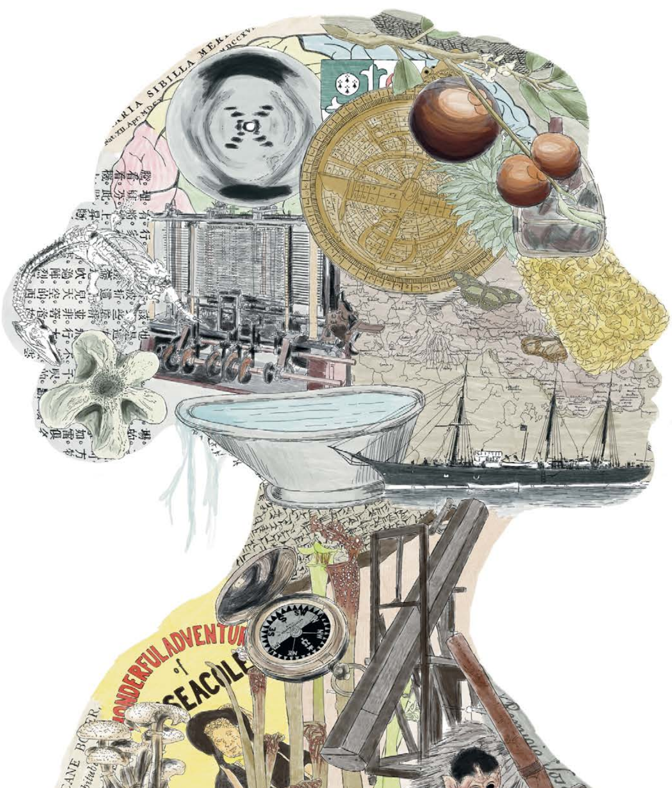
Women in the History of Science

A Sourcebook



Edited by

Hannah Wills, Sadie Harrison, Erika Jones, Farrah Lawrence-Mackey and Rebecca Martin

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For Rowan, and all the curious girls to come.

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Preface

In an effort to create sincere, honest and transparent conversations around race, class and gender in the university, it is important that we, the editors of this volume, acknowledge our own identities and cultural backgrounds. We are five white, middle-class, cisgender women who have been educated in American and British institutions. After receiving our PhD degrees, some of us have continued within academia as early career researchers and others have begun other careers. Our cultural backgrounds and personal experiences have shaped our perspectives and the networks we are part of, which has influenced the framing and content of this volume. We recognise that our perspectives have affected how we write, what we write about and, crucially, what we have not written about. We encourage readers of this sourcebook to be critical – it is not our aim to create a new canon of figures in the history of science with this sourcebook, but to provoke further discussion and to encourage students and teachers to seek out new stories that have not been told here.

A note on pronouns

We have listed our own pronouns, and those of our authors, on our contributors page. Our hope is that this will be helpful to students and readers of this sourcebook, who may wish to quote and reference the contributors to this book. Normalising the use of pronouns is an important step in respecting individuals' gender identities and promoting a more inclusive environment in academic and non-academic settings.

Acknowledgements

We are grateful for the support, both moral and financial, of the Science and Technology Studies Department at UCL. We would also like to acknowledge the patience and assistance of Chris Penfold at UCL Press throughout the publication process. In addition, we are grateful for the comments of our anonymous reviewer and the thorough and diligent efforts of the book's proofreaders, in particular Enya Holland whose work has improved this volume. Finally, we would like to thank our families for their encouragement and continued support of our work.

Introduction

We are inspired by and support UCL's programme to liberate the curriculum alongside other programmes with similar aims.[1] Women are too often excluded in the history of science, and this book aims to recover the voices, works and experiences of women in the production of knowledge through primary sources. This book offers university lecturers and tutors a diverse range of materials that could easily augment existing history of science, history, literature, geography, anthropology, gender studies and sociology courses to include women.

Women in the History of Science aims to expand notions of participation and investigation in the production of knowledge. This book challenges what science is and what science does. In doing so, the activities of women and less celebrated figures in the history of science become more visible. The parts do not replicate traditional accounts of the history of science that focus on the great and famous figures of invention and discovery, who are most often portrayed as men, but bring to light how women of many different backgrounds engaged with the production of knowledge both in formal scientific projects and in their everyday lives.[2]

In the last 50 years, scholars have challenged how we think of the history of science. Rather than approaching science as a linear discovery of facts and theories, scholars are now investigating how knowledge is made in specific times, places and cultures.[3] Instead of focusing on famous inventors or lone geniuses, campaigns such as the History Workshop Movement bring attention to history from below and how science is a fundamental part of larger society.[4] In the field of Science and Technology Studies, scholars in the Sociology of Scientific Knowledge (SSK) movement sought to ground explanations of science within specific social contexts.[5] More recently, the global turn in the history of science has challenged traditional Eurocentric narratives and explored a definition of science which moves beyond elite knowledge and practices to acknowledge the global history of science and knowledge-making.[6] These approaches and others have expanded the history of science beyond the largely white European, male actors that dominated past heroic narratives. To fully embrace the rich and varied history of science means including women as well as people, cultures and spaces outside of Europe.

Diverse histories necessitate an increasingly wide range of historical sources. Scholars are now working with a wide array of primary materials to recover histories less frequently told.[7] The study of material culture has contributed to this shift in the historical literature.[8] The editors of this volume, working as postgraduate teaching assistants, noted a lack of introductory works for new students that addressed these recent trends in the history of science. Particularly in the context of undergraduate courses, we found few published resources that supported teaching a history of science that reflects current historiographical practice and our desire for greater inclusivity in the histories that are being told. This book is the result of our collective effort and the contributions of 53 additional authors towards a more diverse curriculum and an openness to new kinds of historical evidence.

The 12 parts of this book explore the ways in which women have produced, communicated and embodied scientific knowledge. The historical sources presented here – spanning from 1200 BCE to the early twenty-first century – question assumptions and work to destabilise accepted historical narratives. Four critical questions and themes are explored throughout the parts.

What is science?

Science is a concept that became increasingly codified and sharply defined in the nineteenth century, not least with the British scientist and philosopher William Whewell's coining of the term 'scientist' in 1834. Acknowledging the specific cultural and geographical history of the idea of science, this book often refers to 'knowledge production' to acknowledge the diversity of practices that enable understanding of the world around us.

In this sourcebook we hope to encourage critical reflection on the concept of scientific disciplines to allow space for alternative ways of knowing. American philosopher, educator and activist Angela Davis asserts that we must create our own categories, not simply assimilate women into already extant groups that are fundamentally shaped by colonial patriarchal structures.[9] Many of the sources in this book allow for new discussions and categorisations of science to emerge, by questioning standard disciplinary terminology and challenging us to look beyond what our preconceptions might tell us is science and what is not.

In a similar vein, this sourcebook is critical of the terminology used to refer to specific periods in history.[10] The naming of historical eras has its own history. As well as radically shaping the way we think about the past, historical periodisation fundamentally influences what is taught in schools and universities.[11] Terms such as 'Middle Ages', 'Early Modern', and 'Enlightenment' often place Europe as a monolithic centre of events and knowledge. This is to the detriment of other places, which do not fit neatly into these temporal episodes with their associated characteristics and accepted chronologies. On the other hand, the chopping up of history into discrete sections is useful – it helps us to explain to others when something happened, to organise our history classes and to structure arguments and ideas about the past. There are many ways in which to divide history up into sections – we might talk about dynasties and reigns, for example the Tang Dynasty in China, before and after critical events in history, such as pre and post the Haitian Revolution, or specific cultural movements like the Renaissance in Europe.[12] We and our contributors use different terms throughout this book to describe eras in the past. However, we encourage critical reflection on these terms as they are used and seek to acknowledge that none of these terms are neutral – all of them work to highlight and hide different aspects and actors from the past.

What do we consider a historical source?

Sourcebooks have traditionally replicated portions of key publications that have influenced the history of science. These teaching resources, for example, could contain an extract from Isaac Newton's *Philosophiæ Naturalis Principia Mathematica* (1728) to prompt discussion, or a section from Charles Darwin's *On the Origin of Species* (1859). While these texts signify fundamental developments in knowledge production, they focus our attention on a few well-known individuals and events. Textual sources such as these obscure the contributions of women, as they were produced within models of education and publication which were often restricted to white men with the financial means to conduct research and study.[13] By broadening our concept of historical evidence beyond printed volumes, we can draw out more obscure, yet equally valid, ways of knowing.

By rethinking the meaning of science, the historical sources in *Women in the History of Science* are not restricted to traditional geographies, materials or actors. Instead, the materials range from artworks and textiles to diary entries and recipe books. These sources reveal a rich and diverse history of women and science, sparking a broader discussion of the places, people and labours involved – or currently missing – in the teaching of the history of science. These sources represent a range of places and disciplines and date from antiquity to the present day. Individual sources included here vary in their length and nature; by including small fragments as well as longer pieces it is our aim to show that a diverse range of material enriches our understanding of the history of science. These examples are not exhaustive but contribute to a long-term process of exploring and expanding the history of science.

How do we define scientific spaces?

In broadening our understanding of science, we are also re-examining the spaces in which science takes place. Science is often characterised as a collection of practices undertaken within laboratory spaces, a concept that has devalued knowledge-making activities that have occurred elsewhere.[14] Limiting science to the laboratory, however, creates a false dichotomy between what is and is not deemed 'scientific'. As the American philosopher of science and research methodology Sandra Harding has stated, 'the contrast between science and superstition … has been too useful a tool of Eurocentric thinking'.[15] We broaden our conceptions of science when we consider the liminal spaces of the forest and the garden, spaces of labour and domesticity, and spaces of magic and superstition – spaces traditionally held by women and people of colour – as the spaces within which new knowledge is both made and shared.[16]

The sources presented here highlight these other spaces in which knowledge production took place. The laboratory, learned society and the hospital are still present, though the roles women occupied within these were not always formal and were almost always contentious. Several sources describe strategies that women employed to make space for themselves both within and without formal scientific settings. Women also created their own spaces of practice, production and communication.

Who had access to science?

The question of access to science and evolving gender roles over time and within different cultures is one that is raised by each of the sources. From the dominance of women within ancient Assyrian perfumery to the aggressions modern women have faced within traditional scientific fields in the UK, the question of who has access to which scientific spaces, institutions, education and resources, and where, when and why is complex and not always what we might anticipate.[17]

Colonialism plays a significant role in the history of science, in particular during the eighteenth and nineteenth centuries when white European women travelled, collected natural history specimens and commented on cultures in Africa and South America. While some women gained access for themselves within the male dominated scientific communities of their home countries, their travels were supported by imperial structures that operated at the expense of Indigenous peoples.[18]

Similarly, we can consider the role of class when looking at these sources and questions regarding who had access to science. The sources presented here contrast between working-class women conducting the day-to-day work of science, such as sorting silkworms or finding fossils, and middle- and upper-class women who, while facing barriers to acceptance, received recognition as pioneers within their fields by virtue of their social positioning.[19]

It is also important to consider the communication of knowledge and the power of language and how this affects access. The sources in this text, where possible, have been provided in their original language alongside their translations or hyperlinks have been provided for the original language texts. For some of the sources provided, the original language has not been possible to include and we encourage students to consider the pitfalls of reading sources in translation and in particular how translators' voices will influence their reading of the text. These issues are highlighted in part one and part six of this book but should be kept in mind throughout.

Indeed, translation is not a problem only in our historical analysis but an active problem for the people of the past and the present. It is important to consider the dominant language cultures for regions and periods when reading these sources and how this affected, and continues to affect, access to knowledge and its production for those who were unable to speak or read those languages.

How to use this book

This sourcebook was originally envisaged as a tool to support education and learning in the history of science, technology and medicine for undergraduate students, lecturers and course designers. This book is designed to slot easily into existing course structures, augmenting and improving the traditional history of science narrative.[20] However, we believe the discussions and sources included here may also be of interest to school students, student-led discussion groups, teacher training and online reading groups. The themes addressed here could also inform discussions in adjacent fields such as history, literature, geography, anthropology, gender studies and sociology. At the beginning of each part, we have included broad timelines and general introductions to reflect how these sources might fit into history of science narratives as currently taught at major universities in the UK and USA, but these may also serve as more general orientation for readers from a range of disciplines. As discussed, while traditional periodisations are useful we strongly encourage critical consideration of the geographies and cultural implications of these terms.

Incorporating new sources and narratives that are not widely told or accessible within existing introductory literature requires in-depth research and subject knowledge. We hope that this sourcebook will allow early career and established scholars alike to find easily new historical sources, specialist analysis and core readings across a broad temporal and geographic spectrum that will help them to liberate the curriculum and include more women within their courses. The sources within this volume can supplement, revitalise and expand existing core modules or create exciting new undergraduate seminars. However, it is not our intention with this sourcebook to create a new canon that simply replaces the standard pantheon of male figures within the history of science. We encourage our readers to be critical of our selection, to seek out sources beyond what we have included here and to continue the project of diversifying the history of science.

This sourcebook is not alone in pressing historiographical boundaries or highlighting the work of women throughout the history of science. This volume can act as a companion to other sourcebooks such as the Greenwood Press's *Women of Mathematics*, *Women in Chemistry and Physics*, and *Women in the Biological Sciences*, which take a biographical approach in exploring the work of women within these fields. In addition, Alison Oram and Annmarie Turnbull's groundbreaking *Lesbian History Sourcebook* draws on a wide range of source material to illustrate the history of lesbian lives from the eighteenth century to the 1970s.[21] This sourcebook has also been inspired by online resources such as the History of Science in Latin America and the Caribbean (HOSLAC) hosted by the University of New Hampshire, which introduces the history of Latin American and Caribbean science and its importance within Western understandings of the sciences and Empire.[22] This book has been informed by the activities of enterprises like the Electrifying Women project, which sought to raise awareness of the histories of women in engineering since the nineteenth century.[23] Equally, this volume seeks to complement existing readers like Andrew Ede and Lesley B. Cormack's *A History of Science in Society: A Reader*, which includes some of the more well-known female figures in the history of science such as Margaret Cavendish, Marie Skłodowska-Curie, Caroline Herschel and Rachel Carson, along with the companion textbook, *A History of Science in Society,* as well as other surveys in the history of science, such as Peter J. Bowler and Iwan R. Morus's *Making Modern Science: A Historical Survey*.[24]

We also recognise that the format of this text, with its focus on women's roles in the history of science, is only one way of approaching a more inclusive and liberated history of science curriculum.[25] Our hope is that this text may provide a starting point for further source books and discussions that consider issues of equality and diversity in the curriculum from different perspectives. We also note the difficulties beyond the role of curricula when it comes to furthering equality within higher education and hope that this text may also act as a starting point for a more in-depth discussion of these issues in the classroom and help to inform the work of liberating the academy more broadly.[26]

Notes

1 For more detail, see UCL's 'Liberating the Curriculum' webpages: UCL, 'Liberating the Curriculum'. The National Union of Students (NUS) in the UK is also undertaking work in this area and has advice and resources available to download: National Union of Students, 'Liberate the Curriculum'.

2 For an accessible explanation and critique of the 'great man' approach to the history of science, as well as an exploration of feminist approaches which question male-centric definitions of science, see the podcast (available in online transcription as well as audio recording), Lady Science, 'Episode 7: The Great Man Theory of History is Garbage', which features historian of science Marilyn Ogilvie.

3 For an overview of the development of historical geographies of science see Livingstone, *Putting Science in Its Place*, and Naylor, 'Introduction: Historical Geographies of Science', 2005.

4 Davin, 'The Only Problem Was Time', 2000, 239–245.

5 For more on the Sociology of Scientific Knowledge, its development, approaches and critiques of it, see Shapin, 'History of Science and Its Sociological Reconstructions', 1982, 157–211, and Shapin, 'Here and Everywhere: Sociology of Scientific Knowledge', 1995, 289–321.

6 For a good introduction to the 'global turn', see Fan, 'The Global Turn in the History of Science', 2012, 249–258; on decolonising science, see Deb Roy, 'Decolonize Science: Time to End Another Imperial Era', 2018; for a vital critique of Western paradigms of research see Tuhiwai Smith, *Decolonizing Methodologies*.

7 For example see Bittel, Leong and von Oertzen, *Working with Paper*, which explores the use of paper technologies and tools and how these intersect with knowledge production and gender;

for models and craft practices in anatomy see Ballestriero, 'Anatomical Models and Wax Venuses', 2010; for use of Indigenous oral tradition in the interpretation of written sources, ethnologies and archeological evidence see Gunn Allen, *Pocahontas,* and Weaver, *The Red Atlantic*; for a comprehensive anthology of international work in oral history see Perks and Thomson, *The Oral History Reader*; for a broad use of objects in historical study within the material turn see Miller, *History and Its Objects*.

8 See for example Gerritsen and Riello, *Writing Material Culture History,* and De Chadarevian and Hopwood, *Models*.

9 Davis, 'Feminism and Abolition', 2013.

10 For an in-depth and accessible discussion of the problems of periodisation in history, see the 'Monster Mini-Series On periodisation', introduced by Laura Sangha in Sangha, 'On periodisation: an introduction'.

11 Green, 'Periodization in European and world History', 1992, 13–53; Gangatharan, 'The problem of periodization in history', 2008, 862–871.

12 Sangha, 'On periodisation: or, what's the best way to chop history into bits?'.

13 Schiebinger, *The Mind Has No Sex?,* 26–32.

14 For a discussion of knowledge-making practices within the laboratory setting, see Latour and Woolgar, *Laboratory Life*.

15 Harding, *Is Science Multicultural?,* 11.

16 For discussions of knowledge-making within the domestic setting see Werrett, *Thrifty Science*, 42–63; Opitz, Bergwik and Van Tiggelen, *Domesticity in the Making of Modern Science;* Leong, 'Herbals she Peruseth', 2014, 556–578; and Shapin, 'The House of Experiment in seventeenth-century England', 1988, 373–404. For discussion of spaces of magic and superstition in relation to knowledge production, see Delbourgo, 'Science', 2009; Payne-Jackson and Alleyne, *Jamaican Folk Medicine;* and Scott Parish, *American Curiosity,* 2006.

17 For another project that has explored this theme (within the context of twentieth-century Greece), see Lada, *Scientist in the Picture*, which, through the medium of photography, explores both gender identities and who has access to science and how this has changed over time.

18 For women who travelled through the Empire and produced botanical knowledge, see Thompson, 'Women Travellers', 2019, 431–455 and Schiebinger, *Plants and Empire,* 23–35. For more on the imperial structures that enabled travel and the intersections of gender and Empire see Hong, 'Angel in the House', 2021, 415–438.

19 For a discussion of the intersections between class, gender and the necessary credibility to produce knowledge during the Early Modern period see Schiebinger, *The Mind Has No Sex?*, 12.

20 For another example of this kind of work, see the work of the #NoMoreMatildas association, who have produced an insert designed to 'update' existing history of science textbooks for 10–11 year old children to include 'women scientists overlooked by history', available for free download at https://www.nomorematildas.com/.

21 Grinstein and Campbell, *Women of Mathematics*; Grinstein, Rose and Rafailovich, *Women in Chemistry and Physics*; Grinstein, Biermann and Rose, *Women in the Biological Sciences*; Oram and Turnbull, *The Lesbian History Sourcebook*.

22 'History of Science in Latin America and the Caribbean'.

23 The project's published resources, including a list of further reading, can be found at https://electrifyingwomen.org/resources/.

24 Ede and Cormack, *A History of Science in Society: A Reader*; Ede and Cormack, *A History of Science in Society*; Bowler and Morus, *Making Modern Science*.

25 For example see Gunn Allen, *Pocahontas*, 3–4 on the problem of writing within the Western tradition for Indigenous as well as female narratives in which women's lives are told as only adjuncts to their male counterparts.

26 See for example Otten, 'Intercultural Learning and Diversity in Higher Education', 2003, which considers the role of diversity within institutions, including (but not limited to) innovation in the taught curriculum. See also, Tuck and Yang, 'Decolonization is not a Metaphor', 2012; Tuhiwai Smith, Tuck and Yang, *Indigenous and Decolonizing Studies in Education;* Hirsch, 'Is it possible to decolonise global health institutions?', 2021.

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Part I

Ancient ways of knowing (1200 BCE–900 CE)

Timeline: individuals and events in the history of science	**Timeline: individuals, events and objects in this part**
c. 1600 BCE The oldest known surgical treatise on trauma (the *Edwin Smith Papyrus*) is written in Egypt.	
	c. 1200 BCE Tappūtī-bēlat-ekalle, an Assyrian woman, is one of history's earliest recorded chemists.
c. late eighth century BCE Homer, ancient Greek author and poet.	**c. eighth to seventh century BCE** Circe first appears as a goddess in Homer's epic poem the *Odyssey*, before being labelled a 'witch' in later translations.
c. sixth century BCE *Sushruta Samhita*, a Sanskrit text on medicine and surgery, is written by the ancient Indian physician Suśruta (known as the father of surgery).	
570–495 BCE Pythagoras, Ionian Greek philosopher, whose teachings included many mathematical principles.	

Timeline: individuals and events in the history of science	**Timeline: individuals, events and objects in this part**
460–370 BCE Hippocrates, Greek physician considered the father of modern medicine, to whom the Hippocratic Oath is attributed (this is now contested).	
470–399 BCE Socrates, Greek philosopher often described as the founder of Western philosophy. His students included Plato.	
384–322 BCE Aristotle, Greek philosopher and polymath, taught by Plato.	
202 BCE–220 CE Han Dynasty in China which saw many major innovations and inventions including papermaking and the blast furnace.	
99–55 BCE Lucretius, Roman poet and philosopher.	
	69–30 BCE Cleopatra VII, the last queen of Egypt.
23/24–79 CE Pliny the Elder, Roman author and natural philosopher.	
c. 129–216 CE Galen, Greek physician, surgeon and philosopher.	
	200–900 CE Ceramics made by the Southern Moche civilisation in coastal Peru depict women as healers.
	c. 355–415 CE Hypatia of Alexandria, philosopher, astronomer and mathematician.

Timeline: individuals and events in the history of science	**Timeline: individuals, events and objects in this part**
ninth century CE Late Tang dynasty in China, and the invention of gunpowder by Chinese chemists.	

Introduction

Part one confronts the question, what is science? The line between what is and is not considered science is difficult to draw, and by no means has a settled answer. When did humans begin to investigate the natural world in a scientific way? Broadly speaking, historians consider the technologies developed in the stone, bronze and iron ages to be just that; technologies, not science. Historians have debated for almost 60 years whether the Babylonians, one of humankind's earliest recorded civilisations, were scientists or technicians.[1] Some historians argue that science is defined by scientific methods of investigation, regardless of the natural or supernatural conclusions drawn. Other historians suggest that science must be completely disconnected from practical applications to be considered science. Science by this definition must be the investigation of knowledge for its own sake, an endeavour undertaken for the sole purpose of gaining knowledge. The sources in this part challenge this notion. If mixing herbs to create a medicine is considered a scientific practice, then is the mixing of herbs and scents to make perfume also science?

Understanding the ancient past presents unique challenges for historians. Surviving sources are often fragmentary. Many sources have been passed down to us through the writings of later scholars creating ongoing debates over authorship and translation.[2] This problem is compounded when historians attempt to investigate the lives of individuals who belong to groups who were undervalued by record keepers and translators in subsequent ages. It is difficult to assess how much written material may have been lost and who else may have produced texts during the ancient period. This is just one of the reasons that we see so few women, and such little geographic diversity, in the history of ancient knowledge production. As such, it is only by looking beyond text that we can begin to explore other voices. Therefore, this part includes a range of source materials which help us to understand women's contributions to ancient science, from pots to poetry.

Part one includes sources that introduce ancient women's ways of knowing and how these forms of knowledge can be considered alongside more traditional narratives of early science and medicine. The first source is a cuneiform tablet on Middle Assyrian perfumery, which draws our focus away from re-worked, heavily translated and paraphrased fragments of material written on less durable materials. The second source is a work of classical fiction – an extract from Homer's *Odyssey* – which reveals the different presentations of male and female healers in the ancient world, some of which appear similar to depictions we see today. The third source is an excerpt from the *Dialogue of the Philosophers and Cleopatra* – an alchemical text written in Greek – which illustrates the role of women within alchemical writings, demonstrating the positioning of Cleopatra of Egypt within the mythical origins of the discipline. The fourth source, a ceramic vessel from coastal Peru, demonstrates the importance of women healers in the Southern Moche group and the study of material culture in the history of science. The final source in this part is a text by Synesius of Cyrene; a rich source of information on Hypatia of Alexandria which demonstrates her role as a scientific and philosophical authority.

1

Tappūtī-bēlat-ekalle (fl. 1200 BCE): A cuneiform tablet on Middle Assyrian perfumery (c.1200 BCE)

Dr Eduardo A. Escobar[3]

Introduction

Tappūtī-bēlat-ekalle has special significance within the history of science; she was an expert perfumer, an ancient Assyrian woman hailed as history's first chemist.[4] The clay tablet which bears her name was excavated from the city of Assur in what is today northern Iraq and can be dated to c. 1230 BCE, an era known as the Middle Assyrian period. Known by its publication number, KAR 220, the text preserves an extensive recipe for processing aromatic cane oil.[5] An important textual element of KAR 220 is its colophon (at the end of the source below); colophons preserved on cuneiform texts provide critical data regarding the tablet's historical context, including its date and the scribes involved in the text's production. In the case of KAR 220, the colophon ascribes all knowledge contained within the recipe to Tappūtī-bēlat-ekalle herself – or as the Assyrian scribes put it – 'according to (her) mouth'. Middle Assyrian perfume recipes such as KAR 220 below demonstrate the linguistic and chemical sophistication of ancient recipes, as well as highlighting the important role women played in this field of knowledge.

Readers should note that in this translation of KAR 220, technical terms are kept italicised in the original Akkadian and hyphenated with an approximate translation of their meaning (e.g. '*diqāru*-vat' or '*paḫutu*-particulates'). Breaks on this four-column tablet are indicated by ellipses in the translation. Middle Assyrian volume and weight measurements have been translated to approximate modern equivalencies; these include: the talent (*biltu* ≈ 30 kg); mina (*manû* ≈500 g); seah (*sūtu* ≈10 litres); liter (*qû* ≈1 litre); and cup measurement (*kāsu* ≈1/5 litre). The translation also inserts parentheses with implicit instructions and contextual information to ease the readability of this ancient recipe. Finally, square brackets are used to indicate a break in the tablet that has been reconstructed from duplicate texts.[6] The images below demonstrate the refined nature of the clay tablet and cuneiform script preserved on this four-column text, which is housed at the Vorderasiatisches Museum in Berlin.

Source

KAR 220 (VAT 10165): A perfume recipe attributed to Tappūtī-bēlat-ekalle

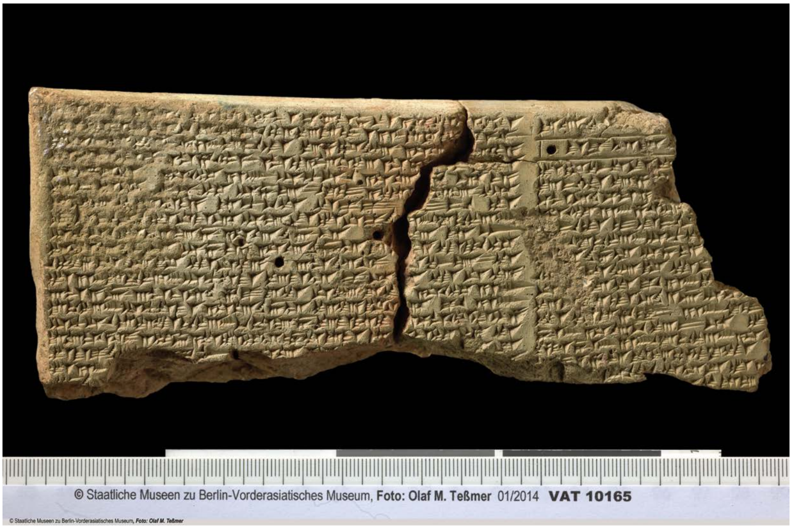

Figure 1.1a Obverse KAR 220 (VAT 10165): A perfume recipe attributed to Tappūtī-Bēlet-Ekallim (© Staatliche Museen zu Berlin – Vorderasiatiches Museum, Foto: VAT 10165).

Obverse column 1, 1–19

If you want to process aromatic cane oil: (take) ≈20 litres (2 seahs) worth of cane, along with their *tubāqu*-roots (i.e. the whole cane). Once you have washed them, you set down a … *diqāru*-vat and heat *tābilu*-aromatics with fresh, high-quality water from a palace well of Aššur. You transfer (the mixture) into a *ḫarû*-vessel.

You (then) pour on top of this liquid mixture, within the *ḫarû*-vessel: 1 litre of *ḫāmimu*-aromatic, 1 litre of *jaruttu*-aromatic, (and) 1 litre of myrtle, good-quality (and) filtered. These are your measurements, to be apportioned according to the amount of water taken. You perform (the steps prescribed) at sunset and nightfall. (The mixture) is to steep overnight.

At dawn, when the sun rises, you filter the liquid and these aromatics through a *sūnu*-cloth into a *ḫirsu*-vessel. You clarify the mixture (by filtering it) from this *ḫirsu*-vessel to another *ḫirsu*-vessel. You remove the *minduḫru*-particulates. You wash 3 litres of crushed nut-sedge with the liquid mixture of these aromatics. You remove the *paḫutu*-particulates.

You put on top of this (filtered) liquid mixture of aromatics, within a *hirsu*-bowl: 3 litres of myrtle, 3 litres of cane, crushed and filtered. You measure out ≈40 litres (4 *sūtu*) of this liquid mixture that has (steeped) overnight with aromatics. You filter through a sieve: 1 1⁄2 litres of unfiltered mash made from almonds (together with) 2 cupsful—(using) small cups–of wood shavings from the *kanaktu*-tree. You gather up the oil (produced) in a *harû*-vessel. In the liquid mixture . . .

Obverse column 2, 1–18

You remove it from the interior of the *diqāru*-vat [which you then wash and wipe clean]. These are the ingredients [for the third stage of processing].

In your fourth pouring, you heat up *tābīlu*-aromatics [with the fresh, high-quality water from a well and you pour it into a *ḫirsu*-vessel. You place into the *ḫirsu*-vessel] 1⁄2 litre of cane, 1⁄2 litre of myrtle, crushed [and filtered onto the heated liquid mixture.] (The mixture) is to steep overnight.

At dawn, [when the sun rises, you clarify the liquid mixture] and these aromatics through a *sūnu*-cloth from this *ḫirsu*-vessel to another *ḫirsu*-vessel. You remove the unwanted *minduḫru*-particulates. You measure out 3 litres [of cane and ≈3 litres of myrrh?] which has been sifted, ≈40 litres (4 *sūtu*) litres of the liquid mixture [that has steeped overnight in aromatics]. You treat this reed and myrtle [as you did previously. You light a fire].

(When) the water is heated, [as required for mixing] you pour oil into the mixture [and you stir with a stirrer]. Once the fat oils, the water, and aromatics have penetrated each other (and) have intermingled thoroughly, [you should not disturb it]. You then gather a beneath the *diqāru*-vat [for two to three days you …]

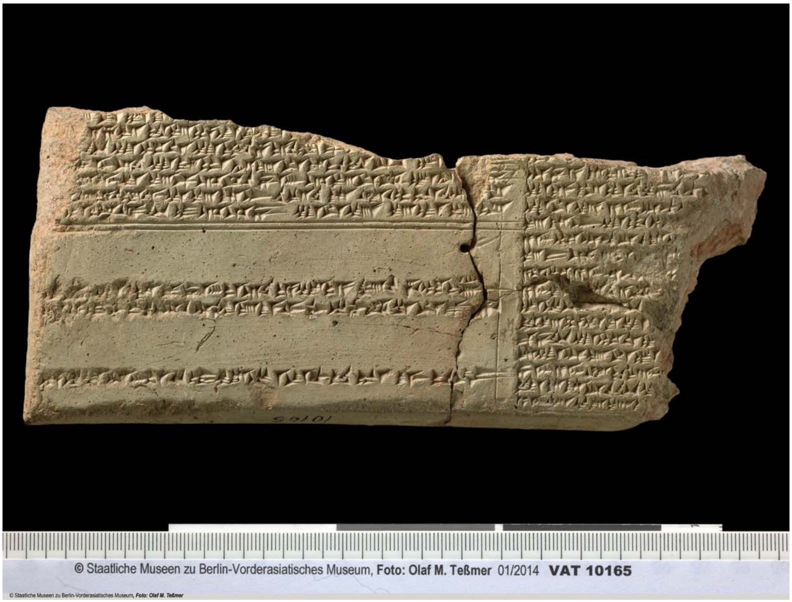

Figure 1.1b Reverse KAR 220 (VAT 10165): A perfume recipe attributed to Tappūtī-Bēlet-Ekallim (© Staatliche Museen zu Berlin – Vorderasiatiches Museum, Foto: VAT 10165).

Reverse column 1, 1′–15′

That which has steeped overnight within the liquid mixture, you scrape away [with your hand]. [You test] the *ṭinṭinu*-components and remove [the bad quality ones]. You filter and clarify this liquid mixture [through a *sūnu*-cloth transferring it into a *ḫirsu*-vessel] …

Your liquid mixture – that which you have [clarified] – you pour into a [*diqāru*-vat]. …[You place] ≈3 litres of … and ≈3 litres (3 *qû*) of "sweet myrrh" (*persạduḫḫu*) onto the top of this liquid mixture within a [*ḫirsu*-vessel. You ignite a fire]. Once the liquid is mixed and heated, [you pour oil into it]. You stir with a stirrer. [If the oil and aromatics] have interpenetrated one other, [you ignite] a fire. [When the oil mixture expels froth,] you cover up the top of the *diqāru*-vat. [You cool it off with water.] As soon as the sun [at the end of the morning watch has risen, you prepare a *šappatu*-jar] for the oils, waters, and aromatics. You gather a fire beneath *diqāru*-vat. [You remove] the liquid mixture and *šēlûtu*-residue. [You then wash out the *diqāru*-vat, and wipe it clean] …

Reverse column 2, 1′–10′

As soon as the sun [at the end of the morning watch has risen], if (the aromatics) have interpenetrated each other, you [ignite] a fire. You cover the top of the *diqāru*-vat, you cool it off. You prepare a *šappatu*-jar for the cane oil. You lay a *sūnu*-cloth with a *bittu*-implement across the *šappatu*-jar. Then, taking a little oil at a time, you strain it through the *sūnu*-cloth into the *šappatu* jar. You go about removing the *ṭišṭišu* and *midduḫru* particulates that have been left over in the bottom of the *diqāru*-vat.

Colophon: Perfume-making recipe for ≈20 litres (2 seahs) of processed cane oil, fit for a king, according to the mouth of Tapputi-belet-ekallim, the perfume-maker: month *Muḫur-ilāni* on the 20th day; the eponymate of *Šunu-qardu*, the chief cupbearer.

Analysis

The modern perfume industry is dominated by male 'noses'.[7] In contrast, women in Assyrian perfumery held the professional title *muraqqītu*, 'experts in aromatics'. The *muraqqītu* were respected for both their technical knowledge of processing aromatics and were charged with securing and preparing the rare and costly ingredients necessary for the production of scented oils.[8] Evidence suggests that perfume making was a collective endeavour, requiring a coordinated team of skilled perfumers. Overseeing this team was a 'head perfumer' who would lead and supervise the close measurement and processing of up to 100 litres of aromatic oil.[9] As such, this tablet provides only a glimpse of a more elaborate industry of women whose knowledge could only partially be recorded on a cuneiform tablet.

There are six known perfume recipes from Assur, and each describes a similar process of heat extraction (collecting and cooking the aromatics in large basins); maceration (allowing plant matter and aromatics to rest in water for extended periods of time); and refinement by means of filtration. Perfume makers employed a range of instruments and vessels to process aromatic oils. A large container called a *diqāru*-vessel served as the primary container for heating large quantities of aromatics. During this initial phase of heat infusion, up to 20 litres of plants and aromatics were processed before being transferred into a secondary filtering container called a *ḫarû*. Thereafter, the oil mixture was allowed to macerate overnight before a third stage of refinement took place by filtering the oil through a fine cloth called *sūnu*. Variations of these phases are repeated multiple times to achieve a fine quality perfume. The highest quality Assyrian perfumes are named according to their level of refinement. After 20 filtrations one produces a grade of perfume suitable for trade (literally: 'for the road'); the finest quality scented oil, however, is achieved after weeks of refinement and 40 filtrations, and was described as 'fit for a king'. This is the product attributed to the expertise of Tappūtī-bēlat-ekalle more than three millennia ago.

Assyrian recipes like KAR 220 are good to think with. In no small part, this is because this tablet and texts like it are at once familiar and deeply unfamiliar. We still have perfume making recipes and instruction manuals today, and yet three millennia of cultural and linguistic distance separates us from the historical actors that first sought to codify knowledge of perfumery in ancient Assyria. While ingredient quantities, for example, could be recorded on a cuneiform tablet in great detail, much of the technical know-how at the heart of perfumery remained tacit, embodied knowledge; this included the experiential and somatic knowledge needed to manage temperature, timekeeping and quality control. In this regard, KAR 220 is not unusual as the history of science, and the history of recipe knowledge in particular, is filled with similar examples of tacit knowledge.[10]

Nevertheless, beyond the challenges of translation and procedural knowledge transmission, this tablet invites us to consider the local contexts of knowledge production. Committing perfume-making instructions to writing allowed scribes to develop a new form of technological literacy during a period of scholarly innovation and cultural expansion in the ancient Middle East. As such, these recipes, and the historical actors mentioned within them, provide invaluable evidence of early court scholarship in Assyria. While the tablet under consideration, KAR 220, belongs to a small corpus of similar technical recipes from Assur, it is also part of a much broader intellectual history of Akkadian procedural texts. Akkadian procedures – instructional texts addressed to an anonymous 'you' – became a long-standing textual format in cuneiform cultures for transmitting technical and scientific knowledge. The linguistic style of these recipes suggests both the influence of Babylonian science on Assyrian knowledge production, as well as the novel contributions of Assyrian perfumers to chemical writing and practice.[11] Middle Assyrian perfume recipes were composed in the Akkadian language using the cuneiform script and employed a linguistic style reminiscent of earlier Babylonian culinary and mathematical procedures. These recipes, however, are far from derivative of a Babylonian tradition. On the contrary, the linguistic evidence points to an innovative mixture of verb forms unique to the Assyrian dialect of Akkadian, foreign terms for plants and ingredients attributed to northern Syria, technical terms for instrumentation and a focus on numeracy and standardised state metrology that establishes a distinctively Assyrian scientific voice.[12] Moreover, the perfume recipes would have served to define and quantify royal taste during a period in which the Assyrian state had only recently entered an international arena. Characterised as an 'international period', the late second millennium BCE in the ancient Middle East and Mediterranean world was motivated by long-distance trade of elite goods and expertise and cultural exchange between the great powers of the known world.[13]

This perfume recipe, attributed to Tappūtī-bēlat-ekalle, demonstrates the rich interface of material and textual cultures that characterise the early history of science. However, KAR 220 also shines a light on not only an individual female perfumer but on the collective and tacit knowledge production of women, as well as raising questions about what 'science' is and how it was practiced in the ancient world. When considered, as above, in its geographic and cultural setting, KAR 220 provides us with evidence of Assyrian female perfumers' significant role in scholarly innovation and codification.

Questions

1. Why do you think Assyrian scribes committed perfume-making knowledge to tablets?
2. Middle Assyrian perfume recipes were excavated from state archives in the city of Assur. What does their archaeological context tell us about their function?
3. When experiential know-how is codified as text, which elements of technical and scientific knowledge are preserved? Which elements are lost? What sorts of knowledge do recipes transmit?
4. Can we characterise the recipe of Tappūtī-bēlat-ekalle as 'chemistry'? Relatedly, what are some methodological drawbacks of identifying Tappūtī-bēlat-ekalle as 'history's first chemist'?
5. Assyrian perfume recipes record both practices of cultural exchange and the standardisation of weights and measures by the state; moreover, the scents described in these recipes provide a glimpse of elite commercial consumerism during the late second millennium BCE. What does the socio-intellectual context of KAR 220 tell us about the broader role of women within Middle Assyrian culture?

Further reading

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2

Circe: An extract from Homer's *Odyssey* (c. 900–800 BCE)

Professor Andrew Gregory

Introduction

Little is certain about the identity and works of the ancient poet Homer.[14] He is presumed to be the author of the *Iliad* and the *Odyssey*, both highly influential classical texts. Homer's *Odyssey* tells of the adventures of Odysseus as he attempts to return home after the Trojan war. He meets Circe, who turns some of his crew into pigs and attempts to turn Odysseus into a pig as well. This raises important questions about nature, magic, knowledge and women's roles. It also raises questions about how we look at early texts. Was Circe a witch? Is it appropriate to apply modern categories to these texts? All these issues are important to both the history of science and how we treat women in the history of science.

Source

Extract from Book X of Homer's *Odyssey*. Translated by Samuel Butler, 1900: 219–38.

Thence we sailed sadly on, glad to have escaped death, though we had lost our comrades, and came to the Aeaean island, where Circe lives—a great and cunning goddess who is own sister to the magician Aeetes—for they are both children of the sun by Perse, who is daughter to Oceanus. We brought our ship into a safe harbour without a word, for some god guided us thither, and having landed we lay there for two days and two nights, worn out in body and mind. When the morning of the third day came I took my spear and my sword, and went away from the ship to reconnoitre, and see if I could discover signs of human handiwork, or hear the sound of voices. Climbing to the top of a high look-out I espied the smoke of Circe's house rising upwards amid a dense forest of trees, and when I saw this I doubted whether, having seen the smoke, I would not go on at once and find out more, but in the end I deemed it best to go back to the ship, give the men their dinners, and send some of them instead of going myself.

When I had nearly got back to the ship some god took pity upon my solitude, and sent a fine antlered stag right into the middle of my path. He was coming down his pasture in the forest to drink of the river, for the heat of the sun drove him, and as he passed I struck him in the middle of the back; the bronze point of the spear went clean through him, and he lay groaning in the dust until the life went out of him. Then I set my foot upon him, drew my spear from the wound, and laid it down; I also gathered rough grass and rushes and twisted them into a fathom or so of good stout rope, with which I bound the four feet of the noble creature together; having so done I hung him round my neck and walked back to the ship leaning upon my spear, for the stag was much too big for me to be able to carry him on my shoulder, steadying him with one hand. As I threw him down in front of the ship, I called the men and spoke cheeringly man by man to each of them. 'Look here my friends,' said I, 'we are not going to die so much before our time after all, and at any rate we will not starve so long as we have got something to eat and drink on board.' On this they uncovered their heads upon the sea shore and admired the stag, for he was indeed a splendid fellow. Then, when they had feasted their eyes upon him sufficiently, they washed their hands and began to cook him for dinner.

Thus through the livelong day to the going down of the sun we stayed there eating and drinking our fill, but when the sun went down and it came on dark, we camped upon the sea shore. When the child of morning, rosy-fingered Dawn, appeared, I called a council and said, 'My friends, we are in very great difficulties; listen therefore to me. We have no idea where the sun either sets or rises, so that we do not even know East from West. I see no way out of it; nevertheless, we must try and find one. We are certainly on an island, for I went as high as I could this morning, and saw the sea reaching all round it to the horizon; it lies low, but towards the middle I saw smoke rising from out of a thick forest of trees.'

Their hearts sank as they heard me, for they remembered how they had been treated by the Laestrygonian Antiphates, and by the savage ogre Polyphemus. They wept bitterly in their dismay, but there was nothing to be got by crying, so I divided them into two companies and set a captain over each; I gave one company to Eurylochus, while I took command of the other myself. Then we cast lots in a helmet, and the lot fell upon Eurylochus; so he set out with his twenty-two men, and they wept, as also did we who were left behind.

When they reached Circe's house they found it built of cut stones, on a site that could be seen from far, in the middle of the forest. There were wild mountain wolves and lions prowling all round it—poor bewitched creatures whom she had tamed by her enchantments and drugged into subjection. They did not attack my men, but wagged their great tails, fawned upon them, and rubbed their noses lovingly against them. As hounds crowd round their master when they see him coming from dinner—for they know he will bring them something—even so did these wolves and lions with their great claws fawn upon my men, but the men were terribly frightened at seeing such strange creatures. Presently they reached the gates of the goddess's house, and as they stood there they could hear Circe within, singing most beautifully as she worked at her loom, making a web so fine, so soft, and of such dazzling colours as no one but a goddess could weave. On this Polites, whom I valued and trusted more than any other of my men, said, 'There is some one inside working at a loom and singing most beautifully; the whole place resounds with it, let us call her and see whether she is woman or goddess.'

They called her and she came down, unfastened the door, and bade them enter. They, thinking no evil, followed her, all except Eurylochus, who suspected mischief and staid outside. When she had got them into her house, she set them upon benches and seats and mixed them a mess with cheese, honey, meal, and Pramnian wine, but she drugged it with wicked poisons to make them forget their homes, and when they had drunk she turned them into pigs by a stroke of her wand, and shut them up in her pig-styes. They were like pigs—head, hair, and all, and they grunted just as pigs do; but their senses were the same as before, and they remembered everything.

Thus then were they shut up squealing, and Circe threw them some acorns and beech masts such as pigs eat, but Eurylochus hurried back to tell me about the sad fate of our comrades. He was so overcome with dismay that though he tried to speak he could find no words to do so; his eyes filled with tears and he could only sob and sigh, till at last we forced his story out of him, and he told us what had happened to the others.

'We went,' said he, 'as you told us, through the forest, and in the middle of it there was a fine house built with cut stones in a place that could be seen from far. There we found a woman, or else she was a goddess, working at her loom and singing sweetly; so the men shouted to her and called her, whereon she at once came down, opened the door, and invited us in. The others did not suspect any mischief so they followed her into the house, but I staid where I was, for I thought there might be some treachery. From that moment I saw them no more, for not one of them ever came out, though I sat a long time watching for them.'

Then I took my sword of bronze and slung it over my shoulders; I also took my bow, and told Eurylochus to come back with me and shew me the way. But he laid hold of me with both his hands and spoke piteously, saying, 'Sir, do not force me to go with you, but let me stay here, for I know you will not bring one of them back with you, nor even return alive yourself; let us rather see if we cannot escape at any rate with the few that are left us, for we may still save our lives.'

'Stay where you are, then,' answered I, 'eating and drinking at the ship, but I must go, for I am most urgently bound to do so.'

With this I left the ship and went up inland. When I got through the charmed grove, and was near the great house of the enchantress Circe, I met Mercury with his golden wand, disguised as a young man in the hey-day of his youth and beauty with the down just coming upon his face. He came up to me and took my hand within his own, saying, 'My poor unhappy man, whither are you going over this mountain top, alone and without knowing the way? Your men are shut up in Circe's pigstyes, like so many wild boars in their lairs. You surely do not fancy that you can set them free? I can tell you that you will never get back and will have to stay there with the rest of them. But never mind, I will protect you and get you out of your difficulty. Take this herb, which is one of great virtue, and keep it about you when you go to Circe's house, it will be a talisman to you against every kind of mischief.

'And I will tell you of all the wicked witchcraft that Circe will try to practice upon you. She will mix a mess for you to drink, and she will drug the meal with which she makes it, but she will not be able to charm you, for the virtue of the herb that I shall give you will prevent her spells from working. I will tell you all about it. When Circe strikes you with her wand, draw your sword and spring upon her as though you were going to kill her. She will then be frightened, and will desire you to go to bed with her; on this you must not point blank refuse her, for you want her to set your companions free, and to take good care also of yourself, but you must make her swear solemnly by all the blessed gods that she will plot no further mischief against you, or else when she has got you naked she will unman you and make you fit for nothing.'

As he spoke he pulled the herb out of the ground and shewed me what it was like. The root was black, while the flower was as white as milk; the gods call it Moly, and mortal men cannot uproot it, but the gods can do whatever they like.

Then Mercury went back to high Olympus passing over the wooded island; but I fared onward to the house of Circe, and my heart was clouded with care as I walked along. When I got to the gates I stood there and called the goddess, and as soon as she heard me she came down, opened the door, and asked me to come in; so I followed her—much troubled in my mind. She set me on a richly decorated seat inlaid with silver, there was a footstool also under my feet, and she mixed a mess in a golden goblet for me to drink; but she drugged it, for she meant me mischief. When she had given it me, and I had drunk it without its charming me, she struck me with her wand. 'There now,' she cried, 'be off to the pigstye, and make your lair with the rest of them.'

But I rushed at her with my sword drawn as though I would kill her, whereon she fell with a loud scream, clasped my knees, and spoke piteously, saying, 'Who and whence are you? From what place and people have you come? How can it be that my drugs have no power to charm you? Never yet was any man able to stand so much as a taste of the herb I gave you; you must be spell-proof; surely you can be none other than the bold hero Ulysses, who Mercury always said would come here some day with his ship while on his way home from Troy; so be it then; sheathe your sword and let us go to bed, that we may make friends and learn to trust each other.'

And I answered, 'Circe, how can you expect me to be friendly with you when you have just been turning all my men into pigs? And now that you have got me here myself, you mean me mischief when you ask me to go to bed with you, and will unman me and make me fit for nothing. I shall certainly not consent to go to bed with you unless you will first take your solemn oath to plot no further harm against me.'

So she swore at once as I had told her, and when she had completed her oath then I went to bed with her.

Meanwhile her four servants, who are her housemaids, set about their work. They are the children of the groves and fountains, and of the holy waters that run down into the sea. One of them spread a fair purple cloth over a seat, and laid a carpet underneath it. Another brought tables of silver up to the seats, and set them with baskets of gold. A third mixed some sweet wine with water in a silver bowl and put golden cups upon the tables, while the fourth brought in water and set it to boil in a large cauldron over a good fire which she had lighted. When the water in the cauldron was boiling, she poured cold into it till it was just as I liked it, and then she set me in a bath and began washing me from the cauldron about the head and shoulders, to take the tire and stiffness out of my limbs. As soon as she had done washing me and anointing me with oil, she arrayed me in a good cloak and shirt and led me to a richly decorated seat inlaid with silver; there was a footstool also under my feet. A maid servant then brought me water in a beautiful golden ewer and poured it into a silver basin for me to wash my hands, and she drew a clean table beside me; an upper servant brought me bread and offered me many things of what there was in the house, and then Circe bade me eat, but I would not, and sat without heeding what was before me, still moody and suspicious.

When Circe saw me sitting there without eating, and in great grief, she came to me and said, 'Ulysses, why do you sit like that as though you were dumb, gnawing at your own heart, and refusing both meat and drink? Is it that you are still suspicious? You ought not to be, for I have already sworn solemnly that I will not hurt you.'

And I said, 'Circe, no man with any sense of what is right can think of either eating or drinking in your house until you have set his friends free and let him see them. If you want me to eat and drink, you must free my men and bring them to me that I may see them with my own eyes.'

When I had said this she went straight through the court with her wand in her hand and opened the pigstye doors. My men came out like so many prime hogs and stood looking at her, but she went about among them and anointed each with a second drug, whereon the bristles that the bad drug had given them fell off, and they became men again, younger than they were before, and much taller and better looking. They knew me at once, seized me each of them by the hand, and wept for joy till the whole house was filled with the sound of their halloa-ballooing, and Circe herself was so sorry for them that she came up to me and said, 'Ulysses, noble son of Laertes, go back at once to the sea where you have left your ship, and first draw it on to the land. Then, hide all your ship's gear and property in some cave, and come back here with your men.'

I agreed to this, so I went back to the sea shore, and found the men at the ship weeping and wailing most piteously. When they saw me the silly blubbering fellows began frisking round me as calves break out and gambol round their mothers, when they see them coming home to be milked after they have been feeding all day, and the homestead resounds with their lowing. They seemed as glad to see me as though they had got back to their own rugged Ithaca, where they had been born and bred. 'Sir,' said the affectionate creatures, 'we are as glad to see you back as though we had got safe home to Ithaca; but tell us all about the fate of our comrades.'

I spoke comfortingly to them and said, 'We must draw our ship on to the land, and hide the ship's gear with all our property in some cave;

then come with me all of you as fast as you can to Circe's house, where you will find your comrades eating and drinking in the midst of great abundance.'

On this the men would have come with me at once, but Eurylochus tried to hold them back and said, 'Alas, poor wretches that we are, what will become of us? Rush not on your ruin by going to the house of Circe, who will turn us all into pigs or wolves or lions, and we shall have to keep guard over her house. Remember how the Cyclops treated us when our comrades went inside his cave, and Ulysses with them. It was all through his sheer folly that those men lost their lives.'

When I heard him I was in two minds whether or no to draw the keen blade that hung by my sturdy thigh and cut his head off in spite of his being a near relation of my own; but the men interceded for him and said, 'Sir, if it may so be, let this fellow stay here and mind the ship, but take the rest of us with you to Circe's house.'

On this we all went inland, and Eurylochus was not left behind after all, but came on too, for he was frightened by the severe reprimand that I had given him.

Meanwhile Circe had been seeing that the men who had been left behind were washed and anointed with olive oil; she had also given them woollen cloaks and shirts, and when we came we found them all comfortably at dinner in her house. As soon as the men saw each other face to face and knew one another, they wept for joy and cried aloud till the whole palace rang again. Thereon Circe came up to me and said, 'Ulysses, noble son of Laertes, tell your men to leave off crying; I know how much you have all of you suffered at sea, and how ill you have fared among cruel savages on the mainland, but that is over now, so stay here, and eat and drink till you are once more as strong and hearty as you were when you left Ithaca; for at present you are weakened both in body and mind; you keep all the time thinking of the hardships you have suffered during your travels, so that you have no more cheerfulness left in you.'

Thus did she speak and we assented. We stayed with Circe for a whole twelvemonth feasting upon an untold quantity both of meat and wine. But when the year had passed in the waning of moons and the long days had come round, my men called me apart and said, 'Sir, it is time you began to think about going home, if so be you are to be spared to see your house and native country at all.'

Thus did they speak and I assented. Thereon through the livelong day to the going down of the sun we feasted our fill on meat and wine, but when the sun went down and it came on dark the men laid themselves down to sleep in the covered cloisters. I, however, after I had got into bed with Circe, besought her by her knees, and the goddess listened to what I had got to say. 'Circe,' said I, 'please to keep the promise you made me about furthering me on my homeward voyage. I want to get back and so do my men, they are always pestering me with their complaints as soon as ever your back is turned.'

And the goddess answered, 'Ulysses, noble son of Laertes, you shall none of you stay here any longer if you do not want to, but there is another journey which you have got to take before you can sail homewards. You must go to the house of Hades and of dread Proserpine to consult the ghost of the blind Theban prophet Teiresias, whose reason is still unshaken. To him alone has Proserpine left his understanding even in death, but the other ghosts flit about aimlessly.'

I was dismayed when I heard this. I sat up in bed and wept, and would gladly have lived no longer to see the light of the sun, but presently when I was tired of weeping and tossing myself about, I said, 'And who shall guide me upon this voyage—for the house of Hades is a port that no ship can reach.'

'You will want no guide,' she answered. 'Raise your mast, set your white sails, sit quite still, and the North Wind will blow you there of itself. When your ship has traversed the waters of Oceanus, you will reach the fertile shore of Proserpine's country with its groves of tall poplars and willows that shed their fruit untimely; here beach your ship upon the shore of Oceanus, and go straight on to the dark abode of Hades. You will find it near the place where the rivers Pyriphlegethon and Cocytus (which is a branch of the river Styx) flow into Acheron, and you will see a rock near it, just where the two roaring rivers run into one another.

'When you have reached this spot, as I now tell you, dig a trench a cubit or so in length, breadth, and depth, and pour into it as a drink-offering to all the dead, first, honey mixed with milk, then wine, and in the third place water—sprinkling white barley meal over the whole. Moreover you must offer many prayers to the poor feeble ghosts, and promise them that when you get back to Ithaca you will sacrifice a barren heifer to them, the best you have, and will load the pyre with good things. More particularly you must promise that Teiresias shall have a black sheep all to himself, the finest in all your flocks.

'When you shall have thus besought the ghosts with your prayers, offer them a ram and a black ewe, bending their heads towards Erebus; but yourself turn away from them as though you would make towards the river. On this, many dead men's ghosts will come to you, and you must tell your men to skin the two sheep that you have just killed, and offer them as a burnt sacrifice with prayers to Hades and to Proserpine. Then draw your sword and sit there, so as to prevent any other poor ghost from coming near the spilt blood before Teiresias shall have answered your questions. The seer will presently come to you, and will tell you about your voyage—what stages you are to make, and how you are to sail the sea so as to reach your home.'

It was day-break by the time she had done speaking, so she dressed me in my shirt and cloak. As for herself she threw a beautiful light gossamer fabric over her shoulders, fastening it with a golden girdle round her waist, and she covered her head with a mantle. Then I went about among the men everywhere all over the house, and spoke kindly to each of them man by man: 'You must not lie sleeping here any longer,' said I to them. 'We must be going, for Circe has told me all about it.' And on this they did as I bade them.

Even so, however, I did not get them away without misadventure. We had with us a certain youth named Elpenor, not very remarkable for sense or courage, who had got drunk and was lying on the house-top away from the rest of the men, to sleep off his liquor in the cool. When he heard the noise of the men bustling about, he jumped up on a sudden and forgot all about coming down by the main staircase, so he tumbled right off the roof and broke his neck, and his soul went down to the house of Hades.

When I had got the men together I said to them, 'You think you are about to start home again, but Circe has explained to me that instead of this, we have got to go to the house of Hades and Proserpine to consult the ghost of the Theban prophet Teiresias.'

The men were broken-hearted as they heard me, and threw themselves on the ground groaning and tearing their hair, but they did not mend matters by crying. When we reached the sea shore, weeping and lamenting our fate, Circe brought the ram and the ewe, and we made them fast hard by the ship. She passed through the midst of us without our knowing it, for who can see the comings and goings of a god, if the god does not wish to be seen?

Analysis

Circe performs what seem to be magical acts when she transforms Odysseus' crew into pigs and back again. As such, Circe has often been considered a witch. Indeed, she is often said to be the first witch in the Western literary tradition.[15] However, it is important to recognise that certain ideas and categories, such as 'witch' and 'witchcraft', have histories. They have not always been with us and were at some stage generated. Two important related ideas here are nature and magic. While every society has had an idea of nature in the sense of knowing flora and fauna, earlier societies did not have a term for nature in general and ideas of nature in general have been controversial.[16] Homer had no word for nature and no expressions for above or beyond nature, contrary to nature or the supernatural. Likewise, he had no term for magic and no term for witch. It is significant that it was only when early Greek philosophers developed an idea of nature and its contraries that terms for magic and magic users appeared in the ancient Greek language.[17] Instead, in Homer's myths, gods and humans exist in the same way, but gods have more powers. When Zeus throws a thunderbolt in Greek mythology, he is not doing something magical, he is exercising the powers he has as a god. In Homer's *Odyssey,* Circe is a goddess. So, when Circe acts, is she doing magic or exercising her powers as a goddess? Circe does not call on any power beyond herself when she transforms Odysseus' crew. In the Western Christian tradition, a witch had no intrinsic power to break the laws of nature but had to call on another power external to herself: the devil. In Homer there is no such evil power and Circe has no need to call on anything external. There is no simple, ahistorical definition of magic. It is better, in any given situation, to study how words like natural and magical are used and what their contraries are, but in Homer we have neither.

Circe transforms Odysseus' crew by means of a *pharmakos*, which can be translated as 'drug' or 'herb' (herbs were used in ancient healing). The Moly plant, which Hermes gives to Odysseus to negate Circe is also a *pharmakos*. In Homer's mythology, plants have powers beyond those we would allow them, but they are natural in Homer and intrinsic to the plants. Critically, Circe does not use a spell or magic wand. She does have a *rhabdos*, a herding stick, and tells the crew to go to the sty, which is a herding instruction. However, in *Odyssey* X, 326–8 Circe says: 'I am amazed that you have drunk this *pharmakos* and not been beguiled. No other man at all has resisted this *pharmakos*, once he has drunk it past the barrier of his teeth'. Here, Circe is amazed that the *pharmakos* has not worked, not that the blow of the *rhabdos* or any supposed spell has failed.

Circe has similar powers to other deities in Homer and uses them in similar ways. So why is she singled out as a witch? If she is a witch for administering a *pharmakos*, why is Hermes not a warlock? If she is a witch for exercising her powers as a goddess, why are the other Homeric deities not witches and warlocks? First, there is a sexist assumption that female deities are magic users while male deities simply exercise their powers. Second, Circe is positioned as an evil magic user to differentiate her from other goddesses. Both of these dualisms have a background in the

Christian conception of witchcraft.[18] However, compared to what other deities do in Homer, there is nothing egregious in turning humans into pigs and back again. Other deities do much worse. Circe's actions are seen as bad or evil because they hinder Odysseus, the male lead in the tale. On the other hand, Athena does morally worse things than Circe but does them to aid Odysseus, so is seen as good. One should not define the merit of women's actions only in relation to the male hero.

Finally, it is important to consider the nature of this source as a translation. Many translators have assumed Circe to be a witch and then translated terms as they think appropriate.[19] For example, Circe *polupharmakos* has been translated as 'Circe, mistress of poisons' and 'Circe, sorceress' where the Greek literally says 'Circe of many herbs'. This is interestingly systematic in some translations where *pharmakos* is translated as 'drug' in relation to Circe, but as 'herb' for Hermes and other characters perceived positively. For example, there are also *ietroi polupharmakoi*, which is translated as 'doctors who know many herbs'. This raises the issue of knowledge. Circe clearly had considerable knowledge of herbs and, as *Odyssey* X develops, it is clear she knows many other things as well. This is not something to be suspicious of because she is a goddess and deities in Homer know many more things than mortals. She also did not sell her soul to the devil for this knowledge. In Homer's text, Circe is merely a strong, independent woman, skilled in herb craft who lives on her own on an island. Parallels with the witch hunts of the sixteenth to seventeenth centuries, which victimised in particular independent women with knowledge or skills which were deemed 'unnatural', suggest that the idea of Circe as a witch has been imposed by later commentators. These commentators were under the influence of much later ideas, often sexist or patriarchal, of nature, magic, knowledge and witchcraft which did not exist within Homer. As such, if you can read texts in the original language, do so, and be aware that translators (including ourselves) often bring their own agenda to their work such that translations are not always neutral.

Questions

1. Is Circe the innocent victim of latter-day literary witch hunting?
2. What does this source tell us about conceptions of nature? Are conceptions of nature highly charged or neutral?
3. Does Circe exercise her powers any differently from other Homeric deities? Does she do anything particularly bad when judged against other Homeric deities?

4. What does the differing treatment of Athena and Circe in this source tell us about the means used to control women in society?
5. Does applying modern categories to older texts seriously distort them?
6. What does the fact that Circe has been perceived as a witch tell us about our heritage and society? Have women, fictional or otherwise, historically been able to have significant knowledge without suspicion?
7. Rosalind Franklin's work on the structure of DNA (the discovery attributed to Watson and Crick) was described as witchcraft by her colleagues. Does this source offer us a new perspective on Franklin's treatment?

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3

Anonymous: *Dialogue of the Philosophers and Cleopatra* (c. 600–700 CE)

Vincenzo Carlotta

Introduction

This source is an excerpt from the *Dialogue of the Philosophers and Cleopatra*, an alchemical text written in Greek and surviving to various extents in most Byzantine anthologies of alchemical works. Although the dating of the *Dialogue* remains uncertain, the surviving version of the work can be dated around the seventh century CE.[20] As for most Greek alchemical writings (and many later works on alchemy), the *Dialogue* is a case of pseudo-epigraphy. That is to say, it was written by an anonymous author and falsely attributed by that author to a famous name in the field of alchemy. In this case, the alchemical teachings are ascribed to Cleopatra VII (69–30 BCE), the last queen of Egypt. In the *Dialogue*, Cleopatra taught a group of alchemists how to produce the agent of alchemical transmutation; a substance by means of which 'vile' metals, such as lead and copper, could be transmuted into silver and gold.

Source

Dialogue of the Philosophers and Cleopatra, ll. 21–64.
Carlotta, Vincenzo. 'The Alchemical Teachings of Cleopatra', *Ambix: Sources of Alchemy and Chemistry* (forthcoming 2023).[21]

[Cleopatra said:] 'And you, my friends, if you want to approach this beautiful art, observe the nature of the plants and whence they come! In fact, some of them come down from the mountains and others are produced by the earth; some go up from the hollows, others are led up from the plains. But observe how you approach them: reap them on appropriate times and specific days, and pick them from the islands of the sea and the highest places. Observe the air that serves them and the nourishment that surrounds them. Do not spoil them, nor kill them! Observe the divine water that gives them drink, and the cloud that lifts them up, and the air that guides them. And if they are unified, they will be one and nobody will be able to separate them, since they have become corporeal in one single substance.'

In response Ostanes and his fellows said to Cleopatra: 'The whole secret – which is both terrible and wonderful – is hidden in you, Cleopatra! Teach us clearly regarding the elements as well! Tell us how the highest comes down to the lowest, and how the lowest goes up to the highest, and how what is in the middle comes close to both the highest and the lowest – and the (two different) parts do not deter what is in the middle from progressing toward unification – and which element is required for these (operations), and how the blessed waters come down in order to examine the dead, which are weakened, bound, and oppressed in Hades, and how the drug of life penetrates into them and awakens them so that they are awakened by (their) owners, and the new waters penetrate into them – the waters which at first (came) [from] the bed, since they were generated in the bed and came (out) together with the light –, and a cloud lifts them up, and the cloud ascends from the sea lifting the waters up: and the philosophers rejoice considering the secrets that have been revealed.'

And Cleopatra told them: 'The waters, when they penetrate, awaken the bodies and the spirits, which are confined and weak.' 'Once again,' she said, 'they have endured oppression and have once again been shut up in Hades, and they grow little by little, and ascend, and are clothed in a riot of bright colours like the flowers in springtime, and this spring rejoices and is glad at seeing they are fully ripe.

'But I say this to you who think wisely; if you raise the plants, the elements, and the stones from their places, they will appear to be too ripe and still unripe, since the fire assays them all. But if they are clothed in the glory coming from the fire and the glowing colour thereof, then (their) appearances (will be) greater, then (there will appear) the glory which has lain hidden so far – the sought-for beauty – and an earthy nature transformed into a divine one; so it will be, if they are nursed in the fire.

'Just as an embryo gradually grows, "nursed" in its mother's womb, and – when the appointed month comes – the infant is not hindered from being delivered, so also is this admirable art: billows and waves one after another injure this art in Hades and in the grave where (these substances) are buried, but if the grave is opened, they will ascend from Hades, like an infant (emerging) from the womb. Then the philosophers, who admire the beauty as a tenderly loving mother (admires) the infant born to her, seek out how they can nurse this art like an infant by means of waters instead of milk. For the art seems like an infant since it receives its own form like an infant and, if it is completed in every respect, here will be a secret that has so far been sealed.'

Analysis

The *Dialogue* presents Cleopatra's teachings using highly metaphorical language. The growth of plants and fruits, death and resurrection, and the development and birth of a child are all images used to illustrate various aspects of alchemical practice. These phases include the destruction of the original ingredients using the alchemical apparatus; the production of vapours; and the gradual transformation of the individual alchemical substances into the agent able to transmute (change) 'vile' metals into silver and gold. The agent of transmutation is presented as a complete unification of the different substances used during the process into a single divine substance. The author's use of diverse imagery in the *Dialogue* made it difficult for alchemists to identify specific ingredients and the alchemical operations described in the text, thus preserving the secrecy of the alchemical discipline, a concern expressed by Cleopatra herself in other sections of the *Dialogue*.[22] Nonetheless, the imagery is also significant as an illustration of natural processes and religious ideas that encompassed alchemy within the broader frameworks of natural philosophy and religious experience. Cleopatra's teachings were, in this respect, both a secretive description of the alchemical practice and a justification of its value within the cultural and intellectual context of the seventh century.

Among the alchemists receiving Cleopatra's teachings, the only one mentioned by name is Ostanes, a Persian magus whom the alchemists credited with having taught alchemy to the Greek philosopher Democritus of Abdera (c. fifth century BCE). The story is fictional and operates alongside a number of important alchemical works falsely ascribed to Democritus dating to the first century CE. Nonetheless, Democritus was considered as one of the most influential practitioners of the discipline by all Greek alchemists. By portraying Cleopatra as an alchemist who was able to explain the secrets of the discipline to Ostanes, and by extension Democritus, the author placed the *Dialogue* in a mythical position at the very origin of the Greek alchemical tradition. Moreover, Greek alchemists frequently depicted themselves as heirs of both the Egyptian and Persian traditions. Therefore, the conversation between the queen of Egypt and the Persian magus also offered a literary portrayal of the convergence of the two traditions and reiterated the importance of Cleopatra to the history of alchemy as it was perceived by its own practitioners.[23]

The pivotal role ascribed to Cleopatra VII by the author of the *Dialogue* is the result of a rich pseudo-epigraphic tradition that credited the last queen of Egypt with important achievements in various fields of the study of nature, especially in medicine and pharmacology. Although these works too were falsely ascribed to Cleopatra, she did in fact give active support to many physicians, geographers and other scholars of the natural world at her court.[24] Moreover, as she faced the threat of Roman expansionism, Cleopatra was able to preserve the independence of Egypt during her reign. For this reason, Cleopatra, despite being a Macedonian ruler, became after her death a symbol of the ancient traditions of Egypt across the Eastern provinces of the Roman Empire.[25] Although Latin sources were frequently influenced by Augustus's powerful propaganda against Cleopatra – as she was the main ally of Augustus's rival Mark Antony – Greek alchemical sources offered a highly positive depiction of the queen of Egypt. Apart from the *Dialogue*, other alchemical texts were circulated under her prestigious name during the Byzantine period (approx. 330 CE–1453 CE). These include an ancient illustration of alchemical apparatus that featured secretive instructions and one of the most famous depictions of the ouroboros serpent. This illustration, which was recorded and preserved by the codex *Marcianus graecus* 299 (end of tenth century CE) at fol. 188v, was originally linked to the works of another important Greek alchemist, Zosimus of Panopolis, but was later entitled *Cleopatra's Gold Making*.[26] The success of the attribution of alchemical works to Cleopatra was further confirmed by Arabic treatises on alchemy that circulated under her name.[27]

Questions

1. In this source, what is the relationship between Cleopatra and the other alchemists she interacted with? What expressions did she use to address them and how was she addressed by them?
2. How did Cleopatra and her fellow alchemists link natural phenomena and religious elements to their discussion of alchemy?
3. To what extent were the various themes and imagery interconnected and/or juxtaposed against one another?
4. The false attribution of alchemical works to Cleopatra appears to be linked to the medical and pharmacological works also (falsely) ascribed to her. What were the specific themes and images that connected alchemy and medicine? Can you find any reasons why ancient alchemists may have regarded medicine as a closely related discipline?
5. While the *Dialogue* portrays Cleopatra as she taught Ostanes about alchemical operations, another Greek alchemist, Zosimus of Panopolis, credited Maria the Jew as his teacher. What does this tell us about the role of female practitioners among Greek alchemists? To what extent did this role influence the false attribution of some alchemical works to women?
6. How can historical alchemy, and the kind of knowledge it produced, be understood in relation to modern conceptions of science and technology?

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4

The Southern Moche group: A ceramic vessel from coastal Peru (c. 200–900 CE)

Esme Loukota

Introduction

This is a ceramic vessel from coastal Peru, dated 200 to 900 CE, depicting a seated female figure holding a San Pedro cactus. This ceramic is held in the collection of the Museo Larco in Lima, Peru (catalogue number ML012887). The museum's description of the vessel is as follows: 'Botella gollete asa estribo escultórica representando mujer sentada, con manta sobre la cabeza, pintura facial, collar de cuentas circulares, trenzas, túnica y cinturón, sosteniendo cactus San Pedro' – 'Stirrup spout vessel depicting woman (healer) seated with blanket covering head, face paint, necklace of circular beads, braids, tunic and belt holding a San Pedro cactus'.[28]

This ceramic was excavated from Tanguche in the Santa Valley in coastal Peru and as such we can identify this ceramic as belonging to the Southern Moche (also referred to as Mochica) group. The Moche were initially understood to be a single centralized state spanning 200 to 900 CE with a centre at Huacas de Moche with leaders who used ritual and military coercion as a means of retaining control.[29] Within this centralised state model, Rafael Larco Hoyle developed a 5-phase development sequence for the Moche civilisation based on changes in the style of the ceramics. However, with further archaeological investigation, it became clear that the Northern areas of the Moche did not fit with the typology or the theory of the centralized state. Although the Larco's typology was still applicable to the Southern Moche valleys, it became clear that there were two separate spheres of Moche occupation. This evidence indicated that the previously conceived centralised Moche state was instead a group with shared iconography and ideology across different territories whose centralisation or fragmentation fluctuated over time.[30] Broadly speaking, the Moche can be considered as two distinct groups: the Northern Moche and the Southern Moche.

There is no surviving writing system for any of the Moche groups, so we do not know how they would have identified themselves or even if the various communities within the Southern Moche 'group' would have considered themselves a homogenous unit under one name in this way. This lack of writing system has also meant that conclusions drawn about the lives of people living in these communities have been based on interpretations of material findings; it is not possible for us to determine if the female figure depicted is a specific individual or a general representation of a role, however multiple similar examples indicate that it was a recognised and established form.

Source

Figure 1.2 Botella gollete asa estribo escultórica representando mujer sentada, con manta sobre la cabeza, pintura facial, collar de cuentas circulares, trenzas, túnica y cinturón, sosteniendo cactus San Pedro. (Stirrup spout vessel depicting woman (healer) seated with blanket covering head, face paint, necklace of circular beads, braids, tunic and belt holding a San Pedro cactus [translation provided by author].) Image courtesy of Museo Larco – Lima, Perú (ML012887).

