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Book reviews

LYNN K. NYHART and THOMAS H. BROMAN (eds.), **Science and Civil Society**. *Osiris*, 17. Chicago and London: University of Chicago Press, 2002. Pp. x+373. ISBN 0-226-07371-8. $50.50 (hardback).
doi:10.1017/S0007087405216965

The study of the history and nature of civil society has enjoyed a resurgence over the last decade and a half. This has been driven by a number of factors, including the translation into English in 1989 of Jürgen Habermas's *The Structural Transformation of the Public Sphere*, the self-conscious re-establishment of civil society in post-Soviet eastern Europe and the growing importance of non-state actors in domestic and international affairs. It is therefore possibly no surprise that historians of science have begun to frame their studies in terms of civil society. In the Preface, Kathryn Olesko introduces the journal's new editorial policy, stressing the mediation of the concerns of historians and historians of science. Studies of associational life have become something of a research industry in history and it is welcome that historians of science, with their own long tradition of institutional and associational studies, should find their interests increasingly relevant to other historical fields. This new volume of *Osiris* is therefore an important addition to both the history of science and the history of civil society.

Thomas H. Broman notes in his valuable introduction that the term 'civil society' is maddeningly difficult to define. It refers to a social and political space between the family and the state in both an empirical and a normative sense. In the empirical sense civil society can be said to exist or manifest itself in certain times and places, while in the normative sense it defines the proper political and social ordering of a liberal democratic society. This distinction is, however, only a first step. As a number of the papers in the collection show, the notion of civil society is valuable even in the absence of the effective functioning of civil society or a liberal democratic system, such as in nineteenth-century Germany and Russia or twentieth-century China. Celia Applegate, in her concluding paper, stresses less the theoretical notion of civil society than its value in framing accounts of the history of science. Such an approach demonstrates that 'scientists are not [just] heroic pursuers of truth or instruments of state power, not merely or only avatars of professionalized self-interest or remote purveyors of socially improving expertise' (p. 351). Rather, the framing of science in terms of civil society focuses attention on the wider social, political and economic entanglements of science and scientists and their often constitutive role in constructing a public sphere.

Partially following Celia Applegate's categorization, three interrelated themes can be identified in papers that form the core of this volume. First, several papers deal with the way science has been used to justify and legitimate social and political reform. Harold J. Cook discusses the relation between Cartesian materialist philosophy and the development of republicanism in the mid-seventeenth-century Netherlands. He argues that proponents of republicanism sought to legitimize their political stance by showing how it flowed from the principles of the new sciences. Similarly, John Carson explores the relationship between Enlightenment science and politics more generally with an examination of the notion of 'merit' in eighteenth-century political and psychological theory. Andreas W. Daum draws attention to the way Humboldtian science in mid-nineteenth-century Germany was mobilized to support and sustain civil society. Lynn K. Nyhart similarly shows how new scientific educational policies could bolster both the state and civil society in later nineteenth-century Germany. Finally, Theodor Porter's account of Karl Pearson's failed programme to create a new aristocracy through scientific and statistical education illustrates the way scientific and political ideas are often intertwined in attempts at reform.

A second set of papers focuses attention on the interaction between scientists and the development of civil society. Elizabeth A. Hachten argues that Russian scientists in the second half of the nineteenth century took advantage of a liberalizing state to reconfigure their professional and social identities to take advantage of the emergence of civil society. H. Glenn Penny's account of

ethnology museums in late nineteenth-century Germany demonstrates how science became a locus of competition between German cities and how this was shaped by civic differences between the cities. Zuoyue Wang, in a paper on the Science Society of China in the first half of the twentieth century, argues that Chinese scientists tried to use science to fashion an embryonic civil society to modernize China for nationalist reasons. Finally, Shelly Costa examines the emergence of civil society in Britain in her account of the role of *The Ladies' Diary* in the co-development of civil society, mathematics and gender roles in eighteenth-century England.

These first two sets of papers stress the creative and, often, positive interaction of science and civil society. Two papers, however, adopt a third, critical stance, pointing to the limits of civil society even in relatively liberal democracies. Alice L. Conklin's account of French ethnology and Paris's Museum of Man in the early twentieth century examines the paradoxical and inescapably colonial dimension of a democratic and left-wing civic institution dedicated to proving the equality of all humans. Jessica Wang's paper on the Federation of Atomic (later American) Scientists explores the politicization of nuclear physicists in the 1950s and their suppression by the increasingly intolerantly anti-Communist American state. These two papers are valuable in undermining often simple narratives about moral responsibility and investigating the relationships between intention and the complex normative worlds in which scientists, and all others, live.

The relationship between civil society and science promises to offer historians of science novel ways of both conceptualizing their own work and integrating their work with that of other historians. The very difficulty of adequately defining civil society analytically may well be one of the idea's strengths. Its value lies less in directing attention to a specific phenomenon than in directing the attention of historians of science towards the wider engagements of science beyond narrow scientific communities and the state. This volume provides an early suggestion of the richness of such an approach and is essential for anyone working in the field.

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Robert Siegfried, **From Elements to Atoms: A History of Chemical Composition**. Transactions of the American Philosophical Society, 92 (4). Philadelphia: American Philosophical Society, 2002. Pp. x + 278. ISBN 0-87169-924-9. No price given (paperback).
doi:10.1017/S0007087405226961

Comparable to mass and time in classical physics, the concepts of 'chemical compound' and 'composition' are so deeply entrenched in classical chemistry (the chemistry of laboratory substances that began to flourish in the second half of the eighteenth century) and in today's basic teaching of chemistry that they appear almost as eternal truths. The idea that these concepts have a history is hard to accept by most chemists, even in a time when quantum chemistry has undermined the theoretical basis of classical chemistry. After the first hesitating attempts to historicize these classical chemical concepts by Pierre Duhem and Ida Freund around 1900, Robert Siegfried and Betty Jo Dobbs in 1968 published a seminal paper on the subject. (See their 'Composition, a neglected aspect of the chemical revolution', *Annals of Science* (1968), **24**, 275–93.) The authors proposed that we gain new insight into the nature of the late eighteenth-century chemical revolution by examining the changes that the new chemical system produced in the concept of composition. Now, Robert Siegfried has published a book-length 'history of chemical composition' that summarizes not only much of his historical work over the past thirty years but also his experience as a teacher of chemistry. As Siegfried states in the Preface to his book, his account 'conforms with the long tradition of scientists who wrote the history of their particular sciences for the educational benefit of their students' (p. vi).

The classical chemical idea that apparently homogeneous materials consist of components which are themselves ordinary materials that can be separated in the laboratory and identified by

a set of experimental procedures is embedded in a network, established during the eighteenth century, of concepts such as analysis and re-synthesis (or 're-union'), affinity and simple substance. Although this conceptual network preserves some of seventeenth-century chemists' philosophical commitments – in particular the idea that the properties of the whole body are caused by its parts – the definition of the parts as laboratory substances and of the whole body as a compound that can be separated into simpler laboratory substances and remade from these analytical components was a novelty with respect to both the older philosophical tradition of elements and the newer corpuscular philosophies. Robert Siegfried's study examines the intricate steps of the slow formation of that conceptual novelty in the French chemical community. Tracing the history of the conception of material composition, he follows many side-routes, such as the development of the concept of neutral salts, the theory of phlogiston and the study of kinds of air, which illuminate the intellectual context of that history and sum up to a short history of chemistry from the seventeenth until the early nineteenth century. In Siegfried's account it is not the chemistry of Lavoisier that is the culminating point of a long development of the theory of composition, but the atomic theory of John Dalton.

Siegfried's main analytical tool for tracing the changing theory of chemical composition is his distinction between a 'metaphysical' meaning of composition and a 'materialist' or 'operational' one. But the historiographical judgements based on this distinction are sometimes hard to follow. This is the case, for example, when he states, without further argumentation, that 'Paracelsus' *tria prima* of Mercury, Sulphur, and Salt, while still essentially metaphysical in meaning, carried a somewhat greater material implication than the four elements of Aristotelian tradition' (p. 26); or that Robert Boyle's corpuscular philosophy was 'a much more materialistic view than the one it was replacing' (p. 42). If the 'materialistic view' was not merely another kind of belief but also 'operational' in the sense of referring to and being embedded in experiments that procured substances understood as components and contributed to their identification, it would have been instructive to learn more about the history of these experiments and the development of collective standards for isolating and identifying chemical components.

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Stanley Finger, **Origins of Neuroscience: A History of Explorations into Brain Function**. Oxford: Oxford University Press, 2001. Pp. xviii + 462. ISBN 0-19-514694-8. £29.50 (paperback).
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The history of the evolution of knowledge of brain function is perhaps one of the most interesting and neglected parts of the history of science. Surely it ranks with Newtonianism or Darwinism in its fundamental transformation of understandings of what we are and how we work. Unlike Darwinism, which everyone thinks they understand, few non-specialists feel they understand the workings of the brain. Even the most basic implications of modern knowledge of brain function for other areas of study whose content is about the workings and memory content of brains, such as the humanities and social sciences, remain to be seen.

The book under review, first published in 1994 and here available in paperback, should help to remedy this obscurity. Nevertheless it is a large, heavy book replete with 350 black-and-white illustrations. It is meant to be a broad overview, for students and the general reader, of the history of the investigation of brain functions. It is divided into seven parts: theories of brain function, sensory systems, motor functions, sleep and emotion, intellect and memory, speech and cerebral dominance, and treatments and therapies. The content is usually focused on the relationship between structure and function. Each chapter is essentially self-contained, surveying the history of recorded observations and interventions into various brain functions from the ancient Greeks, Chinese, Indians, Egyptians or Babylonians to the early twentieth century. Because the work is

divided up in this way it does not read in a continuous narrative. The early chapters touch on what the ancients thought about the brain and, then, on the most significant findings which revealed that the brain is the organ of mind. The coverage does not bring things up to the present day; the explosion of neuroscience in the past thirty years would make this exceedingly difficult, though it would be appropriate for a second volume. A brief epilogue succinctly tells readers about the most important changes in knowledge of the brain and the trends of study in the twentieth century.

