contributions were positive. Second, it ascribes agency to progress, suggesting that this technology advanced autonomously and teleologically towards some better state. And third, it embraces a notion of progress as good. All of the authors invoking progress in this collection use the term in this sense.

Maybe they are right. Surely aeroplanes now fly faster, farther, more cheaply and more safely than ever before. The most modern aeroplanes even produce less noise and other pollution. Of course, we still have pollution, congestion, inequities of access and strategic bombing. Judged in their own frame of reference, aeroplanes surely progressed over their first century. Judged in the larger social context in which they function, talk of progress is more problematic. The contrast brings to mind the late Melvin Kranzberg's 'first law': technology is neither good nor bad, nor is it neutral.

Technology may be seen as getting better, as progressing, in the sense that it operates more efficiently and effectively than before. Whether or not that translates into social, economic, political or cultural 'progress' depends on how the better technology is employed. It is revealing that the authors in this collection addressing policy, war and culture find less occasion to speak of progress than those who address technology. But, as Launius suggests, it would be an interesting question to explore. In the meantime, this book offers useful and stimulating insights into this most American of technologies.

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SLAVA GEROVITCH, **From Newspeak to Cyberspeak: A History of Soviet Cybernetics**. Cambridge, MA and London: MIT Press, 2002. pp. xiv + 369. ISBN 0-262-07232-7. £25.95 (hardback).
doi:10.1017/S0007087406417891

There are many contexts for the emergence of cybernetics: technical and scientific innovation; a culture of mechanization, automation and computation; the merging of disciplinary boundaries

from mathematics to physics to biology. In this history of cybernetics in the former Soviet Union, Slava Gerovitch considers the fate of the science as a form of political and ideological language. Throughout a sometimes detailed exploration of Soviet academic politics in the Cold War era, the author's experience of the USA, where this research was completed, informs and enhances personal knowledge of his native country.

In the West cybernetics is closely associated with Norbert Wiener, who gave it both name and fame when he published *Cybernetics, or Control and Communication in the Animal and the Machine* in 1948. But the component concepts – notably mechanical analogues of the nervous system and mathematical models of communication – had all been current (if under-marketed) for several decades. Even Wiener's term was not new; it had first been used by Ampère in 1843. What brought these elements together into a new science of self-regulating systems was the common perception that, to be accounted a mature and 'complete' science on a par with nineteenth-century physics, twentieth-century biology had to forsake mere observation in favour of mathematical and mechanistic models. Significant contributions came from scientists and mathematicians of Russian origin, among them Markov, Oparin and Rashevsky. Gerovitch introduces us to many more, in a story that moves from perilous dissent under Stalin to decay and desuetude in the Brezhnev years.

Taking the long view of Soviet cybernetics, Gerovitch develops a perspective from which it emerges as, appropriately, a self-regulating system. He argues that the ambiguities and accommodations of the politically nuanced language of newspeak found a natural affinity with cyberspeak. At first cybernetics was a code – a cover for mild dissidence, admired as a replacement for, as Gerovitch puts it, 'the vague and manipulative language of ideological discourse in fields that mathematics had not yet reached' (p. 199). Cybernetics promised a grand and ideologically neutral unification of human knowledge. But such unification had necessarily to engage with political debate and institutional disputes. Cybernetical language thus became political language – a medium for scientists to criticize the philosophers. This delicate balance was not to last. 'Well trained in newspeak techniques', Gerovitch comments, 'some philosophers now adopted cyberspeak as a new ideological language' (p. 257). Adopted, adapted, universal but diluted, cybernetics in the Brezhnev years was, he argues, 'transformed from a vehicle of reform into a pillar of the *status quo*' (p. 279). By the 1970s it had become unrecognizable to its first mathematically trained proponents, who now felt the need to disown it as a pseudo-science. The promised language of truth and objectivity had become the newspeak it had once ridiculed.