Analysis

As the community that produced this ceramic did not leave a writing system, information about it has been largely collected through archaeological excavation and analysis, with some contemporary anthropological comparisons. Bonnie Glass-Coffin's work on the use of modern examples to uncover a greater understanding of the actions, roles and beliefs held by the *curanderas* (healers) depicted in archaeological ceramics establishes that many elements, not least the use of the San Pedro cactus, appear to have endured.[31] The figure shown in this ceramic is often referred to as an *achumera*, based on a contemporary folk name for the cactus held by the figure, which is *achuma* or *huachuma*, also known as the San Pedro cactus.[32] However, there are some gendered issues surrounding modern-day *curanderas* that may or may not be relevant to archaeological sources like this ceramic. Many women following such practices in modern communities were considered witches rather than healers, which can be attributed in some part to the religious persecution of such beliefs by the Spanish invaders in the sixteenth and seventeenth centuries.[33] In contrast, the production and circulation of ceramics depicting female healers would indicate that these individuals were not persecuted within the Moche communities.

The choice of medium by which ideas about these healers were disseminated is equally informative. The Moche chose to represent this female figure through the portable medium of pottery. Committing the idea of woman as healer to a portable medium would have allowed the dissemination of this concept, and any associated values, across great distances. As such, this approach to material culture allows us to consider the political implications of materialising the healing and/or ritual role of women. Through the active creation and dissemination of the figure of the female healer (or indeed, just a healer who happens to be female) we can question how this contributed to the establishment and maintenance of gender roles. In particular, this ceramic encourages us to consider the perpetuation of ideals and the mechanisms of relaying information about the roles played by women in medical and/or ritual knowledge creation in the Moche society.

We may also question the identification of this figure as a woman. As with many iconographic interpretations of the past, Moche figures have been considered male or female based on the activities they were shown performing, applying a modern bias to archaeological material which was critiqued by Margaret Conkey and Janet Spector, calling attention to the lack of any systematic consideration of gender and prompting the development of numerous archaeologies of gender.[34] These archaeological methods interrogate both the potential roles and interactions of gendered people in the past as well as the assumptions made by those in the present about gender in the past. Bonnie Clarke and Laurie Wilkie further advocated a shift away from categories such as woman in the past, considering instead the specific roles that are included within them, for example artisan, healer, religious leader, etc.; a study of identities as opposed to block categories of gender.[35] One can also question how the Moche group conceptualised gender, as they may have had other genders that are not reflected in categories used today. However, addressing modern bias is challenging; with this ceramic, we may be able to identify that women participated in activities involving the San Pedro cactus by the representation of the crown of the cactus rendered as a series of small bumps held in the left hand, but how we categorise this is still influenced by our own understanding of a gendered division of roles.[36]

We must also take care to consider how our modern conceptions of science and knowledge-making influence our understanding of objects like this ceramic. The concepts of both medicine and ritual have been used interchangeably in reference to this ceramic within this piece. The aim of the activities depicted appear firstly to be healing in nature, based on observations of the plants obtained and used in a variety of remedies by contemporary healers, including the San Pedro cactus.[37] However, it is highly likely that these healing activities were inextricably linked to a belief system, thereby making the role of this depicted woman as much about belief and ritual as it is medicine. When considering the way in which the woman depicted (or the group of women she represents) contributed to the creation of knowledge in the Moche communities, it is therefore important for us to consider how our concepts of 'science' and 'medicine' interact with the original Moche context.

Questions

1. What does this source tell us about Moche attitudes and approaches to medicine, if anything?
2. How could we discuss the intersection of medicine and belief in a context where there is no writing system? How much can we comprehend the categorisation (or lack thereof) of these areas of society from the material culture?
3. How is knowledge disseminated? How can the creation and movement of objects contribute to the circulation of knowledge?

4. How could we discuss this source in the context of medical or scientific professionalisation?
5. What is the impact of basing understanding of gender roles and medical approaches on archaeological remains? How can we avoid or minimise applying our bias to the interpretation of this material?

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5

Hypatia of Alexandria (c. 350–415 CE): Letter from Synesius of Cyrene to Paeonius (c. 355–415 CE)

Dr Aiste Celkyte

Introduction

Hypatia was the head of the school of philosophy based in Alexandria, Egypt, which was part of the Eastern Roman Empire during her lifetime. It was one of two dominant philosophical schools in late antiquity, with the other school based in Athens, and therefore Hypatia was undoubtedly one of the most prominent philosophers, as well as mathematicians, of her day.[38] Hypatia is also one of very few women in antiquity who led a school. She inherited this position from her father, Theon, a celebrated mathematician. Theon and Hypatia worked closely together. The third book of Theon's commentary on Ptolemy's *Almagest* is titled 'Commentary by Theon of Alexandria on Book 3 of Ptolemy's *Almagest*, an edition revised by my daughter Hypatia, the philosopher.' This line, combined with the fact that Books 3-13 contain a long division method not found in Book 2, indicates that Theon was commenting on an edition of *Almagest* prepared by Hypatia.[39] This piece of information not only provides a glimpse into Hypatia's early mathematical work but is also one of the very few surviving sources of her writing.

The main obstacle in studying Hypatia's thought is that her written treatises have not survived. Although difficult, the reconstruction of her views is not impossible. Hypatia had a thriving school with pupils whose works have survived. The views of other philosophers have been reconstructed on the basis of the writings of pupils and other testimonies.

For example, neither Socrates or Pyrrho wrote anything at all, yet their thought is studied via the writings of their pupils. In the case of Hypatia, her pupil Synesius of Cyrene is a rich source of information, as he was a prolific writer himself. His surviving letters show correspondence with his teacher, as well as his fellow pupils, and he regularly refers to Hypatia as an authority on scientific and philosophical issues. This manner of referring to her teaching is evident in his letter to Pylamaenes, enclosed with the gift of an astrolabe.

Source

Synesius On an Astrolabe 14-15, translated by Augustine Fitzgerald, slightly altered. Livius.org, 'Synesius On an Astrolabe 3', Last modified 4 May 2019. Accessed 17 February 2022. Available: https://www.livius.org/sources/content/synesius/synesius-on-an-astrolabe/synesius-on-an-astrolabe-3/

Astronomy itself is a venerable science, and might become a stepping stone to something more august, a science which I think is a convenient passage to ineffeable theology, for the happy body of heaven has matter underneath it, and its motion has seemed to the leaders in philosophy to be an imitation of mind. It proceeds to its demonstrations in no uncertain way, for it uses as its servants geometry and arithmetic, which it would not be improper to call a fixed standard of truth. I am therefore offering you a gift most befitting for me to give, and for you to receive. It is a work of my own devising, including all that she, my most reverend teacher [Hypatia], helped to contribute, and it was executed by the best hand to be found in our country in the art of the silversmiths.

Analysis

This text has been used to suggest that Hypatia invented the astrolabe but this is now a widely rejected claim.[40] However, the claim about the invention of this astronomical instrument is arguably less interesting than the question of its application. Synesius regularly mentions various scientific devices in his letters, linking them to Hypatia in one way or another. For example, in his *Letter* 15, Synesius asks Hypatia to send him a hydrometer. These links prompt questions about how these instruments were used in Hypatia's school. We are also prompted to consider what theoretical propositions could have been drawn based on the data collected with these instruments. The source sheds some light on this.

This passage contains some striking Platonic undertones. Arranging different types of knowledge (and, implicitly, sciences) in a hierarchical order, for instance, is reminiscent of the Divided Line metaphor in the *Republic* 6 (509D-511D), which divides different types of knowledge hierarchically into knowing imitations, objects, principles and the Forms in ascending order. This Platonic motif must have found its way into Synesius' writing by way of the education he received from Hypatia as he did not study with any other teachers. Our sources describe Hypatia as working in the tradition of Plotinus (Socrates Scholasticus *Historia Ecclesiastica* 7.15.1.), the founder of Neoplatonism. Furthermore, Synesius' mention of his teacher towards the end of the passage implies her approval of not only the instrument constructed but also the explanation of its significance. This revelation indicates that the contents of the passage either reflect Hypatia's own views or, at the very least, are compatible with her views.

A closer look at the passage reveals that there are some notable differences between this hierarchy and the one in the *Republic*. Synesius puts ineffable theology at the top of the hierarchy of knowledge, with astronomy just below and geometry and arithmetic as its subordinate sciences. This scheme overlaps with the standard philosophical curriculum in late antiquity: the students would start with mathematics, Aristotelian philosophy and slowly advance towards metaphysics, especially Platonist metaphysics. The most advanced, the inner circle students, were given the most esoteric teachings, called 'ineffable theology' by Synesius.[41] Despite Platonic motifs, the point of this passage is therefore quite different from that made by the Divided Line, and it has important implications for how scientific knowledge is modelled and understood. Far from being an inferior type of knowledge, as it is in the Divided Line, astronomy here is a stepping-stone to the understanding of the principles of the universe ('mystic theology'). Synesius explains this connection by noting that although the heavenly bodies are material, and their motion is rational, and they imitate the pattern of the divine mind. By comparing the hierarchy of knowledge in this passage and in Plato, we can draw two important conclusions: first, members of Hypatia's school were using motifs from Platonist tradition, thus embedding their views in a dominant philosophical tradition. Second, they interpreted and adapted these motifs to suit their interests. In this passage, a Platonic motif is interpreted to fit contemporary educational progression.

The source text contains two further notable concepts. First, the notion of a demonstration (*apodeixis*) as described here comes from Aristotle. By late antiquity, it was a popular model of scientific reasoning, found not only in standard theoretical sciences but also medicine; Galen of Pergamum was a famous advocate of medical demonstrations.[42] Aristotle defined a demonstration as a 'scientific deduction' in the *Posterior Analytics* (1.2; 71b18), and it is primarily understood as a tool for discovering unknown truths from what is known by means of logical reasoning. Synesius writes that an astronomical demonstration is produced not uncertainly but in a rigorously established way, by means of geometry and arithmetic. In describing this process, he uses the second notable concept: the criterion of truth. This notion originated in the Hellenistic period (323–30 BCE). Originally, the concept of the criterion of truth referred to the way in which we know that what we are perceiving is true and not, for example, a dream or an illusion. Synesius uses it differently. Here, sciences are fit to be called the criterion of truth because they pave the way for understanding how the divine mind operates. The study of heavenly bodies with the help of scientific instruments, such as an astrolabe, therefore, underpins the study of the divine origins of the universe and how it operates. In Hypatia's school, sciences and philosophy were modelled as uniquely converging domains of knowledge: a key original contribution to scientific and philosophical thought in late antiquity.

Questions

1. How did Hypatia's school present mathematical reasoning as an introduction to philosophy? In what sense are geometry and arithmetic 'criteria of truth'?
2. In what ways does the study of Hypatia resemble the study of, for example, Socrates, who also has no surviving works? In what ways does it differ?
3. Which ideas in the source can be linked to established philosophical traditions and which are innovative?
4. How might we consider Hypatia in her cultural context; what other female philosophers and intellectual figures might we compare her with?
5. Consider the ways in which sources for ancient figures can be used. What are the difficulties, shortcomings, and advantages of the sorts of sources that we tend to be faced with?

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Part I notes

1 Neugebauer, *The Exact Sciences in Antiquity,* and *A History of Ancient Mathematical Astronomy*; Toulmin and Goodfield, *The Fabric of the Heavens*.

2 Nutton, *Ancient Medicine*, for discussion of the specific problems of sources for ancient medicine while being broadly applicable when considering the ancient world and the lack of comprehensive written record; see also Homer, *Odyssey* (2018 translation), for an example of a radically different translation of Homer's *Odyssey* by Emily Wilson.

3 This publication is part of the research project 'Alchemy in the Making: From Ancient Babylonia via Graeco-Roman Egypt into the Byzantine, Syriac, and Arabic Traditions', acronym AlchemEast. The AlchemEast project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement no. 724914).

4 Martin Levey popularised knowledge of Assyro-Babylonian chemical texts during the mid-twentieth century, and introduced Tappūtī-bēlat-ekalle to historians of chemistry; see Levey, 'Perfumery in Ancient Babylonia', 1954.

5 KAR 220 is also referenced by its museum catalogue number VAT 10165; a digital edition of the text may be found at http://oracc.org/glass/P282617 (accessed 15 December 2022).

6 These conventions are in keeping with those generally utilised in Assyriology; see for example Radner and Robson, *The Oxford Handbook of Cuneiform Culture*, xxv. The clearest duplicate for KAR 220 is text KAR 140 (VAT 10096), http://oracc.org/glass/P282611 (accessed 15 December 2022).

7 To list only a few master perfumers: Ernest Beaux (creator of Chanel No. 5); Alberto Morillas (master perfumer at Firmenich); and Jean-Claude Ellena (Hermés). In 2016, after the retirement of Ellena at Hermès, Christine Nagel became the first woman to direct olfactive creations for Hermès Parfums, a rarity in a male-dominated industry. An interview with Nagel may be found at https://www.businessoffashion.com/articles/workplace-talent/how-i-became-hermes-in-house-perfumer (accessed 15 December 2022). The dominance of the 'male nose' – in both perfume production and literature – is not limited to modern or even Western perfume production, as it finds parallels in pre-modern India, for which see McHugh, *Sandalwood and Carrion*.

8 See, for example, MARV 2.22, a Middle Assyrian administrative text wherein a female perfume-maker named Tukulti-ša-šame is tasked with delivering aromatic oils over a period of eight months for state-sponsored cultic events in the city of Assur in Postgate, *Bronze Age Bureaucracy*, 158–59.

9 Jakob, *Mittelassyrische Verwaltung und Sozialstruktur*, 478.

10 See, for example, Pamela Smith's discussion of 'artisanal epistemology' in chapter one of Smith, *The Body of the Artisan*. The sociologist Harry Collins has also explored the concept of tacit knowledge in depth in Collins, *Tacit and Explicit Knowledge*.

11 An introduction to the history of Babylonian and Assyrian science may be found in Rochberg, 'The history of science and ancient Mesopotamia'. A more specialised treatment on the intellectual history of Akkadian procedures will be published in Escobar, 'Mathematics and Technological Change'.
12 For a summary of Akkadian dialects, including the Assyrian dialect of Akkadian, see George, 'Babylonian and Assyrian'.
13 Aruz et al., *Beyond Babylon*, explores the cultural exchange of elite goods during the late second millennium BCE and provides a valuable resource for this period.
14 See, for example, Graziosi, *Inventing Homer*.
15 Gregory, *Early Greek Philosophies of Nature*, 5, 31.
16 See Rochberg, *Before Nature*, 1; Lloyd, *Cognitive Variations*, 31–32; Lloyd, *Methods and Problems*, 419; Grant, *A History of Natural Philosophy*, 1.
17 Gregory, *The Presocratics and the Supernatural*.
18 If you are interested in this background, read Kramer and Sprenger, *Malleus Maleficarum*. The title *Malleus Maleficarum* means 'Hammer of the Evil Doers' and is effectively the first handbook on witch hunting. It is widely available in an English translation. Beware that it is an appallingly misogynistic book, but also fascinating in its paranoia.
19 For a new feminist translation of Homer's *Odyssey* which illustrates a different interpretation of Circe from more traditional works, Emily Wilson: Homer, *Odyssey* (2018 translation).
20 Based on the references to the *Dialogue* in other Greek alchemical works, the manuscript transmission of the treatise, and its contents, I argue for dating the extant version of the work to the seventh century CE. On these topics and the debate surrounding the date of composition of the *Dialogue*, see Reitzenstein, 'Zur Geschichte der Alchemie und des Mystizismus'; Letrouit, 'Chronologie des alchimistes grecs'; and Charron, 'The *Apocryphon of John* (NHC II, 1) and the Graeco-Egyptian alchemical literature'.
21 Original translation by Vincenzo Carlotta.
22 On the secretive language of some alchemical texts and its interpretation, see at least Halleux, *Les Textes Alchimiques*, 114–119 and Principe, *The Secrets of Alchemy*, 143–156.
23 On the crucial role of pseudo-Democritus in the history of Greco-Egyptian alchemy, see Martelli, *The Four-Books of Pseudo-Democritus,* in particular pp. 63–73 on the interplay of Egyptian and Persian elements in the foundational narrative of Greek alchemy.
24 See Marasco, 'Cléopâtre et les sciences de son temps'; and Flemming, 'Women, writing and medicine in the Classical world'.
25 On Cleopatra's cultural and political legacy in Egypt and the Eastern provinces of the Roman Empire, see Chauveau, *Cleopatra;* and El Daly, *Egyptology*.
26 On *Cleopatra's Gold Making*, see Mertens, *Zosime de Panopolis*, 22 and 175–184.
27 See Ullmann, 'Kleopatra in einer arabischen alchemistischen Disputation'.
28 Museo Larco, 'Museo Larco Catalogo en Linea'. Translation by the author.
29 Larco Hoyle, *Los Mochicas*.
30 Castillo-Butters and Quilter, 'Many Moche Models', 2010, 1–16.
31 Glass-Coffin, *The Gift of Life*.
32 Scher, 'The Achumera', 237–256.
33 Glass-Coffin, *The Gift of Life*.
34 Conkey and Spector, 'Archaeology and the study of gender', 1983, 1–38.
35 Clarke and Wilkie, 'The Prism of the Self', 2006.
36 Scher, 'The Achumera', 237–256.
37 Bussman and Sharon, 'Traditional medicinal plant use', 2006, 1–18; Museo Larco, 2010.
38 With reference to our comments in the introduction it is important to critically evaluate terms such as 'Late Antiquity'. Late Antiquity, roughly, spans the period from the third century to the sixth or seventh and traditionally marked the end of the Greco-Roman Classical world and the beginning of the European Middle Ages. It is therefore a term entrenched in Euro-centric conceptions of the past. It is helpful to consider this periodisation in light of the timeline at the beginning of this part marking significant global events and the different periodisations used within the part, such as Middle Assyrian, Southern Moche, Byzantine and Ancient Greek.
39 Cameron, 'Hypatia', 2016, 191.
40 Powell, *From Cave Art to Hubble*, 32.
41 Watts, *Hypatia*, 39–41.
42 Tieleman, 'Methodology', 2008, 49–53.

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Part II

Materials and manuscripts (900–1600 CE)

Timeline: individuals and events in the history of science	Timeline: individuals, events and objects in this part
	c. 620 CE Ku'ayba bt. Sa'd al-Aslamiyya is born and goes on to practise medicine as a nurse or physician in Medina, today in Saudi Arabia.
Late eighth/early ninth century CE The Bayt al-Ḥikmah or 'House of Wisdom' is founded in Baghdad, a large library associated with scholars from the fields of astronomy, philsosophy, mathematics, medicine and many others.	
	c. tenth century CE Mariam al-Ijli al-Asturlabi, astronomer and astrolabe maker in Aleppo.
1088 CE The University of Bologna, said to be the oldest university in continuous operation, is founded.	
c. twelfth century CE Trota of Salerno, medical practitioner from the coastal town of Salerno in Italy, whose writings form part of the *Trotula,* an ensemble of writings on women's medicine.	

Timeline: individuals and events in the history of science	Timeline: individuals, events and objects in this part
c. 1114–1187 CE Gerard of Cremona, Italian translator, who translated scientific books from Arabic into Latin.	
	c. 1300 CE Middle English romance *Bevis of Hampton* features the fictional character Josian, who uses medical and herbal knowledge within the narrative.
1304–1368/9 CE Ibn Battuta, Maghrebi writer and explorer who travelled extensively in Africa, Asia and Europe, whose journeys are documented in the travel narrative *The Rihla*.	
c. 1368–95 CE Early Ming Dynasty, the Huolongjing treatise, a Chinese military treatise, describes the use of cannon, multistage rockets and naval mines in China.	
c. 1450 CE Metal moveable-type printing press is introduced in Europe by Johannes Gutenberg, making block type printing quicker and cheaper.	
c. mid-fifteenth century CE Portuguese and afterwards other European nations begin importing enslaved peoples from Africa, beginning the networks that would become the transatlantic slave trade.	
1492 CE Genoese explorer and navigator Christopher Columbus lands in the so-called 'New World', beginning invasion and colonisation of the Americas by European nations.	

Timeline: individuals and events in the history of science	**Timeline: individuals, events and objects in this part**
1507 CE first recorded epidemic of smallpox in the 'New World'. The native Taíno population is devastated.	
1543 CE Publication of *De Revolutionibus Orbium Coelestium* (*On the Revolutions of the Heavenly Spheres*), by the Polish astronomer, mathematician and polymath Nicolaus Copernicus, which proposes the heliocentric theory that places the sun at the centre of the solar system.	
1564–1642 CE Galileo Galilei, Florentine astronomer, physicist and engineer.	
	1569–85 CE Mary, Queen of Scots, Bess of Hardwick, and other members of Mary's household produce the Oxburgh Hangings, which depict a range of animals and botanical subjects.

Introduction

Part two takes us forward in time to examine materials and manuscripts which draw out women's histories from the fourteenth to seventeenth centuries in Europe and West Asia. This period spans what have been referred to by historians as the Middle Ages and the Renaissance. Both periodic definitions are based within Eurocentric conceptions of discovery, invention and progress. The Middle Ages are traditionally defined as occurring between the fall of the Western Roman Empire in 476 CE and the dawning of the Renaissance in the late fifteenth century.[1] The Renaissance is usually characterised as a 'rediscovery' by Europeans of their scientific inheritance from Ancient Greece and Rome, implying that the Middle Ages was a time of ignorance.[2] This narrative places Europe as the centre and origin of scientific learning, and focuses on the types of knowledge valued by the twentieth and twenty-first centuries.[3]

Adding nuance to our understanding of this period, the sources in this part demonstrate that women possessed knowledge and expertise within a variety of fields, ranging from medical practices to the construction of scientific instruments. In some cases, these spheres of knowledge do not easily map onto the disciplines that are familiar to us today such as biology, chemistry or physics. However, as we will see throughout this sourcebook, it is important to challenge modern-day assumptions. While some sources included in this part form part of the official written record, such as biographies, others allude in more indirect ways to the knowledge and skills women demonstrated through fictional writing and in physical objects.

Considering what is available to us from this period, it is important to interrogate how and why the materials or writings that we study today have survived. Women's voices were not valued by patriarchal archival institutions and are therefore not as represented in archives. Furthermore, European women's voices are more likely to be preserved in archives while the consequences of colonialist and racist academic practices mean that global women's scientific sources are more difficult to find. In each type of source, it is important to consider both how women presented themselves as experts, how women's expertise was described and perceived by others and how it has been portrayed since.

The first source in this part is an excerpt from *Kitab al-tabaqat al-kubra,* the earliest surviving biographical dictionary. The dictionary includes a volume dedicated to women, including this extract, describing the healer Kuʿayba bt. Saʿd al-Aslamiyya. The second source also describes the biography of a Muslim woman, extracted from the encyclopaedia *Fihrist.* This woman, Mariam al-Ijli al-Asturlabi, was a maker of astrolabes. The third source is an extract from the fourteenth-century Auchinleck manuscript of the romance *Bevis of Hampton*. The story tells how Josian, an Armenian princess, escaped imprisonment by using her expertise in herbs. Finally, the fourth source is a series of embroidered emblems created by Mary, Queen of Scots and Elizabeth Talbot (also known as Bess of Hardwick), as well as the ladies of Talbot's household. These emblems depict many motifs that reflect their study and understanding of contemporary natural history texts alongside political symbolism. Together, these sources offer glimpses of women who were actively engaged with science, medicine, botany and zoology in this period, often in ways that are not always recognised by traditional historical narratives.

6
Ku'ayba bt. Sa'd al-Aslamiyya (fl. 620 CE): An extract from *Kitab al-tabaqat al-kubra* (*Book of the Great Generations*) (c. 600–900 CE)

Dr Shazia Jagot

Introduction

The below source is an excerpt from *Kitab al-tabaqat al-kubra* (translated as 'Book of the Great Generations'), a biographical dictionary compiled by the hadith scholar and historian, Ibn Sa'd (784–845 CE). The *Tabaqat* is the earliest and fullest surviving biographical dictionary. The book provides an Islamic vision of universal history that begins with Adam, the first Islamic Prophet. The *Tabaqat* continues through to the life of the Prophet Muhammad and his immediate predecessors, the four *rashidun* ('rightly-guided') caliphs and the hadith transmitters who followed.[4] The *Tabaqat* was divided into eight volumes and was organised by generations or classes. Women appear in the final volume (*Kitab al-Nisa*; 'Book of Women') and were classified into two categories: the women who met the Prophet Muhammad (d. 632 CE) during his lifetime, known as *Sahabiyyat* ('Female Companions of the Prophet'), and women who were hadith transmitters, those who reported the traditions of the Prophet. In general, biographical dictionaries are a rich source for locating women in the early Islamic period and the Islamic Golden Age (approx. eighth to fourteenth centuries CE), with some dictionaries comprising over 1,500 individual biographies.[5]

Source

Ibn Sa'd, *Kitab al-tabaqat al-kubra* ed. Muhammad 'Abd al-Qadir 'Ata (Beirut, 1997): 8: 226–7 translated by Asma Afsaruddin in Afsaruddin, Asma. 'Reconstituting Women's Lives: Gender and the Poetics of Narrative in Medieval Biographical Collections', *The Muslim World* 92 (2002): 461–480.

Ku'ayba bt. Sa'd al-Aslamiyya: She gave her allegiance to the Prophet after the emigration to Madina and is said to have had a tent set up for her in the mosque at Madina, where she would tend to the sick and the wounded. Sa'd b. Mu'adh, when wounded at Khandaq, is said to have received treatment at her hands until he died. Ku'ayba is also said to have been present at Khaybar.

Analysis

The source provides a short factual account of Ku'ayba bt. Sa'd al-Aslamiyya. In keeping with the genre of the biographical dictionary, the entry provides her full name and some anecdotal information verified through first-person accounts indicated by the phrase 'is said to have'. Ku'ayba's entry appears in a section that lists women who became Muslim during the lifetime of the Prophet: 'Naming the Women who Pledged Allegiance from among the Quraysh, their allies (*hulafa'ihim*), their clients (*mawalihim*), and relatively unknown women among the Arabs in general (*wa ghara'ib nisa al-'arab*)'.[6]

While the entry is brief, we can still learn a great deal about Ku'ayba, starting with her name. Her full name follows the Arabic patronymic system, which tells us that she is the daughter of Sa'd al-Aslamiyya (bt is the shorthand for *bint*, 'daughter'). Together, they belong to the Banu Aslam ('Tribe of Aslam'). The entry also provides us with a time frame in which Ku'ayba herself became a Muslim, as she 'gave her allegiance after the emigration to Madina'. This is a reference to the Prophet Muhammad's *hijra* (migration) from Mecca to Medina (then known as Yathrib) which took place in 622 CE and positions Ku'ayba as one of the 'Muhajir women' (*al-Muhajirat*), those who emigrated with the Prophet Muhammad after facing persecution in Mecca.[7] This, along with the references to the battles of Khandaq and Khaybar, also provide us with two further points in time in which to place Ku'ayba. The Battle of Khandaq ('Battle of the Trench') took place in 627 CE and Khaybar, which is considered to have fallen to Muslim forces in 629 CE. This places Ku'ayba in Medina during the decade of the 620s, when she practised medicine as either a nurse or a physician, caring and treating the wounded returning from the battlefields.

Ibn Sa'd tells us that Ku'ayba is 'set up with a tent' in order 'to tend to the sick and the wounded'. It is worthwhile taking a closer look at the language of care used here: Ku'ayba not only tends to the wounded but treats them as well. The brief first-hand report, a convention Ibn Sa'd used throughout the *Tabaqat*, notes that Sa'd b. Mu'adh 'received treatment at her hands before he died'. This gives some indication of her potential clinical skills, suggesting that Ku'ayba was undoubtedly capable of administering medical aid, either as a nurse or a physician. Moreover, we can glean from the text that she held a position of responsibility. Considering that the tent, akin to a field hospital, was set up for her suggests that Ku'ayba was in charge of the entire nursing operation. Thus, Ku'ayba appears as a woman with an active role in the early years of Islam, who used her clinical skills to care for wounded warriors. She was not alone in this role – several women were recorded as tending 'to the sick and wounded'. Ibn Sa'd also provided a record of Umm Sinan al-Aslamiyya, a nurse who went to the battlefield at Khaybar to 'offer water, tend to the sick and the wounded'.[8]

In addition to administering to wounded combatants, women were also active on the battlefield. According to Ruth Roded, 19 women in the *Tabaqat* were cited as having participated in battles.[9] Some of these women were warriors, while others 'encouraged the men with battle cries' or 'killed the wounded enemy warriors and mutilated their bodies'.[10] Altogether, the *Tabaqat* provides a snapshot into seventh-century Arabia (as recorded in ninth-century Baghdad by Ibn Sa'd) of active, capable women whose roles spanned a broad spectrum, from medical carers to fighters. In recent years, the figure of Ku'ayba has resurged. She has been compared to Florence Nightingale and Mary Seacole, with similarities drawn across these notable nurses who worked in field hospitals during periods of intense warfare.[11] However, in public discourse on the internet the name Ku'ayba has morphed into Rufaida. This change seems to arise from a shift in the Arabic consonants from *kaaf* (k) to *raa* (r) and *ayn* (') to *faa* (f). It is not easy to discern when or how this transformation took place but a search for Rufaida al-Aslamiya brings up a figure who maps onto what historians know about Ku'ayba bt. Sa'ad al-Aslamiyya. Indeed, the name Rufaida al-Aslamiya has captured the imagination of nursing communities across the globe – so much so that the Royal College of Surgeons in Ireland at the University of Bahrain now issues an annual nursing prize in her name, the Rufaida Alaslamia Prize in Nursing.

Questions

1. What other evidence may provide a broader picture of women, medicine and nursing in seventh-century Islamic societies?
2. What might the absence of evidence tell us?
3. What clinical skills were required in early nursing?
4. Take a look at Afsaruddin, ‘Reconstituting Women’s Lives’ which contains a number of other entries of women from Ibn Sa‘d’s *Tabaqat* – what does this tell us about the roles of women in early Islamic society?

Further reading

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7

Mariam al-Ijli al-Asturlabi (c. tenth century CE): An extract from *Fihrist al-Nadim* (*Index*) (c. 998 CE)

Dr Shazia Jagot

Introduction

The source below provides the only reference to Mariam al-Ijli al-Asturlabi. She appears in the *Fihrist* (translated as 'Index'), a catalogue compiled in the late tenth century by the Baghdadi courtier, al-Nadim (born c. 935 CE). The *Fihrist* has been described as 'an encyclopaedia of medieval Islamic culture'.[12] Al-Nadim catalogues the names, lives and books written in Arabic by 'all peoples, Arab and foreign' from the early Islamic period through to the tenth century.[13] Two versions of the *Fihrist* exist. The extract below is taken from the fullest version, which was composed of 10 books and categorised by subject: religious scriptures (Islam, Christianity, and Judaism), grammar, history and kingship, poets, theology including ascetics and Sufis, law, philosophy and science, storytellers, non-monotheistic religions and alchemy.

Mariam al-Ijli al-Asturlabi appears in Book Seven, a volume dedicated to 'Philosophy and the Ancient Sciences', which catalogued natural philosophers, logicians, mathematicians, musicians, astronomers, physicians and 'makers of instruments'.[14] The extract below describes the astrolabe, an instrument used for astronomical calculations, and a list of the craftsmen, their apprentices and patrons who produced the instrument. This includes Mariam al-Ijli al-Asturlabi, a woman identified as al-Ijiliyah, the daughter of an astrolabe artisan.

Source

Al-Nadim. *The Fihrist of al-Nadim: A Tenth-century Survey of Muslim Culture*, Vol. 2, edited and translated by Byard Dodge, 671–2. New York: Columbia University Press, 1970.

Statement about the Instruments and their Makers

In ancient times the astrolabes were plane. The first person to make them was Ptolemy. It was said that they were made before his time, but this has not been verified. The first [Muslim] to make a plane astrolabe was Abiyun al-Batriq. Then the instruments came to be made in the city of Harran. Later they were distributed, becoming common and increasing in number, so that the work became plentiful for the makers during the 'Abbasid period, from the days of al-Ma'mun to this our own time.

When al-Ma'mun wished to make [astronomical] observations, he selected Ibn Khalid al-Marwarrudhi, who made a circular form for him which was assigned to some of the scholars of our city. Thus al-Marwarrudhi made the astrolabe.

Names of the Makers

Ibn Khalid al-Marwarrudhi; al-Fazari, who has already been mentioned; 'Ali ibn 'Isa who was clever and of a superior type; Ahmad ibn Khalaf, an apprentice of 'Ali; Ahmad ibn Ishaq al-Harrani; al-Rabi'ibn Farras al-Harrani; Betulus, an apprentice of Khifaf; 'Ali ibn Ahmd the geometrician, an apprentice of Khafif; Muhammad ibn Shaddad al-Baladi, an apprentice of Betulus; 'Ali ibn Surad al-Harrani, an apprentice of Betulus; Shuja' ibn —, an apprentice of Betulus, who was with Sayf al-Dawlah; Ibn Salm, an apprentice of Betulus; al-'Ijli al-Asturlabi, an apprentice of Betulus; al-Ijliyah, his daughter, a pupil of Betulus, who was with Sayf al-Dawlah'.

Analysis

In keeping with the bio-bibliographic genre of al-Nadim's *Fihrist*, Mariam al-Ijli al-Asturlabi is introduced briefly and factually in this extract. The text is one of several Arabic biographical dictionaries, a popular genre that recorded historical events and people across all classes, ethnicities, and occupations, and which has proven to be an especially valuable source for locating women in the Islamic Golden Age. Although the reference to Mariam al-Ijli al-Asturlabi is brief – she appears in a clause at the end of a list of artisans and their apprentices – we can still uncover information about her by taking a closer look at the context in which she was mentioned. Her name can be studied in relation to the astrolabe, a complex astronomical instrument, and within the intellectual and scientific community of tenth-century Aleppo.

In the text, al-Nadim refers to Mariam as 'al-Ijliyah' and states that she is the daughter of 'al-Ijli al-Asturlabi' who worked as an apprentice to 'Betulus'. 'Asturlabi' (astrolabe) is a *laqab* (familiar name) that demonstrated Mariam's father was well-known as a specialist craftsman of astrolabes. As read in the *Fihrist*, Mariam is known simply as 'al-Ijliyah', the grammatical feminine version of her paternal name 'al-Ijli'. However, in modern references, it is common to find Mariam with the *laqab* 'al-Asturlabi' consolidating her position as an astrolabe-maker. But what is an astrolabe?

An astrolabe is a portable, hand-held, circular object that represented the spherical universe on a flat, plane surface. It allowed astronomers to read the skies for timekeeping, to chart the movement of the Sun, Moon, planets and stars and cast astrological horoscopes. In Islamic society, the astrolabe was especially useful for determining the five daily prayers, the direction of Mecca (*qiblah*) and the months of the lunar year. But an astrolabe could be used to calculate more complex astronomical data too: it is, after all, 'an astronomical computer'.[15]

The Greeks developed the first astrolabes, as al-Nadim tells us in his brief introduction to the instrument. By the seventh century, knowledge of the astrolabe passed from Greek to Arabic. Al-Nadim noted this in his reference to the lesser-known figure, 'Abiyun al-Batriq', who he credited as the first Muslim to make an astrolabe. After the instrument reached the Islamic world, astronomers, mathematicians and natural philosophers deployed astrolabes using Greek, Persian and Indian knowledge that was translated into Arabic. The earliest technical treatise on using an astrolabe was composed by the mathematician from whom our understanding of algorithms developed, Muhammad ibn Musa al-Khwarizmi (780–850 CE). Several astrolabes survive including those produced in al-Andalus or Muslim Spain; it is from Spain that knowledge of the astrolabe and accompanying technical manuals spread into Northern Europe.

Astrolabes are also beautiful, artisanal objects made variously from brass, copper and silver. In addition to the precise, intricate engravings needed for astronomical calculations, including script (Arabic or Latin, some contain both), they were also highly decorated with human and animal figures and vegetal motifs. Not only do they reveal the type of complex astronomical work undertaken in Islamic and Christian societies, but the intricate work required by artisans and craftspeople who were involved in their production.

What does this mean for Mariam al-Ijli al-Asturlabi? The source tells us that she came from a family of astrolabe artisans and was part of an important astrolabe workshop. Al-Nadim wrote that she was a 'pupil of Betelus, who was with Sayf al-Dawlah'. Betelus is most likely a reference to Muhammad ibn Abd-Allah al-Nastalus, a craftsman whose name is inscribed onto one of the earliest surviving astrolabes from around 927/8 CE. According to al-Nadim's account, he operated a workshop for artisans and their apprentices to cater for the rising demand for astrolabes as they became 'common and increasing in number'. Al-Nadim's account also gives us a more precise context for Mariam. She worked as a 'pupil' for 'Betelus, who was with Sayf al-Dawlah'. This final reference is to the Hamdanid leader, Sayf al-Dawlah, who ruled in Aleppo between 945 and 67 CE and cultivated learning, culture, poetry and the sciences. Al-Nadim's account suggests Sayf al-Dawlah was a patron to al-Nastulus, and in turn, Mariam was a 'pupil' of al-Nastulus. In the source, al-Nadim distinguishes between 'apprentice' and 'pupil' but the reasons for this are not clear. It is possible that Mariam's age determined her status as a 'pupil' considering her father is called an 'apprentice'. She may have been at an early stage of learning her craft, which is understandable considering the intricate, delicate and precise work needed to produce each object. It is likely that Mariam would have learned how to use an astrolabe too – placing her at the heart of highly complex, skilled scientific work within the flourishing intellectual environment of tenth-century Aleppo.

Mariam's name and reputation as a female astronomer have been preserved in the present day. In 1990, the International Astronomical Union named a minor planet after her (al-'Ijliya). She is also present in imaginative literature: the protagonist in Nnedi Okorafor's Afrofuturist trilogy, *Binti* (published in 2015) is said to have been inspired by Mariam al-Ijlia al-Asturlabi.

Questions

1. Why do you think Mariam is called a 'pupil' and not an 'apprentice'?
2. You can learn how to use an astrolabe by visiting: http://www.astrolabeproject.com (accessed 13 December 2022). What kind of information can you gather?

3. Take a closer look at the astrolabe as an artefact. What kinds of engravings and designs can you see? How do you think one might have produced such an instrument?
4. What might this source tell us about the movement of scientific knowledge from Greek to Arabic?
5. What might this source tell us about how and why astronomical information was important to both Islamic and Christian societies?

Further reading

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8

Josian: Extracts from the Middle English romance *Bevis of Hampton* (c. 1300 CE)

Dr Hannah Bower

Introduction

The excerpts below come from the Middle English romance *Bevis of Hampton* (c. 1300), a tale which narrates the global exploits of a fictional disinherited English hero who eventually regains his father's lands.[16] *Bevis* is based on the twelfth-century Anglo-Norman romance *Boeuve de Hamtoun* and it survives, in part or whole, in nine manuscripts which differ greatly from one another. The first extract comes from the Auchinleck manuscript, a compendium of Middle English romances, saints' lives, and other miscellaneous materials, which was copied in London in the 1330s. The passage describes Josian, a fictional Muslim princess who marries Bevis after converting to Christianity. Within the passage, Josian uses herbs to transform herself into a leper to prevent one of Bevis's enemies from abducting her. The second extract, from a different, fifteenth-century manuscript copy of the poem, depicts a similar scene but in that version Josian's skin colour is altered for her by one of Bevis's male relations.

Source

Extract 1
Kölbing, Eugen (Editor), *The Romance of Sir Beues of Hamtoun*, EETS es 46, 48, 65. London: Kegan Paul, Trench, Trübner and Co., 1885–1894. 172–173, lines 3671–88. Reproduced with permission of the Council of the Early English Text Society. Author's translation.[17]

While ȝhe was in Ermonie,	Whilst she was in Armenia,
Boþe fysik and sirgirie	Both physic and surgery,
She hadde lerned of meisters grete	She learnt of worthy masters
Of Boloyne þe gras and of Tulete,	From Bologna *la grassa* and Toledo
Þat ȝhe knew erbes mani & fale,	So that she could recognise all kinds of herbs
To make boþe boute & bale.	Which could bring about both harm and health.
On ȝhe tok vp of þe grou*n*de,	One she took up of the ground,
Þat was an erbe of meche mou*n*de,	That was an herb of great value,
To make a man i*n* semlaunt þere,	To make a man in his outward shape appear
A foule mesel alse ȝif a were.	As if he were an ugly and stinking leper.
Whan ȝhe hadde ete þat erbe, ano*n*	When she had eaten that herb, at once
To þe Sarasines ȝhe gan go*n*,	To the Saracens she started to go
[...]	[...]
Þai nadde ride in here way	They had not ridden along their way
Boute fif mile of þat contray,	Five miles of that country
Ȝhe was in semlaunt & i*n* ble	And she was in countenance and face
A foule mesel on to se.	A stinking leper to look upon.

Extract 2
Kölbing, Eugen (Editor), *The Romance of Sir Beues of Hamtoun*, EETS es 46, 48, 65. London: Kegan Paul, Trench, Trübner and Co., 1885–1894. 181–82, lines 3601-8. Author's translation.[18]

Syr Sabere toke Iosyan, That was as whyte as any swan, Hyr body, that was so fayre and gent, He anoynted wyth an oyntement And made hyr to seme yelowe & grene, That before was fayre and shene That no man shulde take hyr hym fro Therefore he discoloured her in this way	Sir Saber took Josian That was as white as any swan, Her body that was so fair and attractive He anointed with an ointment And made her to seem yellow and green, That before was fair and bright So that no man should take her from him He discoloured her in this way

Analysis

When these sources were written in England in the fourteenth and fifteenth centuries, knowledge of plants' healing properties were available to literate men and women wealthy enough to buy or copy herbal writings, either in Latin or the vernacular. Those unable to read also shared, or were taught, large amounts of herbal knowledge verbally. Interestingly, the author of the Auchinleck version of *Bevis* (Extract 1) connects Josian to a formal university education acquired at Bologna (Italy) and Toledo (Spain). From the thirteenth century, the mediaeval university at Bologna was renowned for its medical teaching and, from the twelfth century onwards, Toledo was a crucial centre for the translation of Arabic medical writings into Latin.[19] The students at these institutions were, however, almost always male, making Josian's fictional education quite remarkable. Her education resembles that of the twelfth-century figure Trota of Salerno, who is recorded as the author of several academic medical texts. But because Trota survives predominantly as a name and textual construct, rather than a person with a detailed, verifiable history, her existence hovers uneasily between fact and fiction.[20]

The Auchinleck *Bevis* is the only surviving copy of the poem that gives this specific location for Josian's education. Those lines connecting her to the medical centres of Europe make the text more geographically concrete and increase her intellectual authority. Elsewhere in the Auchinleck text, however, the poet claims that Josian came originally from the more distant realm of Armenia – a country that produced its own medical writings and was divided between Islam and Christianity for much of this period.[21] Interestingly, in the Anglo-Norman *Boeve*, Josian is instead identified as Egyptian. Corinne Saunders suggests that this change of her origins from Egypt to Armenia between the Anglo-Norman and English poems would have made Josian more familiar and proximate to English readers while retaining some of the exotic, Eastern associations of Egypt.[22] The figure of the academic, formally educated female physician is therefore presented in the Auchinleck *Bevis* as concrete, imaginable and European on the one hand and as otherworldly, Eastern and exceptional on the other.

Josian is a paradoxical figure in other respects too. For instance, it is significant in the Auchinleck *Bevis* that she transforms herself into a leper. Lepers had mixed associations in the European Middle Ages: leprosy could be considered a divine blessing; a punishment for sin; a disease with astrological and physiological causes; an opportunity for charity and care; or a reason for segregation and condemnation.[23] This ambiguity suggests that Josian is at once powerful and vulnerable: she can only assume power in the poem by transforming herself into another precarious and (potentially) marginalised figure.

Josian's authority is also precarious because she is only able to exercise her medical agency in response to a male threat to her body: the threat of abduction. In a different manuscript version of *Bevis* (Extract 2 above) Josian's agency and authority are even more explicitly diminished: to prevent her being kidnapped again, Bevis's uncle, Saber, applies a colour changing ointment to Josian's face after rescuing her from the enemy. In this episode, Josian's role is passive and her uncle regards her as male property. At the same time, that manuscript version – Western European in its origins and outlook – depicts Josian being subjected to another kind of transformation that is also uncomfortable for modern readers: her skin, described as the colour of a swan, is whitened, obscuring her Armenian heritage. These variations in Josian's presentation show that female practitioners could attract a range of different mediaeval responses, from admiration to fear and prejudice. These changes in the texts also remind us of the gendered nature of scribal culture and that representations of female healers were frequently constructed by men.

Questions

1. What is the relationship between women, medicine and disguise in mediaeval literature and culture?
2. How are Eastern and Western centres of medical knowledge shown to interact in different kinds of mediaeval texts, such as romances, travel writings, medical treatises and remedy books?
3. Are female healers from different regions depicted differently?
4. Do different versions of other texts from this period alter the way the gender or race of a medical practitioner is represented?
5. How are female medical practitioners, such as midwives, depicted in writings and plays? Was this always a position of authority?

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9

Mary, Queen of Scots (1542–1587 CE), Elizabeth Talbot (1527–1608 CE) and members of the Queen's household: The Oxburgh Hangings (1569–1585 CE)

Dr Sarah Cawthorne

Introduction

The embroideries commonly known as the Oxburgh Hangings were created during Mary, Queen of Scots' imprisonment in England under Elizabeth I. The period spanned from 1569, when Mary was placed in the custody of the Earl of Shrewsbury, to her death in 1587.[24] The hangings were produced by Mary, Elizabeth Talbot, wife of the Earl of Shrewsbury (better known as Bess of Hardwick) and other members of Mary's household. The embroideries decorated soft furnishings such as bed hangings, table carpets and cushion covers. Over 175 embroidered panels survive; they consist of multi-panel wall hangings and as detached fragments.

Scholarly attention has focused on decoding Mary's embroidered emblems. The hangings demonstrate a popular motif for the period that combined symbolic images with mottos, short expressions, or guiding principles, to express complex ideas. The majority of the extant panels depict land animals, birds and fish, as well as an impressive range of botanical species. Most of the images – including armillary spheres, albatrosses, onions, and sea lions – were copied from contemporary printed sources. Emblem books and volumes of botany and natural history were popular sources of imagery for the applied decorative arts in wealthy sixteenth-century households.[25] Professional embroiderers would likely have copied patterns from these sources onto canvas before they were stitched by Mary and other noblewomen.[26]

Source

Figure 2.1a Detached panel T3311, A Zydrach (Hammerhead shark). Signed ES. Oxburgh Hangings, © Victoria and Albert Museum, London.

Figure 2.1b Detached panel T33Y, A Dowker (Loon or Grebe). Oxburgh Hangings, © Victoria and Albert Museum, London.

Analysis

The Oxburgh Hangings have been construed as highly legible objects in which hidden political messages might be inscribed and read.[27] In 1572, one of Mary's embroidered emblems was produced at trial as incriminating evidence of her plot to overthrow Elizabeth I. But the hangings also offer evidence of a very different kind of hidden reading. The Oxburgh Hangings provide a glimpse of the manifold and complex ways that wealthy women interacted with natural history books. Moreso, the hangings demonstrate an academic tendency to overlook the fact that scientific interests could be woven into women's everyday lives and activities. The sixteenth-century fascination with natural philosophy was not confined to male scholars in patriarchal institutions, but also found a home in women's domestic spheres.

Conrad Gessner's encyclopaedic, multi-volume *Historia Animalium*, printed in Zürich by Christoph Froschauer from 1551–1587, was a leading work of sixteenth-century natural history. This lavish, visual work was the primary design source for at least 60 of the Oxburgh panels. The hanging's creators also sourced images from volumes written by Pierre Belon and André Thevet, among others. This evidence suggests that Mary and Bess's familiarity with scholarly natural history was wide-ranging and current and was supported by their access to a number of expensive imported books.

How these designs were carefully copied and translated through embroidery demonstrates the needlewomen's sophisticated use of natural history books. Women in Mary's household not only utilised books to source visual imagery in the hangings, but they also incorporated their knowledge of different species. For example, women applied their knowledge of the correct colours and plumage of birds, gained from the commentary in the text, to the monochrome woodcut templates through a careful choice of threads and stitching. Other panels supply clear evidence that the makers cross-referenced different natural histories for increased accuracy. Information about an animal from the commentary of one book was applied to an illustration copied from another.[28] Synthesising information from multiple sources, these embroideries visually approximated the philological approach of authors like Gessner, who sought to compile information from classical, biblical and modern sources to build a fuller picture of each animal.

Although it was fashionable in the sixteenth century to use images from natural histories for decorative effects as varied as ceiling paintings to stained glass, the sheer volume of detailed, time-consuming labour invested in Mary's panels suggests that the creators' interest in animals was not only aesthetic. The eclectic range of images – from native species such as blackbirds, to toucans, to the bizarre peculiarity of the hammerhead shark – suggests the women held a genuine curiosity for the variety of the natural world.

In contrast with the emblem panels, many of the animal embroideries seem resistant to deeper symbolic readings by scholars, indicating what Michael Bath has called 'a less sophisticated taste for the varied creatures of the natural world for their own sakes'.[29] Though perhaps more straightforwardly objective than the veiled political allegory of emblems, these needlework studies of natural history are by no means less sophisticated. In the creation of the Oxburgh Hangings, Mary and her household drew information from multiple print sources. The hanging's design required technical skill, careful observation and attention to detail. Moreover, the hangings reflected the personal tastes of their creators. Although not overtly political, the Oxburgh animals demonstrate the developing analytical, scholarly and empirical approaches of the new science of the sixteenth century and how this was threaded through the fabric of the household.

Questions

1. What kinds of literacy do the Oxburgh hangings demonstrate? What was the relationship between needlework and writing in these embroideries?
2. What does the fashion for using scientific books as sources of imagery for decorative motifs tell us about science in the English popular imagination of the sixteenth century? How might these images transform the domestic space of the household?
3. How was information encoded and transmitted differently in text and images? Consider the difference between the woodcuts and the embroideries: do all types of image convey information in the same way?
4. The producers of the Oxburgh Hangings were wealthy, elite women. How did their privilege affect their relationship with natural philosophy in comparison with lower- and middle-class women of the same era?
5. In these embroideries, allegorical emblems co-exist with images of animals and plants. What role did symbolism play in scientific attitudes and approaches of the period?

6. How might these embroideries relate to the sixteenth-century culture of collecting and cabinets of curiosity?
7. How did developments in print technology affect women's participation in natural philosophy?

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1 These dates are highly contested within their respective fields.
2 Andrea, 'The myth of the Middle Ages', 1992; Shank and Lindberg, 'Introduction', 2013.
3 Lightman, *A Companion to the History of Science*; Schaus, *Women and Gender.*
4 Cooperson, 'Ibn Sa'd', 2006, 367.
5 Roded, *Women in Islamic Biographical Collections,* 2.
6 Afsaruddin, 'Reconstituting Women's Lives', 2002, 461.
7 Afsaruddin, 'Reconstituting Women's Lives', 2002, 462.
8 Afsaruddin, 'Reconstituting Women's Lives', 2002, 464.
9 Roded, *Women in Islamic Biographical Collections,* 35.
10 Roded, *Women in Islamic Biographical Collections,* 35.
11 See part nine.
12 Dodge, 'Introduction', xix.
13 Al-Nadim, *The Fihrist of al-Nadim,* 1.
14 Al-Nadim, *The Fihrist of al-Nadim,* 4.
15 King, *The Astrolabe,* 23.
16 Bevis and Josian are both fictional constructs rather than historical personae. It is customary in literary criticism to talk about the protagonists of literary works in the present tense.
17 The translation is my own. For a more recent edition, see Fellows and Djordjević, *Sir Bevis of Hampton*. I have not used this edition here because Fellows bases her text on Cambridge, Cambridge University Library, CUL, MS Ff.2.38 and Naples, Biblioteca Nazionale, MS XIII.B.29 rather than Auchinleck.
18 These lines come from the version of *Bevis* in Manchester, Chetham's Library, MS 8009, ff. 122r–90v.
19 Siraisi, *Medicine and the Italian Universities*; Bullough, 'Medieval Bologna and the Development of Medical Education', 201–215; Burnett, *Arabic into Latin in the Middle Ages*.
20 Green, *The Trotula,* 1–67.

21 Mitchell, *Medicine in the Crusades,* 209.
22 Saunders, *Magic and the Supernatural in Medieval English Romance,* 123.
23 See Rawcliffe, *Leprosy in Medieval England*.
24 Though Michael Bath, in his *catalogue raisonné* of Mary's embroideries, defines the Oxburgh hangings specifically as the Marian, Shrewsbury and Cavendish hangings which are owned by the Victoria and Albert Museum but still based at Oxburgh Hall, the term is also used more broadly to describe other embroidered panels produced by Mary and Bess in this period – for example, the V&A also uses this term to refer to many of the detached panels and the Oxburgh Valance. See Bath, *Emblems for a Queen,* 127–157; V&A, 'The Prison Embroideries of Mary, Queen of Scots', 2020.
25 Acheson, "The Picture of Nature", 30.
26 Bath, *Emblems for a Queen,* 3.
27 Mazzola, 'Who's She When She's At Home?', 385–417. Bath, *Emblems for a Queen,* 5, 58–60.
28 Bath, *Emblems for a Queen,* 70–73, 79.
29 Bath, *Emblems for a Queen,* 124.

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Part III
Producing knowledge (1600–1700)

Timeline: individuals and events in the history of science	Timeline: individuals, events and objects in this part
c. 1600 Zacharias Janssen, a Dutch spectacle maker, is thought to have developed the first compound microscope.	
1602 The Dutch East India Company is founded and conducts voyages for trade, exploration and colonisation throughout the seventeenth and eighteenth centuries.	
1608 Hans Lippershey, a German-Dutch spectacle maker, files the first patent for a telescope.	
1616–54 Nicholas Culpeper, English physician and astrologer, who wrote *The English Physitian* (1652) which listed medicinal herbs to remedy typical illnesses.	
1620 Publication of *Novum Organum* by English philosopher and statesman Francis Bacon, detailing the Baconian method of empirical observation and reasoning. This text is often considered to be one of the major underpinnings of the Scientific Revolution in Europe.	

Timeline: individuals and events in the history of science	Timeline: individuals, events and objects in this part
	1623–73 Margaret Cavendish, Duchess of Newcastle, natural philosopher and author of *The Description of a New World, Called The Blazing-World*, published in 1666.
1632 Publication of *Dialogue Concerning the Two Chief World Systems* (*Dialogo sopra i due massimi sistemi del mondo*) by Florentine astronomer, physicist and engineer Galileo Galilei, which compares the Copernican system, where the Earth and other planets orbit the Sun, with the Ptolemaic system, which places the Earth at the centre of the universe.	
	fl. 1641 Marie Crous, French mathematician who introduced the decimal system.
	d. 1646 Sati-un-Nisa, the only documented female physician in the Mughal Empire in South Asia.
1687 Publication of the English mathematician and physicist Isaac Newton's *Philosophiæ Naturalis Principia Mathematica* (*Mathematical Principles of Natural Philosophy*), which includes his law of universal gravitation.	
	c. 1690 Mary Chantrell's 'Book of Receipts', a manuscript recipe book containing several food, medicinal, and household recipes, is produced by Mary and others.

Introduction

Part three brings attention to women's involvement in scientific and medical knowledge production from 1600 to 1700. Sometimes described as falling within the Early Modern period in Europe, historians have tended to characterise this era as a time when modern Western thought began to solidify.[1] New approaches to knowledge production and natural philosophy were introduced in this period, including the systematic study of nature and the universe. The European Scientific Revolution is framed around the discoveries of so-called great men of science from Nicolaus Copernicus (1473–1543) to Isaac Newton (1642–1727), giving little recognition to other ways of knowing, geographies and individuals outside of this narrow group of men. In Europe, publication became highly valued as a method for demonstrating scientific expertise and communicating knowledge.[2] As scientific societies and institutions, such as the Royal Society in Britain founded in 1660, gained prestige, European women became increasingly excluded from the formal spaces in which knowledge was produced, debated and displayed.[3]

As with other historical periodisations, there is debate around when exactly the Early Modern period occurred, as well as whether the Scientific Revolution should be defined and understood as such.[4] In this part, we focus on textual sources and women who gained recognition for their knowledge in a variety of contexts, both on the edges of formal European science and completely removed from it. Here we bring attention to women who were able to publish their scientific work and, in doing so, access the prestige that this afforded. However, these sources also showcase other genres of writing, such as a family recipe book, that recorded generations of medical knowledge and expertise, used and shared within the home.[5] Beyond Europe, we see that women were recognised for their expertise; the setting of the Emperor Shah Jahan's court of the Mughal Empire in Agra, India, was a significant space for the patronage of arts, sciences and medicine during this period.

The first source consists of several extracts from the writings of prolific English author, poet, philosopher and playwright Margaret Cavendish that explore her views on belief, sensation and reason. Next, a recipe book dated circa 1690 illustrates the eclectic mix of expertise involved in the daily lives of women in the late seventeenth century through food recipes, medical remedies and general household advice. The third source in this part is an eighteenth-century biography describing Sati-un-Nisa (d. 1646), a renowned expert physician in the

Mughal Empire in South Asia. The fourth source is a mathematical book from the mid-seventeenth century written for the education of girls, composed by the French mathematician, teacher and author, Marie Crous, best known for introducing the decimal point, a fundamental construction of modern mathematics.

10
Margaret Cavendish, Duchess of Newcastle (1623–1673): *Observations Upon Experimental Philosophy, The Blazing World* and *Poems and Fancies* (1668)

Dr Liza Blake

Introduction

Margaret Cavendish, Duchess of Newcastle (1623–1673) lived and wrote during the Scientific Revolution in England.[6] Born just three years after Francis Bacon, who was commonly hailed as the father of modern science, had published his *Great Instauration* (a treatise advocating for a reformation of knowledge), Cavendish grew up in an England shaped by debates about the true understanding of nature. Living in exile in Europe during the English Civil Wars, Margaret Cavendish (née Lucas) and her husband hosted the top scientific minds of the seventeenth century, including the Dutch philosopher Constantijn Huygens, political and natural philosopher Thomas Hobbes, and philosopher René Descartes, among others. Cavendish wrote voluminously during her lifetime, including four versions of a natural philosophical treatise, a book of poems, two volumes of plays, epistles, essays and short stories. She offered cogent critiques of the rise of empirical science and the increasingly exclusive focus on observations and experimentation by early modern scientists.[7] In a variety of genres, she both critiques, and imagines other possible futures for, the sciences.

In the 1660s, after returning to England from exile, Cavendish became more actively engaged in ongoing scientific debates and revised her natural philosophical treatise twice to meet the standards of the time. She wrote *Philosophical Letters* (London, 1664) in which she addressed what she saw as weaknesses in the major natural philosophical thinkers of her day. She also published a hybrid volume called *Observations Upon Experimental Philosophy, to Which Is Added a Description of a New Blazing World* (London, 1666, rev. 1668). This latter work, part treatise and part science fiction, represents her most sustained engagement with the new science of the mid-seventeenth century. The Royal Society brought together those interested in establishing scientific truths about nature by means of experimentation. Cavendish's *Observations* and *Blazing World* offer explicit attacks on the Royal Society and its group of proto-scientists, through the use of rational argument and fictional satire, respectively.

The following texts are excerpts from Cavendish's *Observations*, *Blazing World* and *Poems and Fancies.* The texts used are the 1668 editions, as the final versions of each text. Variants across editions have not been noted; these are too minor to be meaningful for *Observations* and *Blazing World*, and too numerous to be included for *Poems*.[8] The texts have been modernised, including typography, punctuation, spelling and expanded abbreviations, unless those expansions would affect a poem's meter; paragraph breaks have been introduced for ease of reading.

Source

Newcastle, Margaret Cavendish, Duchess of. *Observations Upon Experimental Philosophy, to Which Is Added a Description of a New Blazing World*. London, 1668.

I. from *Observations upon Experimental Philosophy*

I.a. Prefatory Letter

To His Grace the Duke of Newcastle

My Noble Lord,

In this present treatise, I have ventured to make some observations upon experimental philosophy, and to examine the opinions of some of our modern microscopical or dioptrical writers.[9] And though your Grace is not only a lover of virtuosos, but a virtuoso yourself, and have as good and as many sorts of optic glasses as anyone else, yet you do not busy yourself much with this brittle art, but employ most part of your time in the more noble and heroic art of horsemanship and weapons, as also in the sweet and delightful art of poetry, and in the useful art of architecture, etc., which shows that you do not believe much in the informations of those optic glasses, at least think them not so useful as others do that spend most of their time in dioptrical inspections. The truth is, my Lord, that most men in these latter times busy themselves more with other worlds than with this they live in, which to me seems strange, unless they could find out some art that would carry them into those celestial worlds, which I doubt will never be. Nay, if they did, it would be no better than Lucian's, or the Frenchman's art,[10] with bottles, bladders, etc., or like the man's that would screw himself up into the moon.[11] And therefore I confess, I have but little faith in such arts, and as little in telescopical, microscopical, and the like inspections, and prefer rational and judicious observations before deluding glasses and experiments; which, as I have more at large declared in this following work, so I leave it to your Grace's perusal and judgment, which I know is so just, so exact, and so wise, that I may more safely rely upon it, than all others besides. And if your Grace do but approve of it, I care not if all the world condemn it; for your Grace's approbation is all that can be desired from,

My Lord,
Your Grace's honest wife,
and humble servant,
M[argaret] N[ewcastle]

I.b. first three chapters of *Observations upon Experimental Philosophy*

1. Of Human Sense and Perception
   Before I deliver my observations upon that part of philosophy which is called experimental, I thought it necessary to premise some discourse concerning the perception of human sense. It is known that man has five exterior senses, and every sense is ignorant of each other, for the nose knows not what the eyes see, nor the eyes what the ears hear, neither do the ears know what the tongue tastes; and as for touch, although it is a general sense, yet every several part of the body[12] has a several touch, and each part is ignorant of each other's touch. And thus there is a general ignorance of all the several parts, and yet a perfect knowledge in each part; for the eye is as knowing as the ear, and the ear as knowing as the nose, and the nose as knowing as the tongue, and one particular touch knows as much as another—at least is capable thereof. Nay, not only every several touch, taste, smell, sound, or sight is a several knowledge by itself, but

each of them has as many particular knowledges or perceptions as there are objects presented to them.

Besides, there are several degrees in each particular sense: as for example, some men (I will not speak of other animals), their perception of sight, taste, smell, touch, or hearing is quicker to some sorts of objects than to others, according either to the perfection or imperfection, or curiosity or purity, of the corporeal figurative motions of each sense, or according to the presentation of each object proper to each sense. For if the presentation of the objects be imperfect, either through variation or obscurity or any other ways, the sense is deluded. Neither are all objects proper for one sense, but as there are several senses, so there are several sorts of objects proper for each several sense.

Now if there be such variety of several knowledges, not only in one creature, but in one sort of sense—to wit, the exterior senses of one human creature—what may there be in all the parts of Nature? 'Tis true, there are some objects which are not at all perceptible by any of our exterior senses, as for example rarified air and the like, but although they be not subject to our exterior sensitive perception, yet they are subject to our rational perception, which is much purer and subtler than the sensitive—nay, so pure and subtle a knowledge that many believe it to be immaterial, as if it were some god, when as it is only a pure, fine, and subtle figurative motion or perception. it is so active and subtle, as it is the best informer and reformer of all sensitive perception.[13] For the rational matter is the most prudent and wisest part of Nature, as being the designer of all productions, and the most pious and devoutest part, having the perfectest notions of God—I mean, so much as Nature can possibly know of God—so that whatsoever the sensitive perception is either defective in, or ignorant of, the rational perception supplies.

But mistake me not: by rational perception and knowledge, I mean regular reason, not irregular, where I do also exclude art, which is apt to delude sense, and cannot inform so well as reason doth. For reason reforms and instructs sense in all its actions, but both the rational and sensitive knowledge and perception being dividable as well as composable, it causes ignorance as well as knowledge amongst Nature's creatures. For though Nature is but one body—and has no sharer or copartner but is entire and whole in itself, as not composed of several different parts or substances, and consequently has but one infinite natural knowledge and wisdom—yet by reason she is also dividable and composable, according to the nature of a body, we can justly and with all reason say that as Nature is divided into infinite several parts, so each several part has a several and particular knowledge and perception, both sensitive and rational.[14] And again: that each part is ignorant of the others' knowledge and perception, whenas otherwise, considered altogether and in general, as they make up but one infinite body of Nature, so they make also but one infinite general knowledge. And thus Nature may be called both individual, as not having single parts subsisting without her, but all united in one body; and dividable, by reason she is partable in her own several corporeal figurative motions, and not otherwise. For there is no vacuum in Nature, neither can her parts start or remove from the infinite body of Nature, so as to separate themselves from it, for there's no place to flee to, but body and place are all one thing, so that the parts of Nature can only join and disjoin to and from parts, but not to and from the body of Nature. And since Nature is but one body, it is entirely wise and knowing, ordering her self-moving parts with all facility and ease, without any disturbance, living in pleasure and delight, with infinite varieties and curiosities, such as no single part or creature of hers can ever attain to.

2. Of Art and Experimental Philosophy

Some are of opinion, *That by art there may be a reparation made of the mischiefs and imperfections mankind has drawn upon itself by negligence and intemperance, and a willful and superstitious deserting the prescripts and rules of Nature, whereby every man, both from a derived corruption, innate and born with him, and from his breeding and converse with men, is very subject to slip into all sorts of errors.*[15] But the all-powerful God, and his servant Nature, know that art, which is but a particular creature, cannot inform us of the truth of the infinite parts of Nature, being but finite itself. For though every creature has a double perception, rational and sensitive, yet each creature or part has not an infinite perception; nay, although each particular creature or part of Nature may have some conceptions of the infinite parts of Nature, yet it cannot know the truth of those infinite parts, being but a finite part itself, which finiteness causes errors in perceptions. Wherefore it is well said, when they confess themselves, that The *uncertainty and mistakes of human actions proceed either from the narrowness and wandering of our sense or from the slipperiness or delusion of our memory, or from the confinement or rashness of our understanding.*[16] *But*, say they, *It is no wonder that our power over* *natural causes and effects is so slowly improved, seeing we are not only to contend with the obscurity and difficulty of the things whereon we work and think, but even the forces of our minds conspire to betray us. And these being the dangers in the process of human reason, the remedies can only proceed from the real, the mechanical, the experimental philosophy, which hath this advantage over the philosophy of discourse and disputation, that whereas that chiefly aims at the subtlety of its deductions and conclusions, without much regard to the first groundwork, which ought to be well laid on the sense and memory, so this intends the right ordering of them all, and making them serviceable to each other.*[17] In which discourse I do not understand, first, what they mean by our power over natural causes and effects, for we have no power at all over natural causes and effects, but only one particular effect may have some power over another, which are natural actions. But neither can natural causes nor effects be overpowered by man so, as if man was a degree above Nature, but they must be as Nature is pleased to order them; for man is but a small part, and his powers are but particular actions of Nature, and therefore he cannot have a supreme and absolute power. Next, I say that sense, which is more apt to be deluded than reason, cannot be the ground of reason, no more than art can be the ground of Nature, wherefore discourse shall sooner find or trace Nature's corporeal figurative motions than deluding arts can inform the senses. For how can a fool order his understanding by art, if Nature has made it defective? Or how can a wise man trust his senses, if either the objects be not truly presented according to their natural figure and shape, or if the senses be defective, either through age, sickness, or other accidents, which do alter the natural motions proper to each sense? And hence I conclude that experimental and mechanic philosophy cannot be above the speculative part, by reason most experiments have their rise from the speculative, so that the artist or mechanic is but a servant to the student.

3. Of Micrography, and of Magnifying and Multiplying Glasses
   Although I am not able to give a solid judgment of the art of micrography, and the several dioptrical instruments belonging thereto, by reason I have neither studied nor practiced that art, yet of this I am confident, that this same art, with all its instruments, is not able to discover the interior natural motions of any part or creature of Nature.

Nay, the question is whether it can represent yet the exterior shapes and motions so exactly, as naturally they are. For art doth more easily alter than inform: as for example, art makes cylinders, concave and convex glasses, and the like, which represent the figure of an object in no part exactly and truly, but very deformed and misshaped. Also, a glass that is flawed, cracked, or broke[n], or cut into the figure of lozenges, triangles, squares, or the like, will present numerous pictures of one object. Besides, there are so many alterations made by several lights, their shadows, refractions, reflections—as also several lines, points, mediums, interposing and intermixing parts, forms, and positions—as the truth of an object will hardly be known. For the perception of sight, and so of the rest of the senses, goes no further than the exterior parts of the object presented, and though the perception may be true when the object is truly presented, yet when the presentation is false, the information must be false also.

And it is to be observed that art, for the most part, makes hermaphroditical, that is, mixed figures, partly artificial and partly natural. For art may make some metal, as pewter, which is between tin and lead, as also brass, and numerous other things of mixed natures; in the like manner may artificial glasses present objects partly natural and partly artificial. Nay, put the case they can present the natural figure of an object, yet that natural figure may be presented in as monstrous a shape, as it may appear misshapen rather than natural: for example, a louse by the help of a magnifying glass appears like a lobster, where the microscope enlarging and magnifying each part of it makes them bigger and rounder than naturally they are. The truth is, the more the figure by art is magnified, the more it appears misshapen from the natural, insomuch as each joint will appear as a diseased, swelled, and tumid body, ready and ripe for incision.

But mistake me not: I do not say that no glass presents the true picture of an object, but only that magnifying, multiplying, and the like optic glasses may and do oftentimes present falsely the picture of an exterior object—I say "the picture" because it is not the real body of the object which the glass presents, but the glass only figures or patterns out the picture presented in and by the glass, and there mistakes may easily be committed in taking copies from copies. Nay, artists do confess themselves that flies and the like will appear of several figures or shapes, according to the several reflections, refractions, mediums, and positions of several lights—which if so, how can they tell or judge which is the truest light, position, or medium that doth present the object naturally as it is? And if not, then an edge may very well seem flat, and a point of a needle a globe; but if the edge of a knife, or point of a needle were naturally and really so as the microscope presents them, they would never be so useful as they are, for a flat or broad plain-edged knife would not cut, nor a blunt globe pierce so suddenly another body, neither would or could they pierce without tearing and rending, if their bodies were so uneven. And if the picture of a young beautiful lady should be drawn according to the representation of the microscope, or according to the various refraction and reflection of light through such like glasses, it would be so far from being like her, as it would not be like a human face, but rather a monster than a picture of Nature.

Wherefore, those that invented microscopes and such like dioptrical glasses at first did, in my opinion, the world more injury than benefit, for this art has intoxicated so many men's brains, and wholly employed their thoughts and bodily actions about phenomena, or the exterior figures of objects, as all better arts and studies are laid aside. Nay, those that are not as earnest and active in such employments as they, are, by many of them, accounted unprofitable subjects to the commonwealth of learning. But though there be numerous books written of the wonders of these glasses, yet I cannot perceive any such, and at best they are but superficial wonders, as I may call them. But could experimental philosophers find out more beneficial arts than our forefathers have done, either for the better increase of vegetables and brute animals to nourish our bodies, or better or commodious contrivances in the art of architecture to build us houses, or for the advancing of trade and traffic to provide necessaries for us to live, or for the decrease of nice distinctions and sophistical disputes in churches, schools,[18] and courts of judicature, to make men live in unity, peace, and neighborly friendship, it would not only be worth their labor, but of as much praise as could be given to them. But as boys that play with watery bybbles[19] or fling dust into each others eyes,[20] or make a hobbyhorse of snow,[21] are worthy of reproof rather than praise, for wasting their time with useless sports, so those that addict themselves to unprofitable arts spend more time than they reap benefit thereby. Nay, could they benefit men either in husbandry, architecture, or the like necessary and profitable employments, yet before the vulgar sort would learn to understand them, the world would want bread to eat, and houses to dwell in, as also clothes to keep them from the inconveniences of the inconstant weather. But truly, although spinsters were most experienced in their art, yet they will never be able to spin silk, thread, or wool, etc., from loose atoms; neither will weavers weave a web of light from the sun's rays, nor an architect build an house of the bubbles of water and air (unless they be poetical spinsters, weavers and architects).

And if a painter should draw a louse as big as a crab, and of that shape as the microscope presents, can anybody imagine that a beggar would believe it to be true? But if he did, what advantage would it be to the beggar? For it doth neither instruct him how to avoid breeding them, or how to catch them, or to hinder them from biting. Again: if a painter should paint birds according to those colors the microscope presents, what advantage would it be for fowlers to take them? Truly, no fowler will be able to distinguish several birds through a microscope, neither by their shapes nor colors; they will be better discerned by those that eat their flesh, than by micrographers that look upon their colors and exterior figures through a magnifying glass.

In short, magnifying glasses are like a high heel to a short leg, which if it be made too high, it is apt to make the wearer fall, and at the best, can do no more than represent exterior figures in a bigger, and so in a more deformed shape and posture than naturally they are; but as for the interior form and motions of a creature, as I said before, they can no more represent them than telescopes can the interior essence and nature of the sun, and what matter it consists of. For if one that never had seen milk before should look upon it through a microscope, he would never be able to discover the interior parts of milk by that instrument, were it the best that is in the world, neither the whey, nor the butter, nor the curds. Wherefore the best optic is a perfect natural eye, and a regular sensitive perception, and the best judge is reason, and the best study is rational contemplation joined with the observations of regular sense, but not deluding arts; for art is not only gross in comparison to Nature, but, for the most part, deformed and defective, and at best produces mixed or hermaphroditical figures, that is, a third figure between Nature and art, which proves that natural reason is above artificial sense, as I may call it. Wherefore those arts are the best and surest informers that alter Nature least, and they the greatest deluders that alter Nature most—I mean, the particular nature of each particular creature (for art is so far from altering infinite Nature that it is no more in comparison to it than a little fly to an elephant, no not so much, for there is no comparison between finite and infinite). But wise Nature taking delight in variety, her parts—which are her creatures—must of necessity do so too.