As might be expected for a work in the history of science written by a professor of psychology and neural sciences, there are occasional anachronisms, such as the use of 'scientists' in the eighteenth century, or unabashed statements of who got what 'right' in a dispute about localization. However, I think most readers of this book will be interested to know whether the researcher discussed did figure out how the brain does this or that. Readers are also expected to know the difference between the pons and the orbicular prominences – from which we might expect that the intended audience is one of medical students or those otherwise anatomically informed.

The book suffers from the usual problems associated with a one-man survey of a vast field. Experts on any particular area will notice minor errors. For example, in the discussion of Franz Joseph Gall and the origins of phrenology many of the dates and details are inaccurate. Greater use of the work of historians of science could have prevented such errors. It is inevitable that the specialist will find such slips in a book that sweeps across so much time and seeks to summarize all written accounts from around the world about brain function. Nevertheless these slips should not subtract from the general usefulness of this book for most readers. It is an extremely useful reference work for a wide range of topics in the history of brain researches. It is well written, thought-provoking and engagingly dotted with some of the most interesting and amusing anecdotes from the history of the neurosciences from early trepanation to self-experimentation. It is highly recommended.

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JÜRGEN SCHÖNBECK, **Euklid**. Vita Mathematica, 12. Basel, Boston and Berlin: Birkhäuser, 2003. Pp. x + 264. ISBN 3-7643-6584-6. €82.24, SFr 128.00 (hardback).
doi:10.1017/S0007087405246964

The book under review falls into five chapters of unequal length: 'Euclid, the geometer', which is a general presentation of the main character and our (lack of certain) knowledge about him; 'Pre-Euclidean Greek mathematics'; 'Euclidis opera omnia', a discussion of all works (extant, lost, reported) except the *Elements*; 'Ta stoicheia – *The Elements*'; and 'Euclid through the centuries'. Throughout, the character of the book is that of a popularization intended, apparently, for mathematicians, teachers of mathematics, and an educated public interested in mathematics, not that of an original contribution to the history of mathematics or to the study of Euclid in particular. This is no objection, since in this as in many other fields good popularizations are at least as important as works directed solely to specialists, and specialists' works within the sciences of culture are ultimately barren if not communicated through good popularizations. Nor is it a problem per se that most of what is said is reported from others, that original sources are often quoted from the secondary literature, and that even the opinions and conclusions of students of the topic are often quoted indirectly and not from the original.

However, the way this is done by Schönbeck is hardly satisfactory. A first point is the manner in which Schönbeck circumvents our lack of knowledge, for instance (but far from exclusively) about Euclid's life and dates. He admits that much of what he suggests is hypothetical and not built on reliable sources, either when advancing the suggestion or slightly later; but then the same

claim is repeated again and again, still often with an added '(?)'. But the reader who is not extremely attentive will still believe after reading the numerous repetitions that, for example, Euclid started his career at Plato's Academy and lived till c. 280 BC, and that Euclid was consciously working within the Platonic programme. Objections are discarded as 'speculative', even when what they do (e.g. concerning the dating of Euclid) is to point out that the presumed evidence on which Schönbeck builds does not hold water.

Second, Schönbeck uses almost exclusively literature written in German. In the bibliography, said to list what was used directly for the preparation of the book (thus not 'suggested readings' for a German public), 14 percent of the items are in English, 2 percent in French, and less than 2 percent are in Greek and Latin (namely Becker's edition of Aristotle and Heiberg and Menge's edition of Euclid – the former of which left no noteworthy traces in the text). All the rest are in German.

This means that almost none of the major relevant publications from the last thirty-five years have influenced Schönbeck's book. Major and relevant works by Ian Mueller, Wilbur Knorr, Marinus Taisbak, David Fowler, Richard McKirahan, Reviel Netz and Bernard Vitrac are thus absent; H. L. L. Busard's immense work on analysing and publishing the medieval Latin Euclid is similarly overlooked, as is all recent work on the Arabic Euclid. But also older works in German of high relevance for Schönbeck's argument are absent (e.g. Walter Burkert's *Weisheit und Wissenschaft* (Nürnberg, 1962) in spite of all the attention given by Schönbeck to Pythagoras' mathematics, as well as Kurt Vogel's *Habilitations-Schrift* ('Beiträge zur griechischen Logistik'. Erster Theil. *Sitzungsberichte der mathematisch-naturwissenschaftlichen Abteilung der Bayerischen Akademie der Wissenschaften zu München*, 1936, 357–472) – equally mandatory when the origin of the Greek notion of ratios is studied). These absences reflect the fact that Schönbeck never tries to cope with intricate arguments or to challenge current prejudice from the popular historiography of mathematics (rather accepting and repeating it under the euphemism of *hermeneutischer Vorgriff*, 'hermeneutic anticipation' (p. viii)). Indeed, the reason recent work by others goes unmentioned is not that Schönbeck prefers to present his own independent alternative analysis, which could be considered quite legitimate.

To this comes direct misunderstanding of the secondary literature that is used. I shall restrict myself to two examples. First (on p. 9), an arithmetical riddle known as 'Euclid's problem' is believed to be transmitted by Diophantos, because 'Tropfke 1980' (actually the reshaped edition by Kurt Vogel *et al.*) refers to [Diophant 1; 2, X] – which means that it is quoted by Tannery on p. X (that is, the Introduction) of Volume 2 of his edition of Diophantos. Second, Fuat Sezgin's *Geschichte des arabischen Schrifttums*, Bd. V, is cited (p. 213) as the source for the statement that Jābir ibn Ḥayyān recognized 0 as a number; but what Sezgin quotes (not on the page indicated by Schönbeck) is Jābir's reference to zero (*ṣifr*) as opposed to but having a relation with the category of number. Moreover, Sezgin points out (following Ruska and others) that Jābir's reference proves the Hindu numerals to have been known by Arabic scientists before al-Khwārizmī; this is overlooked by Schönbeck, who gives al-Khwārizmī credit for introducing them six pages later.

Similar inconsistencies are found elsewhere. Apollonios is thus believed (p. 221) to have been translated several times in the 'translation school' in Toledo (together with 'the mathematician Hippocrates') in the twelfth and thirteenth centuries (no clear reference is given, but the source for the misconceptions might be Will Durant). It was the 'literary humanist movement' that made Apollonios (and Ptolemy) accessible to the European world (p. 225) – but these are claimed to precede the Renaissance.

The material quality of the book is impeccable, and it is beautifully illustrated and easily read (if one is not disturbed by the shortcomings). Since the prejudice of popular historiography is anyhow rampant and not always wrong, sustaining its survival for another while will perhaps

cause no great damage. But whoever believes to have learned something new from the book should take care and control it well before using it for serious purposes.

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KOENRAAD VAN CLEEMPOEL, ***A Catalogue Raisonné* of Scientific Instruments from the Louvain School, 1530 to 1600**. De Diversis Artibus: Collection of Studies from the International Academy of the History of Science, 65. Turnhout: Brepols, 2002. Pp. xii + 284. ISBN 2-503-51218-6. €75.00 (hardback).
doi:10.1017/S0007087405256960

In recent years a number of informative catalogues of scientific instruments have appeared, providing an important resource that was sadly lacking before. Most of them have concentrated on single museum collections (such as the western astrolabes in the Adler Planetarium, or the globes and the sundials at the National Maritime Museum). However, increasing interest has been shown in the works of particular makers or schools of makers, with Gerard Turner's study of Elizabethan instrument-makers and now the present book on sixteenth-century craftsmen in the Belgian town of Louvain.

Van Cleempoel begins his book with a historical introduction to the instrument-making trade in Louvain, considering the reasons for its origins, the characteristic stylistic features of the objects, and biographical information about the makers themselves. This last is often a scant resource; indeed, in the case of Michael Piquer, van Cleempoel has had nothing to go on but the maker's instruments themselves, and has done remarkably well in gleaning information from them – incidentally demonstrating the importance of instruments as historical sources. The roles of Gemma Frisius and Gerard Mercator in the establishment of Louvain as a centre for mathematical knowledge and craftwork are stressed, and the links with both the Spanish court and Prince Ernst of Bavaria are demonstrated to be an important factor in the development of high-class instruments.

This book is unusual in coming from the hand of someone who was trained as an art historian before turning to work on scientific instruments. He therefore explores the development not only of the instruments themselves but also of their artistic traits and the lettering that appears on them. Particular attention is paid to the history of the Louvain astrolabe rete, which was characterized by a central tulip motif, common to all the astrolabes produced in the town. He also shows the establishment of the italic style of writing by Mercator to be a specific trait of these Belgian instruments. This is a refreshing approach to the study of scientific instruments, which are often only considered as objects for practical use, with no discussion of the ornate decoration and lettering that was common at this period in the trade.

The catalogue itself occupies the major part of the book and is divided into the oeuvres of the five main makers – Gerard Mercator, Michael Piquer, Gualterus Arsenius, Adrian Descrolières and Adrian Zeelst. Arsenius's instruments account for most of the entries – he was by far the most prolific of the Louvain makers – but there is also a significant number by the previously overlooked maker Zeelst. Several of the unsigned instruments have in this work been attributed to their makers for the first time.

While the catalogue gives adequate information about most of the items, I could have wished for more detailed descriptions in some cases, and other readers might want a glossary covering some of the technical terms. However, the most distressing gap was in the illustrations: some instruments were shown in detail, with several photographs, but others received no representation at all. This was most annoying where it resulted in a particular type of instrument (the very unusual models of the planetary spheres by Descrolières) having no accompanying photograph. Although reference was given to a work that does contain photographs this was a poor substitute

for an immediate image – a catalogue like this should be able to stand firmly on its own without requiring props from other texts. Where there are photographs of the instruments the quality is very variable; some are admirably clear and allow errors in transcriptions (of which there are several) to be noted, while others provide no possibility of viewing any of the details.

Unfortunately, poor typesetting has led to a high number of errors and omissions in the catalogue entries – for instance, page references to other examples are frequently missing. However, these only occasionally detract from a useful book, which brings the instruments of a significant craft tradition to general notice and encourages the reader to take note of the artistry as well as the technical skill manifested on these objects. As David King writes in his preface, 'The field desperately needs competent catalogues of instruments' (p. ix) – and here we find a worthy example.

