

## THE ART OF SCIENCE: A ‘REDISCOVERY’ OF THE LISTER COPPERPLATES

by

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In 1712 Martin Lister bequeathed the collection of more than 1000 copperplates to the University of Oxford that he used for his *Historiae Conchyliorum*, the first comprehensive study of conchology. In the mid-eighteenth century, William Huddesford, keeper of the Bodleian Library, used the copperplates to create another edition of *Historiae*, but after that they are not mentioned again in the published literature. I recently ‘rediscovered’ the plates in the Bodleian Library, since their transfer from the Ashmolean Museum in 1860. I use historical analysis, as well as a selective study of the copperplates with X-ray fluorescence techniques, to examine a portion of the plates and the process of their production. I show that Martin Lister’s daughter engraved a paper for *Philosophical Transactions*, and demonstrate that she was among the first female scientific illustrators to use a microscope. Furthermore, one of the Lister copperplates may be the last survivor of those engraved for *Philosophical Transactions*, the rest having been surrendered to the nation in World War I. The significant intellectual and artisanal challenges presented to a skilful naturalist in the transformation of a field specimen into an aesthetically pleasing illustration as well as a scientific object conveying taxonomic information are delineated.

**Keywords:** Martin Lister; copperplates; Anna and Susanna Lister

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### INTRODUCTION

In the early modern era, scientific illustration was a novel genre with few artists able to combine attention to empirical detail, accurate perspective views of the object and aesthetic judgements into one image. As the creation of images of natural philosophy during this period also involved the cultivation of connoisseurship and training the eye of the virtuoso, as well as training the hand in drawing, meeting the demands of ‘art and science’ was a challenging task.<sup>1</sup> The illustrator, by reductionism, needed to focus the viewer’s attention onto the essentials of the specimen without losing its context, scale or dimensions. Engravings were expensive to produce, and publications of natural philosophy often required a knowledge of Latin, sensitivity to the proper placement of figures, and specialized fonts, and many printers simply were not capable. As John Ray complained in

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the preface to Francis Willughby's *Ornithology*, 'the Gravers we employed, though they were very good Workmen, yet in many Sculptes they have not satisfied me...they as often neglected their instructions, or mistook my meaning'; Ray even confessed that, to save money on engraving, 'We have for the most part contented our selves with the figure of one Sex only, and that the Male.'<sup>2</sup> Accurate representations of natural philosophy were thus not something that could be taken for granted.<sup>3</sup> Johns has pointed out that, despite the fact the Royal Society portrayed its experimental scene in minute literary detail, there was no illustration of the Society in action, its Repository collections, or its instruments in use.<sup>4</sup>

As Kusakawa has noted, historians of science have recently shown much interest in how these nascent 'visualizing methods...developed as part of the practices and ideas of scientific investigation'.<sup>5</sup> Often, however, when analysing early modern illustration in natural philosophy, we only have 'part of the picture', usually the finished book, or the drawing or engraving itself, sometimes unattributed. Because the original specimens, the preliminary drawings, and, particularly, the plates have usually been lost (the plates for *Philosophical Transactions*, for example, were 'surrendered to the nation during World War I'), the specific artisanal practices involved in creating an illustrated book or article of natural philosophy can be inscrutable.<sup>6</sup> We have some tantalizing glimpses: David Freedberg has explained how the members of the Accademia dei Lincei not only used watercolours to focus on the interiors of specimens, particularly on the organs of fructification and generation, but also attempted to use images of surface impressions (not entirely successfully) to make taxonomic distinctions.<sup>7</sup> Printed instructional manuals of engraving from the period, such as those of William Faithorne, show in some cases how the burin was held to create shadows and contours, but they also often leave out key information on how to achieve finer effects of *chiaroscuro*.<sup>8</sup> Some of this was due to an authorial desire to preserve trade secrets and some because the training, in Robert Hooke's words, 'of a sincere Hand and a faithful eye' to accomplish illustration is accomplished by observing and doing, not by reading.<sup>9</sup>

In the creation of Martin Lister's *Historiae Conchyliorum* (1685–92), the first comprehensive study of conchology, we are fortunate to have some of the original objects, preparatory and draft drawings, the original copperplates, and draft and final prints (figure 1). Furthermore, the task of illustrating his *Historiae* was one that Lister accomplished in a novel manner. To maintain as much 'creative control' over his work and its publication as possible, he taught his two daughters, Susanna (bap. 1670, d. 1738) and Anna (1671–ca. 1695–1704), how to limn and engrave images.<sup>10</sup> Lister later claimed that their engravings for *Historiae* 'could not have been performed by a Person else for less than 2000 l. Sterling; of which Sum yet a great share it stood me in, out of my Private Purse.'<sup>11</sup> The press, possibly at his house, that turned out images on the same thin and watermarked paper that Lister used for his correspondence, permitted the creation of his masterpiece.<sup>12</sup> There was not a single line of movable type in the first edition, because all the written content was engraved with the figures on the copper plates (figure 2).<sup>13</sup> Movable type only came later for the appendices. The decorative baroque borders around the frontispieces and shell specimens that Susanna and Anna created added an extra step in the printing process (figure 3). As the sheets were run through the home press twice, the strain on the thin paper meant that it was sometimes cut through the surface, and strips had to be pasted on the back of the sheets. Although the lack of movable type made additions and corrections difficult,

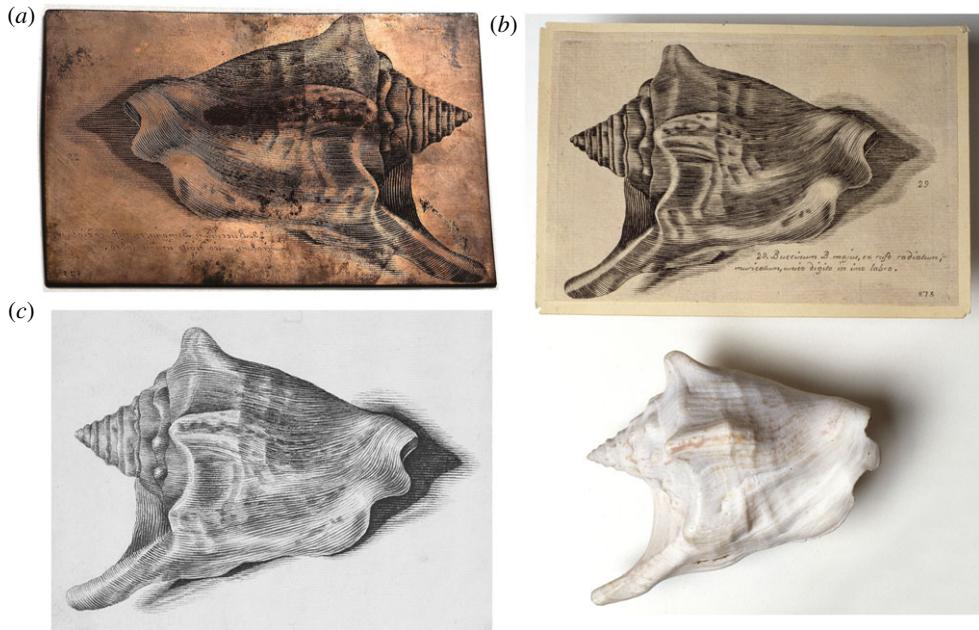


Figure 1. *Strombus tricornis*, lightfoot. The original specimen illustrated for Lister's *Historiae*, its preparatory drawing, the copperplate, and its print. (a) *Strombus tricornis*, lightfoot; Lister Copperplate 332, The Bodleian Library, University of Oxford. (b) *Strombus tricornis*; lightfoot specimen next to plate 873 from Lister's *Historiae Conchyliorum*, Natural History Museum, London. (c) Drawing of *Strombus tricornis*, lightfoot by Anna Lister in her sketchbook; MS Lister 9, The Bodleian Library, University of Oxford. (Copyright © Natural History Museum, London and The Bodleian Library, University of Oxford.) (Online version in colour.)

it also avoided the difficulties of dealing with printers: Lister's illustrators were literally 'in house'. By the time they were teenagers, Susanna and Anna Lister's initials appeared on the title page of *Historiae*.

In 1712 Lister bequeathed the collection of more than 1000 copperplates to the University of Oxford. In the mid-eighteenth century, William Huddesford, keeper of the Bodleian Library, used the copperplates to create another edition of *Historiae Conchyliorum*, but after that there is no further mention of them in the published literature.<sup>14</sup> Using historical analysis, as well as selective study of the copperplates with X-ray fluorescence techniques, this article examines a portion of the plates that I recently 'rediscovered' in the Bodleian Library since their transfer from the Ashmolean Museum in 1860, and the process of their production.<sup>15</sup> I will first elucidate Lister's training of his daughters as illustrators and artists, informed by his own ability to draw. To that end, I will then provide evidence, in addition to that of Woodley, Keynes, and curators at the Linda Hall Library, to suggest that Lister's daughter Anna engraved a paper for *Philosophical Transactions*, as well as analysing her images for *Historiae* to demonstrate that she was among the first female scientific illustrators to use a microscope.<sup>16</sup> The significant intellectual and artisanal challenges presented to a skilful naturalist in the transformation of a field specimen into an aesthetically pleasing illustration as well as a scientific object conveying taxonomic information will thus be delineated.<sup>17</sup>