II. from *The Blazing World*

II.a. Prefatory Letter

To the Reader

If you wonder that I join a work of fancy to my serious philosophical contemplations, think not that it is out of a disparagement to philosophy, or out of an opinion as if this noble study were but a fiction of the mind. For though philosophers may err in searching and enquiring after the causes of natural effects, and many times embrace falsehoods for truths, yet this doth not prove that the ground of philosophy is merely fiction, but the error proceeds from the different motions of reason which cause different opinions in different parts, and in some are more irregular than in others. For reason, being divisible, because material, cannot move in all parts alike, and since there is but one truth in Nature, all those that hit not this truth do err, some more, some less. For though some may come nearer the mark than others, which makes their opinions seem more probable and rational than others, yet as long as they swerve from this only truth, they are in the wrong. Nevertheless, all do ground their opinions upon reason, that is, upon rational probabilities—at least they think they do. But fictions are an issue of man's fancy,[22] framed in his own mind, according as he pleases, without regard whether the thing he fancies be really existent without his mind or not; so that reason searches the depth of Nature, and enquires after the true causes of natural effects, but fancy creates of its own accord whatsoever it pleases, and delights in its own work. The end of reason is truth; the end of fancy is fiction—but mistake me not when I distinguish fancy from reason: I mean not as if fancy were not made by the rational parts of matter, but by reason I understand a rational search and inquiry into the causes of natural effects, and by fancy a voluntary creation or production of the mind, both being effects, or rather actions, of the rational part of matter.[23] Of which, as that is a more profitable and useful study than this, so it is also more laborious and difficult, and requires sometimes the help of fancy to recreate the mind,[24] and withdraw it from its more serious contemplations.

And this is the reason why I added this piece of fancy to my philosophical observations, and joined them as two worlds at the ends of their poles; both for my own sake, to divert my studious thoughts, which I employed in the contemplation thereof, and to delight the reader with variety, which is always pleasing. But lest my fancy should stray too much, I chose such a fiction as would be agreeable to the subject I treated of in the former parts; it is a description of a new world, not such as Lucian's or the Frenchman's world in the moon,[25] but a world of my own creating, which I call the Blazing World: the first part whereof is romancical, the second philosophical, and the third is merely fancy, or (as I may call it) fantastical. Which if it add any satisfaction to you, I shall account myself a happy creatoress; if not, I must be content to live a melancholy life in my own world. [. . .] I am [. . .] as ambitious as ever any of my sex was, is, or can be; which makes that though I cannot be Henry the Fifth, or Charles the Second, yet I endeavor to be Margaret the First. And although I have neither power, time, nor occasion to conquer the world as Alexander and Caesar did, yet rather than not to be mistress of one, since fortune and the fates would give me none, I have made a world of my own: for which nobody, I hope, will blame me, since it is in everyone's power to do the like.

II.b [from] *The Blazing World*

[T]he Empress [. . .] to avoid hereafter tedious disputes, and have the truth of the phenomenas of celestial bodies more exactly known, commanded the bear-men, which were her experimental philosophers, to observe them through such instruments as are called telescopes, which they did according to her Majesty's command. But these telescopes caused more differences and divisions amongst them than ever they had before: for some said they perceived that the sun stood still, and the earth did move about it; others were of opinion that they both did move; and others said again that the earth stood still, and the sun did move; some counted more stars than others; some discovered new stars never seen before; some fell into a great dispute with others concerning the bigness of the stars; some said the moon was another world like their terrestrial globe, and the spots therein were hills and vallies; but others would have the spots to be the terrestrial parts, and the smooth and glossy parts, the sea [. . .].

After they had thus argued, the Empress began to grow angry at their telescopes, that they could give no better intelligence. "For," said she, "now I do plainly perceive that your glasses are false informers, and instead of discovering the truth, delude your senses, wherefore I command you to break them, and let the bird-men trust only to their natural eyes, and examine celestial objects by the motions of their own sense and reason." [. . .]

The bear-men, being exceedingly troubled at her Majesty's displeasure concerning their telescopes, kneeled down, and in the humblest manner petitioned that they might not be broken. "For," said they, "we take more delight in artificial delusions than in natural truths.

Besides, we shall want employments for our senses, and subjects for arguments, for were there nothing but truth and no falsehood, there would be no occasion to dispute [. . .]. Wherefore we most humbly beseech your Imperial Majesty to spare our glasses, which are our only delight, and as dear to us as our lives."

The empress at last consented to their request, but upon condition that their disputes and quarrels should remain within their schools, and cause no factions or disturbances in state or government. The bear-men, full of joy, returned their most humble thanks to the Empress, and to make her amends for the displeasure which their telescopes had occasioned, told her Majesty that they had several other artificial optic glasses [...].

III. from *Poems and Fancies*

It is Hard to Believe that there May Be Other Worlds in this World.[26]

Nothing doth seem so hard to Nature's eyes,
As to believe impossibilities:
Not that they're not, but that they do not clear
Unto our reason and to sense appear.
For reason cannot find them out, since they
Seem wrought beyond all Nature's course and way.
But many things our senses do escape,
For they're too gross to know each form and shape,
As that another world in this may be,
Which we do neither touch, nor hear, nor see,
Nor taste, nor smell. What eye's so clear, that saw
Those little hooks that in the loadstone draw[27]
Hard iron? Or what brain can reason why
The needle's point still in the north will lie?
As for example, atoms in the air
We ne'er perceive, although the light be fair.
For whatsoever can a body claim,
Though ne'er so small, life may be in the same,
And what hath life may understanding have,
Though't be to us as buried in a grave.
Then probably may men and women small
Live in the world, which we not know at all,
May build them houses to dwell in, and make
Orchards and gardens, where they pleasure take,

Have birds which sing, and cattle in the field,
And plowèd grounds, which them small corn may yield.
They may have commonwealths, and kings to reign,
Make wars and battles, where are many slain,
And all without our hearing, or our sight,
Or any of our other senses light.
And other stars, and suns, and moons may be,
Which our dull eyes shall never come to see.
But we are apt to laugh at tales so told,
For our gross senses reason back do hold.
Yet things which are 'gainst Nature we think true—
That spirits change, and can take bodies new,
That life may be, yet in no body live—
For which no sense nor reason we can give.[28]
And incorporeal spirits fancy feigns,
Yet fancy cannot be without some brains,[29]
And if it cannot without substance be,
Then souls are more than reason well can see.

Analysis

As the Royal Society established itself in the early 1660s, its members argued that they offered the reform of natural knowledge originally proposed by Francis Bacon in his *Great Instauration* of 1620. Early Royal Society publications – in particular Robert Hooke's *Micrographia* (a book of microscopical observations, 1665) and Thomas Sprat's *History of the Royal Society* (1667) – advocated for empiricism – the belief that knowledge must be derived from the senses, as opposed to speculation or rational argumentation.[30] Hooke, whose *Micrographia* was endorsed by the Royal Society, argued for 'an inlargement of the dominion, of the Senses' and that it was 'high time that [science] should return to the plainness and soundness of Observations'.[31]

In the source texts, Cavendish seeks to undermine these empirical arguments. In *Observations*, her most systematic critique of the new scientific methods, she makes Hooke's popular and influential *Micrographia* her explicit target. She first showed the flaws of empiricism and then argued that instruments like microscopes distorted senses rather than extending them. Cavendish also argued for the *uselessness* of the new sciences; as she points out in *Observations*, hundreds of detailed drawings of fleas will not stop them from biting. Her sense that Royal

Society members preferred flashy experiments to useful practice may have been exacerbated by her visit to the Royal Society a year later, in which '[s] everal fine experiments were shown [to] her' whose purpose seemed to be to impress rather than to inform.[32] In *Blazing World*, Cavendish extended her scientific critiques to social and political satire, linking scientific arguments to political unrest. Later in the narrative, the debates of the experimental philosophers start a war in the Blazing World.

Though *Observations* and *Blazing World* seem particularly targeted at the Royal Society, Cavendish was sceptical of empiricism from her first publication, *Poems and Fancies*. The source poem from that book speculates on the possibility of other worlds and raises epistemological questions about what kinds of belief require empirical data. However, despite her strong and consistent anti-empirical bent, Cavendish owned and used empirical instruments such as microscopes and telescopes.[33] In the poem 'It is Hard to Believe …' she argues that 'many things our senses dull do scape' to call attention to the fact that some things such as magnetic force would never be knowable with a microscope alone.[34] Cavendish's life-long interest was to carve out a space, in the new and increasingly settled scientific paradigm, for speculation, rationality and even literary writing *as well as* for knowledge derived from the senses. Her writing offers a sceptical perspective on, and systematic correction to, one of the major thrusts of the Scientific Revolution: the desire to separate valid from invalid knowledge practises – to no longer consider as rational anything *but* sensory data.

Questions

1. As described in the Analysis, we know that Margaret Cavendish had a microscope of her own. Why do you think she insists on their uselessness, or at least on their being problematic, throughout her publications?
2. What difference does genre make to the shape of Cavendish's anti-empirical arguments? How do her arguments change when she writes in a prefatory letter, or a treatise, or a fictional narrative, or a poem? How does she shape her arguments differently for different imagined audiences?
3. How do you understand the function of possibility and probability in her 'world-within-world' poems? How does it inflect her epistemological arguments, her arguments about how we know what we know, to insist that other worlds *may* exist (not that they *do* exist)?

4. How does gender function in Cavendish's scientific works – for example, deferring to her husband in prefatory letters, or the metaphor of a microscope as 'a high heel to a short leg'? How do they relate to her rejection of the dichotomy between rationality and fancy?
5. How does she navigate the relationship between scientific treatise and fantastic narrative in her prefatory letter to the *Blazing World*? What does it mean that she classifies both treatise and narrative as forms (or 'motions') of rationality? How do you ultimately understand the division or conflation of these two kinds of thought in this letter?
6. What statement does 'It Is Hard to Believe . . .' ultimately make about the relationship between scientific reason and religious belief? Does she seek to undermine religious belief as ultimately unknowable, or to use it to shore up non-religious natural speculation?
7. What do you think the payoff is, for Cavendish, of carving out a space for speculation, be it rational argumentation or imaginative fancy, in the midst of the rise of science, empiricism and experimentation?

Further reading

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11
Mrs Mary Chantrell (fl. 1690): Book of receipts (1690–1693)

Lucy J. Havard

Introduction

This source consists of pages from a seventeenth-century manuscript recipe (or 'receipt') book from the Wellcome Library in London. The manuscript featured here is Wellcome MS.1548, a recipe book dating from 1690 and attributed to Mary Chantrell, although other individuals were clearly involved in its compilation. Like many of its kind, this recipe book contains an eclectic compendium of food recipes, medicinal remedies and household tips.[35] As well as conventional recipes for sweet and savoury dishes, there are also instructions to make medicaments for sore eyes and the 'Kinges Evill' (a tuberculous swelling of the lymph glands also known as scrofula), and advice on how to clean silks and blacken shoes. There are even songs and sums written on some of the leaves. The pages presented here raise themes of ownership, preservation practices and the female role and responsibility in the home. This source aptly demonstrates the varied bits of knowledge that housewives needed to assimilate to successfully manage a seventeenth-century household.

Source

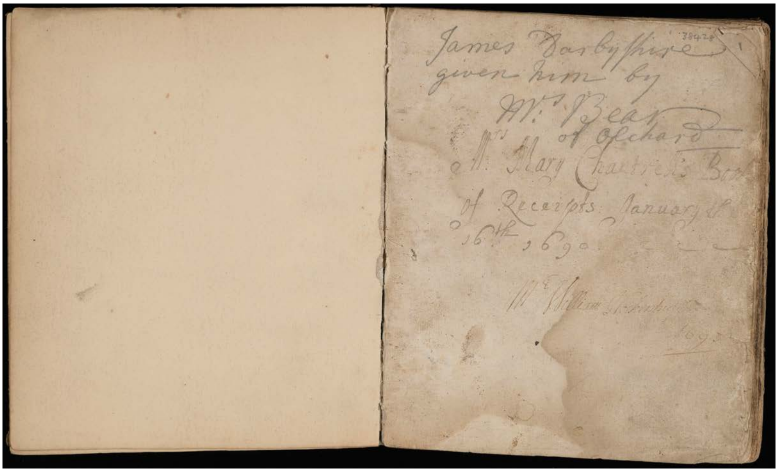

Figure 3.1a Front fly-leaf of a book of receipts by Mary Chantrell and others, 1690, Wellcome MS.1548. Image credit: Chantrell, Mary (and others). Wellcome Collection.

Transcription

James Darbyshire
given him by
Mrs Bear
of Olchard
Mrs Mary Chantrell's Book
of Receipts January the
16th 1690
Mr William Hockenhull
1693

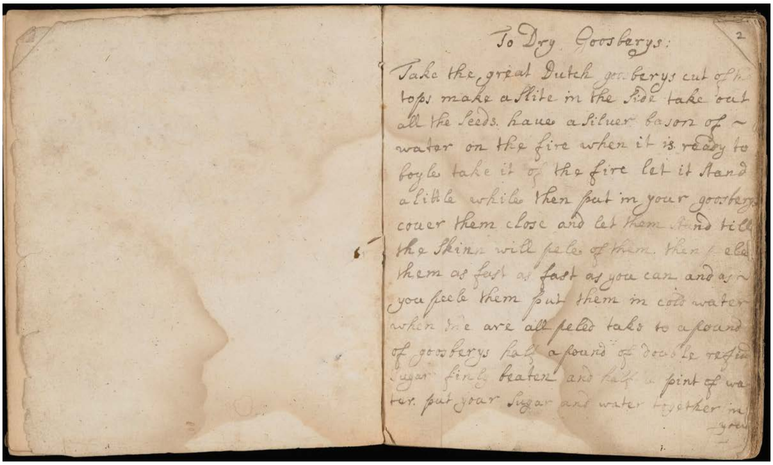

Figure 3.1b A recipe for drying gooseberries, featured in a book of receipts by Mary Chantrell and others, 1690, Wellcome MS.1548, f. 2r. Image credit: Chantrell, Mary (and others). Wellcome Collection.

Transcription

To Dry Goosberys:

Take the great Dutch goosberys cut of the
tops make a Slite in the side take out
all the seeds have a Silver bason of ~
water on the fire when it is ready to
boyle take it of the fire let it stand
a little while then put in your goosberys
cover them close and let them stand till
the skin will pele of them then pele
them as fast as fast as you can and as ~
you peele them put them in cold water
when the are all peled take to a pound
of goosberys half a pound of double refind
Sugar finly beaten and half a pint of water.
put your Sugar and water together in your

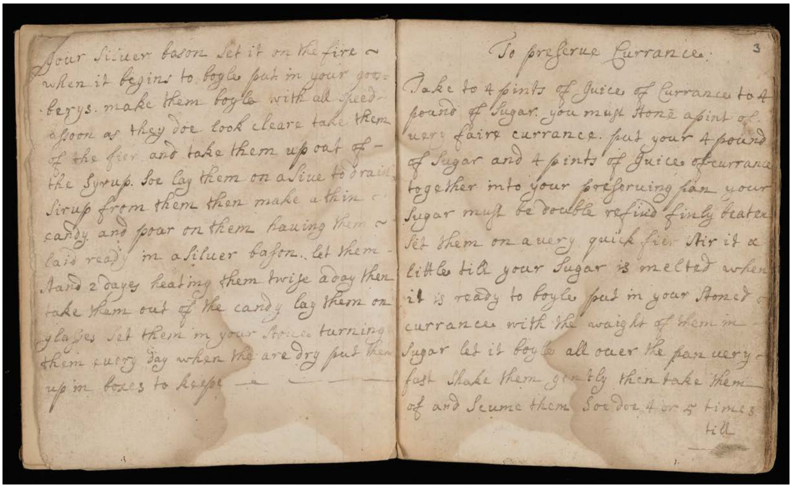

Figure 3.1c A recipe for drying gooseberries (continued), featured in a book of receipts by Mary Chantrell and others, 1690, Wellcome MS.1548, f. 2v. Image credit: Chantrell, Mary (and others). Wellcome Collection.

Transcription (continued from previous)

your Silver bason Set it on the fire ~
when it begins to boyle put in your goos-
berys. make them boyle with all speed
as soon as they doe look cleare take them
of the fier and take them up out of –
the syrup. Soe lay them on a Sive to drain
sirup from them then make a thin
candy and pour on them having them ~
laid ready in a silver bason. let them
stand 2 dayes heating them twise a day then
take them out of the candy lay them on glasses set them in your stove turning
them every day when the are dry put them
up in boxes to keepe -----

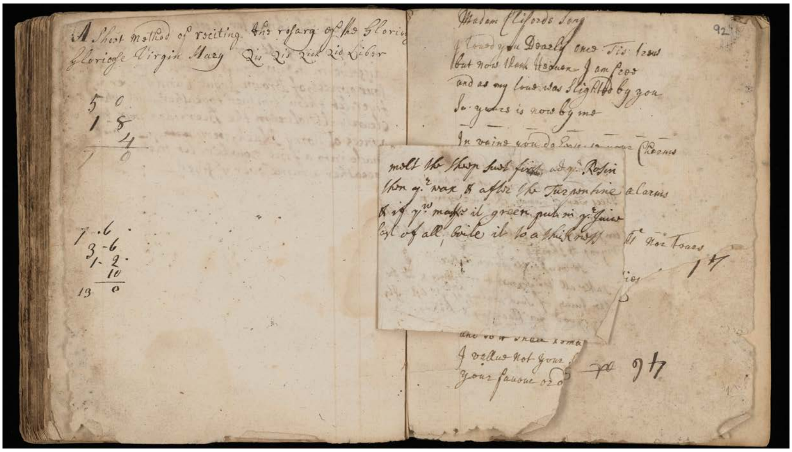

Figure 3.1d A selection of songs, medical receipts and sums, featured in a book of receipts by Mary Chantrell and others, 1690, Wellcome MS.1548, ff. 91v-92r. Image credit: Chantrell, Mary (and others). Wellcome Collection.

Transcription

A short method of reciting the rosary of the Gloriouse
Gloriouse Virgin Mary Qis Qis Qick Qid Libor
50
18
<u> 4</u>
72

To make the yellow healing salve
Take venice turpentin 2 ounces
Bees wax 2 ounces. Rosin 2 ounces.
Sheeps suet 4 ounces. Boyle all togethr to the
7.6 consistence of a salve. This is excellent for
3.6 drying & skinning
1.2 To make the green salve
<u>10</u> Take all the former ingredients & ad to
0 the juices of such healing herbs as y^e wish [?]. Its
13 very good for cleansing & healing

Madam Cliford's Song
I loved you Dearly once Tis true

but now thank Heaven I am free
and as my love was slighted by you
So yours is now by me

In vaine you do Expose your Charms
My hart for to Surprise
Which is prepared for all alarms
and can withstand your Eyes

Not all your feigned Sight nor Tears
My pity Ere Can move
Who once gets free from duties
Is mad againe to love

No Clos is [?] no my harts
And so it shall…
I value not your…
Your favour and…

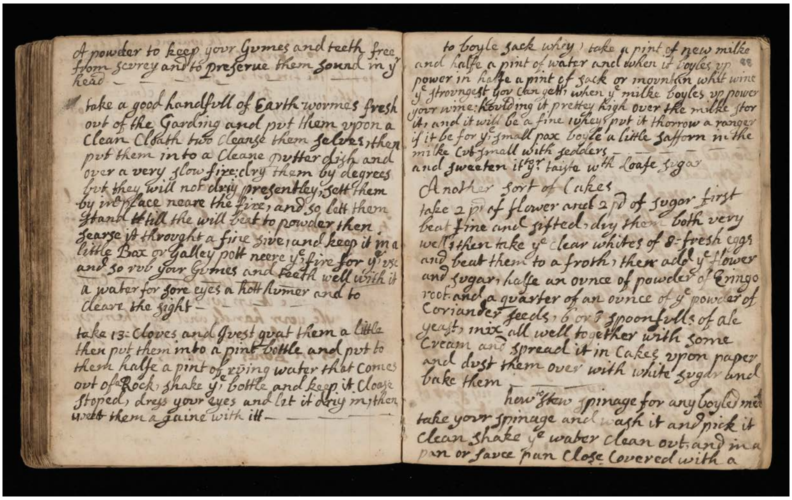
A powder to keep your Gumes and teeth free
from scurey and to preserue them sound in y^r
head
take a good handfull of Earth wormes fresh
out of the Garding and put them upon a
Clean Cloath two cleanse them selves, then
put them into a Cleane putter dish and
over a very slow fire: dry them by degrees
but they will not driy presentley, sett them
by in a place neare the fire, and so lett them
stand till the will beat to powder then
searse it throught a fine sive, and keep it in a
little Box or Galley pott neere y^e fire for y^e use
and so rub your Gumes and teeth well with it
a water for sore eyes a hott humer and to
cleare the sight
take 13: cloves and bruest them a little
then put them into a pint bottle and put to
them halfe a pint of spring water that comes
out of a Rock, shake y^e bottle and keep it Cloase
stoped, dress your eyes and let it driy in, then
wett them againe with itt
to boyle sack whey, take a pint of new milke
and halfe a pint of water and when it boyles up
power in halfe a pint of sack or mountain whit wine
y^e strongest you can gett, when y^e milke boyles up power
your wine: houlding it prettey high over the milke stir
it, and it will be a fine whey, put it thorrow a ranger
if it be for y^e small pox boyle a little saffron in the
milke cut small with seadders
and sweeten it to y^r taiste w^{th} Loafe sugar
Another sort of Cakes
take 2 pd of flower and 2 pd of sugar first
beat fine and sifted, dry them both very
well, then take y^e clear whites of 8 fresh eggs
and beat them to a froth, then add y^e flower
and sugar, halfe an ounce of powder of Eringo
root. and a quarter of an ounce of y^e powder of
Coriander seeds, 6 or 8 spoonfulls of ale
yeast, mix all well together with some
Cream and spread it in Cakes upon paper
and dust them over with white sugar and
bake them
how to stew spinage for any boyled meat
take your spinage and wash it and pick it
clean shake y^e water clean out, and in a
pan or savce pan close covered with a

Figure 3.1e A recipe for 'A powder to keep your Gumes and teeth free from scurey [scurvy] and to preserve them sound in y^r head', featured in a book of receipts by Mary Chantrell and others, 1690, Wellcome MS.1548, f. 87v. Image credit: Chantrell, Mary (and others). Wellcome Collection.

Transcription

A powder to keep your Gumes and teeth free
from scurey and to Preserve them sound in y^r
head ----------
take a good handfull of Earth wormes fresh
out of the Garding and put them upon a
Clean Cloath two cleanse them selves, then
put them into a Cleane putter dish and
over a very slow fire: dry them by degrees
but they will not driy presentley, sett them
by in ^{a} place neare the fire, and so lett them
stand till the will beat to powder then
searse it throught a fine sive, and keep it in a
little Box or Galley pott neere y^e fire for y^r use
and so rub your Gumes and teeth well with it

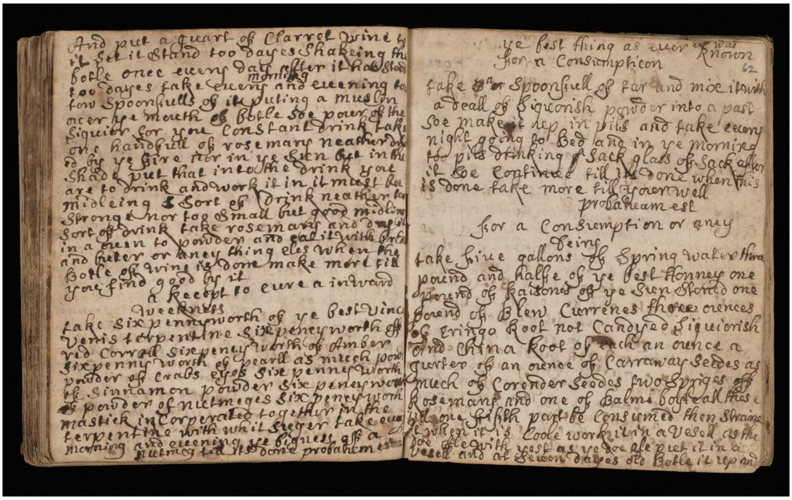

Figure 3.1f A recipe described as 'Ye best thing as ever was known for a consumpsicon', featured in a book of receipts by Mary Chantrell and others, 1690, Wellcome MS.1548, f. 62r. Image credit: Chantrell, Mary (and others). Wellcome Collection.

Transcription

Ye best thing as ever ^{was} known
for a consumpsicon
Take ~~3~~ a Spoonfull of tar and mix it with

a deall of liquorish powder into a past
Soe make it up in pils and take every
night going to Bed and in ye morning
too pils drinking a sack glass of sack after
it soe continue till its done when this
is done take more till your well
Probatum est

Analysis

The front flyleaf of this recipe book (Figure 3.1a) indicates the manuscript's value to the family. Mary Chantrell wrote her name proudly in the centre of the page: 'Mrs. Mary Chantrell's Book of Receipts January the 16th 1690'. Below Mary's name, the book was signed, 'Mr William Hockenhull 1693'. Above these two signs of ownership, in pencil, another line was written in the nineteenth century: 'James Darbyshire given him by Mrs Bear of Olchard'. These names and dates show that manuscript recipe books were treasured objects, passed down through the generations, and ownership and provenance were primary concerns.[36]

These manuscripts are, of course, handwritten, and each recipe book contains a collection of different hands. The various scripts indicate that recipe book creation was a temporal, collaborative activity; people added to and created the book over an extended period.[37] It is therefore impossible to attribute a recipe book to a single author. Contributors also gathered recipes from trusted family members, friends and acquaintances. A recipe's origin is sometimes indicated in its title, for example: 'My Lady Spottwood's Stomacke water'. However, manuscript book owners often altered and modified recipes to reflect their particular needs.

A significant proportion of the food recipes in this manuscript are meant to prevent food from spoiling. Most of these recipes relate to fruits or vegetables, but there are also instructions to preserve meat, fish and even flowers. Given the lack of fridges, freezers, canning or other long-term storage techniques, recipes for food preservation were fundamentally important in this period. Figures 3.1b and 3.1c show a typical recipe to dry gooseberries. Fresh fruits, like gooseberries, were perishable items and the only way to make them last over the long winter months was to preserve them in one form of another – through drying, candying or pickling.[38]

In the seventeenth century, the importance of 'preservation' was understood in a much broader context, and this is made clear in manuscript recipe books. The authors of this recipe book appear to be obsessed with preservation, not only of food but also the preservation of health with medicines and beauty with homemade cosmetics. A prime example can be found in Figure 3.1e, which gives instructions for 'A powder to keep your Gumes and teeth free from scurey [scurvy] and to preserve them sound in y^{r} head'.

The recipes in Figures 3.1b, c, e and f represent the format and layout evident in the majority of seventeenth-century manuscript recipe books. Unlike modern-day recipes, there is no list of ingredients and no step-by-step method. Instead, the author wrote the recipe instructions in complete prose. It is interesting that measurements and quantities of ingredients are sometimes carefully specified ('two ounces', 'a pound', 'a spoonful', 'half a pint'). In other cases, somewhat arbitrary and vague instructions are given ('let it stand a little while', 'make a thin candy'). Brief notes such as this suggest that there was an assumption that readers had a certain level of domestic knowledge and experience. Despite not having exact instructions for every step, the reader was presumably still able to successfully follow the recipe.

Figure 3.1f provides us with an excellent opportunity to examine the concept of trying and testing in the seventeenth-century kitchen – a topic that has been explored in great depth by historians such as Elaine Leong and Alisha Rankin.[39] Readers engaged with recipes by editing them, and various annotations, deletions and additions are visible in the manuscripts. This might be the work of the original writer or later readers and owners of the manuscript. The recipe for 'consumpsicon' (Figure 3.1f) begins: 'Take 3 Spoonfull of tar'. However, the '3' has been crossed out and replaced with an 'a'. It is difficult to tell whether this insertion is in the same hand as the original recipe. The implication is that a reader had tried this recipe out for themselves, found that 3 spoonfuls of tar was too much, and altered the text accordingly.

This recipe for consumption ends with the Latin phrase 'probatum est', translated as 'it has been proved'. These so-called 'efficacy phrases' are often found at the end of recipes; they indicate that the writer had tried the recipe and could vouch for its success.[40] The use of superlatives and emotive language in the title of this recipe confers authority and suggests that the writer had significant experience in making medical remedies: 'Ye *best* thing as *ever* was known … '.[41] As with efficacy phrases, these comments induced confidence in the reader, making them more likely to believe that the recipe did what it claimed.

Not only were these manuscripts repositories for tried and tested recipes for food and drink, but they also contained receipts for various medicines as well as domestic tips and tricks. Mary Chantrell's recipe book includes instructions to 'wash all Ribones', 'dye several colours', 'scowre Callicoe', 'clean silver and gold lace', and 'make blacking for Shoose'.[42] Not only did recipe books act as an *aide-memoire* for conventional food recipes, but spare pages provided the opportunity for doodles, sums, songs and religious advice. For example, Figure 3.1d offers 'A short method of reciting the rosary of the Gloriouse Virgin Mary … '. Considering all these elements, from food preservation to prayers, recipe books are eclectic, multi-layered sources that are invaluable in uncovering nuanced domestic and social history.

Questions

1. How are recipe books representative of the domestic knowledge required to manage a home in the seventeenth century? What other sorts of sources might you be able to use in order to establish this?
2. Consider the similarities and differences between manuscript recipe books and published domestic manuals of the period. What are the advantages and disadvantages of each in helping us establish what really went on in the seventeenth-century English home?
3. What do these recipes tell us about the extent of utensils and equipment that householders in the period had access to within the realms of cookery?
4. What are the similarities and differences between the kitchen as a 'domestic' space of experimentation and early scientific laboratories?
5. Consider the concept of domestic networks and ideas of knowledge exchange which helped to facilitate the transfer of recipes, cooking skills and techniques.

Further reading

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12

Sati-un-Nisa (d. 1646): *Ma'asir-ul-Umara* (*Biography of the Notables*) (1780) and photographs of the mausoleum Saheli Burj (Female Companion's Monument) (2020)

Mariam Sabri and Anurag Advani

Introduction

The sources below relate to Sati-un-Nisa (d. 1646), the only documented female physician in the Mughal Empire in South Asia. She came from an illustrious Persian family of scholars, poets and physicians who migrated in the late-sixteenth century from Mazandaran, Iran, to the Mughal court in Agra, India. She was renowned for her expertise in medicine and housekeeping. She possessed great literary prowess in Persian and Arabic, which earned her the title 'Princess of Poets' (*malika-us-shu'ara*) at Emperor Shah Jahan's court. Sati-un-Nisa was appointed the chief lady-in-waiting to his queen, Mumtaz Mahal. After the queen's death, she became the head of the harem (royal women's quarters).[43] As a Greco-Arabic or Unani medicine practitioner, Sati-un-Nisa was further renowned as a nurse who cured the afflictions of many members of the harem. She also tutored the Emperor's eldest daughter, Princess Jahanara, who became a notable patron of the arts and sciences, including medicine, at the Mughal court.

The first source is an excerpt from the *Ma'asir-ul-Umara* ('Biography of the Notables'), a canonical Mughal text written by the nobles Shahnawaz Khan and Abdul Hai Khan in Aurangabad in 1780.[44] It extols

Sati-un-Nisa's achievements more than a century after her death. The text was a compilation of Persian histories about Mughal bureaucracy over a two-hundred-year period, from the 1550s to the 1750s. In this sense, the entry on Sati-un-Nisa is testament to her status as a female polymath, and her work for the Mughal ruling elite as a physician. As a biographical memoir, the *Ma'asir-ul-Umara* is a crucial canon memorializing the lives and legacies of influential actors – including scholars and bureaucrats – in the Mughal empire over two centuries. Critically, it relays the existence and activities of otherwise occluded epistemic agents integral to the production and purveyance of Mughal science. Unastonishingly, Sati-un-nisa's medical milieu was entangled with the elite echelons of Mughal society given the pervasive princely patronage of Eurasian science during this period. The second source are photographs of Sati-un-Nisa's modest mausoleum, Saheli Burj ('Female Companion's Monument'). The tomb is located adjacent to the Taj Mahal in Agra, the grand mausoleum of her patron queen, Mumtaz Mahal.

Sources

Khan, Nawwab Samsam-ud-daula Shah Nawaz and Abdul Hayy, *Ma'asir-ul-Umara. Being Biographies of the Muhammadan and Hindu Officers of the Timurid Sovereigns of India from 1500 to about 1780 AD by Nawwab Samsam-ud-daula Shah Nawaz Khan and his son Abdul Hayy: Vol. 1.* Translated by Henry Beveridge and Baini Prashad, 260-261. New Delhi, India: Janaki Prakashan, 1941. Accessed 13 December 2022, *https://archive.org/details/MasirAl-umaraTranslationByBeveridgeAndBainiPrashadVolume1.*

At the end of the 22nd year corresponding to 1059 (1649), at the time when Kabul was the halting-place of the standards of victory, 'Aqil K. suddenly died. He was versed in poetry and in accounts. The adopted daughter of Sati Khanum — who had charge of the king's harem — was married to him. The said Khanum was descended from a Mazandaran family, and she was the sister of Talib-i-Amuli, who in the reign of Jahangir received the title of *malik-us-shu'ara* (King of Poets). After the death of her husband Nasira, the brother of Hakim Rukna of Kashan, she by good fortune entered the service of Mumtaz-uz-Zamani (Nur Mahal, the wife of Shah Jahan). As she was adorned with an eloquent tongue, and a knowledge of etiquette, and knew house-keeping and medicine, she advanced beyond other servants and reached the rank of *muhrdar* (sealer). As she knew the art of reading (the Qur'an) and was acquainted with Persian literature, she was appointed to be instructress of the Begum Sahib (Shah Jahan's eldest daughter Jahanara) and so attained to high distinction (rose to the sphere of Saturn, the seventh heaven). After the death of Mumtaz-uz-Zamani, the king, who appreciated her merit, made her head of the Harem. As she had no child, she after (her brother) Talib's death adopted his two daughters. The eldest was married to 'Aqil K., and the younger to Zia-ud-din, who was styled Rahmat K. and who was the son of Hakim Qutba, the brother of Hakim Rukna. In the 20th year, when the royal residence was Lahore, the younger daughter — of whom the Khanum was very fond — died in childbirth. The Khanum went home and mourned for her for some days. After that, the king sent for her and placed her in the quarters that he had in the palace, and personally came to her there and administered her consolation. She, after discharging the duties connected with the presence of the king, went to her appointed dwelling and surrendered her soul to God. The king gave from the treasury 10,000 rupees for her funeral and burial, and ordered that her body should be kept in a temporary grave. After a year and odd it was conveyed to Agra and buried at a cost of 30,000 rupees in a tomb west of the sepulchre of the Mahad 'Aliya (Nur Mahal) in the Jilaukhana Chowk (the ceremonial forecourt of the Taj Mahal complex). A village yielding 3,000 rupees was assigned for the expenses (of the upkeep) of the tomb.

Analysis

Sati-un-Nisa was part of an early modern Persianate society of intersecting and interdisciplinary knowledge. Physicians did not merely serve as medical theorists and doctors but simultaneously as poets, tutors and courtly aides. Indeed, the Persian word for a doctor – *hakim* – implied a polymath who excelled in several subjects. These polymaths migrated from West and Central Asia to the courts of Mughal rulers and Deccan Sultans for patronage. They shaped a cultural milieu where the court valued medical expertise, literary prowess, spiritual erudition and political wisdom.

Sati-un-Nisa was one of the rare female polymaths in this Mughal milieu hailing from a learned family. As the excerpt from Ma'asir-ul-Umara reveals, her brother Talib Amuli was also a renowned court poet, and her husband Nasira was the brother of a *hakim*. Shahnawaz Khan and Abdul Hai Khan, writing 150 years later in Aurangabad, lauded

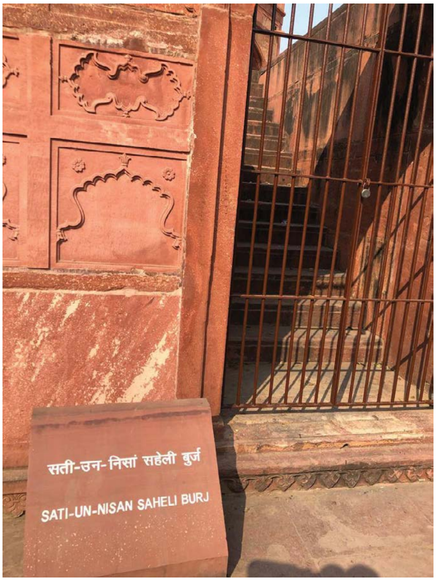

Figure 3.2a A photograph of Sati-un-Nisa's mausoleum (close up), Saheli Burj (Female Companion's Monument). Image credit: photograph taken by Anurag Advani, 4 February, 2020.

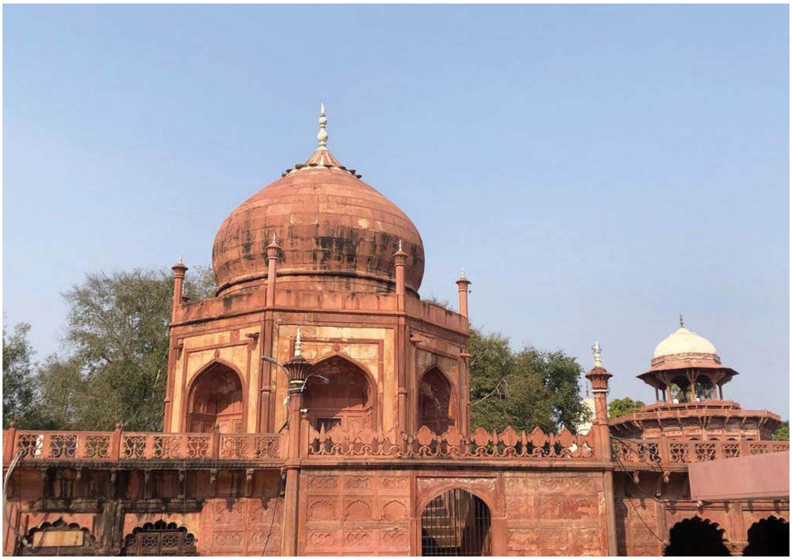

Figure 3.2b A photograph of Sati-un-Nisa's mausoleum, Saheli Burj (Female Companion's Monument). Image credit: photograph taken by Anurag Advani, 4 February, 2020.

Sati-un-Nisa for her service to Mumtaz Mahal, her mastery over Arabic and Persian, her poetic abilities and her religious knowledge. In addition to her medical practice, these skills afforded Sati-un-Nisa political mobility. The close relationships she cultivated with members of the imperial court enabled her to 'advance beyond other servants'. After Mumtaz Mahal died in 1631, Jahanara took control of the harem. As her tutor, Sati-un-Nisa helped Jahanara carry out her responsibilities, including organising royal weddings and gift ceremonies.[45] The source mentions the marriages contracted by her adopted daughters with 'Aqil K. and Rehmat K.', both important Mughal functionaries. Marital alliances were key for cementing political allegiances in South Asia and were central to how women exercised their agency in Mughal India.

Of course, not all women rose to such prominence as Sati-un-Nisa did. Within the harem, there was a hierarchy among female medical practitioners. At the lowest rung were *dai*s, midwives, and wet nurses, who helped during childbirth but were looked upon with suspicion by the court. Then there were *qabila*s, medically trained nurses. Finally, there were *hakima*s or *tabibas* (i.e., female *hakim*s or *tabib*s) such as Sati-un-Nisa, – expert physicians who were well-versed in Unani medicine. Regrettably, the above extract does not give us an insight into the specific herbal compounds and drugs that *hakima*s administered to patients. However, contemporary pharmacopoeia and medical lexicons indicate sophisticated medical knowledge combined Unani with Ayurvedic modes of treatment.[46] Doctors strived to achieve an ideal humoral balance in the body, which in turn symbolised the health of the Mughal body politic.[47]

When Sati-un-Nisa died in 1646, Shah Jahan provided a handsome sum for her burial. As a reward for her loyal service, Sati-un-Nisa's tomb was positioned close to the Taj Mahal, the resting place of the queen she originally served. Sati-un-Nisa's tomb was named 'Saheli Burj', literally translated as 'female companion's monument'. Like many Mughal monuments, Sati-un-Nisa's tomb was constructed from red sandstone obtained from quarries in nearby Rajasthan. There are only two more such Saheli Burjs in the Taj Mahal complex, both housing the graves of Shah Jahan's other queens, Fatehpuri Begum and Sirhindi Begum. That Sati-un-Nisa's tomb received the same title and stature as those of the emperor's wives indicates her significant position at the Mughal court.

In line with recent scholarship exploring the dynamic roles of Mughal women, Sati-un-Nisa's story highlights the agency and authority wielded behind the veil.[48] Gendered segregation of space did not imply a clear division of public and private societies, since the harem was a critical locus for political and scientific activity in the Mughal Empire.

Questions

1. In the excerpt from Ma'asir-ul-Umara, what does Sati-un-Nisa's example reveal about non-European, pre-colonial knowledge and social mobility in early modern South Asia?
2. What traditions, referenced in these sources, converge to form Mughal medicine? What do you know about the longer history of these traditions?
3. What does the architecture and location of Sati-un-Nisa's tomb in Figures 3.2a and 3.2b suggest about the status of a female physician in the Mughal Empire? How does this compare to the ways in which women in science are remembered in other parts of the world during this period?
4. How does Sati-un-Nisa's story enable us to dispel notions of the historical invisibility or absence of Muslim women in science?
5. What does Sati-un-Nisa's story reveal about gender, science and social mobility in the Mughal Empire and Asia more broadly? Can you identify similar or different patterns between Sati-un-Nisa's story and the other sources in this book?

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13

Marie Crous (fl. 1641): Extracts from two of her mathematical works, the *Advis de Marie Crous* (1636) and *Abbrégé recherché de Marie Crous* (1641)

Professor Giovanna Cifoletti and
Dr Jean-Marie Coquard

Introduction

Marie Crous appears in history as the name of the author of two mathematical works: the *Advis de Marie Crous aux filles exerçantes l'arithmétique sur les dixmes ou dixiesmes du sieur Stevin….* (*Notice by Marie Crous to the girls practising arithmetic on the tithes or tenths by Sir Stevin*, published in Paris in 1636) and the *Abbrégé recherché de Marie Crous. Pour tirer la solution de toutes propositions d'arithmétique…* (*Summary invented by Marie Crous to find the solution of all problems of arithmetic,* published in Paris by Jacques Auvray in 1641). Active around the middle of the seventeenth century, little is known of Crous, though in the preface to both books she describes herself as being of humble origins.

In the *Advis*, Crous introduced computation with the decimal system, while transforming the Flemish mathematician Simon Stevin's notation for written decimal numeration. With the second book, *Abbregé,* Crous developed a complete text of commercial mathematics. The full title for the *Abbregé* alluded to the comprehensive nature of the volume, being a 'Summary invented by Marie Crous to find the solution of all problems of arithmetic depending on changes, discount, interest, company, association, payments, division of money, alloying mint and measure of lengths, divided in three parts. Bound with a notice to girls practising arithmetic on the tithes or tenths of Sir Stevin'. In the full title of her earlier book, the *Advis*, Crous alluded to her second work, stating 'It all refers to my *Abrégé* and will be very useful to it', revealing that the two were intended to be read and used together.[49]

Below you will see two extracts taken from both books. The first, taken from the *Abrégé,* consists of a letter to Madame de Combalet, to whom the book was dedicated, and a letter addressed 'To the Girls my fellows', which alludes to Crous's intended audience for the work. The second extract, taken from the *Advis*, is a letter to Mademoiselle Charlotte de Caumont, Damoiselle de la Force, and again a letter addressed 'To the Girls my fellows'.

Source

Extract from Crous, Marie. *Abbrégé recherché de Marie Crous. Pour tirer la solution de toutes propositions d'arithmétique…* Paris: Jacques Auvray, 1641.[50]

II.1 Epistre:

[f1r] To Madame

Madame de Combalet.

Madame,

The respect that Your Highness and your eminent virtues deservedly acquired everywhere do not allow me to doubt the person to whom I should [f1v] offer this needle point flower picture, this lettering book and particularly this Abregé d'Aritmetique. I have done it for the utility of the people of my own sex […] [f2r] & will give me the boldness to present it to girls, hoping they will find in it the truth of a very-useful invention. I submit my propositions to the censorship of the most critical audience, in the case that by the rules cited in this treatise and the order followed in it I did not give the solution of all the propositions depending on them. I dare to assert to Your Highness, MADAME, that there is no other book published before this one; where this invention is taught; attributable entirely to the vigils of your very-humble servant: rejecting a lot of ordinary practice letters, that I prove useless: since the solution [f2v] is reached as easily, & more expeditiously without them: & particularly in great companies accounts: by the means of one division, that I named division of Denomination, remarkable at the two final propositions of the last part, and by the resolution given, on the R.M.'s bankruptcy mentioned in my writing book: that I put at your feet, MADAME, although I did not propose there only but the proportion and relation of unembellished figures, as some have done for the satisfaction of the eye, by means of the subtlety of a burin, but with only a pen: like also the plant pot with only one hand: […] [f3r] My aim is not to undertake the most erudite scholarly efforts, acknowledging also there that high-wrap works [large tapestries] cannot be girl's: […] [f3v]

Your very-humble, & very-obedient
MARIE CROUS

II.2 Aux filles mes compagnes:

[f4r] NOTICE TO THE GIRLS

my fellows.

MESDAMES,

I think I would greatly fail against the goodness God had freely exercised toward me, if I didn't try to give some utility to the girls of my condition; even more in this century where so many examples of scholars and wise spirits of my own sex who, by their own work, triumph in full view of all erudite men. It is not that I desire or pretend such a glory [f4v] and I have confidence in your sincerity that you will not make a judgement opposite to my intention which is no other than try to share talent God put in my hand, for what I give thanks, recognizing him very great toward me, but nothing compared to those He gave to the lower. It is, that I pray you to receive as a proof, that I have no other goal offering you, my dear fellows, this little treatise of Arithmetic, to try to ease those who practice this science; for the necessity of their own affairs and for the satisfaction of their wit.

Extract from Crous, Marie. *Advis de Marie Crous aux filles exerçantes l'arithmétique sur les dixmes ou dixiesmes du sieur Stevin...* Paris, 1636.

III.1 Epistre:

[3] TO

MADEMOISELLE

CHARLOTTE DE

Caumont, Damoiselle de la Force.

MADEMOISELLE,

If something could make me glorious, it is the honour I had, to have placed alone the pen to the hand of your tender years: & to have been considered worthy of this task by two so virtuous [4] Ladies, late Madame la Mareschale your grandmother, & Madame la Marquise your Mother; what would be enough to make me unrecognisable to myself, if your kind gestures did not stop me, when they are together, and as signs of so many virtues, they show that eloquence will be inadequate to publish them to the world. This augury is so much engraved in my spirit; that it seems it could shift me away from the aim I always had, as soon as I undertake to put into light this Advis on the Sir Stevin's tenths [5], that it should be under your auspices time will make famous amongst great people. But I cannot ignore that mine is rightfully owed to you, since I have this good and honour to be continuously at your service, where it will be needed to be exposed: I have the boldness to beseech very-humbly MADAME to allow this advis to have her name on its top in order to cease the judgement of those who dare accuse it of impertinence or vanity: making consistent my felicity in the honour you [6] please grant to my very-humble requests; that I can present myself all my life,

MADEMOISELLE,
Your very-humble, very-obedient & very-loyal servant,

MARIE CROUS

III.2 Aux filles mes compagnes:

[7] TO THE GIRLS

my fellows.

I did not believe very-dear fellows you did see what Stevin had said in his arithmetic, to avoid the multiplicity of fractions by means of dividing the integer only in tenths; & likewise, each species of fractions: & therefore, I believe that if you follow his opinion, you will acknowledge the utility that could bring this change of division of the integer. But it seems to me following this opinion that it is up to the Sovereigns [8] to change the division of their currencies, weights and measures. This is because even if the surveyors marked their measures on a side with tenths on the side where there are no marks of the King, they would not be allowed to use them to measure at all for the distribution of their commodities. Therefore, waiting for this change, nobody can use it except for one's own convenience (which I believe you will find great) but it consists of being able to reduce one to the other, to sell and measure observing the decrees. What is even more necessary for currencies & weights; where by no means to it is possible [9] to use such marks, & I do not know if you have understood how we could use them: According to me, I cannot see how. My opinion is that Stevin, after searching such a great shortcut; & put into light such a beautiful method, he did not want to amuse himself to build such a reduction; likewise I believe it is not useful to describe to you what others have done or not done for this art. Having promised to spend the little time I can have to serve you, I shall not explain further what is and what is not in Stevin (since it is easy to verify). Instead, I will try to explain to you as clearly as possible the use [10] of four tables. I beseech you, my dear friends, to excuse me my lack of study which is the cause of the fact that I don't have the knowledge of the terms of several sciences close to this art: thanks to these terms I could be more understandable. Certainly it would be easy to show that there has been no lack of my will. Many well known afflictions have occurred in my father's house during my childhood and the time which should have been appropriate to studying and prevented me to do it. However, seeing that those excuses would be only for my discharge and of no utility for you, I skip them. Rather, I say that, according to what will be said in what follows after the tables, you will be able to use this subdivision of integers practising calculation as it is explained in the first book, which is similarly useful for fractions as it is for usual numbers. For, as Stevin did not change at all the usual calculation, similarly there is no need to change this compendium, elaborated on it. This gave me the opportunity, in all the propositions below, to refer to the first book, following the rules on which they depend. I beg you to receive this little labour, my very honoured Ladies, not looking at it but at the will of the one who has no other desire than to be employed in your service.

Analysis

These two books are bound together and there is only one known copy of them. The *Advis*, dated 1636, was bound after the *Abbrégé,* dated 1641. The volume belongs to the ancient collection of Giulio Raimondo Mazzarino's personal library. Mazzarino was an Italian cardinal and famous patron of the arts and collector of books. However, the fact that the book can be found in Mazzarino's collection provides no indication of the readership of the book. Given that the *Abbrégé* was dedicated to Madame de Combalet, the niece of Armand Jean du Plessis, Cardinal de Richelieu – and Mazzarino was Richelieu's protégé – it is likely that Mazzarino's library acquired this volume directly in this way.

The *Advis*, instead, is dedicated to Crous's pupil, Charlotte de Caumont, Mademoiselle de Force, who came from a Protestant family. According to Crous's prefaces, she wrote both books to assist women who, for their necessity or out of curiosity, wanted to study business arithmetic with fractions of the various units of measure. While one might now think of mathematics as a traditionally 'masculine' subject, this was not always the case, as this source reveals. For centuries it had been a *topos,* or literary tradition, for women authors to address themselves to women. However, since Crous described herself as a teacher and protégée of women, she intended the public audience of her book to be women. Did this fact have an impact on the mathematical content?

Utilising base ten as a universal reference, Stevin's idea was to extend the use of decimal fractions, present in astronomical tables, to other measures such as surveying, gauging and even to commerce. But for his ideas to be realised, the decimal system needed to be adopted at a political level, and for that reason Stevin was not able to systematically use his powerful conversion. Crous's idea was to take into account Stevin's invention, but to extract it from high mathematics and to focus instead on commercial arithmetic. This new arithmetic involved calculation of units of measures with their multiples and submultiples and then moved to a decimal reference, with the use of tables. In his work, Stevin's notation was uniform for tables of sines, powers of the unknown and for decimals. Crous, instead, insisted that notation should be univocal, concerning only one sort of numbers – fractions of the unit. To do so, Crous introduced a new notation, for explicit computations and for tables, with the point before the decimals. This notation has been in use since then as an alternative to the comma.

Questions

1. What status did Marie Crous have in seventeenth-century Paris?
2. Consider the gender, status and religion of Marie Crous's patrons. What do you notice?
3. In Crous's opinion, decimal fractions were linked with political decision and with education. How might this relate to the fact that she addresses herself to noblewomen, as well as to 'aux filles, mes compagnes' ('to the girls, my fellows')?
4. Marie Crous's books were published in 1636 and 1641. The French philosopher and mathematician René Descartes published his *Discours de la méthode* and his *Géométrie* in 1637. What are the differences between the genres and the topics of these mathematical publications?
5. Why might women and girls have used and read Marie Crous's books? What does this say about the practice and gendering of mathematics in the seventeenth century?

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Part III notes

1 Dear, *Revolutionizing the Sciences*; Daston and Park, *The Cambridge History of Science.*

2 Shapin, *A Social History of Truth*.

3 Merchant, *The Death of Nature*; see also Haraway, *Modest_Witness@Second_Millennium. FemaleMan_meets_OncoMouse,* especially 23–48.

4 Shapin, *The Scientific Revolution*. See also Cohen, *The Scientific Revolution*.

5 See for example, Leong, *Recipes and Everyday Knowledge*. For more on women's recipes as knowledge in later eras, see also part twelve.

6 Shapin, *The Scientific Revolution;* please refer to our Introduction and commentary on periodisation. The Scientific Revolution is used within this source as a useful framework within which to consider Cavendish's work however we encourage readers to consider this critically throughout.

7 Compare her contemporary Thomas Hobbes' critiques, whose importance is described in Shapin and Schaffer, *Leviathan and the Air-Pump*.

8 Textual variants are available in O'Neill, *Observations upon Experimental Philosophy*, and Blake, *Margaret Cavendish's Poems and Fancies*.

9 Dioptrics is 'that part of the science of Optics which treats of the refraction of light'. Dioptrics, here and elsewhere in the selections, includes all attempts to enhance sight, such as microscopes and telescopes. (Definitions are taken from the Oxford English Dictionary unless otherwise noted.)

10 Cavendish here cites literary precedents: both Lucian (a Roman author), and Cavendish's contemporary Cyrano de Bergerac (the 'Frenchman') describe imaginative journeys to the moon or other worlds.

11 Perhaps a reference to Francis Godwin's imaginative narrative *The Man in the Moone*, though that contraption involves pulleys and strong geese, not screws.

12 In other words, separate, individual part of the body.

13 In other words, rational perception (a phrase meant to invoke empiricism while actually sidestepping it; what one 'perceives' with one's rationality is not based on sight).

14 In Cavendish's philosophy, Nature was one body or substance, and because Nature was infinite and infinitely divisible it was impossible to know *all* of Nature. See Cavendish, *Grounds of Natural Philosophy.* See also Blake, 'The grounds of literature and science'.

15 The italics mark slightly modified quotations from the Preface to Hooke's *Micrographia*, sig. a1r. Cavendish's use of the plural 'some' and 'they' here and below suggests that she sees Hooke as speaking on behalf of himself and the Royal Society (who, indeed, explicitly endorsed his book).

16 Hooke, *Micrographia*, sig. a2r.

17 Hooke, *Micrographia,* sig. a2r.

18 I.e., universities.

19 Glass tubes [Cavendish's marginalia].

20 Atoms [Cavendish's marginalia].

21 Exterior figures [Cavendish's marginalia].

22 In other words, imagination.

23 Though the letter begins by highlighting the differences between reason and fancy, this sentence asserts that, despite their different effects, *both* reason and fancy are *rational*, caused by the rational motions of matter.

24 'Recreate' means both to provide recreation or refresh, and, possibly, to create anew.

25 See note 24.

26 In the 1653 edition, the title reads 'Are' not 'May Be.'

27 Small invisible hooks was one hypothetical scientific explanation for how the loadstone or magnet attracted iron.

28 Lines 35–38 casually equate the Christian belief in the survival of the soul after the death of the body with the equally empirically unsubstantiated belief in worlds within worlds; religious belief and rational speculation, she suggests, are both based on something other than the senses.

29 This line is either a commentary on the impossibility of an immaterial soul (imagination, like the soul, cannot exist without the material substrate of the brain), or an expression of the inherent rationality of fancy or imagination (see the prefatory letter to her *Blazing World*, above).

30 Hooke, *Micrographia*; Sprat, *The History of the Royal Society of London*.

31 Hooke, *Micrographia,* sig. a2r, b1r; italics regularised.

32 Latham and Matthews, *The Diary of Samuel Pepys,* 243; Mintz, 'The Duchess of Newcastle's Visit to the Royal Society', 1952; Wilkins, 'Margaret Cavendish and The Royal Society', 2014.

33 Whitaker, *Mad Madge,* 99.

34 Newcastle, Margaret Cavendish, Duchess of. *Poems and Fancies*. London, 1668. *It is Hard to Believe that there May Be Other Worlds in this World* (ll. 11–14).

35 Kowalchuk, *Preserving on Paper,* 3–4.
36 DiMeo, 'Lady Ranelagh's Book of Kitchen Physick?', 2014, 343.
37 Leong, *Recipes and Everyday Knowledge,* 38–9.
38 Thorne, *The History of Food Preservation,* 14.
39 Leong and Rankin, 'Testing drugs and trying cures', 157–182.
40 LeJacq, 'The bounds of domestic healing', 453.
41 Author's own italics.
42 Wellcome MS.1548 80.v, 81.v, 82.r, 91.r.
43 Verma, 'The growth of Greco-Arabian medicine in medieval India.', 359.
44 The authors note that the Arabic transliteration is *Ma'athir-ul-Umara.*
45 Sarkar, 'The Companion of an Empress.', 1917, 151-6.
46 Speziale, 'The circulation of Ayurvedic knowledge in Indo-Persian medical literature.', 1–7.
47 Alavi, 'Medical culture in transition', 853–897.
48 Lal, *Domesticity and Power in the Early Mughal World*.
49 The full titles of these texts are *Advis de Marie Crous aux filles exerçantes l'arithmétique sur les dixmes ou dixiesmes du sieur Stevin. Contenant plusieurs advertissements démonstrations et propositions esquelles est déclaré comment elles se peuvent servir de la partition des dixmes, sans le changement des divisions des monnoyes, poids et mesures, par le moyen des cinq tables y contenues. Le tout renvoyé à mon Abrégé pour y être très utile.* Paris, 1636. Notice by Marie Crous to the girls practicing arithmetic on the tithes or tenths by Sir Stevin, containing several notices, cases and problems by means of which we explain how they can make use of the partition of tenths without switching divisions of currencies, weight and measures, thanks to the five tables contained in it. It all refers to my *Abrégé* and will be very useful to it. Paris, 1636. *Abbrégé recherché de Marie Crous. Pour tirer la solution de toutes propositions d'arithmétique, dependantes des regles y contenues. Avec quelques propositions sur les changes, escomptes, interests, compagnies, associations, payemens, departemens des deniers, meslanges, bureau des monnaies et thoisages, divisé en trois parties. Ensemble un advis aux filles exersantes l'arithmétique sur les dixmes ou dixiesmes du sieur Stevin*, Paris, Jacques Auvray,1641. Summary invented by Marie Crous to find the solution of all problems of arithmetic depending on changes, discount, interest, company, association, payments, division of money, alloying mint and measure of lengths, divided in three parts. Bound with a notice to girls practicing arithmetic on the tithes or tenths of Sir Stevin. Paris, Jacques Auvray, 1641.
50 Please note numbers in square brackets in this source denote page numbers.

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Part IV
Art, gender and knowledge (1700s)

Timeline: individuals and events in the history of science	Timeline: individuals, events and objects in this part
1594 The first anatomical theatre built at the University of Padua.	
	1647–1717 Maria Sibylla Merian, German naturalist and illustrator.
1660–1753 Hans Sloane, Anglo-Irish physician, collector and president of the Royal Society.	
	1714-74 Anna Morandi Manzolini, Italian sculptor and anatomist.
	1715-85 Margaret Cavendish Holles Harley Bentinck, Duchess of Portland, English aristocrat and collector.
1752 Benjamin Franklin, Founding Father of the United States, performs the kite experiment during which he demonstrates the electrical nature of lightning.	
	1758–1836 Marie-Anne Paulze-Lavoisier, French noblewoman and chemist.

Timeline: individuals and events in the history of science	Timeline: individuals, events and objects in this part
1761 Russian Mikhail Lomonosov discovers the atmosphere of Venus while observing its transit from the St Petersburg Observatory.	
1764 English cotton weaver James Hargreaves invents the spinning jenny, a machine for use in textile manufacture.	
1764 Scottish engineer and chemist James Watt begins developing his steam engine.	
1775–83 American Revolutionary War.	
1778 French chemist Antoine Lavoisier recognises the role of oxygen in combustion and opposes the theory of phlogiston (which posited the existence of a fire-like element, known as phlogiston, responsible for combustion).	
1789–99 French Revolution.	
1791–1804 Haitian Revolution.	

Introduction

There has not always been such a sharp distinction between art and science as is generally understood in the Western world today.[1] Crafts such as drawing, wax work, embroidery, shell work and paper cutting all incorporate specialist knowledge about materials, chemical processes, the environment and nature.[2] As noted in the previous part, the formalisation of knowledge that occurred alongside the foundation of scientific societies and institutions in Europe meant that many women in the seventeenth and eighteenth century were marginalised within formal sites of knowledge-making and sharing.[3] However, this exclusivity did not reach all areas of natural knowledge and women in the eighteenth century continued to express and cultivate their knowledge in domains that, though not considered scientific today, incorporated extensive knowledge about the natural world.[4] The sources in this part demonstrate how women's expertise was expressed through artistic endeavour, expanding our understanding of knowledge production and the close links between art and science.

It is important to note that the European women in this part were all well-educated and wealthy. This was not the case for all women – many worked within guilds and at home producing materials requiring extensive knowledge of the natural world. However, the privileged circumstances of the women included in this part have helped to preserve their works for posterity.

The first source is an image and extract from *Metamorphosis Insectorum Surinamensium* (*The Metamorphosis of Insects in Surinam*), published in 1705, by Maria Sibylla Merian (1647–1717), a German naturalist and illustrator. It features Merian's descriptions and illustrations of insects and plants of Surinam, South America. The second source is a self-portrait in wax produced by one of the most famous Italian sculptors and anatomists of her time, Anna Morandi Manzolini (1714–1774). Manzolini's waxworks were used in the academic study of anatomy at the University of Bologna, Italy. The third source, an engraving of Margaret Cavendish Bentick, Duchess of Portland (1715–1785), demonstrates the ways that women were able to collect and display natural specimens that expressed their knowledge of botany and zoology. The final source in this part is a drawing by Marie-Anne Paulze-Lavoisier (1758–1836), recording an experiment that she and her husband, Antoine-Laurent Lavoisier, carried out in their home laboratory. These sources demonstrate the depth of knowledge and breadth of experience that some women were able to attain and express through art in the eighteenth century.

14

Maria Sibylla Merian (1647–1717): Extract from *Metamorphosis Insectorum Surinamensium* (*The Metamorphosis of Insects in Surinam*) (1705)

Dr Tamara Caulkins

Introduction

The hand-coloured engraving and description below is from *Metamorphosis Insectorum Surinamensium* (translated as *The Metamorphosis of Insects in Surinam*), an enormous book of engravings and text by Maria Sibylla Merian (1647–1717). It was published in Amsterdam in 1705 in Dutch for local connoisseurs and in Latin for the wider European market. Merian grew up in Frankfurt as the daughter of the famous printer Matthäus Merian who died when she was three. She learned to draw, paint and engrave from her stepfather, Jacob Marrel, whose beautiful tulip paintings contributed to a bulb buying frenzy in the seventeenth-century Dutch Republic. When she was only 13, Merian started recording her observations of caterpillars and the process they went through to become butterflies. She studied and collected insects throughout her life. She eventually published a popular book on caterpillars and one on flowers that could be used for embroidery patterns. In 1699, Maria Sibylla and her youngest daughter Dorothea departed for the Dutch colony of Surinam in South America, where they studied the plants and insects that she described through text and images in *Metamorphosis Insectorum Surinamensium*. Many of the engravings in Merian's *Metamorphosis* describe edible fruits. This second plate describes the pineapple – a fruit which most Europeans had never tasted.

Source

Figure 4.1a Portret van Maria Sibylla Merian by Jacob Houbraken, engraving/etching on paper, 165mm x 125mm, Rijksmuseum, Netherlands. Object number RP-P-1940-337.

Figure 4.1b Extract from Maria Sibylla Merian, *Metamorphosis Insectorum Surinamensium* (1705), page 2.

Description accompanying Figure 4.1b in *Metamorphosis Insectorum Surinamensium*:

This is a ripe pineapple. If one wants to eat it, one must remove a layer of peel about as thick as a thumb. If it is peeled too thinly, little sharp hairs get stuck in the tongue which is very painful. The taste of this fruit is as if one mixed grapes, apricots, currants, apples and pears all together. When a pineapple is cut open, the sweet, strong fragrance fills the whole room. The crown and the shoots which sprout from the sides can be planted in the earth and new plants spring up. They grow as easily as weeds. The young shoots need six months to produce ripe fruit. Pineapples are eaten both raw and cooked. One can also press and distil them to make wine and brandy, both of which are more delicious than any other.

In early May 1700, I found this caterpillar sitting on this pineapple in the grass next to the pineapple plants. It is light green with a red and white stripe along the whole length of its body. On May 10, it turned into a pupa and on May 18, a beautiful butterfly emerged, yellow and adorned with lovely shining green patches, like the ones shown at rest and in flight.

On the crown of the pineapple sits a small, reddish worm that will spin a tiny cocoon in which a little pupa will lie. The worm is the one that becomes the cochineals in this country. Anyone who is interested can see it here. Above the cocoon of that worm lies a pupa whose skin I opened and in which I found a cochineal, which is shown somewhat higher on the crown, and does not differ from the body of the two beetles, which are shown here at rest and in flight, and whose red wings are rimmed with black. I have added these only to decorate the plate, selected from dry cochineals. These are not different from those which other researchers have found such as Mr. Leeuwenhoek, Letter 60 written on November 28, 1687, pp. 141–144, and Dr. Blankart in *De Insectis*, fol. 215.

When the butterfly is seen through a magnifying glass, the dust on the wings looks like fish scales. Each scale has three sections with long hairs on each. The scales are laid out so regularly that one could easily count them. The body is covered in feathers and hairs intertwined.

Analysis

The stylish composition and subtle colours of this image of a pineapple plant indicate the skill of a consummate artist. The anatomic details of the insects signal the trained eye of a field naturalist. Does this image represent a work of science or of art? In seventeenth-century Europe, science was not yet a professional discipline. Those who studied the natural world were called 'natural philosophers' and often were part of an aristocratic class who collected rare and beautiful items displayed in 'cabinets of curiosity'. These natural objects and human artefacts – antiquities from ancient Greece and Rome were especially coveted – exhibited the owners' wealth and connections more than serving as specimens for systematic study. Although many illustrated herbals featured detailed illustrations of plants, European medicine did not often prescribe insects or animal parts for treating disease and promoting health, so illustrations of insects were rare.[5] Robert Hooke's 1665 *Micrographia* included enormous engravings of insects such as a louse and a flea, but these images aimed to reveal the amazing capabilities of one of the first microscopes rather than to study these lowly pests.[6]

Maria Sibylla Merian was a member of a thriving community of artists in Amsterdam. Because of the exceptional quality of her work, Merian was able to command a high price for her art. Like many artists who depicted natural objects, Merian also traded in specimens. Pictures often served to identify specimens to ascertain whether they were rare and thus valuable.[7] Realistic depictions of natural objects in catalogues fostered a brisk business of selling and buying rare and beautiful natural objects that could be contemplated by natural philosophers, such as fish preserved in alcohol, stuffed snakes, exotic shells and pressed plants. The realism of Dutch art during this period contributed considerably to the development of early European professional science.[8]

Fifty years later, when Carl Linnaeus published *Species Plantarum* (1753), textual ways of classifying the natural world began to be adopted. Linnaeus codified the binary taxonomic system still used by biologists today. This hierarchical system divided animals and plants into kingdoms, families, genera and species. It was written in Latin – the language young men learned as part of their university education.[9] Merian was excluded from a classical university education by her gender and class. However, outside of male-dominated academia, Merian pursued her studies using what would become the modern scientific method – empirical enquiry. While male academics learned Latin and debated Aristotle's views on caterpillars or the theological implications of metamorphosis, Merian studied live specimens and recorded their various stages of development in her notebook. The images in Merian's *Metamorphosis* are striking in their depiction of the complete life cycle of each insect on one page – from egg to caterpillar to pupa to butterfly or moth. She based her drawings on painstaking observations of insects that she brought into her home, recording these daily in a notebook. Her 'Study book', as she called it, is filled with minute observations including exactly how long it took for a specific pupa to hatch into a butterfly.

Merian's designs are also unique because she situated insects in their natural environments. She usually portrayed them on the plant she saw them eating and in the context of other species found nearby. Other artists often drew insects on a plant without considering whether that plant was one on which the insect would normally be found.[10] Many illustrations from this period pictured insects laid out side-by-side in sterile rows. These rows of specimens can be seen as precursors to the charts of descriptive Latin words used by Linnaeus' apostles to distinguish different species. Merian, in contrast, was interested in observing particular insects in their particular surroundings. She understood the specificity of different insects' needs – that many would only eat certain plants and that those plants would only grow in specific places and times. Her illustrations show she was not interested in classifying specimens separately from the habitats in which they lived. Instead, she depicted insects within ecological groupings, arguably making her one of the first ecologists.[11]

Questions

1. Merian employed both images and text together to describe the insects and plants she found in Surinam. How do these two modes of description work in tandem to more fully inform the reader?
2. How many different senses does Merian enlist in her textual description? (Sight? Taste? Smell? Touch?) Does this deepen what the reader understands about the scene? If so, how?
3. What does this popular nature book tell us about the interests of seventeenth- and early eighteenth-century readers? What does it tell us about how European entomologists approached the study of nature during this period?
4. What various purposes might this lavishly illustrated volume have served?
5. Merian refers to the work of two other prominent naturalists of her day: Mr. Leeuwenhoek and Mr. Blankart. What does this tell you about Merian's place in entomology of the period?

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15
Anna Morandi Manzolini (1714–1774): Self-portrait in wax (1755)

Professor Corinne Doria

Introduction

This source is a self-portrait in wax, produced by Anna Morandi Manzolini (1714–1774), an Italian sculptor and anatomist who lived and worked in Bologna. From a modest family, she lived with her mother and brother until 1740, when she married the sculptor Giovanni Manzolini. Both former students of artists Giuseppe Pedretti (1694–1778) and Francesco Monti (1685–1768), Anna and Giovanni worked together fabricating anatomical wax models for the local university, where the study of anatomy was being developed and practised. Following her husband's death in 1755, Manzolini began working on her own. She developed a particular technique of human dissection and experimented with a new wax compound. She also produced a 250-page notebook in which she assembled and noted her observations, which challenged some of the dominant anatomical theories of the day. Her wax models depicted a diverse range of anatomical parts and included an impressive series on the human senses and the male reproductive organs. At her home studio, Manzolini offered anatomical demonstrations to students and amateurs alike, making her house one of the most important places for learning anatomy as well as a significant attraction for people making the 'Grand Tour'. In 1756, the Institute of Bologna appointed Manzolini Professor of Anatomy. Four years later, she received the title of Modellatrice (Sculptor) from the same institution. She became an internationally famous sculptor and received invitations and commissions from the Royal Society of London, the Emperor Joseph II of Austria and the Empress Catherine of Russia.

Source

Figure 4.2 A self-portrait in wax by Anna Morandi Manzolini, 1755. Image credit: by kind permission of the University of Bologna – Sistema Museale di Ateneo, Museo di Palazzo Poggi.

Analysis

Manzolini produced this self-portrait in 1755. She represented herself performing an anatomical dissection, an unusual act for a woman of the time. This self-portrait reveals the intersection of art, anatomy and gender during the eighteenth century.

During this period, women became more visible in both the intellectual and scientific domains across Europe. It was not unusual for aristocratic educated women to portray themselves wearing elegant dresses while sitting at a desk manipulating scientific instruments.[12] Manzolini represented herself wearing a pink taffeta dress and jewellery – an outfit certainly not practical for performing dissections. In this respect, the sculpture follows the conventions of eighteenth-century depictions of female scientists in aristocratic and elegant clothes. However, the refinement of Manzolini's dress stands in sharp contrast with the materiality of her act – she is seen in the process of performing a dissection. Although most women who depicted themselves as scientists were aristocrats, Manzolini was of humble origins. Her self-portrait presents a few more provocative characteristics: her gesture intentionally recalls the traditional portraits of male anatomists such as Andreas Vesalius; she is seen dissecting a brain, the organ considered at the time as the unifying centre of the human body and the seat of reason; and her elegant fingers grasp surgical tools (a forceps and a scalpel now lost). This portrait simultaneously displays elegance and refinement, at the time considered proper of a woman, while her action – anatomical dissection – is rather more gruesome.

This sculpture can be seen as a challenge to contemporary theories of sexual differences. In early 1770 in Bologna, there was a dispute among intellectuals about women's mental and rational abilities. Some, such as the intellectual Petronio Zucchini, claimed that women's mental stability was influenced by their uterus. Others such as Germano Azzoguidi argued that the burden of social and cultural factors negatively impacted women's rational abilities.

This self-portrait is deeply symbolic: produced at the beginning of Manzolini's career, it is a bold statement of her professional identity. The decision to represent herself while performing a dissection implies that she saw herself as an anatomist rather than an artist. It also alludes to her vision of anatomy as a science based on empirical observation. This self-portrait combines the two complementary aspects of Manzolini's work: the manufacture of wax models and the recollection of anatomical observations gathered in her notebook.

Manzolini's self-portrait can also be used to explore the changing relationship between art and anatomy in Europe in the eighteenth century.[13] Wax modelling has a long tradition, especially in Bologna. Prior to the eighteenth century wax models were predominantly made for artistic purposes and served as models for sculptors and painters. The eighteenth century saw a radical change in the conception and use of wax anatomical models, and they increasingly became used in medical education. At the time, teaching anatomy entailed significant difficulties. The civic and religious authorities had to provide authorisation to obtain corpses, which usually only happened once a year. Due to the lack of efficient conservation techniques, dissections were only possible in winter, when cold temperatures aided preservation. It was also difficult for students to examine body parts in great detail; corpses both decomposed and were damaged by the dissection itself.