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BARBARA M. BENEDICT, **Curiosity: A Cultural History of Early Modern Inquiry**. Chicago and London: University of Chicago Press, 2003. Pp. ix + 321. ISBN 0-226-04264-2. £17.50, $25.00 (paperback).
doi:10.1017/S0007087405266967

The concluding sentence of this volume is: 'Curiosity is the ambition to go beyond' (p. 254). This is the central theme of this interesting examination of what were perceived as transgressions of class, political, religious, moral and gender boundaries by new objects and modes of enquiry. Despite the book's subtitle, its scope is limited to the analysis of literature and periodicals in England from the founding of the Royal Society to 1820. Wholly new objects of curiosity were added during this period by a shift to 'the pursuit of information by empirical means' (p. 23). Critics defending the status quo saw those pursuing them as themselves objects of curiosity.

The experiments conducted by the Royal Society and the attitudes of the virtuosi were satirized by Aphra Behn, Samuel Butler, Thomas Shadwell and Jonathan Swift, and were mocked as frauds and as useless. New objects of curiosity evolved with the expansion of commerce and wealth, with the growth of the middle class and increased literacy, and were discussed in newspapers, journals and novels. New opportunities for consumption increased visual curiosity in several ways. Among them was the acquisition and collection of unusual and rare objects – an outgrowth of the earlier cabinets of curiosities of the virtuosi. In many cases this was less an expression of curiosity than of attempts to appear cultured or a connoisseur. Individuals pursuing new areas of inquisitiveness were attacked for their ambition and for their self-indulgence, as exhibiting idle curiosity with no social function and as threatening the social order.

An important aspect of the changing nature of curiosity was the role of women, who constituted a growing and influential readership. Poems were written expressing curiosity about the nature of sex, the female sex organs and the pursuit of sexual pleasure. The curiosities expressed by women became an object of wonder, derision and satire beginning in the eighteenth century. Women were attacked for self-exposure and as idle, silly, prurient and non-systematic.

The later eighteenth century saw extensive interest in freaks, dwarfs and giants, the raising of the dead, ghosts, and a multiplicity of wonders. There was wide interest in exhibits of tricks by horses, of strange and 'intelligent' animals, and unique exercises of horsemanship. The curious consumers of these wonders were themselves criticized as monsters. Ballooning, initially seen as an example of scientific progress, was around 1780 converted into a form of entertainment. Thousands came to watch ascensions. A literature arose mocking the pretensions of 'science', and on the vanity, hubris and fraud associated with ballooning enterprises. Critics deplored the absence of limits and lack of boundaries in science. Science also was held to strip away the mystery of life and of wonder by objectification.

Some ambivalence, however, may be seen in the Romantic period, when many writers became enamoured of revolution and social equality, 'but they did not lose the traditional fear of the dangers of curiosity' (p. 244). Mary Shelley's *Frankenstein* exhibits scientific curiosity as a violation of the divine order and alienation from nature through the creation of a monster, yet it shows sympathy for the monster and the scientist.

Benedict has chosen to ignore the development of new areas of curiosity about religion, psychology, politics, economics, the arts and the sciences. She says her book 'is not a history of science', yet, she continues, 'I analyze literary representations of the way curious people, including scientists, authors, performers, and readers, were engaged in practicing and producing curiosity itself' (p. 1). While describing Francis Bacon's justification for the pursuit of natural philosophy as a means for the improvement of the human condition, she omits the Baconian concept of knowledge as wrested from nature. Emphasizing a passive empiricism, Benedict keeps referring to the 'scientific method', yet neglects curiosity directed by experiment, or the search for harmony in uniting disparate areas of knowledge into a unified whole. Idle curiosity, in which nothing new is learned, is emphasized; curiosity that satisfies a sense of structure characteristic of what we mean by knowledge is ignored. Surely the increasing number of popular works, lectures and exhibitions on science could have been mentioned. Moreover, the shape of curiosity had begun to change in England well before the beginning of Benedict's story. Empiricism did not begin with the founding of the Royal Society. The curiosity expressed by Gilbert and Harvey, the response to discoveries with the telescope and microscope, and to the people, flora and fauna found in the New World, marked significant turning points.

Despite Benedict's very dense prose style, which could have been more effectively edited, her book nevertheless raises a host of interesting questions concerning responses to the novel areas of curiosity in the period under examination. She has examined a vast literature on a limited aspect of this most interesting and complex aspect of human behaviour. Her work is stimulating and valuable for the questions it raises, and opens up a host of issues deserving further examination.

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Carl von Linné, **Nemesis Divina**. Edited and translated with explanatory notes by M. J. Petry. Archives internationales d'histoire des idées, 177. Dordrecht, Boston and London: Kluwer Academic Publishers, 2001. Pp. xviii + 483. ISBN 0-7923-6820-7. £119.00, $169.00 (hardback).
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This book is a fascinating addition to the ongoing reappraisal of the Enlightenment, from new expositions of local contexts and scientific practice to reassessment of the realms of spirit and the flesh. Natural philosophers who addressed the human condition should make fine material for enquiry into the relations of science to rational religion and morality. M. J. Petry's annotated text and rich introduction provide just such a look into Linnaeus's view of the relation of the physical and mental in man-the-animal. In this private manuscript, available now in a definitive English edition, we see behind the public face of Newtonian natural history and its programmatic statements to Linnaeus's religious and moral inspirations.

Linnaeus's text is structured as a series of statements about the basis of human biological, social and spiritual life. Linnaeus arranged quotations and proverbs, both folk and classical, on human nature. These he intermixed with observations from the natural world, listing relevant physical traits and behaviours. Occasionally the presentation is syllogistic, more commonly a compilation of aphorisms. Illustrating each are short anecdotes, in which a character meets with Providential retributive justice (Nemesis) for his behaviour. For these, Linnaeus drew on his own experience, written accounts and word-of-mouth knowledge. The tales are harsh, full of downfall and suffering, although at times coarsely amusing over behaviour and the ironic vengeance exacted on

the wicked. In totality it builds a case for the animality of man, driven by passions, comparable in physiology and behaviour to animals and plants, despite his possession of a soul. Nature, fate and Providence combine with intention, as revealed in the individual case studies. In each category, be it incest or riches or pride or relations with parents, the stories illustrate what happens, justly, to those who violate moral principles.

The manuscripts themselves date from the early 1760s, just after the definitive tenth edition of *System of Nature* and in the midst of other theodicies on suffering and the economy of nature. The text takes only 144 pages of the present book; half the volume is taken by Petry's extraordinary notes on Linnaeus's sources and details of his case studies. Petry also compares Linnaeus intellectually with other natural theologians, and places him within contemporary politics.

Reading the odd flow of aphorisms, proverbs and short parables of action and fate one encounters neither a finished publication nor a reasoned public dissertation. It is more like a research notebook, but a notebook that has been arranged into theoretical order after jotting down all the bits. The technique shows us something about early views of evidence and argumentation. Natural history was a search for grand systems, built by piling up anecdotes and examples and collections. Meant as a catalogue of evidence, Linnaeus also saw the arrangement as a synthetic, rational sequence revealing how the human spirit develops from biological and social passions to moral knowledge and spiritual self-knowledge.

The text is also idiosyncratic, immersing us in one man's world view, with its tenor of dismay and disgust over the human physical condition, a fascination with sin and penalty, and a desire to work out empirically a vision of the tangled net of interactions in which humans are caught. Proceeding from the passions through to the spiritual, Linnaeus strives to build a convincing argument that there is indeed divine order and justice in the world. The regularities of the natural world that naturalists were organizing along Newtonian ideals provided Linnaeus with an instructive contrast to the apparent disharmony and mystery of human affairs.

Like the best of cases where we acquire new primary source material, immersing oneself and dwelling for a while in Linnaeus's mindset allows us to re-examine our organizing themes for his work. Linnaeus has been an epitome of rationalist projects, with his massive attempt at cataloguing the world's biota. This book joins the analytical and biographical studies of recent years in broadening Linnaeus's intellectual life. Granting access to Linnaeus's philosophical musings about humanity, it reveals the strong urge to manage, scientifically, matters of morality. Certainly Linnaeus's goal to write theodicy has been apparent, as have his political and economic concerns. Nonetheless, Linnaeus kept this material private, and scholars have mostly used the structure and content of his *System of Nature* and smaller works to examine his systematic and ecological vision of the world. Petry's contention is that earlier Swedish versions of *Nemesis Divina*, published periodically from 1848 to 1960, missed the awareness of how this material fitted into Linnaeus's systematic thinking. In particular, the reconstructed project can be seen in the 'Note on Man' in the last edition of *System of Nature*. Petry's accomplishment has been to bring out more fully Linnaeus's theological vision of human nature in a web of cause and effect.

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Jean-Luc Chappey, **La Société des observateurs de l'homme (1799–1804): Des Anthropologues au temps de Bonaparte**. Bibliothèque d'histoire révolutionnaire, 5. Paris: Société des études robespierristes, 2002. Pp. 573. ISBN 2-908327-45-7. €46.00 (paperback).
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Established in January 1800, the Société des observateurs de l'homme held its first public meeting in August of the same year. Within the space of two years its rooms at the Hôtel de la

Rochefoucauld, in the rue de Seine, saw the activities and at times just a quick visit by members of a very heterogeneous group of savants, philosophers, literary figures and *instituteurs* (to the right and left of a shaky political spectrum) willing to supplement their meagre and uncertain salaries by undertaking a variety of editorial jobs. The société's trajectory was as remarkable as it was short-lived: by 1804 it had faded away, and it was completely forgotten until key protagonists of the early institutionalization of French anthropology during the middle decades of the nineteenth century (Paul Broca and Ernest-Théodore Hamy), and of the rivalry with British colleagues, resuscitated it to the role of mythical precursor of the modern science of man. That, needless to say, was unquestionably French.