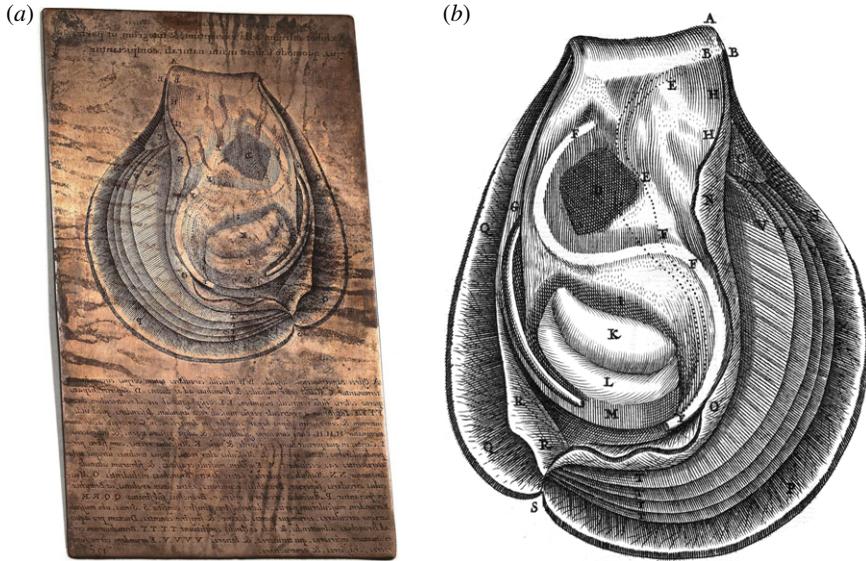


Figure 2. Most of the text in the *Historiae* was not typeset but engraved directly on the plates. (a) Accompanying text for *Historiae*, for example in this portrayal of a molluscan dissection, was engraved directly on the copperplate. Lister Copperplates 75, The Bodleian Library, University of Oxford. (b) The print portraying the molluscan dissection in Martin Lister, *Historiae Conchyliorum* (published by the author, London, 1685–92), vol. 2, p. 34, illustration 184. The Wellcome Library, London. (Copyright © The Wellcome Trust and The Bodleian Library, University of Oxford.) (Online version in colour.)



Figure 3. Decorative borders were added after the initial printing of an image, such as in the frontispiece of the *Historiae*. (a) Note the inclusion of ‘Susanna et Anna Lister Figuras pin[xerunt]’ on the frontispiece. Frontispiece of Martin Lister’s *Historiae Conchyliorum* (published by the author, London, 1685–92). (Copyright © The Royal Society, London.) (b) Copperplate of Decorative Border. Lister Copperplates 17, The Bodleian Library, University of Oxford. (Copyright © The Bodleian Library, University of Oxford.) (Online version in colour.)

*HISTORIAE CONCHYLIIORUM: LISTER AS ARTIST AND TEACHER*

Martin Lister was baptized in Radclive, Buckinghamshire, and educated at St John's College, Cambridge (MA 1662); he then studied medicine at Montpellier from 1663 to 1666. While in France he became 'an avid natural historian' and physician, eventually becoming a court physician to Queen Anne in 1702.<sup>18</sup> Elected a Fellow of the Royal Society in 1670/71, Lister devoted himself to a variety of biological studies, including botany, fossils and shellfish. He forged a friendship with, and performed a lengthy correspondence with, John Ray (1628–1705), and ultimately contributed more than 60 papers to *Philosophical Transactions*.<sup>19</sup> He was a member of the Society's Council and vice-president of the Royal Society from 1685 to 1686, often chairing meetings when the President, Samuel Pepys, was called away on business. While a Fellow and officer, Lister sponsored Ray's books on insects and birds, helping to identify species, and was on the committee to see *Historia piscium* by Francis Willughby and Ray through the press, Lister supervising the completion of the engravings and the printing.<sup>20</sup>

His greatest contribution to natural history, however, was his masterwork *Historiae Conchyliorum*, the primary edition compiled between 1685 and 1692.<sup>21</sup> Sir Hans Sloane, the founder of the British Museum, lent Lister specimens from his travels in Jamaica.<sup>22</sup> In 1674 Thomas Townes, 'a learned and ingenious Physician' working on a sugar plantation, wrote to Lister, 'I goe shortly to the Barbados, where if I can serve your curiosity in inquiring after anything that is rare . . . you may command me'.<sup>23</sup> Townes subsequently sent parcels of shells. Edward Lhwyd, Keeper of the Ashmolean Museum, reported, 'I have sent by John Bartlet of the White Swan at Holbourn bridge a small strawberry basket, with a parcel of your curious wrong turned snails of the woods'.<sup>24</sup> The snails were kept alive by being buried in wet moss. John Ray and his colleague Samuel Dale, an Essex physician, also compared conchological notes with Lister, commenting on gastropod morphology, shell pattern, and habitat, and sending him species for identification.<sup>25</sup> The 1140 pieces of Lister's correspondence left to us show that he was part of a global Republic of Letters of virtuosi who exchanged ideas and specimens.<sup>26</sup>

From 1685 to 1692 Lister was preparing the four books and two appendices of *Historiae sive Synopsis Methodica Conchyliorum*. He had already published a small tract on molluscs in his *Historiae animalium* (1678). By 1692 his work, which had been enriched by observations from a variety of collectors and naturalists, grew to 1073 plates of shells, slugs and molluscan anatomy, as well as titles, subtitles, pages for classification, and dedications. Table 1 lists the arrangement and dates of the four books.<sup>27</sup>

Between 1692 and 1697 a second edition was produced in two folio volumes, with an addition of 22 anatomical plates with typeset explanations. Lister had intended to follow his volume of plates with anatomical descriptions of every family in the proper order, but he did not carry out his plan. *Historiae Conchyliorum* was divided into Books, Sections and Headings, which to some degree correspond to the Orders, Families and Genera that Linnaeus employed years later.<sup>28</sup> Despite the richness of the visual illustrations, there was no text other than sectional headings and specific descriptions engraved on the plates.

To assemble this vast work, Lister employed his daughters as the primary draftswomen. The first recorded indication that Lister was encouraging his daughters' artistic interests was from a letter to his wife, Hannah, in July 1681. He wrote:

I did send home a Box of Colours in oil for Susan and Nancy [Anna] to paint with. As for the pencills sent with them, and the colours in shells, which are for Limning, I would have thee Lock them carefully up, till I return, for they know nott yet the use of them.<sup>29</sup>

Table 1. The contents of Martin Lister's *Historiae Conchyliorum*

book	date	pages	content
book I	1685	1–105	exotic land shells and slugs
book II	1686	106–160	freshwater shells, snails [turbinates] <sup>91</sup> and bivalves
book III	1687	161–445	marine bivalves
appendix	1688	446–523	fossil [lapidus] bivalves
book IV	1688	524–1025	marine molluscs, marine snails [buccinis], molluscan anatomy
appendix	1692	1026–1054	fossil snails [buccinis]
appendix	1692	1055–1059	minor addition to text [mantissa] and synopses

‘Susan and Nancy’ were his eldest daughters Susanna and Anna [sometimes known as Anne], who were 11 and 9 years old at the time.

The term ‘limning’ has its source in the word ‘illumination’, or the medieval technique of painting on parchment. In the sixteenth century the miniaturist Nicholas Hilliard’s *A Treatise on the Art of Limning* explained his manner of work. Portraits or figures were painted in watercolour, made by mixing finely ground pigments and gum arabic to the proper consistency.<sup>30</sup> The ‘pencils’ to which Lister referred were small brushes, made of sable or squirrel hair, and ‘colours in shells’ referred to the practice of keeping watercolours of paste consistency in mussel shells. Edward Norgate in his *Miniatura* advised to take as much pigment ‘as will lie in a muscle shell (which of all others are fittest for limning, or otherwise those of Mother Pearle) and with a little gum water temper it with your finger till it come to a fitting consistency or stiffnes.’<sup>31</sup> As Sloane indicated, limning was used ‘mainly in the seventeenth century for heraldry, maps, birds-eye views, miniature portraits, and copies of old master paintings’, and it was considered a suitable pastime for young ladies, being generally a ‘sedentary, clean and quiet occupation which employed rich materials and resulted in decorative works’.<sup>32</sup> Little did Lister’s daughters know at the time the significance that limning and shells would have to their young lives.

Lister’s colleague and travelling companion Thomas Kirke (d. 1706) also wrote a manuscript entitled ‘Art of Limning’, so perhaps this work was a source of instruction, and there were several drawing manuals published as ‘companions’ for the ‘ingenious of either sex’.<sup>33</sup> Both girls turned out to be quite artistically talented, but it is not known who gave them drawing lessons because there is no manuscript evidence of a limning tutor, although there were several artists in the circle of the York virtuosi of which Lister was a prominent member, such as the artist and engraver Francis Place (1647–1728) or the glass painter Henry Gyles (1640?–1709). It is, however, probable that Lister was his daughters’ teacher, having skills as an illustrator himself.

In 1669 Lister wrote a letter to John Ray, which reveals his innermost motivations to become a naturalist. Lister stated:

For my part, I think it absolutely necessary that an exact and minute distinction of things precede our learning by particular experiments, what different parts each body or thing may consist of; likewise concerning the best and most convenient ways of separation of those parts, and their virtues and force upon human bodies as to the uses of life; all these, besides the different textures, are things subsequent to natural history.