The introduction of wax models solved most of these problems. Models were available year-round and posed no risk of putrefaction or fear of contagion. Furthermore, wax models depicted body parts in great detail. Models also allowed for more effective teaching since students could touch them. From the beginning of their careers, Manzolini and her husband conceived of their wax models as tools that could be used for medical teaching. They cared for the accuracy of minute anatomical details and wanted their models to illustrate a living body part and its connections with the rest of a living human body. Thus, their work contributed to establishing a standard of human anatomy and physiology in Europe.

Questions

1. What does this source reveal about the professionalisation of medicine and anatomy in eighteenth-century Italy?
2. In what ways did wax anatomical models enable more effective teaching of anatomy?
3. Discuss the ways in which the teaching of anatomy combined the visual, the textual and the oral.
4. What might anatomical wax models such as this reveal about the relationship between art and science, and between realism and symbolism?
5. How does this depiction both adhere to and break conventions for women in science during the period?

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16

Margaret Cavendish Holles Harley Bentinck (1715–1785): Frontispiece to *A Catalogue of the Portland Museum* (1786)

Dr Sadie Harrison

Introduction

Margaret Cavendish Holles Harley Bentinck, second Duchess of Portland, was an immensely powerful and wealthy aristocrat whose fortune allowed her to amass one of the finest collections of natural knowledge of her time.[14] While she did not travel to collect specimens or publish her observations, she transformed her domestic spaces into hubs of knowledge exchange, gathering around her the finest botanists, entomologists and other naturalists.[15] This source is an engraved illustration of her collection, accompanying the auction of her possessions after her death. The engraving shows a tower of coral, shells, trees, ceramics and mounted insects. Though the collection dispersed during this auction, this engraving is a portrait of Margaret Cavendish Bentinck's lifetime project of collecting and displaying natural knowledge.

For someone so well connected and influential in the world of eighteenth-century natural knowledge, the Duchess of Portland has had precious little attention from recent scholars. She is usually a character in the biographies of her male friends, such as Joseph Banks and Hans Sloane. However, historians Madeline Pelling, Rebecca Stott and Beth Fowkes Tobin have helped to bring Margaret Cavendish Bentinck to the forefront of collecting culture in the eighteenth century.[16]

Source

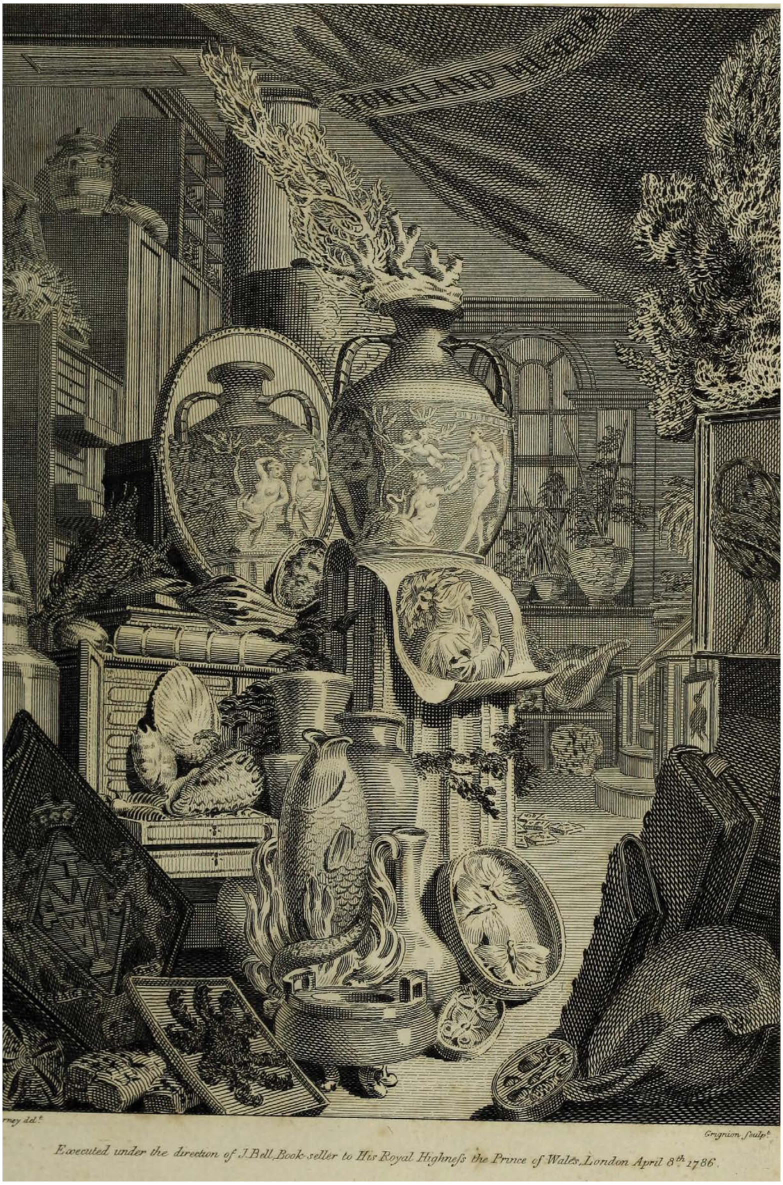

Figure 4.3 Frontispiece to *A catalogue of the Portland Museum, lately the property of the Dutchess Dowager of Portland, deceased: which will be sold by auction, by Mr. Skinner and Co. on Monday the 24th of April,* 1786. Image credit: Wellcome Collection.

Analysis

Margaret Cavendish Bentinck's wealth meant that she was able to take advantage of the consumer culture around *naturalia,* or objects from nature, in the eighteenth century. Displaying a physical collection of *naturalia* in the home or garden implied that the collector had an intellectual understanding of that *naturalia* – one possesses both the object and the knowledge it symbolises. Collectors brought plants into their homes and gardens from all over the world in order to display their understanding of the new knowledge being funnelled in through global botanical networks. Bentinck was a collector, a patron of explorers both in England and abroad, and kept a variety of gardens and glasshouses on her properties.

One of the most sociable forms of botanic consumption was the practice of travelling to wild places in groups to identify plants and collect them: this was known as 'herborising' or 'botanising'.[17] Going on botanising trips could be a day out or a long holiday. Sometimes, these trips were led by experts. Margaret Cavendish Bentinck funded many botanical excursions and was fond of bringing visitors on a botanising tour of her gardens at her home, known as Bulstrode.[18] The Duchess of Portland's constant companion and fellow botanist for many of these botanising trips was Mary Delany, who recorded many such days with Bentinck, showing the daily presence of botany in the domestic spaces of Bulstrode. The letters written by Delany allow historians to look at the ways women's practices and handmade arts could enable women to express botanical interest and knowledge.[19] Delany herself gained notice in eighteenth-century botanical networks through artistic practices that expressed her botanical knowledge. She 'invented a new way of imitating flowers' through detailed 'paper mosaics'– a kind of botanical illustration firmly entrenched in the craft of paper cutting.[20] Delany's illustrations were honed in Bentinck's house as they practised gentlewomanly craft together, known as 'accomplishments'. Accomplishments, or crafts that middling to noble women created to occupy their minds and decorate their spaces included embroidery, paper cutting, drawing, shellwork, featherwork, and other domestic decorations. In artistic circles, these crafts have often been ignored or derided. The problem, as Amanda Vickery states, is that these objects were 'neither useful nor truly art'; women were relegated to creating crafts because they were excluded from more legitimised fine arts.[21] This derision runs parallel to the scientific world's dismissal of women's cultivation of natural knowledge in the same era.

Recently, some historians have begun to look at these crafts as worthy of study. Historian Amanda Herbert's book *Female Alliances* demonstrates how women's domestic production practices were tools to forge and strengthen relationships.[22] Women such as Bentinck and Delany created crafts for each other, such as fruit marmalades and embroidered textiles, and gave them as symbols of friendship. Moreover, creating domestic projects together served to strengthen female relationships. Accomplished women practised shellwork – in which collected or purchased shells were formed into patterns on walls or furniture – and the similar craft featherwork. Delany and Bentinck spent many hours together creating designs with shellwork and collaborated on a shellwork room, or 'grotto' at Bulstrode.[23]

Bentinck and Delany used the collections and gardens at Bulstrode to inspire their accomplishment crafts. Along with shells, Bentinck particularly loved working with fungi. Delany reported the transformation the house underwent when fungi was in season:

> Her Grace's breakfast-room, which is now the repository of sieves, pans, platters, and filled with all the productions of *that nature*, are spread on tables, windows, chairs, which with books of all kinds, (opened in their useful places), make an agreeable confusion; sometimes, notwithstanding twelve chairs and a couch, *it is* indeed a little *difficult* to find a *seat!*[24]

Bentinck employed botanical expert John Lightfoot (1735–1788), who escorted Bentinck and Delany on many excursions to collect *naturalia*. Delany's letters described going 'out in search of curiosities in the fungus way, as this is now their season', before returning to hear Lightfoot recite 'a lecture on [fungi] an hour before tea, whilst her Grace examines all the celebrated authors to find out their linnean classes'.[25] During these lectures, Delany wrote that she would frequently undertake embroidery projects inspired by their specimens.

By training in accomplishments, women learned to draw, paint and embroider flowers. These accomplishments were expressions of feminine observation and knowledge-making. Just as histories of science privilege male practices, histories of fine art are dominated by male creators. Histories of accomplishments present an alternate, feminine way knowledge was created and disseminated through visual, artistic practices. The collections and crafts of the Duchess of Portland served more than a merely static, decorative function. They were wholly interactive – to be shared and delighted in together.

Questions

1. How does collecting natural items reflect on the knowledge of the collector?
2. Look at the image of Margaret Cavendish Bentinck's home and imagine you are standing in that room. What impressions would you form of the woman who lives in that home? What is Bentinck saying about herself?
3. Many women, such as Margaret Cavendish Bentinck, practised botanical drawing or embroidery. What sort of natural knowledge or scientific practices might go into such a craft?
4. Illustrations of nature that are published in books are considered scientifically valuable, but depictions of nature in embroidery, paper cutting, unpublished drawings and other accomplishment-style crafts are not given the same credit. What factors may contribute to this distinction, and is the difference fair?
5. During her life, Margaret Cavendish Bentinck's collection was lauded as comparable to those of contemporaries such as Hans Sloane, whose collection served as the foundation of the British Museum. However, Bentinck's collection dispersed at auction after her death. What consequences could that loss have had on her legacy?

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17

Marie-Anne Paulze-Lavoisier (1758–1836): Illustration in a scientific text (c. 1790)

Francesca Antonelli

Introduction

The source below is a drawing by Marie-Anne Pierrette Paulze-Lavoisier (1758–1836), a woman of the French *haute bourgeoisie* who, since the mid-1770s, became known as the wife and scientific associate of the chemist and farmer general Antoine-Laurent Lavoisier. In this artwork, dating to the early 1790s, she depicted a moment of laboratory life, notably the experiments on human respiration and transpiration performed in her Parisian residence by Lavoisier and his collaborators. In the middle of the drawing, we see a man who is exhaling through a pipe, while the other investigators are measuring the physical and chemical effects produced by his respiration. At the same time, a third man is interacting with Paulze-Lavoisier, who is sitting at a desk and taking notes of the experiments. The presence of Lavoisier's autograph annotations (such as '*fig. 1ere*', on the top right of the apparatus) suggests that the image was meant to be published as an illustration for a scientific text, most probably the *Mémoires de physique et de chimie*.[26]

Source

Figure 4.4 A man seated in a barrel with his head under a glass canopy; he breathes and his pulse is taken. Lavoisier dictates to his wife, who is writing a report. Drawing attributed to M.A.P. Lavoisier, c. 1790, Wellcome item no. 37197i. Image credit: Lavoisier, Marie-Anne-Pierrette, 1758-1836, Wellcome Collection.

Analysis

The most striking feature of this drawing lies in the fact that a woman, here represented in the act of taking notes during an experimental session, is the author of *both* the written protocols of, and the image that illustrates, the experiments. In the early 1790s, when Paulze-Lavoisier realised this artwork, she was already known as one of Lavoisier's most active associates. From the early 1770s, she promoted her husband's theories through correspondences and domestic sociability. Furthermore, on the eve of the French Revolution, she joined some of Lavoisier's most important editorial projects, including the French edition of the *Essay on Phlogiston* by Richard Kirwan (published in 1787 and translated by Paulze-Lavoisier in 1788) and the *Traité Élémentaire de Chimie* (published in 1789 with 13 engraved plates signed by Paulze-Lavoisier).[27] Writing letters, translating and illustrating were indeed quite common practices among eighteenth-century elite women. They were also some of the ways women contributed to knowledge-making, often working alongside fathers, husbands and other family members.

In the selected visual source, Paulze-Lavoisier represented herself in a rather unusual way. She depicted herself as a note-taker or, to use her own words, as a 'secretary' (*secrétaire*). In eighteenth-century French, the term '*sécretaire*' referred to a high-ranking official who wrote letters and formal documents on behalf of political and ecclesiastic authorities. During the seventeenth and eighteenth centuries, the secretary's role was also embodied within French scientific academies. Secretaries relied on a set of writing practices to stockpile great amounts of information.[28] Similarly, Paulze-Lavoisier was responsible for keeping and ordering notes during experimental sessions; a process intended to preserve observational data and protect it against the weakness of memory. Her work was added to Lavoisier's 'experimental archive' (the so-called *Registres de Laboratoire*), a contribution which was strongly emphasised in this drawing.

It is important to note, however, that throughout her life Paulze-Lavoisier was careful not to be represented as an ambitious woman. Quite the opposite, she described herself as a modest and unpretentious person and was apparently unwilling to attract the attention of her husband's colleagues and readers. On several occasions, for instance, Paulze-Lavoisier attempted to reduce her role as a translator of chemical texts. She also published her translations anonymously and justified her interest in science as a way to honour and serve her husband.[29] By doing so, she conformed to the gender norms of her time; women were expected to appear modest and discreet, especially when dealing with intellectual ambitions.

In fact, the rise of a new female authorship coexisted with a sense of mistrust towards female authors.[30] It is likely that Paulze-Lavoisier personally experienced this tension. While she adopted a modest and cautious attitude towards authorship, Paulze-Lavoisier repeatedly engaged in a constant effort of self-promotion. Domestic spectacles and salon sociability, for instance, were some of ways she displayed her talents as a secretary to a selected audience. The audience often expressed a positive sense of wonder and astonishment while attending her performances. In this sense, she resisted becoming an 'invisible technician' – a person who worked for eighteenth-century savants and natural philosophers in domestic laboratories but whose work and contributions were not recognised.[31] Rather, Paulze-Lavoisier tried to build her own reputation as a scientific associate, while at the same time protecting herself from social scorn. The selected drawing epitomises Paulze-Lavoisier's personal strategies and provides an exceptionally rich visual document of her role in the laboratory practice.

Questions

1. Born in a family of tax farmers, Paulze-Lavoisier belonged to one of the highest social ranks of the *ancien régime* France. How might this biographical detail relate to her collaboration with Lavoisier? How might her social background have influenced her pursuit for social recognition?
2. Paulze-Lavoisier's drawing illustrates a collective experiment. How can we identify the roles and individual contributions? How can we determine if there are gender barriers? How can this picture help us to reassess the concept of scientific authorship?
3. Lavoisier's experiments on respiration were performed in a domestic context. What can this tell us about the role of domesticity in knowledge production? How could this feature of this period affect women's involvement in experimental practice?
4. The French term '*secrétaire*' refers to a political office which was connected to a set of scribal practices. How could Paulze-Lavoisier's work as a '*secrétaire*' relate to the recent literature on the history of information management in the seventeenth and eighteenth centuries?
5. Paulze-Lavoisier's drawing was meant to be published as an illustration of scientific text. What can this tell us about the role of visual sources in knowledge production? To what extent would her choice of representing herself as a part of the picture have challenged gender norms of the time?

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1 Smith, *The Body of the Artisan*; Smith and Schmidt, *Making Knowledge in Early Modern Europe*.
2 Capern, *The Routledge History of Women in Early Modern Europe*.
3 Schiebinger, *Nature's Body*.
4 Shteir, *Cultivating Women,* 1996.
5 Chinese medicine, however, did draw on animal and insect parts. See Nappi, *The Monkey and the Inkpot*, 96–110.
6 Hooke, *Micrographia.*
7 Margócsy, *Commercial Visions*, 38–42.
8 Alpers, *The Art of Describing.*
9 Koerner, *Linnaeus*, 46.
10 Especially when insects were depicted on flower arrangements, they were understood to be *memento mori* – reminders of mortality and death.
11 Etheridge, 'The biology of *Metamorphosis Insectorum Surinamensium*', 29–31.
12 For instance, the portrait of Émilie du Châtelet (1706–1749) by Maurice Quentin de La Tour.
13 Riva et al., 'The evolution of anatomical illustration and wax modelling in Italy', 209–222.
14 Lightfoot, *A Catalogue of the Portland Museum*; Pelling, 'Collecting the World', 101–120.
15 On the circle of naturalists gathered around the Duchess of Portland, see Cook, 'Botanical exchanges', 142–156.
16 Tobin, *The Duchess's Shells.* Stott, *Duchess of Curiosities.* Pelling, 'Collecting the World', 101.
17 Tobin, *The Duchess's Shells*, 60.
18 Tobin, *The Duchess's Shells,* 62.
19 On Mary Delany's life and works, see Delany and Llanover, *The Autobiography and Correspondence of Mary Granville*. Laird et al., *Mrs Delany & Her Circle*. Babilas, 'From female accomplishment to botanical science', 631–642.
20 Delany and Llanover, *The Autobiography and Correspondence of Mary Granville*.
21 Vickery, *Behind Closed Doors*, 231.
22 Herbert, 'Noble presents', 2014, 52–77.
23 Moore, 'Queer gardens', 2005, 49–70, 61. Pelling, 'Collecting the World', 101.
24 Delany and Llanover, *The Autobiography and Correspondence of Mary Granville.*
25 Delany and Llanover, *The Autobiography and Correspondence of Mary Granville,* 48.
26 Beretta, 'Imaging the experiments on respiration and transpiration of Lavoisier and Séguin', 2012.
27 Kawashima, *Émilie du Châtelet et Marie Anne Lavoisier,* 2013.
28 Blair, *Too Much to Know,* 2010.
29 Roberts, *Sentimental Savants,* 2016.
30 Knott and Taylor, *Women, Gender and Enlightenment*, 2005.
31 Shapin, 'The invisible technician', 1989.

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Part V

Societies and networks of science (1660–1850s)

Timeline: individuals and events in the history of science	Timeline: individuals, events and objects in this part
1660 The Royal Society of London for Improving Natural Knowledge (later the Royal Society) is founded.	
1666 The Académie des Sciences (Academy of Sciences) founded in France.	
1699–1777 Marie Thérèse Rodet Geoffrin, French salon host with connections to some of the most influential philosophers and writers of the time, and a leading figure in the French Enlightenment.	
1718–1800 Elizabeth Montagu, British patron of the arts, writer, literary critic, and known for her salons, where she hosted men and women from literary and scientific backgrounds to exchange ideas.	
1724 The Saint Petersburg Academy of Sciences (later the Imperial Academy of Sciences and Arts) founded in Russia.	
1743–1820 Joseph Banks, English naturalist, patron of the sciences, and president of the Royal Society between 1778 and 1820.	

Timeline: individuals and events in the history of science	Timeline: individuals, events and objects in this part
	1744–1810 Ekaterina Romanova Dashkova, Russian noblewoman, invited by the Russian Empress Catherine II to lead the Imperial Academy of Sciences in St. Petersburg in 1782.
	1749–1833 Josefa Amar y Borbón, Spanish writer and member of the Aragonese nobility, and the first woman admitted to the Academia Médico-Práctica de Barcelona (Medical Academy of Barcelona).
	1750–1848 Caroline Lucretia Herschel, German astronomer.
1770 The Academia Médico-Práctica (Medical Academy) founded in Barcelona.	
	c. 1780–1855 Lady Jane Davy, British socialite with connections to many contemporary natural philosophers and intellectuals.
1780–1872 Mary Somerville, Scottish writer elected as one of the first female honorary members of the Royal Astronomical Society.	
1789–94 The Malaspina expedition, a scientific expedition commanded by Tuscan explorer Alejandro Malaspina and funded by the Spanish government, which travelled to South America, the Pacific, the Philippines, New Guinea, New Zealand and Australia.	

Timeline: individuals and events in the history of science	Timeline: individuals, events and objects in this part
	1799 The Junta de Damas de Honor y Mérito (Committee of Ladies of Honour and Merit) took over the running of the Madrid Foundling House.
1799 The Royal Institution of Great Britain is founded, known for its lectures on scientific subjects.	

Introduction

This part explores how women participated in scientific networks, located in both formal institutions and domestic spaces, between the mid-eighteenth and mid-nineteenth centuries in Europe and Russia. Previous parts have referred to the rise of learned academies as key spaces for promoting and pursuing knowledge.[1] Founded in the seventeenth and eighteenth centuries across Europe and Russia, these establishments often restricted their membership, allowing only men of a certain standing to join their ranks.[2] Several sources in this part reveal female exceptions; women who were able to access these male-dominated spaces under certain conditions. At the very end of the eighteenth century, the Royal Institution of Great Britain was founded, which offered lectures to the general public in London and invited women to attend from the outset, opening the door for women's participation in more formal spaces of science.[3]

This part explores the admission of women to institutions that shaped intellectual discourse and directed scientific priorities in Europe. Josefa Amar y Borbón became the first woman admitted to the Academia Médico-Práctica de Barcelona (Medical Academy of Barcelona) on the grounds of the intellectual prestige she had acquired through her published works, such as the one featured in this part. The second source is an extract from the memoirs of the Russian princess Ekaterina Dashkova, the first woman to lead the Imperial Academy of Sciences in St Petersburg, and the first woman appointed as head of a scientific academy in Europe. The third source is an extract from the writings of Caroline Herschel, the first salaried female astronomer, and the first woman to be awarded the Gold Medal of the Royal Astronomical

Society in Britain. Besides their individual intellectual and personal achievements, it was their wealth, education, familial connections and social networks that made it possible for these women to be recognised in these patriarchal spaces.[4]

Looking beyond the academies, women engaged in other activities and social contexts devoted to the furthering of scientific knowledge. Comments concerning Lady Jane Davy, wife of the chemist and inventor Sir Humphry Davy, reveal the importance of the aristocratic home – a place often presided over by women – as a significant social space for the sharing and production of knowledge.[5] The fifth source, which explores the management of the Madrid Foundling House by the *Junta de Damas de Honor y Mérito* (Committee of Ladies of Honour and Merit), is another example of a space outside of the formal scientific academy that produced new medical knowledge.

18

Josefa Amar y Borbón (1749–1833): An extract from *Discurso sobre la educación física y moral de las mujeres* (*Discourse on women's physical and moral education*) (1790)

Professor Mónica Bolufer Peruga[6]

Introduction

This text is the introduction to the first part of a pedagogic work by the eighteenth-century Spanish writer Josefa Amar y Borbón (1749–1833), the *Discurso sobre la educación física y moral de las mujeres* (*Discourse on women's physical and moral education*), published in Madrid in 1790. Josefa Amar y Borbón belonged to a family of the lower Aragonese nobility whose male family members were physicians or bureaucrats (one of her brothers, Antonio José Amar y Borbón, was the last viceroy of Nueva Granada in Spanish colonial America). Her father, José Amar y Arguedas, was a university professor in Zaragoza from 1743, appointed royal physician in 1754, and later elected vice-president of the Academia Médica Matritense (Madrid Medicine Academy). Her mother, María Ignacia de Borbón, was a learned woman and the daughter and granddaughter of other prestigious physicians, Miguel Borbón y Berné (vice-president of the Royal Medical Court) and Felipe Borbón. Josefa Amar married the lawyer Joaquín Fuertes Piquer, nephew of another distinguished physician and philosopher, Andrés Piquer. In November

1790, Josefa Amar became the first woman admitted into the Academia Médico-Práctica de Barcelona, on the grounds of the intellectual prestige she had acquired nationally, and to some extent internationally, with her published works. Her *Discourse,* published that same year, was particularly influential in helping her gain this recognition, as were her family connections to the medical profession and its institutions.

Source

Amar y Borbón, Josefa. *Discurso sobre la educación física y moral de las mujeres* [1790]. Edited by María Victoria López-Cordón. Madrid: Cátedra, 1994. 1–6.

Entre los bienes de la naturaleza ninguno hay comparable con el de la salud y robustez del cuerpo. Este solo puede recompensar la falta de los demás, y sin él todos son inútiles. Porque ¿de qué le sirve a un rico enfermizo la abundancia de manjares, la multitud de criados y de conveniencias, y aun el séquito de aduladores, si su estómago no puede digerir sino ciertas viandas, y esas en poca cantidad, ni se encuentra en disposición de usar de sus facultades sino con un millón de limitaciones? Si tiene entendimiento, y vuelve la vista a considerar el estado de un labrador destituido de riquezas, pero sano y contento en el centro de su familia, gozando de su vida desde el momento que amanece, y muriendo quizá de solo vejez, ¿no trocaría gustoso su aparente felicidad por la de éste? Pues toda la diferencia está en que el uno disfruta de cuanto tiene, y hasta de su misma existencia por el beneficio de la salud, y el otro es verdaderamente pobre y desgraciado en medio de la opulencia, porque no puede gozar de ella. Sus privaciones le son más sensibles que al otro la falta de conveniencias, de que acaso no tiene idea. Por otra parte, ¿y qué satisfacción se encuentra en el estudio o en las diversiones cuando no hay salud? Nada se puede hacer en este estado, o si se hace algo es con perjuicio de la vida, o con cierta flojedad de ánimo que se trasluce desde muy lejos. Nuestra máquina está de tal suerte organizada en todas sus partes, que cuando alguna padece, las otras no pueden ejercer libremente sus funciones, y éste es uno de los motivos para que se procure y estime la salud.

La salud es conveniente a entrambos sexos: porque si los hombres deben ocuparse en varios destinos que requieren fuerza y agilidad, del mismo modo hay bastantes mujeres que están precisadas a trabajar corporalmente para ganar su vida, y cuando esta razón no hubiera, bastaría la que tienen todas señoras y no señoras, como es la de parir y criar hijos robustos. Esto importa más de lo que parece, y si todos los legisladores ordenasen sus le yes en cuanto a la infancia con la prudencia que Licurgo, serían más universales los maravillosos efectos que se vieron en Esparta. Licurgo estableció que las muchachas se ejercitasen igualmente que los muchachos en los juegos militares, y no lo hacía, como dice Plutarco en la vida de aquél, para que siguiesen la profesión de las armas, sino para que produjesen hijos inclinados a la milicia, y que pudiesen tolerar fácilmente las fatigas. El efecto de esta providencia y de otras encaminadas al mismo fin correspondió a los designios de su promulgador. En cierta ocasión preguntó una extranjera a Gorgo, mujer del Rey Leónidas, en qué consistía que las mujeres de Lacedemonia eran las únicas que tenían verdadero dominio sobre los hombres, y con razón respondió ésta: "porque también somos las únicas que parimos hombres invencibles".

¡Qué distinta es nuestra educación! Tan lejos está de fomentar una fortaleza varonil en las mujeres, que se les permite contraer desde niñas el vicio de asustarse por cualquier cosa, aun sin discernir entre los verdaderos peligros o imaginarios. Lloran por costumbre, y todo esto ocasiona una delicadeza y pusilanimidad, que llega a hacerlas inútiles para todo. Mr. Fénelon es de sentir que en esto hay gran parte de afectación, y que no hay otro modo de vencerla que el desprecio, pues aunque no hayan de tener la mismas ocasiones que los hombres de manifestar el valor, es bueno tenerlo para poder resistir los peligros imprevistos que ocurren a todos, y no asustarse sino de casos muy terribles. Las mujeres tienen tanto influjo en la primera educación física y moral de los niños, que por esto quería Platón que se las instruyese del mismo modo que a los hombres, conociendo que son de mucha consecuencia para el Estado sus errores o sus virtudes.

Translation

Of the gifts granted us by nature, none is comparable to that of bodily health and strength. It alone can compensate for the lack of the others, and without it, all are useless. For what good to a wealthy invalid are an abundance of fine food, a multitude of servants and income, and even a retinue of flatterers, if his stomach can only digest certain foods, and those in small quantities, or if he is in no state to use his faculties except with a million limitations? If he had wisdom, and were to consider the circumstances of a working man who has no money but lives happily and healthily, surrounded by his family, who takes pleasure in his life from the moment it begins and perhaps dies only of old age, would the rich man not willingly exchange his apparent happiness for that of the worker? For the difference lies in the fact that the poor man enjoys what little he has, and indeed enjoys his very existence because he has the benefit of good health, while the rich man is in truth poor and wretched in the midst of his wealth, because he cannot enjoy it. He feels his privations more than the other feels his lack of income, of which he may not even be aware. Moreover, what satisfaction is to be found in studies or diversions unless one has good health? We can do nothing if we suffer from poor health, or at least not without risking harm to our lives, or by acting with a certain lack of spirit that is easily perceptible. The workings of our body are organised in such a way that when one part suffers, the others cannot freely fulfil their functions, and this is one of the reasons why good health is both sought after and highly valued.

Good health is expedient for both sexes: while men need to occupy themselves in various employments that require strength and agility, there are similarly plenty of women who are required to undertake physical labour in order to earn a living. And were this reason not to exist, there would still exist that other which applies to all women, whatever their station, namely that of giving birth to and bringing up healthy children. This matters more than it seems, and if all legislators were to arrange their laws regarding children with the prudence of Lycurgus, the miraculous results seen in Sparta would now be more universal. Lycurgus ordained that girls should take as much part as boys in military games, and as Plutarch tells us in his life of Lycurgus, this was not to turn young women themselves into soldiers, but to strengthen their bodies so that they would be better able to endure the pain of childbirth and produce sons inclined to a military life. The effect of this ruling and of others designed for the same end met its promulgator's aims. A foreign woman once asked Gorgo, wife of King Leonidas, why it was that the women of Sparta were the only ones who could hold sway over men, and the Queen with good reason replied, "Because we are also the only ones who give birth to men".

How different is our education. Far from encouraging virile strength in women, it instead allows them to acquire from girlhood the vice of taking fright at the slightest thing, without distinguishing between real and imagined dangers. They are accustomed to weeping, and all this instils a delicacy and timidity in them which render them unfit for anything. It is Monsieur Fénelon's opinion that much of this is simple affectation, which has to be treated with contempt, since although women may not encounter the same opportunities as men to demonstrate their valour, it is right that they possess this quality in order to ward off the unforeseen dangers that face all people, and only to take fright in extreme situations. Women have so much influence on the early physical and moral education of children and this is why Plato wanted them to be educated in the same way as men, knowing that their faults or virtues are of great consequence to the State.

Analysis

Although the selected passage, being an introduction, includes virtually no references to authorities, throughout her work Josefa Amar displays familiarity with the intellectual traditions of the early Spanish Enlightenment (c. 1760s–1816).[7] This familiarity includes the works of Andrés Piquer, as well as contemporary European medical knowledge, including the works of Ballexferd, Fourcroy, Le Roy, Tissot, Van Swieten, Raulin, Orlandi, and the proceedings of the Berlin, Stockholm and Helvetica academies. A talented girl, Josefa Amar received a highly unusual education, especially considering she was not an aristocrat, but a member of the middle ranks. She had a solid training in Latin and Greek, modern languages (French, English and Italian), the classics, and the sixteenth-century Spanish humanists (Vives, Fray Luis de León, Nebrija, and Arias Montano).[8] She also benefited from a well-stocked family library for her extensive readings of medical literature, which went far beyond what was customary among cultivated women of her time.

The *Discourse on the physical and moral education of women* (1790), her major work, is a learned and lengthy treatise divided into two sections.[9] The second and longer section covers women's moral, domestic and intellectual education, with a particular stress not only on its importance for the public good, but also, in contrast to the more usual utilitarian approaches, the importance of education for self-esteem and for the fulfilment of women's potential as rational beings. The first section of the book, from which this passage is taken, is a thorough revision of contemporary medical advice concerning women's healthcare, particularly through pregnancy (covered in chapter one), childbirth and breastfeeding (covered in chapter two, where she does not share the harsh judgements of contemporary male authors towards the ignorance of midwives), choice of wetnurses if needed (covered in chapter three, where again she distances herself from the most dogmatic arguments favouring breastfeeding regardless of the circumstances and severely blaming women who could not, or did not, practice it), and childcare (covered in chapters four to seven).[10]

Amar's arguments in this passage stress the importance of health and physical wellbeing for both men and women, for their own sake as well as for its social consequences for the public good. In this respect, she subtly but significantly differs from other perspectives on women's physical education and healthcare, heavily dominated by populationist aims, which stressed above all women's role in reproduction and the need to make them healthy breeders. Although she shared this eighteenth-century concern with increasing population in numbers and strength, the first paragraph of her introduction makes no gender differentiation in praising health as a source of personal happiness (a central pursuit for her) and pleasure.[11] Only in the second paragraph does she introduce a gender differentiation, and even there, she underlines that many women, just like men, need to undertake physical work to earn their living; it is in their role as mothers that the difference lies, but this comes later in her arguments. Finally, the last paragraph lays out even more clearly her strong criticism of how women were educated and her plea for more balanced, in some aspects egalitarian, gender relations. She presents women's physical and psychological weakness, to a great extent, as the result of an education that encourages bodily inhibition, shyness and fear, instead of courage, determination and confidence. Amar argues that, instead, physical and moral education should make women not only stronger and more capable of raising healthy children, but also more self-assertive.

This passage, along with the rest of the work, attests to both the refined education of its author and to her firm defence of gender equality, which can also be found in her earlier published works. Born in Madrid, Josefa Amar had moved after marriage to Zaragoza. Here she translated various important texts from Italian and English, connected with intellectual and reformist circles, and approached the Aragonese Economic Society of Friends of the Country to which her husband and many male friends belonged. She was the first woman to be admitted into the Aragonese Economic Society of Friends of the Country in 1782.[12] She wrote her *Discurso en defensa del talento de las mujeres y de su aptitud para ejercer el gobierno y otros cargos en que se emplean los hombres* (Discourse in defence of women and of their aptitude for government and other positions in which men are employed) (1786) to argue for women's admission to the Economic Society in Madrid, to which she was later successfully admitted.[13] She claimed and tried to persuade the male members of the Society that intellectual equality between men and women was a requirement in an institution that claimed to represent modernity and progress.[14] This text was widely acclaimed and was both published in the periodical press and translated into Italian in 1789 and 1810 respectively.[15]

On 22 November 1790, Josefa Amar was admitted to the Academia Médico-Práctica of Barcelona, founded in 1770 and accorded in 1785 the status of Royal Academy, as *socia libre* (free associate). This was a newly-created position to allow relevant intellectual figures, not just physicians, who did not reside in Barcelona, and therefore did not attend the meetings, to be admitted to the Academy. Among the first six to be admitted in this role were two Frenchmen – the botanist and treasurer of the Académie des Sciences Mathieu Tillet, and the chemist Louis Proust – and three distinguished Spaniards – physicians Antoni Martí i Franquès and Antoni Palau, and the chemist Pedro Gutiérrez Bueno. The members of the Academy acknowledged Josefa Amar's 'instruction in medical questions', particularly visible in her work on women's physical education, but also her family origins, described as her 'ancient lineage of very learned royal physicians'. The fact that the archives of the Madrid Medicine Academy are partially destroyed for the period 1752–1791 makes it impossible to verify whether this sister Academy reacted in some way to the work of the daughter of the man who was its vice president up to his death in 1779.

Questions

1. How might the notion of women's bodies as a product of education and socialisation shown in this passage relate to modern theories of gender?
2. Compare this source to the final source in this part, The Junta de Damas de Honor y Mérito (Committee of Ladies of Honour and Merit): children's parchments in the Madrid Foundling House (1802). What are the similarities and differences between the forms of knowledge produced?
3. How might we consider this source within the context of the Spanish intellectual milieu of the late eighteenth and early nineteenth centuries?
4. From where could the author have taken the idea of the body as a well organised machine, and how might this be understood in relation to her Catholic religious beliefs?
5. Consider the social backgrounds and connections of the women mentioned in this part, including Josefa Amar y Borbón. How might this have enabled them to undertake natural philosophical pursuits?

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19

Ekaterina Romanova Dashkova (1744–1810): An extract from *Memoirs of the Princess Daschkaw, Lady of Honour to Catherine II* (1840)

Professor Simon Werrett

Introduction

This source is an extract from Ekaterina Romanovna Dashkova's *Memoirs of the Princess Daschkaw, Lady of Honour to Catherine II* (1840), in which she discusses her first meeting, in 1782, with the members of the Imperial Academy of Sciences in St Petersburg, Russia. Dashkova had just been asked by the Russian Empress Catherine II to lead the academy. This was the first time that a woman had been appointed to the position in Russia, and the first time a woman had been appointed to lead a scientific academy in Europe. Catherine argued that Dashkova was eminently suited for the job, being unparalleled in Russian society at the time for her education and connections to prominent European intellectuals of the period. Dashkova went on to be a brilliant administrator of the Academy.

Source

Dashkova, E. R. *Memoirs of the Princess Daschkaw, Lady of Honour to Catherine II Volume 1*. Edited by W. Bradford, 301-8. London: Henry Colburn, 1840. https://archive.org/details/memoirsprincess03wilmgoog/page/n7/mode/2up (accessed 14 December 2022).

The third day after my nomination, which was a Sunday, I received a visit from the professors, the inspectors, and other officers of the academy. I told them it was my intention to go next day to the academy; and I begged them to understand that on all occasions, whenever they might wish to confer with me on matters of business, they had full permission to enter my house without ceremony.

The whole of that evening I was occupied in reading the several reports which had been presented, earnestly intent on gaining some clue to the intricacies of that labyrinth in which I was involved, under a full persuasion that every step I took would be a subject of criticism, and that I could not fall into the most trifling error without censure.

I made myself acquainted, also, with the names of the most distinguished members of the academy, and the next morning, before I went thither, I paid a visit to the celebrated Euler[16] who had known me for many years, and had always treated me with kindness and consideration. In disgust with the conduct of Domashneff,[17] he had ceased all attendance at the academy, except when opportunities offered of counteracting, in concert with others, the ruinous effects of the late director's proceedings, which he had more than once represented by letter to the empress.

This learned person was, without question, one of the first mathematicians of the age. He was, besides, well versed in every branch of science, and such was his vigour of mind and habitual industry, that even after he had lost his sight he did not at all abate of his intellectual labours; but with the aid of Mr. Fuss,[18] the husband of his granddaughter, who read to him, and wrote as he dictated, he prepared a variety of materials, which served to enrich the publications of the academy for several years after his death.

I begged of him to accompany me that morning, that on my first appearance at the head of a scientific body I might have the advantage and sanction of his attendance, which, if inconvenient or irksome to him, I promised never to ask on ordinary occasions. He appeared flattered at my request, and allowed himself to be conducted to my carriage by his son, the perpetual secretary of the academic sittings, whom I also invited, as well as his grandson, who had the task of leading the illustrious blind.

As soon as I entered the hall of their sittings, addressing the professors and members there assembled, I lamented my own deficiency in scientific attainments, but spoke of the high respect I entertained for science, of which M. Euler's presence amongst them, whose auspices I had solicited in conducting me to the academy, would, I hoped, be received as the most solemn pledge I could offer.

After having delivered these few words I took my seat, and remarked that M. Schteline,[19] professor of Allegory, as he was called, had taken his place next to the director's chair. This gentleman, whose pretensions to science might, perhaps, be suited to the designation he bore, gained this extraordinary title and appointment in the time of Peter the Third, and with it the rank of councillor of state, which, answering to that of major-general, gave him, as he thought, a claim to the highest distinction amongst the members of the academy. Turning, therefore, to M. Euler, "Sit down, Sir," I said, "wherever you please, and whatever seat you may happen to take, that seat must consequently be deemed the highest." [...]

From the hall of assembly I passed on into the chancery, where a registry is kept of everything relative to the pecuniary and economical concerns of the establishment. Here the superintendents were at their posts, to whom I observed, that a general idea had gone abroad of the great neglect and malversation which had been suffered under the late director, such as not only to have exhausted the revenue of the academy, but to have left it in debt.

"Henceforward," I said, "it must be our common duty to redress these abuses; and as it is not necessary that any branch of the establishment should fall to decay, the most obvious and efficacious means in our power are, to apply exclusively to its own wants and advantages all the resources which the academy may possess. With this view, therefore, I am resolved neither to enrich myself at its expense, nor to allow the smallest peculation in any of the subordinate offices; and could I but persuade every one to regulate his conduct strictly by this principle, I should very soon be in a situation to recompense the zealous and deserving, by promotion or some addition to their salaries."

The Commentaries which had formerly been published by the academy, in two volumes quarto, yearly, had dwindled down into one, and were now discontinued altogether for want of the requisite types.[20] The printing office and presses I found in the utmost disorder, and in want of everything to make the latter effective. It was one of my first cares to have them completely repaired, and to have such types provided as were fit and appropriate; and it was not long before two volumes of

Commentaries were again issued from the academy, compiled, for the most part, from articles which had been furnished by M. Euler […]

The academy was in debt to the different booksellers of Russia, France, and Holland; but as I did not choose to ask her majesty for an extraordinary supply to answer these demands, I had recourse to the expedient of offering those books to sale which were issued from the academic press, at thirty per cent lower than the established prices. From this source I had soon the means of paying these debts […]

In a little more than a year I had the power of raising the stipends of all the professors, and also of establishing three new courses of lectures in mathematics, geometry, and natural history, which were delivered gratuitously to all who chose to attend them, by a native professor in our own language. I often attended them myself, and had the satisfaction of knowing that the sons of some of the poorer nobles, as well as many of the junior officers of the guards, derived much benefit from the institution. The remuneration paid to each of the professors, at the end of each course, was two hundred roubles out of the economic fund.

Analysis

Born into a noble Russian family in 1743, Ekaterina Dashkova (neé Vorontsova) received a good education and maintained a lifelong love of writing, literature and learning.[21] Married at the age of sixteen to a nobleman, Mikhail Ivanovich Dashkov, she rose in court circles after the ascent to the throne in 1762 of her friend, Empress Catherine II. The two women were close but also rivals. When tensions rose with Catherine, Dashkova left Russia to make a tour of Europe from 1768 to 1782. During this time, she oversaw the education of her son and met numerous enlightened savants including Denis Diderot, Voltaire, and Benjamin Franklin. She was, via Franklin, the first woman to be elected to the American Philosophical Society.[22] She lived in Paris and Edinburgh and enjoyed access to the most notable natural philosophers of the time. When she returned to Russia, Catherine considered her ideally qualified to direct the Academy of Sciences, though she may also have considered the position would remove a potential rival from the court.

Perhaps for this reason, Dashkova resisted the appointment at first, but then accepted and went on to reform the academy with much success, as she recounts in this source. A series of previous noble presidents and directors had been corrupt, negligent or scornful of the sciences, and Dashkova is remembered today as one of the first academic leaders to have significantly improved the academy's position in Russian society.[23] It needs to be remembered that it was only in the age of Tsar Peter I, who reigned between 1696 and 1725, that European science was introduced to Russia.[24] Previously, the Russian Orthodox religion provided explanations for the natural world. Peter founded the Academy of Sciences in 1725 in his new capital city of St Petersburg, a city situated to allow Russia to be closer to Europe. Staffed at first almost entirely by foreign professors, the Academy trained Russians in the sciences, a process that Peter viewed as vital for improving Russia's military and government. After Peter's death, however, the academy's fate often hung in the balance, and dissention and disarray were common. Only in the 1750s did some order emerge, partly due to the presence of several professors of allegory and eloquence who used their skills to produce poetry and spectacles that praised the Russian court. Jacob von Stählin, a German rhetorician, was the most prominent among these, and his work was vital to the academy in the early years of Catherine's reign.[25] As shown in this source, this was all forgotten when Dashkova gave Stählin short shrift compared to the illustrious mathematician Leonhard Euler, whom she asked to accompany her on her first visit to the Academy. This anecdote should be read cautiously, though – it was written some two decades after the event and at a time when there was more concern to distance the arts from the sciences than had previously been the case. Even so, debates continued for years as to whether academies should focus narrowly on the sciences or become broad umbrella organisations that supported diverse kinds of learning.

When Tsar Paul I came to the Russian throne in 1796, Dashkova was removed from her directorship and sent into exile, reflecting Paul's deep resentment of his mother Catherine II and her supporters. Living in isolation in Novgorod and Moscow, Dashkova completed her memoirs, which were published in Paris in French in 1804. She died in January 1810. Dashkova's memoir, written long after the events they describe, is a rare example of a record of a woman directing a major scientific enterprise in the eighteenth century. It gestures towards not only her achievements at the Academy of Sciences but also her skill in managing changing expectations and values relating to the sciences during this time.

Questions

1. Did Dashkova expect there to be resistance to her directorship? If so, how did she try to counteract it?
2. What reforms did Dashkova undertake at the Academy of Sciences?

3. How did aristocratic status enable or constrain women's roles in the sciences in the eighteenth century?
4. What does this source suggest about Dashkova's opinion of the relative importance of different disciplines within the Academy?
5. Consider the nature of this source, as a memoir written two decades after the described events took place. How might this shape the narrative and impression of the Academy that Dashkova presented in this extract?

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20

Caroline Lucretia Herschel (1750–1848): An extract from *Memoir and Correspondence of Caroline Herschel* (1876)

Dr Mascha Hansen

Introduction

'Great men and great causes have always some helper of whom the outside world knows but little', Mary Cornwallis Herschel, Caroline's grandniece and her first biographer, wrote in the introduction to her edition of Caroline's memoirs in 1876, reiterating a familiar trope.[26] The 'great man' was William Herschel and the 'great cause' was astronomy. In fact, Caroline Herschel was not merely the self-obliterating and dutiful 'helper' of her famous brother. She rose to be an accomplished astronomer in her own right. In the first source chosen here, a passage of her autobiography, she outlined the difficult and even dangerous working conditions of a budding astronomer tasked with using a large telescope to 'sweep' the night skies for nebulae, clusters of stars or, more excitingly, comets. The second source is an official letter in which Caroline announced her discovery of a comet to the Royal Society.

Source

Extract from Herschel, Mary Cornwallis [Mrs John Herschel].
Memoir and Correspondence of Caroline Herschel.
London: John Murray, 1876.

Chap. II [1782–1783]: 52–55

In my brother's absence from home, I was of course left solely to amuse myself with my own thoughts, which were anything but cheerful. I found I was to be trained for an assistant-astronomer, and by way of encouragement a telescope adapted for "sweeping," consisting of a tube with two glasses, such as are commonly used in a "finder," was given me. I was "to sweep for comets," and I see by my journal that I began August 22nd, 1782, to write down and describe all remarkable appearances I saw in my "sweeps," which were horizontal. But it was not till the last two months of the same year that I felt the least encouragement to spend the star-light nights on a grass-plot covered with dew or hoar frost, without a human being near enough to be within call. I knew too little of the real heavens to be able to point out every object so as to find it again without losing too much time by consulting the Atlas. But all these troubles were removed when I knew my brother to be at no great distance making observations with his various instruments on double stars, planets, &c., and I could have his assistance immediately when I found a nebula, or cluster of stars, of which I intended to give a catalogue; but at the end of 1783 I had only marked fourteen, when my sweeping was interrupted by being employed to write down my brother's observations with the large twenty-foot. I had, however, the comfort to see that my brother was satisfied with my endeavours to assist him when he wanted another person, either to run to the clocks, write down a memorandum, fetch and carry instruments, or measure the ground with poles, &c., &c., of which something of the kind every moment would occur. For the assiduity with which the measurements on the diameter of the Georgium Sidus, and observations of other planets, double stars, &c., &c., were made, was incredible, as may be seen by the various papers that were given to the Royal Society in 1783, which papers were written in the daytime, or when cloudy nights interfered. Besides this, the twelve-inch speculum was perfected before the spring, and many hours were spent at the turning bench, as not a night clear enough for observing ever passed but that some improvements were planned for perfecting the mounting and motions of the various instruments then in use, or some trials were made of new constructed eye-pieces, which were mostly executed by my brother's own hands. Wishing to save his time, he began to have some work of that kind done by a watchmaker who had retired from business and lived on Datchet Common, but the work was so bad, and the charges were so unreasonable, that he could not be employed. It was not till some time afterwards in his frequent visits to the meetings of the Royal Society (made in moonlight nights), that he had an opportunity of looking about for mathematical workmen, opticians, and founders. But the work seldom answered expectation […]

But that the nights after a day of toil were not given to rest, may be seen by the observations on Mars, of which a paper, dated December 1, 1783, was given to the Royal Society. Some trouble also was often thrown away during those nights in the attempt to teach me to re-measure double stars with the same micrometers with which former measures had been taken, and the small twenty-foot was given me for that purpose. […] I had also to ascertain their places by a transit instrument lent for that purpose by Mr. Dalrymple, but after many fruitless attempts it was seen that the instrument was perhaps as much in fault as my observations.

July 8. – I began to use the new Newtonian small sweeper, (for a description of this instrument see note to Neb. No. 1, V. class, at the end of the catalogue of first 1000 Neb. and Cl.) but it could hardly be expected that I should meet with any comets in the part of the heavens where I swept, for I generally chose my situation by the side of my brother's instrument, that I might be ready to run to the clock or write down memorandums. In the beginning of December I became entirely attached to the writing-desk, and had seldom an opportunity after that time of using my newly-acquired instrument.

My brother began his series of sweeps when the instrument was yet in a very unfinished state, and my feelings were not very comfortable when every moment I was alarmed by a crack or a fall, knowing him to be elevated fifteen feet or more on a temporary cross-beam instead of a safe gallery. The ladders had not even their braces at the bottom; and one night, in a very high wind, he had hardly touched the ground before the whole apparatus came down […]

That my fears of danger and accidents were not wholly imaginary, I had an unlucky proof on the night of the 31st December. The evening had been cloudy, but about ten o'clock a few stars became visible, and in the greatest hurry all was got ready for observing. My brother, at the front of the telescope, directed me to make some alteration in the lateral motion, which was done by machinery, on which the point of support of the tube and mirror rested. At each end of the machine or trough was an iron hook, such as butchers use for hanging their joints upon, and having to run in the dark on ground covered a foot deep with melting snow, I fell on one of these hooks, which entered my right leg above the knee. My brother's call, "Make haste!" I could only answer by a pitiful cry, "I am hooked!" He and the workmen were instantly with me, but they could not lift me without leaving nearly two ounces of my flesh behind. The workman's wife was called, but was afraid to do anything, and I was obliged to be my own surgeon by applying aquabusade[27] and tying a kerchief about it for some days, till D. Lind, hearing of my accident, brought me ointment and lint, and told me how to use them. At the end of six weeks I began to have some fears about my poor limb, and asked again for Dr. Lind's opinion: he said if a soldier had met with such a hurt he would have been entitled to six weeks' nursing in a hospital. I had, however, the comfort to know that my brother was no loser through the accident, for the remainder of the night was cloudy, and several nights afterwards afforded only a few short intervals favourable for sweeping, and until the 16th January there was no necessity for my exposing myself for a whole night to the severity of the season.

I could give a pretty long list of accidents which were near proving fatal to my brother as well as myself. To make observations with such large machinery, where all around is in darkness, is not unattended with danger, especially when personal safety is the last thing with which the mind is occupied […]

An account of a new comet: By Miss Caroline Herschel. Read at the Royal Society, Nov. 9, 1786. London: printed by J. Nichols, MDCCLXXXVII [1787].[28]

SIR,[29]

In consequence of the friendship which I know to exist between you and my Brother, I venture to trouble you in his absence with the following imperfect account of a comet.

The employment of writing down the observations, when my Brother uses the 20-feet reflector, does not often allow me time to look at the heavens; but as he is now on a visit to Germany, I have taken the opportunity of his absence to *sweep* in the neighbourhood of the sun, in search of comets; and last night, the 1st of August, about 10 o'clock, I found an object very much resembling in colour and brightness the 27th nebula of the *Conoissance des Temps*, with the difference however of being round. I suspected it to be a comet; but a haziness coming on, it was not possible intirely [sic] to satisfy myself as to its motion till this evening. I made several drawings of the stars in the field of view with it, and have inclosed [sic] a copy of them, with my observations annexed, that you may compare them together.

August 1, 1786, 9h. 50', the object in the center is like a star out of focus, while the rest are perfectly distinct, and I suspect it to be a comet. Tab. I. fig. i.

10h. 33', fig. 2. the suspected comet makes now a perfect isosceles triangle with the two stars *a* and *b*.

11 h. 8', I think the situation of the comet is now as in fig. 3.; but it is so hazy that I cannot sufficiently see the small star *b* to be assured of the motion.

By the naked eye the comet is between the 54th and 53d Ursæ majoris, and the 14th, 15th, and 16th Comæ Berenices, and makes an obtuse triangle with them, the vertex of which is turned towards the south.

August 2. 10 h. 9', the comet is now, with respect to the stars *a* and *b**, situated as in fig. 4. therefore the motion since last night is evident.

10 h. 30', another considerable star *c* may be taken into the field with it, by placing *a* in the center; when the comet and the other star will both appear in the circumference, as in fig. 5.

These observations were made with a Newtonian sweeper of 27 inches focal length, and a power of about 20, the field of view is 2° 12'. I cannot find the stars *a* and *c* in any catalogue; but suppose they may easily be traced in the heavens; whence the situation of the comet, as it was last night at 10 h. 33', may be pretty nearly ascertained.

You will do me the favour of communicating these observations to my brother's astronomical friends.

I have the honour to be, &c.

CAROLINE HERSCHEL

Slough, near Windsor,

Aug. 2, 1786.

*A doubt having arisen about the identity of the stars marked *a* and *b* in the figures, I have examined that part of the heavens in which the comet was the 1st of August, in order to settle this point, but find so many small stars in that neighbourhood that I have not been able to fix on any of them that will exactly answer these figures; and as they were drawn from observations made by moonlight, twilight, hazy weather, and very near the horizon, it would not be at all surprising if a mistake had been made; however, as these figures were only given with a view to shew [sic] the motion of the comet, the conclusion of the change of place, which was drawn from them, was equally good whether these stars were the same or different.

Dec, 14, 1786. WILLIAM HERSCHEL

Analysis

The young Caroline Herschel's prospects were bleak: without funds, she was unlikely to marry, and without education, she could not even hope to become a governess. Her brother William's invitation to join him at Bath in 1772, where she was to act as his housekeeper as well as a singer if she proved talented enough, seemed a godsend to her. Though all her brothers had been instructed by their father, a musician in the Hanoverian Military Band, to play various instruments, the resourceful Caroline had to practise her singing when the family was away from home. She later became a singer because her brother William Herschel, then the Director of Public Concerts at Bath, required a talented performer in his oratorios. Similarly, Caroline next became an astronomer because her brother desired a skilled assistant to aid his scientific career. In this source, readers get a glimpse of the struggle she felt to abandon her new-found success in music, and to adapt to the life of her brother's astronomical ambitions. Yet, she resolved not to resent her fate but to excel in the new art chosen for her.

Fortunately, neither Caroline nor her brother assumed that she should be content to serve his coffee and polish the mirrors needed for his new telescopes, the production of which also required that she pound and sift great quantities of loam made from horse dung to prepare the mould.[30] She did do these things, and more, quite willingly, but she also taught herself first English, and then mathematics and astronomy. She began to record her observations in August 1782. A year later, William created a telescope for her personal use, with which she independently discovered various unknown nebulae. While compiling a new star catalogue, she succeeded in being the first person to spot a new comet in August 1786; she would go on to discover seven more.

Her relegation to the role of a helpful partner was partly a nineteenth-century regression, as can also be seen by the reactions of her contemporaries. In 1786, the novelist Frances Burney longed to meet Caroline Herschel, 'whose knowledge in [her brother's] own Science is so extraordinary, & who herself was the first Discoverer of the last comet: but she had been up all night, & was then in Bed.'[31] At the time, Burney was in service to Queen Charlotte, who was herself a botanist, a keen observer of developments in the field of science and a patron to several women artists and writers. Not surprisingly, William Herschel applied to the Queen for a pension for his sister of £50 per year. By way of comparison, William's own salary as Royal Astronomer was only £200 a year, the same amount that Frances Burney earned as Keeper of the Robes to the Queen. The pension was granted, paid by King George III, and Caroline became the first woman ever to earn a salary as an astronomer.

By 1795, Caroline's fame had spread to France, where Jérome Lalande included her in his second edition of the *Astronomie des Dames*. Three years later, Caroline published *Catalogue of Stars* (1798), a revision of Sir John Flamsteed's *Atlas Coelestis* (published posthumously by Flamsteed's wife, Margaret Cooke Flamsteed, in 1729). Her publication meant much to Caroline. To Nevil Maskelyne, Astronomer Royal to George III, she wrote: 'You see, Sir, I do own myself to be vain because I would not wish to be singular, and was there ever a woman without vanity? Or a man either? Only with this difference, that among gentlemen the commodity is generally st[y]led ambition.'[32] She would later be the first – and for more than 150 years the only – woman to be awarded the Gold Medal of the Royal Astronomical Society in 1828. The next woman to be thus honoured was Vera Rubin in 1996. Together with the mathematician Mary Somerville, Caroline was elected as the first female honorary member of the Royal Astronomical Society in 1832. Indeed, Caroline's autobiographies prove her to have been anything but the silent and devoted 'helper' the nineteenth century wanted to see in her. Only in the late twentieth century did her contributions to astronomy regain the scientific attention they deserve.

Questions

1. How did Caroline Herschel both deny and assert her status as an astronomer in her own right in these abstracts?
2. In relation to the question above, why might Caroline have chosen to present her status as an astronomer in this way?
3. How did she present her brother's role in her professional life, and her own role in his?
4. What can we infer about her views on female scientists, and her own authority as a female astronomer?
5. How does her narrative contribute to certain stereotypes about scientists?

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21

Lady Jane Davy (c. 1780–1855): As described in two extracts from her contemporaries (1812 and 1815)

Professor Frank A. J. L. James

Introduction

The short extracts below, written by the romantic poet William Wordsworth and the American academician George Ticknor, present two contrasting views of Lady Jane Davy, formerly Jane Apreece, *née* Kerr, wife of the chemist and inventor Sir Humphry Davy. While in Bristol, Davy had helped see through the press that seminal text of English Romanticism, the second edition of Wordsworth's *Lyrical Ballads* (1800). Like many of his early friends, Wordsworth was concerned at the turn Davy's life had taken due to his marriage. On the other hand, Ticknor only knew the Davys by their fame and like many American academics at this time who visited them, lacked any basis on which to form a critical judgement. There is not much secondary literature devoted specifically to Lady Davy, and no significant deposit of her papers exists, though documents, mostly letters, are scattered through the archives of numerous contemporaries. She is invariably mentioned in studies of her husband and of the natural philosopher Michael Faraday as well as in the published lives, letters and diaries of many of those who knew her. As a wealthy woman with connections to many high-profile natural philosophers and intellectuals of the day, Lady Davy's career provides an important source for understanding the role of women in relation to knowledge production in the nineteenth century.

Source

William Wordsworth to Mary Wordsworth, 23 May 1812.
Extract from *The Love Letters of William and Mary Wordsworth*
Edited by Beth Darlington, 172–77. Ithaca:
Cornell University Press, 1981.

Lady Davy … is a good natured woman with considerable cleverness but her Manners are bad, she never lets her features alone. … She is a plain woman, thin & tallish, very dark complexion, and wretchedly bad skin [?not] tawny but black, that is the blackest I ever [?saw] on any english Woman.

George Ticknor, *Diary*, 15 June 1815. Extract from Ticknor, George. *Life, Letters, and Journals of George Ticknor: Volume 1*. Boston: Osgood, 1876. 57.

[Lady Davy] is small, with black eyes and hair, a very pleasant face, an uncommonly sweet smile, and, when she speaks, has much spirit and expression in her countenance. Her conversation is agreeable, particularly in the choice and variety of her phraseology, and has more the air of eloquence than I ever heard before from a lady.

Analysis

Jane Davy had a divisive quality to her. Few of her contemporaries took a neutral view of her, but either sided with Wordsworth or with Ticknor in their opinions of her. She was born, probably in 1780, on Antigua which has led some commentators to suggest that she was mixed-race, implied by Wordsworth, but the genealogical evidence points to Scottish and Devonshire descent. Her father, a border Scot, worked as a merchant and Royal Navy prize agent on Antigua and seems to have made his fortune by retaining (not altogether legally) large amounts of prize money.[33] When he died in 1795, the money he left his widow and only child made them both attractively wealthy and both married in London in 1798. Jane married a member of the Northamptonshire gentry, Thomas Apreece (d. 1807) and her mother wed a wealthy Antigua planter.

Jane Apreece, now independently wealthy in her late twenties, then deliberately set about constructing for herself a career as the hostess of intellectual salons (as opposed to political), forming acquaintances (of varying degrees of closeness) with some of the leading intellectuals of the day, such as Maria Edgeworth, Sydney Smith, Mary Somerville, Walter Scott (a cousin of sorts, who did not much care for her), Lord Byron, Madame de Staël and many others.[34] Salons were gatherings where individuals met to discuss and share knowledge, often of a natural philosophical nature, and were regularly hosted by influential women. Apreece was brilliantly successful in establishing a salon in Edinburgh for a year starting at the end of 1809. She was less so in repeating the process in London following her move there at the end of 1810.

In London she attended the Royal Institution, an institution devoted to providing lectures on scientific and other subjects to its members, subscribers, and guests which, significantly, had admitted women since its foundation in 1799. It was at the Royal Institution that Apreece heard and saw the spectacular performances of its Professor of Chemistry, Humphry Davy. They met socially and his idea of a date was taking her to Slough to see William Herschel's 40-foot telescope, which suggests she had convinced him of her interest in science.[35] After a fairly speedy courtship they married on 11 April 1812, two days after Davy had been knighted by the Prince Regent. The day after the marriage, Byron composed a slightly risqué skit on 'late nuptials between Conceit & Chemistry':

> Apreece with her Davy resolved an alliance
> A little for love & a good deal for Science,
> And the *Strength* of her *parts* has already been shewn
> For last night she found out the *Philosopher's Stone*.[36]

Widely rumoured at the time of her second marriage to have an annual income of £4,000 and capital of £60,000, Davy was able to resign all his paid positions, telling his brother, John Davy, rather optimistically, that he would now have more time for research.[37] Following their return in April 1815 from an 18-month tour of the Continent, stories began to circulate about the unhappy state of their marriage. Joseph Banks, President of the Royal Society of London, who had expressed concern about the effect of the marriage on Davy's career, heard a rumour that they would separate.[38] When Davy succeeded Banks (who had been President for 42 years when he died in 1820), Lady Davy made some effort to help Davy continue the *conversaziones* that Banks had arranged, but in the end spent a large amount of time on the Continent during the 1820s ostensibly for the sake of her health. Indeed, in 1822 there was talk of a formal separation though that came to nothing, presumably because they were already leading very separate lives. However, she quickly went to Davy during his final illness which ended with his death in Geneva in

1829. She lived for a further 26 years, a significant proportion of which she spent hosting a salon in Rome, well frequented with visitors from Britain as well as Roman notables. She died in her London home in 1855 and was buried in the nave of the church of the Holy Sepulchre in Northampton, where her surviving Kerr relations had settled.

Lady Davy has had bad press in part because of the haughty way she treated Michael Faraday, who worked as Davy's assistant on the Continental tour of 1813–1815 and partly because of the criticisms from those who had known Davy before he married, such as Wordsworth, Robert Southey and John Davy – 'it might have been better for both if they had never met' because 'she was not qualified for domestic life'.[39] This seems oversimplistic, as right from the start of his appointment in 1801, Davy had sought to join the aristocratic ranks who had founded the Royal Institution. There was nothing that Davy liked more (apart from fishing) than staying in large aristocratic stately homes; sometimes it seems he wrote inconsequentially to his mother simply so she could see where he was staying, showing that he had risen socially way beyond his Cornish yeoman background.[40] To speculate, he may have seen in marrying the very well connected Apreece the opportunity to become closer to that aristocratic life, and indeed they formed close friendships with the Marquess of Stafford (later the Duke of Sutherland) and the Marquess of Lansdowne, and were on good terms with many other aristocrats; but others could not stand them – divisive indeed.

Questions

1. How might Lady Davy's mercantile and colonial background have affected her approach towards becoming part of high society?
2. Does the lack of a formal separation or divorce (at the time difficult and expensive, but possible) suggest the importance that Lady Davy attached to possessing a title?
3. Widowed for a second time in her late forties, Lady Davy never married again. Might that suggest she had formed an aversion to marriage or wished to retain her connection with one of the most famous men of the day, or even just her title?
4. To what extent does Lady Davy's career cast light on the relationship of science, culture and society during the first half of the nineteenth century or to what extent was it so atypical that little can be generalised from it?
5. Does Lady Davy deserve the 'bad press' she has received?

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22

The Junta de Damas de Honor y Mérito (Committee of Ladies of Honour and Merit): Children's parchments in the Madrid Foundling House (1802)

Dr Elena Serrano[41]

Introduction

More resistant than paper, these little pieces of parchment (4 cm by 10 cm) were filled in and attached to babies' waists as soon as they were received in the Madrid Foundling House. They worked as children's identity cards – necessary as children drifted from hand to hand. As in many other foundling houses, children only spent a few days in the wards before they were sent to be wet nursed by women who lived in poverty in the surrounding neighbourhoods.[42] However, children were often returned after only a few weeks and the affair of finding another wet-nurse had to begin again. Wet-nurses needed to show the parchment and the baby at the Foundling House to assure the baby's identity, and to be paid. If the child died, a doctor or a clergyman would write the date of death on the parchment's back, which then had to be returned to the Foundling House. As can be seen in this source, the parchments of deceased children were cut at the corners and in the centre to prevent them being sold on the black-market.

Source

Figure 5.1 Children's parchment used to identify a baby in the Madrid Foundling House, 1802. Image credit: Archivo Regional de la Comunidad de Madrid. Fondo Diputación, Inclusa.

Analysis

By the late eighteenth century, the Madrid Foundling House was receiving around three to four babies a day, approximately a thousand babies a year, which amounted to a quarter of the total number of children born annually in Madrid. Mortality rates were terrifying even for contemporaries: more than 90 per cent of children died during their first month in the care of the House.[43] In 1799, a female society, the Junta de Damas de Honor y Mérito (Committee of Ladies of Honour and Merit) replaced the previous male committee and took full control of the House's management.[44] The Junta construed its practices as feminine and enlightened. It touted its own management of the Foundling House as a break from the previous old-fashioned, careless and masculine way of running it. The Junta meticulously ordered the everyday life of the Foundling House, mirroring the ideal ways of ruling domestic households. It specified all the tasks of employees and the daily hygienic chores, checked the accounting books, ordered the archives and tightly controlled the incomes and expenses of the House. It increased the hygienic medical measures, doubled the medical personnel and controlled the health of wet-nurses. It was especially careful in supervising how babies were treated, issuing rules for the new nuns that the Junta contracted, and involving the local priests to oversee the behaviour of external wet-nurses.

Moreover, in order to correctly calculate mortality rates (the proportion of children that died in relation to the total that were received), and to be able to prove that the new measures were working, the Junta developed a refined system of tracing the entrance and exits of children and their identities.[45] Children were carefully registered in the legend books in which all of babies' known data, including parents' names, place of birth and the circumstances of their finding were recorded. Babies were also labelled with parchments (as seen in the source image) and placed in numbered cradles during their time in the Foundling House.

The parchments could be considered as mobile elements in a sophisticated system of 'paper tools' or 'paper technologies' that organised the life in the Foundling House.[46] Parchments functioned in a similar way to library book labels, which linked books to catalogues, so that books could be found, sorted and classified. Likewise, the parchments linked babies with information held in the legend books. As can be seen in this source, in addition to the name and the date the child entered the Foundling House, there were two numbers in the corners. The one in the left corner indicated the number of the legend book in which the baby was registered and the one in the right corner noted the page. For instance, baby Remigio Josef was inscribed in Book 170, which corresponded to year 1802, page 118. In this year, the Junta made a further step: it changed the old system of registering the children that had been set up in the seventeenth century, reunifying in one legend book all the information about the child that had previously been scattered in two. In this way, it claimed, it would be easier to calculate mortality rates weekly, monthly and annually.[47] Moreover, the Junta was able to quantify the most frequent causes of death and analyse its distribution by age and sex.[48] The female society also introduced new categories for qualifying the condition in which children arrived and how this might affect their chances of survival.

Eventually the new paper technologies allowed for the creation of medical knowledge. The analysis of parchments, legend books and other notebooks that classified deceased children by age, sex and place of death, and mortality rates lists, demonstrate the ability of women to produce knowledge in places beyond scientific venues.[49]

Questions

1. How would you define 'paper technologies' and 'paper tools'? Can you think of any other eighteenth-century examples? You might consider different fields such as natural history.
2. What role did these parchments play within the wider system of identifying and tracing foundlings?
3. To what extent did paper technologies such as the one used in the Madrid Foundling House enable the production of new knowledge?
4. How did the paper technologies employed in the Madrid Foundling House relate to skills considered at the time necessary in the education of high-class women, such as accounting and housekeeping?
5. The Foundling House was an institution run by women, whereas many scientific academies of the day only permitted men. Might this have had implications for the kinds of knowledge produced, shared, and valued by these places? If so, how?

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Part V notes

1 Porter, 'Introduction', 2003, 1–22.
2 McClellan, 'Scientific Organisations and the Organisation of Science', 2003, 90–94.
3 For an exploration of the role of women within the Royal Institution, see Lloyd, 'Rulers of Opinion', 2019.
4 For the role of class in enabling women to access spaces of knowledge production within elite society see Schiebinger, *The Mind Has No Sex?*, 12.
5 Schiebinger, *The Mind Has No Sex?*, 10; Goodman, 'Enlightenment Salons', 1989, 338.
6 The research for this piece has received funding from the European Research Council under the European Union's Horizon 2020 research and innovation programme (Project CIRGEN, ERC Grant Agreement No 787015).

7 The Spanish Enlightenment is a subject of internal debate within the field and, as has been highlighted within this text, it should be considered critically who is centralised as the source of Enlightenment thought, what the term Enlightenment means and who it includes and excludes when reviewing these sources. For a selection of essays on the various definitions of the Spanish Enlightenment, see Astigarraga, *The Spanish Enlightenment Revisited.*
8 López-Cordón, *Condición femenina y razón ilustrada.*
9 Amar y Borbón, *Discurso sobre la educación física y moral de las mujeres*.
10 Martínez Vidal and Pardo Tomás, 'Un conflicto profesional, un conflicto moral y un conflicto de género', 2001.
11 Lewis, *Women writers in the Spanish Enlightenment*.
12 Sullivan, 'Josefa Amar y Borbón and the Royal Aragonese Economic Society (with documents)'; López-Cordón, *Condición femenina y razón ilustrada*.
13 Amar y Borbón, 'Discurso en defensa del talento de las mugeres y de su aptitud para el gobierno y otros cargos en que se emplean los hombres'; Facsimile editions in López-Cordón, *Condición femenina y razón ilustrada*; English translation in Barker, *In Defence of Women*.
14 Bolufer Peruga, 'New Inflections of a Long Polemic'.
15 Fabiani, *Il calamaio sulla finestra*.
16 Leonhard Euler (1707–1783), Swiss mathematician.
17 Sergei Gerasimovich Domashnev, director of the Academy from 1775 to 1782.
18 Nicolas Fuss (1755–1826), Swiss mathematician, trained in Russia by Leonhard Euler.
19 Jacob Stählin (1709–1785), German poet, professor of allegory and rhetoric at the academy from 1735.
20 The *Commentarii Academiae Scientiarum imp. Petropolitanae* were the academy's scholarly journals, published in Latin since 1728.
21 On Dashkova's life see Prince, *The Princess and the Patriot,* and Woronzoff-Dashkoff, 'Dashkova', 2008.
22 Woronzoff-Dashkoff, 'Dashkova', 2008, xxiii.
23 Gordin, 'Arduous and Delicate Task', discusses her role in the Academy of Sciences.
24 Gordin, 'The Importation of Being Earnest', 2010.
25 Werrett, 'The Schumacher Affair', 2010.
26 Herschel, *Memoir and Correspondence of Caroline Herschel*, v.
27 Aquabusade was a lotion, usually containing alcohol, used to clean wounds.
28 Available at https://royalsocietypublishing.org/doi/pdf/10.1098/rstl.1787.0001 (accessed 14 December 2022).
29 The letter is addressed to Charles Blagden, then Secretary of the Royal Society.
30 Herschel, *Caroline Herschel's Autobiographies*, I, 63.
31 Burney, *The Court Journals and Letters of Frances Burney,* vol I, 152; 317.
32 Herschel is quoted in Winterburn, *The Quiet Revolution of Caroline Herschel*, 268.
33 James, 'Making Money from the Royal Navy in the late Eighteenth Century', 2021.
34 Walter Scott to John Bacon Sawrey Morritt, 9 August 1810, in H.J.C. Grierson, Ed., The Letters of Sir Walter Scott, London: Constable, 12 volumes, 1932–1937, 2: 368.
35 Humphry Davy to Jane Apreece, c.8–12 July 1811, in Fulford et al. *The Collected Letters of Sir Humphry Davy*, vol. 1: 273.
36 Lord Byron to Samuel Rogers, 12 April 1812, in Marchand, *Byron's Letters and Journals*, vol. 11: 180–181.
37 Humphry Davy to John Davy, June 1812, in Fulford et al. *The Collected Letters of Sir Humphry Davy*, vol. 2: 327.
38 Joseph Banks to Charles Blagden, 3 October 1816 in Chambers, *The Scientific Correspondence of Joseph Banks*, *vol. 6*, 217–19.
39 For example, see Packer et al., '2308. Robert Southey to Edith Southey, 25 September 1813'; Davy, *Fragmentary Remains, Literary and Scientific of Sir Humphry Davy, Bart*, 142.
40 For example, Humphry Davy to Grace Davy, 22 August 1812, in Fulford et al. *The Collected Letters of Sir Humphry Davy*, vol. 2: 339. Written from Dunrobin Castle, the Scottish seat of the Marquess of Stafford, Davy managed to namedrop a further two dukes and an earl with whom they would be staying.
41 The research for this essay was funded by the European Research Council under the European Union's Horizon 2020 research and innovation program (Project CIRGEN, ERC Grant Agreement No 787015). I am thankful to the Max Planck Institute for the History of Science in Berlin (MPIWG-Berlin) in which part of this research took place.