Jean-Luc Chappey's masterful study represents a fundamental revision of long-cherished, highly ideological accounts of the life and achievements of the société. To take only one instance of the depth of the revision proposed by Chappey, it is sufficient to recollect that the *observateurs de l'homme* have been seen as the prototypes if not the heroes of the republican, materialist, a-religious if not positively atheist effort to exclude traditional philosophical or Christian accounts of man's physical and moral accomplishments. The société, following this highly successful interpretative line (endorsed, among others, by Georges Gusdorf, Michel Foucault and Sergio Moravia), represented the heyday of the *idéologues*' influence, and it fell with them, after Bonaparte's closing down of the moral and political sciences section of the Institut, in 1802. Painstaking archival work, the systematic prosopography of well- and hardly known personalities, and the perusal of large numbers of contemporary periodicals and political pamphlets allow Chappey to trace the origins of the société within traditionalist, very conservative Catholic circles, fiercely opposed to the *idéologues* and to what they regarded as the unchristian scientific values promoted by the political authorities of the Directoire. Rank-and-file Catholic publicists – *seconds couteaux*, as Chappey aptly calls them – led by the Abbé Sicard, the famous and politically experienced instructor of deaf and dumb children, announced the constitution of the société well before it existed. Chief among its immediate objectives was the vindication of the right of the Abbé Sicard, and of the institute for the deaf and dumb he directed, to be granted the exclusive privilege to study and educate the then and still now famous wild child of Aveyron. The long-term strategy was to open a space for a Catholic comeback – culturally and philosophically, as well as, literally, the return of exiled members of the clergy or of Catholic intelligentsia.

The success of the société during 1801 and 1802 attracted a variety of intellectual actors, some indeed sympathizers of the *idéologues*, or active promoters of their intellectual agenda. Chappey's excellent study of the social, political and intellectual career of scores of figures related to the debate on man's moral and physical attributes emphasizes the difficulty of living in uncertain times, when the final outcome of the revolutionary decade was still very much open; many felt it safer to be present wherever visibility and good contacts could be gained. Many Catholics and (former) atheists, conservatives and (former) Jacobins compromised with the Terror could not afford to disdain temporary social and intellectual intercourse with colleagues belonging to factions likely to emerge as the intellectual spearheads or the coriphers of a new order – whatever the order. The rapid ascent of Bonaparte, and the consolidation of a new conservative regime, open to the Catholics and ready to confide the study of man's higher faculties and superior nature to traditional philosophical and religious reflection, made the société superfluous in the eyes of the Catholics who had established and run it. At the same time the pursuit of a study of man as some of the *idéologues* conceived it became socially and politically unacceptable if not unsafe. Scientists and philosopher–scientists were sent back to their barracks, implicitly and explicitly invited by the new ruler to leave the subject of man, and of society, to those who knew how to run consciences and people.

This short summary of the main theme of Chappey's book is far from exhaustive, and renders no justice to the many new insights it provides on the close and complex relationship between

science, society and politics in the years of Bonaparte's rise. Readers patient enough to plough through the more than five hundred pages of close print – unfortunately, French doctoral dissertations below four pounds in weight are not taken seriously by the system – will be amply rewarded by this important, innovative and excellent study.

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ROBERT J. RICHARDS, **The Romantic Conception of Life: Science and Philosophy in the Age of Goethe**. Chicago and London: University of Chicago Press, 2002. Pp. xix + 587. ISBN 0-226-71210-9. £24.00, $35.00 (hardback).
doi:10.1017/S0007087405296966

Forty years ago history and philosophy of science was a package, but fashions have changed and it brings the shock of surprise, in which Romantics delighted, to meet again with science treated as applied logic. Because Richards's focus is closely upon Germany, especially Jena, where *Naturphilosophie* was born in a small and intense group of thinkers and experimenters, this approach is highly appropriate. His book is very learned, with footnotes in nineteenth-century fashion sometimes taking up almost half the page; his style is sometimes a bit sticky – he likes words like 'limn' and 'bosket' – and Germanic, but especially when biographical it gets livelier. 'My effort', he writes (p. 5), 'is first to observe the leading ideas of these individuals as they emerged from the interstices of personal interactions and then more carefully to explore those conceptions in order to reveal their inner logic and external relations'. Thought, that is, cannot be divorced from lives and lifestyles, especially in this case, and because the lives are intertwined, with women playing crucial roles, the story coheres and illuminates at least a central part of the elusive 'Romantic movement'.

For Liebig, *Naturphilosophie* was the Black Death of the nineteenth century, and despite Helmholtz's partial rehabilitation of Goethe's science, it seemed implausible to place this romantic science in any mainstream, especially when philosophy of science was closely linked to versions of positivism. To see polar forces everywhere was not exactly to anticipate the electrochemistry of Davy and Berzelius, or the laws of thermodynamics, and urplants and other archetypes seemed a long way from the close study of taxonomy, distribution and the fossil record that lay behind Charles Darwin's evolutionary theory, with its connections to Paley and Malthus. Richards seeks to show that this is wrong. Members of his cast of characters were doing serious science, genuinely proposing evolution. They not only made Darwinian evolution readily acceptable in Germany, but were part of its prehistory; Charles Darwin is for him a romantic biologist, bringing from Alexander von Humboldt not merely an aesthetic enthusiasm for tropical fecundity but an organic and value-laden vision of nature. Not the glum naturalism that many perceived, but good coming from evil, altruism from the struggle for existence, teleology and progress rather than mechanism, are what Richards sees in the *Origin of Species* and *Descent of Man*.

Richards conveys the excitement of Jena, a blissful dawn, and the particular importance of Schelling; but one-third of the book is concerned with Goethe and his 'scientific revolution'. Here we meet 'the erotic authority of nature': fine art, science, nature and women all coming together in the hands of genius – a term we find being applied to men of science, as Wordsworth did in response to Davy, in recognition that they too were creative. This macho worship of the goddess Nature, philosophically grounded in Spinoza's 'natura naturata', was very different from sober 'Newtonian' analysis of clockwork. Goethe's botanical and anatomical study led into morphology, to the vertebral theory of the skull, to the archetypes that became central to understanding life and its variety in Owen's less exuberant hands, and then to Darwin and Haeckel.

We might notice that Darwin had an evolutionary shrub where Haeckel had a tree, and wonder about their affinity. Jena was a small place, and Weimar nearby, so informal and immediate contact was the key. But as Alexander von Humboldt recognized, Paris was really the centre of things in science. There, making a career, one specialized, published in journals, taught in institutions and sought to establish laboratories and research schools in the new world of 'professional' science that was opening up. It was not to be long, and Wilhelm von Humboldt's University of Berlin was a leader, before this kind of science spread to Germany, Britain and beyond, and these aspects are what historians of science have mostly looked at since their ties with philosophers have weakened. They went with empiricism, or even positivism, while fine writing was left to travellers and popularizers. But reading Richards, one cannot doubt that despite Charles Darwin's distaste for Oersted's *Soul in Nature* (1852), and the row in the Ray Society that attended the publication of Oken's *Principles of Physiophilosophy* (1847), romantic ideas about the nature of life cannot be sidelined. They were an important part of the cultural dimension of science. Richards reminds us of people and events that historians of science must take note of; it is therefore a pity that he does not cite English translations of his primary sources where these are available.

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HUGH TORRENS, **The Practice of British Geology, 1750–1850**. Variorum Collected Studies Series, CS736. Aldershot: Ashgate, 2002. Pp. 372. ISBN 0-86078-876-8. £59.50 (hardback).
doi:10.1017/S0007087405306960

To those familiar with the history of the earth sciences, the name of Hugh Torrens will be quite familiar. Over the past few decades he has remained committed to excavating the life and work of forgotten personalities who had a notable effect upon how the Earth's subterranean composition was viewed in Georgian, Regency and Victorian Britain. For the most part his research has intentionally avoided many of the grand-scale theories written by armchair philosophers. Instead, he has focused less on the 'thinkers' and more on the 'doers' who shaped the practice of collecting minerals, drafting stratigraphic maps, fashioning drills and extracting extraneous fossils. In pursuing these topics, he has delved deep into previously untapped and often remote archival collections and he has gone to great lengths to locate defunct material objects often missed by historians enamoured of paperwork and published sources.

Because of the specific nature of Torrens's research, he has often chosen to publish his articles in journals and edited books that are not mainstream sources for most historians of science. *The Practice of British Geology* is a collection of such works and its publication makes it easier for Torrens's research to be housed on the shelves of university libraries. The book's chapters are previously printed articles, most of which came out during the 1990s. On the whole, Torrens interprets the word 'geology' quite liberally and this allows him to address a plethora of episodes in the history of the earth sciences, including events that are sometimes narrow-mindedly included under the history of chemistry, mineralogy, palaeontology and even the social construction of scientific societies and periodicals. Additionally, though most of the book's chapters focus upon Britain, there are sections devoted to America, Italy and Australia. In every essay the reader will encounter the names of miners, surveyors, cartographers, prospectors, lapidaries, conchologists, engineers and travellers that have received scant attention elsewhere. Indeed, the book's index is itself an invaluable reference resource and its breadth points to Torrens's impressive forty-six geologically relevant entries in the new *Oxford Dictionary of National Biography*.

Throughout the book, the careers of the following 'practical geologists' receive close attention: John Williams (1732–95), William Smith (1769–1839), John Farey (1766–1826), James Ryan

(c. 1770–1847), Arthur Aikin (1773–1854) and Joseph Harrison Fryer (1777–1855). On top of pointing out how these men fashioned the practices that would eventually lead to the modern discipline of geology, Torrens also demonstrates a remarkable and sometimes macabre fascination with studying the foibles, disputes and infortitude that often brought intellectual infertility or economic hardship (and perhaps this proclivity also explains why such a surprising number of illegitimate children are mentioned throughout the book). In pursuing such biographical and economic themes, Torrens's work complements similar methods used in histories of science over the past three decades – particularly the economic motifs of the 1960s and 1970s, and the biographical approaches used during the 1980s and 1990s.

In keeping with his focus on the earth sciences, Torrens also mentions several personalities whose names are commonplace in British colonial, industrial and scientific history. For instance, Torrens points out that Sir Joseph Banks sought to learn more about minerals when he unexpectedly inherited an Overton estate that contained mines. This interest was then transferred to the exploration itineraries that he engineered as President of the Royal Society. There are also informative references to Joseph Priestley's classes at Warrington Academy, James Hutton's travels in the Peak District, Charles Lyell's surveying trip to America, and the following assessment by Josiah Wedgwood of Emanuel Mendes da Costa: 'I thought him to be the most disagreeable mortal who bore the name philosopher that I had ever known' (III, 218).