In the early 1670s Lister put his convictions to work, employing his knowledge of parasitism to correct the Dutch naturalist Jan Goedart’s work *On Insects*, which was not

printed until 1682.<sup>34</sup> Lister explained in the preface, 'I have taken great care of the Designes, in transferring them upon Copper Plates, which I dare promise are Exquisitly performed, by the best of our English Artists which was my expence.'<sup>35</sup> He took such care because he thought 'Naturall History is much injured, through the little incouragement, which is given to the Artist, whose Noble performances can never be enough rewarded; being not only necessary, but the very beauty, and life of this kind of learning.'<sup>36</sup> Natural history, sensitive illustration to record the 'exact and minute distinction of things' (in other words, the essential characteristics of the organism) and 'the very beauty' or aesthetics were, in Lister's eyes, inseparable. The 'best of our English artists' who did the engravings was Lister's friend Francis Place, but the original manuscript draft of the book shows that Lister probably drew the illustrations himself either from life, or from Goedart's own images, because it contains sketches of butterflies, bees, and developmental cycles of other arthropods interspersed with his notes.<sup>37</sup> Lister apparently then transferred the designs to Place to engrave.

At the same time as Lister was working on *On Insects*, Marcello Malpighi was using the microscope to aid in his dissection of insects and to display their anatomical structure isolating the animal from the environment; Lister, however, thought it necessary to have the insect portrayed as much as possible in its ecological niche.<sup>38</sup> In particular, he noted 'how necessary it is, in order to the compleating of Naturall History, that our Naturallist shou'd be well skilled in Plants: Viz the Food of most Insects.' As Goedart had 'left us in the darke' about the food sources of some of the insects, for 'want of a more particular Title of this Plant', where the plants could be specifically identified he portrayed the butterflies with the caterpillar feeding on its favoured food source. In fact, one of the proof sheets for *On Insects* contains Lister's annotations of the preferred food sources and time of the hatching of the caterpillars for each of the insects portrayed.<sup>39</sup> Not only did Lister's illustration provide a more complete natural history of insects, but it was also regarded as an exercise in identifying which caterpillars infested which types of wood, as well as the determination of 'what kind of Wood is best, for Sheathing of Ships'. Lister thought it would be possible to 'essay certain published pieces thereof like Tallies tyed to a Buoy in the Waters and streames much infested by the Worm' to see which species of tree they preferred. He speculated that 'as the Indies are stored with greater variety of Timber, then Europe, so that it would be very probable there may be some found, which that kind of River Worme will absolutely refuse to eat.' Detailed illustrations of insect life cycles could help this early venture in economic botany, and at the same time, their 'exquisite' rendering and sensitive placement on the page elevated these small creatures into objects of beauty.

Why did Lister insist that the images be beautiful as well as scientifically accurate? Some of it was his own artistic sensitivity, but some of it was because of the nature of the specimens he portrayed. Lister would later be satirized by Shadwell in his play *The Virtuoso* (1676) for dedicating his life to the study of spiders; and in the preface to his *Exercitatio Anatomica in qua de Cochleis* (1696), a comprehensive anatomical guide to land shells and slugs, he remarked that he was also aware that his work might 'provoke the laughter of spectators'.<sup>40</sup> He also wrote to his friend Edward Lhwyd, stating that there were 'ensorious mouthes who think and say a man that writes on Insects can be but a trifier in Phisic', and that he hoped he would be left 'alone to pursue Philosophie amongst the inferiour sort of beings'.<sup>41</sup> Lister moved to London from York in 1683 and established a lucrative medical practice in which public perception of his activities was

important to securing professional respect. Visually pleasing images of insects and molluscs would help overcome the public perceptions that his study of them was trivial, an exemplar of the madness of a virtuoso; through beautiful illustrations, these ‘inferior’ beings were elevated into important specimens of natural philosophy. So, the illustrations for his books can be seen as an example of his self-fashioning as a skilled physician, artist, connoisseur and collector, as well as a natural historian concerned with taxonomy.

Lister’s abilities as an artist and skilful naturalist were also indicated in his mixed manuscript and print draft book for *De Cochleis*, the first book of *Historiae* published in 1685, which was devoted to exotic land shells. The eighteenth-century annotation on the endpapers stated: ‘This book belonged to Dr M. Lister, it was probably, a Pocket book, in use, during the compilation of his Book of Shells’, and ‘in this Book was found the Picture, which is supposed to be the Portrait of Anna or Susan Lister, Daughters of Dr. L. who drew the Shells for the Synopsis’.<sup>42</sup> Although unfortunately there was no portrait, there were other illustrations: the first page shows Lister’s drawing of a dead ‘Anadavad’ bird (red munia, *Amandava amandava*), ‘said to be brought from the East Indies’, with his detailed empirical description of its size and coloration ‘like that of a Robbing red-breast’, and an annotation that the species was in Willughby’s *Ornithology* (1678).<sup>43</sup> Lister’s illustration of the ‘Anadavad’ carefully elucidated its finch-like beak and lark-like claws that made it a distinctive species, its uniquely spotted plumage rendered beautifully in pencil shading. Lister’s keen understanding of surface features necessary for ornithological classification was not surprising, because he had worked with Ray to complete Willughby’s posthumous work and contributed bird species. He therefore had extensive interests in avians; for instance, correspondence with Ray in 1670 shows that Lister provided a definitive identification of ‘heath throistles’ (ring ouzels) that he spotted in Carleton-in-Craven, Yorkshire. Ray also provided in the preface to *Ornithology* ‘two or three Observations communicated by Mr. Martin Lister of York, my honoured Friend’, which included feeding habits of buntings and robins, and an experiment in which Lister ‘subtracted daily’ a swallow’s eggs, spurring her to lay ‘nineteen successively’.<sup>44</sup>

Lister also taught his daughters the craft skills and careful empiricism necessary for scientific illustration, guiding their artistic development closely. Evidence suggests that Lister may also have sat with his daughters while they drew the specimens, and he certainly pointed out the features they were to record. When Lister commissioned the artist William Lodge to do illustrations for his work *Historiae Animalium* (1678), he noted in the preface that he had taken ‘particular care to distinguish genuine species . . . by extremely minute but extremely faithful observations pertaining to the habits and life of these animals’, and he insisted on a high level of proficiency. Lister indicated that he made sure

that practically all the drawings of the animals were carried out in my presence. My aim was to see that the excellent artist did not merely . . . express his own personal conception. To facilitate this I first of all indicated with my finger the characteristics of each species that I most particularly wished to have depicted.<sup>45</sup>

Another sketchbook for Lister’s *Historiae* featured Anna’s wash drawing of a sea-urchin marked by Lister’s annotations and directions in correcting its shape. For instance, he wrote ‘the plates between the subluxis a:b:c:d \* are somewhat less at the bottom than they are in the life’ (figure 4).<sup>46</sup> With such detailed guidance, no doubt pointing out the

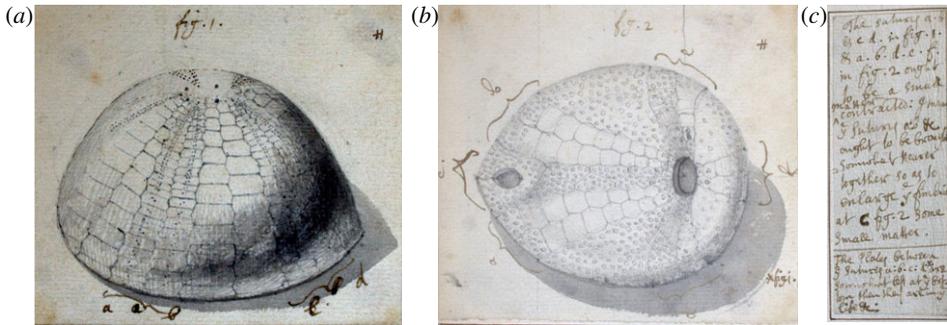


Figure 4. Lister's corrections of his daughters' drawings of sea-urchins, particularly directing them to pay attention to the size of the sublaxal plates. We see top (a) and bottom (b) views of the specimen, along with Lister's admonition to contract their size (c). From 'Original Drawings for Lister's Conchology ca. 1690,' MS 685, ff. 61v–62r. (Copyright © Science Museum Archives, Wroughton, Wiltshire.) (Online version in colour.)

animal's features, he taught them, in Lorraine Daston's words, an 'ontology of perceptual habit'. This habit was reinforced by an evident pleasure of skilful perception that Susanna and Anna experienced that manifested on the page as they gained experience in training their eyes to observe and their hands to illustrate.<sup>47</sup> As each book of *Historiae* came out between 1685 and 1692, his daughters' skills as illustrators grew keener, supporting Daston's point that in scientific observation there is 'seeing well' which may be inextricably intertwined with the acquired ability to see as.<sup>48</sup>

We do know that Susanna and Anna were drawing items from Lister's shell collection by the time they were teenagers, because their intertwined initials next to the misspelt abbreviation (pni for *pinxerunt*) appear on the title page of the *De cochleis* (1685) (figure 5). In this presentation copy to his friend Hans Sloane there was also careful handwritten elaboration of the fact that Susanna and Anna 'delineaverunt' or drew the illustrations; subsequent editions of *Historiae* had variations of these attributions—Susanna et Anna Lister Figura *pin[xerunt]* or *delineaverunt*.<sup>49</sup>

Although it is not unusual, as Woodley has noted, for 'exceptional children to draw skilfully at an early age', it seems that the daughters were not only drawing but also etching and engraving (*sculpsit*).<sup>50</sup> The draft manuscript book for *De Cochleis* demonstrated Lister's careful correction of his daughters' efforts in etching, editing Anna Lister's calligraphic captions above her floral ornament twice.<sup>51</sup> (Lister's corrections also demonstrate that he was a stickler for Latin prose, later editing the Roman cookbook by Apicius, his correspondence in the 1690s debating philological matters with Theodorus Janssonius van Almelooven (1657–1712), the Dutch classicist and editor.<sup>52</sup>) Keynes speculated, on examining the final print of this work, that it was etched because that was an easier technique than engraving, and Anna, being younger, may have begun with that before learning engraving for her father's *Historiae*.<sup>53</sup> Another of her floral ornaments appears in the 1685 edition in Lister's dedicatory plate to the collector William Courten. Indeed, Lister wrote to Henry Gyles in 1685 asking him to 'pray get Mr. Massenger to make me 6 etching sticks as formerlie & putt good and fine needles in them, neatlie after his fashion, & send them by the Carrier', indicating that some sort of etching was being done at or near his home.<sup>54</sup> Francis Place also complained in a letter to Henry Gyles in 1682, 'I pray at the retorne of ye Dr [Lister] lett him not have my Oyle for Printing.'<sup>55</sup>

*Martini Lister,*  
*de*  
*Cochleis,*  
*tam Terrestribus, quam Fluviatilibus*  
**EXOTICIS,**  
*seu,*  
*quæ non omnino in Anglia*  
*inveniuntur,*  
*liber.*



**Londini,**  
*are incisus, Sumptibus authoris.*  
 F. }  
 A. } *pni.*      1685

Figure 5. The frontispiece of *De Cochleis*, the first book of *Historiae*. In this presentation copy to Sloane, we see Susanna and Anna credited with drawing the figures. From Martin Lister, *De cochleis, tam terrestribus, quam fluviatilibus, exoticis, seu, quæ non omnino in Anglia inveniuntur* (published by the author, London, 1685), shelfmark 1256.i.25. (Copyright © British Library Board.)