42 On wet-nursing see Sussman, *Selling Mother's Milk*; Valerie Fildes, *Wet Nursing*.
43 For a comparison on the situation in other foundling houses, see Fuchs, *Abandoned Children* and Levene, *Childcare, Health and Mortality at the London Foundling Hospital, 1741–1800*. See also Styles, 'Objects of Emotion'.
44 On the Spanish intellectual and political context in which the Junta de damas was set up, see Serrano, 'Chemistry in the city', 2013; Bolufer Peruga, 'Neither Male, Nor Female'; and Bolufer Peruga, 'Women in Patriotic Societies'.
45 On numbers as a measure of objectivity, see Porter, 'Making Things Quantitative', 1994.
46 A good revision of the historiography can be found in Jardine, 'State of the Field', 2017. See also Bittel, Leong, and von Oertzen, 'Introduction' and Oertzen, 'Keeping Prussia's House in Order'. On notebooks and note taking as paper-technologies, see Heesen, 'The Notebook: A Paper-Technology'; Yeo, *Notebooks, English Virtuosi, and Early Modern Science*. Also useful is Blair, *Too Much To Know*. On paperwork, lists and other literary technologies, see Kafka, 'Paperwork', 2009; Yale, 'The history of archives', 2015; Delbourgo and Müller-Wille, 'Listmania', 2012.
47 Details of how the inscription of babies in legend books worked in Serrano, 'Bookkeeping for Caring'.
48 Hess and Mendelsohn, 'Case and series', 2010.
49 Oertzen, Rentetzi, and Watkins, 'Finding Science in Surprising Places', 2013.

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Part VI

Maps, scientific travel and colonialism (1800s)

Timeline: individuals, events and publications in the history of science	**Timeline: individuals, events and publications in this part**
1803–15 Napoleonic Wars.	
1814–29 Publication of Prussian explorer Alexander von Humboldt's 1799–1804 travels to the Americas, describing Spanish American cultures, geography animals and plants from a Western scientific point of view.	
1839 Publication of English naturalist Charles Darwin's account of his 1831–1836 voyage on HMS *Beagle*.	
1843 The steam-powered rotary printing press invented in the United States by Richard M. Hoe, dramatically speeding up the mass production of printed works (steam printing for newspapers had been in use since 1812).	
1850s European governments increasingly support mapmaking for control of territories at home and in overseas colonies.	

Timeline: individuals, events and publications in the history of science	**Timeline: individuals, events and publications in this part**
	1835–69 Alexandrine Petronella Francina Tinné, Dutch explorer who took several journeys on the Nile and its tributaries, and is featured in Austrian botanist Friedrich Welwitsch's 'Map of Travellers in Africa'.
1845 British Navy officer and Arctic explorer John Franklin departs England to lead the expedition aboard HMS *Erebus* and HMS *Terror* to explore the Northwest Passage. The expedition disappeared in 1848.	
	1852–53 Publication of British translator Thomasina Ross's translation and edited version of Alexander von Humboldt's *Personal Narrative of Travels*, increasing the book's audience and popularity.
1867 Publication of *Plantae Tinneanae,* a volume of plant descriptions based on Dutch explorer Alexandrine Petronella Francina Tinné's travels in Africa.	
1869 North America's first transcontinental railroad is completed, increasing the speed of international travel and the postal service.	
	1871–72 Elizabeth Cary Agassiz, American educator and naturalist, accompanies the voyage of the US Coast Survey steamer *Hassler* from Boston to San Francisco around the coast of South America and records the voyage's narrative.

Timeline: individuals, events and publications in the history of science	Timeline: individuals, events and publications in this part
1872–76 The British *Challenger* Expedition circumnavigates the globe making deep-sea experiments and collecting specimens.	
	1892 Publication of Lutheran pastor, ethnographer and linguist August Bielenstein's map of 'The Latvian Language Area', drawn by his daughter Martha Luise Sophie Bielenstein.

Introduction

This part explores women's scientific work in print at a time when nineteenth-century advances in publication technologies propelled science to a wider audience.[1] In addition to analysing the content of texts, maps and illustrations, this part examines how published forms of knowledge were made. This methodological approach reveals forms of 'invisible' labour performed by women in the making of science.[2] Besides writing and authorship, which is more easily recognised, nineteenth-century women undertook a wide variety of scientific activities – such as keeping diaries, travelling, translation and map-making – each of which are explored in this part.

In the mid-nineteenth century, the steam press and division of labour meant that a wider range of books, newspapers and journals became available on the market. Lower manufacturing costs also meant that more people could afford to purchase printed items. Scientific publications began to be written for a much broader audience and were produced in various formats, from articles in daily newspapers to expensive and lavishly illustrated expedition reports.[3] At the same time, the expansion of continental railroads and steam-powered marine postal routes increased the circulation of printed literature between English-speaking readers located across Europe, the Americas and Asia, changing how scientific knowledge was produced and disseminated.[4]

Steam-powered travel aided the movement of scientists as well as literature. In the mid-nineteenth century journeys to South America and

Africa became more accessible for wealthy European and American intellectuals and adventurers.[5] Women travelled on scientific expeditions, either by themselves or with their husbands.[6] A 'Map of Women Travellers in Africa' by the Portuguese botanist Friedrich Welwitsch and the published letters of Elizabeth Cary Agassiz (1822–1907) demonstrate that white women played significant roles as collectors, writers and observers, while at the same time revealing how the rise of the professional 'expert' naturalist and differentiation from the 'amateur' often served to diminish women's scientific work. These sources also reveal the roles played by women in colonial and imperial endeavours.

A map of 'The Latvian Language Area' produced by Martha Luise Sophie Bielenstein, though generally attributed to her father August Bielenstein, reveals how scrutinising the authorship of published sources can disclose the collaborative nature of science and can make women's work more visible. The title page to an English translation of a work by Prussian explorer Alexander von Humboldt produced by Thomasina Ross brings further attention to authorship noting the importance of women translators as important transnational mediators.

23
Women travellers in Africa: Map by Friedrich Welwitsch (c. 1853–1860)

Dr Sara Albuquerque and Dr Silvia Figueirôa

Introduction

The 'Map of Travellers in Africa' is a nineteenth-century manuscript produced by Friedrich Welwitsch (1806–1872), an Austrian botanist in the service of the Portuguese government. The National Museum of Natural History and Science, Lisbon, Portugal (MUHNAC) holds this document. It contains the names of travellers who worked in different parts of the African continent. Observation of the map in detail allows us to extract various kinds of information. One detail that particularly stands out is the reference to several women: Mary Elizabeth Barber, Isabella Maria Elliott, Maria Elizabeth Holland, Katharine Saunders, Alexandrine Petronella Francina Tinné, and Miss Turner. Their presence demonstrates white, largely European, women's involvement in knowledge production, illustrating that they were considered among other famous travellers, although their work and names were often more obscure.[7] According to Diane Kennedy, 'Although a growing number of financially independent women took up travel in this period, and some of them won respect and recognition for their arduous and often risky journeys into remote regions, contemporaries did not consider them explorers'.[8] Women were not considered 'explorers' because the term 'evoked qualities of leadership, courage, and physical endurance that were inextricably associated at the time with masculinity'.[9] Furthermore, the discrepancy between men's and women's access to higher education in this period meant that only a few women acquired scientific and other technical skills that were essential to explorers.[10] Below follows a brief resumé of the women named in Welwitsch's map.

Full name	Date of birth/death	Name on the map
Barber, Mary Elizabeth (née Bowker)	1818–99	Mrs. F. W. Barber
Kolbe, F.W. (née Isabella Maria Elliott)	1830–93	Miss Elliott
Holland, Maria Elizabeth (née Armstrong)	1836–78	Mrs. Holland
Saunders, Katharine	1824–1901	Mrs. Saunders/ Miss Saunders
Tinné, Alexandrine Petronella Francina	1835–69	Mss Tyne/Mss Tinne
Turner	fl.1820s	Miss Turner

Source

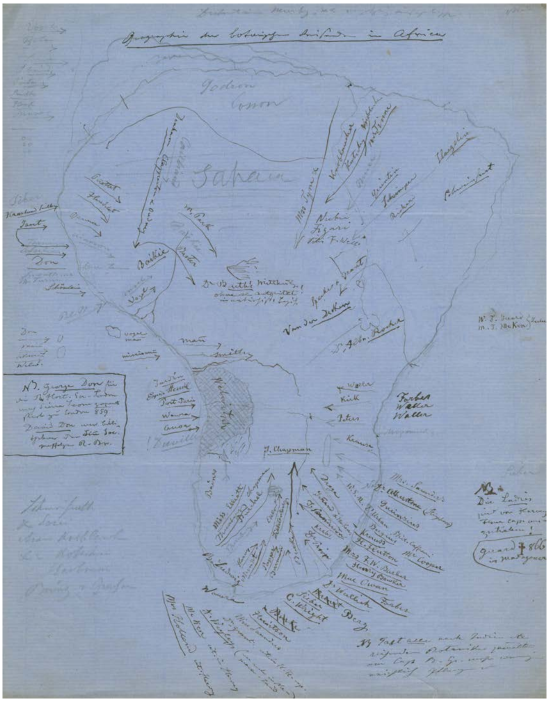

Figure 6.1 'Map of Travellers in Africa'. Manuscript produced by Friedrich Welwitsch (PT-MUL-FW-01-008). MUHNAC/Museums of the University of Lisbon Historical Archives. Image credit: courtesy of University of Lisbon, part of PRISC Infrastructure.

Analysis

Nineteenth-century science was inextricably linked to the expansion of empires. This political and economic context gave an impulse for European exploration, especially in search of territories and natural resources. Geographical knowledge of the African continent excited Western popular imagination, spurred commercial ambitions, generated political challenges and intellectual discussions and aroused debates surrounding issues of health, race, trade and colonial administration.[11]

The nineteenth century also saw the increasing importance of science popularisation – the process of communicating and disseminating scientific knowledge to the general public. Science popularisation made room for women to be included in science, not only as members of an interested public but as scientific investigators. Women, however, were largely limited to participating in science as amateurs, not professionals. As historian of science Katherine Pandora reminds us, 'the only category of scientific practice open to most [women] was that of "amateur," that is one who might collect specimens, make detailed observations of natural phenomena, produce scientific illustrations, or author books and articles for children and the general public'.[12]

The women who appeared on 'Map of Travellers in Africa' were colonial wives, companions, colleagues and co-workers, but they rarely assumed the role of visible protagonists. Tinné (Alexandrine Petronella Francina Tinné, 1835–1869) was an exception.[13] She was recognised by her contemporaries for taking 'several journeys on the Nile and its tributaries' between 1860 and1865 and 'filled the roles of a noble lady, adventuress, explorer and that of Victorian lady traveller'.[14] Early female scientists often shared common characteristics: they were generally born into wealthy families; they had private income or material support from a husband; and they often worked as research assistants to their husbands or fathers.[15] Women dedicated to natural historical investigations often did much of the time-consuming work, such as sketching landscapes and structures, fossil-hunting, preparing botanical and zoological samples, and even contacting local experts.[16] Since women's work was habitually integrated into the publications of the men for whom they worked, women obtained little academic credit.[17]

Although the manuscript here is referred to as a map, it can also be seen as a kind of diagram. The 'Map of Travellers in Africa,' a two-dimensional representation, is a type of scientific iconography that can be 'a tool for thinking used for those creating and those using diagrams'.[18] It seems that Welwitsch condensed the scattered available information in a synthesis map, a single manuscript, where the author could easily see who did what and where, making this document a working tool in the study of his collections. Interestingly, Welwitsch did not exchange any direct correspondence with these female travellers in the production of this map. Still, it is worth noting that although the Austrian botanist did not exchange correspondence letters with Tinné directly, he was in contact with Karl Georg Theodor Kotschy (1813–1866). Kotschy later composed *Plantae Tinneanae* (1867), a volume of plant descriptions based on Tinné's African expedition.[19] Unlike other 'invisible' women explorers on Welwitsch's map, Tinné's findings were recognised in a published academic manuscript.

Questions

1. What did these women travellers have in common?
2. What does this source tell us about Euro-American women's roles as 'agents of empire'?
3. Besides white European women, who else was often 'invisible' in published academic manuscripts concerning geographic knowledge of Africa?
4. What can this map tell us about the differences and similarities between male and female travellers in this period? What does this map tell us about the routes into science available to women in the nineteenth century?
5. What do sources like this map tell us about the production of nineteenth-century scientific knowledge?

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24
Martha Luise Sophie Bielenstein (1861–1938): Map of 'The Latvian Language Area' (1892)

Dr Catherine Gibson[20]

Introduction

This map was published in the *Atlas of the Ethnological Geography of Present Day and Prehistoric Latvians* (1892), as part of a series of thematic maps on archaeology, history and language. Historians and library catalogues attribute authorship to August Bielenstein (1826–1907), a German-speaking Lutheran pastor and well-known ethnographer and linguist from the Kurland/Kurliand province in the western Russian Empire, today in southern Latvia.[21] However, a close examination of the map's cartouches – decorative emblems that contain information about the mapmaker – reveal that the mapmaking process involved various members of the Bielenstein household. On this map, August's daughter Martha is named as the draughtswoman. Martha Luise Sophie Bielenstein (1861–1938) was the third of nine children. She never married and, as the eldest surviving daughter, managed the family home and was the primary caregiver for her ageing parents. Unlike her brothers, she did not receive any formal higher education, but grew up speaking both German and Latvian and read widely from her father's library. As an adult, she helped her father with research, acted as a private secretary, assisted him with the preparation of his publications, and drew maps and scientific illustrations. In later life, Martha authored several of her own publications. However, much about Martha's life remains unknown and most of what we know about her comes from the memoirs of her father and brother.[22]

Source

Figure 6.2 A map titled 'The Latvian Language Area' (*Das lettische Sprachgebiet um das Jahr 1884*), developed by A. Bielenstein and drawn by M. Bielenstein. The map was published in: August Bielenstein, *Atlas der ethnologischen Geographie des heutigen und des praehistorischen Lettenlandes*, St. Petersburg, 1892.

Analysis

Martha's role in the process of making maps for the *Atlas* highlights several overlooked dimensions in the history of cartography, including the collaborative nature of mapmaking, the gendered nature of cartographical labour, and the role of the family and household in providing women with opportunities to become involved in scientific research and publications.

Map cartouches often attribute authorship to a single individual, usually male, who was responsible for overseeing the project. In practice, however, the process of making a map was a highly collaborative endeavour. Many anonymous and invisible hands participated in the various stages, from collecting data and compiling, to drawing and hand colouring.[23] The division of labour often reflected contemporary ideas about women's work. For instance, while in the nineteenth century surveying was done by men, jobs requiring fine handwork, such as sketching, hand colouring, typesetting and book-binding were often done by women. Although Martha received no formal education, she was able to apply skills traditionally taught as part of girls' education in the home, such as drawing, painting and cartography.

Finding sources about those involved in cartography can be challenging as many of the skills related to the material production of maps were perceived as artisanal or handicrafts, and thus not deemed worthy of record. Moreover, as Judith Tyner argues, sources containing the names of those who contributed to making a map often only note the initials and surnames, which makes it hard to study the gendered aspects of map-making.[24] In this case, it is possible to confirm the identity of 'M. Bielenstein' from August's acknowledgement, where he thanks his daughter for her help: 'I must not pass over with silence the faithful care of my daughter Martha, who, according to my instructions, worked on the maps of the accompanying atlas…'[25]

The Bielensteins are an example of a scientific family and highlight how the home and family were important spatial and social contexts for knowledge production in the nineteenth century. The manuscript of the *Atlas* was prepared in the family's parsonage on the outskirts of the small town of Doblen (today's Dobele in southern Latvia), which allowed Martha to become involved in science at a time when women were barred from formal participation in universities and scientific societies. As August was blind for the last fifteen years of his life, he relied heavily on Martha to continue researching and publishing. For Martha, scientific labour and her role as primary caregiver for her parents were closely interconnected.

Questions

1. What can we learn about cartography if we shift our focus from analysing the content of maps to examining the wider social history of mapmaking processes?
2. Discuss the different kinds of invisible labour embedded in cartography.
3. To what extent did scientific families play a role in both enabling and restricting opportunities for women to participate in scientific activities and knowledge production?

4. In spring 2017, the Twitter hashtag #ThanksforTyping was used to share examples of research papers acknowledging wives who assisted their husbands with research and preparing publications. How can we relate this source to the wider issue of the unacknowledged role of wives, daughters and sisters who participated in the production of scientific knowledge as typists, secretaries, illustrators, editors and co-authors?
5. In addition to the home, what other sites might be studied to uncover the lives of women involved in science in the nineteenth century?

Further reading

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25

Thomasina Ross (fl. 1850s): Title page of Alexander von Humboldt's *Personal Narrative of Travels* (1852–1853)

Professor Alison Martin

Introduction

The Prussian explorer Alexander von Humboldt (1769–1859) was one of the most eminent scientists of the nineteenth century. His principal works were written in French and German and offered important new ways of rethinking nature as the interconnection of global forces. They were accessible to both a specialist and more general audience and were written in a lyrical and vibrant style that actively sought to engage the reader's imagination. Best sellers in their time, these books were also swiftly translated into English.

What is intriguing about the British reception of Humboldt's work is that the (re)translations of nineteenth-century editions of these key books were, for the most part, written by women. The presence of translators tends to go unnoticed when reading a work in translation. Yet they are important transnational mediators, who determine the voice their authors acquire in a different language and potentially influence their reception by foreign readerships. They can change a text subtly or substantially through stylistic and lexical choices and through the omission or addition of information. Historically, translation has offered women a valuable conduit into scientific knowledge-making that remains underexplored because of the apparent invisibility of the translator in a translated text.

The source image is the title page to an English translation of one part of Humboldt's multi-volume account of his journey to the Americas undertaken between 1799 and 1804 with the French botanist Aimé Bonpland. After returning from his travels, Humboldt settled in Paris, then at the heart of European scientific activity. Working with a Parisian publisher, Humboldt's account was originally written and published in French as the *Relation historique du voyage aux régions équinoxiales du Nouveau Continent* (*Historical Account of the Voyage to the Equinoctial Regions of the New Continent*) from 1814 to 1825.[26] Overseen by Humboldt, the work was first translated into English by the poet and novelist Helen Maria Williams, and appeared as the seven-volume *Personal Narrative of Travels to the Equinoctial Regions of the New Continent during the Years 1799–1804*, published from 1814 to 1829.[27] Just under 40 years later, a new and considerably shorter three-volume English edition appeared with the slightly more contemporary title, *Personal Narrative of Travels to the Equinoctial Regions of America, during the Years 1799-1804*, published from 1852 to 1853 and translated and edited by Thomasina Ross, a female journalist.[28]

Source

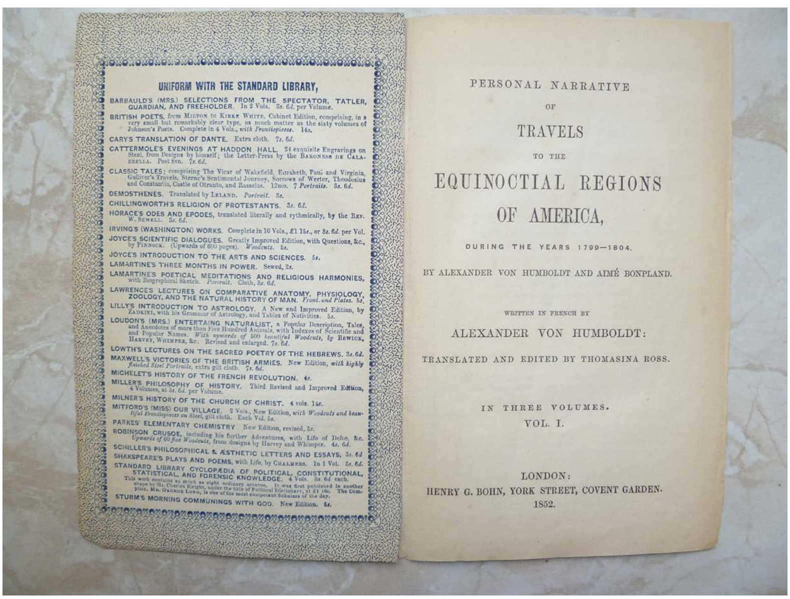

Figure 6.3 Title page, *Personal Narrative of Travels to the Equinoctial Regions of America, during the Years 1799–1804* (London: Bohn, 1852–1853). Image credit: Alison Martin.

Analysis

The title page of Humboldt's *Personal Narrative of Travels* (1852–1853) is interesting for three main reasons. It foregrounds Thomasina Ross as the linguistic gatekeeper enabling Humboldt's work to reach an English-speaking audience, it underlines her centrality as the translator and editor reshaping his prose for an British readership, and it highlights the significance of the publisher Henry G. Bohn in encouraging women's involvement in the public print sphere.

The visibility of the translator's name on the title page of a work they had translated was by no means a given. Translation had long been characterised as tedious, uncreative 'hack work', and was remunerated accordingly. Scientific translation, often considered formulaic and devoid of style, has suffered particularly as a result of this generalisation.[29] Henry G. Bohn, a publisher of German extraction who had himself worked as a translator, was keen to promote the work of his translators as a serious, committed undertaking.[30] Ross, whose name is given in the same font size as that of the scientific travellers Humboldt and Bonpland, is presented on typographically equal terms with them, implying a respect for the work she had carried out.

The radical reduction of Humboldt's text from its original seven volumes in the Longman edition to the three volumes for the work published by Bohn raises several questions. How did Ross approach the task of radically shortening Humboldt's text, what were the strategic reasons for doing so, and how did the end result look? The skills Ross had acquired as a journalist came into play here. By paring the text back, she made it more linear, concise and impersonal. She jettisoned the asides in which Humboldt had modestly reflected on experiments that had failed or not delivered conclusive results, removed lengthy tributes to colleagues within the international scientific community, and selected more gender-neutral wordings for the 'scientific men' of the Longman translation. These changes modernised Humboldt's work, aligning it stylistically with what now typifies scientific prose and making it more readable for a contemporary audience.

Bohn was one of the most strategic publishers in mid-century London. He recognised that the Anglophone book market was ready for a new edition of Humboldt's *Relation Historique*, since the Longman edition never reached a wide audience for reasons of cost and length. The decision to publish the *Personal Narrative* as a three-volume edition was in line with trends in nineteenth-century publishing. The so-called ‘three-decker’ was a format typical of English language novels in the period. Published part by part, they brought work onto the market in ways that aroused curiosity about the later volumes and encouraged demand.[31] Bohn also grouped his works according to subject in his various series or libraries. Each library was bound in a different colour, which likewise had market appeal as the volumes had visual impact when placed together on the bookshelves of the aspiring middle-class reader.

Questions

1. How does knowledge move across linguistic borders and why? Readers may want to refer to similar concerns raised in part one.
2. Which other mediators – apart from translators – are involved in publishing a text in a foreign language edition?
3. How do you think scientists felt about having their work translated into a language they could not read?
4. Which different types of power are at work in translation?
5. What role does the study of translation play in researching science, language and national identity in the nineteenth century?

Further reading

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Elizabeth Cary Agassiz (1822–1907): The *Hassler* expedition (1871–1872)

Dr Erika Jones

Introduction

Elizabeth Cary Agassiz (1822–1907) was an American intellectual, educator, author and researcher of natural history who had a strong interest in marine life. This source is a series of letters written by her during her time on the *Hassler*, a steamship that travelled from Boston to San Francisco along the coast of South America and visited the Galápagos Islands along the way.[32] Elizabeth accompanied her husband, Professor Louis Agassiz (1807–1873), director of the Museum of Comparative Zoology at Harvard University, who organised the *Hassler* Expedition in collaboration with Benjamin Pierce, Superintendent of the United States Coast Survey. The three-masted, iron-hulled US Coast Survey steamer left Boston in early December 1871 and arrived in San Francisco in August 1872. Over the course of eight months, the *Hassler*'s naval crew observed and recorded ocean temperatures, depth and currents, and collected deep-sea animals by deploying a dredge.[33] Although often overlooked in the historiography of the voyage, historians have begun to recognise Elizabeth's participation in the scientific work of the expedition.[34]

Elizabeth was a talented and prolific writer and her ability to create engaging accounts helped to propel Louis's career. During his lifetime, he was one of the most influential scientists in the United States. By the time of the *Hassler*, however, he had begun to lose favour for his clinging belief to creationism, and his scientific legacy today is tainted by his promotion of racist ideologies.[35] While Elizabeth's work supported her husband, in her letters written during the voyage she demonstrated her own, and sometimes differing, opinions. The scope of the collection, of which a sample is included here, provide evidence of her continuous recording of the events and details of the voyage, an important but often overlooked aspect of expeditionary work. The range of letters also convey some of Elizabeth's impressions of the changing conditions of the ship at sea, from tedium to gales, and some of the challenges of studying the ocean in the 1860s.

Throughout her life Elizabeth promoted women's access to higher education. In 1879, she was one of seven female directors of the Society for the Collegiate Instruction of Women in Cambridge, Massachusetts. This gave qualified young women access to tuition from professors at Harvard University, then closed to female students. In 1894, Radcliff College became incorporated, and Elizabeth became its first President. After her death, an edited selection of Elizabeth's letters were published in *Elizabeth Cary Agassiz: A Biography* (Boston and New York: Houghton Mifflin Company, 1919) by Lucy Allen Paton. Radcliff College produced the biography, 'in order that the future students might have some knowledge of her character and of what Radcliff owes to her.'[36]

Source

Excerpts from Paton, Lucy Allen. *Elizabeth Cary Agassiz: A Biography*. Boston and New York: Houghton Mifflin Company, 1919.[37]
https://archive.org/details/elizabethcaryaga00patouoft/page/n7/mode/2up/mode/2up

[119] TO MRS. THOMAS G. CARY, December 12, 1871.

We are and have been all day floating along on a summer sea. You can hardly imagine waking in the morning so warm that it is a relief when the cabin boy brings me my bath tub full of fresh sea water. There is little to tell, but I wish you could see us as we sit on deck under our awning, I with my work in my lap and my book at my side, sewing sometimes, reading sometimes, talking, as circumstances favor. Agassiz is busy, of course, and he has begun as before on the Colorado to lecture on the work of the day, only here he lectures on deck. This morning I sat with my back to the little audience, but the Captain told me that nothing interested him more in the scene than to [120] watch the faces of the sailors, some of whom were free and gathered round to listen. He said they looked so earnest and engrossed, and while Agassiz was describing with the help of the blackboard the structure of some of the little animals found on the gulf weed. Dr. Hill went out to them with a microscope and showed them the actual specimen through the lens. It does more than please them. It gives them such an interest in the work [that] they are indeed most ready to help. I am just going to bed having been on deck, with the exception of meals, from half-past seven o'clock this morning till half-past eight this evening. You who now only the North Atlantic voyages have little idea of this tropical sailing.

[122] TO MRS. THOMAS G. CARY, *At Sea*, January 12, 1872.

My letters will be dull enough, for since we left Barbadoes there is nothing to record but an uneventful voyage, very rough during the first part for a week or so, but very pleasant and calm for the last five or six [123] days. What do we do? For my part read, read, read: four volumes of *Froude* are already disposed of and much of my light literature devoured also. I read German every day with Dr. Steindachner, who is most kind in helping me, and then I read aloud a good deal to Mrs. Johnson. [...] Then we watch the Portuguese men-of-war on days when they are plenty, and see occasional troops of flying fish and many phosphorescent creatures floating by at night. Still on the whole the sea is a niggard of its treasures — when one thinks how full it is of things, the sight of which, were it only a single one, would make a day rich, and after all how little one sees, it makes you quite discontented. I crave a whale or a dolphin; I would not despise even a shoal of porpoises, and day after day passes and the sea gives us nothing but itself — *ad nauseam*, in the truest sense of the words sometimes.

[126] TO MRS. THOMAS G. CARY, *Rio de Janeiro*, February 10, 1872.

The life one falls into on board ship is so strange. You have known it only in the European passages, where in the first place you have so many more companions to choose from, and then you know too that it is only for a fortnight; but to be shut up with some eighteen people for a year in such narrow quarters, seeing them day in and day out, all their little peculiarities brought out by the friction of close contact, is a curious experience; and then you add to it that you yourself are subjected to the same sharp analysis — that they are looking at you through their microscope as well as you at them through yours, and the position is still more singular.

[126] TO MRS. QUINCY A. SHAW, *Straits of Magellan, Sandy Point*, February 18, 1872.

Here we are safe and sound at the threshold of the wonderful region where mountains rise steeply from narrow ocean channels and glaciers plunge sheer down into the sea, — at least, that is what people say. I'll tell you whether it's true the next time we meet. At all [127] events we see superb snow mountains from this point, Mt. Sarmiento, Mt. Darwin, Mt. Buckland; they are beautiful even at this distance of some seventy miles.

In the early part of our voyage I was a little anxious lest the many delays, not only before starting but for the repair of defects in the ship which we did not discover till we were well on our way, would interfere with the success of the enterprise and would make your father so anxious, too, that he would not have any benefit from it either for his health or for science either. But for the last six weeks the real work has begun, and if he had no further successes he would feel more than repaid. He is tolerably cautious, but there are many days when he works as I have not seen him work for years, but he seems to bear it wonderfully well. Tell the children we have four live penguins, a number of wild geese, two cockatoos and two rabbits on board for pets. Many of them are quite tame and will eat from our hands; indeed, the "bunnies" would like to sit in my lap and be fed all day if I would let them.

[127] TO MRS. CHARLES P. CURTIS, *Monte Video*, February 24, 1872.

We started from Rio in fine feather a week ago, expecting nothing in this summer weather but a quick pleasant voyage down to Montevideo. We ran straight into a "stiff gale." I wish you had seen my room, which looked so pretty when we left Boston, about the middle of the second night. All the books had leaped out of the shelves and were rolling round on [128] the floor. My clothes which I had carefully arranged on the big chair had capsized with the chair and formed an indiscriminate heap increased by a number of additional articles which had fallen from the pegs; in the midst of the confusion a port broke open and let in four or five buckets of water which flooded the floor, and there the whole mass went swash, swash, — books, clothes, shoes, up and down, taking a general swim. Such a mess you never saw and is not to be conceived of on land. After this we had a day or two of beautiful weather; then another gale, in the midst of which Mr. Kennedy took me up to the top of the companion way to look out upon the scene. It is more grand than pleasant to see the great waves surging up about the little vessel looking as if they must inevitably pour down upon her. However, they do not, — she rides them like a duck. You need not imagine we have been in any danger from my descriptions, which I flatter myself are very thrilling; on the contrary I believe we've always been quite as safe, though not as comfortable, as if sitting in our parlors at home and that the gales we have met have been bagatelles to a great storm. I'm not ambitious to test the difference and am quite content with what I have already seen of the terrors of the great deep.

[128] TO MRS. THOMAS G. CARY, *Off Bahia Blanca*, March 3, 1872.

The next morning [after leaving Monte Video] we had a dredging which was a delightful chance for Agassiz. [129] He got a most characteristic and complete collection from the river of great scientific value. Among other things there was the egg of some shell (Agassiz thinks of a large Voluta). It was about the size of a small hen's egg, quite transparent, the egg itself being about the hardness and consistency of isinglass, and contained a number of young, which Agassiz examined. The whole thing was entirely new to him and of great interest. Then, there were quantities of beautiful shells of various kinds of starfishes (some quite rare) and so forth. It is very interesting to see these beautiful living shells, which we only associate with shells in collections, with the animals all expanded and active, walking about. One little shell I saw, a perfect little beauty, had its mantle all spread out, and folding the sides upward it used them just like wings, flapping them with the greatest rapidity and flying through the water like an arrow. How little after all we know of the life and enjoyments of these creatures which we see preserved in Museums.

The next day, March 1, was simply heavenly — like the purest of our September days, without taint or blemish, — one of the days when even I can say that life at sea under such circumstances is delightful. At about two o'clock we had another dredging, now in open sea, if you are particular about localities and depths, to the northeast of Cape Corrientes in about forty-five fathoms. This time we found things that made Agassiz ready to jump overboard with joy. If he had not thought the dredge would do it better, I verily believe he would have gone down himself to [130] see what he could find. Among other things he found a very rare shell, and *two* specimens, the young and the old, one would say, from the relative size, and only known heretofore from the Straits of Magellan where we had had a faint hope he might find it, though even there it's not easy. Then some beautiful sea-urchins and many very young ones, from the size of a pea, and even smaller, upwards, all of which he preserved with great care for Alex [his son], as that is a specialty with him, and the young are not easy to have. Altogether this dredging was more interesting even than the previous one.

[135] TO MRS. THOMAS G. CARY, March 9, 1872.

I left you on Thursday, just after we had rounded the point of San Mathias Gulf and river, keeping on our southern course again. We had a fine day and being nearly out of the "Pampiro" region began to flatter ourselves we had escaped, but the sun went down in magnificent clouds which the Captain said were full of wind and looked risky. The whole evening the lightning was superb with chains of electricity from cloud to cloud and down into the ocean. Still the night was still as sleep and the water almost without a ripple. At about ten o'clock with the force of a hurricane and the suddenness of lightning, the land wind struck the ship. After that there was little sleep for any one; everything (in sailor's parlance) that could "fetch away" "fetched away"; among other things my bed, which as Helen and Sallie will remember was clamped with an iron bar to the inner one, worked itself loose and I found myself adrift. I jumped on to the inner bed, and there I remained blockaded calling for help. Finding no one heard in the noise of the storm I climbed over it and called to the carpenter to make all fast. At last I was settled. Towards morning the row abated, and we got a nap. We waked to fine weather though a very rough sea and came out to hear the funny adventures of the night — upsetting of water-pitchers, drenching of beds, smashing of crockery, etc., — but we came through safe and sound, no harm done and have seen the elephant in the shape of a "Pampiro"; once is enough. I don't appreciate the grandeur of storms at [135] sea. However, you must not imagine we have had any alarming ones except to the uninitiated. I only tell you about them to show that our experience is a varied one, and there is always a funny side to these rough times when not only things but people are whacked about without any respect for personal dignity. The sea went down towards evening yesterday, and after the sleepless night before all turned in early. I think the "sleep of the just" must be a restless slumber in comparison to mine last night; from nine o'clock to six this morning I never stirred and when I waked it was a beautiful warm morning and the ship as quiet as our own house in Quincy Street.

We have just been dredging off the Gulf of St. George in about fifty fathoms of water, and beautiful things have come up; a starfish more than a foot in diameter, its ten arms subdivided a hundredfold into countless delicate fibrous-like branches, winding and coiling in an endless variety of curves; another huge starfish, like an immense sunflower, with thirty-seven arms, measuring some fifteen inches from the tip of one arm to the tip of the opposite arm; then beautiful sea-urchins, a skate egg with the living young, etc., etc. As we go south the ship is surrounded with birds, albatross, ducks, gulls and other birds, the names of which we do not know. They are so tame that we pass them quite close without disturbing them.

[135] March 15, 1872.

Yesterday was again very fine, but with a pretty strong wind and sea, and as the beach was difficult to [137] land upon, Mrs. Johnson and I did not have our walk on shore. The two parties started with daylight and at about four o'clock in the afternoon Agassiz and his companions returned. He was on the top wave of life, so happy with the results of his day. You know geologically he is seeking for glacial phenomena, and on their way to a hill between the shore and Mt. Aymond to which Pourtalès and his party had gone, Agassiz had come upon a terminal moraine having all the characteristic features, built of glacier-worn boulders, pebbles and stones of all sorts and sizes packed into a paste of earth. It had been pushed up evidently by a mass of ice advancing from the southward, the southern slope being steep as is always the case with the side of the moraine turned towards the glacier, while the northern slope was more gradual. He also found a salt pond some two hundred feet above the level of the sea with moraine shells living in it. This will please Darwin if he does not already know it, because it illustrates a statement he made many years ago that the geology of this coast was connected with upheaval. The whole party came back in a state of great elation, looking like a company of Nimrods, loaded with game, ducks, snipe, cormorants, a fox and a skunk, the smell of which made me quite homesick, it recalled so vividly certain summer evenings at Nahant. It may be interesting to you as a scientific fact to know that skunks smell in Patagonia exactly as they do in New England. In order that the birds might be prepared we deferred dinner till six o'clock and had it made ready in great style with a centre [138] ornament which we thought could not be matched at any dinner party on Beacon Street or Fifth Avenue. A guanaco skull supported a spreading bunch of ostrich plumes gathered on the Patagonian shore, while the base of our bouquet was finished with green drooping fronds of "kelp" — match that if you can. *First Course*: Mussels roasted on the shell (from the beach of Possession Bay). *Second Course*: Patagonian snipe on toast. *Wines*: Sherry, Sauterne, Claret, Champagne, *Not* native. Our wine cellar is getting low but we thought we would not be niggardly on this first dinner in the Straits. We were quite a snug party, nine instead of eighteen as usual in the mess, for the Mt. Aymond party had not yet returned; but just as we were sitting over our dessert hearing all the details of the day and everybody talking together, a shout on deck announced the return of the second party. We all rushed up and there they were with great trophies. They had shot and skinned a guanaco and brought him bodily, and this morning we have breakfasted sumptuously off guanaco steak (very much like beefsteak and seemed to me as good), but we have been so long without fresh provisions that we are likely to do more than justice to Patagonian fare. They brought also upland goose and other game, but their news was the most interesting of all. Pourtalès had found Mt. Aymond to be the centre of a nest of extinct volcanoes. The mountain itself had two craters very perfectly formed about 200 feet in depth. He gathered fine specimens of lava and volcanic debris all around them. Near the main peak [139] were several lesser hills called the "Asses' Ears" which were all craters and from Mt. Aymond Pourtalès said you could see thirty or forty such craters. All this is very interesting and novel, as none of the explorers seem to have examined these hills though they have been named and entered on the charts, but I suppose their position has been ascertained from a distance. The mountain party with the exception of one or two of the strong ones were "dead beat," for the tramp had been a most fatiguing one, but I never saw Pourtalès look so animated and so excited as he did on his return. They had seen large herds of guanacos, from fifty to a hundred at a time; they say they were so graceful, and when disturbed they hurry close together and stand startled and alert with their pretty heads heads listening and whinnying to each other like young colts. While they feed on the plain they have a sentinel at watch on high ground to give warning of danger. The skin and fur are very soft and make excellent robes, and the Indians use them also for their tents. The skin and head of the one they shot yesterday are lying on the deck now. It is a beautiful head like that of a young deer.

[144] TO MRS. THOMAS G. CARY, March 31, *Easter Sunday*, 1872.

And such a beautiful morning. I was on deck very early between moonlight and sunrise and the sight was a lovely one till the sun came fairly up, as Sallie says, "to spoil it all." I bade you all good-night on the 28th in Mayne's Harbor, or Owen's Island. We passed the 29th there for a more complete repair of our engine, and it was a day well spent for collections and for geology. I took a long tramp up the nearer ridges of the mountains with Pourtalès in search of glacial furrows, and Agassiz dredged on board ship very successfully besides getting a good many new birds from the sportsmen. The next morning we were all right again for proceeding and came on to Puerto Bueno. This is a harbor within a harbor. We anchored in the outer one, and then half a dozen of us took a boat to row to the inner one. I wish I could make you understand what a vagabondish kind of life we lead. For instance, landing at the mouth of a little brook that came brawling down through trees and rocks into the inner harbor, we followed it for about a quarter of a mile and it brought us to a large lake broken by islands. Mrs. Johnson and I found an old log which made an excellent seat. Pourtalès and Steindachner left us to hunt for specimens in the lake and were soon out of sight. Presently Dr. Hill comes prowling along the bank of the brook with his tin box for botany on his shoulder and his hands full of [145] specimens, and he stops for a little talk, and then he too wanders on. Mrs. Johnson and I sit and talk in the afternoon sunshine, and then we stroll back through the woods to the harbor, picking berries as we go and gathering bouquets for the dinner table. Arrived on the shore we encountered Mr. Kennedy who was just coming along in his little dingy, a mite of a boat in which he can run into all the nooks and corners and collect for Agassiz. He lands and makes a fire, and presently Dr. Pitkin arrives upon the scene with some mussels, and we roast them in the cinders, and so the afternoon passes, and the others come back one by one, and we take to the boat again and reach the ship just in time for dinner. This is a specimen of many such little excursions; but this gypsy life will soon be over, I suppose. If things go on all right, we shall be out at sea again in a few days.

[145] TO MRS. THOMAS G. CARY, *Talcahuana*, April 12, 1872.

I left you on the third of April putting out to sea about sunset and taking our last look at the snow mountains of the Straits in all their rosy moonlight beauty. We met head winds outside and had two very rough days and nights. How easy to write it, how hateful to experience! On Saturday, April 6, the weather was again delightful, and we entered Coreovado Gulf (now you must look on the map and see where that is, because I'm confident you don't know). Here we had beautiful snow mountains in sight all day, the peak of Corcovado and a wonderfully beautiful volcanic mountain called Melimoya [146] white as the purest marble to the summit, and the crater clearly defined against the sky. We anchored in the Port San Pedro, no port in the sense of settlement, only a harbor surrounded by forest-covered hills, the silence unbroken except for the cry of the birds which whiten the rocks and now and then the rush of a steamer duck through the water. We went on shore at a lovely little beach and collected animals and plants. The flowers on the bank of this beach were beautiful, among others a superb specimen of the wild pineapple kind with very large crimson leaves and lilac centre. We enjoyed our ramble on this beach very much, and we saw from there a sunset I shall never forget. The opening of the harbor gave us a full view of the snow mountains, and Agassiz said he had not often in his life seen the Alps in such beauty at that hour.

We put to sea again and made the upper end of the island [of Chiloe] and anchored at the little town of Ancud, or San Carlos, on Monday, the eighth. I see that the book speaks of this generally as a squalid little place and of the climate as dreary, rainy and foggy to the last degree. Everything depends upon the circumstances under which things are presented to you. All I can say is that the little town of Ancud on one of the most brilliantly beautiful days we have had seemed to me a cosy, cheerful, picturesque little place. Her great volcano, Osorno, was quite uncovered, without a cloud, and so was the whole snowy Cordillera, the southern spurs, I suppose, of the Andes. We only intended to stay a few hours, and while [147] Agassiz and his corps went at once to their scientific researches, Mrs. Johnson and I devoted ourselves to the social investigation of the little town.

First, we went to the market, a central square surrounded by booths where were lying and sitting, grouped about in all sorts of attitudes, some asleep, some nursing their children, Indian and Chilian women, with their bright shawls thrown mantilla-like over their heads and shoulders, men lounging about in their characteristic poncho and slouched hat. We met in the market a gentleman, whose name we did not know, but he joined us, offered to be our escort and took us all over the village, up on the hill where stands the Catholic church commanding a superb view of mountains and harbor and hillsides with little farms scattered about. Then we wandered through the streets under his escort, looked in at the school, were invited into one or two houses where we saw the linen lace work made, were presented with flowers, and altogether treated with much cordiality. We saw the fuchsias growing wild in tall bushes in the poorest gardens; we saw the groups of Indians who come in across the river in the morning from their outlying farms to sell milk and eggs, now resting and sitting about on the street corners with empty milk bottles and egg baskets. We saw the country people driving out their double teams of strong powerful oxen drawing shallow wooden troughs filled with manure for their fields. We saw the ladies of Ancud, always with the half shawl, half mantle, drawn over head and shoulders, sitting in their [148] porticos around the braseiro where simmered the little kettle for the preparation of their maté tea; altogether it looked to me very cheerful and vastly entertaining, perhaps because we had been for three weeks so out of reach of people. When we returned to the landing place to embark, we were met by a most gratifying spectacle. Now I have already mentioned that our larder was low and the truth is we had had nothing but beans and bread for a number of days, and not too much of that. Our caterer and steward were on the wharf with chickens, beef and mutton, with potatoes, eggs, cheese and butter, with fresh rolls and loaves from the baker's, with cabbages, cauliflowers, beets and carrots. I dare say that sounds very commonplace and uninteresting, but it is utterly impossible for you people living on the fat of the land to conceive of the emotions awakened in the company of the Hassler by the sight of these provisions. I shall never to my last hour forget the soup we had for dinner that day. We left that afternoon and had a good run to Lota, our next port, where we were to take in coal. We reached there toward evening on the tenth. Lota has left a strange impression on my mind. We went on shore that night and visited the great copper foundries which lie just along the beach and are fed by the coal mines on the shore, the discovery of which has made or is making the fortune of this little place, which hardly existed fifteen years ago. A foundry has always a kind of weird, uncanny element to me with its fierce unceasing fires, and this was especially impressive at night with the [149] roar of the surf on one side and the roar of the huge furnaces at white heat on the other, and the figures of the workmen moving about between in the intense Rembrandt lights and shadows. This is the only picture I brought away from Lota, for we left early the next day, and I did not therefore go on shore by broad sunlight to dispel my fantastic vision of the night.

[164] TO MISS MARY FELTON, *San Francisco (on board the Hassler)*, August 31, 1872.

I walk up and down the deck and say to myself, "Is it true? You are here, the voyage so dreaded is over; that day, when you waved your handkerchief from the port to the tug in Boston Harbor is ever so far away in the distance, and you are anchored before the wharves of the San Francisco Company." I really cannot believe it. It seems impossible. The voyage was so long when we looked forward, and then all the doubts as to the results ! I have not been on shore yet. I feel too excited and happy, and it is enough to know that we are here. I want to pause and take it all in. We will stay on board tomorrow and rest and get our traps ready. Ah, how strange it has seemed to me to take down Mrs. Sargent's "Bon Voyage" and dear Sallie Whitman's picture, "His blessing like a line of light Is on the water day and night" (how often I have taken comfort from it), and the picture of the Nahant house hanging beneath it, and the shoe bags and the comb cases. Many of the things I hope to put up in my room at home, for it will be a pleasure to recall my cosy little chamber here. I thought I could never become attached to the Hassler, but your prophecy was a true one, — I feel as I sit writing to you in the little cabin that, though I would not sail another mile in her for a fortune, I shall leave her with a kind of affectionate feeling.

Analysis

In the mid-nineteenth century, the deep ocean was a new frontier for science and empire. As the unexplored depths became more accessible due to improved marine steam engines and dredging apparatus, naturalists sought to understand the ocean's geologic history, the distribution of marine species, and the origins of life on Earth. It is within this wider context that the *Hassler* conducted deep-sea experiments in 1871–1872. At the same time, the study of marine life was a popular occupation for seaside visitors and intellectuals.[38] In this realm, Elizabeth wrote *Seaside Studies in Natural History: Marine Animals of Massachusetts Bay*.[39] While her step-son, naturalist Alexander Agassiz, is listed as the book's second author, *Seaside Studies* established Elizabeth as a popular scientific writer. As marine biology became more professionalised and deep-sea research took place on naval ships and research vessels in the late 1860s, however, women became excluded from ocean science.

Elizabeth gained access to the *Hassler* Expedition through her husband, but she was a key member of the voyage's scientific team in her own right.[40] Journal keeping was an important part of the work of scientific expeditions; travel narratives recorded scientific observations and personal reflections and could be later transformed into lucrative publications. Elizabeth had proven experience writing in this format. Beginning in 1865, Louis and Elizabeth travelled for 14 months from Boston through Brazil – including along both the Amazon and Rio Negro rivers – to collect plants and animals to compare them to those of North America.[41] The resulting narrative account of the expedition, *A Journey in Brazil,* was a popular success and in its sixth edition by 1869.[42] Although again listed as a co-author, Elizabeth's voice and perspective dominate the account, while Louis's scientific contribution was reduced to footnotes, quotes from his lectures and the appendix.[43]

It is significant that in the planning of the expedition, Pierce invited both Louis and Elizabeth to join *Hassler*. The superintendent was Louis's colleague at the Lawrence Scientific School, but he was also an ardent fan of *Journey in Brazil*.[44] Recording her observations during the voyage, Elizabeth's letters can be viewed as evidence of her preparations for writing *Hassler*'s travel narrative. Nineteenth-century voyaging accounts included reflections on nature and overcoming obstacles, such as Elizabeth's account of storms at sea. Often presented as daily entries, maritime literature related the scientific work of expeditions as well as anthropological descriptions of the people they met, another feature of her letters.[45]

Although Elizabeth supported her husband, her writing style allowed her to freely express her own opinions.[46] At times, her letters playfully swipe at Louis's scientific obsessions, such as his devotion to building the Museum of Comparative Zoology's collections. She reflected on the sublime beauty of a living shell, observing 'a perfect little beauty' swimming in the ocean and mused, 'How little after all we know of the life and enjoyments of these creatures which we see preserved in Museums.'[47] While avoiding direct confrontation, Elizabeth questions the validity of studying preserved specimens compared to the richness of observing living animals in their natural habitat.

In addition to her observation of ocean life, Elizabeth and Elvira Lindsay, wife of Commander Philip Carrigan Johnson 'devoted themselves to the social investigation' of cultures they encountered on shore. Following the form of European travel narratives, Elizabeth's depictions explained to readers and prepared other travellers for what to expect in unfamiliar lands. Writing from a position of both wealth and ethnocentric tendencies, similar to her style in *A Journey in Brazil,* Elizabeth was charmed by the 'cheerful and vastly entertaining' women of Ancud, Chile.[48] Although patronising, her sympathetic observations contrasted sharply with her husband's avid racism and promotion of polygenism.[49]

The *Hassler* was Louis's final expedition, as he died in 1873. Without Louis' co-authorship, except for a series of newspaper articles, Elizabeth's narrative of the expedition remained unpublished.[50] After her husband's death, she continued to write, publish and support women's education.

Questions

1. Elizabeth co-authored her books with her step-son and husband. What might have been some of the benefits of publishing as a co-author rather than on her own?
2. Elizabeth recorded in detail her time on shore, during what historians consider to be a deep-sea dredging expedition. What does her

portrayal of Indigenous people tell us about scientific exploration and empire?
3. How does the source reveal the importance of social dynamics during long voyages at sea?
4. From her letters, what can we infer about Elizabeth's role in the expedition?
5. Elizabeth makes several comparisons between the ship and her Boston home. What material and social contexts made it more like home while travelling on the *Hassler*? What aspects were markedly different?

Further reading

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Part VI notes

1 See Fyfe, *Steam-Powered Knowledge* and Topham, 'Scientific Publishing and the Reading of Science in Nineteenth-Century Britain'.
2 Shapin, 'The Invisible Technician', 1989.
3 See Secord, *Victorian Sensation*; Cantor et al. (Eds.), *Science in the Nineteenth-Century Periodical*; Nyhart, 'Voyaging and the Scientific Expedition Report, 1800–1940', 2012.
4 For example, in 1852, the Smithsonian's International Publication Exchange Program transmitted nearly 8,000 volumes and received over 4,000 foreign publications.
5 For works on nineteenth-century female travellers, writers and colonialism see: Mills, *Discourses of Difference*; Stevenson, *Victorian Women Travel Writers in Africa*; McEwan, *Gender, Geography and Empire*.
6 For a discussion of colonial wives, see Gartrell, 'Colonial Wives'.
7 Albuquerque and Figueirôa, 'Depicting the Invisible', 2018, 109–129.
8 Kennedy, 'Professionals', 2000, 62–94.
9 Kennedy, 'Professionals', 2000, 62–94.

10 Kennedy, 'Professionals', 2000, 62–94.
11 Buttimer, 'Beyond Humboldtian Science and Goethe's Way of Science', 2001, 105–120.
12 Pandora, 'Amateurs', 143.
13 Gartrell, 'Colonial Wives', 165–185.
14 Cardona, 'Alexine Tinné', 2012, 124–138.
15 Burek and Higgs, 'The Role of Women in the History and Development of Geology', 2007, 1–8.
16 Kölbl-Ebert, 'The Geological Travels of Charles Lyell, Charlotte Murchinson and Roderick Impey Murchinson in France and Northern Italy (1828)', 2007, 109–117.
17 Jackson and Jones, 'The Quiet Workforce', 2007, 97–113.
18 Bigg, 'Diagrams', 2016, 557–571.
19 Kotschy, *Plantae Tinneanae in Expeditione Ad Bahr Ghazal*.
20 This research was funded by the European Regional Development fund and Mobilitas Pluss programme (grant number: MOBJD517).
21 Trumpa, 'Karte des lettischen Sprachgebiets', 2009, 79–102; British Library, 'Atlas by August Johann Gottfried Bielenstein, 1892'.
22 Korsaka, 'Martha Bielenstein', 2005, 79–84; Bielenstein, *Ein glückliches Leben*; Bielenstein/Bīlenšteins, *Bet mājas palika / Die Häuser aber blieben*.
23 Güttler, 'Unsichtbare Hände', 2013, 133–153.
24 Tyner, 'Mapping Women', 2016, 7–14, 8.
25 Bielenstein, *Die Grenzen des lettischen Volksstammes und der lettischen Sprache in der Gegenwart und im 13. Jahrhundert,* vi.
26 von Humboldt, *Relation historique du voyage aux régions équinoxiales.*
27 von Humboldt, *Personal Narrative of Travels to the Equinoctial Regions of the New Continent* (1814–1829).
28 Von Humboldt, *Personal Narrative of Travels to the Equinoctial Regions of America* (1852–1853).
29 Montgomery unpacks the processes and meanings of scientific translation in his introduction to *Science in Translation,* 2000, 1–14.
30 Martin, *Nature Translated*, 120.
31 On the marketing and dissemination of science, see Fyfe and Lightman, Eds. *Science in the Marketplace*, especially Topham, "Publishing 'Popular Science' in Early Nineteenth-Century Britain," 135–168.
32 Found in Paton, *Elizabeth Cary Agassiz.*
33 National Oceanic & Atmospheric Administration, 'The 1871 *Hassler* Expedition and Louis Agassiz'.
34 Irmscher*, Louis Agassiz,* 311–342.
35 For an account of Louis Agassiz's enduring legacy of promoting 'scientific racism' see Iqbal, 'Louis Agassiz, Under a Microscope'.
36 Paton, *Elizabeth Cary Agassiz,* v.
37 Please note numbers in square brackets in this source denote page numbers.
38 Rozwadowski, *Fathoming the Ocean*, 99–132.
39 Agassiz and Agassiz*, Seaside Studies in Natural History.*
40 Irmscher*, Louis Agassiz,* 311–342.
41 Landau, 'The Agassizes Take Brazil'.
42 Agassiz and Agassiz*, A Journey in Brazil*.
43 Fontes de Oliveira, *Three Traveling Women Writers,* 143.
44 Irmscher, *Louis Agassiz,* 311.
45 Rozwadowski, *Fathoming the Ocean*, 20.
46 Irmscher*, Louis Agassiz,* 334.
47 Paton, *Elizabeth Cary Agassiz,* 129.
48 Landau, 'The Agassizes Take Brazil'.
49 Iqbal, 'Louis Agassiz, Under a Microscope'; for Elizabeth's attitudes concerning race and her writings on the *Hassler* expedition see Irmscher, *Louis Agassiz*, 319.
50 Agassiz, Elizabeth Cabot Cary. *Narrative of the Voyage of the Hassler in the Form of Letters Written on Board by Mrs. Agassiz and Published in the Boston Transcript and the New York Tribune, 1871–1872*. Spec. Coll. MCZ 023. Ernst Mayr Library, Museum of Comparative Zoology, Harvard University, Cambridge, Mass.

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Part VII
Representations of the natural world (1800s)

Timeline: individuals, events and publications in the history of science	Timeline: individuals, events and publications in this part
1708–70 Georg Dionysius Ehret, German botanist, entomologist and botanical artist.	
1759 Princess Augusta, mother of King George III, founds the botanic garden at Kew, England.	
1768–71 The English naturalist Joseph Banks joins Captain James Cook's voyage to the South Pacific, aboard HMS *Endeavour*. Upon his return Banks becomes unofficial director of the gardens at Kew.	
	fl. 1775–1824 Margaret Meen, British watercolour painter and botanical artist.
1787–90 British Naval officer and colonial administrator William Bligh captains HMS *Bounty* on a voyage to the South Pacific to bring breadfruit to the West Indies. The crew mutinies during the voyage.	

Timeline: individuals, events and publications in the history of science	**Timeline: individuals, events and publications in this part**
	1803–57 Sarah Anne Drake, British botanical artist.
	1828–1901 Eleanor Ormerod, British economic entomologist.
	1830–90 Marianne North, British traveller and botanical artist.
1837 Publication of first edition of Spanish friar and botanist Manuel Blanco's *Flora de Filipinas*.	
1838 The Royal Agricultural Society of England is established.	
1840 British botanist William Hooker is appointed Director of Kew.	
	b. 1858 Emina María Jackson y Zaragoza, Spanish botanical artist.
	fl. 1860s–1870s Sally Paul, Mi'kmaq medical practitioner.
1863 The Inspección General de Montes (Forestry Bureau) is established in the Philippines under the Spanish government, to assess the extent of the country's forests and oversee their use.	

Introduction

This part explores sources connected with the movement of knowledge from the Americas and Asia to Europe through representations of the natural world. To better understand how and why knowledge travels, it is important to consider the power dynamics and interests involved.[1] Collecting knowledge about plants and animals during the nineteenth century was strongly entwined with colonialism. Many nation states used the pursuit of natural knowledge and its communication to justify and legitimise imperial conquest by connecting such knowledge with the idea of improvement and the rational study of the world.[2]

Several of the women featured in this part had connections to Kew Gardens, a botanical research and education centre that acquired and displayed plants collected from around the world. Founded as a botanic garden by Princess Augusta in 1759, Kew Gardens in the nineteenth century transformed into a national storehouse of preserved and live plants that assembled natural knowledge and projected imperial power.[3] This collecting and classifying impulse was not unique to Britain, and can be observed in the colonial projects of many European nations.[4]

The sources in this part, as in part four, also reveal how processes of artistry and craft were central to the ways in which scientific knowledge was communicated. The process of creating a visual representation of the natural world, such as depicting a flower or landscape, is not a neutral one, and artists made many choices about which features and details to include, which to highlight, and which to reject.[5] Another important choice these artists made was the medium they used to recreate their subjects – this part includes examples of specimens and models, two-dimensional visual depictions and textual descriptions.

This part includes botanical illustrations produced by Margaret Meen, Sarah Anne Drake and Marianne North which reveal different artistic styles, alluding to the various modes of display and audiences for their work. The second source is a collection of entomological specimens which were presented to the Museum of Economic Botany at Kew Gardens by Eleanor Ormerod – a display that provided information that could be used to improve crop health and yields, thereby enabling more profitable exploitation of natural products. The third source, an illustration by Emina María Jackson y Zaragoza, reveals how representations of the natural world – particularly knowledge of Indigenous flora – contributed to European nations' colonial projects. The final source is an article by Captain Campbell Hardy that describes a curative for smallpox appropriated from Sally Paul, a Mi'kmaq woman in Nova Scotia. This source draws attention to the role of Indigenous people within colonial botany and highlights white perceptions of Indigenous knowledge in the nineteenth century. Even when acknowledged as knowledge holders, Indigenous communities were framed within bio-colonialism. Readers may wish to reassess the earlier sources in this part in light of this final source and question who is missing from these narratives of collection and depiction of the natural world.

27

Margaret Meen (fl. 1775–1824), Sarah Anne Drake (1803–1857), and Marianne North (1830–1890): Three botanical illustrations from women with connections to the Royal Botanic Gardens, Kew

Julia Buckley

Introduction

Margaret Meen was a painter of landscapes and flowers, and exhibited her work at the British Royal Academy between 1775 and 1785. She also made a significant contribution to botany, documenting many new plant introductions of the day. She was born in Suffolk and travelled to London to teach flower and insect painting and to exhibit her work. Between 1770 and 1820, Meen was employed to document the new plants being grown in the Royal Gardens at Kew, using Head Gardener William Aiton's 'Hortus Kewensis' to name the species she illustrated. She recorded many exciting new plant introductions to Britain, including the now familiar dahlia, introduced from Mexico. Meen worked alongside other renowned botanical illustrators of the day, including Georg Dionysius Ehret (1708–1770) and Francis Bauer (1758–1840), even giving lessons to Queen Charlotte. She established the short-lived journal 'Exotic Plants from the Royal Gardens at Kew' in 1790, which included a plate of *Strelitzia reginae*, the genus named in honour of Queen Charlotte, Duchess of Mecklenburg-Strelitz. It was intended that this publication be issued twice a year, featuring four illustrations in each issue, but it only ran to two issues, possibly due to the cost of production.[6] Though little is known about Meen, she is recognised as a highly accomplished artist and her paintings serve as important records of plants being raised in the Royal Gardens at Kew and other collections. Meen's work is represented in the collection of the Royal Botanic Gardens, Kew and in the Victoria and Albert Museum.[7]

The botanical illustrator Sarah Anne Drake produced highly accomplished and meticulously observed illustrations for some of the most acclaimed botanical publications of her day. She worked under the supervision of John Lindley (1799–1865), Assistant Secretary to the Royal Horticultural Society, orchidologist and Professor of Botany at University College London. In a similar way to Meen, Drake's background and early life is somewhat enigmatic. She was born in Norfolk and moved to London around 1830 to join the Lindley household, possibly as a governess.[8] However, her talent for botanical draughtsmanship was clear, and she was soon set to work by Lindley to illustrate specimens for his publication *Sertum Orchidaceum*.[9] Drake became adept at illustrating orchids, though she did not focus exclusively on this plant family. Alongside Mrs Augusta Withers, she was one of the principal illustrators of the esteemed publication *The Orchidaceae of Mexico and Guatemala* by James Bateman, the largest botanical book ever published.[10] Drake also contributed an incredible 1,100 plates to 'The Botanical Register', a prominent flower journal which described the plants being cultivated in British gardens in the nineteenth century. Each entry in 'The Botanical Register' featured a scientific description, with advice for cultivation, accompanied by an illustration.

The botanical artist Marianne North was born in Hastings in 1830. As the daughter of a politician, she was introduced to some of the eminent thinkers of the day. North developed an early interest in travel through visits abroad with her father, and took lessons in flower painting which equipped her with skills in observation and an appreciation for the natural world. The Australian artist, Robert Dowling, introduced her to oil painting and she immediately abandoned the use of watercolour, her previous medium, in favour of this. North was left a large sum of money after her father's death in 1869, which enabled her to continue her travels, and she resolved to dedicate herself to the study of nature; painting the landscape and flora she encountered across the world. She visited numerous countries including Jamaica, Brazil, Indonesia, Sri Lanka, New Zealand, South Africa and North America. The first scientific description of the plant *Crinum northianum* was produced from North's original painting. She associated with the key scientists of the day, including Sir Joseph Hooker and Charles Darwin, who encouraged her to document the flora of Australia. She also influenced other artists in her field, such as the Australian botanical illustrator Ellis Rowan.

Sources

Figure 7.1a Illustration in watercolour on vellum of the common chestnut tree *Fagus castanea* (current accepted name *Castanea sativa*) painted by Margaret Meen in 1783. The Tankerville Collection. Image credit: © The Board of Trustees of the Royal Botanic Gardens, Kew. Licence: CC BY-NC.

Figure 7.1b Illustration in watercolour on paper by Sarah Anne Drake for plate XXXVII *Galeandra devoniana* in John Lindley, *Sertum Orchidaceum* (London: J. Ridgway, 1837-1841). Image credit: © The Board of Trustees of the Royal Botanic Gardens, Kew. Licence: CC BY-NC.

Figure 7.1c A New Pitcher Plant from the Limestone Mountains of Sarawak, Borneo – MN561. Oil on board. A gift from the artist (Marianne North) to the Royal Botanic Gardens, Kew in 1882. Image credit: © The Board of Trustees of the Royal Botanic Gardens, Kew. Licence: CC BY-NC.

Analysis

Margaret Meen's illustration, the first source in this collection of three, is a watercolour on vellum – an expensive material made from untanned calfskin or goatskin.[11] The work is adhered to a heavy paper support. It depicts a sweet chestnut and is described as a 'native of England; this is in fact an erroneous statement as sweet chestnut is indigenous to the Balkan Peninsula and northern Iran and was brought to England by the Romans.[12] The paper on which the painting is mounted features a two-letter key in the bottom left hand corner, which refers to the character of the plant and indicates that the sweet chestnut was 'hardy' and 'shrubby'. The painting is signed 'M. Meen' and dated 1783.

Meen produced this illustration under the patronage of the Earl of Tankerville. The Library, Art and Archives at Royal Botanic Gardens, Kew was presented with 34 of Meen's paintings in 1925 and holds additional work by her from the Earl of Tankerville's Collection, possibly illustrated from plants grown in his gardens at Chillingham Castle, Northumberland. While the painting focuses on the botanical parts of the plant – its key features are instantly identifiable – there is some artistic expression in the sweeping composition of the leaves. Meen has portrayed the verisimilitude of the specimen with all its natural flaws rather than presenting an idealised version.

Sarah Anne Drake's illustration, by contrast, features pressed specimens mounted on the page alongside her original illustration. It shows the connection between documenting the plant through the creation of botanical illustrations and dried specimen material; both can be used to convey the form of the plant as source material to inform scientific study. Furthermore, the inclusion of diagrammatic floral cross-sections, on the left-hand side of the image, elevates the work beyond that of an aesthetic reference to an analytical study. This source was a preparatory sketch for Lindley's *Sertum Orchidaceum,* and is rendered in monochrome with the addition of colour. Drake was careful to include just enough information on the colour of the flower and leaves to inform the lithographer, Maxim Gauci, on production of the full colour printed plate for Lindley's publication. The accompanying text to this image notes that Robert Hermann Schomburgk sent specimens of this plant to Loddiges Nursery, and recounts that they saw 'this plant no where else but at the banks of the Rio Negro, a tributory of the Amazon, where, … we found it growing in large clusters on the trees which lined the river'.[13]

Drake's scientifically observed studies, including this example, testify to her understanding of plant structure. Her illustrations made her a prolific contributor to the dissemination of new botanical knowledge and her work documents the introduction of many plant species. In recognition of the extent of Drake's achievements, Lindley named the genus *Drakaea* in her honour.

The final source in this entry was produced by Marianne North, whose paintings record a wide range of species in their natural habitat, including rare and endangered flora and fauna as well as those new to science such as the eponymous *Nepenthes northiana* (named after North herself), depicted in the third image. This painting of a pitcher plant is displayed amongst several hundred other artworks by the artist in the Marianne North Gallery at the Royal Botanic Gardens, Kew. The painting is juxtaposed with others, which are hung floor-to-ceiling in a jigsaw fashion. North funded the creation of this bespoke gallery at Kew to house over 800 of her paintings. The Gallery opened to the public in 1882 and, in an era when photography was not a readily available form of communication, her geographically arranged paintings gave visitors the opportunity to take a visual journey around the flora of the world. Birds, animals and insects often appear amongst her plant studies, alongside the topography and architecture of the places she encountered. North left a substantial body of work as her legacy and her paintings serve as a unique record for the worldwide distribution of plant species in the nineteenth century.

North was fascinated by the pitchers she encountered in Borneo and species were collected for her to paint on the veranda of the house in which she stayed. Sir Joseph Hooker (1817–1911), second director of Kew, named the plant *Nepenthes northiana* in honour of North at the request of Veitch Nurseries.[14] This reveals the esteem in which her work was held within the horticultural and botanical communities. An early catalogue to the Marianne North Gallery notes that this *Nepenthes* 'has the largest pitchers of any known species, except N. Rajah' and that in 'consequence of seeing this painting, Messrs. Veitch sent a collector all the way to Borneo on purpose to get the species'.[15] *The Gardeners' Chronicle* of 1881 features an illustration of the plant after North's painting and a scientific description by Joseph Hooker.[16] It describes the situation in which the pitcher was found; growing around 1,000 feet above sea level on the limestone mountains of Sarawak, Borneo.

Questions

1. Consider the role of patronage and social connections in relation to the work of Margaret Meen and Sarah Anne Drake. How might this have impacted their work?
2. Marianne North had sufficient financial means to work without the support of a patron and, although she sought the expertise and advice of some of the leading scientists of the day, she primarily worked independently. What were the advantages and disadvantages of this, in contrast to Meen and Drake's situations?
3. Margaret Meen not only documented the plants at Kew but was an established mainstream artist, having exhibited at the Royal Academy in Britain. What does this reveal about the relationship between the disciplines of art and science in Britain in the eighteenth and nineteenth centuries?
4. Little appears to be known of Sarah Anne Drake's background and education. How can her work be viewed in the context of female education at the time and in what way does it break new boundaries?
5. Think about scientific nomenclature. How does the naming of different plant species imbue power? Why does it matter that the genus *Drakaea* was named in honour of Sarah Anne Drake, and *Nepenthes northiana* was named after Marianne North? Who is made visible and invisible in this process?

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28

Eleanor Ormerod (1828–1901): Entomological specimens presented to the Museum of Economic Botany at Kew Gardens (1875–1880)

Dr Caroline Cornish

Introduction

The specimens in this source were collected and mounted by entomologist Eleanor Anne Ormerod and presented to the Museum of Economic Botany at Kew Gardens. They are among many specimens, illustrations and models relating to the study of insects injurious to plants, which Ormerod and her sister Georgiana donated to the museum at Kew between 1874 and 1884, and of which 22 survive.

In the last quarter of the nineteenth century, Ormerod was a leading figure in the expanding field of applied or economic entomology. From 1882 to 1892 she worked as Consulting Entomologist to the Royal Agricultural Society of England (RASE); she also lectured to a range of audiences and published extensively on her subject. Ormerod was home-educated; she and Georgiana were tutored in painting by the pre-Raphaelite artist William Holman Hunt, and this skill was to prove useful in her scientific career. Joseph Hooker, botanist and director of Kew Gardens, was a family friend and three years after the death of their father, the sisters moved to Isleworth, just across the River Thames from Kew, to be closer to Hooker and his wife. Eleanor visited the gardens daily to further her entomological research and to cultivate socio-scientific networks. It was at Kew that she was first able to develop her interest in disseminating scientific knowledge through museum objects and displays.

From 1882–1886 she collaborated with Kew's William Thiselton-Dyer, Thomas Henry Huxley, and others on the Committee of Advice and Reference for Economic Entomology for the South Kensington and Bethnal Green Museums. Her task on the committee was twofold: advising on the rearrangement and display of the collections there such that they were 'easy for reference, to all, and at the same time perfectly satisfactory in a scientific view', and commissioning illustrations and models to supplement the specimens on display.[17] Ormerod's objects are unusual in their composite nature, consisting of the specimen itself, illustrations (usually same size and magnified) and, on occasion, three-dimensional models (see EBC 41863), all mounted as a single exhibit. They demonstrate a pedagogical approach to museum display, aimed at a range of audiences: popular, scientific and commercial.

Sources

Figure 7.2a Artefact name: Galls on oak bark. Geography description: Sedbury Park, Chepstow, Great Britain. Donor: Ormerod Miss E. Donor date: 18/05/1875. Label source: Natural size and magnified section. 1876. With drawing by Miss Ormerod. Model. Galls caused by insect *Trigonaspis megaptera* Panz. Eleanor A. Ormerod. EBC 41863. Image credit: Economic Botany Collection, Royal Botanic Gardens, Kew.

Figure 7.2b Closeup of Galls on oak bark. EBC 41863. Image credit: Economic Botany Collection, Royal Botanic Gardens, Kew.

Figure 7.2c Artefact name: Galls on oak leaves from *Cynips divisa*. Geography description: Near Isleworth, Great Britain. Donor: Ormerod Miss E. Donor date: 00/00/1876. Label source: Galls on oak leaves, natural size and magnified, giving both rose and brown colours. EBC 41830. Image credit: Economic Botany Collection, Royal Botanic Gardens, Kew.

Figure 7.2d Closeup of Galls on oak leaves from *Cynips divisa*. EBC 41830. Image credit: Economic Botany Collection, Royal Botanic Gardens, Kew.

Figure 7.2e Artefact name: Sugar Cane Borer Beetle. Geography description: Berbice, Guyana. Donor: Ormerod Miss. Donor date: 00/00/1880. Label source: *Tomarus bituberculatus*. EBC 32510. Artefact name: Sugar beetle. Geography description: Berbice, British Guiana. Donor: Ormerod Miss. Donor date: 00/00/1880. Label source: *Rhyncophorus sacchari*. EBC 32511. Image credit: Economic Botany Collection, Royal Botanic Gardens, Kew.

Analysis

Examining the specimens donated to collections is a valuable method of researching the histories of female naturalists, particularly as women rarely held official posts in institutions before the twentieth century and had fewer opportunities to publish. Ormerod's museum specimens may be seen as evidence for the greater likelihood of women finding roles for themselves within popular science.[18] Donating to collections was a recognised means for women to penetrate the male-dominated bastions of science, and Ormerod was awarded a silver medal by the Royal Horticultural Society in 1870 in recognition of her donations.[19] Furthermore, her scientific research was conducted in her own home, not in a university or museum laboratory. However, in other ways she defied the popularist archetype, for she was very much an insider in certain institutions of science – the Royal Agricultural Society of England (RASE), the Royal Agricultural College, the Royal Botanic Gardens, Kew – and through these institutions, colonial networks of knowledge.

These specimens also reveal much about the development of applied science in the nineteenth century. This type of science, often described at the time as economic, occurred in the fields of entomology, botany, zoology and geology. Today, historians and sociologists associate economic botany with concepts such as bioprospecting, biopiracy and asset stripping; flora and fauna were removed without recognition, consent or context from Indigenous settings and sold in the global marketplace.[20] While such science was often of benefit within the British Isles, scholars have also argued that it was intimately connected with the rise of the British Empire, which appeared to offer limitless natural and human resources for the enrichment of British industry.[21] However, when, through processes of acclimatisation, species were moved from their primary habitat to be cultivated on a commercial scale in territories under British control, new challenges might arise, particularly pests and pathogens.