Overall, Torrens's staccato prose describes several forgotten chapters of geological history and the evidentiary strata of his arguments are firmly cemented together with his view that we 'should have learned from history the danger of allowing the protagonists in any scientific advance to prejudge the history of that advance' (X, 13).

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David Philip Miller, **Discovering Water: James Watt, Henry Cavendish and the Nineteenth-Century 'Water Controversy'**. Science, Technology and Culture, 1700–1945. Aldershot: Ashgate, 2004. Pp. xiii + 316. ISBN 0-7546-3177-X. £55.00 (hardback).
doi:10.1017/S0007087405316967

Water has always been a controversial 'stuff'. Was it the basic material from which all things were made? Could it be transformed into earth and air, or even into nitrogen? Was it an element or a compound? Was it a molecule with an atomic composition represented by HO, H_2O or hydrogen-bonded in an H_3O array? Does the anomalous polywater exist? Does water exist in water, as contemporary philosophers of chemistry like to ask?

The question of whether water was a compound was answered decisively in the last two decades of the eighteenth century when the factitious airs later named hydrogen and oxygen were exploded into water by the electric spark, and steam was reduced over iron into hydrogen and oxide of iron. The analysis and synthesis of water provided one of the key foundations for a new system of chemistry and for what historians of chemistry have always called 'the chemical revolution'. But who deserved the credit for establishing the compound nature of water: James Watt, Henry Cavendish or Antoine Lavoisier?

The 'facts', as perceived at the time, seemed clear enough. While investigating the heat liberated when atmospheric air was exploded with inflammable air (hydrogen) by an electric spark in 1781, Joseph Priestley noted the presence of water droplets in his eudiometer. He reported the observation to Cavendish, who was interested in how airs became phlogisticated. Cavendish repeated the experiment quantitatively. In 1784 he reported to the Royal Society that when exploded in the exact proportions of four parts air to one part inflammable air, 'plain water' was produced. Prior to publication Cavendish passed this observation back to Priestley, who duly told his Lunar Society friend James Watt. The latter, in the tradition of Joseph Black, was deeply

interested in the role of heat in maintaining the physical state of 'airs'. Watt drew the conclusion that water was a compound of pure air and inflammable air, which he identified as phlogiston. Watt made no public pronouncement concerning the compound nature of water until after Lavoisier and Laplace described their experiments and conclusion that water was a compound of hydrogen and oxygen in 1784. Watt then circulated claims of priority of discovery, only to find himself forestalled by the appearance of Cavendish's Royal Society paper. Despite some contemporary bitterness concerning Lavoisier's intervention, Watt seems to have accepted that Cavendish deserved the honour of the discovery in terms of priority of publication. From a later historical perspective, of course, neither Watt nor Cavendish interpreted the composition of water in Lavoisier's terms though, as Miller ably demonstrates, because of Cavendish's experimental skills and quantitative approach to experimental design and execution, it was easy to reinterpret his findings in the language of Lavoisier's new chemistry. To all intents and purposes the first low-key dispute was settled in favour of Cavendish, at least by the British.

Why, then, did a far more bitter controversy break out thirty years later? It was certainly not because the scientific community had suddenly become more historically minded. According to Miller's finely honed and convincing argument, we must look for a sociological explanation for why the attribution for discovering the composition of water came to be given to Cavendish rather than to Watt. Miller's purpose is not to provide a historical verdict on who did first identify water as a compound, but is rather to study how rival constituencies chose one candidate over another. The attribution to Watt was revived in the 1820s by James Watt junior, the Mr Gradgrind of the controversy, as an act of filial tribute. His father's case was to be based upon dates, like the figures in a business account, as he told Dominique Arago. The Frenchman, who was no stranger to controversy, had his own agenda to reform French scientific institutions and to industrialize France with steam power. For Arago, Watt was the ideal model of his vision of the organization of science in which science and practice worked jointly to promote economic progress. This was the gist of his eloge of Watt that was eventually published in 1839. To the British university elite of gentlemen of science, however, Watt was merely an empirical industrialist who could never provide a model for the kind of pure disinterested science they wished to see a British government supporting. Cavendish provided a much better icon of the pure research, driven not by commerce but by natural curiosity and mathematical and experimental precision. Accordingly, Vernon Harcourt, one of the chief supporters of the British Association, reasserted Cavendish's priority by producing strong chemical arguments for the attribution. Watt's supporters were chiefly Scottish lawyers and literary figures like Henry Brougham, James Patrick Muirhead (Watt's eventual biographer) and Francis Jeffery. The chemical community, newly organized around the chemical and pharmaceutical societies in the 1840s, rebutted Watt's case by forming the Cavendish (book) Society, which sponsored George Wilson's biography of Cavendish that gave the water prize to him in 1851. In an elaborate and fascinating overview of attributions awarded for or against Watt and Cavendish in encyclopaedias and chemistry textbooks between 1840 and 1890, Miller shows how the controversy was largely closed in favour of Cavendish.

Despite some stylistic problems, such as the repeated restatement of the main argument and the awkward placement of Wilson's defence of Cavendish before the attributional survey, this is a fascinating addition to the literature on the nature of discovery. Miller brings great clarity to the water debate and provides an impressive sweep of private correspondence that reveals the hidden negotiations, animosities and fears that drove the controversy. The vacillating views of David Brewster and of Wilson are particularly revealing for the social argument. Now that access to Watt's papers is easier (they were moved to Birmingham Public Library after Miller's study was completed), the book will also prompt closer analysis of Watt's extensive chemical work.

Had there not been a water controversy, Wilson might never have written his Cavendish biography. In that case, British chemists in the 1890s might never have been aware of Cavendish's meticulous observation that a bubble of 'air' resisted the electric spark. In practice, it was reading Wilson's biography that prompted Dewar, Ramsay and Rayleigh and their respective supporters into a viciously conducted row over whether the bubble was nitrogen or an unknown gas and who deserved the honour of discovery. Miller's study provides an excellent model for understanding this later 'argon controversy'.

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Augustí Nieto-Galan, **Santponç – Monturiol – Isaac Peral: la seducción de la máquina vapores, submarinos e inventores**. With a Preface by Saturnino de la Plaza. Novatores, 2. Madrid: Nivola, 2001. Pp. 129. ISBN 84-95599-10-4. No price given (paperback).
doi:10.1017/S0007087405326963

This little gem of a book is a wonderful account of technological development in Spain in the nineteenth century. It ranges from the introduction of steam engines to the Catalan textile industry, to two cases of inventors of submarines, one roughly in mid-century, the other at the end. It is meant for a broad public, and succeeds admirably in bringing the arguments of modern history of science and technology to that wider audience (though not, it must be said, to the author of the Preface). The multiple biography, covering a wide period and many themes, is very well suited to such a task, which is here carried out with aplomb. This is popular contextual history of science and technology of a high order.

There are very particular problems associated with the writing of the history of science and technology in most parts of the world. Unlike the few major centres of scientific and technical innovation, whose histories define what we mean by the history of science and technology, most places in the world, however hard they try, can line up few giants so certified by metropolitan power and authority. Spain is a typical case – the anglophone world will barely register any scientific or technical Spaniards of note, though writers, painters, musicians and certainly bullfighters are another matter. Yet there is a history of science and technology to be told, and it is an interesting one. The first case is of the bringing of the steam engine, not to Spain, but to the emergent textile mills of Barcelona around 1800. This was the work of an enlightened medical doctor steeped not only in French medicine but also in French mechanics and liberal frenchified politics. This is a world of museums of machines, schools of mechanics, intertwined theory, practice and reform. Francesc Santponç (the name is Catalan, not Spanish) was like, it seems, a key member of a Mediterranean Manchester Lit & Phil or indeed Lunar Society. Narcís Monturiol, also a Catalan, was a radical lawyer from mid-century, a reformer who built two submarine boats (what he called fish-boats), both tested in Barcelona harbour. He is wonderfully compared with his fictional near contemporary Captain Nemo, the extraordinary captain of the *Nautilus*, Jules Verne's creation in *Twenty Thousand Leagues under the Sea*. As it happens Monturiol is now the subject of a book in English (Matthew Stewart, *Monturiol's Dream: The Extraordinary Story of the Submarine Inventor who Wanted to Change the World* (New York, 2004)). The last of the trio was Isaac Peral, a naval officer of humble background and republican politics, and also a follower of the so-called *jeune école* movement of naval officers who looked to radically new small warships which could defeat large conventional fleets. The Navy built his pioneering electrically powered submarine, but in a complex story in which politics is central the young naval officer's invention became a very public symbol of technological progress in the face of a reactionary establishment. What would later be seen as the first modern submarine was abandoned, and its inventor went from extraordinary fame to being ignored and an early death

very quickly. Spain would not get its first submarine until 1916, bought from the USA, the nation which had defeated Spain so significantly, for Spain, in 1898.

This then is a story of assimilations and inventions themselves of great interest, where the links to politics, to national and regional projects, are effortlessly made in the narrative.

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Uwe Hoßfeld, Lennart Olsson and Olaf Breidbach (eds.), **Carl Gegenbaur and Evolutionary Morphology**. *Theory in Biosciences*, 122, 2–3 (special issue). Jena: Urban & Fischer, 2003. Pp. 198. ISSN 1431-7613. No price given (paperback).
doi:10.1017/S000708740533696X

Carl Gegenbaur (1826–1903) was one of the most influential figures in German morphology. Although crucial in founding and establishing the whole discipline, he was overshadowed by his more prominent contemporary Ernst Haeckel, who was his colleague at the University of Jena for many years. Haeckel still gains more attention due to his striking evolutionary simplifications. Gegenbaur's contributions to the field were, however, much more serious and better founded in empirical studies. Based on his extensive studies in comparative anatomy of vertebrates in particular, Gegenbaur published several textbooks on the topic, which were published in two or more editions and translated into many languages. Gegenbaur was involved in almost every debate arising in comparative morphology during the second half of the nineteenth century and accompanying the establishment of evolutionary theory, for instance the development of the vertebrate head and the origin of vertebrate limb structures. A comprehensive treatment of Gegenbaur's career and ideas is thus certainly overdue.