The story of Soviet cybernetics thus presented was a battle over vocabulary, between scientists wanting a pure, politically free terminology, ideal and mathematical, and ideologists wishing another kind of universality with nothing left out of politics. Comparisons and contrasts with the fate of cybernetics elsewhere are instructive. In general, though the science had its roots in mathematical formulations, extending the boundaries of precision and logic from the statistics of thermodynamics into the fuzzy world of communication and behaviour, the mathematical underpinnings diluted as the claims broadened. In the West, shorn of its precision, cybernetics rapidly faded, leaving only a faintly sinister aura – the fear of a world controlled by machines. In the USSR, by contrast, it was the initial claim to mathematical verity that first aroused suspicion, marking cybernetics as a science of behaviour standing outside ideology. In the post-Stalin era, with the mathematical rigour taken away, what was left proved an ideal vehicle for the ideology of 'scientific socialism': universal, amenable to pragmatic interpretation, yet with all the cachet of approved words such as 'rational', 'objective', 'progressive' and 'scientific'. In the Soviet case, cybernetical language was employed as much as a means of concealment as of precision. Gerovitch describes the contrast in academic language between the USSR and the USA as between acceptance of ambiguity and a desire for at least the appearance of precision. Yet, for each community in its own way, the search for a universal scientific language – the desire to pin

everything down with 'precise language', to reduce the world to the certainties of mathematics – remained central.

Derived from a doctoral thesis, *From Newspeak to Cyberspeak* probably contains more information on cybernetics in the old USSR than anyone will ever need. It is nevertheless a welcome achievement: scholarly, well researched and unrivalled in the expertise with which it tells a story of singular interest.

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Garland E. Allen and Roy M. Macleod (eds.), **Science, History and Social Activism: A Tribute to Everett Mendelsohn**. Boston Studies in the Philosophy of Science, 228. Dordrecht, Boston and London: Kluwer Academic Publishers, 2001. Pp. x + 388. ISBN 1-4020-0495-8. £85.00, $124.00 (hardback).
doi:10.1017/S0007087406427898

It was only after reading this collection of essays that I first met Everett Mendelsohn. The setting was the international history of science congress in Beijing in late July 2005, where he delivered a wonderful political analysis comparing J. D. Bernal and Robert Merton in the 1930s. Its beauty lay principally in the context: a symposium on science and political engagement where many of the papers were strong on empirical research but weak in conveying a clear sense of the political contexts and traditions under review. Mendelsohn's performance was all the more inspired and inspiring. Indeed, his impressive depth of knowledge in a wide sphere of fields, his political conviction and instinct (rare among academic historians) and glorious warmth of humanity kept all around thinking. He radiated joy and enthusiasm at the prospect of the symposium and promptly led the collective excitement as the debate exploded over four intense sessions.

Mendelsohn's work has been multifaceted. As a professor at Harvard he helped resuscitate methodologies for exploring social context in the history of science. More than any other, he made the works of Boris Hessen and Edgar Zilsel parts of the standard analytical toolbox for generations of historians since the 1960s. He has made fascinating and path-breaking contributions in the fields of history of biology, genetics and the atomic scientists movement, to name a few. However, his lasting contribution is as a politically engaged activist historian, whose research has been eclectic in response to the many fronts on which he campaigned. From the civil rights movement and the anti-Vietnam War movement through to the Palestinian–Israeli conflict, he has worked to use his knowledge and his experience in pursuit of a more humanistic world.

The series of essays contained here mirrors this extraordinary achievement. Wide-ranging, analytically stimulating and reflective, they demonstrate Mendelsohn's effect and legacy. Those on the history of the life sciences include a startlingly original piece on 'the radical nature of the *Encyclopédie*' by Shirley Roe and also excellent essays on 'Mendel's hypothesis' by Raphael Falk and the rise of molecular biology by the late Lily Kay. Each succeeds, in Mendelsohnian fashion, in being rich in empirical content while also reflective on the subtle and overt political issues evoked in the historical record and its context.

The sequence of papers listed as 'perspectives on the social studies of science' and 'science, society and social responsibility' are more uneven. While there are some interesting pieces on, for instance, the 'dark side of progress' by Jean-Jacques Salomon ('China, "qi" and the challenges of engaged scholarship'), these tend to illustrate the extent to which the project of the 1970s and early 1980s to develop a political history of science with a distinct emphasis on political engagement of scientists has lost its way. 'Engagement' drifted into some very strange territory, leaving one to wonder why it is a divisive issue in modern history of science and why Mendelsohn's own political engagement should be so controversial. There are, however, some real pearls here, such

as Garland Allen's account of his politicization into a Marxist in the late 1960s and Gary Werskey's reminiscence of being taught by Mendelsohn. Werskey wrote one of the seminal works of the political history of science, *The Visible College* (London, 1978), a meditation on political engagement in the 1930s and 1940s.