Typically, economic science was a male concern, not least because it often involved close liaison with the Colonial Office and overseas agencies. The beetles shown in these sources are illustrative of the research Ormerod conducted into West Indian entomology through her association with RASE. In 1892, she published on the sugar-cane shot-borer beetle, having previously advised the Barbados Agricultural Society on the matter. It has been argued that economic entomology in particular was not an inherently feminine endeavour; botanising and botanical illustration had traditionally been understood as suitable interests for gentlewomen, but economic entomology, advocating the eradication of insects and the extermination of sparrows, was seen by some as counter to accepted norms of femininity.[22]

These sources also highlight a particular moment in museum history beginning in the 1880s, which was dubbed the 'new museum idea'.[23] Museums became increasingly aware that in trying to cater for the non-specialist public and the scientific researcher, their displays were failing to satisfy either. The proposed solution was to have pared-down interpreted displays for the public, and reserve or reference collections in separate spaces for specialists. In reality, however, few museums had the resources to realise this ideal. In her letters to Kew, Ormerod's frustration in preparing displays for the Bethnal Green Museum is clear: she understood the primary audience to be growers – farmers and gardeners – but the Museum was not conveniently located for this group, and she was dubious of the value of the displays to local residents, wondering whether 'much greater pleasure might not be given by other occupation of the spaces'.[24]

Questions

1. What evidence can objects provide that textual documents cannot? Think here about the materiality of the object – its form, scale and finish – and about the inscriptions on or around the object, including labels and notes.
2. How can the study of museum objects and their movement across time and space help us to trace networks of knowledge? How was new knowledge produced from museum specimens?
3. We have previously considered women as agents of Empire. How did Ormerod's work with the Barbados Agricultural Society on the sugar-cane shot-borer beetle further Imperial interests?
4. You will see from the catalogue descriptions of these objects, that, like many female donors, Ormerod was known only by her unmarried status 'Miss' and her surname. What are the effects of such documentary occlusions on the histories of female naturalists?
5. Compare and contrast Ormerod's background and education with that of other women featured in this part. What might these reveal about opportunities for women in science during this period?

Further reading

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29

Emina María Jackson y Zaragoza (1858–?): Illustration of *Diospyros embryopteris* in the third edition of Manuel Blanco's *Flora de Filipinas (Flora of the Philippines)* (1877–1883)

Dr Kathleen Cruz Gutierrez

Introduction

In the final decades of the Spanish colonial occupation of the Philippines, officials in Madrid and in the colonial capital of Manila increased efforts to catalogue the plant life of the archipelago. This coincided with Spanish attempts to reinforce its national self-image after the loss of its American colonies in the first half of the nineteenth century.[25] A systematic understanding of the flora of one of Spain's remaining Pacific colonies could lay the foundation for commercial exploitation of Philippine forests and agriculture and bolster the country's imperial standing. Such an undertaking fashioned Spain as a producer of scientific knowledge in the new global imperial field that coalesced at the turn of the century.[26]

Alongside this urgency to produce rigorous botanical information, the Catholic Order of Saint Augustine in the Philippines enlisted the help of botanists and artists to revise friar Francisco Manuel Blanco's *Flora de Filipinas* (1837). A naturalist-missionary, Blanco surveyed the plants growing in and around Manila, and his *Flora* had been the most comprehensive publication on local plants in the first half of the nineteenth century. The Augustinians published the four-volume reissue from 1877 to 1883. The outcome not only provided nomenclatural corrections to Blanco's original work but also included 455 coloured plates that transformed the publication into a magisterial project on behalf of Spanish botany and art in the Philippines.

Source

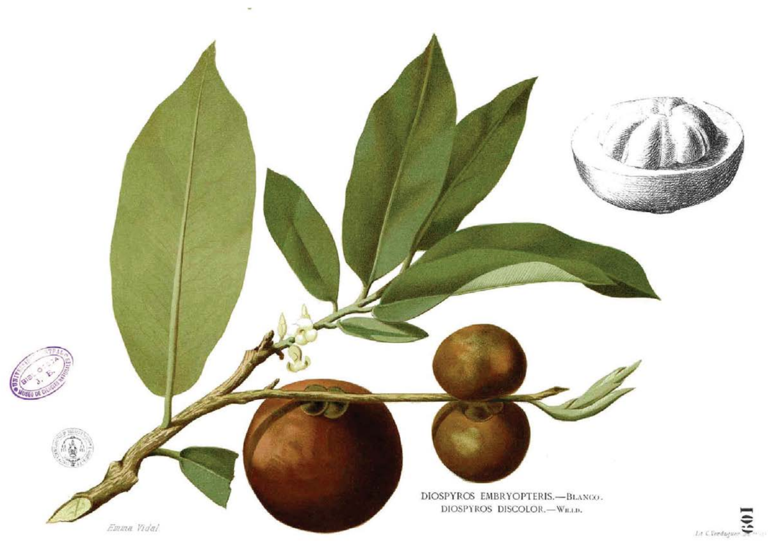

Figure 7.3 Image plate of *Diospyros embryopteris* Blanco [*kamagong*, *mabolo* (Tagalog), velvet apple (English), *Diospyros discolor* Willd]. By Emma Vidal in the third edition of Manuel Blanco's *Flora de Filipinas* (1877–1883). Image credit: Digital Library Royal Botanic Garden (Madrid, Spain). License: CC BY-SA-NC.

Analysis

The plate for *Diospyros embryopteris* (Tagalog: *kamagong*, *mabolo*) is thought to be the only one in the reissue produced by a female artist, Emina María Jackson y Zaragoza (also known as Emma Vidal).[27] The plate features a branch of a *kamagong* tree with elements of its life cycle. White flowers on the branch capture the earliest reproductive stage of the tree and differently sized fruits are suspended beside these. The specimen's leaves range from newly developed to mature and partially destroyed. An uncoloured cross section of a mature *kamagong* fruit sits by the coloured sample, revealing its fleshy interior. These elements reflect conventions of botanical drawing and aided local and foreign readers' understanding of tropical flora.

This plate produced by Jackson opens a rich conversation on the role of female relatives, spouses, and widows of colonial botanists in the Philippines. Jackson was speculated to have been the sister or daughter of the lead botanist of the *Flora de Filipinas* project, Domingo Vidal y Soler.[28] Pension records indicate, however, that she was his wife. Jackson was born in Manila in 1858 to Tondo native Juana Zaragoza y Aranquizna and an English merchant, Edward Jackson. Jackson hailed from a prominent family associated with the Spanish tobacco monopoly, and her high social standing likely secured elite opportunities for her. Women of Jackson's class in the late nineteenth century sometimes attended formal instruction at select institutions of higher learning or obtained education informally from exposure to the social and cultural circles surrounding them.[29] Jackson and Vidal married on January 29, 1876, and their son Sebastián Tito Juan was born soon after. She may have interacted with and learned from other painters, especially as Manila boasted an uncanny scene of artist-naturalists associated with the Jardín Botánico de Manila (Botanical Garden of Manila) and the Academía de Dibujo y Pintura (Academy of Drawing and Painting).[30] After extended sick leave to the peninsula, Vidal died unexpectedly in Barcelona on September 5, 1878, well before the full publication of the four-volume series. Jackson was in the Philippines at the time of his death, and in the years following she petitioned the Spanish state for her widow's pension that would contribute to the education and care of their son.[31]

Often appearing in archival records as travel companions or as representatives of their late spouse's effects, women like Jackson backed the enterprise of colonial Philippine botany and played an important role in the bureaucratic mechanisms that enlisted the labour of collectors and forest surveyors. While the petitions for post-mortem pensions reveal little of the activities undertaken by wives in general, there exist substantive contributions made by spouses. In the final decades of Spanish colonisation of the Philippines, several *insulares* (Philippine-born Spaniards), *peninsulares* (Iberian-born Spaniards), and *mestizas* (mixed-race Chinese or Spanish, which Jackson would have been considered) produced intellectual knowledge while living in the archipelago. Resources in Manila were available to upper-class women seeking to publish and to produce art. Colonial officials' wives like Ana García del Espinar wrote secular novelas and features in periodicals.[32] Administratively, widows assisted with gathering biographical data on behalf of their deceased spouses. Death while in the colony, especially for botanical collectors and surveyors stationed in provinces distant from Manila, was common. Such remote work at times hampered the recovery of important effects. Ulpiana Barona y Palacios and Elisa Evarista Diez y González, widows of two employees of the Inspección General de Montes (Forestry Bureau; IGM), provided civil and professional documents on behalf of their husbands thereby enhancing the administrative reach of the metropolitan and colonial bureaucracy.[33] They are only two of dozens of women in the Spanish pension records for deceased IGM employees' families.

Though these women's labours served Spanish intellectual endeavours or the colonial administration, no professional personnel files exist on these women in the Spanish state's botanical archive. Nevertheless, such women and their work raise essential questions about expertise, amateurism and recognised labour in late nineteenth-century colonial science.

Questions

1. How might this source make us reconsider who is an expert, and what constitutes scientific expertise?
2. What is an amateur? Who or what delineates the labours of the expert in relation to the amateur? Consider this in relation to the other women presented in this part.
3. How do the natural sciences apportion credit, authorship and recognition? What intellectual role do labourers, collectors and informants play in the production of botanical knowledge?
4. In the colonial context, what factors could necessitate the work of family members?
5. Compare and contrast the way in which the natural world is depicted in all the sources included in this part.

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30
Sally Paul (fl. 1860s): Captain Campbell Hardy's 'Indian Remedy for Smallpox', *Teranaki Herald* (1872)

Dr Farrah Lawrence-Mackey

Introduction

The source below refers to Sally Paul, a Mi'kmaq woman (spelled Micmac in the text) who had married Chief Francis Paul in Shubenacadie, Nova Scotia.[34] In the text Sally is referred to as Mohawk (Kanien'kehaka),[35] perhaps giving her a certain authority in the eyes of British readers as the Kanien'kehaka were British allies during the mid-nineteenth century.[36] The Mi'kmaq Nation's ancestral land, Mi'kma'ki, covered modern Nova Scotia and Prince Edward Island, the Gaspé Peninsula of Quebec, the north shore of New Brunswick and inland to the Saint John River, eastern Maine, and part of Newfoundland, including the islands in the Gulf of Saint Lawrence as well as Saint Pierre and Miquelon.[37] Sally lived among the community based seasonally at Shubenacadie and Dartmouth in Nova Scotia.

Captain Campbell Hardy, the author of the piece, was an artillery Captain who had been posted in Nova Scotia during the mid-nineteenth century. He was associated with Herbert Chalmers Miles, a surgeon, in the promotion of the *Sarracenia purpurea* as a remedy for smallpox. When he published his account of these events in the *Taranaki Herald,* a New Zealand newspaper, he was stationed in Gibraltar.

Source

Hardy, C. 'Indian Remedy for Smallpox', *Teranaki Herald* XX edition (1872).

Captain C. Hardy, of the Royal Artillery, wrote the following letter to Land and Water: – Indian Cup (Sarracenia purpurea). – as the question of an infusion of the root of the above plant being used as an effectual remedy for smallpox has recently been resuscitated in your paper, and as I was personally concerned in bringing the nostrum to light (it was then retained as a secret in the hands of an old Indian) when quartered in Halifax, Nova Scotia some years since, I feel myself bound to tell you all I know on the subject, I must trust to memory, as I left in England all my notes bearing on the subject, and correspondence in various local papers at the time therewith connected. Your correspondent, "wahwahtaysee" is quite right in his general account of the plant, its mode of employment, and effects with which it is credited. Its use may be general amongst the Nova Scotia Indian. When I was there they all, when afflicted with smallpox, or desiring to use it as a preventative, applied for it to Old Sally Paul, of Shubenacadie, the proprietress.

The following are the circumstances under which I was induced to obtain the squaw's secret: – in 1864 or 1865 (I forget which year) my curiosity was aroused by the many stories about the marvellous cures effected by Old Sally in cases of smallpox, which I could hear from the lips of my Indian hunters over the camp fire in the backwoods. How Indians would go to her by water or through the woods, even with the sickness on them, from all parts of the Province; the rapidity with which a dose or two relieved them, and how in each case the formation of the pustules was immediately arrested and pitting prevented. I told all this to a brother officer, Dr. Miles, R.A. and volunteered to obtain the secret from the old squaw, with the view to the remedy being made public and fairly tested. At this time I had suspicion of what it was, and which afterwards turned out to be correct. My old friend a guide in the woods, John Williams, once said to me with a smile, "ah, Captain you'd laugh if you knew what common thing that is; grows most everywhere; wont tell you though; no take bread out of old squaw's mouth." I asked him how he knew it. He said he had come across her where she and her daughter had been grubbing up roots in the woods behind her camp, when returning from hunting; and that though she had tried to cover up the place with snow there were plenty of traces to show what it was. From what Williams said, I guessed this occurred in a swamp, and so to the swamps (everywhere in North American woods, and which are carpeted with a dense growth of sphagnum moss, with iris, cotton grass, indian cups &c.) I betook myself to taste roots, leaves, and stems, of all plants growing in such situations. I had tasted the remedy (apparently a plain infusion) a short time previously at the squaw's camp; it was a light clear, cherry coloured liquid, with a pleasant and peculiar bitter flavour, and I soon recognised the flavour in an infusion from the root of the Indian cup (Sarracenia). However, there might be more in the remedy than the one plant, and a good deal in the preparation; so I went straight up to Mistress Paul to induce her to part with her nostrum, this was rather a difficult matter. A few dollars helped, though, and my assurance that in case of success in England, she would be rewarded, at last led her to tell me. Her daughter urged her strongly to do so. I was well known amongst the Indians as having always taken a deep interest in their welfare, and she said she ought to confide it to me. She was nearly ninety years of age, a Mohawk by birth, and brought the secret with her from Canada, when she married old Francis Paul, a Micmac chief. When about to tell me, I told her I would guess it, "you're right", was the reply. Dr. Miles at once sent home the remedy for testing, with the accounts of its use, effects, and mode of preparation, which I had carefully elicited from the squaw; at the same time I communicated on the subject with several local papers. I think the first favourable report of its efficacy appeared in The Times, shortly afterwards in a communication from Dr. Logan, surgeon of a guard regiment, who spoke most highly in its favour and said he had effected a good many cures amongst soldiers with it. The generality of reports, however, from other medical men, which soon afterwards appeared in the medical papers were decidedly unfavourable, and pronounced it quite worthless, Dr. Miles was recalled to England, and I gave up hopes of being able to do anything more for poor Old Sally on the score of her Indian remedy. She is dead now, but if, on being given a fresh trial, the Sarracenia proves, as I am confident it will, a preventative and antidote to Variola, I trust to be able to secure some recognition of the old Indian sacrifice of self-interest, which, I can aver, she actually made in imparting her life cherished secret to me for her daughter, who still lives on the banks of the Shubenacadie. Having thus placed it in the hands of the facaulty, my connection with the Indian remedy for smallpox ceases. I believe the root has been largely exported to England from the swamps of Nova Scotia, and that it has been advertised by Messers. Savory and Moore at the price of eight-and-twenty shillings per pound, if this is the case surely something might be done for the old squaws family (who might have retained the secret yet to their own advantage) by whoever has been the channel of the Indian cup root from Nova Scotia. From what I learn from the Indians, one of the most remarkable features of the remedy is its power of arresting the progress of the disease at almost any time; for, however virulent may be the poison, after the first two or three doses (about a small teacupful) of the strong infusion the patient feels an amendment and a new hope, the symptoms of the disease all quickly disappear, the development of the pustules ceases, and they die off, when no pitting need be apprehended.

Analysis

The way in which Hardy writes of Sally Paul, as simultaneously Indigenous, female and old speaks to continuities in white perceptions of both indigeneity and its intersection with gender and age. Indigenous women, when portrayed by white commentators as 'good Indian' women, have appeared, broadly, in two forms. The first Devon Mihesuah has discussed in the mythologies of figures like Pocahontas and Sacagawea, as Indian princesses romanticised by their youth, beauty and most significantly the help they gave to Europeans, turning their backs on their own people as they understood the inevitability of civilisation's progress.[38]

Sally Paul was not a youthful princess, though in Hardy's account she helped Europeans with her remedy and, Hardy was careful to note, she was married to the Chief at Shubenacadie marking her, in the eyes of British readers, of a higher social standing than her peers. More prominent in this account, however, is her depiction as the other positive imagining of female indigeneity, the 'squaw'.[39]

Imagery of the 'squaw' stems from first contact with the Indigenous occupants of North America and, in many ways, continues on into the present day. 'Squaw' is a complex and nebulous term, and was broadly perceived in white accounts as both positive and negative. The focus here is on the positive imagery of the 'squaw'. It is important to note that the term 'squaw' is considered highly offensive amongst Indigenous women today due to its use in networks of oppression. In Hardy's article his continued reference to Sally as either Old Sally or 'the squaw', connected with his apparent concern for her and her family's economic position is intended as affectionate, yet it resonates with implications of service to white interests and the Indigenous woman as a 'knowing object' of nature.[40] Her knowledge and her provision of the same to white men fed into the archetype as the Indigenous princess who was a 'good Indian' by virtue of her understanding and providing for the needs of the white man and her understanding the inevitability of civilisation's progress at her and her community's expense. Sally Paul's passing on of her *Sarracenia* curative is perceived as part of an inevitable process in this light.

Furthermore, the continued reference to Sally Paul's advanced age served to highlight both her overall health, lending her curatives legitimacy, and her declining role in the modern world. She lived long because of her connection to nature and she understood the natural world because of her long experience in it. But her age also placed her in the space between life and death. The final reference to her as having passed away by the time of Hardy's writing, therefore, reflects the images of Indigenous communities' decline in the face of modernity – a decline that the 'good Indian' 'squaw' understood and participated in as she passed knowledge and flora to white extractors. Despite Hardy's call for economic aid for Sally's family, the image he creates of her, as the aged 'squaw', is one of Indigenous decline, advancing civilisation, and his salvaging of what may be considered valuable knowledge, separating the *Sarracenia* from the woman, Sally Paul, and the living community of which she was a part.

Questions

1. What does this source tell us about Mi'kmaq medicine, if anything?
2. This source raises questions of bioprospecting and ownership. Who owns knowledge and is there an essentialised origin for medical flora or information about it?
3. How does knowledge move and why? Hardy was writing of his interactions with Sally Paul in Halifax Nova Scotia in a New Zealand newspaper, but he was based in Gibraltar at the time of publication.
4. How and why did Sally sell or share her knowledge of *Sarracenia?*
5. How does this source speak to wider Atlantic Histories, specifically the concept of 'the Red Atlantic'?
6. How does the story of Sally Paul relate to histories of vaccination more generally?
7. How could we discuss this source in the context of medical professionalisation?

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2 Drayton, *Nature's Government.*
3 Stewart, 'Global Pillage', 828.
4 Stewart, 'Global Pillage', 825–844.
5 For more on this see Daston and Galison, *Objectivity*.
6 Desmond, 'The history of the Royal Botanic Gardens, Kew', 108.
7 Bénézit, *Bénézit Dictionary of Artists*, 688.
8 Duttson, 'Drake, Sarah Anne (1803–1857), botanical artist'.
9 Lindley, *Sertum Orchidaceum.*
10 Bateman, *The Orchidaceae of Mexico and Guatemala.*
11 Rickman et al. 'The Conservation of Botanical Illustrations on Vellum', 117.
12 Royal Botanic Gardens, '*Castanea sativa* Mill'; Sherwood and Rix, *Treasures of Botanical Art*, 30.
13 Text accompanying plate XXXVII in Lindley, *Sertum Orchidaceum.*
14 Anon, 'New Garden Plants', 717.
15 Royal Botanical Gardens Kew, *Kew Official Guide to the North Gallery*, 87.
16 Anon, 'New Garden Plants', 717.
17 Letter from Ormerod to Thiselton-Dyer, 23 December 1882, RBG Kew Archives, South Kensington Museum. Science and Art Department 1855–1912 [MR/41], f. 336.
18 Lightman, *Victorian Popularizers of Science*.
19 Hill, *Women and Museums 1850–1914.*
20 Schiebinger, *Plants and Empire;* Vogel, *American Indian Medicine,* 241; Murphy, 'Translating the Vernacular', 2011, 29; Whitt, 'Cultural Imperialism and the Marketing of Native America', 1995; Whitt, *Science, Colonialism, and Indigenous Peoples,* i, 6; Galtung, 'Scientific Colonialism', 1967.
21 See for example, Brockway, *Science and Colonial Expansion*; Drayton, *Nature's Government*.
22 Shteir, *Cultivating Women, Cultivating Science*; Clark, *Bugs and the Victorians*, 171.
23 Sir W. H. Flower, *Essays on Museums and Other Subjects.*
24 Letter from Ormerod to Thiselton-Dyer, 7 March, 1885; Kew Archives, 'South Kensington Museum. Science and Art Department 1855-1912' [MR/41], f. 372.
25 Schmidt-Nowara, *The Conquest of History*, 10.
26 Go, 'Introduction', 20.
27 Blanco, *Flora de Filipinas.*
28 Doronila, 'How a Rare Botanical Filipiniana Came to the Baillieu Library', 23.
29 Owen, 'Maria Clara and the Market', 30.
30 Santiago, 'The Painters of *Flora de Filipinas* (1877–1883)', 92.
31 Archivo General de la Administración. 'Expediente de clasificación de pension de Jackson Zaragoza, Emma María. Viuda de Domingo Vidal'.
32 Santiago, 'The Flowering Pen: Filipino women writers and publishers during the Spanish period, 1590–1898, a preliminary survey', 584.
33 Archivo General de la Administración.'Expediente de clasificación de pension de Barona Palacios, Ulpiana. Viuda de Pedro González Arribas'. Archivo General de la Administración.

'Expediente de clasificación de pension de Díez y González, Elisa. Vida [sic] de Felipe Díaz López'.

34 McMillan, 'Mi'kmawey Mawio'mi Changing Role of the Mi'kmaq Grand Councuil from the Early Seventeenth Century to the Present', 29–30. Lawrence-Mackey, 'Medical Appropriations in the "Red" Atlantic', 169–184. Since completion of this thesis and reassessment of the literature, my conclusions that Sally was Kanien'kehaka are less certain, while she may have married into the community it is also possible that her framing as Kanien'kehaka served to lend her authority in the eyes of British readers.

35 Yellow Bird, 'What We Want to Be Called', 1–21. Kanien'kehaka, translated as people of the land or crystal rock or flint, is the self-identified name of the Indigenous peoples called amongst colonial English speakers 'the Mohawk', a name that was a bastardised translation of a neighbouring community's name for the group, which meant cannibal.

36 Berkhofer Jr. *The White Man's Indian,* 31. Kilpikoski, '(De)Constructing The White Man's Indian in James Welch's "Fools Crow" and Disney's "The Lone Ranger"', 5.

37 Pereira, 'A Preliminary Case Study of Perceptions of Access to Ethnomedicine in the Environment in the Mi'kmaq Community of Indian Brook', 27–28; Cape Breton University, 'The Mi'kmaq'.

38 Mihesuah, 'Commonalty of Difference', 45.

39 Collins, *Black Feminist Thought,* 84.

40 Scott Parrish, *American Curiosity,* 229.

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Part VIII

Women and geology – a case study (1823–1919)

Timeline: individuals, events and publications in the history of science	Timeline: individuals, events and publications in this part
	1775–1845 Etheldred Benett, British fossil collector and geologist.
	1799–1847 Mary Anning, British fossil collector and dealer.
1807 First meeting of the Geological Society of London.	
1811 French naturalists Georges Cuvier and Alexander Brongniart argue that the relative ages of fossils could be determined through a study of geologic strata or layers.	
1823 British fossil collector Mary Anning discovers the first complete plesiosaur skeleton in Dorset, England.	
1824 British geologist William Buckland becomes president of the Geological Society of London and announces his description of *Megalosaurus*. His wife, Mary Morland, provided drawings of the bones to be used for illustration.	

Timeline: individuals, events and publications in the history of science	Timeline: individuals, events and publications in this part
1830 Publication of *Principles of Geology* by British geologist Charles Lyell, which demonstrates that geological processes occur at the same rates in the present as they did in the past and account for all of the earth's geological features.	
1831 Etheldred Benett, rejected from membership in the Geological Society on the basis of her gender; self-publishes her illustrated monograph, *Catalogue of the Organic Remains of the County of Wiltshire*.	
1859 Publication of British naturalist Charles Darwin's *On the Origin of Species*, which expounds his theory of evolution by natural selection.	
1862 Physicist William Thomson, Lord Kelvin, speculates that the Earth was once a molten object and calculated its age in millions of years as the time it took for the surface to cool.	
1871 University College London is the first British university to teach women and men together.	
	1872–1960 Gertrude Lilian Elles, British geologist and palaeontologist.
1878 Women at the University of London are granted degrees. Women are admitted on equal terms to men, except in the field of Medicine.	

Timeline: individuals, events and publications in the history of science	Timeline: individuals, events and publications in this part
1912 German climatologist, geologist and meteorologist Alfred Wegener proposes the theory of continental drift.	
1948 Women become full members of Cambridge University and are granted degrees.	

Introduction

Who can be considered a scientist? This part focuses on three British women who engaged with geology in markedly different ways from the 1820s to the 1930s. In doing so, it highlights some of the major themes that have come out within the parts thus far: issues of social standing, gender and who can participate in scientific institutions. As discussed in part five, while promoting the ideas and advancement of science, formal scientific societies closely guarded who could be admitted to their ranks.[1] The quality of a candidate's research was only one criterion by which potential entrants were judged. For most of the nineteenth century, entrance to British scientific societies was largely limited to wealthy, socially connected, university-educated white men.

The formation of the Geological Society of London is a case in point. The society's first meeting was on 13 November 1807 at a dinner at the Freemason's Tavern in Covent Street, London. The group resolved:

> That there be forthwith instituted a Geological Society for the purpose of making geologists acquainted with each other, of stimulating their zeal, of inducing them to adopt one nomenclature, of facilitating the communications of new facts and of ascertaining what is known in their science and what remains to be discovered.[2]

However, this warm scientific fellowship did not extend to women. Women were excluded not only from membership, but also from attendance at the Society's lectures. The rationale was that women did not possess the intellectual rigour to engage in scientific study. Despite this rejection, women contributed significant findings to geology's early years, furthering our knowledge of Earth's history and the creatures who have lived upon it.[3]

These sources present three British women who, due to their class and educational backgrounds, each received varying levels of acknowledgement for their scientific discoveries during their lifetimes.[4] The first source is a series of letters sent by the British fossil hunter Mary Anning to Sir Henry Bunbury, member of the Geological Society, which give insight into how she carefully navigated her position across gender and class divides. The second source is the preface to Etheldred Benett's *Catalogue of the Organic Remains of the County of Wiltshire*, which alludes to some of the social difficulties Benett encountered in getting her work published; she drew on her own resources to illustrate and publish this scientific monograph. The third source, geological hammers that belonged to Gertrude Lilian Elles, are material proof of Elles' remarkable career as one of the first female Fellows of the Geological Society in 1919. Her career demonstrates some of the societal and professional changes over the course of the century that enabled her to gain this position.

31

Mary Anning (1799–1847): Letters from Anning to Sir Henry Bunbury (1823)

Ross MacFarlane

Introduction

This source consists of letters sent by Mary Anning (1799–1847) to Sir Henry Bunbury. The letters date from December 1823 and provide a description of Anning's discovery of the first complete plesiosaur skeleton, along with a detailed sketch. The letters illustrate the scientific networks Anning was involved in, and the role these networks played in scientific discovery. Anning's letters are addressed to Sir Henry Bunbury, seventh Baronet (of Bunbury) (1778–1860), a soldier and historian. Noted for his interest in antiquarianism, he was an early member of the Royal Geological Society in Britain.

Ascribed the description 'the greatest fossilist the world ever knew', Anning was an English fossil hunter, dealer and palaeontologist.[5] Although not properly credited with her achievements during her lifetime, in recent years Anning has been hailed as a key figure of nineteenth-century science. Anning was born and lived all her life in Lyme Regis, Dorset. Her father Joseph, a cabinet maker, developed a sideline in finding and selling the fossils that were found in the nearby cliffs. At a young age, Mary displayed a remarkably fine eye for locating fossils. In 1811, Anning's brother found the fossilised head of an as-yet unidentified animal. The following year, Anning discovered a well-preserved fossil of the rest of the animal, later named *Ichthyosaurus anningae*, a remarkable find which established her reputation. Thereafter, Anning and her family lived by the fossil trade. She followed her discovery of the ichthyosaurus with further, more complete specimens, and then by the first complete plesiosaurus, on 10 December

1823. In 1828 she discovered the first pterodactyl. Her discoveries brought her considerable fame and she became something of a tourist attraction in her own right. She died of breast cancer in 1847.

Source

Two autographed letters written by Mary Anning, now in the library collections of Wellcome Collection. The letters, dated from December 1823, were written from Anning to Sir Henry Bunbury.

Extract 1. Wellcome Collection MS8592/1

Sir

I have taken the liberty of writing, to inform you that I have discovered [sic] a fossil skeleton of an unknown species. It is nine feet long and from the extremity of one paddle to the other four feete [?] broade [sic], it as [sic] a remarkable small head not more than eight inches in length long neck measuring from the sternum to the head it is four feete short body from the sternum to the pelvis two feete ribs one foote intercaustal [sic] ribs 16 inches on the whole it is the most Curious and illustrative yet discovered it is the skeleton generally [sic] named plesiosus [sic?], I have also a small skeleton of the Ichthyosaurus better than the one you saw at Charmouth but not so good as Cpt [sic] Warry[ings]. Sir should you be coming anywhere in the neighbourhood they are worth you coming a little out of your way to see them.

I remain with great respect

Your humble servant

Mary Anning

Extract 2. Wellcome Collection MS8592/2

Sir

I have endeavoured in a rough sketch to give you some idea of what it is like. Sir you understand me right in thinking that I said it was the supposed plesiosaurus [sic], but its remarkable long neck and small head, shows that it does not in the least verifie [sic] their conjectures [sic]; in its Analogy to the Ichthyasaurus, it is large and heavy but one thing I may venture to assure you it is the first and only one discovered in Europe, Colonel Birch offered one hundred guineas for it unseen, but your letter came one day past before [but] I consider your claim to be an answer prior to this, Should you like it the price I ask for it is one hundred and ten pounds, one hundred guineas was my intended price, but if take the same sum as Col B offered he would think I had used him ill in not taking his money – Sir I am gratefully obliged to both you and Lady Bunbury for condescending [sic] to think of my favourite he returned to Lyme at midnight quite well I also greatly obliged for your kind present of the [game].

Your humble servant

Mary Anning

PS Since I wrote the above I have received an Ordere from the Duke of Buckingham if not sold to send him the Specimen on his account I hope you will not think me impertinent in requesting an answer by the return of post I had forgot the Ichthyosaurus it is about four feete long although not equal to Cpt Warryings it is not a bad specimen the price is five pounds.

Analysis

These letters were sent to communicate Mary Anning's discovery of the first complete plesiosaur skeleton to Sir Henry Bunbury, a member of the Geological Society. However, they also reveal Anning's socio-economic status and gendered role within wider social and scientific networks of the time.

The second letter provides clear insight into Anning's working methods as a dealer. Anning writes to Bunbury that she has also been in communication with 'Colonel Birch' who has offered for the skeleton 'one hundred guineas for it unseen'.[6] However, Anning gives first refusal of the specimen to Bunbury – due to his reply to her first letter having arrived before Birch's – but at a cost of 'one hundred and ten pounds', legitimating her decision by stating her fear that if she accepts less from Bunbury then Birch 'would think I had used him ill' in not taking his money. As a dealer, Anning was an economic actor whose wellbeing and welfare depended on her skill in negotiation with men from a higher social standing than hers. Social class is also present through her fear of Birch thinking she had ‘used him ill’; a sense of Anning not ‘playing fair’ may well mean a damaging blow to any future transactions between the two.

The letters also seem to hint at Anning’s personal life, very little of which is known for certain. Its conclusion reveals the pleasant social relationship between Anning and Bunbury and his wife with Anning ‘greatly obliged for your kind present’ and, intriguingly, thanking them both for ‘condescending [sic] to think of my favourite he returned to Lyme at midnight quite well’. The tone suggests that amiable relations existed between the lower class Anning and the upper class Bunburys – a relationship that appears to transcend class boundaries.

Anning sent a number of letters after her discovery of the skeleton. Another was to the geologist William Buckland. He in turn gave word to Richard Grenville, first Duke of Buckingham, who eventually purchased the specimen in early 1824.[7] Another geologist, William Conybeare, also heard of Anning’s discovery and hurried to Lyme Regis to see it in situ. He announced the discovery at a meeting of the Geological Society on 20 February 1824 to the largest audience yet for a meeting of that Society, which had formed in 1807.[8] It is suggestive of Anning’s status that she was not credited in the published paper. Furthermore, as a woman she was not able to become a member of the Society. However, Conybeare made sure *Buckingham* was duly named and patronised in his paper – an insight into how important social prestige was for him as well.

Questions

1. What do these sources tell us about the nature of discovery? Can a discovery ever be attributed to one individual? Is it collaborative? Competitive?
2. What does this source say about Anning’s agency? Was she playing possible purchasers off against each other?
3. What does this source tell us about commerce and the worth of scientific discovery?
4. What does this source reveal about knowledge exchange? Is the range of people Anning wrote to evidence of the scientific networks she was part of?
5. What does this source tell us about Anning’s personal life?
6. Compare this source with that of Anning’s contemporary Etheldred Benett, also in this part. What similarities and differences do you see in their careers and their legacies? How do notions of class and wealth interact with the stories of these two women?

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32

Etheldred Benett (1775–1845): Preface to *Catalogue of the Organic Remains of the County of Wiltshire* (1831)

Professor Susan Pickford

Introduction

This source is the preface to a scientific monograph written by Etheldred Benett (1775–1845), an early English geologist often credited as the first female geologist in Britain. Benett was an unmarried member of the landed gentry and had the time and wealth to indulge in geology, a popular hobby in the nineteenth century. There was a strong amateur geological culture in Benett's home county of Wiltshire, Southwest England; nearby Chicksgrove Quarry was one of many rich local sources of fossils. Outside of Wiltshire, Benett took part in the wider geological network of her day: she contributed research, such as a hand-drawn stratigraphic section of Chicksgrove, to the Geological Society of London; corresponded with geologists across the country and abroad; and lent specimens from her collection to leading names in the field such as Gideon Mantell and William Fitton. Benett's *Catalogue of the Organic Remains of the County of Wiltshire* was privately printed in her local town, Warminster, in 1831 with lithographic plates drawn in London by E. D. Smith. Lithography was then a new technology and eminently suited to the fine-grained detail of geological illustration. The images illustrate the great quantity and variety of specimens she discovered. She sent copies of her catalogue to a number of leading geologists and geological institutions both in Britain and abroad.

Source

Preface to Benett, Etheldred. *Catalogue of the Organic Remains of the County of Wiltshire*. Warminster, England: J. L. Vardy, 1831.

Some years since, at the request of Sir Richard Colt Hoare,[9] I undertook to draw up the best account I could of the Geology of South Wiltshire: and I had proceeded as far as two hundred and fifty numbers in a catalogue of the fossils to accompany it; when my time was entirely engrossed by unforeseen circumstances, for such a length of time, as to make me almost despair of ever being able to fulfil my promise; and my subsequent ill health extinguished what little hope remained of my being able to accomplish it.

During the last summer, Sir R. C. Hoare again expressed a wish, that so interesting a portion of the history of South Wiltshire, should not be passed over in silence, and the following pages are the result of my attempt to illustrate it. Those who know me best will be fully aware, that I have endeavoured to render this catalogue as correct as possible; and when I mention that it has been approved by Mr. Greenough,[10] it will run no risk of being despised in the Geological World.

If it should be objected to my new names in the genus Polypothecia, that they are all derived from external form; I beg to state, that three scientific gentlemen undertook, at different times, to describe and name this class of fossils, and to each I offered all the assistance which my very large collection of them afforded; that all have disappointed me; and having waited fifteen years, and the fossils being now, by the death of the late Mr. J. S. Miller,[11] again on my hands unnamed, I have done the best I could. Mr. Miller did, however, publish a Prospectus of a work on them; to that I am indebted for the generic name 'Polypothecia'; and Mr. D. Don[12] obligingly gave me his valuable assistance in latinizing the characters I wished to express in their specific names.

When this catalogue was first thought of, my geological friends expressed a wish that it should be published separately; but considering it a thing of mere local interest, I have preferred printing a few copies only for the acceptance of my Friends. [...]

ETHELDRED BENETT,

Norton House,

25th April 1831.

Analysis

The catalogue's preface raises interesting questions about how women were able to participate in formal and informal networks of scientific knowledge in the nineteenth century, at a time when geology was still in its infancy. The text touches on the question of how women fitted science into their everyday lives, as Benett alludes to the other calls on her time, such as supporting her brother's parliamentary career to the detriment of her own intellectual ambitions. Living in rural Wiltshire, Benett also found it difficult to keep up with the latest geological discoveries, writing to Gideon Mantell in 1816 that her local booksellers did not like the trouble of enquiring for periodical publications for her as the shops made little profit from the transaction, so did not care whether or not she had the journals.[13]

Benett's masculine-sounding first name meant she was often presumed to be a man: indeed she was awarded an honorary doctorate on this basis by the University of St Petersburg in recognition of a donation of fossil specimens. However, in Britain, her gender excluded her from formal geological institutions such as the Geological Society, founded in 1807, which only accepted women as fellows in 1919. This seems to have been a source of some annoyance to her, as she wrote to a fellow geologist in 1836, 'it is provoking that no-one will believe that a Lady could write such a trifling thing in this Diploma I am called Dominum Etheldredum Benett & Mr Lyell told me that he had been written to by foreigners to know if Miss Benett was not a gentleman [...] so you see that scientific people in general have a very low opinion of the abilities of my sex'.[14] Even after Benett's death, her life was read through this reverse gendered frame: an anonymous Warminster writer described her in 1872 as a masculine and eccentric old subject.[15]

As a woman, publishing her geological work was fraught with social difficulties. As a result, Benett had her work printed privately. She made use of a typical modesty topos, downplaying its significance by describing it as a work of 'mere local interest' and pointing out that she only proposed names for specimens because her male colleagues repeatedly failed to do so. She did, however, seek to make the catalogue scientifically authoritative, using the latest print technology and an expert botanical illustrator, and boasting that it was approved by no less an expert than the renowned geologist George Greenough (1778–1855).

The catalogue's status as an authoritative source, according to the International Code of Zoological Nomenclature (ICZN), was called into doubt in the twentieth century by some experts who held that her new nomenclatures were instances of *nomen nudum*, a designation that follows standard scientific taxonomy but fails to meet the requirement of being published with an adequate description. This argument was eventually rejected in 1990 when the ICZN commission upheld her precedence in the use of contested nomenclatures such as *Drepanites* on the grounds that pragmatic considerations should outweigh Benett's statement of her modest plans for the distribution of her catalogue.[16]

Questions

1. Which was the greater obstacle to Etheldred Benett's participation in geological culture, her gender or living far from London?
2. To what extent was her family background and status significant to her scientific work?
3. How significant is it that Etheldred Benett was a very early adopter of lithographic technology, even before the Geological Society?
4. How typical was Etheldred Benett of amateur nineteenth-century scientific practice?
5. Compare this entry with the preceding piece on Mary Anning. Anning and Benett were both active in British geology at the same time . Why is Etheldred Benett so much less well known than her younger contemporary?

Further reading

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33
Gertrude Lilian Elles (1872–1960): Geological hammers

Sandra Freshney

Introduction

Geological hammers have been in use for over 200 years. The Sedgwick Museum is fortunate to have a collection of these indispensable tools of the trade, two of which belonged to Gertrude Lillian Elles, and are shown in this source. Elles' fossil collections, many unearthed with the use of these hammers, total over 3,700 specimens and are mostly graptolites.

Educated at Wimbledon and Newnham College Cambridge, Elles rose from being an undergraduate and assistant demonstrator, to a university lecturer in the Department of Geology in 1926. Ten years later, she became the first female reader.[17] After graduating in 1895, Elles did a year's research in Lund, Sweden, with Sven Tornquist before returning to Cambridge. Together with her Newnham contemporary Ethel Wood, she studied Lower Palaeozoic strata in Wales, specialising in fossil graptolites. In collaboration with Charles Lapworth, Elles and Wood produced a pioneering *Monograph on British Graptolites* (1901–18). It described and illustrated all the then-known graptolites and their biozonal distribution in time. Elles prepared the text and Wood prepared the illustrations, with Lapworth acting as editor. In later life she also worked on metamorphic rocks in the Highlands with Cecil Edgar Tilley.

Elles was one of the first female fellows of the Geological Society in 1919, and became Vice Principal of Newnham College from 1925 to 1936. Her efforts for the Red Cross during the First World War were later acknowledged in the form of an MBE in 1920.[18] Elles died on 18 November 1960 in Helensburgh, Scotland. Her obituary, written by a former research student (and Woodwardian Professor) Oliver Bulman, described her as 'The doyen of women geologists'.[19]

Source

Figure 8.1 Geological hammers used by Gertrude Lilian Elles. References: Objects X5227.27 and X50227.28. Image credit: Sedgwick Museum of Earth Sciences, University of Cambridge.

Analysis

Elles's hammers have the potential to provide an alternative source for students studying the history of science and the role of women, as they are tools closely associated with her geological fieldwork, professional education and standing.

The hammer is an ancient tool and, by the 1870s, there were over 70 different hammers being manufactured, which were used to perform a range of tasks.[20] Hammers were used for breaking, splitting or flaking rocks and prising samples from a larger rock outcrop. The geological hammer was often described as 'indispensable' for field work, but it was also a recognisable feature of an emerging profession.[21] It was a badge of honour.

The learning environment of the 1800s was restricted for women, and historians have argued that as a consequence, women were by and large 'consumers not producers of science'.[22] However, by the 1870s the situation was changing with increased access to education for women playing an important role in furthering the position of women within the geological community.[23] At Cambridge, where Elles studied, women were present on geological field trips from the 1880s.[24] This was largely due to the influence of Professors Thomas McKenny Hughes and John Edward Marr. McKenny Hughes' wife, Mary 'Clara' Hughes, 'companioned as well as chaperoned' young girl-graduates, and pointed out the different stages of development and condition of specimens.[25] Fieldwork facilitated interaction between men and women during a time when this was rare.

In 1896 the Sedgwick Club, which was founded in 1880 in memory of the geologist Adam Sedgwick, and is the oldest student-run geological society in the world , permitted women to join its ranks, with the then-president, Mr Brand, recognising the ability of women and the benefits to the club in admitting them.[26] Cambridge University meanwhile, rejected plans for women to receive degrees a year later.[27]

Excursion diaries and photographs offer irrefutable evidence of the presence of women and their scientific contributions. Gertrude Elles features in these records, from student participant in 1896, to expedition leader in 1921. Writing in the 1970s, Alice White (née Dale), who was a contemporary of Elles and became the Bursar of Newnham College in 1946, described a woman geologist as 'a rare phenomenon', however Elles was something of a trailblazer.[28] Elles' hammers are a physical reminder of her distinguished professional career and her presence in the field.

Questions

1. How did the hammer facilitate learning for would-be geologists?
2. How might this object relate to the histories of conducting geology and its emergence as a profession?
3. Compare these hammers to the maps presented in part six of this text. What do these sources reveal about craftsmanship and its importance in geology and other scientific endeavours?

4. How might this source be discussed in the context of masculine and feminine stereotypes in society, especially in relation to science and fieldwork?
5. Consider the symbolic associations of the hammer, for example as a symbol of labour as opposed to a tool for science.

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Part VIII notes

1 Membership to scientific societies granted access to certain scientific spaces, for more on nineteenth-century spaces of science, see Livingstone and Withers, eds. *Geographies of Nineteenth Century-Science.*

2 The Geological Society, 'History'.

3 For additional examples of women who contributed to nineteenth-century geology, see The Geological Society, 'Women and Geology in the 19th Century'.

4 Greater access to the university system was part of this change, see Burek and Higgs, 'The Role of Women in the History and Development of Geology', 3, 10.

5 Torrens, 'Mary Anning (1799–1847) of Lyme', 1995, 257–284.

6 Lt. Col. Thomas Birch (1768–1829) was a collector of fossils; in 1820 he sold off the collection he had purchased from the Annings and made a donation to support Anning's family.

7 The specimen was purchased from Buckingham in 1848 by the British Museum. It is now on display in the Mary Anning Hall of the Natural History Museum (BMNH 22656). Torrens, 'Mary Anning (1799–1847) of Lyme', 264 states that the purchase sum was likely £100 but as high as £200.

8 Conybeare, 'XXI. - On the Discovery of an Almost Perfect Skeleton of the Plesiosaurus', 1824, 382–389.

9 Sir Richard Colt Hoare (1758–1838), antiquarian, archaeologist and local historian.

10 George Bellas Greenough (1778–1855), founding president of the Geological Society.

11 John Samuel Miller (born Johann Müller, 1779–1830), English naturalist and member of the Linnean Society.

12 David Don (1799–1841), botanist and librarian to Benett's brother-in-law Aylmer Bourke Lambert.

13 Benett, Etheldred. Alexander Turnbull Library, National Library of New Zealand, MS-Papers-0083-010A, Correspondence with Gideon Mantell dated 29 August 1816.
14 Burek, 'The First Lady Geologist, or Collector Par Excellence?', 2001, 192–195.
15 Torrens et al. 'Etheldred Benett of Wiltshire, England, the First Lady Geologist', 64.
16 Hoare, "Comments on the Proposed Conservation of Drepanites Mojsiskovics, 1893 and Hyphoplites Spath 1922 (Mollusca, Cephalopoda)." Bulletin of Zoological Nomenclature 47.3 (1990): 187–88, 218–219.
17 Bulman, 'Dr. Gertrude L. Elles, M.B.E', 1960, 1152.
18 British Red Cross, 'Miss Gertrude Lilian Elles M.B.E.'.
19 Bulman, 'Dr. Gertrude L. Elles, M.B.E', 1960, 1152.
20 Palmer, *Tools of the Trade*, 6.
21 Sedgwick Museum Archive, SGWC, DDF 939, Sedgwick Club excursion instructions, 1936.
22 Burek and Higgs, 'The Role of Women in the History and Development of Geology', 2007, 10.
23 Burek and Higgs, 'The Role of Women in the History and Development of Geology', 2007, 3.
24 Sedgwick Museum Archive, SGWC 02/02/05, 1885 group photograph (Wales) includes four women.
25 Eleanor Sidgwick wrote to Professor Hughes asking him a series of questions about teaching mixed classes, as she was aware that geological excursions often had both male and female participants. Sedgwick Museum Archives, HGHS DDF 720; Also see Sedgwick Museum Archive, SGWC 02/02/08, Anon 'A Pleasure Party', *The Queen: The Ladies Newspaper* (August 2 1890).
26 Sedgwick Museum Archive, SGWC 01/01/06, Sedgwick Club minutes, 1896.
27 1,707 against the proposal for women's degrees, 661 in favour. Hunt and Barker, *Women at Cambridge*, 14.
28 White, *Newnham College Register, 1871-1971*, 10.

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Part IX

Education, access and agency (1850–1905)

Timeline: individuals, events and publications in the history of science	Timeline: individuals, events and publications in this part
1791–1871 Charles Babbage, British mathematician and computer pioneer.	
	1805–81 Mary Seacole, British-Jamaican nurse.
	1815–52 Ada King, Countess of Lovelace, British mathematician and computer pioneer.
1820–1910 Florence Nightingale, British nurse and reformer of army medical services.	
	1830–1921 Sarah Emily Davies, British suffragist and promoter of women's education.
1836–1917 Elizabeth Garrett Anderson, British physician, and first woman in Britain to qualify as a physician.	
1847 Hungarian obstetrician Ignaz Semmelweis implements handwashing with chlorinated lime among students and doctors at the Vienna General Hospital, dramatically decreasing mortality rates within maternity wards, where previously many new mothers had died from puerperal fever.	

Timeline: individuals, events and publications in the history of science	**Timeline: individuals, events and publications in this part**
	1856–1917 Anna Fischer-Dückelmann, Swiss physician.
1865 Austrian mathematician, biologist and friar Gregor Mendel first proposes his laws of inheritance, later seen as the basis for genetics.	
1866 First permanent transatlantic telegraph line is completed, dramatically increasing the speed with which messages can be sent from Europe to America.	
1869 Russian chemist Dmitri Mendeleev publishes his first periodic table of the elements.	
	1872–1919 Laura Esther Rodríguez Dulanto, Peruvian physician.
1892–98 Discovery of the first virus, Tobacco mosaic virus, by Dutch microbiologist and botanist Martinus Beijerinck, building on earlier work by Russian botanist Dmitri Ivanovsky.	
1895 German physicist Wilhelm Conrad Röntgen is the first person to witness X-rays.	

Introduction

This part considers the role that access to education played in women's knowledge production. Within the traditional canon of the history of science, the nineteenth century is seen as an era of discovery and scientific progress. This perceived Western modernity, however, was built upon the work of many individuals less recognised by the history of science, including women and colonised peoples. Women of colour were even more actively written out of many narratives of scientific discovery. Imperialism offered European and colonial scientists the opportunity to expropriate Indigenous knowledge – a process in which white women also participated. This issue is complicated because while white women acted as agents of Empire within colonial settings, they also faced oppressions within spaces of science.

These sources speak to women's global struggles to receive a scientific education and enter a scientific profession during the nineteenth century.[1] A formal education was now required for a career in the fields of science and medicine. However, many universities did not yet accept female students. In 1868, the University of London was the first British university to accept female students for bachelor's degrees, and in 1874 the London School of Medicine for Women was the first medical school in the country to train women as doctors.[2] Although they were admitted to study from 1879, it was not until 1948 that the University of Cambridge allowed women to graduate with degrees.

The first source, an anonymous obituary following the death of Ada King, Countess of Lovelace, explores the reactions of her contemporaries to her mathematical abilities, and reveals how gender intersects with the concept of genius and 'Great Man of Science' narratives.[3] The second source, an extract from Mary Seacole's autobiography, reveals themes around formal versus informal learning, as well as issues of race, and her commemoration in comparison to her well-known contemporary Florence Nightingale. The third source, a letter from Sarah Emily Davis to Barbara Leigh Smith Bodichon, co-founders of Girton College in Cambridge, explores the methods by which upper-class British women obtained scientific instruction in the controversial subject of anatomy.[4] The fourth source, taken from Dr Laura Esther Rodríguez Dulanto's introductory passage to her medical surgery doctoral dissertation, similarly touches upon womens' access to university-level education, and her experience as the first Peruvian woman to obtain a doctoral degree as a medical surgeon. The final source in this part, an extract from Anna Fischer-Dückelmann's *Woman as Family Doctor*, demonstrates how medical information on women's bodies began to become available to women in the home, and the controversy this caused.

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Ada King, Countess of Lovelace (1815–1852): Anonymous obituary published in *The Examiner* (1852)

Dr Hannah Wills

Introduction

This source is an anonymous obituary published in the British newspaper *The Examiner* following the death of Ada King, countess of Lovelace, on 27 November 1852. Ada Lovelace was born Augusta Ada Byron, on 10 December 1815, the only child of the poet George Gordon Noel Byron, sixth Baron Byron (1788–1824) and his wife Anne Isabella Noel, Lady Byron (1792–1860). Her parents having separated shortly after she was born, Lovelace was raised by her mother, who, it has been suggested, chose to educate her in mathematics and the sciences to prevent her from pursuing poetry. She was taught by a number of tutors, including the British mathematician Augustus De Morgan (1806–1871), and knew many notable figures within contemporary learned circles, including Mary Somerville and Charles Babbage.[5]

Today, Lovelace is celebrated for her contributions in the field of mathematics. Lovelace was first introduced to Babbage in 1833, who showed her his first calculating engine – the difference engine – an automatic calculating machine based on the principle of calculating finite differences.[6] Lovelace is perhaps best known for her comments on Babbage's later plans for his analytical engine.[7] In 1843, she translated a paper by the Italian mathematician General Luigi Federico Menabrea, which described Babbage's plans for the analytical engine. Lovelace wrote extensive comments on the paper and produced what has been described as one of the earliest computer programmes. This work was published as *Sketch of the analytical engine invented by Charles Babbage esq. by L F Menabrea of Turin officer of the military engineers*.[8]

Lovelace suffered from ill health throughout her life. She married William King, eighth Baron King of Ockham, later earl of Lovelace, in 1835, and the couple had two sons and a daughter. In 1852, Lovelace died from cancer of the uterus.

Source

'Death of Lady Lovelace'. *The Examiner. A Weekly Paper, On Politics, Literature, and the Fine Arts, for the year 1852*. London: George Lapham, 1852. 771.[9]

DEATH OF LADY LOVELACE.

Who has not felt an interest in the only child of Byron, the Ada whose name is so caressed in his verse, and a lock of whose hair is the subject of a touching passage in his letters? Who has not felt at least a curiosity to know what features of genius and character had descended from the father to the daughter? The Countess of Lovelace was thoroughly original, and the poetic temperament was all that was hers in common with her father. Her genius, for genius she possessed, was not poetic, but metaphysical and mathematical, her mind having been in the constant practice of investigation, and with rigorous exactness. With an understanding thoroughly masculine in solidity, grasp, and firmness. Lady Lovelace had all the delicacies of the most refined female character. Her manners, her tastes, her accomplishments, in many of which, music especially, she was a proficient, were feminine in the nicest sense of the word, and the superficial observer would never have divined the strength and the knowledge that lay hidden under the womanly graces. Proportionate to her distaste for the frivolous and commonplace was her enjoyment of true intellectual society, and eagerly she sought the acquaintance of all who were distinguished in science, art, and literature. But from this pleasure, and all else, in the prime of life she has been cut off. She bore a long and painful illness with the fortitude, the heroism belonging to her character. We need not add to this feeble, imperfect tribute how deeply she must be mourned by all honoured with her friendship - a friendship so cordial, so frank.

Analysis

This obituary reveals a number of themes in relation to the position of women in British society and as producers of knowledge in the nineteenth century. Whilst most histories of Lovelace focus on her mathematical writings, this text allows us to explore the gendering of disciplines and the representation of genius. The description of Lovelace's mathematical ability as 'thoroughly masculine in solidity, grasp, and firmness', contrasted with her more 'feminine' accomplishments in 'manners, her tastes… music especially' appears to demonstrate that mathematics was considered a male discipline in the nineteenth century. At the time, many did consider mathematics to be a subject particularly inaccessible for women's minds. There were many physiological explanations offered for why this was thought to be the case, including the claim that women's bodies were colder, and therefore less suited to philosophical and mental exertion.[10] However, it was not uncommon for upper class English girls to be taught mathematical subjects. Typically, such girls were taught by a governess, in subjects including arithmetic, astronomy and geometry, in addition to the more 'feminine' pursuits of languages and music.[11] Popular publications such as *The Ladies Diary*, which presented mathematical questions and answers solved by readers for enjoyment, led to popular familiarity with mathematics as a subject, including among educated young women.[12] Lovelace's mathematical learning did however go beyond what might have been considered normal familiarity with the subject. As a teenager, she was taught by several tutors, one of whom, Dr William King, recommended to her the books he had used when studying mathematics at the University of Cambridge.[13] Under the later tutelage of Augustus De Morgan, Lovelace developed a stronger grasp of what would have been university-level mathematics at the time – a level of learning which would have typically been restricted to men who were able to attend such institutions.[14]

Praise of Lovelace's 'masculine' mathematical ability is paired with a representation of her as a suffering 'genius' who 'bore a long and painful illness'. It was not unusual for Victorian intellectuals to be presented as sickly, and this association had added significance for women, in that ill health replicated many of the ideals of femininity, such as delicacy and confinement to the domestic sphere.[15] Many Victorians speculated about the possible links between intellectual powers and bodily health, and while some contemporaries described Lovelace's nervousness and ill health as the result of mental overexertion, others argued that her illnesses were physical manifestations of an intellectual power too immense for her female mind to contain.[16] On the other hand, some historians have suggested that Lovelace's mother, Lady Byron, insisted upon teaching her daughter mathematics as a way to bolster her mental strength, by combatting the 'passions' she might have inherited from her father, famed for his volatile psyche.[17] As with the gendering of mathematics, theories of the impact of certain subjects upon the mind and body were contested during this period.

While this obituary celebrates Lovelace as an exceptional genius, historians have since questioned the depth of her understanding and mathematical abilities. The historians Dorothy Stein and Doron Swade have argued that Lovelace's ability was not as great as some of her contemporaries suggested, and have questioned whether she possessed the necessary understanding to contribute to the 1843 paper on Babbage's engine. By examining Lovelace's early mathematical education and her correspondence with Augustus De Morgan, historians Christopher Hollings, Ursula Martin and Adrian Rice have counter-argued that such criticisms of Lovelace's ability are unjust.[18] Today, Ada Lovelace is a widely celebrated figure; there are many biographies dedicated to her, a computer language named after her, and representations of her feature in several novels, comics and films.[19]

Claims are often made about Lovelace which cast her as a lone heroine, who in some way foresaw or foreshadowed technologies and developments in computer science today.[20] It is important to consider the implications of this, and how the representation of particular women as isolated geniuses might obscure other kinds of contributions to knowledge that do not fit this model. The social context surrounding those who are remembered and celebrated as the 'great women' of science reveals these other contributions.[21] This source reveals that Lovelace did not produce knowledge alone. She was part of a community engaged in knowledge production across a variety of spheres: 'eagerly she sought the acquaintance of all who were distinguished in science, art, and literature'. Thus, while this obituary reveals much about the presentation of women and knowledge in the nineteenth century, it also reiterates long-standing questions about how we present knowledge-making practices in our retelling of the history of science.

Questions

1. Why do you think this obituary begins with a reference to Ada's father, Lord Byron? What might this reveal about her fame at the time?
2. What does this source suggest about nineteenth-century views on heredity, and the inheritance of particular talents or attributes?
3. What does this source reveal about the gendering of particular areas of knowledge? Compare and contrast this with other sources in this volume.
4. Compare Ada Lovelace to other 'great' women in the history of science and how they are presented. You might want to consider representations of them in popular culture, for example in literature and film. How similar are these narratives?
5. What do historians' debates over Lovelace's mathematical abilities show about approaches to the concepts of discovery and genius within the history of science?

Further reading

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35

Mary Seacole (1805–1881): Extract from Seacole's autobiography *Wonderful Adventures of Mrs Seacole in Many Lands* (1857)

Dr Marie Allitt

Introduction

Mary Seacole was born Mary Jane Grant in 1805, in Kingston, Jamaica, to a Scottish father and Creole mother. She describes herself as Creole, which in the 1850s, as Sara Salih explains, 'was most commonly used either in a racially neutral sense, or to describe the white offspring of settlers in the colonies'.[22] The source below is taken from Seacole's autobiography *Wonderful Adventures of Mrs Seacole in Many Lands*, first published in 1857. The memoir briefly describes her upbringing and early travels around the West Indies, before she ventures to England with the intention of travelling on to the Crimea – for which she is most well-known. Early chapters in her memoir are dedicated to her travels around the West Indies, making a series of trips back and forth between Jamaica, and Cuba, Haiti, and the Isthmus of Panama, primarily as entrepreneurial expeditions rather than nursing voyages. In 1850, cholera raged through Jamaica, which Seacole witnessed first hand. At the time she was running a boarding house, and she explained that, especially due to one of her boarders, a 'Dr B—', she had 'but too many opportunities of watching its [cholera's] nature, and […] received many hints as to its treatment which I afterwards found invaluable'.[23] Soon after this, she travelled to Cruces, Panama to follow her brother, who was doing a roaring trade as an independent hotelier amidst the Californian Gold Rush. Travellers had to pass the Isthmus to reach California by land, so the town of Cruces was a popular point on the way. While here, her previous experience with cholera certainly proved invaluable – as this extract describes.

Source

Seacole, Mary. *Wonderful Adventures of Mrs Seacole in Many Lands*. Edited by W. J. S. London: James Blackwood, 1857. 27–31.

It was scarcely surprising that the cholera should spread rapidly, for fear is its powerful auxiliary, and the Cruces people bowed down before the plague in slavish despair. The Americans and other foreigners in the place showed a brave front, but the natives, constitutionally cowardly, made not the feeblest show of resistance. Beyond filling the poor church, and making the priests bring out into the streets figures of tawdry dirty saints, supposed to possess some miraculous influence which they never exerted, before which they prostrated themselves, invoking their aid with passionate prayers and cries, they did nothing. Very likely the saints would have got the credit of helping them if they had helped themselves; but the poor cowards never stirred a finger to clean out their close, reeking huts, or rid the damp streets of the rotting accumulation of months. I think their chief reliance was on 'the yellow woman from Jamaica with the cholera medicine.' Nor was this surprising; for the Spanish doctor, who was sent for from Panama, became nervous and frightened at the horrors around him, and the people soon saw that he was not familiar with the terrible disease he was called upon to do battle with, and preferred trusting to one who was.

It must be understood that many of those who could afford to pay for my services did so handsomely, but the great majority of my patients had nothing better to give their doctress than thanks. The best part of my practice lay amongst the American store and hotel keepers, the worst among the native boatmen and muleteers. These latter died by scores, and among them I saw some scenes of horror I would fain forget, if it were possible. One terrible night, passed with some of them, has often haunted me. I will endeavour to narrate it, and should the reader be supposed to think it highly coloured and doubtful, I will only tell him that, terrible as it seems, I saw almost as fearful scenes on the Crimean peninsula among British men, a few thousand miles only from comfort and plenty.

It was late in the evening when the largest mule-owner in Cruces came to me and implored me to accompany him to his kraal, a short distance from the town, where he said some of his men where [sic] dying.

One in particular, his head muleteer, a very valuable servant, he was most selfishly anxious for, and, on the way thither, promised me a large remuneration if I should succeed in saving him. Our journey was not a long one, but it rained hard, and the fields were flooded, so that it took us some time to reach the long, low hut which he called his home. I would rather not see such another scene as the interior of that hut presented. Its roof scarcely sheltered its wretched inmates from the searching rain; its floor was the damp, rank turf, trodden by the mules' hoofs and muleteers' feet into thick mud. Around, in dirty hammocks, and on the damp floor, were the inmates of this wretched place, male and female, the strong and the sick together, breathing air that nearly choked me, accustomed as I had grown to live in impure atmosphere; for beneath the same roof the mules, more valuable to their master than his human servants, were stabled, their fore-feet locked, and beside them were heaps of saddles, packs, and harness. The groans of the sufferers and the anxiety and fear of their comrades were so painful to hear and witness, that for a few minutes I felt an almost uncontrollable impulse to run out into the stormy night, and flee from this plague-spot. But the weak feeling vanished, and I set about my duty. The mule-owner was so frightened that he did not hesitate to obey orders, and, by my directions, doors and shutters were thrown open, fires were lighted, and every effort made to ventilate the place; and then, with the aid of the frightened women, I applied myself to my poor patients. Two were beyond my skill. Death alone could give them relief. The others I could help. But no words of mine could induce them to bear their terrible sufferings like men. They screamed and groaned, not like women, for few would have been so craven-hearted, but like children; calling, in the intervals of violent pain, upon Jesu, the Madonna, and all the saints of heaven whom their lives had scandalized. I stayed with them until midnight, and then got away for a little time. But I had not long been quiet, before the mule-master was after me again. The men were worse; would I return with him. The rain was drifting heavily on the thatched roof, as it only does in tropical climates, and I was tired to death; but I could not resist his appeal. He had brought with him a pair of tall, thick boots, in which I was to wade through the flooded fields; and with some difficulty I again reached the kraal. I found the worst cases sinking fast, one of the others had relapsed, while fear had paralysed the efforts of the rest. At last I restored some order; and, with the help of the bravest of the women, fixed up rude screens around the dying men. But no screens could shut out from the others their awful groans and cries for the aid that no mortal power could give them. So the long night passed away; first a deathlike stillness behind one screen, and then a sudden silence behind the other, showing that the fierce battle with death was over, and who had been the victor. And, meanwhile, I sat before the flickering fire, with my last patient in my lap – a poor, little, brown-faced orphan infant, scarce a year old, was dying in my arms, and I was powerless to save it. It may seem strange, but it is a fact, that I thought more of that little child than I did of the men who were struggling for their lives, and prayed very earnestly and solemnly to God to spare it. But it did not please Him to grant my prayer, and towards morning the wee spirit left this sinful world for the home above it had so lately left, and what was mortal of the little infant lay dead in my arms. Then it was that I began to think – how the idea first arose in my mind I can hardly say – that, if it were possible to take this little child and examine it, I should learn more of the terrible disease which was sparing neither young nor old, and should know better how to do battle with it. I was not afraid to use my baby patient thus. I knew its fled spirit would not reproach me, for I had done all I could for it in life – had shed tears over it, and prayed for it.

It was cold grey dawn, and the rain had ceased, when I followed the man who had taken the dead child away to bury it, and bribed him to carry it by an unfrequented path down to the river-side, and accompany me to the thick retired bush on the opposite bank. Having persuaded him thus much, it was not difficult, with the help of silver arguments to convince him that it would be for the general benefit and his own, if I could learn from this poor little thing the secret inner workings of our common foe; and ultimately he stayed by me, and aided me in my first and last *post mortem* examination. It seems a strange deed to accomplish, and I am sure I could not wield the scalpel or the substitute I then used now, but at that time the excitement, had strung my mind up to a high pitch of courage and determination; and perhaps the daily, almost hourly, scenes of death had made me somewhat callous. I need not linger on this scene, nor give the readers the results of my operation; although novel to me, and decidedly useful, they were what every medical man well knows.

We buried the poor little body beneath a piece of luxuriant turf, and stole back into Cruces like guilty things. But the knowledge I had obtained thus strangely was very valuable to me, and was soon put into practice. But that I dreaded boring my readers, I would fain give them some idea of my treatment of this terrible disease. I have no doubt that at first I made some lamentable blunders, and, may be, lost patients which a little later I could have saved. I know I came across, the other day, some notes of cholera medicines which made me shudder, and I dare say they have been used in their turn and found wanting. The simplest remedies were perhaps the best. Mustard plasters, and emetics, and calomel; the mercury applied externally, where the veins were nearest the surface, were my usual resources. Opium I rather dreaded, as its effect is to incapacitate the system from making any exertion, and it lulls the patient into a sleep which is often the sleep of death. When my patients felt thirsty, I would give them water in which cinnamon had been boiled. One stubborn attack succumbed to an additional dose of ten grains of sugar of lead, mixed in a pint of water, given in doses of a table-spoonful every quarter of an hour. Another patient, a girl, I rubbed over with warm oil, camphor, and spirits of wine. Above all, I never neglected to apply mustard poultices to the stomach, spine and neck, and particularly to keep my patient warm about the region of the heart. Nor did I relax my care when the disease had passed by, for danger did not cease when the great foe was beaten off. The patient was left prostrate; strengthening medicines had to be given cautiously, for fever, often of the brain, would follow. But, after all, one great conclusion, which my practice in cholera cases enabled me to come to, was the old one, that few constitutions permitted the use of exactly similar remedies, and that the course of treatment which saved one man, would, if persisted in, have very likely killed his brother.

Analysis

Seacole followed in the footsteps of her mother, who also worked as a 'doctress'. While this was not a formal, established role, Seacole witnessed her mother tending to many people, and soon developed a desire to follow this work. In her own words, 'It was very natural that I should inherit her tastes; and so I had from early youth a yearning for medical knowledge and practice which has never deserted me […] the ambition to become a doctress early took firm root in my mind'.[24] That she described her mother and later herself as a 'doctress' is significant; she identified not 'as a "healer" but as a curer with no religious affiliation'.[25] The term 'doctress', or 'doctoress', dates from the sixteenth century, denoting women who informally acquired knowledge of medicine and health, as opposed to their university-educated male counterparts. Such knowledge and skills were often handed down through families and communities, domestic remedy books, and sometimes learned from medical men around them. Seacole even mentioned how, from surgeons staying in her hotel, she 'never failed to glean instruction, given, when they learned my love for their profession, with a readiness and kindness I am never likely to forget'; a surprising suggestion of male acceptance, given centuries-old resistance to women in medicine.[26] It is also notable that while Seacole referred to herself as 'doctress' in the context of caregiving in Jamaica and Panama, it was not a term she uses to describe her role in the Crimea, suggesting that she did not use this term or embody this specific role when there were qualified male doctors and surgeons present. Seacole seems to use her position as a marginal figure of Empire, and Scotch-Creole woman, to move between medical discourses to establish herself as both representative and exceptional. This form of hybridity is indicative of her own complex and self-conscious self-fashioning, in and through which she seeks to claim a distinctive space for herself within histories of Empire, where such stories often go untold.

Seacole is most known for her role during the Crimean War, and consequently, is most often discussed in comparison to Florence Nightingale. Aspects of this scholarship picks out an antagonistic comparison between the two: there are areas of recent Nightingale scholarship which aim to de-centre the prominence of Seacole's role, perceiving it as a dilution to Nightingale's legacy.[27] The antagonism that is drawn out of these two figures demonstrates the fluidity of the label and idea of nursing during this time, before it was fully professionalised. Both figures, their legacies, and the wider context in which they sit, are central to definitions of nursing, raising questions about who can call themselves a nurse, what permission they are granted in such a role, what qualifications they require, and a reminder that there are examples of nursing that are outside of the hospital domain. However, this source re-focuses our understanding of Seacole within histories of nursing, science and caregiving, situating her not as part of military medicine, but within an earlier tradition of medical knowledge and caregiving in cholera epidemics.

Part of the complexity in reading the figure of Seacole is influenced by the contemporary and enduring mythology around her, which owes much to the self-fashioning of her autobiographical writing and the nascent celebrity culture of Victorian Britain, as well as her own representations of racial identity and race relations, which rarely follow or allow for binary thinking. She is simultaneously – and contradictorily – defending the legitimacy of her black subjectivity, while also exploiting the exceptionalism she is offered by Britain: as Amy Robinson notes, 'her narrative enacts the profound dis-ease of a Jamaican "British" subject, who can only appear *as* an exception to the rules of her metropolitan British readers'.[28] Seacole's 'fundamental freedom,' Sandra Pouchet Paquet argues, comes from 'the freedom to be a subject of the British Empire and to be celebrated as a unique individual who challenges the boundaries of race, gender, and privilege within the parameters of that

Empire'.[29] Seacole mimics 'imperial idioms', reaffirming her 'good Scotch blood', and 'ventriloquises the voices of imperial authority by describing herself variously, as "brown," "slightly brown," and "yellow,"' in turn raising queries as to how much she is using irony or attempting to exhibit a degree of deferential self-awareness to appeal to her white audience.[30] Seacole displays a complicated relationship with white imperial power, where she seeks to counter, for example, the accusations of 'mulatto illegitimacy', but does not condemn British Imperialism outright.[31] In fact, she defines herself as part of it: she is not West Indian, but instead a Jamaican 'British subject' which 'is itself the product of British colonial policy during the sixty-one years that elapsed between the abolition of slavery in England and the abolition of slavery in England's dominions,' which further dislocates post-Emancipation identities.[32] There is great debate about the extent to which Seacole resists Imperial powers and how much she relies upon manipulating the hybridity of her racial and national identities to be both of and outside Britain, which, subsequently suggests the need for as much literary history as colonial history in these contexts.[33] Remaking the Victorian tradition of autobiography and travel writing to tell a tale of mobility and migration that reveals the complexity of 'belonging' for the colonial subject, Seacole self-fashions, at different times showing or occluding her ambition, entrepreneurial prowess, and marginalisation. Much of the scholarship focuses on her time in Crimea and thus her relationship with British Imperialism, but more might be gained from looking at her earlier experiences. Her time in Central America, which was 'only recently liberated from Spanish control and battling with a growing Anglo-American encroachment signified by the construction of a transisthmus railroad,' is where she comes into direct contact with Americans, and encounters, and takes part in, marked differences in the discourse of race.[34]

Prior to this episode in Cruces, Seacole had nursed many different people through yellow fever and cholera. Her depictions of how people handled these diseases was directly tied to race: she discussed how British soldiers suffered worse than Jamaicans in the 1850 cholera outbreak, suggesting the superior constitutions of native peoples and, in turn, raising doubts about the British colonial project.[35] However this is complicated in her account of her travels: as well as suggesting the weak constitutions of foreigners, she also depicted the Panamanians as weak, passive and unable to help themselves, relying on this 'yellow woman from Jamaica'. She noted that while the white Americans passing through easily succumbed to the disease, it was worse for the native inhabitants. With the insufficiencies of the Spanish doctor sent from Panama, and presumably his fear of the disease, Seacole appears to have been granted sole responsibility for providing care, given her experience of cholera. Her reputation preceded her, or was amplified by the services she provided in the town to paying hotel residents, so she was appealed to for help by the local muleteers. She illustrated her methodical approach and re-establishment of order by immediately ventilating the stuffy, putrid hut, erecting screens around the dying men and setting the willing women to work.

The patients she describes in this source are all men, until a final, pitiful mention of a young child dying in her arms. One of the most shocking moments of this extract is the post-mortem examination of the young child. We are told very little about this child: we know they were orphaned, and that they are about a year old, but we are not told its gender or given any other details. We have no idea how this child came to be orphaned, whether by the cholera outbreak or something else, or who was then supposed to be caring for them. Although Seacole sets up the scene of the post-mortem examination, she spares the readers the anatomical details. We are not told what she found, but she informs the reader that it was instructive. We might assume, for example, that it illustrated how the disease dehydrated the body completely, so serving as a definitive indicator for how vital it is to replenish the patient's fluids.[36] This moment appears to have given her confidence in treating patients in the future; she goes on to detail her accumulation of medical knowledge, the use of poultices, mustard plasters and cinnamon water for example, and establishes a longer narrative of having gained knowledge through successive cholera epidemics, implying working theories proved and disproved through experience and attention. This scene can also be read as establishing her credentials for working in the Crimea – it was not an accident that she made a pre-emptive reference to scenes she witnessed there. Through this event, and others described throughout the memoir, Seacole established herself as strong, unlikely to succumb to illness herself, and capable to serve and care for British subjects.[37]

Questions

1. What does the source, and wider context, tell us about the acquisition and movement of medical knowledge and skills?
2. Medical authority is placed on Seacole because the only qualified doctor is unable to cope. What does this tell us about attitudes to expertise, authority and experience?
3. What attitudes are displayed towards race and racial identity, and how does this affect the medical care that is given and received? What

might this tell us about race theories and racialised medicine in the nineteenth century?