As Lister was also a practising chymist, his home laboratory regularly infecting his York neighbourhood with fumes, he would have certainly been familiar with the procedure for making *aqua fortis* for the purposes of etching.<sup>56</sup>

As for Susanna, we see that by 1685 (if not before, because this was a draft book for the 1685 publication) she was certainly engraving.<sup>57</sup> The draft book for *De Cochleis* shows her engraved figure of a nautilus shell, plate 556, signed ‘Susan’, which also appeared in the

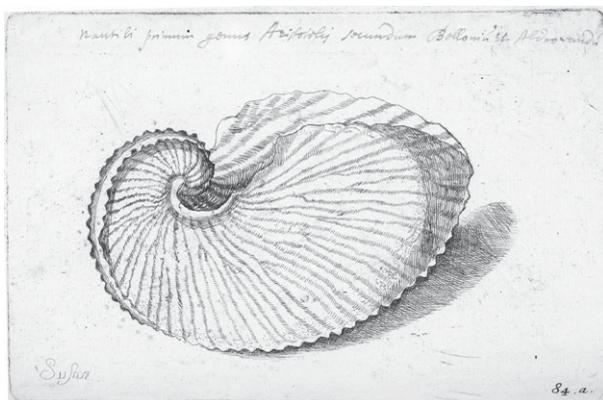


Figure 6. Susanna Lister's draft engraving of a nautilus shell, with her signature in the lower left-hand corner for *De Cochleis*. She was thus engraving by 1685, if not before, because this is a draft book for the publication. We can see her father's annotation above, tracing other portrayals of the shell in the work of other naturalists, such as Aldrovandi. Martin Lister, *De Cochleis tam terrestribus* (published by the author, London, 1685), Lister L. 95, figure 84a. The Bodleian Library, University of Oxford. (Copyright © The Bodleian Library, University of Oxford.)

printed book, and we can see her signature scratched on the original copperplate (shelfmark 222, Bodleian Library). Keynes and Wilkins had noted the final print of the shell, but in the draft copy of *De Cochleis* we also see Lister's annotation next to his daughter's work indicating the taxonomic information about the species, and the shell's presence in the work of Pierre Belon (1517–64) and Ulysse Aldrovandi (1522–1605) (figure 6).<sup>58</sup>

Lister also provided his daughters with the best possible materials for their work. According to William Faithorne's *The Art of Graveing and Etching* (1682), 'here in England you must buy your Copper ready forged from the Brasiers', and he advised 'that Copper is best which is free from flaws, and not too hard... and if it be too soft, you may some what perceiv it by its too much pliableness in bending.'<sup>59</sup> The addition of too much zinc (more than 5%) would result in a harder brass alloy and a more durable plate, but one that would be more difficult to carve; a plate that consisted mostly of copper would be easier to carve but would have to be thick to withstand wear from wiping and repeated use in the rolling press. A thicker copper plate also withstood alterations as the plate was heated and beaten out flat, polished smooth, and then re-engraved. A portable X-ray fluorescence device (Bruker Tracer III-V), providing quick and reliable surface elemental analysis, was used by Dr Peter Bray to examine two dozen of the Lister copperplates in the Bodleian Library on 8 April 2011.<sup>60</sup> The X-ray spectrum is recorded as characteristic peaks whose intensity corresponds to the percentage of each element in the alloy; Bray's analysis revealed plates made of 98% pure copper, the rest being made up of impurities from the copper ore rather than deliberate additions. This composition would permit easier carving and amendments. However, the plates averaged 2–3 mm thick, and although not easy to bend they would have been expensive to produce. The plates were probably specially commissioned from the braziers, because plates such as these would be made outside the normal brass production process.<sup>61</sup> With their nearly pure copper content, it is little wonder that Lister commented on the expense he incurred for them.

*PHILOSOPHICAL TRANSACTIONS AND MICROSCOPY*

The artistic skills of Lister's daughters may not have been limited to *Historiae*. Keynes and Woodley have also noted that by 1685 Susanna Lister had been illustrating papers for *Philosophical Transactions*, both for her father and for the Royal Society more generally.<sup>62</sup> Their claim rests partly on a signature with the plainly styled and intertwined initials 'SL sculp' in volume 15, no. 172 (1685) resembling the one engraved on the presentation copy of *De Cochleis* to Hans Sloane, also dated 1685.<sup>63</sup> The signature is below a variety of drawings: a honeycomb sent to the Royal Society by Lister's friend, Monsieur Cabart de Villermont, a geographer posted in the West Indies; a hygroscope sent by William Molyneux from Dublin to William Musgrave; and an asbestos cloth provided by Robert Plot. Woodley and Keynes also mention another set of illustrations signed 'S. sculp.' for volume 15, no. 175 (1685), done for a series of articles: a published letter from Lister to Ray concerning ornithology with 'Dr Lister's figure of a silk tail', and 'the figures of some antiquities, communicated by a Member of the Royal Society'. Furthermore, there are also other works in *Philosophical Transactions* articles attributed to Susanna Lister by the curators of the Linda Hall Library (Kansas City, Missouri) in a 2005 Exhibition: 'Women's work: portraits of 12 scientific illustrators'. The curators identified an article from the Royal Society's journal dated 1685, which include engravings of Anton von Leeuwenhoek's wine salts also signed 'SL sculp' in the same plain style.<sup>64</sup> Another article from *Philosophical Transactions*, Leeuwenhoek's discussion of wood histology dating from 1683, also has the characteristic signature.

It could be argued that such a young woman as Susanna, who would have been 13 years old in 1683 (she was baptized on 9 June 1670)<sup>65</sup> could not have possibly had the artistic maturity to engrave plates for *Philosophical Transactions*. This line of chronological reasoning was behind Keynes's incorrect identification of the drawings and engravings of Anna Lister in Lister's *Historiae* as having been engraved by Lister's wife, Hannah, whom he speculated was nicknamed 'Anna'; this surmise was corrected by Woodley, who clearly demonstrated from Lister's correspondence that the artists were the two daughters.<sup>66</sup> In addition, we know for certain that by 1685, if not before, from the draft book of *De Cochleis*, the 15-year-old Susanna was engraving, and the 13-year-old Anna was etching with her father's careful assistance.

However, it may be possible that the 'SL' signature in *Philosophical Transactions* could be that of the little-studied and elusive John Savage (*fl.* 1683–1700), an engraver and print seller of portraits, playing cards, book illustrations and title pages.<sup>67</sup> Savage advertised himself as an engraver for *Philosophical Transactions*, and indeed he was the only known engraver for the Royal Society's journal with initials that might match the signature of 'SL sculp';<sup>68</sup> it could be argued that 'SL' might instead be 'SI', an abbreviation for 'Iohannis Savage'. There is a portrait by Savage that contains a monogram of plain initials intertwined, done after Anthony Van Dyck, that has been attributed to Savage. It has an intertwined 'S and I sculp' or perhaps just an 'S' with a flourish, but the monogram (as the portrait itself) is quite different in style from the signature in *Philosophical Transactions*.<sup>69</sup> In *Philosophical Transactions* we also see one illustration of Edward Tyson's roundworm signed by 'I and S' intertwined followed by Savage; it is unclear whether the 'I and S' referred to Johannes or whether the monogram was redundant.<sup>70</sup> In most of his works, however, Savage usually signed his name more fully as 'I Savage sculp';<sup>71</sup> although we can see the attribute 'Savage sculp' in some of his works,<sup>72</sup> 'Iohn Sauage' for his playing cards,<sup>73</sup> or in a 1685

engraving for Lister's paper concerning the Roman origins of a multiangular tower at York we observe 'J Savage sculp', the 'J' fairly elaborate and distinctive.<sup>74</sup> His trade card also refers to him as 'John Savage'.<sup>75</sup>

Furthermore, the intertwined signature of 'S' and 'L' followed by 'sculp' in volume 15, no. 172 (1685) of *Philosophical Transactions* is, as Keynes noted, 'in reversed writing as if by an amateur hand'; it would be unusual for an engraver of Savage's ability to make such an elementary mistake, but it would be more characteristic of a younger engraver such as Susanna.<sup>76</sup> Last, the engraving of 'Dr Listers figure of a silk tail' in volume 15, no. 175 (1685) accompanying his article about ornithology, which portrays an illustration of a bird quite similar in artistic style to that of his 'Anadavad' specimen in the *de Cochleis* draft notebook, is signed 'S. sculp', which is certainly not in keeping with any known signature by Savage. It is possible that Susanna engraved her father's own drawing of the avian, he guiding her along so she recorded the essential features necessary for taxonomic classification.