The present special issue of *Theory in Biosciences* attempts to fill this gap by providing an overview of Gegenbaur's contributions in all their diversity. In twelve articles the authors deal with a variety of issues, ranging from the institutional environment, the equipment of Gegenbaur's chair and his visible influence on collections, to modern approaches based on his fruitful concepts. The paper by Uwe Hoßfeld and Lennart Olsson treats the institutional development of comparative anatomy in Jena. It is supplemented by the contributions of Luminita Göbbel and Rüdiger Schultka and Michael Ghiselin, which are devoted to personalities who either had a scientific influence on Gegenbaur, like Johann Friedrich Meckel the Younger, or who were themselves influenced by his approach, like Anton Dohrn. Rosemarie Fröber gives a historiographical account of the anatomical collection in Jena. In 1873 Gegenbaur took a chair at the Heidelberg University and became founder of a research school, which was manifest, for example, in a particular method of comparison and evolutionary inferences. This process is studied by Lynn Nyhart in her paper. The contribution of Olaf Breidbach provides a detailed reconstruction of Adolf Naef's idealistic morphology offering in some respects a counter to Haeckel's biogenetic law. This first set of papers is devoted to issues of rather historical and/or theoretical interest.

The second set of papers introduces recent topics in morphology having been based on Gegenbaur's seminal concepts and ideas. The contribution of Manfred Laubichler and Jane Maienschein is devoted to cell lineage studies playing an important role in American cell biology. The papers by Christian Mitgutsch, Shigeru Kuratani and Lennart Olsson deal with head development from a comparative as well as developmental and evolutionary perspective. The last two papers, by Michael Coates and Heiner Grandel, finally discuss comparative and evolutionary aspects of limb development. The second set of articles especially provides ample evidence of how influential and fertile Gegenbaur's concepts still are in recent morphology. However, relating recent approaches and research questions convincingly to Gegenbaur's method of comparative anatomy requires detailed methodological and theoretical reconstructions.

This issue of *Theory in Biosciences* touches a large number of issues and encompasses some excellent teasers. In terms of the history of concepts and ideas it provides a delightful foretaste of more detailed studies of contributions to the establishment of evolutionary theory by German morphology. Lynn Nyhart's book *Biology Takes Form* (Chicago, 1995), although focusing rather on the institutional establishment of German morphology, represents a single endeavour in this respect available for an English-speaking readership. The issue of *Theory in Biosciences* offers a variety of different perspectives and may thus not replace a careful study of Carl Gegenbaur's contribution to the establishment of evolutionary theory as a general framework of understanding. A comprehensive reconstruction of Carl Gegenbaur's methods and concepts is still desirable and would contribute much to the acknowledgement ultimately deserved by one of the most influential morphologists from Germany.

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STEVEN J. DICK, **Sky and Ocean Joined: The U.S. Naval Observatory 1830–2000**. Cambridge: Cambridge University Press, 2003. Pp. xiii + 609. ISBN 0-521-81599-1. £90.00, $130.00 (hardback).
doi:10.1017/S0007087405346966

Histories of scientific institutions, as the author notes, are relatively sparse in the history of science. This is particularly true of nineteenth-century American institutions, and especially astronomical organizations. The US Naval Observatory, as the oldest of these, has perhaps been neglected owing to the routine nature of its work. It has been responsible for maintaining the Master Clock, and thus the time standard for the United States; it studies positional astronomy, and determines the parameters of Earth orientation; and it compiles sundry almanacs relating to astronomy, geodesy and navigation. Consequently this book classifies the work undertaken at the Naval Observatory as 'normal science' in Thomas Kuhn's sense, and 'falls largely within that category which he calls "'data gathering"' (p. 22). Despite the institution's circumscribed remit, this is not a history that over-emphasizes progress and order. Indeed, it attempts to represent the sometimes chaotic nature of science from the perspective of its practising scientists. Dick distinguishes his book from the majority of written history of science 'which emphasizes revolutionary events and heroic figures', and identifies it as more representative of the majority of science which has yet to be discussed in print by historians.

Written over a period of fifteen years at the Observatory, the book focuses on three perspectives: the history of astronomy, of science in America and of navigation in the context of the US Navy. The institution was part of a national observatory movement, and a relative latecomer in the pattern of governments supporting astronomy for the national interest. It began as the US Navy's Depot of Charts and Instruments in Washington, DC in 1830, following several previous attempts to found a national observatory for accurate coastal surveying. For such purposes, stellar position measurement, prediction of planetary positions and accurate timekeeping were crucial scientific activities. One of the interesting lines explored by the book is the institution's interactions between traditional 'positional astronomy' and the newer subject of astrophysics. As one of the guardians of the older tradition, the Observatory came to be seen as increasingly outmoded during the twentieth century, but it has been rehabilitated by more recent recognition of the links between positional astronomy and modern astrometry.

A permanent American science was established during the lifetime of the Naval Observatory, and the book explores its wider interactions with individuals and organizations. It again divides the history into three parts: the founding era up to 1865, the golden era of 1866 to 1893, and the twentieth century. During the founding period it was transformed from a small depot for navigational data and instruments into a national observatory under the supervision of Matthew

Maury, who departed in 1861 to join the Confederate cause at the start of the American Civil War. The book explores the importance of individual actions, policy-making and political manoeuvring in establishing and expanding the institution. The golden era, by contrast, is discussed chiefly through the work of three scientific figures: Asaph Hall, who employed the Observatory's Great Refractor telescope to discover the moons of Mars; William Harkness, who directed the observations of the transits of Venus in 1872 and 1888; and Simon Newcomb, Professor of Mathematics, US Navy and later Superintendent of the Nautical Almanac Office, whose wide-ranging work included mentoring Albert A. Michelson and their precise determination of the speed of light. The activities during the twentieth century focused on identifying new uses for the astronomy of position, and much more accurate means of measuring and disseminating time and navigational information.

The institution drew its original mandate and scope from the needs of the US Navy. In this respect, it is interesting to contrast its history with later small science-centred government agencies within a large agency (i.e. the Department of Defense); one recent study that springs to mind is Jeffrey T. Richelson's *The Wizards of Langley: Inside the CIA's Directorate of Science and Technology* (Boulder, 2001). Authority over the Naval Observatory, which was passed between six different Navy organizations over its 170-year history, illustrates the variable relationship between purposeful applied research and less tethered investigations.

This is a relatively expensive but finely produced book rich in detail about an early exemplar of American institutional science, and one that complements studies of its other nineteenth- and twentieth-century counterparts very well.

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Helen Small and Trudi Tate (eds.), **Literature, Science, Psychoanalysis, 1830–1970: Essays in Honour of Gillian Beer**. Oxford: Oxford University Press, 2003. Pp. vii + 255. ISBN 0-19-96667-0. £50.00 (hardback).
doi:10.1017/S0007087405356962

Gillian Beer won my undying approval when she was awarded her DBE in 1998, not merely for the tribute itself but for her response to it. Her press release, as quoted in the local Cambridge paper, contained the word 'nice' about three times in two sentences, breezily flouting my old English teacher's moratorium upon that lame approbation. It was nice to receive an award, nice that English literature was being recognized, nice to meet the Queen (or something – my memory may not be entirely reliable). Here was one of literature's greatest luminaries, completely unafraid to rewrite the rules.

This collection of essays in Beer's honour echoes that simple act of defiance. As Helen Small writes in her introduction, Beer's researches have, notwithstanding their literary and historical rigour, been marked by a confidence to seek out the childlike curiosity expressed by their oft-elevated subjects, and indeed to nurture that unlikely quality in academics. Hers is an ability to un-think the canonical and to re-engage with heart-felt questions, a willingness to entertain 'new and perhaps heretical plots' (p. 3).

First, let me deal with the collection's weakness, which paradoxically is a function of its strength. The sheer breadth of the collection, in terms of both subject matter and approach, means that some essays will inevitably be more appealing to readers than others – a significant issue given the book's cost. Though there are natural affinities between small clusters of essays (such as those on psychoanalysis, or those on children), and although an attempt has been made to bridge those essays which are not naturally linked, the danger is that they end up detracting from one another, like too many colours swirled together all at once.

Thus we range through arguments for the supervenience of Humboldt's intertextual influence on Darwin, the non-equivalence of regarding a metaphorical theory as 'ideological' and 'wrong', Freud's implicit critique of the representational potential of language, the problematic place of childhood in Victorian psycho-evolutionary hierarchies and its eventual dissolution as a meaningful category, the twentieth-century subordination of the experimental evidence of 'truth sera' to the changing relative value attributed to narrative and empirical memory, and so on. All the essays are good – many are excellent – but one fears that there are some which, not being indexed and disseminated like journal contents, may never come to the attention of interested scholars. For example, Trudi Tate's wonderful piece on memorializing the Crimean campaign is unlikely to reach students of war, who would hardly think to read a book on literature and psychoanalysis. And why does the book – perhaps at the publishers' behest – cover '1830 to 1970' in particular? Such a precise chronological designation seems spurious for a collection whose imaginative and intellectual bourns are so wide. Check the index for yourself, lest you miss out.

In another sense, of course, it is this very variety that bears testament to the breadth of Beer's scholarship. This has itself been in largely essayistic form, with all the scope that affords for ranging freely. The collection also tacitly sheds light upon the methods and approaches which are gathered up together in the term 'science and literature'. Its essays differ widely in the methodological relationship presumed or constructed between these categories. Some take evidence from literature in order to construct a relatively empirical history; by contrast E. F. Keller's piece on Rosalind Franklin begins with a post-structuralist account of James Watson's *Double Helix* (New York, 1968) and ends up pretty much applying this literary interpretation to events themselves.

In between these extremes there lies perhaps a shared sensitivity to the text itself, not merely as a material epiphenomenon of 'what happened' but as a privileged artefact to whose traditions of interpretation we must pay attention – even love. Having recently attended a literature conference, I have been struck by the personal engagement of literary scholars, the respect and affection which they have for their subject matter. This is a somewhat alien concept for historians of science, and perhaps worthy of reflection now that the battle against naive hagiography has been won.

A final notable feature of Beer's oeuvre is that it has never focused particularly on gender, so frequently the emphasis for women scholars. (Discuss.) Or rather, Beer weaves issues of gender seamlessly into a cloth of nature and culture, one (but only one) of the metaphors that condition science. Here too the volume is reflective of its honouree. All too often a collection of essays has just one chapter written by a woman, which is invariably about the theme of the book in relation to gender. How nice to see a book completely dominated by female authors for a change, without that being its point.