4. At the heart of what have at times been vicious disputes among Seacole and Nightingale scholars is the question of nursing as a profession. What does the source, and Seacole as a figure, tell us about the professionalisation of nursing?
5. How do the descriptions of her medical role here compare to descriptions of Seacole's work in the Crimea. How does she present her knowledge, power and authority in each context?
6. What does this autobiography tell us about Seacole's self-fashioned identity, a) as a woman, b) as a person of colour and mixed ethnicity, c) as a colonial subject, and d) as a non-professional nurse?
7. Having become bankrupt in 1857, Seacole was motivated to write this memoir to demonstrate her good deeds and worthiness to receive financial support. How does this influence the figure of Seacole, self-presented and socially constructed?

Further reading

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36

Sarah Emily Davies (1830–1921): A letter to Barbara Leigh Smith Bodichon (1873)

Dr Rebecca Martin

Introduction

Sarah Emily Davies (1830–1921) was a staunch advocate of women's rights: a feminist, a suffragist and a campaigner for women's access to university education. In 1879 she co-founded Girton College in Cambridge with Barbara Leigh Smith Bodichon (1827–1891), with whom she converses in this letter. Girton was the first women's college at the University of Cambridge, although it was not granted full college status until 1948, when women were officially admitted to the university. The college continued to display progressive educational ideas during the twentieth century, becoming the first Cambridge women's college to admit men in 1976.

Davies is a complex character, and her letters reveal the interweaving of her various different interests and projects; from the foundation of both the British women's suffrage movement and Girton College, to her campaigns to open the Cambridge Local Examinations to girls.[38] This particular letter highlights the range of considerations included in Girton's college business, discussing both arrangements for anatomy lessons and the choice of a curtain material, it integrates rather than separates the scientific and the domestic. The elements of this source that discuss arrangements for anatomical education are illustrative of both the ingenuity of women in obtaining an education when it was not specifically permitted and the somewhat unofficial routes by which this was achieved.

Source

A Letter to Barbara Leigh Smith Bodichon (1873), Archives & Special Collections, Girton College, Cambridge, GCPP Bodichon 1/75.[39]

Girton College. | 17, Cunningham Place N.W.

Sept. 6.|[1873]

Dear Mrs. Bodichon,

I went to Girton & Cambridge yesterday & had a long talk with Professor Liveing about the Natural Science studies, which ended in our deciding that our three Students (Miss Kingsland, Dove & Gamble) had better attend his Professorial Lectures on Chemistry, & Professor Humphrey's on Anatomy & Physiology.[40] Prof. L. thinks the course he is to give will be suitable for them & it will take less of his time & he can do more for them than if he came out to Girton. I don't think he has had any women in his class before, but Prof. Humphrey had one last year. In speaking of his, it would be best to call it Physiology, as the word Anatomy may give the impression that the Lectures are different from what they are.

Prof. L. has attended them himself & thinks that as to the subject, there is no reasonable objection to a mixed class. I should go with them at first & occasionally.

I could not undertake to go always, as between the two Professors there will be a Lecture (of an hour) every day. We must let them have a fly both ways, which will cost 4/. a Lecture for the three students. The Lectures cost nothing, as the Professors are not paid by fees. The Students by attending the Lectures will come in for other privileges, such as the use of University skeletons. I have written to Professor Humphrey about his Lectures. He has always been a friend of the College & is sure to be pleasant. Prof. Liveing went into the matter in the kindest way, taking it up as if it was quite his business to do the best he could for our Students. It is certainly a great thing to come within range of these nice friendly people. We shall want Mr. Hicks at Girton besides, & probably some more apparatus, which we can the better afford as we shall be paying so little for the teaching.

I had not time to open the Japanese parcel yesterday, but a question has occurred to me. How will it look on the outside, to have the linings for the sitting & bedroom curtains alternately blue & white? Would it be better to have them all alike? I should incline to white. (as I am so afraid of not being able to get a blue that won't kill the Japanese. the Butcher's blue at Shoolbred's would not do at all.) but I don't know how that would look in a sitting room & on the outside. If it were glazed white stuff, perhaps it would do. Please advise. I came across a difficulty about the planks. The bedroom windows come down to the within 2ft. of the floor, so that tables of 2ft.6. would prevent the casement from opening, if the tables were close to the wall. If they were, say two inches from the wall, they would open a little way, & of course at the top besides, which is what one wants most in a bedroom. I don't like giving up the planks. Seymour will make them for 18/. each, & they would be much nicer than even tolerably good dressing & washing tables. Shall we try five or six? Mr. Howard told me that the windows for the bathrooms &c. are to be ground glass, so we shall not want curtains for them. I showed the linen rep to Mrs. Liveing & she liked it very much. She gave me a good deal of useful advice about shops.

Mr. Waterhouse has bought the Cottage for us. Mr. Loveday proposed £60. we offered £50. & he accepts £55. with immediate possession. I am telling James to get in as soon as he can. Mrs. Martineau has heard of a boy for us, a lad of 20, her gardener's son. If he comes I shall ask her to send us things for the garden by him. I have been offering gardens to the students, but so far, they have been declined. Miss Dove ~~& Miss Maynard~~ says ~~they~~ she has not time, & Miss Maynard that the winter is not a good time for working, which is true.

I have been seeing Miss Edwards of Clifton & she told me she heard from a Bristol lawyer last May that he had been making a will containing a handsome legacy to the College. We have no idea who it can be.

I have written to Professor Rogers to-day.

I shall be going to Girton for the first night there on the 15th, the day you begin your travels. There will be perpetual reminders of you at Girton. Howard has achieved the iron bar with holes in it for the windows, & it works well. He is certainly very thoughtful & ready to do what we want.

Bon - (or best possible) voyage - if I don't write again.

Ever your affecn.

ED.

Thanks for the Vassar pamphlet.

Analysis

Arguments around women's supposedly limited intelligence, the impact of a laborious education on women's physical ability to bear children, and the cruelty of educating women who were destined for motherhood and the domestic sphere were all raised during this period in defence of excluding women from higher education.[41] In particular, there was considerable resistance to women's scientific education in Britain during the second half of the nineteenth century despite women's clear engagement with science as public consumers and funders of science in the early-to-mid nineteenth century.[42] Many who campaigned for the increased education of women still argued against the inclusion of scientific subjects in women's education. Harry Chester, for example, whilst lamenting the shortage of schools for girls in London, advocated for a curriculum which included 'the Holy Scriptures, … plain needlework, domestic economy … and the management of children and the sick'.[43] Advocates of greater examination in girls' education continued to insist on the need for a distinctly different curriculum for women: one without scientific subjects or logical rigour, lest education create 'masculine' women.[44]

In stark comparison, Emily Davies strongly advocated that female students should follow a curriculum identical to their male counterparts. Indeed, Girton College itself was designed to replicate every element of a male education at Cambridge, from the buildings to the examination structure, subjects offered, three-year programmes and term timetable.[45] This was tangibly different to counterparts like Newnham College, which provided more flexible options for women's higher education at Cambridge. These flexible practices at other colleges drew ire from critics over the unfair advantage that women were afforded by the slower pace and flexibility of their studies (demonstrating, the critics argued, that women were not actually fit for real Oxbridge degree programmes).[46]

Anatomy was a particularly contentious subject within these debates. In this letter, even Davies expresses a desire to describe Sir George Murray Humphry's ('Prof. Humphrey' in Davies' letter) course as physiological rather than anatomical. Although on initial inspection this comment might appear to be about accurately reflecting the content of the curriculum, Humphry was first and foremost an anatomist, not a physiologist (although he later went on to the Professorship in Surgery). Davies' concern about terminology was therefore likely based instead on the arguments raised against the education of women in anatomy – a science which was deemed particularly unseemly for female sensibilities. These arguments had both a physical and moral dimension. The visceral and unpleasant sights and smells of the anatomical classroom were deemed to be overpowering for women's comparatively delicate sensibilities.[47] However, a longstanding connection between anatomy and pornography also contributed towards arguments for barring women from anatomical study.[48]

Anatomical textbooks have historically been one of the few places, outside of public and private art galleries, to openly display images of the naked body. However, in textbooks these images were simultaneously both more accessible, and more private, than works of art.[49] Concerns about women in particular accessing images of the naked body were reflected in the response of the medical profession to nineteenth-century public anatomy museums, who decried them as salacious and immoral spaces under the 1857 Obscene Publications Act.[50] Public anatomy museums, such as those run by Dr Kahn, kept collections of wax models of genitalia, many displaying the ill-effects of various sexually transmitted diseases, in private rooms within their museums with separate opening times for ladies so that they could view these objects separately to men.[51] Indeed, even when admitted to medical schools in Britain, women often had to dissect separately from men. Alison Bashford argues that separate dissections stemmed from a fear that, in mixed company, female dissectors would sexualise male corpses in the same way that men had commonly characterised female corpses.[52] As such, by describing their course as physiological, Davies and the women of Girton College may have been able to sidestep any extra controversy surrounding this course of study.

When women *were* able to access formal scientific education during the nineteenth century, their attendance at these classes was controlled by male gatekeepers. Women attended University lectures, in the words of one campaigner against Oxford degrees for women, 'by the private complacence of a lecturer'.[53] In the case outlined in this letter, permission was required from Professors George Downing Liveing and George Murray Humphry for the women of Girton to attend their lectures. Davies' comments about the kindness and friendliness of Liveing, noting their great fortune on finding him so accommodating, illustrate that this interaction was somewhat out of the ordinary. The description of Humphry as a friend to the college demonstrates the politics of educating women at Cambridge at this time, in which allies had to be identified and maintained for the continuation of women's education. As such, this source speaks to the networks of subterfuge and support involved in orchestrating women's scientific and medical education, as well as highlighting the privilege and status required to access such networks. Attendance at Girton and the cultivation of relationships with Professors

Liveing and Humphry were access requirements that would have excluded many from these opportunities. Readers should therefore remember that this is a source which speaks only to the ways in which white, upper-class British women received scientific education in the late nineteenth century and situate it accordingly.

Questions

1. How does this letter help us to understand women's access to science and scientific education in nineteenth-century Britain?
2. What does this letter tell us about the importance of personal relationships in the inclusion of women within science?
3. What does this letter tell us about the additional difficulties for women looking specifically to obtain anatomical education in nineteenth-century Britain?
4. How does this source contribute towards the broader contextualisation of nineteenth-century science?
5. What elements of this source, not focused on women's scientific education, e.g. the discussion of material for curtains, add to our understanding of women's relationship to nineteenth-century science?
6. What do, for example, the relationships with Mrs Liveing and Mrs Martineau suggest about the ways in which women's scientific networks were formed in Britain?

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37

Dr Laura Esther Rodríguez Dulanto (1872–1919): Introductory passage to her medical surgery doctoral dissertation, Perú (1900)

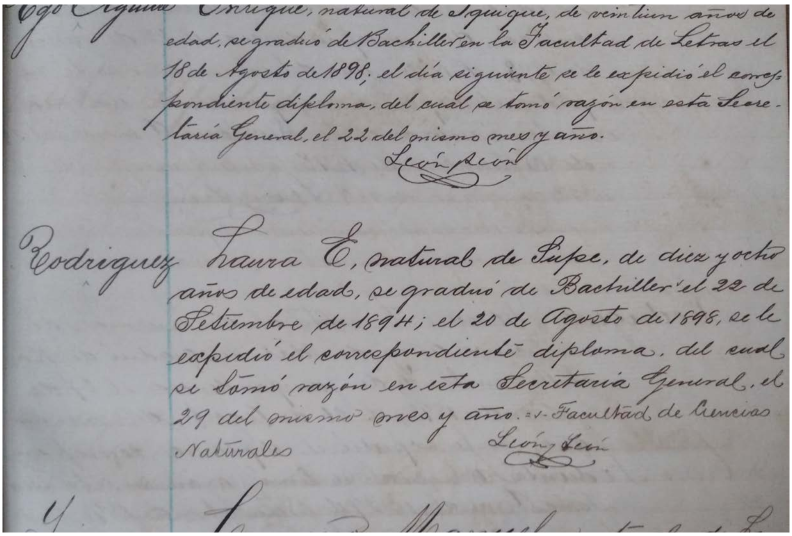
José Ragas and Camila Rodríguez-Birke[54]

Introduction

Writing about women's struggle for equality in unexpected places, like in the introductory pages of her dissertation, Dr Laura Esther Rodríguez Dulanto (1872–1919) delivered a powerful message about the role of women in science in the nineteenth-century.[55] As the first Peruvian woman to obtain a doctoral degree as a medical surgeon in September 1900 (she had already earned a doctoral degree in Natural Sciences two years earlier), she used the introductory passage to her dissertation to bring awareness of her unique position in a field dominated by men. She also took advantage of her privileged position to denounce the enduring structures that blocked other women from attending university and pursuing careers in science and medicine themselves. In doing so, she pioneered the use of scientific writing as a subversive site at a time when criticisms of early feminism came mainly from literature and female writers.

Dr Rodríguez Dulanto was born in Supe, Peru in 1872. Throughout her career, she encountered numerous obstacles. During her childhood, she could not attend school because education was only provided to boys. When she sought to study medicine at university, she had to request special permission from the university's all-male Congress. Once admitted, she was required to perform medical exercises in a separate room from her peers and under male supervision. Despite her brilliant career, prejudice toward her as a result of her gender forced her to work in spaces designated for women, such as schools and convents. She passed away in Lima in July 1919 at the age of 46.

Source


Aguirre Enrique, natural de Iquique, de veintiun años de edad, se graduó de Bachiller en la Facultad de Letras el 18 de Agosto de 1898; el día siguiente se le expidió el correspondiente diploma, del cual se tomó razón en esta Secretaría General, el 22 del mismo mes y año.
León León

Rodríguez Laura E., natural de Supe, de diez y ocho años de edad, se graduó de Bachiller el 22 de Setiembre de 1894; el 20 de Agosto de 1898, se le expidió el correspondiente diploma, del cual se tomó razón en esta Secretaría General, el 29 del mismo mes y año. = Facultad de Ciencias Naturales
León León

Figure 9.1a Dr. Laura Rodríguez Dulanto's BA registration in the Faculty of Natural Sciences issued by Universidad Nacional Mayor de San Marcos in Lima, Peru (1894, 1898). Image credit: Archivo Historico Domingo Angulo – UNMSM.

Translation

Twelve years have passed since the day that, motivated by an irresistible force, I made a commitment to science; twelve years of work and efforts but also of ideals and hope.

I am flattered by the illusion that I might be the first Peruvian woman in having the honor to hold the doctoral insignia; hence I came to this University to hear your word and to dissipate my own ignorance.

I came here, today, to ask for your justice, so you declare if I have accomplished what I pursued.

Laura Rodríguez

Dean.- [Jose Francisco] Maticorena

Figure 9.1b Portrait of Dr Laura Rodríguez Dulanto. In Elvira García y García. *La mujer peruana a través de los siglos: pasado y presente*. Lima: 1926, p. 393. Image credit: Archivo Historico Domingo Angulo - UNMSM.

Analysis

The brief passage that opens Dr Rodríguez Dulanto's dissertation invites us to reflect on and question of how nineteenth-century female scientists operated in the margins of society and the subsequent legacy of this exclusion. The passage elegantly encapsulates the contradictions of Peruvian society with respect to incorporating female voices in male-hegemonic spaces. Her tone in this passage is both defiant and humble.

Although she demanded 'justice' after having accomplished the requirements to complete the degree, she also expressed a humble pride in being 'the first Peruvian woman' to receive a PhD in this subject in the country. This balance in tone was strategic as she knew that her doctoral examiners, on whom her degree relied, would read this passage. This document highlights how women like her were quietly building a new moment in the history of science, a transitional period in which women were breaking the male academic monopoly.

Dr Rodríguez Dulanto also shared the intimate motivation behind her enduring pursuit of a scientific career – an 'irresistible force' she felt at the age of 14. Such episodes are illustrative of her tireless activity across a lifespan of just forty-six years. As well as her degree as a medical surgeon, Dulanto earned a Bachelor of Science and PhD in Natural Sciences in 1892 and 1898 respectively. However, as Elizabeth McGrew notes, 'in the early days, a woman had to be a fighter as well as a scientist … to become a doctor'.[56] This is a characterisation which substantiates what Dr Rodríguez Dulanto overcame in order to obtain her degree. The entrance of women in universities subverted the academic and medical establishment. Like Dulanto, other fierce women sought to obtain a degree in science and medicine in the nineteenth century, such as Dr Eloísa Díaz in Chile, Dr Cecilia Grierson in Argentina, and Dr Dolors Aleu in Spain to name a few. These women have received recognition as pioneers in recent years.

Dr Rodríguez Dulanto's words echo those of Dr María Teresa Ruiz, a Chilean astronomer and the first woman to receive The National Award in Exact Science in Chile. Interviewed about her tumultuous career as a female scientist, Dr Ruiz recalled her days in the university in the late 1960s: 'All the students were men: there were only two or three women per class, out of a hundred and twenty students in each classroom … Yes, it was a male environment'. No doubt this also describes the environment where Dulanto studied one hundred years earlier.

The place Dulanto chose to enact this early feminist scientific manifesto – the first pages of her dissertation – should lead us to rethink what we know about how minority groups appropriated the written word to defy both social and literate conventions. Most of what we do know about female Peruvian and Latin American writers comes from an excellent body of academic scholarship that focuses on novelists and the stories they penned.[57] Dulanto was not a writer herself, and as far as we know, she was not in contact with the brilliant generation of writers and activists such as Clorinda Matto de Turner who denounced the ills of society and suffered exile and repression as a result.[58] Instead, Dulanto co-opted the unconventional literary spaces available to her for her feminist ends. In doing so, Dulanto's short piece also expands our understanding of how science was written beyond conventional spaces such as conferences, laboratories, books and articles.

Questions

1. What obstacles did women like Dr Rodríguez Dulanto face in their pursuit of STEM careers?
2. What other documents can we obtain to reconstruct the trajectories of female scientists in Latin America?
3. What does this source tell us about the kinds of institutions that have been involved in shaping, limiting or promoting the careers of female scientists?
4. How does the case of Dr Rodríguez Dulanto compare to other examples of women pursuing scientific qualifications in this part and beyond?
5. How can we position this source within wider feminist writings of the period?

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38

Anna Fischer-Dückelmann (1856–1917): Extract from *Woman as Family Doctor* (1905)

Izel Demirbas

Introduction

Anna Fischer-Dückelmann (1856–1917) was one of the first female doctors trained in Switzerland, the first Western country to accept female medical students into the same institutions as men. She was a controversial figure who sought to liberate women from 'illness, prejudice, and ignorance', which she believed was caused by an ignorance of medical matters, through the publication of a female-centred health book. Her text *Woman as Family Doctor* was first published in German in 1901. Almost 900 pages long, the manual contained precise and avant-garde information about women's health. The first edition depicted controversial images of female genitalia and contraceptive methods. However, the revolutionary nature of the original text was later subdued, adapted and censored to suit male lecturers and readers. These later, less controversial versions remained popular, seeing translations in French, English, Polish and Spanish and remaining in print until the 1960s.

Source

Fischer-Dückelmann, Anna. *La Femme, Médecin du Foyer*. Paris, 1905. 255–304. [Original Language Text Available: https://archive.org/details/diefraualshaus00fiscuoft (accessed 15 December 2022).

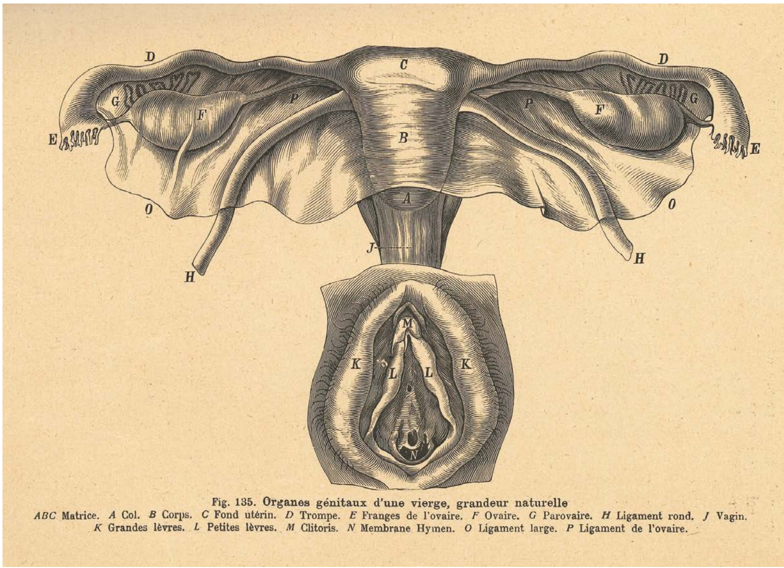

Figure 9.2a Anna Fischer-Duckelmann, *La Femme, médecin du foyer.* 1905 (French edition), 1st Edition Paris: 257 showing 'Genitalia of a virgin'. Image credit: courtesy of the Bibliothèque de L'Institut des humanités en médecine, CHUV-UNIL, Lausanne. HMA 11068 87.

Translation

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Chapter VII: Sexual life

'The only secret of prolonging life is to not shorten it' - by Feuchtersleben

A book of therapeutics and hygiene would be incomplete if it did not provide information on all questions concerning the sexual life. We tried our best in the previous chapters to leave aside, where possible, as much as we could about procreation by only saying what was indispensable and in as discreet a way as possible. Unfortunately, in a time in which sexual activity is unhealthy, it would be quite contrary to the general interest that we refrain from dealing with the subject altogether.

More and more erroneous theories about the most natural of questions are being asserted, at the same time as the physical endurance of the female sex is diminishing. Yet, it is her strength, her purity of manners, and her health that, to a large extent, the future generation and the happiness of the family depend upon. As we shall see, there are sufficient reasons for us to decide to overcome our scruples, to reveal the lamentable conditions that exist in our time and also to try energetically to achieve an improvement. That is what we will do, thanks to the information given here about the rational care necessary for health.

It is with what we have just said in mind that we invite you to read the following pages. This subject is so important that it also requires the participation of those who read our book. For, as perfect as the writer can hypothetically be, she cannot fulfil her duty totally, if the reader does not help her by giving her serious moral assistance. There are so many questions, above all, for example, the regularization of family life and the education of the youth that depend on the woman, that one could affirm that it is she who holds the future in her hands, and yet she does not appreciate her power! May these lines inform our readers of their responsibility!

In order to be able to follow the results of our deductions, we urge our readers to review the chapter on 'The genitals' (see Chapter I), as well as the information on the pelvis about the 'skeleton' and to be well acquainted with the attached drawings. If it is not clear what the general care required for health is, one will not be able to make an accurate account of the sexual life either. It is for this reason, and in order to avoid repetition that we refer to the previous chapters, where we have indicated the fundamental principles.

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Purpose of the genitals

All living beings with genitals are intended for the propagation of the species. In higher animals this task is divided between two individuals. Nature has endowed each of them with different devices, which complement one another. It is only through their meeting that they reach their goal: reproduction. The interest in looking at the various stages of development involving the absence of sex, is purely a scientific one. Let us simply say that there are inferior beings who multiply by budding or by a division of their own body. In them the propagation of the species is consequently carried out without specialized genitalia. The fact that two individuals contribute to reproduction also coincides with the peak of development in animals, and at the top of this scale is man. This differentiation between two individuals has determined the sexual character precisely: we see the establishment in individuals of special qualities perfectly defined and related to the task they have to perform, for example, on the one hand, the foresight necessary for feeding the offspring and the other […]

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[…] the strength and courage of the one who will have to defend it. The differentiation of the reproductive functions took place in such a way that one of the parties was instructed to bring to maturity the elements which will have to contribute to the formation of the new individual, while the other was attributed with the care of ensuring in her own body the development of the future individual and, by nourishing it with her own blood, giving it her own life to bring it into being.

The first stage gave the masculine type; the second is the female type.

The result is that the male individual is the one who fertilizes and gives the principle of life, and the female individual is the one who nourishes and begets.

Just as we see the animal dominated by the need to satisfy its hunger and to propagate its species, so also the woman, among peoples not yet civilized, has the absolute objective of fulfilling the duties of her sex, and is then properly considered only as a being destined purely for progeny.

As soon as she reaches puberty, she is free, and as long as she can, she will be mother, nurse, and educator of her children.

Then, when old age reaches her, the woman has no reason to exist, since the main function of her life has come to an end. She becomes, in fact, useless, because at that moment, she is akin to individuals without sex and she can no longer be used for reproduction.

But her influence and social position are very different when she participates in the civilization of her time. In addition to her physical duties, she must have for many years a psychic and intellectual life, and this side of her life tends to develop more and more. The more it dominates the woman, the more she moves away from being the purely sexual type.

On the other hand, she is more closely connected with the animal when she devotes little to the culture of the spirit.

To ensure the proper functioning of the physical and psychological health of man, it is necessary that the natural genital needs be satisfied to a certain extent, when their activity is normal. When this is not the case, degenerate types result, as can be seen by observation. We must therefore ensure the health of these organs that characterize sexuality, to prevent their etiolation.

Thanks to her more marked intellectual development, the woman raises the level of her genital functions. In this way, without losing the characteristic of her sex, she enriches her spirit and ennobles herself. All those who want to rise, to progress, are obliged to seek, to hesitate, to be in constant struggle with themselves, because it often happens that the customs of the age and the voice of the nature are not in agreement.

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What are the reproductive organs in women? We have already mentioned it in the first chapter: a hollow muscle, the matrix (uterus in Latin), the germinal or ovarian glands, the tubes of derivation or tubes, the vagina, enabling copulation, and the external genital organs. [Figure 9.2a] represents the sexual apparatus of a virgin, with some external and internal parts. The ovary gives birth to ovules, small germinative cells which, when impregnated by the fertilizing liquor of man, develop, grow and produce a new individual in the mother's womb. These are the organs that characterize the female type. Their healthy state is necessary in a normal woman.

The uterus is none other than the receptacle of the product of conception. In fact, it has only one role: to receive the ovum and the sperm, and to preserve the developing fruit until it is mature enough to be expelled. The fallopian tubes are 'afferent' organs, leading the egg from the ovary to the womb. The vagina is the channel where it emerges, it's role consists in evacuating the uterine secretions, as well as the completed foetus. During copulation, it serves to receive the penis and allow it to penetrate sperm into the matrix.

The external genitals include the external orifice of the urethra, as well as that of the vagina, various glands, and the apparatus intended to provide voluptuous sensations, situated on each side of the openings mentioned. It is highly vascularized and becomes turgid during genital excitation: it contributes to the firmness of the external parts. In women with sexual insensitivity [...]

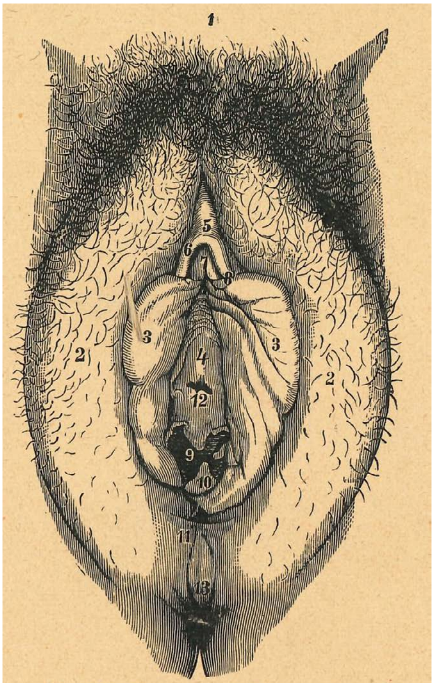

Fig. 136. **Organes génitaux externes de la femme**
1 Vulve. 2 Grande lèvre. 3 Petite lèvre. 4 Vestibule. 5 Clitoris. 6 Prépuce du clitoris. 7 Gland du clitoris. 8 Racines du clitoris. 9 Orifice du vagin. 10 Caroucules de l'hymen rompu. 11 Frein de la grande lèvre. 12 Orifice de l'urèthre. 13 Périnée avec l'anus en dessous.

Figure 9.2b Anna Fischer-Duckelmann, *La Femme, médecin du foyer.* 1905 (French edition), 1st Edition Paris: 259 showing 'External genitalia of the woman.' Image credit: courtesy of the Bibliothèque de L'Institut des humanités en médecine, CHUV-UNIL, Lausanne. HMA 11068 87.

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[…] and never feeling any sexual ardour, it never inflates itself. Their apparatus of copulation is in conditions unfavourable with conception.

It must be remembered that nature has created no organ without purpose. When one of them does not work, it is because there are pathological changes such as disorders or the stop of the afferent nerve conduction or a lack of completion of the parts in question.

Above the urethral opening is a small protruding body, the clitoris. It can reach an abnormal size and sometimes have the length of a man's penis. It is one of the organs likely to arouse sexual desire, and it is connected with an important nervous plexus. Exciting the clitoris through pressure or touching it can cause uterine contractions. [Figure 9.2b] shows the external genitals of a woman who has had intercourse. We know from the chapter on the anatomy of the organs of generation (see page 47) that both sexes have the same basic origin, which explains why we meet the same elements in both. If the woman wants to make an accurate account of what she is and is well prepared for motherhood, she must know the opposite sex and have some understanding of his physiological manifestations. It is for these reasons that we will give a short description of the genital organs of a man – a study of which is essential for understanding the process of reproduction.

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On Condoms

Some serve the man, but most are employed by the woman. Assuming that the penetration of sperm into the matrix must be prevented, a variety of means have been employed. Lots of men often use a rubber wrap or fish bladder, but apart from the fact that this is easily torn, it is repugnant to many people. It is found everywhere […]

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[…] under the name of 'condom'. Thanks to this process, the woman can dispense with all other unpleasant measures; but this membrane prevents intimate contact and thus decreases direct communication at the time of coitus, which can cause disorders in sensitive persons. Often, in line with their use, we have observed excitation phenomena in sickly and nervous men. Condoms are likely to protect men and women from contagious diseases, since they oppose immediate contact with the mucous membranes. Unfortunately, though, they certainly have a depressive effect and blunt the sensation. Intrauterine injection in humans, involving substances capable of killing sperm, has also been advocated, but this method has not been very successful. Men, in general, are unwilling to impose uncomfortable methods, it cannot be denied, though, that his urethra is much more sensitive than the vagina. As a result, the responsibility of undergoing all these experiences is put on the woman.

We will leave aside the enumeration of various disgusting condoms that oppose the flow of sperm. We will confine ourselves to describing those who to a certain extent seem justified, either from the point of view of health or morality and apply only to the body of women. While it is easy for some of them to obviate fertilization, in others it is more difficult.

The conception works all the better for the fact that the matrix is further down, the orifice of the cervix is more accessible and that the collar itself is very short. However, the more the uterus is elevated or laterally deviated, the longer and tighter the cervical portion is, the more difficult it is to become pregnant. It is also in these cases that preventive means are used with the most success. It is therefore important for every woman to undergo a medical examination that provides information on the anatomical conformation of her internal genitalia before choosing a particular condom. Thus the 'pessaries', the small rubber cups, are hardly applicable when the collar is undeveloped. On the other hand, when the cervix is long, anti-conception substances thrown at the bottom of the vagina are of little use, because they have a chance of straying into the vaginal dead-ends, etc.

The various means only offer problematic results whenever the matrix has a normal position, or if it is, so to speak, devoid of its neck, as a result of repeated deliveries. In these conditions any condom, instead of being maintained […]

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[…] securely, is mobile and moves, which results in the sperm easily entering the uterus. These phenomena can be observed in women who, after a month of abstinence, have sexual intercourse, after which they become regularly pregnant. In general, these people are small, sickly, and extremely fertile. They are very much to be pitied because it is not long before they are completely exhausted as a result of 4 or 5 successive deliveries. Often very anxious about what is happening to them, they ask for help, while the desolate husband does not know what to advise them. It is these women who must be mainly informed on appropriate use of condoms, in order to prevent the household from eventually separating.

Let us look at the simplest means of protection, within the reach of each individual and not coming at a great expense: it is a cotton ball dipped in vinegar water and placed as high as possible in the vagina. It must be carefully observed that it does not curl up, but on the contrary, it should be spread out as completely as possible, in front of the opening of the cervix. In addition, it must be well soaked with liquid. If these conditions are not carried out, then this will result in discomfort.

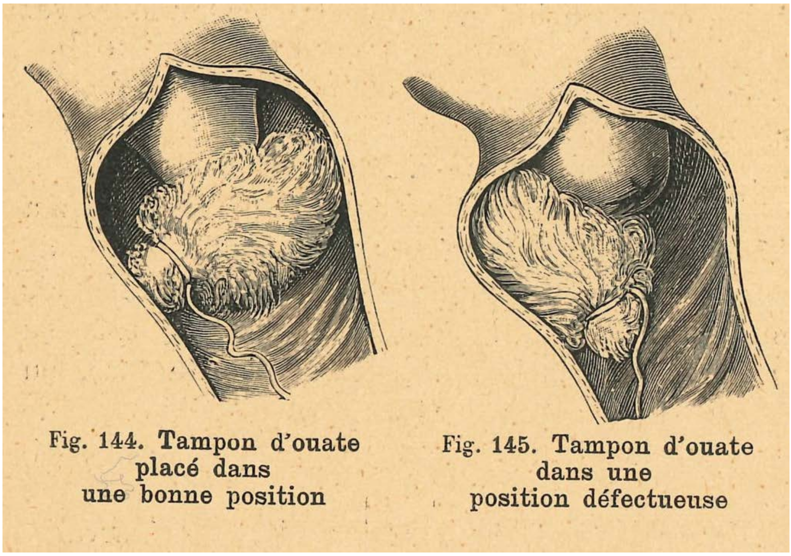

Figure 9.2c Anna Fischer-Duckelmann, *La Femme, médecin du foyer*. 1905 (French edition), 1st Edition Paris: 296 showing 'Cotton pad placed in a good position' and 'Cotton pad in a defective position'. Image credit: courtesy of the Bibliothèque de L'Institut des humanités en médecine, CHUV-UNIL, Lausanne. HMA 11068 87.

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In order to understand the internal disposition, we place before our eyes two images clearly indicating the opening of the cervix with its vaginal dead-end, and where we can clearly see the cotton wool pad in both the correct position and in the incorrect position. In [Figure 9.2c], if the sperm empties into the left dead-end, as the entrance to the uterine cavity is free, fertilization will easily occur. What is needed, then, is to obtain some sort of buffer, as shown in [Figure 9.2c], which happens very quickly after a few repeated attempts. As for the vinegar water, this has the result of killing the spermatozoa thanks to its acidity. This circumstance therefore promotes the use of the quilted tampon.

It is understood that the prevention is all the more effective as it allows more of its liquid content to flow into the internal parts while it stays there. We must add, in fact, that when spermatozoa are deprived of their spontaneous vibratory movements, they can no longer produce any fertilization, even though the sperm penetrates the uterine cavity. It is good to note all this.

The application of the cotton ball has, however, some disadvantages, which are as follows: it moves about easily and it causes some discomfort, since it acts as a foreign body placed in the internal parts. It can also cause the sexual exchange to wane somewhat. Finally, sometimes it occurs that it is quite difficult to put it in place, for example, when the woman has very short arms, a big belly, or that the vagina is narrow and the matrix high.

The same can be said of ‘sponges’, mainly in terms of the disadvantages.

The small sponges of Lister, once soaked, are pushed into the vagina as high as possible. The small silk ribbon attached to it should be allowed to hang outside so that it can easily be removed at any time.

Liquids kill germs in a more effective way than melting powders or fats, because they penetrate more easily into all areas. On this basis, it has been suggested that a soft substance giving off a liquid capable of annihilating the spermatozoa be introduced into the vagina, which would give absolute certainty of non-conception.

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Dr Cave’s ‘condom ring’ responds well to this issue. It contains a fluid that slowly transudes without causing any discomfort and evenly lubricates the uterine orifice on all sides, so that the effect of the semen is permanently annihilated.

The tube forming the ring contains boric acid, which must be renewed after a few weeks. This substance liquefies under the influence of moisture and heat. The instrument also offers a big advantage: it leaves the cervix and the vagina free and brings no obstacle between the intimate contact of the two sexes. It must, however, surround this section of the organs, which is perfectly possible, provided that this can be achieved with the cervix and that the introduction of the pessary is performed in a satisfactory manner.

To do this, at the time of adaptation, the tube must not be pressed too strongly resulting in a discharge of too much of the liquid that it contains. Another advantage of this ring is that once in place, it does not require any other manipulation, and therefore it does not interrupt the charm of sexual intercourse, whereas this inconvenience does exist when injections or other methods are used.

The effect of Dr Martini’s ‘ballotos’ is analogous to that of the ring we have just studied. After filling them with vinegar water, gently introduce them as high as possible into the vagina and remove them with a small ribbon. This process is harmless and is applicable to all conformations;

these instruments are easy to place and spread their contents on all the parts that they are in contact with. Their only disadvantage is that they must be put in place immediately before coitus, and women endowed with some delicacy are reluctant to these preparations.

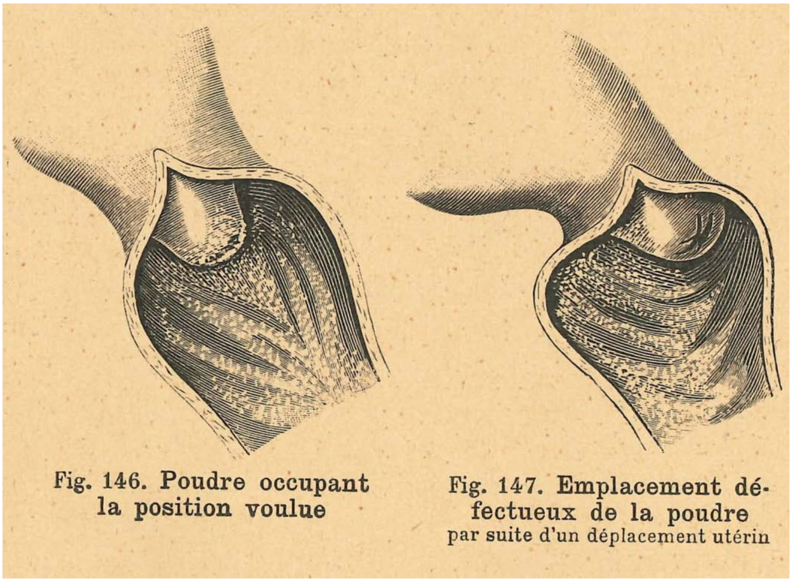

Figure 9.2d Anna Fischer-Duckelmann, *La Femme, médecin du foyer.* 1905 (French edition), 1st Edition Paris: 296 showing 'Powder occupying the desired position' and 'Poor location of the powder.' Image credit: courtesy of the Bibliothèque de L'Institut des humanités en médecine, CHUV-UNIL, Lausanne. HMA 11068 87.

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The advantages and disadvantages of the Atocos vaginal insufflator (Dr Justus' model) and the mode of application can be seen from [Figure 9.2d]. It is necessary to introduce it before coitus and, with the aid of applying pressure; a powder containing Arabic gum is injected into it. It is very adhesive and dissolved little by little and it has the property of killing spermatozoa. The shape of this device, which is generally known as the 'anticonceptor', has been improved. To reach its goal it must fulfil certain conditions: first it is necessary that the powder can really reach the cervix. We see in [Figure 9.2d] that the left and posterior dead-ends are covered with powder, and this, since it is soluble, must extend even further. In spite of this, the orifice of the neck can escape its effect.

Moreover, it is very unfortunate that one is not informed in this application by a special sensation, allowing for some certainty that it arrived safely on the cervical part. When, for example, it is deflected, as in [Figure 9.2d]; a very frequent case, its orifice is not reached by the powder 'spermicide', although it has penetrated well into the vagina, but instead flows liquefied towards the lower parts. Fertilization, in this case, will occur if the spermatozoa have a strong vitality, and if the woman is highly fertile. It is necessary to use a good injection of hot water, which will help ensure cleanliness and give more security. The use of this insufflator can be regarded as a safe means of condom in the particular case where the vaginal walls are very contiguous, the internal parts small, and especially if one practices sex while the powder is in full period of activity. We would say just the same about Dr Kamp's 'safety ova', cocoa butter vaginal suppositories and drug additives. To be effective, they must first liquefy. They should be placed as close as possible to the neck opening, otherwise their usefulness is only very hypothetical. In addition, it is worth noting that the fat principle of these suppositories decreases the effectiveness of the substance intended to kill sperm […]

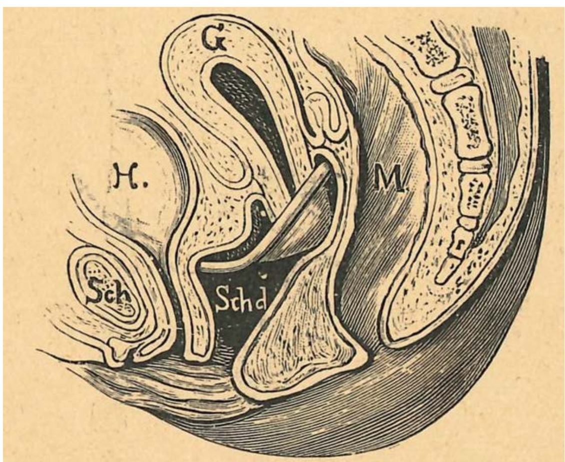

Fig. 152. Position normale du pessaire de Matrisalus

G Utérus. *H* Vessie. *M* Rectum. *Schd* Vagin. *Sch* Pubis.

Figure 9.2e Anna Fischer-Duckelmann, *La Femme, médecin du foyer.* 1905 (French edition), 1st Edition Paris: 300 showing 'Normal position of the Matrisalus pessary.' Image credit: courtesy of the Bibliothèque de L'Institut des humanités en médecine, CHUV-UNIL, Lausanne. HMA 11068 87.

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[…] and does not spread easily in all directions. Liquid substances are therefore preferred.

Concerning condom caps, also called occlusive pessaries, those of Drs Mensinga, Matrisalus, Potulsky, amongst others are the most common. Several doctors have described them. We have shown above a spring pessary, with the front part curved and another of rubber ribbons. The first offers the advantage of being better on the pubis and less likely to move. The second is devoid of spring and more easily mobilized. They are made using lightweight rubber, and if applied properly, they achieve the best mode of protection. But all too often they are badly placed, and on the other hand, one may wonder whether it is not bad for a woman to carry such a large foreign body.

Indeed, if one wants constant protection, one must withdraw it only during the menstruation. It therefore has the consequence of gathering together all the uterine secretions, either normal or pathological. Then during coitus, it raises a troublesome barrier between the organs of both sexes, modifying the sensations, and obstructing the delicate natural phenomena. Few women know how to properly introduce the pessary. The correct position depends on the conformation and the situation of the cervix. If one wants to be certain of having a result, it is a difficult procedure and therefore, each month, they are obliged to go to the doctor. This circumstance prevents preference being given to the pessary and its use can be generalized. Its exact position is shown in [Figure 9.2e]. The cervix and its orifice are placed behind the cup, and the spermatozoa cannot penetrate as long as the edge holds well. As part of our toilet care, we must regularly take hot water injections.

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However, they cannot clean the inner surface of the pessary directly applied to the cervix. According to Dr Mensinga, these instruments have brought happiness and health to many spouses by protecting the woman.

By using them one feels neither discomfort nor an attenuation of sexual sensation. Certainly, we can admit that these affirmations are just, with this restriction, that in all the cases mentioned, it was very probably nervous women, caused more or less to suffer, because they indulged in unfinished coitus. As this one, practiced for years, could not give them any satisfaction, they obviously, thanks to the pessary, had infinitely more normal and enjoyable sexual intercourse. On the other hand, a healthy person, accustomed to normal full copulation, will formulate a different opinion and her opinion has more scope.

If we are dealing with serious cases, where the life and health of the woman are at stake, where childbirth is to be feared and where it is necessary to ensure absolute security, then we can prescribe, without hesitation, the use of an occlusive pessary, without focusing on the inconveniences it entails, but always under medical direction. This is the choice too if the woman, in order to preserve the happiness of her household, consents to have sex, while complete abstinence should have been ordered. To prevent the neck from being irritated by the secretions accumulated behind the pessary, it must be removed every fortnight to clean it thoroughly. For this purpose, one must ask the family doctor. Only they are able to introduce this instrument so that it occupies the necessary position, and also without hurting the internal parts. If the woman indulges herself in incomplete and inexperienced manoeuvres, she may not only fail to achieve her goal of preserving conception, but also create disease. As for those who are not placed in circumstances such that they must sacrifice their person rather than risk the loss of their greater good, the happiness of their household, they need not employ the pessary. They can try other methods, such as the condom ring: they can thus have normal sexual relationships, while retaining the rights of their sex. [...] shows us how the pessary is introduced, pointing the curved part forward and up. In [...] we have shown another combination, which is Dr Hintz's tubular syringe. It consists of three parts: [...]

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A small pear pierced with holes, a pipe and a big pear. We introduce the first, which is perforated, into the vagina, as high as possible, and handling the second, we inject a liquid that kills the sperm during coitus. When the hand no longer presses the big pear, it sucks the mixture of sperm and liquid. It is thus a very advantageous double combination, in order to avoid all risks. It is good, before intercourse, to inject a small quantity of liquid to impregnate the parts using a standard syringe. The following question has been raised: who is to put pressure on the pear at the right time? According to Dr Hintz this role is given to the man, because, he claims, he is likely to do it more easily, thanks to the general contraction of muscles that occurs at the moment of ejaculation.

For our part, we will add that we cannot entrust this manoeuvre to all men: only those who keep their presence of mind awake at all times are, in fact, able to execute it punctually, most will forget to proceed in time to apply the pressure. It seems to us in these cases that the woman would offer more security. One thing is certain, that the concern for this manoeuvre is certainly unpleasant for both. The fact that it takes various preparations, dissolving the powder in hot water, filling the pear, introducing the pipe, etc. We must look for other methods that provide such a preparatory technique, while ensuring a sufficient guarantee. Nevertheless, one must consider the tubular syringe as one of the most satisfactory discoveries. It is quite harmless, does not interpose any point of foreign body between the sexes and provides great security, provided that the manipulation is carried out properly.

Unfortunately, experience has shown that this instrument easily refuses its service if it is put in the hands of unintelligent and narrow-minded husbands. It happens, in fact, sometimes, that it is too hard, or too soft, which prevents a satisfactory aspiration, or else it is badly placed, and the contents of the pear reaches the cervix too late.

Inevitably, a condom fails because of the complexity of its application. Unfortunately, in this […]

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[…] case, the most perfect way cannot be simple because there are too many factors to consider.

We therefore recommend the tubular syringe but recognize that it is far from perfect. Pure water already kills the spermatozoa, this result will be even better obtained if we add a little vinegar: it can therefore be used, in place of powder, provided that the liquid is never cold.

As for the vaginal injections performed immediately after coitus, we will simply point out that they are extremely inconvenient. As they should be done only with hot water, they are made difficult and we prefer not to resort to it at night.

But, on the other hand, by delaying the injection for too long, the spermatozoa are allowed time to penetrate the matrix, and the whole process is useless. We have seen women obtain excellent results with vaginal injections, for two consecutive years, then become pregnant, in the course of the third, because of the reasons that we have just explained. This is not surprising! Similar failures could be reported, either for the occlusive pessary or for the syringe. We have already given the explanation of these various phenomena.

There is and will never exist a preventive means offering an absolute guarantee and failing under no circumstances. Only strict abstinence is able to provide complete security. The administration of an injection is not rational, while the internal organs are very congested, and it can produce unpleasant sensations in sensitive women. As for the injections of cold water, they can make one perfectly ill and we cannot be careful enough.

All that remains is to point out what we call the ‘third week’ process; it satisfies the most unfavourable conditions of conception, partly because coitus practiced at that time no longer meets the ovum of the previous menstruation already dissolved long ago, and partly because that of the menstruation to come, has not yet begun its migration: we know that sperm can only have an effect if it is in contact with the mature feminine egg. It is for these reasons that it was advised to engage in sexual intercourse only during this third week. It is certain that this is good advice, but there is also an important caveat: that no fixed rule can be established in nervous subjects, whose physiological processes are irregular. We are therefore at home in the material impossibility of […]

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[…] mathematically calculating the time when the egg is expelled. Under these conditions, intermittent abstinence will be of no use, since the female egg staggering irregularly can also meet in the course of the third week. Ultimately, this circumstance, to a certain extent, can be relied upon only by healthy women with a perfectly balanced nervous system. These, provided that they also use hot injections, will succeed in being safe from pregnancy for a long time.

It is understood that sexual excitement reaches its climax in the female sex, and it is also at this moment that conception is the most feasible. There is no doubt that the ancient Jews paid full attention to this phenomena, and that they put to use this favourable time, in order to increase their family. Currently, we practice the opposite! At this time, complete abstinence is observed, and sexual intercourse occurs only when one knows that one has the least chances of increasing one’s family. If one wishes to restrict procreation, it is certainly this method that one should consider, as the most normal, the least harmful, the simplest, and at the same time, as the most moral. We would recommend trying it in cases where total safety is not required. The most convenient way to carry out hot injections is to do them in bed: for this, beforehand, one fills, a small pear with hot water and then screws a vaginal cannula on it. We put lots of things in the bed, to keep it warm. When administering this injection under the sheets, a small pelvis (dressing basin) is placed below. By doing so we are safe from colds, and more or less unpleasant circumstances. It must be emphasized that all women abhor these injections.

Analysis

When we speak of the feminization of medicine, perhaps most commonly, this is with reference to the sexual revolution of the 1960–70s.[60] However, the sexual revolution has a longer history. The above source is dedicated to the sex lives of women. The proposed aim of the text was to fight against unhealthy sexuality, with women perceived as the guardians of future generations. Female health and 'purity of manners' were presented as equally important for global salvation, which fits into the hygienist context of the period.[61] However, Anna Fischer-Dückelmann's work was revolutionary for its time and offers insights into the ways in which women viewed their own bodies through medicine.

With her introduction to a sensitive chapter on how to avoid pregnancies, Fischer-Dückelmann justified her writing on the topic by defending women's right to a healthy life with a limitation of births and adequate care before, during, and after their chosen pregnancies. However, in a copy of the text published in 1923 the chapter was edited, asking instead 'Why would women want to avoid pregnancies?'. These later editions demonstrate the ways in which this text defied social norms of the time in its discussion of female sexuality and women's control over it. Other sections of the text and illustrations also shocked a number of readers and were removed from later editions of the book.[62] For example, on page 257 the clitoris was drawn with unprecedented precision and directly referred to within the accompanying textual passages.

Meanwhile, Fischer-Dückelmann's discussion of mental health and intellectual stimulation alongside the more practical information on contraceptive methods further suggests the emancipatory aims of the text; 'in addition to her physical duties, she must have for many years a psychic and intellectual life' which will raise 'the level of her genital functions'. Medicine, as practised by Fischer-Dückelmann, challenged the code of silence on female sexuality in nineteenth-century Europe.

To promote her educational aims, Fischer-Dückelmann sought to collaborate with her readers. The book can be seen as an intermediary between the expert and the layman, with medical practice taking place outside of orthodox medical spaces such as private clinics or hospitals. The text encourages the reader to undertake, and understand, medical tasks such as the placement of contraceptives in their own body. Self-care practices are also discussed with the intent of educating women in ways of staying healthy without going to the doctor. The process of reading, performing and thinking about the text drew the reader into the practice of medicine, integrating them in their own medical care outside of the professional and academic spheres. Given the success of this book, which was republished over a 50-year period, we might imagine its potentially significant impact on European women and their understanding of medicine and their own bodies.[63] The popularity of the text also highlights that the publication of health manuals embodied a way to survive professionally and that some female doctors, like Fischer-Dückelmann, were able to create an integrative and political way to practise medicine.

Questions

1. What does this health book reveal about alternative medicine practices in nineteenth-century Europe?
2. How does this source problematise traditional narratives within western medical history that tell a story punctuated by great inventions and great inventors, often white men, negating the previous existence of a certain practice by another group of people?
3. Consider the role of censorship in relation to this source. How and why did later editions change? You may wish to refer back to the source on Sarah Emily Davies and consider the relationship between pornography and anatomy.
4. How did medicine, as practised by Fischer-Dückelmann, challenge the code of silence on female sexuality in nineteenth-century Europe?
5. How does this health book promote concepts of 'civilisation' and white supremacy? How does this work relate to the history of eugenics?

Further reading

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Ortiz-Gómez, Teresa et al. 'Part II: Perspectives on gender and health/Perspectivas en género y salud'. In *Dynamics of Health and Welfare: Texts and contexts*, edited by L. Abreu, P. Bourdelais, T. Ortiz-Gómez, and G. Palacios, 101–173. Lisbon: Colibrí, 2007.

Part IX notes

1 As illustrated by the sources reproduced in Hamilton and Schroeder, *Nineteenth-century British women's education, 1840–1900*.
2 Some women and people who transitioned gender managed to obtain medical qualifications earlier than this by exploiting loopholes in the system. James Barry, who lived and worked as a man from the age of 20, qualified in medicine in 1813; see Manion, *Female Husbands*. Elizabeth Garrett Anderson gained her licence to practise medicine in 1865 through a loophole in the regulations of the Worshipful Society of Apothecaries, which was promptly closed.
3 For a discussion of the intersection of concepts of genius and Victorian feminism see Alaya, 'Victorian Science and the "Genius" of Woman'.
4 See also Martin, 'Normalising whiteness'.
5 Toole, 'Byron, (Augusta) Ada [married name (Augusta) Ada King, countess of Lovelace] (1815–1852), mathematician and computer pioneer'.
6 Toole, 'Byron, (Augusta) Ada [married name (Augusta) Ada King, countess of Lovelace]'.
7 Swade, 'Babbage, Charles (1791–1871), mathematician and computer pioneer'.
8 Menabrea,'Sketch of the Analytical Engine Invented by Charles Babbage, Esq.'
9 Available at https://hdl.handle.net/2027/uc1.c0000127407?urlappend=%3Bseq=777 (accessed 15 December 2022).
10 Winter, 'A calculus of suffering', 203.
11 Hollings, et al., 'The early mathematical education of Ada Lovelace', 226.
12 Hollings et al., 'The early mathematical education of Ada Lovelace', 231.
13 Hollings et al., 'The early mathematical education of Ada Lovelace', 228.
14 Hollings, et al., 'The Lovelace–De Morgan mathematical correspondence', 204.
15 With reference to our comments in the introduction, 'Victorian' is a very specifically temporally and geographically located periodisation. It can also be used as a descriptor for people that lived through or objects that were constructed during the period in question. It refers solely to Britain and British individuals/objects during the period of Queen Victoria's reign (1837–1901). It is not often used when discussing subjects of and objects produced in the British Empire, despite the concurrent colonial elements of Queen Victoria's role. Winter, 'A calculus of suffering', 202.
16 Winter, 'A calculus of suffering', 203; 214.
17 Winter, 'A calculus of suffering', 212.
18 Hollings et al., 'The early mathematical education of Ada Lovelace' and 'The Lovelace–De Morgan mathematical correspondence'.
19 Haigh and Priestley, 'Innovators Assemble'.
20 Haigh and Priestley, 'Innovators Assemble'.
21 Jones and Hawkins, 'Women and science', 7.
22 Salih, 'Introduction', xvi.
23 Seacole, *Wonderful Adventures of Mrs. Seacole in Many Lands*, 9.
24 Seacole, *Wonderful Adventures of Mrs. Seacole in Many Lands,* 3.
25 Salih, 'Introduction' [endnote], 183.
26 Seacole, *Wonderful Adventures of Mrs. Seacole in Many Lands,* 8.
27 McDonald, *Mary Seacole*.
28 Robinson, 'Authority and the Public Display of Identity', 1994, 537.
29 Paquet, 'The Enigma of Arrival', 2017, 864.
30 Hawthorne, 'Self-Writing, Literary Traditions, and Post-Emancipation Identity', 2000, 319.
31 Hawthorne, 'Self-Writing, Literary Traditions, and Post-Emancipation Identity', 318.
32 Robinson, 'Authority and the Public Display of Identity', 1994, 538.
33 For example, see: Fryer, *Staying Power*, and Paquet, *Caribbean Autobiography.*
34 Gunning, 'Traveling with Her Mother's Tastes', 2001, 952.
35 Howell, 'Mrs Seacole Prescribes Hybridity', 2010, 119.
36 Robinson, *Mary Seacole*, 53.
37 Howell, 'Mrs Seacole Prescribes Hybridity', 2010, 115.
38 Murphy and Raftery, *Emily Davies*, xix.
39 Reproduced with the kind permission of the Mistress and Fellows, Girton College, Cambridge.
40 Students identified as Mary Kingsland, Jane Dove, and Isabella Gamble in Murphy and Raftery, *Emily Davies,* 407.

41 Schwartz, 'Feminist Thinking on Education in Victorian England', 2011, 674.
42 Lloyd, 'Rulers of Opinion'.
43 Chester, '"The Education of Women in London"', 109.
44 Norris, '"On the Proposed Examination of Girls of the Professional and Middle Classes"', 119.
45 Hamilton and Schroeder, *Nineteenth-century British women's education, 1840–1900*, 4–5.
46 Case, '"Against Oxford Degrees for Women"'.
47 Bates, '"Indecent and Demoralising Representations"', 2008, 11.
48 Heyam, 'Paratexts and Pornographic Potential in Seventeenth-Century Anatomy Books', 2019.
49 Heyam, 'Paratexts and Pornographic Potential in Seventeenth-Century Anatomy Books', 2019.
50 Bates, '"Indecent and Demoralising Representations"', 2008.
51 *Anonymous, 'Christmas "sights".*
52 Bashford, 'Dissecting the Feminine', 114–115; see also Jordanova, *Sexual Visions*.
53 Case, '"Against Oxford Degrees for Women"', 255.
54 We want to express our gratitude to Laura Martínez Silva and Yenisa Guizado for sharing with us the portrait of Dr Rodríguez Dulanto included in this essay. Furthermore, Jesús Martínez Laya and Alejandro Salinas, as former and current directors of Archivo Histórico Domingo Angulo (Universidad Nacional Mayor de San Marcos) generously granted the permission to reproduce Dr. Rodríguez Dulanto's Bachelor degree registration.
55 On Dr. Rodríguez Dulanto's biography see Díaz. "Primera médica peruana, Dra. Laura Esther Rodríguez Dulanto (1872-1919)", 2007; Valladares Chamorro. "La incursión de las mujeres a los estudios universitarios en el Perú, 1875–1908", 2012; Ramos Núñez. *Historia del derecho civil peruano*, 490 and note 15; Delgado Matallana and Rabí Chara. "La primera mujer médico", 121–122; and Tauro del Pino. *Enciclopedia Ilustrada del Perú*, 2281.
56 McGrew, 'The History of Women in Medicine', 1956, 23.
57 Denegri, *El abanico y la cigarrera*.
58 Denegri, *El abanico y la cigarrera*, 170.
59 Please note numbers in square brackets in this source denote page numbers.
60 Fauvel, Begert and Demirbas, 'Quand la Suisse était "féministe"', 2021.
61 At the end of the nineteenth century, widespread diseases in the cities were explained, among other things, by a moral aspect; their resolution was seen as possible only by correcting social behaviour and establishing good morals.
62 See Lucci, *Le livre d'or de la femme,* 259.
63 See Fischer, *La femme médecin du foyer*.

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Part X
Women in the scientific workforce (1890–1950)

Timeline: individuals, events and publications in the history of science	**Timeline: individuals, events and publications in this part**
1868–1921 Henrietta Swan Leavitt, American astronomer, who developed a method for determining the distance of stars.	
	c. 1894–99 The Pasteur method is used by women in rural Portugal to sort silkworm cocoons.
1903 Polish physicist and chemist Marie Skłodowska-Curie wins the Nobel prize for physics for work on the theory of radioactivity. The prize is shared with Pierre Curie and Henri Becquerel.	
1905 German-born theoretical physicist Albert Einstein completes his thesis and publishes ground-breaking papers on Brownian motion, special relativity and the equivalence of mass and energy.	

Timeline: individuals, events and publications in the history of science	Timeline: individuals, events and publications in this part
	c. 1915–31 *Funü zazhi (The Ladies' Journal)* is published in China, featuring scientific subjects including medicine, hygiene, parenting, agriculture, home economics and domestic crafts.
	1922 'Women Engineers in the Field of Radio Telegraphy' is published in *The Woman Engineer,* the quarterly journal of the British Women's Engineering Society, and explores opportunities for women in radio telegraphy and communications.
1921 Insulin is successfully extracted by four medical researchers at the University of Toronto, Frederick Banting, Charles Best, John Macleod and James Collip.	
1924 American astronomer Edwin Hubble discovers that the Milky Way is one of many galaxies.	
1927 Belgian astronomer George Lemaître formulates the modern Big Bang theory.	
1928 Scottish bacteriologist Alexander Fleming discovers penicillin.	
	1930s Electrical companies in America and Europe produce advertising materials featuring women demonstrators using electrical appliances to persuade potential customers of their safety and utility.

Timeline: individuals, events and publications in the history of science	Timeline: individuals, events and publications in this part
	1950s Archaeological excavations at the Vila Nova de São Pedro site, a chalcolithic (Copper Age) hillfort located near the town of Azambuja, north of Lisbon in Portugal.
1952 American virologist Jonas Salk develops a polio vaccine.	

Introduction

This part investigates women's roles in the day-to-day labour of science. Marie Skłodowska-Curie won the Nobel prize for physics in 1903, and by the mid-twentieth century co-education in science became more common. Yet opportunities for women in the scientific workforce – especially in highly respected fields that were dominated by male practitioners – were often restricted to a few exceptional women whose access did not grant or guarantee the same for others.[1] Histories of women in twentieth-century science often sideline the role of class in suppressing female attainment in science during this period.[2]

It is important to consider the effect of the First and Second World Wars on women's role in the workforce. During the First World War, more women in the United States and Europe undertook work in transportation, munitions factories and nursing, while women with higher qualifications found themselves filling roles previously occupied by men, such as museum curation. However, after the conflict ended, old prejudices returned, and women had to step down from their newly gained positions in favour of men returning from war.[3] The Second World War again required women to undertake a broader range of both skilled and unskilled roles in the workforce. However, the gains made by women in the workforce remained modest after the War and patriarchal attitudes stayed relatively fixed.[4]

Examining photographs and excerpts from women's magazines, this part takes a closer look at the kinds of labour that women performed within the scientific workforce. In particular, these sources offer historians insight into the role of working-class people in the production of scientific knowledge. A lack of sources in this area has often frustrated scholars.[5] The sources in this part demonstrate ways in which women cultivated and communicated specialist knowledge. Rather than focusing on great discoveries and publications, this part highlights how unrecognised women undertook the daily work of science in the field, the laboratory, the home and the commercial showroom.

The first source in this part pertains to Portuguese women who used scientific methods to sort silkworm cocoons, illustrating how knowledge production occurred in the workplace, even in the completion of repetitive tasks. The second source features three illustrations from the Chinese magazine *Funü zazhi (The Ladies' Journal)* that demonstrate how women's scientific knowledge – whether tacit or obtained through formal education – was deeply connected to publishers' political agendas and visions of the modern Chinese nation. The theme of modernity is also present in the fourth source in this part, an illustrated report from Barcelona which features women demonstrating electrical appliances for use in the home – another example of the kinds of specialised labour that is often understudied within the history of science. Meanwhile, the third source in this part is an article titled 'Women Engineers in Radio Telegraphy', a piece which highlights the strategies by which working-class women could seek to enter the scientific workforce. In doing so, it acknowledges the challenges faced by these women within a male-dominated field.

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Rural Portuguese women: Image of silkworm sorting using the Pasteur method (1890–1900)

Dr Isabel Zilhão[6]

Introduction

These two sources concern silkworm breeding by peasant women at an agricultural station located in the northeast of Portugal (Estação de Sericicultura de Mirandela) in the last decade of the nineteenth century. The first source depicts women sorting infected silkworm cocoons using the Pasteur method.[7] These women were hired and trained at the station and their job was the production of disease-free silkworms, which the station supplied to local women. This photograph is part of a set of eight portraying women workers in their routine work at the station. The photographs as well as other information about the agricultural station are deposited at the local archive, the Arquivo Distrital de Bragança. However, no written records about these women survive at either the local archive or the national archive in Lisbon.

The photographs do not come with captions, but we know that they must have been taken somewhere between 1894, when these women completed their training, and 1900, when three of these photographs were published in *Le Portugal au point de vue agricole*.[8] This book was commissioned by the Portuguese government for the 1900 World Fair and consists of a thorough assessment of the state and history of Portuguese agriculture. Silkworm breeding had been a very important business activity in Portugal, although it declined during the nineteenth century. The reasons for this decline were commercial competition, mostly from France, and diseases, mostly pebrine, for which Pasteur created a successful eradicating procedure.[9] The procedure identified and isolated uninfected silkworms and involved selective breeding of productive and healthy silkworms, with a focus on the cleanliness of silkworm colonies and breeding houses. As the activity survived in the northeast of Portugal, the government decided to reboot the sector there at the end of the nineteenth century with the creation of a dedicated station.

The second source is taken from the 1892 official report of the Portuguese Agriculture Directorate General, and was written by the director of the station, the agricultural engineer João Pimentel. It describes the first silkworm breeding experiments, which took place while the silkworm breeding station was still under construction.

Sources

Figure 10.1 Estação de Sericicultura de Mirandela, c. 1894–1899. Arquivo Distrital de Bragança, Bragança, Portugal. Image credit: DGLAB/ADBGC, PT/ADBGC/ACD/DRAPN (Fotografias – CX1).

Excerpt from João Inácio Teixeira de Menezes Pimentel's 'Tentativa de um plano de regeneração da sericicultura portuguesa'.[10]

Original

Fui procurá-lo [sirgo] a uma aldeia outrora muito produtora de casulo, o Navalho, do Concelho de Mirandela. Mulheres perfeitamente amestradas no tratamento do bicho-da-seda, muito cuidadosas e activas, porém com os mesmos defeitos que por todo o distrito se encontram na prática desta indústria. Eu e o preparador tivemos no princípio uma luta para as obrigar a cumprir as nossas descriminações. Depois, convictas, obedeciam cegamente. Era para elas um assombro e um crime pegar nos pequeninos vermes ao sair da eclosão e colocá-los na sirgaria, com portas abertas e com o frio que corria naquela época. A mortalidade foi enorme durante alguns dias. Eu próprio me cheguei a convencer de que morria todo o sirgo, assaltando-me então a ideia de que tudo quanto os livros diziam sobre as criações ao ar livre, não passava de pura mistificação. Perdoem-nos os sr. Pereira Coutinho e outros ilustres bacólogos, mas a temperatura não subia, a mortalidade aumentava e as sirgueiras rodeavam-nos com súplicas para lhes deixar colocar os vermes na cozinha junto à lareira. Se a mortalidade era tão extraordinária nos insectos primeiro nascidos, e que por isso maior garantia de robustez deveriam ter, o que não seria nos vindos depois! Eu via já o público, curioso com a notícia de que nos estávamos criando sirgo, a rir-se de mim e da ciência sericícola. As próprias sirgueiras passavam da real e verdadeira aflição ao riso reprimido e aos preparativos de enfardamento da sua trouxa, para irem contar à sua aldeia como o governo mandava criar sirgo, e quais os bons processos que empregava. Confesso que a experiência foi arrojada e imprudente, porque eu não conhecia a robustez das castas que ia criar. Um facto porém me alentou no meu papel de tirano. Bichos saídos de sementes da mesma procedência, incubados no mesmo dia e à mesma temperatura, nascidos na mesma ocasião, e agora em condições perfeitamente idênticas, uns morriam ao passo que outros iam sobrevivendo. Não tive que me arrepender do arrojo.

Translation

I sought after silkworm seeds at Navalho, in the municipality of Mirandela, a village known for producing high quantities of cocoons. Trained women were found there, carefully and active, but bearing the same weakness that can be found elsewhere in the county in the practice of this industry [silkworm breeding]. At the beginning, me and the technical assistant struggled to make them follow our instructions. But then, wholeheartedly, they blindly obeyed. It was both with a sense of amazement and a guilty feeling that they handled the little etching worms [larvae] and put them at the breeding house with doors wide opened and all the cold that went through at the time. For a couple of days, the mortality was enormous. I was myself convinced that the worms would die out, and all I had read about silkworm breeding in the open air was a mystification. Forgive me Mr. Pereira Coutinho as well as other illustrious silkworm breeders, but the temperature would not rise, mortality was scaling-up and the women were begging us to let them put the worms [larvae] in the kitchen by the fireplace. If mortality was so extraordinary in the first-borns, which for that reason should be more resistant, I could not help but wonder what would become of the next batch! I could already hear the curious public all too eager to learn more about our silkworm breeding experiments, laughing at me and at Silkworm science. The women workers would go from true and sincere affliction to repressed laughter and the preparation of the bundle with their belongings to go and tell their village how the government ordered the raising of cocoons and the good process it used. I must confess that the enterprise was bold and imprudent because I was not familiar with the robustness of the silkworm strains I was going to raise. But a fact gave me hope to carry on my tyrant role. Larvae etched from seed coming from the same source, etched in the same day and at the same temperature, born on the same occasion, and now under the same conditions, some would die but some would survive. I regret not my audacity any more.

Analysis

Rural women played an important role at the silkworm breeding station, learning to sort infected silkworms, as revealed in the second source. Yet, the two sources seem to portray two very different groups of women. Compare the poise and confidence of the women in the photograph handling the laboratory material to the way they are described in the text. There, women are portrayed as either passive and obedient receivers of instructions or as resorting to old and 'wrong' ways of silkworm breeding, in spite of all their training, at the slightest setback. Their knowledge of local strains, used by Pimentel to select the initial silkworm batch, as well as their contribution to the success of the silkworm breeding experiments is never highlighted or recognised; at best, it is ridiculed. In fact, their training is considered part of the experiment solely conducted by the agricultural engineer. Their initial resistance to learning is equated to the initial failure to hatch local silkworm strains, with both needing to be tamed by the male agricultural engineer to meet the demands of modern science. These women are never recognised as producers of knowledge in their own right, despite their role in the process of experimentation.

These women are part of an invisible world of technicians. This invisibility is all the more acute when one considers that these workers were women of low social standing from non-central European or North American countries. There are many traditional arguments for the exclusion of these women from the historical narrative: that they were not producers of normative science, that they were merely following instructions, or that they were only passive receivers of knowledge. However, these women learned a sophisticated technical routine and played an important part in both the development of the experiments and the production process. These two sources therefore speak about the significant others that are part and parcel of the production of knowledge. These sources call into question the very disciplinary assumption of both what and who the history of science should be about.

Questions

1. In these sources there are scant clues about the knowledge these women brought to the station. In what ways could we learn more about their contribution to the experiments undertaken at the station? What other types of sources could be consulted to try to learn more about these women?
2. How would you discuss and fit the activity of these women within the history of 'popular science'?
3. These are peasant women. How important is their social status for discussions about professionalisation and the social construction of science? How would you include these women in a narrative about laboratory technicians?
4. How might Portugal's economic difficulties during this period, with its reduced imperial holdings and reliance on British financial support, and growing republicanism and social unrest factor into our consideration of this source?
5. In what ways do mainstream narratives within the history of science about women and significant 'others' parallel the narrative of the agricultural engineer, João Pimentel, about the peasant women who participated in the cocoon experiments?
6. How would you weigh up the relevance of nationality, gender and social status in the construction of mainstream narratives within the history of science?

Further reading

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Funü zazhi, 婦女雜誌 *(The Ladies' Journal)*: Three illustrations from the magazine (c. 1915–1931)

Dr Hsiang-Fu Huang

Introduction

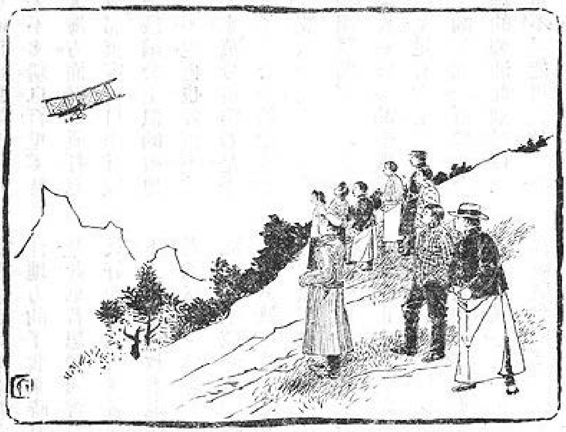
The first two decades of the twentieth century witnessed dramatic changes in China. The collapse of the Qing empire (China's last imperial dynasty) brought instability to the newly established republic. Various factions called for different degrees of political, social and cultural reforms in a time of upheaval. Some historians describe the growing publishing trade in China as the 'enlightenment business', because it played a significant role in the intellectual and cultural life of this era.[11] Newspapers and periodicals were especially powerful and fresh channels for the debate and spread of ideas. Among these were publications aimed at women as a new class of readers, as women's education had traditionally been repressed and neglected in Chinese society. *The Ladies' Journal* (*Funü zazhi*, 婦女雜誌) is a representative example of women's magazines in this period.[12]

Sources

Figure 10.2a The cover of *The Ladies' Journal* volume 1, issue 1. Image credit: © Courtesy of the Institute of Chinese Studies, Library, Heidelberg University.

Figure 10.2b The cover of *The Ladies' Journal* volume 1, issue 4. Image credit: © Courtesy of the Institute of Chinese Studies, Library, Heidelberg University.