However, a later article, 'The Anatomy of a Scallop', published by Lister in *Philosophical Transactions*, provides more definitive evidence of the contributions of the daughters to the Royal Society, but in this case, those by Anna.<sup>77</sup> Printed in volume 19 (1695–97) of the journal, the article is accompanied by an engraving of a molluscan dissection from a copperplate that was later used for the second edition (1692–97) of Lister's *Historiae Conchyliorum* (figure 7). In *Historiae*, the scallop became part of a series of 22 illustrations that Anna Lister made of molluscan anatomy accompanied by an elaborate typeset figure legend in the appendix. Many of the dissections drawn by Anna are extant in her sketchbook for *Historiae* (MS Lister 9, Bodleian Library), and she signed some of the anatomical prints as well (figure 8). It is thus quite likely that Anna was the artist of the anatomy of the scallop printed in *Philosophical Transactions*. In other parts of volume 19 of *Philosophical Transactions*, Lister published articles that had been printed in his earlier books or that were the subject of past experiments, so it is characteristic of his behaviour that he used a copperplate for two publications.<sup>78</sup> Indeed, in the *Philosophical Transactions* article, the plate of the scallop was accompanied by Latin text that was copied verbatim for the figure legend for *Historiae*.

The only change to the printed figure in *Historiae* was an alteration of part of the heading, presumably from 'Transct: no. 229' (for the journal article) to 'Table 17' (for *Historiae*). There seems to be a good deal of rubbing evident around the area of the heading on the recto of the plate; this evidence indicates alteration of the title with a burnisher, the copper being levelled out with a scraper. In a process akin to *repoussage*, the plate was also beaten out from the back with a punch and a small hammer to raise the old title, which could then be scraped off to achieve a smooth surface that could be cut again; Mei-Ying Sung's analysis of the copperplates of William Blake has indicated that Blake also used *repoussage* to revise and correct his work, and that it was a common technique of alteration among engravers.<sup>79</sup> Neither Anna nor her sister Susanna would have been strangers to this technique because they employed it often in *Historiae*; as Wilkins has noted:

Constant additions to the numerous plates contained in the various books and sections of the growing *Historiae* made it impossible for them to be numbered consecutively with any certainty . . . it appears from the many erased plate numbers still to be faintly seen that this attempt was soon abandoned, and it was not until the second edition, some time after 1697, that the whole of the plates were satisfactorily numbered in sequence.<sup>80</sup>

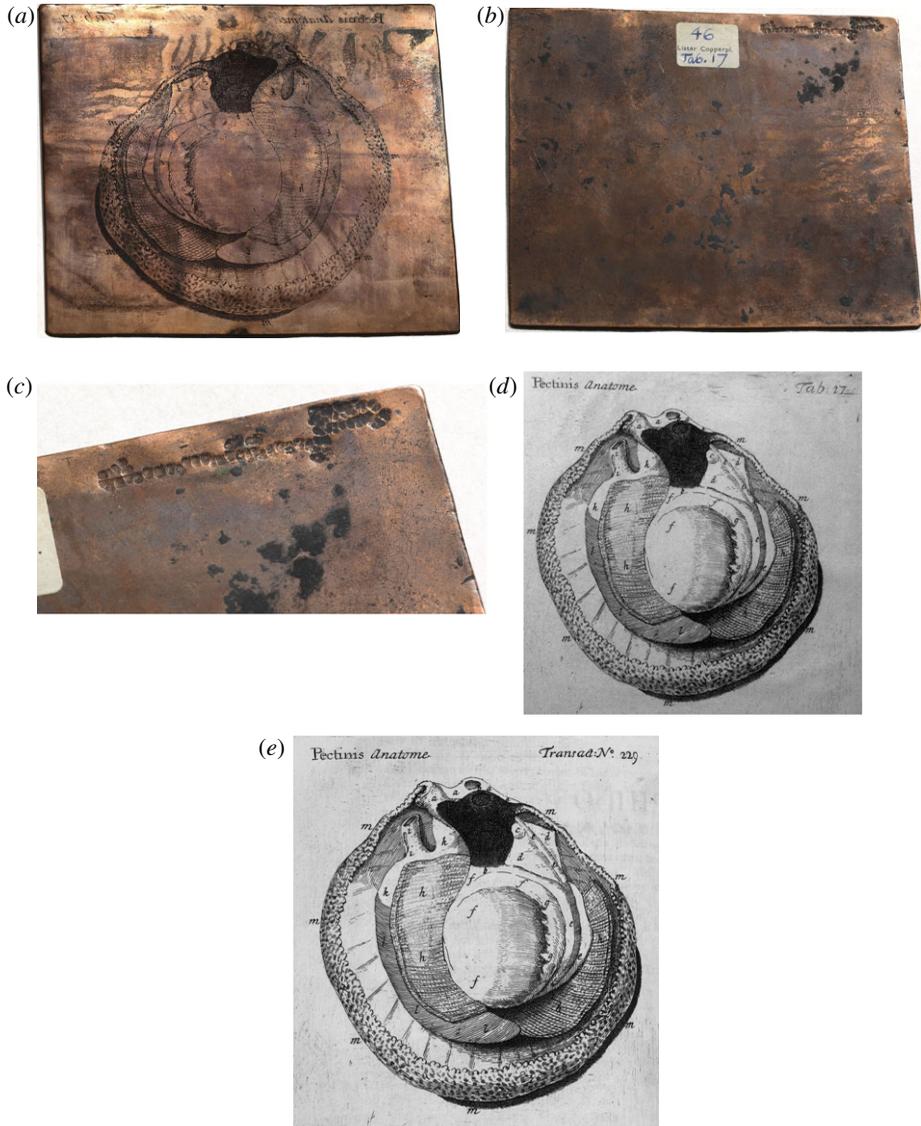


Figure 7. Lister repurposed his daughter Anna's engraving of a scallop done for an article in *Philosophical Transactions* for a later book concerning molluscan anatomy. (a) Copperplate for the *Anatomy of the Scallop*, *Historiae Conchyliorum*, Lister Copperplate 46. The Bodleian Library, Oxford. (b) Verso of the copperplate of the Scallop Dissection, Lister Copperplate 46, The Bodleian Library, University of Oxford. (c) Magnified view of the verso of the copperplate for the *Anatomy of the Scallop*. The copperplate shows evidence of alteration of the title, the verso of the plate being raised from behind and rubbed and burnished on the recto. Lister Copperplate 46, The Bodleian Library, Oxford. (d) Table 17 from Martin Lister, *Historiae Conchyliorum* (published by the author, London, 1685–92; 2nd edn 1692–97); The Bodleian Library, University of Oxford. (e) The illustration was reused for Martin Lister, 'The Anatomy of a Scallop', *Phil. Trans. R. Soc. Lond.* **19**, 567–570 (1695–97), image preceding the article on p. 560. (Copyright © The Royal Society, London.) (Copyright © The Bodleian Library, University of Oxford.) (Online version in colour.)

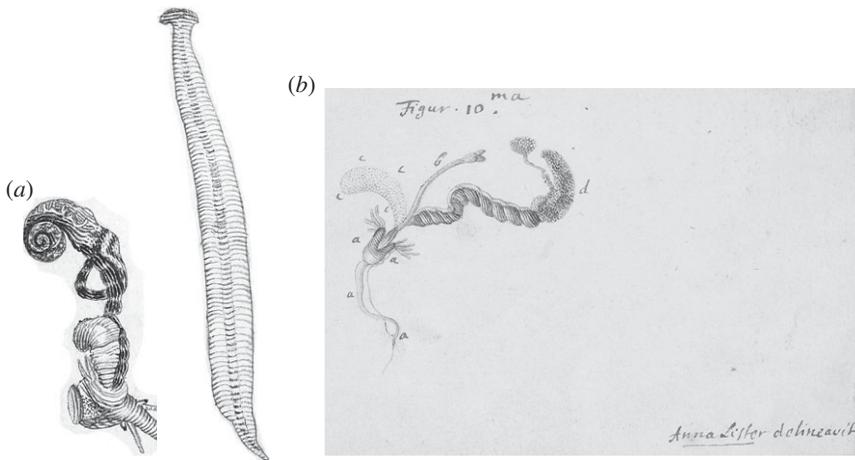


Figure 8. Anna Lister's sketchbook contained several sketches of molluscan anatomy, accomplished as part of her father's unfulfilled plan to do a complete anatomical atlas of conchology. (a) Anna Lister's sketches of molluscan anatomy; MS Lister 9, f. 115r, The Bodleian Library, University of Oxford. (b) Anna Lister's sketches of molluscan anatomy. Note her signature: 'Anna Lister delineavit'. MS Lister 9, f. 122v., The Bodleian Library, University of Oxford. (Copyright © The Bodleian Library, University of Oxford.)

Because (as mentioned above) the copperplates for *Philosophical Transactions* were surrendered to the nation in World War I, it is also likely that Anna's engraving may be one of the few, if not the only, surviving plate from the early era of the Royal Society's journal.

