

In these terms, Black's letters are a valuable addition to our understanding of the place of science in the broader culture and polity. Edited by Robert Anderson (a former president of the BSHS) and the late Jean Jones (who died in 2009), a historian of the Scottish Enlightenment, they cover Black's life from his late teens until his death at the age of seventy-one. In terms of knowledge of the natural world, Black's contributions can be summed up in just five words: carbon dioxide and latent heat. Yet as the editors point out in their useful and informative introduction (part of an excellent and comprehensive critical apparatus), Black made both of these discoveries before he was appointed professor of chemistry at the University of Edinburgh in 1766, at which point he ceased research in chemical philosophy. In terms of his correspondence, by 1766 only fifty-four out of a lifetime's total of 835 letters survive. Also Black was not particularly good at publishing his research—for instance, in 1783 his protégé, James Watt, whom he taught at the University of Glasgow, urged Black to publish his work on latent heat. As Peter Jones has pointed out, Black was regarded as being discourteous to the republic of letters in not publishing. His reluctance to publish doubtless accounts for Black not being elected to the Royal Society of London, though he was a founder of the Royal Society of Edinburgh.

Many of the luminaries of the Scotland of the second half of eighteenth-century and beyond corresponded with Black. They include, in addition to Watt, William Cullen, Adam Smith, Lorenz Crell, Josiah Wedgwood (both Sr and Jr), Thomas Beddoes, Antoine Lavoisier, Jan Ingenhousz and James Macie (later Smithson). There are, however, gaps, since, for instance, there are no letters between Black and his friend James Hutton. Their close institutional and geographical proximity in Edinburgh doubtless accounts for this lack, which is partially made up by a large number of references to Hutton in many of the letters published here. On the other hand there are a significant number of letters between Black and his extended family.

What all these letters tell us is that what Black was doing while at Edinburgh, aside from teaching, was undertaking an enormous amount of work in providing chemical advice for those businessmen and industrialists who needed it, for example in processes such as glassmaking and bleaching. Letter 301 exemplifies this perfectly. Written in March 1783 by the otherwise little-known Hammersmith brewer George Blake, it discusses the possibility, stemming from a very brief meeting with Black, of establishing a brewing industry in Russia using the contacts Black had made when he was invited to teach chemistry in St Petersburg. The editors have thus provided a resource which will be invaluable in the continuing endeavour to understand how in practice, rather than in theory, scientific knowledge affected and was affected by the processes of industrialization of the eighteenth century.

FRANK A.J.L. JAMES
The Royal Institution

DANIELA BLEICHMAR, **Visible Empire: Botanical Expeditions and Visible Culture in the Hispanic Enlightenment**. Chicago and London: The University of Chicago Press, 2012. Pp. xii + 286. ISBN 978-0-226-05853-5. £33.50 (hardback).
doi:10.1017/S0007087413000526

What does it mean to observe something? Is it simply the act of looking at an object, or is it a more complex process that aims to understand the object's meaning in a specialized way? What kinds of analytical activity are associated with these observational practices and does imagery play an essential role in this framework? In her book *Visible Empire*, Daniela Bleichmar aims to answer these questions by looking at the relationship between natural history, Spanish imperialism, visual culture and observational study. The book is rich in detail and it contains many beautiful examples of botanical illustrations from the eighteenth century. Without a doubt Bleichmar's work is a significant contribution to the history of science and art history. It will be a staple read for anyone interested in natural history and visual culture.

The book is divided into five chapters and it examines over 12,000 illustrations produced by eighteenth-century naturalists and artists throughout the Spanish world. At the heart of Bleichmar's investigation is an awareness of the highly sophisticated visual culture associated with botanical imagery during this period. Thus the focus of the book is not simply on the images themselves but on the entire activity connected with their production and use. Bleichmar calls this approach to studying imagery 'visual epistemology'. In Chapter 1, Bleichmar shows how the Spanish were trying to make their empire visible from afar. The production of botanical illustrations for natural-history investigations brought distant objects from places such as the Americas to Madrid. Through this process of making the empire visible the abstract became real. Chapter 2 pushes the argument further, and focuses on the application of botanical illustrations in natural history. Bleichmar breaks down observation into a three-part process that involves collecting data, analysing the meaning and representing its results through textual and visual accounts.

Chapter 3 provides a detailed explanation of how botanical illustrations were made. Natural-history images followed a standard style throughout Europe, and readers were expected to understand the iconographic language of these pictures. Naturalists systematized their illustrations just like any other type of data so that researchers could compare and contrast their investigations and reproduce their results. To ensure the accuracy of their visual depictions, botanists and artists worked collaboratively to ensure that each image met certain standards and that they followed natural-historical conventions as closely as possible. As Bleichmar explains, these images were not intended to be true representations of botanical specimens but idealized versions (or composites) depicting an average.