Alas, Werskey's essay itself reflects the drift in 'engagement', as he offers a perspective on corporate social responsibility programmes and 'knowledge capitalism' as spheres of engagement. While knowledge capitalism needs critical attention, Werskey's recommendations are of a piece with an apparent lack of radicalism that belongs to a former world. Since 1999 the significance of anti-capitalism and the post-Seattle anti-war and environmental movements have grown apace. At the same time, the recognition of global warming has produced a profound radicalization within the scientific community, with a minority at least willing to engage politically. But if his essay here disappoints, Werskey was quite brilliant in commentary at the recent Beijing symposium, as was Roy MacLeod, who here has a fascinating essay on military involvement in the Pacific Ocean biological survey programme in the 1960s. Other thought-provoking contributions include Mark Adams's on the changes in Russian science under Khrushchev, Whittlemore's on the debate on plutonium exposure and Watkins's on radioactive fallout.

This tribute volume itself contributes to many areas of Mendelsohn's research. It is not, however, the final word. The book's major failing is its emphasis on Mendelsohn's academic studies at the expense of the succession of fruitful political engagements he has led. His research interests are so eclectic because they inform and are informed by his activism. What defines the significance of Mendelsohn as a historian is his willingness to participate in shaping the historical process rather than pretending to stand aloof. Unlike many in the history and sociology of science, feigning a lack of politics while subtly shaping agendas in universities and society, Mendelsohn has openly contested the public stage in defence of his political beliefs and his historical awareness of the importance of lessons from the history of science. His demand that Ph.D. candidates should deliver their theses to the public in Harvard Square is no trite idiosyncrasy but a clarion-call to historians of science that historical lessons and knowledge are bankrupt unless utilized for a social purpose. He stands as a genuine leader and exemplar of the direction towards which the history of science should be heading.

The Seattle (or Baghdad?) effect so recently represented at Beijing demonstrates that some have been listening. This volume, and Mendelsohn's example more broadly, offer a future for the historian of science as a humanistic, socially responsible actor on the historical stage.

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Spencer R. Weart, **The Discovery of Global Warming**. New Histories of Science, Technology and Medicine. Cambridge, MA and London: Harvard University Press, 2003. Pp. xi + 228. ISBN 0-674-01157-0. £19.95 (hardback).
doi:10.1017/S0007087406437894

The United States remains the world's most significant contributor of greenhouse emissions as well as the nation most resistant to the recognition and redress of global warming. Yet it is also true that American scientists have played a major role in the discovery of the phenomenon. *The Discovery of Global Warming* is Spencer R. Weart's attempt to reconcile these facts through a study of the institutional, ideological and technological contingencies that shaped the history of the study of climate change.

Discovery is a compelling story of the good, the bad and the ugly – roles that Weart assigns respectively to scientists, Republicans and the fight for research funding. In a concise and

accessible book clearly targeted at a popular audience, Weart questions the stereotype (still perpetuated by many environmentalists) that scientists are the bad guys in our dealings with nature. At the same time the book is sufficiently scholarly to serve as an introductory text on the subject for historians of science and environmental historians. Part of a larger project, it is supported by a website including links to extensive research, a short history of climate change and further essays and information (http://www.aip.org/history/climate).

The story begins in late nineteenth-century England with John Tyndall's investigations into the evidences of previous ice ages and his recognition that both carbon dioxide and water vapour act as what we would now call greenhouse gases. Tyndall hypothesized that without these elements in the atmosphere the Earth would be plunged into another ice age. Tyndall's conclusions remain pertinent to the story. However, given Weart's presentist concerns, his focus quickly shifts to the United States. While those who wish to explore the European, and particularly the British, context might turn to Gale Christianson's *Greenhouse* (Vancouver, 1999), Weart's American tale is an important and compelling one that has yet to be told.

He argues that concern with global cooling in the formative years of the study of climate change delayed recognition of the evidence that temperature was actually rising until well into the 1970s. Indeed, it is pertinent to his narrative that sceptics about global warming in Washington marshalled the possibility of global cooling as a part of their ongoing campaign to delay remedial action – a strategy that met with some success. Faced with incredibly complex data, inconclusive cross-disciplinary models and uncertainty about conflicting theories, the majority of scientists remained reluctant to be drawn into the political arena.