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Mark McCartney and Andrew Whitaker (eds.), **Physicists of Ireland: Passion and Precision**. Bristol and Philadelphia: Institute of Physics Publishing, 2003. Pp. xiv + 298. ISBN 0-7503-0866-4. £40.00, $58.00 (hardback).
doi:10.1017/S0007087405366969

Physicists of Ireland: Passion and Precision is the latest attempt by Irish scholars to rehabilitate the scientific heritage of Ireland to a position comparable with its literary and political heroes. Like its inspiration and immediate predecessor, Ken Houston (ed.), *Creators of Mathematics: The Irish Dimension* (Dublin, 2000), the editors have decided to follow a biographical approach to the history of science in Ireland. Essays on thirty-two men of science (sadly, Kathleen Lonsdale is omitted) who were born or worked in Ireland are included, ranging from the opportunistic

colonist William Petty in the seventeenth century to Lochlainn Ó Raifeartaigh's work on supersymmetry in the late twentieth century. An exotic dimension is added to the volume by the editors' decision to include non-Irish men of science, such as Erwin Schrödinger, Walter Heitler and Cornelius Lanczos, who found an intellectual harbour during the Second World War in Eamon De Valera's Institute for Advanced Studies in Dublin. For a country renowned for exporting its best and brightest (especially in science), the experience of scientific refugees in Ireland is intriguing. Their fond memories of Ireland are contrasted with those of Robert Boyle, who was always anxious to distance himself from 'the barbarous country' of his birth. The authors use the biographical format well and most contributions admirably situate their subjects within their social and political contexts.

The editors have also skilfully exploited the inherent mutability of the term 'physicist' and the volume contains individuals better known for their achievements in the fields of chemistry (Robert Boyle, Thomas Andrews) and astronomy (William Parsons, Earl of Rosse). While the giants of the Victorian era such as William Rowan Hamilton, James MacCullagh, George Gabriel Stokes and John Tyndall are familiar to most readers, the accounts here are eminently lucid and a worthy addition to existing biographical material.

The biography has become a particularly attractive format for Irish historians of science in recent years. The project of reclaiming science as a viable constituent of the cultural heritage of Ireland has emerged as a self-conscious attempt to provide heroes for an increasingly progressive and secular society. Accordingly, interest in the history of science in Ireland has proven to be especially vigorous. This is an excellent addition to a growing corpus of works and a fine point of departure for further studies.

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Jagdish Mehra and Kimball A. Milton, **Climbing the Mountain: The Scientific Biography of Julian Schwinger**. Oxford: Oxford University Press, 2000. Pp. xii + 677. ISBN 0-19-850658-9. £45.00 (hardback).
doi:10.1017/S0007087405376965

Julian Schwinger (1918–94) was a Nobel Prize-winning theoretical physicist of tremendous creativity, whose contributions continue to shape the field. Despite his extensive legacy within contemporary physics, much less is known about him than about such peers as Richard Feynman. *Climbing the Mountain*, the first book-length scientific biography of Schwinger, was written to try to redress this imbalance. Both authors were trained in theoretical physics and the book treats much of Schwinger's work in detail. The authors would have been well served by the assistance of at least three additional types of specialist: an editor, a historian and a lawyer. An editor could easily have helped the authors trim down their tome, which weighs in at more than six hundred pages, by cutting down on repetitions, needless diversions and awkward postponements of topics briefly introduced but dealt with later.

A historian could have aided with sources. This book is based almost exclusively on references to scientific articles and interviews conducted decades after the events in question. Nearly all of the small handful of quotations from archival materials are actually quoted from Silvan Schweber's lengthy biographical study of Schwinger in *QED and the Men Who Made It: Dyson, Feynman, Schwinger, and Tomonaga* (Princeton, 1994). Transcriptions from interviews often run, uninterrupted, for two pages at a time, with little or no critical analysis – even when discussing complicated or controversial topics. The authors quote from Mehra's 1988 interview with Schwinger, for example, to explain why Schwinger never went to work on the Manhattan Project during the war, as so many of his colleagues did. (Schwinger worked on radar instead.) Over four decades after the fact, Schwinger related that he did not work on nuclear weapons in part because

he had 'visceral' moral qualms; he said that Los Alamos somehow struck him as having 'something unnatural', indeed 'something evil', about it (p. 104). Perhaps this is a reasonable approximation to what Schwinger actually felt in the mid-1940s (rather than the late 1980s) but, if so, he would have been unique in an entire generation of physical scientists. Surely such uniqueness demands additional analysis from the authors, based in part on contemporaneous documents.

Equally troubling is the lack of any engagement with, or even recognition of, the vast extant literature. Well over one hundred thousand pages have been published by now, for example, on physical scientists' work during the Second World War on such projects as radar and the atomic bomb; dozens of scholarly analyses have been published on the conceptual development of post-war particle physics. With the exception of Schweber's 1994 book and Mehra's own 1994 biography of Richard Feynman, no citations to these many works clutter the authors' endnotes. This is not to say that additional sources have not likely had some influence. The authors describe, for example, Schwinger's many efforts to forge conceptual and linguistic bridges between the recondite mathematical theory of electrodynamics and more concrete efforts in electrical engineering during wartime radar research (pp. 110–12). This is an important and interesting observation – and it is one analysed at length in Peter Galison's well-known *Image and Logic: A Material Culture of Microphysics* (Chicago, 1997).

If an editor and a historian could have aided in this book's construction, a lawyer (or some other expert in copyright issues) would surely have come in handy, too. Most of Chapter 6, occupying thirty pages, appeared verbatim in Mehra's 1994 Feynman biography (as Chapter 11), and the first few sections of the next chapters in each book are also an exact match. More important is how the authors handle other people's prior publications. Abraham Klein, for example, explained that he first learned of the Bethe–Salpeter equation from Schwinger's lectures, and that Klein applied this material with Robert Karplus to analyse positronium, adding, 'I would like at this point to correct a glaring error made by James Gleick in his generally excellent biography of Feynman. Because the methods used by Schwinger in his early papers on QED were superseded by the Feynman formulation …, Gleick claims that by the early fifties, the young physicists around Schwinger found themselves at a distinct disadvantage' (Klein, in *Julian Schwinger: The Physicist, the Teacher, and the Man* (ed. Y. Jack Ng) (World Scientific, 1996), p. 4.) Mehra and Milton apparently agree, since they repeat Klein's anecdote about the Bethe–Salpeter equation and positronium – without citing Klein's essay at this point, or indeed anything at all except the original Bethe–Salpeter article – and go on to write, 'This illustrates a major error in James Gleick's biography of Feynman. Gleick claims that by the early 1950s Schwinger's students were at a serious disadvantage because they were not exposed to Feynman's techniques' (pp. 160–1).

None of these disturbing features – radically inadequate citations to the extant literature, verbatim and unacknowledged repetition from previous publications – is new in the work of Jagdish Mehra. Scholars have pointed them out at length in reviews of his previous work, in wide-circulation venues such as *Science* and the *Times Higher Education Supplement* and specialized journals such as *Isis* and *Annals of Science*. At this point, major responsibility for these blatant violations of basic scholarly conduct must therefore rest upon Oxford University Press as much as upon Mehra himself.

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HANS RADDER (ed.), **The Philosophy of Scientific Experimentation**. Pittsburgh: University of Pittsburgh Press, 2003. Pp. xii + 311. ISBN 0-8229-5795-7. $29.95 (paperback).
doi:10.1017/S0007087405386961

One of the nice things about philosophy is that you do not have to agree with a work in order to find it interesting, valuable and of high quality. That is certainly the case for *The Philosophy of Scientific Experimentation*, edited by Hans Radder. When I finished reading the book I had not only copious notes on the essays but also a significant number of questions and disagreements. That did not change my opinion that the book is a valuable contribution to the ongoing discussions of the philosophy of experiment. It is a book that I will keep on the shelf I reserve for books that are of importance in doing my own work.

Although, as Radder admits, the book is not a complete philosophy of experiment (that would be asking far too much of a collection of essays by twelve different authors) it does give us a very good idea of many of the significant issues that people in the field are working on and also of some of the answers that are being provided. These issues include the material realization of experiments and its philosophical significance; experiments and causality; the science–technology relationship; theory and theoretical knowledge in experimental practice; experiment, modelling and simulation; and the scientific and philosophical significance of instruments.

There are two curious omissions. First, there is no detailed discussion of how one can determine whether an experimental result is correct, or at least justified. Second, there is no discussion of those 'analysis procedures' which transform experimental data into an experimental result. In several cases in modern physics, including the early searches for gravity waves and the proposed heavy (17-keV) neutrino, it was the choice of analysis procedures that gave rise to discordant experimental results.

In this short review I will comment only on three of the essays. David Gooding's 'Varying the cognitive span: experimentation, visualization, and computation' discusses the increasing mathematization and digitalization of science. Gooding worries about whether some modern techniques will exclude humans from science. He illustrates this with the work of Paul Meehl and others, who, in the 1950s, applied statistical methods to the problems of identifying certain psychiatric disorders and to the prediction of those people on probation who were most likely to re-offend. These programmes performed as well as and sometimes better than experienced humans. Gooding argues the need for humans first to reduce the 'cognitive span', the range of skills, competencies and knowledge needed, so that the computer programs can function. Humans are also needed to expand the results into a familiar notational system. 'Just as the possibility of using an instrument depends on reduction, so the interpretation and use of its output requires expansion' (pp. 278–9).

Mary Morgan's 'Experiments without material intervention: model experiments, virtual experiments, and virtually experiments' offers a fascinating glimpse into computer 'experiments'. Morgan distinguishes between 'virtually' experiments (non-material experiments on semi-material objects) and 'virtual' experiments (non-material experiments mimicking material objects). The former is illustrated by computer simulations using known physical laws on digital images of real bone slices that have been reassembled into a computerized image of the bone. In the latter one uses a computer image of a stylized bone. Morgan describes the first as close to a real experiment because it uses a mathematical model as an experimental instrument, whereas the latter is an experiment on a mathematical model. What seems to be lacking is any detailed discussion of how one might argue that the results of either type of experiment are trustworthy or reliable and applicable to nature.