One of these illustrations of molluscan dissections, clearly signed 'Anna Lister delineavit', also indicates that she was using a microscope to observe molluscan anatomy. As I have previously demonstrated in my biography of Lister, we do know without doubt that from 1694 Lister and his daughters were regularly using a microscope in the creation of scientific illustrations.<sup>81</sup> In the preface of his *Exercitatio Anatomica in qua de Cochleis* (1694), Lister mentioned that to aid him in the 'dissection of minute animalcules . . . I am now for the first time, owing to defective vision, compelled to use a microscope, I rejoice greatly that I can by its aid again enjoy the same studies which were long denied to unassisted eyes'.<sup>82</sup> Although simple microscopes based on Leeuwenhoek's design with their tiny bead-like spherical lenses 'surpassed all others in both distinctness and magnification', magnifying 200–300 diameters, their use was only viable to those, as Hooke noted, 'whose eyes could well endure it'.<sup>83</sup> The simple microscope had to be brought very close to the object it was viewing, and it provided a very constricted field of view.<sup>84</sup> From 1650 pocket microscopes, 'flea glasses' and compound instruments were widely available, and by the early eighteenth century many of Lister's colleagues throughout Europe used the more 'comfortable compound instrument for observations at medium and lower magnification, turning to the simple microscope to explore smaller realms'.<sup>85</sup> Because Lister used microscopes as aids to the dissection of molluscs and his poor vision obviated the use of a simple microscope, an early compound instrument in conjunction with a hand lens would have been more than sufficient for his purposes. Despite the prominent decorative image of the compound instrument in Hooke's *Micrographia*, Hooke turned to the single-lens microscope to produce his spectacularly

magnified and detailed engravings that demonstrated the very power of the instruments to mitigate the Baconian idols of the senses, his aim to provide ‘a *full* sensation of the Object’ [my italics]. In contrast, Lister’s purpose was to present the *essential* features of the molluscan external structure and internal anatomy for the purposes of taxonomy in a visually pleasing manner. Hooke’s flea dazzles; Lister’s mollusc classifies.

More practically, a very powerful microscope would also have led to less accurate depth perception, which was necessary for the creation of taxonomic illustrations containing these essential features. As an analogy, in general microsurgical technique the use of the lowest level of magnification necessary for manipulation is recommended. Recent neurophysiological studies also show a close correlation between depth perception and visually guided hand movements in primates, including humans.<sup>86</sup> These hand movements not only include surgical manipulation but would also encompass the fine hand–eye coordination necessary in the use of the microscope and the subsequent drawing and engraving that Lister’s daughters performed. As Wilson has indicated, ‘When Hooke speaks . . . of the coordination of hand and eye, one remembers that hand and eye are not coordinated in microscopical work, that a new series of coordinated movements must be learned, with some difficulty’.<sup>87</sup> A microscope with a lower magnification would make it easier to learn such techniques.

Susanna’s younger sister Anna was certainly using a lower-magnification microscope in the early 1690s in a coordinated fashion; her notebook with her original drawings for *Historiae Conchyliorum* includes a close comparison of the shells of the species *patellidae* labelled *ex microscopio*, as well as a depiction of a brachiopod gill and dissected mollusc penises.<sup>88</sup> In the latter case, the image was transferred to copperplate, and the printed work also carried the label indicating her use of the instrument. It is possible that the sisters were some of the first women, and certainly among the youngest women, doing scientific illustrations with the use of microscopes.<sup>89</sup>

In a letter of 16 May 1694, John Place, the physician of the Grand Duke of Tuscany, told Lister of ‘the Great Duke’s singular satisfaction . . . especially with your ingenious, and elaborate booke [*Historiae*]. I told him that the figures were the work of your daughters, which surprises him extremely.’<sup>90</sup> Place then wrote, ‘I believe he will present you with a parsell of his Florence wine.’ This selective analysis of the significance of the copperplates and their prints was similarly rewarding, indicative of what a detailed examination of all the 1000 plates and their images will tell us. Some plates give us first-hand evidence of the erasing and re-engraving performed as the final set of the plates evolved through its several editions created between 1685 and 1697; confirmation of this by laser scanning confocal microscopy will finally allow a definitive bibliographic history of Lister’s masterpiece. Potential approaches could include taking silicone moulds of the plate surfaces to assess tool marks and engraving techniques, as well as metallographic investigation of exposed edges to interpret manufacturing processes. The Lister copper plates are witnesses to the important and often hidden role of family connections, artisanal work, aesthetic practice and empirical perception in the transformation of a field specimen into an object of scientific enquiry in the early modern era.

#### ACKNOWLEDGEMENTS

I would like to thank Keith Moore and Joanna Hopkins at the Royal Society for their assistance and suggestions. I am also grateful to Dr Alexandra Franklin and Clive Hurst of the Bodleian

Library at the University of Oxford for their assistance with the copperplates, as well as the staff in Imaging Services in the Bodleian Library. The Wellcome Trust, the Natural History Museum, London, and the Science Museum generously provided permission to use images from their collections. Professor Mark Pollard and Dr Peter Bray at the Research Laboratory for Archaeology and the History of Art, the University of Oxford, deserve special thanks for their analysis of the plates by X-ray fluorescence. My thanks also to Antony Griffiths and Sheila O’Connell of the British Museum and to Dr Mei-Ying Sung of FoGuang University, Taiwan, for their cogent comments about techniques of copperplate engraving and correction. Dr Jeremy Woodley and Dr Jeff Carr also provided important information about Martin Lister and his work. I would also like to thank Cultures of Knowledge at the University of Oxford and the Mellon Foundation for sponsoring my research, with a special mention to Dr James Brown, Professor Howard Hotson and Miranda Lewis. My thanks also to the anonymous reviewers, whose comments enriched and improved the article.

## NOTES

- 1 Sachiko Kusakawa, ‘Picturing knowledge in the early Royal Society: the examples of Richard Waller and Henry Hunt’, *Notes Rec. R. Soc.* **65**, 273–294 (2011), at pp. 288–289.
- 2 John Ray, ‘Preface’, in *The Ornithology of Francis Willughby* (John Martyn, London, 1678), p. 6.
- 3 Unwin in fact analyses how the artists Lister used for earlier works in natural history, such as William Lodge and Francis Place, often produced illustrations that were not accurate or were incomplete. See Robert Unwin, ‘A provincial man of science at work: Martin Lister, FRS, and his illustrators, 1670–1683’, *Notes Rec. R. Soc. Lond.* **49**, 209–230 (1995).
- 4 Adrian Johns, *The nature of the book* (University of Chicago Press, 1998), p. 475.
- 5 Kusakawa, *op. cit.* (note 1), p. 273.
- 6 Kusakawa, *op. cit.* (note 1), p. 294, n. 90.
- 7 David Freedberg, *The eye of the lynx: Galileo, his friends, and the beginnings of modern natural history* (University of Chicago Press, 2002). This point is also made by Dániel Margócsy, ‘Refer to folio and number; encyclopedias, the exchange of curiosities, and practices of identification before Linnaeus’, *J. Hist. Ideas* **71**, 63–89 (2010), at p. 71.
- 8 William Faithorne, *The art of graveing and etching . . .* (William Faithorne, London, 1682).
- 9 Robert Hooke, ‘Preface’, in *Micrographia* (John Martyn, London, 1665), p. 4.
- 10 Anna Lister is also referred to in the literature as Anne Lister, reflecting her Latinized and given names. I am using Anna throughout the article for the sake of consistency. I thank Jeremy Woodley for pointing out this distinction.
- 11 Guy Wilkins was the first to note that some of the shells that Lister used from the collection of Sir Hans Sloane still survive in the Natural History Museum, London. See Guy Wilkins, *A catalogue and historical account of the Sloane Shell Collection* (British Museum, London, 1953). Kathie Way, the Collection Manager of Higher Invertebrates, has also written a chapter about Sloane’s invertebrate collection in Arthur MacGregor, *Sir Hans Sloane: collector, antiquary, founding father of the British Museum* (British Museum Press, London, 1994). For the cost of Lister’s plates, see Martin Lister, *A Journey to Paris in the year 1698* (ed. Raymond Phineus Stearns) (University of Illinois Press, Urbana, 1967), p. 107.
- 12 The watermark is extant on several pages of the 1685–88 edition of *Historiae Conchyliorum* (shelfmark Gough Nat. Hist. 57, Bodleian Library), as well as in several pages of Lister’s letters. The watermark’s three circles, Griffins, Cross and Crown and Arms of Genoa are similar to ARMS.099.1 from the Thomas Gravell Watermark Archive (<http://www.gravell.org>). The source of the Gravell watermark was a 1666 London imprint from the Folger Shakespeare Library, Washington DC (shelfmark L.F.WM Coll 1).