Weart contends that the origins of the field framed not only the questions asked but also the technologies that were built in attempts to answer them. The uniformitarian assumptions at the heart of late nineteenth-century Lyellian geology continued to rule out consideration of catastrophic change until very recently. Models had been built to record only gradual change and, assuming a largely stable system, scientists were initially blinded to the significance of core ice and seabed samples that suggested fluctuations that were both catastrophic and global. Both were indicative of a precariously unstable ecosystem.

Somewhat ironically, Weart points out that advances in the field have largely resulted from funding based upon the potential military applications of the research, or as a result of borrowing technological innovations from the oil industry – neither usually associated with environmentalism. The funding of this important research, Weart notes, has historically been only slightly better under Democratic administrations than Republican.

The Discovery of Global Warming incorporates a vast amount of information into a short, readable and punchy narrative. It is an excellent introduction to the subject for the non-specialist and the academic reader alike. In addition, the companion online project will doubtless prove an invaluable resource to the field.

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Finn Bowring, **Science, Seeds and Cyborgs: Biotechnology and the Appropriation of Life**. London and New York: Verso, 2003. Pp. xiii + 388. ISBN 1-85984-687-4. £19.00, $29.99, C$39.00 (hardback).
doi:10.1017/S0007087406447890

Finn Bowring does not like biotechnology, and the first ten of the twelve chapters of *Science, Seeds and Cyborgs* articulate a familiar jeremiad. Biotechnology always fails to deliver on its promises. Moreover, if these failures are sometimes so disastrous that they attract a great deal of public attention, the legitimacy of biotechnology and cognate sciences is untarnished because

their reductive assumptions about the nature of life are sustained by an increasingly hegemonic alliance of state and capital. If we have been here before, Bowring nevertheless makes some useful observations along the way. He notes very astutely both the way in which bio-ethical discourse is complicit in the legitimation process, as it rejects deontology for consequentialist reason (despite the inescapable dependence of the latter on the former), and the consequently paradoxical effects of regulation and legislative oversight.

If the aim of the first ten chapters of *Science, Seeds and Cyborgs* would then seem to be persuasion by overwhelming force of factual evidence, the tone of the last two chapters is quite different. Bowring starts with the development of reproductive technologies, closely examining their implications for the relationship between parent and offspring, to argue very effectively that 'humanity' is racing towards extinction. He does so by drawing on the writings of Jürgen Habermas and Peter Sloterdijk. Significantly, Bowring deploys the former's critique of the latter to call into question Donna Haraway's 'cyborg manifesto', highlighting how, despite its claims to transcend the dualism that has haunted Western culture from its very inception, it is in fact predicated on the dream of achieving the realm of freedom by escaping the mortality of the body. *Science, Seeds and Cyborgs* closes with a call to the reader to accept human vulnerability as immensely precious – an ethic neatly encapsulated by the words of Paul Virilio:

> The basic error of the ontology of 'not yet' and its eschatological hope is repudiated by the plain truth, ground for neither jubilation nor dejection, that genuine man is always already there and was there throughout known history: in his heights and depths, his greatness and wretchedness, his bliss and torment, his justice and his guilt, in short, in all the *ambiguity* that is inseparable from his humanity. Wishing to abolish this constitutive ambiguity is wishing to abolish man in his unfathomable (quoted on p. 272; original emphasis).

I find these thoughts quite provocative, but I also think that Bowring fails to appreciate their full implications. More specifically, his jeremiad rests on the opposition of genetic reductionism and an understanding of the world as more complex than reductionism would allow – a world in which environmental factors are far more important than genes. Yet reductionism and environmentalism can be understood as competing epistemological claims that share a common ontology. Moreover, as Tiago Moreira and I have argued elsewhere, the 'regime of hope' and the 'regime of truth' are 'parasitic' on each other. That is, the expectation that new and better technologies are always about to come, entailing endless deferrals to stabilize the identity of these technologies, reinforces and is reinforced by the expectation that these technologies always are less effective than claimed, entailing their constant return to original claims, failures and ethical downfalls. From this perspective, environmentalism alone must lead to epistemic paralysis, for it needs reductionism for its own definition and articulation.