I feel that I should discuss one essay which comments on work in my own *The Neglect of Experiment* (Cambridge, 1986). There I described an epistemology of experiment, a set of strategies that can be, and have been, used to argue for the correctness of an experimental result.

Giora Hon's 'The idols of experiment: transcending the "Etc. List"' argues that these strategies are eclectic and ad hoc and that, as I admit, they are neither exclusive nor exhaustive. I plead guilty to all charges in the sense that the strategies have no deeper basis and because I have recently added 'blind' analysis, a way of guarding against experimenter bias, to the list. Hon prefers to base his analysis of experimental validity on the avoidance of error. Following Francis Bacon he presents us with fours 'idols': the script, the background theory of the experiment; the stage, the assumptions regarding the apparatus and its operation; the spectator, making observations and measurements; and the moral, the theoretical conclusions. It seems to me that the list of possible errors is reasonably complete, although I would be cautious in making that claim, but Hon does not tell us how we know we have avoided the idols. In my own defence I would claim that that is exactly what the strategies I have espoused do. Still, I find Hon's classification of types of error quite useful in thinking about experiments.

This is a book intended for philosophers and will be of considerable value to them. Most of the contributors seem to subscribe to Radder's view that philosophy is primarily a theoretical, normative and reflexive activity. Although examples from the practice of science are sometimes used to illustrate the philosophical points, there are no detailed discussions of historical episodes. Still, I believe that the book will be of value to historians of science who want to know about many of the analytical tools available for the discussion of experiments. It is a very good book.

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Ulf Larsson (ed.), **Cultures of Creativity: The Centennial Exhibition of the Nobel Prize**. English translation by Daniel M. Olson. Nobel Museum Archives, 2. Canton, MA: Science History Publications, 2001. Pp. 228. ISBN 0-88135-288-8. $40.00 (paperback).
doi:10.1017/S0007087405396968

This book is a companion to, rather than a formal catalogue of, the exhibition designed to celebrate the centenary of the institution of the Nobel Prizes. The exhibition itself, not seen by this reviewer, was organized in collaboration with an impressive international team, and depended heavily on the use of film. The book was therefore designed to be taken away, to remind the visitor, and to stimulate reflection about the nature and variety of creativity, as well as to be a durable memorial to the Nobel centenary.

The introductory section on creativity asks more questions than it proposes answers or definitions. The general consensus seems to be that individual creativity comes in many shapes and sizes, and that it might have a destructive side. After a short passage on Nobel as inventor, researcher, businessman and idealist, and on the Nobel system, the book is divided into sections of a few pages each. The first series is devoted to forty-four Nobel Prize-winners, or joint winners, drawn from across the categories of science, medicine, literature, economics and peace. Each section on a prize-winner is headed by a short epitome, encapsulating something about the variant of creativity shown. Choosing simply from among the scientists included, we find 'Against the current' (Marie Curie), 'The risks of curiosity' (Werner Forssmann, who in 1929 inserted a catheter into his own heart, but was forced by opposition to abandon his research, awarded the prize in 1956), 'Hard work's reward' (Max Perutz), 'Inspiration from play' (Richard Feynman), 'Train your subconscious mind' (Linus Pauling, with a particular emphasis on his ability to think visually), 'Chance as method' (Fleming) and 'Conversation after conversation' (Crick and Watson). This does not really take the reader very far into an analysis of creativity, but the mini-biographies are skilfully written and lavishly illustrated with many interesting and unfamiliar pictures, both of instruments and of scientists and writers at work and play.

The second part of the book focuses on fifteen 'Creative milieus'. These vary from complete towns, such as Budapest, Copenhagen, Paris, Tokyo and Vienna, to universities and research

institutes, such as Cambridge, Cold Spring Harbor, the Pasteur Institute and CERN. The towns tend to stand in for particular sites or environments: Copenhagen for Niels Bohr's Institute, for example, or for general characteristics such as Paris as a rendezvous for literary exiles. The emphasis is on the tension between individual creativity and the environment where creation takes place, though the nature of that 'tension' is somewhat under-explored. Finally there is a section on 'creative conferences' (Solvay) and 'creative networks' (International Campaign to Ban Landmines).

This is an attractive pot-pourri rather than a series of scholarly essays. Overall, however, the themes work well. What is notable throughout the brief outlines is the role of communities of workers, no matter how much ultimately depended on the talents of each individual, as Perutz insisted. There are hints of personal conflicts and power struggles, but this is an upbeat story, where personal struggles have generally been rewarded. It is also notable that the most stimulating environment where a whole and productive life could be nurtured was one where sociability in and across groups was encouraged, whether it was located in the laboratory, at the seaside or in a foreign city, and was nourished as much by the homelier pleasures of good food and comfortable chairs. Nothing, of course, better promotes good conversation.

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Ken Arnold and Danielle Olsen (eds.), **Medicine Man: The Forgotten Museum of Henry Wellcome**. London: British Museum Press, 2003. Pp. 397. ISBN 0-7141-2794-9. £19.99 (paperback).
doi:10.1017/S0007087405406962

A confession: I can still recall my sense of awe on walking into the Science Museum's reserve store in West London for the first time. In a long hall stood mountains of packing crates containing part of Henry Wellcome's collection of medical artefacts, still unpacked a dozen or so years after their transfer to the museum from the Wellcome Trust. What I saw was only the rump of the hundred thousand-odd objects already crammed into the store's labyrinthine basement, which in turn represented only a tenth of the total acquired by Wellcome in a lifetime of obsessive collecting. Wellcome's impossible dream of a museum to house the million or so medical, archaeological and anthropological artefacts which he amassed died with him in 1936; today his collections are scattered across the globe, with much still uncatalogued and never displayed.

It is the prodigious scale of Wellcome's collection and its subsequent dispersal that challenges any attempt to summarize his work. Like early mapmakers the temptation is to surrender reason to wonder, to revel in abundant strangeness – here be monsters, or at least a monstrous museum. It is not surprising, therefore, that the co-editors of this volume should draw heavily upon their own interest in and knowledge of the *Wunderkammern* of early modern Europe. In their Introduction to this volume, produced to accompany a temporary exhibition of Wellcome material at the British Museum and a new permanent display planned for the Wellcome Trust's building on Euston Road, co-curators and editors Ken Arnold and Danielle Olsen describe how they were drawn to 'the weird, the important and the unusual', choosing objects that 'not only help us to tell medical stories but also which simply stopped us in our tracks' (p. 45).

There is certainly much arresting material on show here. Six beautifully varied 'visual essays' on themes such as 'The end of life' and 'Seeking help' challenge the idea that a collection as diverse as Wellcome's might be tamed through neat classification. Alongside these are six short chapters from contributors whose own experiences and interests have intersected with Wellcome or his collections.

Notable among these is Ghislaine Lawrence, whose 1986 paper on 'Wellcome's Museum for the science of history' is given a much-deserved reprise in an updated, albeit abridged, version. As one

of those tasked with wrestling the Science Museum's proportion of Wellcome's collection into some kind of order, Lawrence offers a distinctive perspective. She sketches out the influence of Oxford anthropologist Edward Burnett Tylor (1832–1917) on Wellcome's programme – already outmoded by the time Wellcome came to put together his museum, it was nevertheless Wellcome's desire to link 'primitive' origins to modern practice that shaped his collection. The posthumous disaggregation of the collection in accordance with museological disciplines has obscured the breadth of Wellcome's ambitions, yet it was precisely his desire to represent human endeavour in its widest sense that opens the way to the kind of cross-cultural interdisciplinarity exemplified in Arnold and Olsen's perspective.

Like Lawrence, Frances Knight is able to draw upon her own experience of research on the Wellcome collections at the Pitt Rivers Museum in Oxford. Here her focus is directed towards what is probably the best-known, most accessible and least-forgotten part of the collection, the Wellcome Library. As with Lawrence, Knight's familiarity with the source materials helps build a broader picture of Wellcome's intentions, highlighting in particular his preoccupation with the process, and not the products, of collecting.

Chris Gosden and John Mack offer useful introductions to Wellcome's interest in archaeology and anthropology, and use their contributions to suggest how ways of thinking about objects within these disciplines might be applied more broadly in the consideration of both the Wellcome collections and Wellcome's work as a collector. In a similar vein, John Pickstone offers up a set of historiographical frameworks which make familiar reading to those working in the history of science and medicine, but which serve as a useful introduction to newcomers to the field.

In contrast, the final essay, by Ruth Richardson, offers a more personal reaction to her first encounter with the Wellcome collections – a meeting between a curious cultural historian and Wellcome's 'curios'. Richardson identifies the ability of individual objects to evoke emotional response, to hint at lost narratives and forgotten biographies. In contrast to Knight's upbeat assessment, Richardson notes the difficulties facing a researcher who wishes to trace the history of individual objects within the Wellcome collections.

In doing so, Richardson highlights a long-standing problem that this book, for all its virtues, only partly addresses. Our inability to respond to the Wellcome collections with any critical faculty other than wonder is as much the product of neglect as obliviscence – would we be as sympathetic to an established researcher such as Richardson encountering the PRO or the British Library Reading Rooms for the first time? While we can revel in what Lawrence terms Wellcome's 'bricolage', or Pickstone the 'prolix babble' of the collections, moving beyond the realm of imagination requires a deeper knowledge of the biographies not just of Wellcome and his cadre of collectors but of the objects themselves. The suggestions for further reading and the brief bibliographies provided by the contributors expose a shamefully scanty secondary literature. *Medicine Man* is not intended as a scholarly reference work, and it would be unfair to judge it in these terms. Nevertheless it will prompt some long-overdue interest in Wellcome's 'forgotten museum' and in this regard it is disappointing that so little encouragement is offered to those wishing to use the collections for research. Wellcome material is now dispersed in institutions 'from Australia to Zimbabwe', but there is no list of exactly where these are, or how to find out about what they hold. There is passing reference to the online catalogue of the Wellcome Trust's archives, but no mention of other online sources that might encourage the screen-tied researcher to click into action. Beautifully produced, lavishly illustrated and modestly priced, this is a splendid book that provides a stimulating introduction to its subject. Yet for all its glossy heft, Henry Wellcome and his collections are still awaiting the substantial volume they deserve.

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