- 13 Guy Wilkins, 'Notes on the *Historiae Conchyliorum* of Martin Lister (1638–1712)', *J. Soc. Hist. Nat. Hist.* **3**, 196–205 (1957), at p. 197.
- 14 Arthur MacGregor, 'William Huddesford (1732–1772): his role in reanimating the Ashmolean Museum, his collections, researches, and support network', *Arch. Nat. Hist.* **34**, 47–68 (2007).
- 15 See Eugenie Reich, '300-year-old engravings shed light on women in science', *Nature News* (24 December 2010); see <http://www.nature.com/news/2010/101224/full/news.2010.689.html>
- 16 Geoffrey Keynes, *Martin Lister: a bibliography* (St Paul's Bibliographies, Bury St Edmunds, 1981), p. 32; Jeremy Woodley, 'Anne Lister: illustrator of Martin Lister's *Historiae Conchyliorum* (1685–92)', *Arch. Nat. Hist.* **21**, 225–229 (1994), esp. p. 227; Jeremy D. Woodley, 'Lister, Susanna (bap. 1670, d. 1738)', *Oxford Dictionary of National Biography* (Oxford University Press, 2004); online edn, January 2008 (<http://ezproxy.ouls.ox.ac.uk:2117/view/article/58454>; accessed 28 November 2011).
- 17 For an analysis of the practices involved in transforming the documentary form of a scientific object from one stage of a project to another, see Michael Lynch, 'Discipline, images and scientific visibility', *Social Stud. Sci.* **15**, 37–65 (1985).
- 18 Harold J. Cook, 'Natural history and seventeenth-century Dutch and English medicine', in *The task of healing* (ed. Hilary Marland and Margaret Pelling), pp. 253–270 (Erasmus Publishing, Rotterdam, 1996), at p. 257.
- 19 J. D. Woodley, 'Lister, Martin (bap. 1639, d. 1712)', *Oxford Dictionary of National Biography* (Oxford University Press, 2004); online edn, October 2008 (<http://ezproxy.ouls.ox.ac.uk:2117/view/article/16763>; accessed 28 November 2011). See also 'Martin Lister', s.v. *Biographia Britannica* (London, 1747–66), and William Munk, *The roll of the Royal College of Physicians of London* (The College, London, 1878), vol. 1, pp. 442–445. For Lister's correspondence with Ray, see John Ray, *The correspondence of John Ray* (ed. Edwin Lankester) (The Ray Society, London, 1848; reprinted by Arno Press, New York, 1975).
- 20 For instance, Lister's *De scarabaeis britannicus* was printed as part of Ray's publication of Willughby's *Historia insectorum* (A. & J. Churchill, London, 1710).
- 21 Martin Lister, *Historiae sive synopsis methodica conchyliorum* (published by the author, London, 1685–92; 2nd edition published by the author, London, 1692–97).
- 22 See Wilkins, *op. cit.* (note 11).
- 23 Bodleian MS Lister 3, f. 228.
- 24 Bodleian MS Lister 36, ff. 72–73.
- 25 See, for instance, Dale's letter to Lister in BL [British Library] MS Stowe 747, f. 24.
- 26 I have calendared Lister's correspondence and am currently editing the calendar for publication with the Cultures of Knowledge Project at Oxford (<http://www.history.ox.ac.uk/cofk/>). A three-volume edition of Lister's correspondence is also forthcoming from Brill, scheduled for 2013–17.
- 27 This scheme is taken from Guy L. Wilkins, 'Notes on the *Historiae Conchyliorum* of Martin Lister (1638–1712)', *J. Soc. Bibliogr. Nat. Hist.* **3**, 196–205 (1957), at pp. 202–203.
- 28 Wilkins, *op. cit.* (note 11), p. 13.
- 29 Bodleian MS Lister 4, f. 77r. Woodley also discusses the girls' artistic development in Woodley, 'Anne Lister', *op. cit.* (note 16), pp. 225–229.
- 30 Roos, 'Limnings of Love', *Arts Antiques Mag.*, pp. 59–61 (2008).
- 31 Edward Norgate, *Miniatura: Or the Art of Limning* (1627/8, London; Clarendon Press, Oxford, 1919), p. 10.
- 32 Kim Sloan, 'A Noble Art': *amateur artists and drawing masters, c. 1600–1800* (British Museum Press, London, 2000), pp. 23 and 42.
- 33 Thomas Kirke, 'The Art of Limning', MS Thoresby 33, York Archaeological Society, Leeds. Kirke's death date was taken from Henry Gyles's commemorative stained glass window in Adel St John the Baptist Church, Leeds. Kirke died on 24 April 1706. He was a virtuoso who lived in Cookridge Hall, Leeds, and he was famous for creating a geometrical maze in

- Moseley Wood. For a typical example of a limning manual, see C. K. *Art's master-piece, or, A companion for the ingenious of either sex* (G. Conyers, London, 1697). The latter provided instructions not only on how to limn and paint in oils, but also on how to make 'glass of crystal'.
- 34 MS Ray, f. 11, letter 29, Natural History Museum, London. This is also partly reprinted in Lankester (ed.), *op. cit.* (note 19), pp. 48–51, at p. 49: *Johannes Goedartius, Of Insects: done into English and Methodized, with the Addition of Notes* (published by the author, York, 1682). Lister printed this work privately.
- 35 Lister, 'To the Reader', *Goedartius*, f. A3v.
- 36 *Ibid.*
- 37 MS 30, Thoresby Collection, Yorkshire Archaeological Society, Leeds. We can be certain that these were not the work of Lister's daughters, because the date of the manuscript is from the early 1670s. Four prints by Place with register numbers 'en série' with illustrations for *On Insects* that do not appear in the printed book can also be found in the British Museum, Prints and Drawings Department, Registration number Ee,2.60, Bibliographic Reference Hake 85. Location: British XVIIIc Mounted Roy. Lister was doing extensive work on insect parasitism at the time and was thus closely studying metamorphosis, so these plates may have been made as part of his research. For instance, he employed his knowledge of parasitism to correct *On Insects*, noting that many of Goedart's 'caterpillars' and their 'offspring' were actually larvae of parasitic wasps or 'by-births', the 'Caterpillar which bore them, serving only as Food to them, not a Mother'. See Lister, *Goedartius*, p. 11.
- 38 For Malpighi, see Matthew Cobb, 'Malpighi, Swammerdam, and the colourful silkworm: replication and visual representation in early modern science', *Annls Sci.* **59**, 111–147 (2002), at p. 144. The quotes from Lister's *Goedartius* in this paragraph are on pages 8 and 41.
- 39 Plate [8] of 14 illustrating Martin Lister's translation of 'Johannes Godartius of Insects, done into English and methodized, with the addition of notes. The figures etched upon copper by Mr F. Pl. York' (1682) depicts nine flies and moths, alongside their pupal and larval forms, against a blank background etching. British Museum, Prints and Drawings Department, Registration number Ee,2.69, Bibliographic Reference Hake 71. Location: British XVIIIc Mounted Roy.
- 40 Martin Lister, 'Preface', in *Exercitatio anatomica altera de buccinis fluviatilibus et marinis* (Samuel Smith & Benjamin Walford, London, 1695), p. 2; Thomas Shadwell, *The virtuoso* (ed. M. H. Nicolson and D. S. Rodes) (University of Nebraska Press, Lincoln, 1966), pp. 42–43. Shadwell wrote, 'I think I have found out more Phoenomena's or Appearance... of Nature in Spiders, than any Man breathing: Wou'd you think it? there are in *England* six and thirty several sorts of Spiders; there's your Hound, Grey-hound, Lurcher, Spaniel Spider.' This was a pointed reference to Lister's table of 36 spiders in his *Historiae Animalium* (J. Martyn, London, 1678).
- 41 Bodleian MS Ashmole 1816, f. 176. He also expressed much the same sentiment in Bodleian MS Ashmole 1816, f. 116.
- 42 Martin Lister, *De Cochleis tam terrestribus* (published by the author, London, 1685), Bodleian Library shelfmark Lister L 95. Although this work is listed as a printed book, it is a draft printing interspersed with sketches.
- 43 The bird is indeed portrayed in John Ray and Francis Willughby, *The Ornithology of Francis Willoughby*... (John Martyn, London, 1678), p. 266.
- 44 For the reference to heath throstles see Bodleian MS Lister 5, f. 113r; for the swallow experiment, see Ray and Willughby, 'Preface', in *Ornithology*, *op. cit.* (note 43), book 1, pp. 6–7.
- 45 Lister, 'Preface', in *Historiae Animalium Angliae tres tractatus* (J. Martyn, London, 1678), pp. 2 and 3. 'Summam sanè diligentiam adhibui, ut veras species distinguendo, non multiplicando citra necessitatem, singulas, minutissimis licèt, fidissimis tamen Observationibus, quae ad animalium mores vitámque; spectarent, exornarem.' (Literally, 'I have taken particular care to distinguish genuine species and not to multiply them beyond necessity: in this way I have set