Chapter 4 is particularly interesting and looks at economic botany, which sought to make imperial nature profitable. Within this context, botanists were employed by trading companies to verify the quality of organic resources in Spanish colonial settlements. From an imperial economic perspective it was all about locating, exploiting and promoting the natural wealth of different regions of the world. Imagery played an important part in this process as it was used to show prospective investors what kinds of plant were available in various locations. However, as Bleichmar points out, many problems arose at a practical level. Although imagery served to visually represent the wealth that grew afar, harvesting this material was incredibly difficult. Turning these potential assets into reliable and lucrative resources was fraught with obstacles. Many living specimens perished en route to Spain, while in other instances seeds failed to germinate. In cases where plants were successfully transplanted in Europe, it was very costly to maintain them. The survival of exotic crops was often reliant on hothouses to sustain their growth.

In the final chapter, Bleichmar looks at illustrations of nature that did not adhere to the traditional depictions of natural-history specimens. Instead of showing images of plants with empty white backgrounds that were decontextualized from their natural surroundings, Bleichmar examines images containing humans, plants and animals situated together in nature.

Bleichmar's compelling argument outlines the significance of imagery in constructing nature. The illustrations produced collaboratively by naturalists and artists in places such as New Granada and New Spain formed the foundation of armchair studies in Europe and stimulated imperial economic projects. Nevertheless, there are some points of criticism to consider. Although this study focuses on the Spanish context, it would have been beneficial for Bleichmar to draw more detailed comparisons between the activities of Spanish naturalists and artists, and those of other European nations. There is some passing mention of other European imperial and scientific activities but a more rigorous analysis would have greatly strengthened the examination. Another important issue, which is overlooked in the book, is the role of indigenous populations in making botanical knowledge. The degree to which extra-European and European populations exchanged botanical

information remains unclear. Moreover, Bleichmar does not discuss the impact these botanical expeditions and activities had on the daily lives of native groups. An analysis of this tension would add substantial weight to the work and provide the reader with more perspectives, not just those of the Spanish. However, putting aside these issues, this book is a tremendous contribution to the secondary literature which opens up new research areas for exploring the intersection of science, visual culture and empire.

EFRAM SERA-SHRIAR
York University,
Canada

MARGARET BRADLEY, **Charles Dupin (1784–1873) and His Influence on France: The Contributions of a Mathematician, Educator, Engineer, and Statesman**. Amherst, NY: Cambria Press, 2012. Pp. xx + 368. ISBN 978-1-60497-751-6. £71.99 (hardback).
doi:10.1017/S0007087413000538

The great merit of this first English-language biography of Charles Dupin is to draw renewed attention to the importance of this key player in the formation of nineteenth-century science. Born before the French Revolution, in 1784, Dupin was one of the first *polytechniciens*, taken straight from his studies under Monge to Boulogne to design barges for the invasion of England. After Trafalgar he was sent to the newly conquered Greek islands to help found the Ionian Academy, where he honed his rhetoric of science. In the aftermath of the *restauration*, he courageously wrote the *éloge* for Monge and would be a pioneer of the reformed Conservatoire des arts et métiers (CNAM). Almost reaching the advanced age of ninety years, he died as a baron in the aftermath of the Franco-Prussian war. He had been a radical and a supporter of British ways, a mathematician, engineer, promoter of statistics and politician. Above all, he had been an influential, if maverick, ideologist of science, industry and modernity. Anybody interested in the construction of nineteenth-century images of the relations between science, practice and the state should pay heed to Dupin.

For a century after his death in 1873 he was overlooked by historians of science, but his contribution was recovered as part of an English commemoration. It is now four decades since Robert Fox, in an article for Donald Cardwell's 1974 volume celebrating the foundation of Manchester University's ancestor, the Mechanics' Institute in Manchester, first drew attention to Dupin. CNAM had been France's pioneering institution in adult science education. Having been founded during the French Revolution, Robert Fox showed how, in the aftermath of Napoleon's fall, it was captured from the protagonists of craft by a younger generation of protagonists for the application of science, led by Dupin. Perhaps surprising at first, the context of Robert Fox's paper was exactly appropriate, for Dupin was both a significant observer of the British industrial revolution centred on Manchester, and an important influence upon it. Having watched enthusiastically the teaching of Andrew Ure in Glasgow, he was the most active proponent of science *appliqué aux arts*, memorialized in the 1819 revised charter of CNAM, and translated into English as 'science applied to the arts'.

A decade after the publication of Robert Fox's paper, the life of Dupin was the subject of a *doctorat d'état*, bound in seven, albeit slim, volumes of typescript, by intellectual-property specialist Fernand Perrin, under the supervision of René Taton. The typescript is available in such French academic libraries as that of CNAM itself, but, neither in its content nor in its accessibility did it do justice to its topic. Robert Fox's important paper was reprinted in French two decades later in a volume (edited by Carole Christen-Lécuyer, François Vatin and Robert Fox and published in 2009) that came out of a 2007 Paris symposium, the first systematic attempt to explore the significance of Dupin. That volume still provides the outstanding contextualization of the work and life of Dupin. It did not claim to be a biographical treatment but rather, as the