We also maintain that the very same problematic of 'man' that lies at the heart of *Science, Seeds and Cyborgs* is an effect of this parasitic relationship. It is precisely this bind that motivates Virilio's emphasis on 'ambiguity'. As long as Bowring will not tarry much more explicitly with the onto-theological issues that underpin Virilio's theodicy, he risks complicity with the very phenomenon he would criticize, insofar as his argument could then be construed as just as consequentialist as those of the bio-ethicists he puts in the dock. Be that as it may, *Science, Seeds and Cyborgs* is a welcome contribution to the critique of biotechnology insofar as it begins to open up these difficult and unfashionable questions. But I do wish I had not had to wade through the first ten chapters before getting to them.

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HENRY C. LEE and FRANK TIRNADY, **Blood Evidence: How DNA is Revolutionizing the Way We Solve Crimes**. Oxford: Perseus Publishing, 2003. Pp. xxx + 418. ISBN 0-7382-0602-4. £19.99 (hardback).
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Since the late nineteenth century, administrators, scientists and policemen have been developing ever more precise techniques for the physical identification of individuals, especially criminals. The saga began with the anthropometric system of the French policeman Alphonse Bertillon – precise measurement of eleven bodily parts, Bertillon claimed, was enough to distinguish an individual from all others – and reached what seemed to be a climax in the early twentieth century with fingerprinting, which was quick, cheap and supposedly incontrovertible. Towards century's end, however, the fortunes of fingerprinting began to wane, especially in the United States. Influential voices began to claim that the matching of fingerprints was a subjective process and vulnerable to 'the personal equation'. The jury is still out on the issue but even if the verdict on fingerprinting turns out to be negative, a crisis is unlikely to ensue. For the century that began with fingerprinting ended with the development of a new kind of identification that, at least for now, seems to be wholly impregnable to scientific criticism. This, of course, is DNA typing. The features of one's genetic material – the DNA – are unique to each individual and can be identified from bodily fluids without, it is claimed, the slightest ambiguity.

There have been several recent historical studies of the emergence of fingerprinting, but DNA typing remains virtually untouched by professional historians. This, of course, is understandable; the technique is too recent to have what most scholars would consider to be a significant past, and the science involved, frankly, may be too technical for the average historian. Nevertheless, as this excellent book establishes, DNA typing has already revolutionized forensic science and is fast expanding into other areas of science, medicine and culture. It deserves to be seen in a historical context, and although Lee and Tirnady do not claim to be historians – Tirnady is a science writer and Lee a forensic scientist hailed by one ecstatic blurb on the back cover as the 'modern day Sherlock Holmes' – their book will aid any scholar who might be bold enough to explore how the molecular depths of the human organism came to be endowed with individuality.

The book is essentially a survey of what DNA typing is, how it has changed over the two short decades since its birth, what it has achieved in the law courts and how it is now moving beyond the legal domain into other fields. The basic science of DNA typing, although constantly evolving, is already rebarbatively technical; the authors make every effort to explain the scientific and technical aspects as simply as possible, but their pages bristle nevertheless with long scientific names and arrays of acronyms. The subsequent chapters are devoted to notable criminal cases where DNA typing featured prominently. Most of these are fascinating, although the authors' passion for detail (sustained by what seems to be a phenomenal collection of newspaper clippings) often blurs the focus on DNA typing. Of the trials they discuss, the one that will be most familiar to non-American readers is the O. J. Simpson case, which also brought out the central problem with DNA fingerprinting. As Lee and Tirnady remind us, the DNA evidence in that trial came to be doubted not because it was scientifically unreliable but because of suspicions of wilful contamination of the samples that were tested. This, of course, is the Achilles heel of this brave new technology. It is rigorously scientific, but it is only as reliable as the samples it tests. If one sample (say, the blood collected at a crime scene) is substituted with another (say, the blood of a suspect) by error or malice, then no amount of scientific expertise could save the integrity of the test. Whilst accepting this problem, Lee and Tirnady do not really examine what it means for the future of DNA typing. They also avoid getting drawn into discussions of the ethical aspects of

the whole business of personal identification. They shower much praise, for instance, on the national DNA databank in the United States. That praise is no doubt justified from the forensic perspective, but is it silly to worry that such databases might strengthen the surveillance states in which we all live? One hopes that future scholarship will investigate such questions and connect the DNA story, told so well in this book, with broader questions of politics, ethics and liberty.

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