- out individual species by extremely minute but extremely faithful observations pertaining to the habits and life of these animals.’ *Ibid.*, p. 3. (‘Rursus omnium ferè Animalium figuras coram me delineandas curavi; ut optimus artifex, non suum tantùm conceptum, ut fieri solet, exprimeret; sed, quò faciliùs acciperet, quae uniuscuiusque; speciei maximè depingendae essent Notae, eas primum digito indicavi.’)
- 46 ‘Original Drawings for Lister’s Conchology ca. 1690’, MS 685, f. 62r, Science Museum Archives, Wroughton, Sussex.
- 47 Lorraine Daston, ‘On scientific observation’, *Isis* **99**, 97–110 (2008), at p. 107.
- 48 *Ibid.*
- 49 Martin Lister, *De Cochleis tam terrestribus* (London, 1685), British Library shelfmark 1256.i.25. See also Keynes, *op. cit.* (note 16), p. 34.
- 50 Woodley, ‘Anne Lister’, *op. cit.* (note 16), p. 226.
- 51 Lister, *op. cit.* (note 42). The folios in this volume are not numbered. For Almeloveen, see Anna Marie Roos, *Web of nature: Martin Lister (1639–1712), the first arachnologist* (Brill, Leiden, 2011), pp. 401–412. The original letters between Lister and Almeloveen are in the University of Utrecht Library, MS 6K12 and 6K13, letters from Van Almeloveen to Lister (1694–1710).
- 52 The correspondence between Almeloveen and Lister about philology is in Bodleian MS Lister 2, ff. 70–90, *passim*, as well as in the University of Utrecht Archives, MS 6K12 and MS 6K13. A full calendar of Almeloveen’s correspondence is provided in S. Stegeman, *Patronage and service in the Republic of Letters: the network of Theodorus Janssonius Van Almeloveen (1687–1754)* (APA-Holland Universiteits Press, Amsterdam, 2005).
- 53 Keynes, *op. cit.* (note 16), p. 28. Because the etcher has only to draw the design through wax rather than wield a tool to cut into metal, the work proceeds more easily than with engraving.
- 54 For the discussion of Anna’s floral ornaments, see Keynes, *op. cit.* (note 16), p. 28; the original letter is Bodleian MS Lister 4, f. 77, as discussed in Woodley, ‘Anne Lister’, *op. cit.* (note 16), p. 227.
- 55 BL MS Stowe 746, f. 70. Place to Henry Gyles, 17 July 1683.
- 56 Anna Marie Roos, ‘A speculum of chymical practice: Isaac Newton, Martin Lister (1639–1712), and the making of telescopic mirrors’, *Notes Rec. R. Soc.* **20**, 105–120 (2010), at p. 109. Lister’s chymistry is also discussed in Roos, *Salt of the Earth: natural philosophy, medicine and chymistry in England, 1650–1750* (Brill, Leiden, 2007), ch. 3, *passim*.
- 57 As the draft notebook also contains an original drawing for one of Lister’s articles for *Philosophical Transactions* about a Roman altar dating from 1683, the date for the book and thus for Susanna’s drawings may be earlier than 1685.
- 58 Lister was referring to Aldrovandi’s *De reliquis animalibus exanguibus, utpote de mollibus, crustaceis, testaceis & zoophytis libri quatuor* (B. Bellagambam, Bologna, 1606) and Pierre Belon’s *De aquatilibus* (Carolus Stephanum, Paris, 1553).
- 59 Faithorne, *op. cit.* (note 8), p. 4.
- 60 Dr Peter Bray and Professor Mark Pollard (University of Oxford), Clive Hurst (Head of Rare Books, Bodleian Library), Dr Alexandra Franklin (Bodleian Library) and I were present.
- 61 My thanks go to Professor Mark Pollard for this information.
- 62 Keynes, *op. cit.* (note 16), p. 32; Woodley, ‘Susanna Lister and Anna Lister’, *op. cit.* (note 16).
- 63 Keynes, *op. cit.* (note 16), p. 32; Woodley, ‘Anne Lister’, *op. cit.* (note 16), p. 227. Keynes was referring to illustrations following the article ‘A Letter from William Molyneux Esq; Secretary to the Dublin Society; to One of the S. of the R.S. concerning a New Hygroscope, Invented by Him’, *Phil. Trans. R. Soc. Lond.* **15**, 1032–1035 (1685).
- 64 ‘Women’s work: portraits of 12 scientific illustrators from the 17th to the 21st Century’ ([http://www.lindahall.org/events\\_exhib/exhibit/exhibits/womenswork/lister3.shtml](http://www.lindahall.org/events_exhib/exhibit/exhibits/womenswork/lister3.shtml)). There is also a printed catalogue for the exhibit, which was curated by Nancy Green of the Linda Hall Library with contributions from Douglas Holland of Missouri Botanical Garden Library and from the history of science department of the Linda Hall Library. The articles are as follows:

- A. von Leeuwenhoek, 'An Abstract of a Letter from Mr. Anthony Leewenhoek of Delft to Mr. R.H. concerning the appearances of several woods and their Vessels as observed in a Microscope', *Phil. Trans. R. Soc. Lond.* **13**, 197–208 (1683); A. von Leeuwenhoek, 'An Extract of a Letter from Mr. Anthony Leewenhoek F. or the R.S. to a S. of the R. Society', *Phil. Trans. R. Soc. Lond.* **15**, 963–979 (1685).
- 65 Lister remarked to John Ray in March 1670 that he 'must carry my wife to ly in at her mothers in Craven, where I shall be most part of this Summer'. MS Ray 1, f. 9, letter 25b, Natural History Museum, London. Susanna was born at Carleton Hall in Carleton-in-Craven, Yorkshire, and was baptized on 9 June 1670. See Parish Register (P 18/3) of Carleton-in-Craven, West Yorkshire Archive Service, Leeds.
- 66 Woodley, 'Anne Lister', *op. cit.* (note 16), *passim*.
- 67 Antony Griffiths, 'Savage, John (fl. 1683–1701)', *Oxford Dictionary of National Biography* (Oxford University Press, 2004); online edn (<http://ezproxy.ouls.ox.ac.uk:2117/view/article/24718>, accessed 28 November 2011). For more on Savage, see also Griffiths, *The print in Stuart Britain, 1603–1689* (British Museum, London, 1998), p. 260. This possibility of Savage was suggested by the anonymous reviewer of this paper.
- 68 See John Savage's 'The merry Fidler', British Museum, registration number 1972,U.370.35. Savage signed the work: 'I Savage Sculptr. A:O et S:R:, the 'S:R' standing for *societatis regiae* or 'Royal Society'.
- 69 Print of Head by van Dyck, Registration number P,3.247, British Museum.
- 70 Edward Tyson, 'Lumbricus Teres, or some anatomical observations on the roundworm', *Phil. Trans. R. Soc. Lond.* **13**, 154–161 (1683). My thanks go to the reviewer for alerting me to this signature.
- 71 For instance: engraved frontispiece to 'Syntagmata theologico authore P. Augustino Laurent'; British Museum, registration number 1900,1019.244; I have examined works in the catalogues of the National Gallery and the British Museum.
- 72 Robert 'Beau' Fielding, mezzotint, National Portrait Gallery, NPG D11968.
- 73 Playing-card, British Museum, registration number 1982,U.4655.
- 74 Martin Lister, 'Some Observations upon the Ruins of a Roman Wall and Multangular Tower at York', *Phil. Trans. R. Soc. Lond.* **13**, 238–242 (1683). We see the same signature on Savage's edition of Tuttle's Mathematical Playing Cards, British Museum, Playing-cards Willshire E.222. See Griffiths, 'Savage', *op. cit.* (note 67) for Savage's biographical information and place of address. The print is registration number P,3.247, British Museum.
- 75 John Savage, British Museum, Trade cards Heal 59.130.
- 76 Keynes, *op. cit.* (note 16), p. 32.
- 77 Martin Lister, 'The Anatomy of a Scallop', *Phil. Trans. R. Soc. Lond.* **19**, 567–570 (1695–97). The illustration appears before the article, on p. 560. The exhibit 'Women's work', *op. cit.* (note 64), also notes this illustration, but there it is attributed to Susanna Lister; it is more likely that the work was by Anna because she signed the other works in the series, as well as signing anatomical drawings in her sketchbook (MS Lister 9, Bodleian Library).
- 78 See for instance, Martin Lister, 'An Account of the Nature and Differences of the Juices, More Particularly, of Our English Vegetables', *Phil. Trans. R. Soc. Lond.* **19**, 362–364 (1695–97). Lister remarked, 'These were some Papers, which belong'd to a Treatise of Vegetation; they were most of them made about Thirty Years ago; but as I cannot now attend the finishing of them, so I would not lose them; and therefore recommend them to your Care, such as they are.'
- 79 Mei-Ying Sung, *William Blake and the art of engraving* (Pickering & Chatto, London, 2009). My thanks go to Antony Griffiths, Mei-Ying Sung and Sheila O'Connell for their explanation of the process.
- 80 Wilkins, *op. cit.* (note 27), p. 197.
- 81 See Roos, *op. cit.* (note 51), pp. 300–301.
- 82 Martin Lister, 'Preface', in *Exercitatio Anatomica in qua de Cochleis* (Sam. Smith & Benj. Walford, London, 1694, p. 2. ('Et cùm jam primùm microscopio, ex visù defectu uti cogar,

- eisdem ope me rursus iisdem studiis frui, quae diu nudis oculis denegata sunt, magnopere gaudio.’)
- 83 Edward G. Ruestow, *The microscope in the Dutch Republic: the shaping of discovery* (Cambridge University Press, 1996), p. 15. See also Brian Bracegirdle, ‘The performance of seventeenth and eighteenth century microscopes’, *Med. Hist.* **22**, 187–195 (1978); Marian Fournier, *The fabric of life: microscopy in the seventeenth century* (Johns Hopkins University Press, Baltimore, MD, 1996); Catherine Wilson, *The invisible world: early modern philosophy and the invention of the microscope* (Princeton University Press, 1995).
- 84 Ruestow, *op. cit.* (note 83), p. 16.
- 85 *Ibid.*
- 86 Amami Kato, ‘Distorted depth perception under the microscope: compensation by surgical navigator and image projection’, *Acta Med. Kinki Univ.* **33**, 1–8 (2008); M. Carrozzo, ‘A hybrid frame of reference for visual manual coordination’, *Neuroreport* **5**, 453–456 (1994); I. Faillenot, H. Sakata and N. Costes, ‘Visual working memory for shape and 3-D orientation; a PET study’, *Neuroreport* **8**, 859–862 (1997).
- 87 Catherine Wilson, *The invisible world: early modern philosophy and the invention of the microscope* (Princeton University Press, 1995), p. 102.
- 88 Bodleian MS Lister 9, f. 9r. Brachiopods are a phylum of marine animals with hard shells on the upper and lower surfaces. They differ from bivalve molluscs (such as scallops or clams), which have shells on the left and right.
- 89 Maria Sibylla Merian (1647–1717) has been proffered as the first woman to use a microscope, but Natalie Zemon Davis has indicated that Merian was only using a magnifying glass to do her work with insects. See Natalie Zemon Davis, *Women on the margins: three seventeenth-century lives* (Harvard University Press, Cambridge, MA, 1995), p. 151.
- 90 Bodleian MS Lister 3, ff. 211–218.
- 91 Turbinate: having a broadly conical spire and a convex base.