中寫了兩個8字兔起鶻落其妙不可方物一時全場的人鼓掌如雷俱各讚歎不置毓芬越發把機昇的高下邊止望見一點黑影大約總有數千呎的高度了誰知天有不測風雲也是這女子飛行大家應該受些磨折並非著者故作波折這當兒天空的西北那邊驀地吹過陣烈風來其勢十分利害原來飛行家在空中遇著暴風止有將機上昇斷無下降之理毓芬此時自然竭力昇騰看看機上高度計的針



已指著六千呎部位風力尚是有增無減毓芬雖然並不慌張却也不免暗暗叫苦心想道此刻已有六千呎的高度了若再上昇上面空氣漸漸稀薄酸素不足又沒帶有酸素吸入器來呼吸難免困難若想下降看這風力下面氣流定然更是險惡降下必然難免危險的逆風而行機力又有所不逮爲今之計只有順風而行想定主意再不昇高只管向著東南方面駛去希冀跳出風力範圍那知越駛出外邊風

Figure 10.2c An illustration from the novelette 'Chinese female aviator'. Image credit: © Courtesy of the Institute of Chinese Studies, Library, Heidelberg University.

Analysis

The Ladies' Journal (*Funü zazhi*, 婦女雜誌) was a monthly magazine published by the Commercial Press (*Shangwu yinshuguan*, 商務印書館) in Shanghai between 1915 and 1931. It had nationwide circulation and its readers were predominantly female teachers and students.[13] Like many contemporary periodicals, the journal also underwent drastic changes in response to the ebb and flow of public opinion. The journal was originally inclined to a reformist conservative view in its early years. It supported the ideology of 'good wife, wise mother' (*Xianqi liangmu*, 賢妻良母) inspired by both the nationalist educators of Meiji Japan and the home economics movement spreading from the United States.[14] After 1920, however, the journal took a radical turn following the rising trend of anti-traditionalism, advocating women's suffrage, feminism and called for a total reform of women's education.

Science received extensive coverage in *The Ladies' Journal,* though the scientific topics discussed reflected the political agendas of the editorial board. In the early years, the journal paid particular attention to subjects related to useful household knowledge such as medicine, hygiene, parenting, agriculture, home economics and domestic crafts. These subjects suited the journal's goal of equipping readers with modern knowledge to improve domestic life. Later on, as the editorial style moved towards radical causes, the home economics coverage decreased and there were more articles on gender issues from the standpoint of physiology or social sciences. The objective of these articles was to prove that women were not scientifically inferior to men, and therefore deserved equal opportunities of education.

The richly popularised science coverage in *The Ladies' Journal* exemplifies a common purpose in pursuit of modernity in early twentieth-century China. The journal's different visions of women's education also reflect the social and cultural change in modern Chinese history, and make good comparisons with contemporary social movements in the Western world. The journal serves as, in the historian Joan Judge's words, a 'republican lens' to understand the changing attitudes towards gender and science in this period.[15]

The first source in this set of three is an elegant illustration, titled 'Reading leisurely at home' (蘭閨清課). It depicts a young Chinese lady reading the magazine. In this source, the journal conveys an idealistic image of its female readers – the prototype of an educated and enlightened Chinese woman.

The second illustration, titled 'Gardening of mulberries in the silkworm month' (蠶月條桑), depicts a woman preparing mulberry leaves for the cultivation of silkworms. The cultivation of silkworms was traditionally an important domestic craft in China to produce raw silk for the textile industry. *The Ladies' Journal* in its early years stressed that modern knowledge of scientific disciplines, such as agriculture and biology, could revive old crafts and was essential for households. This illustration also shows another image of an idealistic Chinese woman: an industrious lady that comfortably excelled in domestic production.

The third illustration relates to the novelette 'Chinese female aviator' by Xie Zhijun, which was published in *The Ladies' Journal* volume 4, issue 1, in January 1918. This novelette drew on the misadventure of a fictional female pilot, Yufen. In a flying accident, Yufen makes an emergency landing on a desert island. She bravely deals with the adversity and escapes from the island through her composure and scientific knowledge.

This novelette took inspiration from a real case. Aviation was a novel industry in the early twentieth century; several woman pioneers embarked on exhibition flying. In early 1917, American pilot Katharine Stinson (1891–1977) performed stunt flying in Shanghai, which was the first event of its kind in China.[16] Stinson's Shanghai airshow was a part of her Asian tour to Japan and China fundraising for the Red Cross. Her spectacular display attracted thousands of audiences and admirers in both countries, and apparently inspired the creation of this novelette. *The Ladies' Journal*, particularly in its early period, often used the 'science novelettes' genre as a vehicle for conveying scientific knowledge and technological innovations. This particular novelette conveyed the idea of gender equality, demonstrating that women were not inferior to men and could contribute to the grand cause of revitalising the nation.

Questions

1. Can you find other examples of women's magazines that communicated scientific knowledge to female readers in countries or cultures other than the Western world, like *The Ladies' Journal* in China?
2. *The Ladies' Journal*, like many contemporary periodicals in East Asia, often reflected the conflicts or reconciliations between traditional values and radical ideas. What vision of 'modernity' did it provide to the readers?
3. In the past, educational opportunities for women in China were often rare; very few women could receive a formal education. How did

women learn outside of schools? What kind(s) of knowledge did they learn?

4. What does *The Ladies' Journal*'s editorial progression show us about the relationship between science, social attitudes and politics?
5. Different ideas about women's roles in society developed in the early twentieth century, including Meiji Japan's ideal of 'good wife, wise mother', the American home economics movement, and the suffrage and feminist movements. What kind(s) of womanhood or motherhood did these ideologies envisage in a changing world of scientific and technological progress?

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‘Women Engineers in the Field of Radio Telegraphy’: Extract from *The Woman Engineer* (1922)

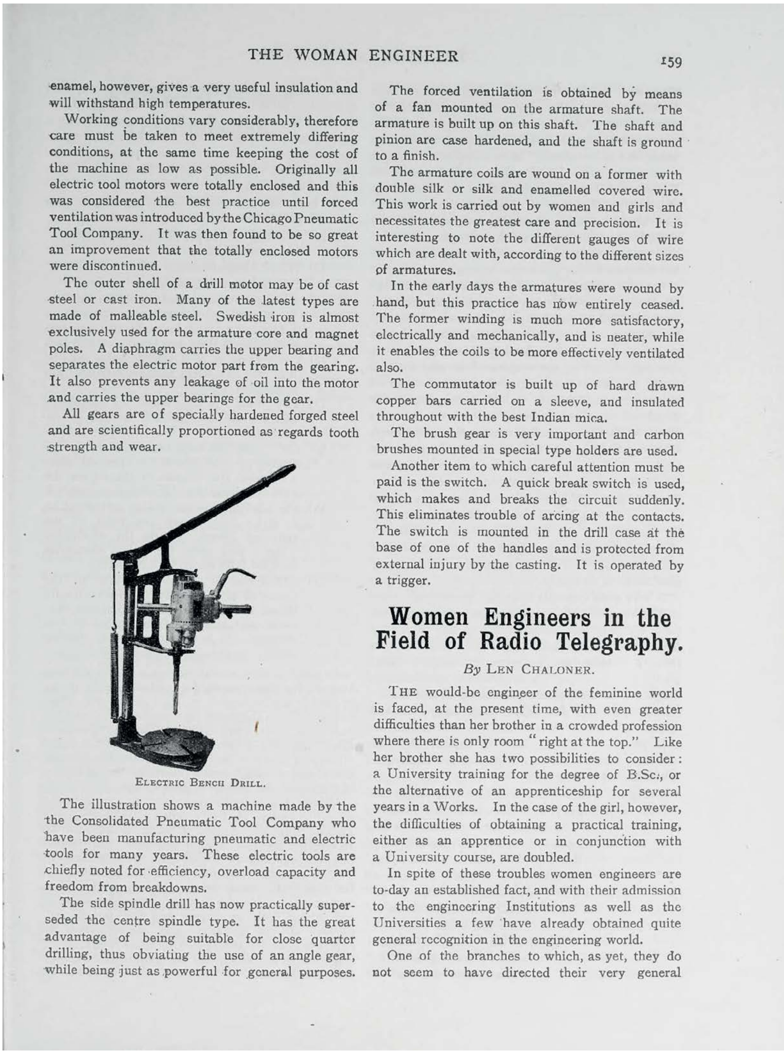
Dr Elizabeth Bruton, Professor Graeme Gooday and Anne Locker

Introduction

Written by Len (Lenore) Chaloner, ‘Women Engineers in the Field of Radio Telegraphy’ was published in the June 1922 issue of *The Woman Engineer*, the quarterly journal of the Women’s Engineering Society (WES). WES was founded in 1919 to inspire and support girls and women to achieve their potential as engineers, applied scientists and technical leaders, building upon the opportunities briefly opened up in the First World War. ‘Women Engineers in the Field of Radio Telegraphy’ provided inspirational career paths for women in radio communication while acknowledging the limitations for women in engineering at the time of writing in 1922.

Source

Chaloner, Len. 'Women Engineers in the Field of Radio Telegraphy', *The Woman Engineer* 1 (1922): 159–60.



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enamel, however, gives a very useful insulation and will withstand high temperatures.

Working conditions vary considerably, therefore care must be taken to meet extremely differing conditions, at the same time keeping the cost of the machine as low as possible. Originally all electric tool motors were totally enclosed and this was considered the best practice until forced ventilation was introduced by the Chicago Pneumatic Tool Company. It was then found to be so great an improvement that the totally enclosed motors were discontinued.

The outer shell of a drill motor may be of cast steel or cast iron. Many of the latest types are made of malleable steel. Swedish iron is almost exclusively used for the armature core and magnet poles. A diaphragm carries the upper bearing and separates the electric motor part from the gearing. It also prevents any leakage of oil into the motor and carries the upper bearings for the gear.

All gears are of specially hardened forged steel and are scientifically proportioned as regards tooth strength and wear.

ELECTRIC BENCH DRILL.

The illustration shows a machine made by the the Consolidated Pneumatic Tool Company who have been manufacturing pneumatic and electric tools for many years. These electric tools are chiefly noted for efficiency, overload capacity and freedom from breakdowns.

The side spindle drill has now practically superseded the centre spindle type. It has the great advantage of being suitable for close quarter drilling, thus obviating the use of an angle gear, while being just as powerful for general purposes.

The forced ventilation is obtained by means of a fan mounted on the armature shaft. The armature is built up on this shaft. The shaft and pinion are case hardened, and the shaft is ground to a finish.

The armature coils are wound on a former with double silk or silk and enamelled covered wire. This work is carried out by women and girls and necessitates the greatest care and precision. It is interesting to note the different gauges of wire which are dealt with, according to the different sizes of armatures.

In the early days the armatures were wound by hand, but this practice has now entirely ceased. The former winding is much more satisfactory, electrically and mechanically, and is neater, while it enables the coils to be more effectively ventilated also.

The commutator is built up of hard drawn copper bars carried on a sleeve, and insulated throughout with the best Indian mica.

The brush gear is very important and carbon brushes mounted in special type holders are used.

Another item to which careful attention must be paid is the switch. A quick break switch is used, which makes and breaks the circuit suddenly. This eliminates trouble of arcing at the contacts. The switch is mounted in the drill case at the base of one of the handles and is protected from external injury by the casting. It is operated by a trigger.

Women Engineers in the Field of Radio Telegraphy.

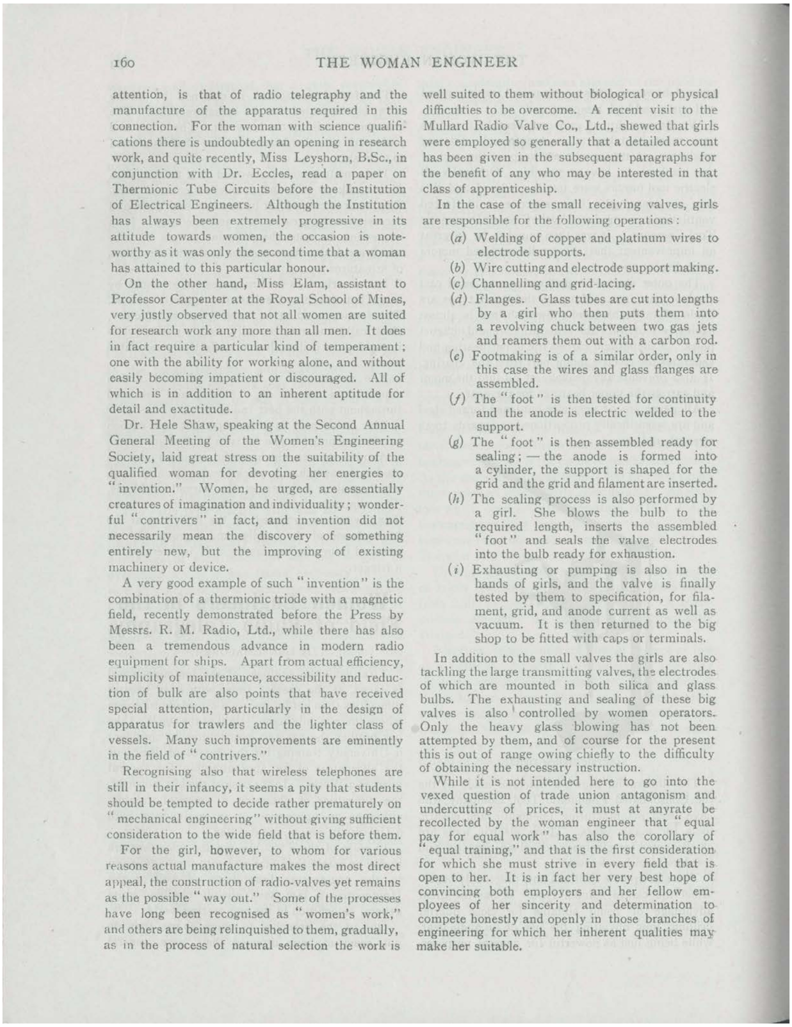
By LEN CHALONER.

THE would-be engineer of the feminine world is faced, at the present time, with even greater difficulties than her brother in a crowded profession where there is only room "right at the top." Like her brother she has two possibilities to consider: a University training for the degree of B.Sc., or the alternative of an apprenticeship for several years in a Works. In the case of the girl, however, the difficulties of obtaining a practical training, either as an apprentice or in conjunction with a University course, are doubled.

In spite of these troubles women engineers are to-day an established fact, and with their admission to the engineering Institutions as well as the Universities a few have already obtained quite general recognition in the engineering world.

One of the branches to which, as yet, they do not seem to have directed their very general

Figure 10.3a 'Women Engineers in the Field of Radio Telegraphy' by Len (Lenore) Chaloner published in the June 1922 issue of *The Woman Engineer*, Volume 1, 159. Image credit: IET Archives and WES.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attention, is that of radio telegraphy and the manufacture of the apparatus required in this connection. For the woman with science qualifications there is undoubtedly an opening in research work, and quite recently, Miss Leyshorn, B.Sc., in conjunction with Dr. Eccles, read a paper on Thermionic Tube Circuits before the Institution of Electrical Engineers. Although the Institution has always been extremely progressive in its attitude towards women, the occasion is noteworthy as it was only the second time that a woman has attained to this particular honour.

On the other hand, Miss Elam, assistant to Professor Carpenter at the Royal School of Mines, very justly observed that not all women are suited for research work any more than all men. It does in fact require a particular kind of temperament; one with the ability for working alone, and without easily becoming impatient or discouraged. All of which is in addition to an inherent aptitude for detail and exactitude.

Dr. Hele Shaw, speaking at the Second Annual General Meeting of the Women's Engineering Society, laid great stress on the suitability of the qualified woman for devoting her energies to "invention." Women, he urged, are essentially creatures of imagination and individuality; wonderful "contrivers" in fact, and invention did not necessarily mean the discovery of something entirely new, but the improving of existing machinery or device.

A very good example of such "invention" is the combination of a thermionic triode with a magnetic field, recently demonstrated before the Press by Messrs. R. M. Radio, Ltd., while there has also been a tremendous advance in modern radio equipment for ships. Apart from actual efficiency, simplicity of maintenance, accessibility and reduction of bulk are also points that have received special attention, particularly in the design of apparatus for trawlers and the lighter class of vessels. Many such improvements are eminently in the field of "contrivers."

Recognising also that wireless telephones are still in their infancy, it seems a pity that students should be tempted to decide rather prematurely on "mechanical engineering" without giving sufficient consideration to the wide field that is before them.

For the girl, however, to whom for various reasons actual manufacture makes the most direct appeal, the construction of radio-valves yet remains as the possible "way out." Some of the processes have long been recognised as "women's work," and others are being relinquished to them, gradually, as in the process of natural selection the work is well suited to them without biological or physical difficulties to be overcome. A recent visit to the Mullard Radio Valve Co., Ltd., shewed that girls were employed so generally that a detailed account has been given in the subsequent paragraphs for the benefit of any who may be interested in that class of apprenticeship.

In the case of the small receiving valves, girls are responsible for the following operations:

(*a*) Welding of copper and platinum wires to electrode supports.
(*b*) Wire cutting and electrode support making.
(*c*) Channelling and grid-lacing.
(*d*) Flanges. Glass tubes are cut into lengths by a girl who then puts them into a revolving chuck between two gas jets and reamers them out with a carbon rod.
(*e*) Footmaking is of a similar order, only in this case the wires and glass flanges are assembled.
(*f*) The "foot" is then tested for continuity and the anode is electric welded to the support.
(*g*) The "foot" is then assembled ready for sealing; — the anode is formed into a cylinder, the support is shaped for the grid and the grid and filament are inserted.
(*h*) The sealing process is also performed by a girl. She blows the bulb to the required length, inserts the assembled "foot" and seals the valve electrodes into the bulb ready for exhaustion.
(*i*) Exhausting or pumping is also in the hands of girls, and the valve is finally tested by them to specification, for filament, grid, and anode current as well as vacuum. It is then returned to the big shop to be fitted with caps or terminals.

In addition to the small valves the girls are also tackling the large transmitting valves, the electrodes of which are mounted in both silica and glass bulbs. The exhausting and sealing of these big valves is also controlled by women operators. Only the heavy glass blowing has not been attempted by them, and of course for the present this is out of range owing chiefly to the difficulty of obtaining the necessary instruction.

While it is not intended here to go into the vexed question of trade union antagonism and undercutting of prices, it must at anyrate be recollected by the woman engineer that "equal pay for equal work" has also the corollary of "equal training," and that is the first consideration for which she must strive in every field that is open to her. It is in fact her very best hope of convincing both employers and her fellow employees of her sincerity and determination to compete honestly and openly in those branches of engineering for which her inherent qualities may make her suitable.

Figure 10.3b 'Women Engineers in the Field of Radio Telegraphy' by Len (Lenore) Chaloner published in the June 1922 issue of *The Woman Engineer*, Volume 1, 160. Image credit: IET Archives and WES.

Analysis

Mrs Len (Lenore) Chaloner was a professional editor of magazines such as *Ideal Home, Decoration, Parents, Home and School* and *Woman's Magazine*. She was also a prolific author, who wrote books on topics as diverse as how to do fly fishing affordably, wine and motherhood and raising children. She was a member of the WES council and an occasional contributor to *The Woman Engineer* in the early 1920s.

The Woman Engineer offers a rare insight – often in their own words – into women's participation in engineering and technical professions since the First World War. It also serves as documentation and publication of their own experiences, history and potential in this male-dominated field.

Chaloner's article explores a few, albeit limited, opportunities for women in radio telegraphy, point-to-point radio communications mostly using Morse code, in the early 1920s. Before the First World War, radio communication in the UK was an almost exclusively masculine profession.[17] Women were not employed as wireless operators and the limited opportunities in the field for women almost entirely consisted of factory work manufacturing wireless sets and later, radio valves.

Chaloner provided a detailed account of work at the Mullard Radio Valve Company, which hired women to work in the dexterous task of valve manufacture. This intricate work was considered best suited for women's small hands, tying into paternalistic ideas of gendered work by women's bodies. Interestingly, the British Marconi Company's Hall Street Works in Chelmsford continued the tradition of employing women as it had previously done in its earlier iteration as a silk weaving factory from 1861. In 1898, the building was converted to the first wireless factory in the world. In the early 1920s, this type of intricate wireless construction work was still one of the main entry points into the field for women, acknowledged by Chaloner as 'women's work' but also as a good way into radio communications.

Chaloner listed other, more professional, career paths in radio communications: innovation and scientific research. For scientific research, Chaloner provided the example of Miss W.A. Leyshon who worked with British physicist and radio pioneer William Eccles to research and produce a paper on radio valve electronic circuits for relaying and measuring, presented before the Wireless Section of the Institution of Electrical Engineers (IEE, now IET) in 1921. Leyshon would later co-author a paper with Eccles that linked mechanical and electrical vibrations.[18]

She also mentioned opportunities in innovation, making specific reference to a speech made before the second WES Annual General Meeting (AGM) by Dr Henry Selby Hele-Shaw, a British mechanical engineer and university professor. At the second WES AGM, Dr Hele-Shaw spoke about women being 'creatures of imagination and individuality', suited to various tasks in innovation. Chaloner elaborated that innovation consisted of invention – discovering something new – as well as improving existing machinery and devices.

More generally, Chaloner acknowledged that women aspiring to a career in engineering, including in radio communications, faced twice the difficulty of their male peers in getting access to practical training, either as an apprentice or through a university course. Chaloner concluded that the best hope for women was to convince employers and fellow employees of their 'sincerity and determination to compete honestly and openly' in their chosen field of engineering, potentially in the case of radio communications. Chaloner celebrated female engineers as 'an established fact' and that they were starting to receive general recognition through their role in engineering institutions and universities, although Chaloner noted they did not always receive 'equal pay for equal work … or equal training'.

Questions

1. What opportunities were available for women in radio communications in 1922? How widely available do you think they were?
2. How do you think the Women's Engineering Society (WES) supported women's entry into radio communications?
3. Women were considered to have natural attributes that made them suited to radio telegraphy. What does this say about assumptions about gender roles in the 1920s?
4. How did Winifred Leyshon's work with William Eccles affect her position within the field of Radio Telegraphy?
5. Think about the readership of the *Women Engineer.* How might this article have inspired them or not?

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42 Women demonstrating electrical appliances: Public Demonstration of Appliance Utilities, Barcelona (1934)

Jordi Ferran Boleda

Introduction

This source depicts a young woman demonstrating electrical appliance usage in a showroom located in Barcelona in 1934. In Europe and North America, electricity entered the domestic sphere during the first part of the twentieth century. Electricity companies and the electrical appliance industry needed to persuade potential customers to purchase domestic electrical appliances to foster adoption. The industry used several strategies to popularise electricity for everyday life, including cooperative associations popularising electric lighting and appliances; women's associations specially created to educate the public on the uses of electricity; re-engineering housewife programmes; and training to explain how to use domestic electrical appliances.[19]

Source

Figure 10.4 Illustrated report, 'Public Demonstration of Appliance Utilities' (Barcelona, 1934). *Arxiu Nacional de Catalunya [National Archive of Catalonia]. Collection: Fuerzas Eléctricas de Cataluña (FECSA) [Electric Forces of Catalonia].* Registration numbers: ANC1-211-N-11469; ANC1-211-N-11470; ANC1-211-N-11471; ANC1-211-N-11473.

Analysis

Domestic appliances are a relevant but often unexplored source for considering technological popularisation. By studying everyday gadgets, one can learn about the technologies in use as a result of their appropriation by the public. The use of domestic electrical appliances – irons, washing machines, stoves, water heaters, ovens, boilers, refrigerators, grills, fans, etc. – in the first half of the twentieth century is especially relevant in relation to gender. This perspective enriches the history of technology as it incorporates new spaces, new characters and new technological objects.

Although only a limited number of households could afford the most sophisticated devices, Barcelona witnessed a boom of showrooms like the one in this image. The wide range of prices enabled domestic electrification according to the purchasing capacity of each user.

In the public sphere, young women teaching other women how to use technological devices was one of the most effective ways for electric companies to popularise their electrical appliances to middle-class families. However, the presence of women teaching about or commercialising domestic appliances did not necessarily promote their empowerment. On the contrary, the marketing strategy of depicting women using electric appliances reinforced the idea that women were obliged to do each of the domestic chores that these gadgets were devoted to.

Discourses on the increased freedom that electrical appliances brought to women concealed the new ways in which women were being consigned to the role of housekeeper. Notably, the use of an electric cooker or washing machine came with ideas about security, ease of use and hygiene. Rejecting them meant putting the family, which the woman should be taking care of, at risk. However, it was not care for the family alone, but an interest in presenting expected femininity and feminine beauty, that convinced women, for example, of the benefits of owning a hair curling machine. The public discourse on domestic devices reinforced in images such as these were designed to create a feeling of guilt in women who did not use these appliances, for not living up to the expected standards of beauty, familial obligation and domesticity.

In the private sphere, new devices designed by men wrought changes in household organisation and the women who used them. This necessarily affected how women appropriated technology. However, it was inside the household where the most interesting things happened: women learned how to use electrical appliances, figured out how to adapt them to their changing needs, considered new ways of usage, and, finally, shared this information with other women.

Questions

1. Are there other periods or spaces, beyond the twentieth century and the household, where the relationship between gender and technological devices is particularly prominent?
2. How might we read this source of domesticity in light of the social and political unrest in Spain during the 1930s?
3. What kinds of tacit knowledge might the user require in order to operate the equipment pictured in these sources? Do you consider this to be scientific knowledge? Why, or why not?

4. If owning domestic electrical appliances in reality increased the expectation upon women to perform household chores, why might households still seek to buy these items? What other pressures might be at work?
5. How much has the advertising and promotion of domestic electrical appliances changed today?

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Women in Portuguese archaeology: A photograph of the Vila Nova de São Pedro excavation team (early 1950s)

Dr Ana Cristina Martins

Introduction

This photograph was taken during one of numerous archaeological excavations at the Vila Nova de São Pedro (VNSP) site in the 1950s. The site itself is a chalcolithic (Copper Age) hillfort located near the town of Azambuja, north of Lisbon in Portugal.[20] The VNSP archaeological site has been studied intermittently since the 1930s. Some of the initial campaigns were directed and co-directed by Manuel Afonso do Paço (1895–1968), a member of the Association of Portuguese Archaeologists, founded in Lisbon in 1863. We see him pictured in this photograph together with the young archaeologist Maria de Lourdes Costa Arthur (1924–2003). Maria de Lourdes had a degree in Historical and Philosophical Sciences from the Faculty of Letters of the University of Lisbon and specialised in archaeology from the Roman period during her time as a scholarship holder of the Portuguese State in Madrid. Nothing, however, prevented her from taking an interest in and investigating sites and materials belonging to other chronologies, as was the case with VNSP. These archaeological campaigns were largely made possible by the participation of local workers, both men and women, hired seasonally to carry out specific tasks: a set of actors also present in this photograph.

Source

Figure 10.5 Vila Nova de São Pedro excavation team, early 1950s. Unknown photographer. Image credit: Ana Cristina Martins (IHC – Polo University of Évora & UNIARQ – University of Lisbon).

Analysis

Photography can play an extraordinary role in the comprehension of issues around gender in the history of science, especially if we apply the iconographic and iconological method of analysis.[21] This image reveals the roles that women assumed in the excavation of the archaeological site of Vila Nova de São Pedro (VNSP) and suggests something of the social and economic backgrounds of those pictured. One can also establish a more direct relationship between archaeological fieldwork and the Portugal of the 1950s during a specific period of the totalitarian regime 'Estado Novo' (New State).[22] This decade is particularly interesting as it includes the beginning of a period of transition, not only for the country but also for the production of archaeological knowledge and heritage itself, which began to absorb distinct foreign influences.[23]

Contemporary monographs, journals and newspapers contain many images of women attending archaeological meetings, visiting museums, collecting archaeological artefacts, becoming members of archaeological societies, funding archaeological works, helping their fathers, brothers and husbands with field work, translating papers, and illustrating archaeological works. One discovers local female workers (mostly peasants) hired by archaeologists and receiving (at least) half the money earned by their male colleagues. It is likewise possible to identify young and audacious women studying archaeology and becoming archaeologists, both in the field and in the lab. Women at this time struggled to reconcile archaeological work with their personal and family lives; at least while Portugal was dominated by a right-wing totalitarian political regime under which women's roles were confined to that of wives, mothers, daughters or sisters. This was especially true of middle- and upper-class women, who comprised the majority of women studying archaeology at university.[24] Women who had a professional career, particularly in science and technology, rarely had their own family and usually remained single and childless.[25] Only museums, archaeological museums, and museums with archaeological collections seemed to provide genuine spaces for women to be employed as archaeological experts: as curators, archivists, librarians, drawers and exhibition guides. As field archaeologists, in contrast, women were expected to have superior male support.

In this image, the economic, social and political context of daily survival explains the presence of so many women amongst these precarious workers.[26] Economic difficulties are evident in some faces, facial expressions, body language and clothing fixed by the photographic lens. These local people were conducting seasonal activities like this archaeological excavation to complement otherwise meagre household incomes. In this rural environment, the coexistence of men and women in working spaces outside the home would have been necessary. Nevertheless, the body language and gestures of these men and women indicates a relationship with the archaeological field as a space and moment of some individual freedom from social norms and conventions. This image depicts women shoulder to shoulder with men, almost as equals. However, they shared the space, but not the tasks. As in the case of mining companies, men in these contexts were responsible for the most physically demanding work, while women were responsible for sorting through the material excavated. As this task demanded meticulous attention to detail, women were hired in greater numbers than men. Both of these aspects of the division of labour are reflected in this image, which simultaneously depicts a greater number of women, but also the men holding picks used for labour-intensive excavation work. The men of course were paid twice as much, not only for fulfilling harder tasks, but simply because of their gender, as was the norm in 1950s Portugal.

Looking instead towards the leading figures of this excavation, we can see that Maria de Lourdes Costa Arthur stands to the right of Afonso do Paço in this image, occupying the second most important place in the photograph. This positioning may have been arranged by Paço, however it could also have been organised by Costa Arthur herself. Costa Arthur was a woman with a strong personality, empowered by an open-minded family; a combination which facilitated her university studies and allowed her to fulfil her wish of studying archaeology abroad.[27] It was as a scholarship holder during her time in Madrid that Costa Arthur joined this excavation team, coordinating fieldwork. This is perhaps why we see her standing with one knee raised, the very image of a team leader, with her hands in her trouser pockets; a gesture barely accepted as feminine within the prevailing cultural norms of the time.[28] This dynamic raises questions about the ways in which women accessed or were able to access scientific power and prestige during the early twentieth century.

Questions

1. Is a picture worth a thousand words? Do pictures accurately represent reality? As a result, how can we use images as sources for the history of science?
2. How might one discuss this source in the context of the history of archaeology, the history of women, and the history of visual arts?
3. What does this source reveal about women's access to scientific education and scientific professions during the mid-twentieth century?
4. Which intersectionalities does this source encourage us to consider in relation to women in the history of science?
5. How does this source demonstrate the dangers of extrapolating women's experiences of science in general from the experience of one woman?

Further reading

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Part X notes

1 See Rossiter, *Women Scientists in America,* 125–126.
2 Muka, 'Portrait of an Outsider', 2014, 30–31.
3 Fara, 'Women, science and suffrage in World War I', 2015, 11–24.
4 Goldin, 'The Role of World War II in the Rise in Women's Employment', 1991, 741.
5 Secord, 'Science in the Pub', 1994, 269.
6 Affiliation: CIUHCT, Centro Interuniversitário de História das Ciências e Tecnologia, Departamento de História e Filosofia das Ciências, Faculdade de Ciências, Universidade de Lisboa, 1749-016 Lisboa, Portugal. Funding by Fundação para a Ciência e a Tecnologia (FCT, IP), Portugal. Grants: UIDB/00286/2020 to CIUHCT. Researcher contract: Norma Transitória - DL57/2016/CP1479/CT0070.
7 In 1865, the pebrine disease hit the French silkworm industry hard. Pasteur identified it as a microbiological disease and devised a procedure to prevent its spread within breeding houses. For more see 'Silkworm diseases' in Institut Pasteur, 'The Middle Years 1862–1877'.
8 Pimentel, 'Geração do bicho da seda e meios de reconstituir a industria sericicula em Hespanha por Don Fernando Ortiz Cañavate', 1894, 553–554; and Pimentel, 'La sericiculture', 758–761.
9 Pasteur, *Études sur la maladie des vers à soie;* and Pimentel, 'Tentativa de um plano de regeneração da sericicultura portuguesa', 1892, 134.
10 Pimentel, 'Tentativa de um plano de regeneração da sericicultura portuguesa', 1892, 134. English translation by Isabel Zilhão.
11 For example, see Lee, *Shanghai Modern,* 47.
12 Many collections of *The Ladies' Journal* in libraries have been digitised. Two open access databases that provide full-page graphic scans of the magazine's contents are: Chinese Women's Magazines in the Late Qing and Early Republican Period (*WoMag*), Heidelberg University, Germany https://uni-heidelberg.de/womag/ (English, accessed 16 December 2022), and The *Ladies' Journal* database, Institute of Modern History, Academia Sinica, Taiwan http://mhdb.mh.sinica.edu.tw/fnzz/ (Chinese, accessed 16 December 2022). These are good stepping stones for researchers looking to access the rich resources of *The Ladies' Journal*. All of the images in this source are taken from these two databases.
13 Nivard, 'Women and the Women's Press', 1984, 37–55.
14 Chiang, 'Womanhood, Motherhood and Biology', 2006, 519–545; Suzuki, 'Shimoda's Program for Japanese and Chinese Women's Education', 2013.
15 Judge also discusses a wider scope of Chinese women's periodicals in this era. See Judge, *Republican Lens.*
16 Taylor, 'Goddess of the skies'.
17 Women were first admitted to the Institute of Radio Engineers in 1927, see: 'Letting The Women In – When did engineering organisations first admit women?'.
18 Eccles and Leyshon, 'Some new methods of linking mechanical and electrical vibrations'. 229.
19 For cooperative associations popularising electric lighting and appliances see Worden, 'Powerful Women: Electricity in the Home, 1919–1940', 131–150. For women's associations see Symons, 'The Electrical Association for Women, 1924–1986', 1993, 215–220; Reece and Roberts, '"This electric age is woman's opportunity"', 1998, 94–107; Pursell, 'Domesticating modernity', 1999, 47–67. For re-engineering housewife programmes see Graham, 'Domesticating Efficiency', 1999, 633–675. For training on how to use domestic appliances see Goldstein, 'From Service to Sales', 1997, 121–152.
20 With reference to our comments in the introduction it is important to critically evaluate terms such as 'Copper Age' or 'Chalcolithic'. The British Museum notes: 'The term is used in various

cultural and geographical contexts to define the period between the Neolithic and the Bronze Age, for instance in Cyprus, the Middle East, and Britain and Ireland, where well-defined cultural developments differentiate the period from the preceding Late Neolithic. It is not used everywhere. In parts of Northern Europe including Russia, there are only rare copper and gold artefacts in Late Neolithic contexts transitional to the Early Bronze Age, and these do not constitute a well-defined Chalcolithic (Copper Age) culture.' (The British Museum, 'Chalcolithic'). 'Copper Age' is therefore not a universal term and readers should consider how this periodisation has, like others, been influenced by Euro-centric conceptions of the past.

21 Alatalo, 'Reading Pictures, constructing narratives', 2015; Ruck and Slunecko, 'A portrait of a dialogical self', 2008, 261–290; McFadyen and Hicks, *Archaeology and photography*; Panofsky, *Studies in iconology*; Serrão, *A trans-memória das imagens*.

22 Torgal, *Estados Novos*.

23 Martins, '"Mission": *modernize!*', 179–186.

24 Vicente, 'Mulheres', 565–571 and Vaquinhas, 'A família, essa "pátria" em miniatura', 118–151.

25 Martins, 'Pioneiras da Arqueologia em Portugal', 2016, 77–100.

26 Graça, 'Agrícola', 563 and Luís, 'Pobreza', 102–107.

27 Martins, 'Women in the field', 41–62.

28 Vicente, 'Mulheres', 565–571 and Vaquinhas, 'A família, essa "pátria" em miniatura', 118–151.

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Part XI
Women and the institutions of science (1910–1950)

Timeline: individuals, events and publications in the history of science	Timeline: individuals, events and publications in this part
1878 Women at the University of London are granted degrees. Women are admitted on equal terms to men, except in the field of Medicine.	
	1886–1972 Elsie Wakefield, English mycologist.
	1887–1961 Caroline Eustis Seely, American mathematician.
	1875–1951 Anna Tumarkin, Russian-born psychologist who migrated to Switzerland and became the first female associate professor in Europe in 1909.
1891 British mathematician Charlotte Scott becomes the first woman to join the American Mathematical Society.	
	1903–71 Kathleen Lonsdale, Irish prison reformer and crystallographer.
1914–18 First World War, during which women take on new roles within the workforce, for example in manufacturing.	

Timeline: individuals, events and publications in the history of science	Timeline: individuals, events and publications in this part
	1920–58 Rosalind Franklin, English chemist and X-ray crystallographer.
1918 The Representation of the People Act is passed in the United Kingdom, giving all men over the age of 21, and women over the age of 30, who meet certain qualifications around property, the right to vote.	
1920 University of Oxford admits women to take degrees.	
1920 The Nineteenth Amendment becomes part of the United States' Constitution, which asserts that the right to vote in any State cannot be denied on the grounds of sex, enabling women to vote.	
1939–45 Second World War, during which women again take up new roles, for example within universities.	
1939–46 The Manhattan Project, a research and development programme led by the United States of America, creates the first atomic weapons.	
1945 The Royal Society elects Kathleen Lonsdale and Marjory Stephenson as the first ever female Fellows of the Society.	

Introduction

This part focuses on women who interacted with formal institutions of science – including learned societies and universities – during the first half of the twentieth century. Due to the social changes brought about by the World Wars and movements like the women's suffrage campaign in Britain, the decades from 1910 to 1950 are often regarded as a period of advancement for women. During the First World War, as nations sought to align science with military interests, women gained career opportunities, including within science and its institutions. Coupled with pressing labour needs to maintain the war effort at home, some women had the opportunity to move into roles traditionally held by men, including in science and engineering.[1] The Second World war offered further opportunities for women to participate in government-sponsored science and recognised institutions of learning. Female physicists such as Maria Goeppert Mayer (1906–1972) and Leona Woods Marshall Libby (1919–1986), for example, worked on the atomic bomb project in the United States, while other women took up roles in universities, replacing male professors who were drawn away from their posts.[2] At the same time, women had increased access to higher education within the United States and Europe.

Yet, despite these improvements, women's participation within scientific and university institutions was still curtailed by gendered hierarchies. As historians have shown, many of the changes brought about by wartime were short-lived and have perhaps been overstated in terms of the available opportunities for women to cultivate a career within science.[3] During and after wartime, women struggled to achieve equal pay to men and were often denied the most prestigious positions regardless of their qualifications.[4]

The first two sources in this part reveal how university-educated women undertook supporting, yet significant, roles within the scientific workforce as assistants to more famous men. These positions attracted lower pay, often regardless of the skills of the women who undertook them, and in some cases, this served to demarcate these activities as 'women's roles'. The first source is a photograph of mycologist Elsie Wakefield (1886–1972) shown taking part in an outdoor expedition to collect fungi, known as a 'fungi foray', and the second is a letter from the mathematician Caroline Eustis Seely (1887–1961) to the American Mathematical Society.

Women also participated in more recognised and visible roles. The third source is a translation of an excerpt from the Russian-born psychologist Anna Tumarkin's (1875–1951) *Methoden der Psychologischen*

Forschung (Methods of Psychological Inquiry). Although Tumarkin held an associate professorship at the University of Bern, she was denied the opportunity to become a full professor on the grounds of her gender. The fourth source is a letter from the crystallographer Kathleen Lonsdale (1903–1971) to Hubert Peet, editor of the British Quaker magazine, *The Friend*. Alongside the biochemist Marjory Stephenson (1885–1948), Lonsdale was one of the first women to be elected to the Fellowship of the Royal Society.[5] This source reveals that after achieving this prestigious position, Londsdale considered how her gender and personal beliefs might have implications for her public image as a scientist. The fifth source in this part consists of the chemist and crystallographer Rosalind Franklin's (1920–1958) 'Photograph 51', and its subsequent use as an image featured on a commemorative coin. In the context of her life, the coin draws attention to the ways in which women continued to be marginalised, despite increased access to the formal institutions of science.

44
Elsie Wakefield (1886–1972): Photograph of a fungi foray in Epping Forest, England (c. 1910)

Katherine Harrington

Introduction

The jovial scene in this source (note the half-caught smiles on many of the faces) is a fungi foray in Epping Forest, England c. 1910. The purposes of a foray can be varied; from hunting for edibles, or collecting for scientific study and identification, to simply observing the beauty and diversity of mushrooms. The figures depicted are primarily staff of the Royal Botanic Gardens, Kew, and student gardeners. Student gardeners came to Kew to undertake practical training and attend lecture courses before pursuing careers around the world in agricultural departments and stations, and public and private gardens. The fourth figure from the left is the mycologist Elsie Wakefield. Next to her (fifth left) is the mycologist George E. Massee (1845–1917), then Head of Mycology at Kew. The other woman featured in the photograph is Ivy Massee, daughter of George, who also studied mycology. Ivy assisted in the creation of her father's 1911 book *British Fungi* by illustrating its coloured plates for publication.[6]

Source

Figure 11.1a Photograph of Elsie Wakefield on a fungi foray in Epping Forest, England, c. 1910. Image credit: image reproduced with kind permission of the Board of Trustees of the Royal Botanic Gardens, Kew.

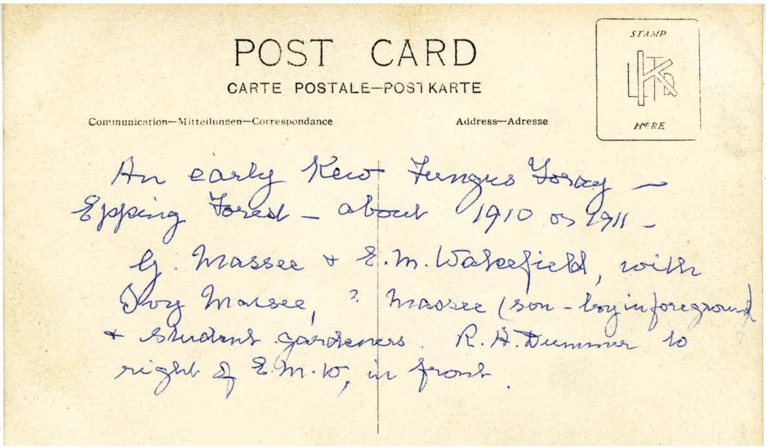
POST CARD
CARTE POSTALE—POST KARTE
Communication—Mitteilungen—Correspondance
Address—Adresse
STAMP HERE
An early Kew Fungus Foray –
Epping Forest – about 1910 or 1911 –
G. Massee & E.M. Wakefield, with
Ivy Massee, ? Massee (son - boy in foreground)
+ student gardeners. R.A. Dummer to
right of E.M.W, in front.

Figure 11.1b Reverse of photograph listing the participants of the fungi foray. Image credit: image reproduced with kind permission of the Board of Trustees of the Royal Botanic Gardens, Kew.

Analysis

Elsie Wakefield was encouraged to pursue the study of nature by her father Harry, a lecturer in science who became a science demonstrator in elementary schools in Swansea, Wales. Following a first-class honours degree in botany from Somerville College, Oxford, Wakefield took up a scholarship to study at the Forestry and Botanical Institute in Munich, where she focused on a group of fungi called Hymenocytes. On her return to England, Wakefield became first assistant to George Massee in the fungal herbarium at Kew (1910). An adequately qualified man could not at the time be found for the role as the initial salary was noted as being of 'insufficient inducement'.[7] Wakefield, however, was eminently qualified and as such was offered the position.

Wakefield was very active in the broad promotion of mycological studies and a great supporter of the British Mycological Society. She attended their spring and summer fungi forays, served as the Society's Secretary for 17 years, and became its President. She officially assumed George Massee's position as Head of Mycology at Kew in 1915 following his retirement and remained at Kew until her own retirement in 1951. Archive material at Kew includes several carefully worded requests to receive the same equal incremental pay increases as her male counterparts.[8]

An authority on a group of fungi named Basidiomycetes, Wakefield's contributions to mycology were chiefly in nomenclature and collection curation. She developed skills in tropical mycology with a secondment to the Imperial Department of Agriculture, West Indies (1920–1921). She first published an academic article in 1909, and her last paper was published in 1969, aged 83. Wakefield was a skilled painter, having been 'taught to paint by a gifted father'.[9] She provided clear informative illustrations of over 100 species for the Observer's book of *Common British Fungi.*[10] Wakefield may be considered a pioneer professional female mycologist who 'successfully invaded the ranks of the scientific Civil Service which had previously remained almost exclusively masculine'.[11]

However, despite accessing these spaces, one could argue that Wakefield was undervalued during her lifetime. From receipt of an initial job offer only because the available salary was simply too low for a similarly qualified man, to the fact that if she had married then her position in the Civil Service would have been terminated.[12] One might argue that even when women 'successfully invaded' traditionally male spaces in the early twentieth century, they were never valued as highly, and their participation was governed by strict societal and gendered norms.

Questions

1. Consider the role of family relationships in the development of scientific skills, particularly in relation to field observation in the biological sciences.
2. What effects might membership and activity in a learned society have on the development of a professional career for a woman in science in the early twentieth century?
3. Consider Wakefield's secondment to the Imperial Department of Agriculture in the West Indies in the 1920s. How might we view this in light of the themes of bioprospecting and colonialism as raised in part seven?
4. Compare and contrast Wakefield's career and her access to learned societies with that of other women featured in this part. Was she unusual in receiving a lower salary to that of her male counterparts?
5. Compare the networks of knowledge sharing and career advancement alluded to in this source with those in previous parts. How far had things changed between earlier periods and Wakefield's day?

Further reading

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45 Caroline Eustis Seely (1887–1961): A letter to the American Mathematical Society (1922)

Dr Ellen Abrams

Introduction

Caroline Eustis Seely was a graduate of Barnard College and earned her PhD in mathematics from Columbia University in 1915. She worked as clerical assistant to the Secretary of the American Mathematical Society, Roland George Dwight Richardson (1878–1949), for 22 years. Seely became associate editor of the *Bulletin of the American Mathematical Society* and cooperating editor of the *Transactions of the American Mathematical Society*. In addition to her clerical and editorial work, she also presented her research in mathematical analysis at Society meetings.[13] The recipient of this letter, Roland George Dwight Richardson, served as Secretary of the American Mathematical Society from 1921 to 1940. During that time, he was also head of the Department of Mathematics at Brown University. There is blue pen ink on the manuscript version of this letter, suggesting that Richardson passed Seely's letter on to a colleague.

Source

A letter from Dr Caroline Eustis Seely to the Secretary of the American Mathematical Society, Professor Roland George Dwight Richardson, dated December 1922.

American Mathematical Society
501 West 116th Street
New York City

December 2, 1922

Dear Professor Richardson:

I hope the Buffalo meeting was a success and that you survived.

I find I have the supplementary list of members elected to the L. M. S. in 1921–22. I will try to get the bills straight. Enclosed are some replies from members.

The programme looks all right to me. It seems to me the women are well taken care of, and get a great deal of tea. I warn you there is always trouble about how we get seated at general dinners. The ladies don't like to be segregated off in a corner (Fiske made that awful break once in New York), and yet if left to themselves are likely to segregate themselves and then be discontented because they have. Once Slaught had a good solution (wasn't it in Chicago) of announcing that no two ladies were to be allowed to sit together; as there is always a superfluity of men, the women haters can get together in spite of this. I suppose I oughtn't to give away trade secrets like this, but they all come and confide in me if they don't like things.

I can't see why your programmes didn't come. As lots of ballots from all over the counry [sic] have been coming in all week, it looks as if your Providence Post Office might be the one to blame; you might blow both them and the New Era up.

Sincerely yours,
[signed Caroline Seely]

Analysis

Feminist scholarship since the mid-twentieth century has interrogated historical and ongoing assumptions about scientific objectivity as a masculine endeavour.[14] The relationship between gender and mathematics has both aligned with and departed from the relationship between gender and science. Although mathematics has been considered the epitome of disembodied (yet somehow still masculine) objectivity, it has also served as an entry point for women who were excluded from physical spaces like the laboratory or machine shop.[15]

Caroline Seely's career as the first mathematician to be employed full-time by the American Mathematical Society points to one of many ways in which women were marginalised within the profession. In the early twentieth century, earning a PhD rarely led to research-oriented employment for American women. Instead, women scientists and mathematicians were often confined to 'women's work', such as assisting other researchers, teaching young women or performing clerical work. As historian Margaret Rossiter has noted, the rise and professionalisation of big science brought with it new administrative and auxiliary roles that many thought would benefit from women scientists' feminine skills.[16] While some women scientists argued for the equality of men and women outright, others seemed to have thought that employment of any kind, even if limited and segregated, would eventually lead to greater opportunities for women in science overall. But instead, women's subordinate place in science was fairly set by 1910, and then increasingly cemented by war and the Great Depression. While other forms of big science may have generated more assistant-type roles than mathematics did, Seely's career as a clerk and administrative assistant certainly fits Rossiter's definition of sex-typed employment, which often involved the economic advantage of hiring overqualified women for low-paying jobs.

Seely's letter to Richardson points to another important way in which women scientists were excluded from scientific research. The bulk of her letter has to do with the experiences of women mathematicians who attended Society meetings, specifically the separation of men and women – either by design or by default – during conference dinners. Women scientists in the early twentieth century were often allowed to attend official conference sessions but were at times barred from all-male spaces like smoking rooms. However, it was at dining tables and in smoking rooms that informal collaborations, professional camaraderie, fresh ideas and new opportunities were formed. As men occupied the leadership roles and made up the majority of the early twentieth-century American mathematics community, separating women from men at mealtimes would have meant separating them from the community itself.

Although increasing numbers of women were being trained in mathematical research in the early twentieth century, they were often excluded – sometimes explicitly – from formal research-oriented employment as well as informal collaborative spaces. As Rossiter has argued, prestige and professionalism were traits most commonly associated with men, and without the opportunities to pursue postdoctoral and professional mathematical research, women had very little chance of garnering the level of male-coded prestige needed to be given such opportunities.[17] As this letter and others that she wrote demonstrate, Seely often approached the inequitable dynamics of the mathematics community with perceptive humour and cynicism.

As American mathematics grew in the early twentieth century from an upstart, nascent enterprise into a well-established programme of international repute, the category of 'mathematician' shrunk. Many leading mathematicians were attuned to the fact that scientific prestige, as well as recognition from scientists in Europe, was garnered less through teaching, writing, or applying mathematics, and more through researching modern, or abstract, mathematics.[18] Mathematics became more narrowly defined by abstract mathematical research and was simultaneously constructed as a man's domain.

Still, women mathematicians were essential to the growth of American mathematics through teaching, writing, calculating, problem-solving, library services and administration. As Rossiter has pointed out, however, the relationship between the gendering and the valuing of work was reciprocal. Uncelebrated work was women's work and women's work was uncelebrated. As uncelebrated work is rarely preserved in archives, historians must discover and study marginalised women mathematicians in other ways – through the institutions for which they worked and those with whom they corresponded.

Questions

1. How might the experiences of women mathematicians have been similar to or different from the experiences of other women scientists?
2. How does Seely's letter fit into the broader women's movement?
3. How might historians learn more about the work and experiences of women scientists and mathematicians?

4. Compare the importance of informal social spaces such as the dining room, as alluded to in this source, with their importance in networks of knowledge production in earlier periods, as discussed in previous parts.
5. Looking across the parts in this sourcebook, what kinds of activities within the production of knowledge have been gendered as ‘female’ throughout history? Can you identify any common themes?

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46

Anna Tumarkin (1875–1951): A translation of an excerpt from her *Methoden der Psychologischen Forschung (Methods of Psychological Inquiry)* (1929)

Stefan Reiners-Selbach

Introduction

'My name is Tumarkin Anna Esther. I was born on 16th of February 1875 in Dubrowna […] Russia, daughter to Paul Tumarkin and Sophie, née Herzenstein; of Jewish descent and faith'.[19] It was in this manner that Anna Tumarkin introduced herself in her application letter to the University of Bern. As a woman, she could not attend university in Russia, and so in 1892 she migrated to Bern in Switzerland in order to attend the university there. Here, she became the first female associate professor in Europe to be granted full rights. However, she could not acquire a chair due to certain reservations of the university's faculty against appointing a female full professor. Nevertheless, she taught and wrote on philosophy and psychology for many years. As a professor, she also fought for women's rights in Switzerland. She lived together with her lifelong partner Ida Hoff, one of the few female physicians in Bern, a feminist, and the first municipal school doctor.

The following source is an excerpt from her book *Methods of Psychological Inquiry*, a work on non-reductionist psychology. In it, she claimed that the human *Geist*, meaning 'mind' and also 'culture', is a world of its own – human culture is second nature to the human mind and cannot be described or inquired into by methods of natural science. Thus, Tumarkin argued that there is a need for a distinct method to investigate *Geist*, which is 'understanding'. Tumarkin proposed 'understanding' as the method for one *Geist* seeking knowledge about another *Geist*; one can only understand because one shares human (second) nature. Today, with the mainstream cognitive sciences explaining the human mind as an entirely natural phenomenon, Tumarkin's *Methods of Psychological Inquiry* offers an interesting contrast.

Source

Extract from Tumarkin, Anna. *Die Methoden der psychologischen Forschung*. Leipzig: Vieweg and Teubner, 1929. 90–93.

Original

Der Unterschied zwischen der beschreibenden und der erklärenden Psychologie, von dem wir ausgegangen sind, fällt zunächst unter den allgemeinen auf allen Gebieten der Forschung in gleicher Weise sich zeigenden methodischen Unterschied zwischen einer unvoreingenommenen Beobachtung auf der einen und einer der Erfahrung vorgreifenden Konstruktion auf der anderen Seite. So allgemein aufgefaßt, stellt sich die „beschreibende Psychologie" auf den gleichen empirischen Boden wie die beschreibende Naturwissenschaft, die deswegen, weil sie das Hauptgewicht legt auf die Feststellung von Tatsachen, noch nicht den Glauben aufgibt an ein „geheimes Gesetz", das diesen Tatsachen zugrunde liegt. In ihrer allgemeinen Bedeutung schließt auch die beschreibende Psychologie die Möglichkeit einer Erklärung des Seelenlebens nicht aus.

Erst wenn innerhalb der Psychologie der Unterschied zwischen Beschreibung und Erklärung sich zu einem prinzipiellen Gegensatz zuspitzt, und die Beschreibung des Lebens soviel bedeutet wie einen absoluten Verzicht auf jede Erkenntnis des Lebens aus seinen Ursachen heraus, erscheint die psychologische Beschreibung als eine besondere, der Eigenart der psychischen Wirklichkeit angepaßte Methode; die beschreibende Psychologie tritt dann der gesamten Naturwissenschaft, die mehr oder weniger direkt immer auf Erklärung der Wirklichkeit gerichtet ist, prinzipiell entgegen.

In diesem Sinne aber aufgefaßt, in ihrem prinzipiellen Gegensatz zu aller erklärenden Wirklichkeitserkenntnis, ist die beschreibende Psychologie nicht eine selbständige, auf sich gestellte Erkenntnis, sondern sie setzt bereits eine ursprüngliche Erkenntnis, jenes Verstehen des

Lebens voraus, welches erst auch der Beschreibung der Lebensäußerungen ihre psychologische Bedeutung sichert. Dieses Verstehen des Lebens bildet den eigentlichen methodischen Gegensatz zum Erklären des Lebens aus dessen Ursachen heraus; und erst mit diesem Gegensatz tritt die Psychologie methodisch in prinzipiellen Gegensatz zu der gesamten erklärenden, auf der Idee des Kausalzusammenhangs der Wirklichkeit gegründeten Wissenschaft; sie will Wissenschaft sein in einem anderen Sinn, als es alle Naturerkenntnis ist. Die grundlegende Bedeutung, welche in der Erkenntnis der Natur der Erklärung ihrer Erscheinungen zukommt, soll beim Erfassen des seelischen Lebens das Verstehen haben. Und wenn in der Naturerkenntnis auch die Beschreibung nie den letzten Zweck der Erklärung der Naturerscheinungen aus den Augen läßt, so setzt bei der Psychologie auch die „einfache Beschreibung" das Verstehen des Seelenlebens voraus.

Damit erhebt das psychologische Verstehen den Anspruch, nicht bloß eine unter den verschiedenen Formen der Erkenntnis, sondern die Grundlage jeder Erkenntnis zu sein, welche der Eigenart der psychischen Wirklichkeit gerecht würde. Der Erklärung alles Naturgeschehens aus einem zum Zweck der Sicherung der Einzeltatsachen konstruierten Kausalzusammenhang tritt gegenüber, als die der Psychologie eigentümliche Methode, das Verstehen des Seelenlebens aus einem ihm selber eigenen und ihm entnommenen Sinnzusammenhang heraus. Daß das Leben ein Sinnzusammenhang ist, macht die verstehende Methode der Psychologie möglich, aber auch erforderlich. [...]

Wir stellen also die Frage nicht im Sinne der Hermeneutik: wodurch wird uns das Verstehen des Lebens vermittelt? oder woran erkennen wir das Leben?, sondern im rein psychologischen Sinne: was bedeutet das eigentümliche Verstehen des seelischen Lebens? oder als was erkennen wir verstehend das seelische Leben?

Verstehen im weiteren Sinne bedeutet, wie es sich schon aus der Verwandtschaft der Begriffe Verstehen und Verstand ergibt, die Erkenntnis eines Zusammenhanges: wir nehmen ein Einzelnes wahr, und wir verstehen den allgemeinen Zusammenhang, in den das Einzelne gehört, wir verstehen das Band, das Einzelnes miteinander verbindet. So verstehen wir den allgemeinen Zusammenhang des systematischen Denkens, das alle Begriffe umfaßt, wir verstehen den Zusammenhang der Rede, in der wir die einzelnen Worte vernehmen, wir verstehen den einheitlichen Zusammenhang der Wirklichkeit, deren Einzeltatsachen wir wahrnehmen.

Wir verstehen aber auch Einzelnes selbst, soweit wir es aus dem Zusammenhang heraus erkennen: wir verstehen den Einzelbegriff aus dem Zusammenhang des Denkens, wir verstehen die Einzelworte aus dem Zusammenhang der Rede, in der sie gebraucht werden, wir verstehen das Einzelgeschehen aus dem Zusammenhang der Wirklichkeit, in den wir es einordnen. Diese Erkenntnis des Einzelnen aus dem Zusammenhang heraus ist Verstehen im eigentlichen Sinne des Wortes. Und zwar dürfen wir mit um so mehr Recht von diesem Verstehen im eigentlichen Sinne des Wortes sprechen, je enger das Einzelne mit dem allgemeinen Zusammenhang verbunden ist, aus dem heraus es erkannt wird, je mehr dieser Zusammenhang das Wesen des Einzelnen selbst ausmacht.

Verstehen im eigentlichsten Sinne ist daher Erkenntnis der einzelnen, gegebenen Wirklichkeit als eines unlösbaren, ursprünglichen Zusammenhangs. Daher ist Leben, und in erster Linie das seelische Leben, der eigentliche Gegenstand der verstehenden Erkenntnis. Denn das Leben steht nicht bloß, wie alles Wirkliche, im Zusammenhang mit der Umwelt, sondern es kann auch selber nur als ein in sich geschlossener Zusammenhang, als eine Welt für sich gedeutet werden. Und was die Psychologie zur verstehenden Wissenschaft macht, ist nicht der Kausalzusammenhang des Lebens mit der Gesamtwirklichkeit, mit dem Reiz auf der einen und mit der Körperbewegung auf der anderen Seite; auch nicht jener andere, unabhängig von aller Erklärung erkennbare Zusammenhang zwischen Erleben und Lebensäußerung, sondern der innere Zusammenhang des Lebens selbst, den wir nicht anders denken können denn als Sinnzusammenhang.'

Translation

The difference between descriptive and explanatory psychology consists in the methodical difference, which manifests itself in every field of research in the same manner: Unbiased observation on one side and construction that anticipates experience on the other side. Defining it roughly, 'descriptive psychology' shares the same empirical basis as descriptive natural science, which, since its main focus is the identification of facts, still does not abandon the belief in some secret law that underlies those facts. In its general meaning, descriptive psychology does not rule out the possibility of an explanation of mental life.

Only if the distinction between description and explanation in psychology is intensified to a principal opposition and only if description of life means disregard for any insight into life in correlation to its causes, will psychological description appear to be a special method that is adapted to the peculiarities of mental reality; descriptive psychology will thus become an opponent of the entirety of natural science, which nearly always aims to explain reality.

In this sense, in its principal opposition to all explanatory insight into reality, descriptive psychology is not an independent form of perception. Rather, it requires an initial knowledge, an understanding of life, which enables any psychological value of descriptions of life in the first place. This understanding of life constitutes the methodic contrast to the explanation of life from its causes; and in this very contrast psychology opposes the entirety of explanative natural science, which is grounded on the idea of causal relation. Psychology aims to be a science in a different sense than natural science. Understanding shall have the same fundamental significance in the comprehension of mental life as the explanation of phenomena has in natural science. And as description in natural science never loses sight of its aim of explaining natural phenomena, so 'simple description' in psychology presupposes the understanding of mental life.

Thus, psychological understanding does not aspire to be one of many forms of perception, but rather the basis of the entirety of knowledge that suits the peculiarities of mental reality. All natural phenomena are explained by a causal relation which is constructed to assure the possibility of singular phenomena. However, the understanding of mental life – the characteristic method of psychology – is enabled by coherence of meaning, which is inherent to life. That life in and of itself is a continuum of meaning, renders the method of understanding not only feasible but necessary. […]

We do not pose the question in the sense of hermeneutics: Whereby is the understanding of life conveyed? Whereby do we recognize life? Rather, we ask in the purely psychological sense: What does the peculiar understanding of mental life entail? What do we make of mental life by understanding?

Understanding in a broad sense means realization of coherence: We perceive a phenomenon and we understand how it relates to its general principle, we understand the bond that connects the phenomena. Thus, we understand the general coherence of systematical thought which includes all concepts and ideas. We understand the coherence of speech whose single words we perceive. We understand the consistent nature of reality whose single phenomena we perceive.

We also understand an individual phenomenon, insofar as we perceive it by its context: We understand an individual concept by its context of thought. We understand individual words by the context of speech, in which they are used. We understand single events by the consistency of reality, into which we categorize them. This comprehension of individual phenomena by their context is understanding in the proper sense of the word. Indeed, we may rather speak of understanding in its proper sense the closer the single phenomenon is tied to its own fundamental structure, by which it is understood, the more this structure is the essence of the individual phenomenon.

Understanding in its most proper sense is thus perception of the single given reality as an unresolvable, elemental continuum. Therefore, life and especially mental life, is the true object of perception by understanding. For life exists not only, like every real thing, in relation to an environment, but rather it can only be interpreted as a self-contained structure of relations and meaning, as its own reality. It is not the causal relation of life with the totality of reality, with stimuli on the one and bodily reactions on the other side, that makes psychology the science of understanding. Neither is it the obvious connection of experience and active manifestation of life. Rather, it is the self-contained coherence of life itself, which can only be thought of as a coherence of sense and meaning.

Analysis

Tumarkin's concept of psychology was founded on the distinction between describing, explaining, and understanding – the latter being the method she subscribed to. These methods represented different approaches to science. While describing was connected with empiricism, explaining was connected with rationalism. However, as Tumarkin pointed out, empiricist methods most often incorporated some kind of explanation, with investigators explaining results by examining their causes. This combination of describing and explaining in turn constituted the investigative method of the natural sciences, especially physics.

In the late nineteenth century, psychophysicists such as Ernst Heinrich Weber (1795–1878) and Gustav Theodor Fechner (1801–1887), or to a degree the early experimental psychologists such as Wilhelm Maximillian Wundt (1832–1920), applied this scientific approach to psychology.[20] They proposed that mental phenomena could be explained by certain laws, just as the laws of nature explained natural phenomena, reducing mental phenomena to physical phenomena. Tumarkin objected, arguing that psychology needed its own method. Since psychology studies the human mind or *Geist*, which cannot be reduced to nature, it is a categorically – but not ontologically – different domain. Human mind, or life as she phrased it in the excerpt, is not merely some physical fact; rather 'life in and of itself is a continuum of meaning'. She emphasised 'continuum', stressing that meaning *could* be analysed further, but *should* also be grasped as a whole. Understanding should therefore strive to conceive the human mind as the 'unresolvable, elemental continuum' it is.

Tumarkin's approach was part of the non-reductionist and humanist opposition to late nineteenth and early twentieth-century materialist psychology, and can therefore be regarded as part of a more general discourse on the scientific status of the humanities in German philosophy of the time. In German, humanities are called *Geisteswissenschaften*, literally 'sciences of the mind'. However, the German word *Geist* can also encompass the entire sphere of mental phenomena, even those that are shared socially, such as culture. The German historian, psychologist and philosopher Wilhem Dilthey (1833–1911), with whom Tumarkin studied in Berlin for three years after she finished her doctoral thesis, aimed to found the entirety of *Geisteswissenschaften* on the operation of understanding. Dilthey's influence on Tumarkin's psychology is evident. In his main psychological work, *Ideas for a Descriptive and Analytic Psychology,* he aimed to elaborate a foundation for the humanities, focusing on 'the reality of lived experience and on the immediate understanding of human life'.[21] Understanding in this holistic sense was the main method of the humanities for Dilthey. However, Tumarkin's opinion of Dilthey's work was rather ambivalent; though she endorsed his results, to some degree she rejected his methodology as too subjective and not goal-oriented or analytical enough.[22] In this extract, Tumarkin elaborated on Dilthey's work, rendering it more scientific and adapting it for the twentieth-century discourse on psychology.

Questions

1. How could one achieve 'understanding' of other people? What did Tumarkin mean when she says that there is a 'bond' that connects individual phenomena?
2. In what ways are general assertions about the human mind possible in accordance with Tumarkin's theory?
3. 'We […] understand an individual phenomenon, insofar as we perceive it by its context'. Comment on this statement – is this a feasible method for psychology or philosophy?
4. What does this source reveal about the role of women in the intellectual conception of the sciences?
5. What does this source reveal about how science was defined in this period?

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47

Kathleen Lonsdale (1903–1971): A letter to Hubert Peet, editor of *The Friend* magazine (1945)

Ash Arcadian[23]

Introduction

Kathleen Lonsdale (née Yardley, 1903–1971) was one of the first women to be elected Fellow of the Royal Society of London in 1945. Lonsdale began her scientific career in 1922 as a research student under William Henry Bragg (1862–1942) at University College London in a new field of physics: X-ray crystallography. This was a method that had been devised to determine the internal structure of crystals by bombarding them with X-rays and deducing their structures by a combination of observing the light diffraction, and no small amount of mathematics. In 1945, news of Lonsdale's potential election as Fellow of the Royal Society caused quite a stir, both inside and outside scientific circles. The source below is a letter written by Lonsdale to the editor of *The Friend* magazine, a weekly periodical for the Quaker community in Britain.

Source

University College London, Lonsdale Papers, GB 103 LONSDALE. Lonsdale, Kathleen. A letter to Hubert Peet, editor of *The Friend* magazine, (1945).

[This letter is reproduced with kind permission of Dr Stephen Lonsdale]

121 Station Road,
West Drayton,
Middlesex.
21.3.1945

Dear Hubert Peet,

I am returning the form for your obituary files.

The account you gave of my work on diamonds, taken from Chemical Age, was, if I remember, quite correct. If it had not been, I would have written to you. But my work on "artificial diamonds" has occupied not more than a few days out of my twenty two years of research work. It just happened to have "public appeal". What happened was that I tested a minute speck of dust labelled as being artificial diamond made by J. B. Hannay, a Scottish chemist & engineer, in 1879-80, and now in the possession of the British Museum. It proved to be a genuine diamond, and research into records made it seem probable that Hannay did in fact make it artificially (i.e. in the laboratory).

I certainly was not made a Fellow of the Royal Society for that!

My best-known work (among scientists) has been the determination of the structure and size of the benzene ring (a very stable ring of 6 carbon atoms that occurs in many thousands of chemical compounds); preparation of tables applying the mathematical theory of crystallography to practical X-ray analysis; new X-ray methods of determining the movements of atoms in solids about their average positions.

I'm sorry it won't go into 25 words!

There is one comment that I would like to make and which you may use either now or in my obituary, if you write it, & if you wish to!

In spite of the fact that many of my scientific colleagues and contemporaries strongly disagree with my religious views and the action I have felt bound to take as a result, not one has allowed it to make the least difference in his or her attitude towards me or my work. Nor have I ever felt that my sex was a hindrance. Before allowing my name to go forward for nomination to the fellowship of the Royal Society I enquired very carefully whether the nomination of a woman was likely to cause controversy or ill-feeling, because I felt that that would be very undesirable. Actually, a referendum to the entire body of fellows (reported Oct. '44 in The Times, and in "Nature", 154 Oct. 28, 1944 p. 543) showed that the admission of women, which had been legal since 1919, would in fact be welcomed, and I have been personally assured of this from many quarters. I need hardly say that this has given me very great pleasure.

- - -

Yes, I do realise that the reporter's lot is not a happy one, and I try not to be rude to one even when I am showing them the door. They can hardly expect me to comment on an event that may not occur, though!

With kind regards,
Yours sincerely,
Kathleen Lonsdale.

Analysis

This letter reveals the intersection of Lonsdale's professional and personal achievements, and suggests how what women scientists did, and what the public perception of them was, can shed light on the complex relationship between popular science, professional science and subjectivity. Lonsdale was nominated as Fellow of the Royal Society (FRS) for her work on the benzene ring by establishing its shape and structure. In this letter, she tells Hubert Peet that, 'among scientists', this was her best-known work. The popular science magazine, *Chemical Age*, had felt that it should be her work on artificial diamonds. At the time this letter was written, artificial diamonds had not yet been synthesised in the laboratory.[24] This was a development that would take another decade for scientists to achieve. Lonsdale's achievement had been to determine that a fragment of supposed artificial diamond made around 1880 was in fact a real diamond. Seemingly, a female scientist working on 'artificial diamonds' struck a more resonant chord with the editors of popular science magazines, more so than working out the exact shape of an abstract molecule. But in her personal papers, Lonsdale's record of achievements tended to place the preparation of mathematical tables, which is referred to in the second point in the second paragraph, consistently over and above her work on benzene.[25]

The creation of mathematical tables to assist later crystallographers with the complex equations needed to 'solve' the internal structure of a crystal, would cut out an enormous amount of time-consuming work that could be avoided should the method be tabulated effectively. Much of Lonsdale's work in constructing mathematical tables for this purpose took place in her home, and while she was recovering from childbirth, or on the dining table when the children were growing up. It could be argued that this was domestic work, in that it was work that was suited to the home; it needed little in the way of specialist equipment (though Lonsdale was not shy of putting together, modifying or even designing equipment herself), but it required space and time. Perhaps this work was deemed less exciting to the reading public than the work on benzene, and for professional scientists too, who would happily rely on the tables for their own crystal work. However, work on the tables continued to occupy Lonsdale's time – among other things – into the 1950s and 60s, when the children were grown up and she was employed in substantive research posts.

The last paragraph of the letter touches on Lonsdale's personal religious beliefs and how they, and her sex, had impacted on her work in science. It might seem surprising that Lonsdale first mentions that she experienced no hindrance due to her sex, and yet then goes on to note her efforts to investigate whether or not it would cause 'ill-feeling' or might be likely 'to cause controversy' within the ranks of the Royal Society.

Her religious beliefs are not well documented, given their deeply personal nature, but Lonsdale did find expression of them within the remit of her scientific work and publications: 'Contributions of Science to Peace' (in *Physics Bulletin*, 1953) and *Is Peace Possible?* (Penguin, 1957). These leanings dramatically shaped her scientific views – Quakers were both supporters of women's education and leaned towards more observational branches of science – but were founded in deeply held personal and religious convictions.[26] As a Quaker and a pacifist, Lonsdale refused to do compulsory service during the Second World War by refusing to sign up as a fire watcher.[27] She was sentenced to one month in prison in default of unpaid fines for this, but she carried on her scientific work from the confines of a prison cell.[28] Her unwavering pacifism led her to undertake pacifist work for the rest of her life (alongside scientific work), and she later remarked that she had strong views on the potential for the global collaborative work of science in this process.[29] Her personal history of being subjected to parental alcoholism and familial discord, bombing in both world wars (including witnessing an exploding zeppelin full of people over Ilford) and the loss of people close to her, all when she was still a small child, may put her religious views in some context.[30]

Questions

1. Why is the difference between what scientists do, and what the public believe that they do, important for the history of science?
2. What does the disparity between what the editors of Chemical Age considered to be Lonsdale's highest achievement, and what she herself considered it to be, tell us about the relative value ascribed to different activities?
3. What does this letter reveal about the prevailing attitudes towards certain religious groups during this period? How did this impact Lonsdale's life and career?
4. Consider the different physical settings in which Lonsdale conducted her work. How might this have affected the popular perception of this work?
5. Are there any similarities between the image of science popularisation in this source, and how science is popularised in the media today?

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48

Rosalind Franklin (1920–1958): 'Photograph 51' and a 50 pence piece marking the centenary of her birth

Professor Frank A. J. L. James

Introduction

In 2020 the Royal Mint issued a number of commemorative 50 pence coins devoted to various subjects. These included the final coin in a series on Peter Rabbit as well as one marking Britain leaving the European Union. More seriously, it minted a 50 pence piece marking the centenary of Rosalind Franklin's birth on 25 July 1920. The design of the coin drew inspiration from the famous 'Photograph 51', an X-ray image of crystalline DNA fibre, taken in 1952. This 50 pence piece joined the £2 coin issued in 2003 marking the fiftieth anniversary of the determination of the structure of DNA, though, tactfully, that coin did not reference any individual. How scientists are remembered and commemorated is always important because of what it reveals about the self-perception of the scientific community and of the place of science in society and culture generally. But in Franklin's case, the development of her reputation and its commemoration after her early death is especially crucial.[31]

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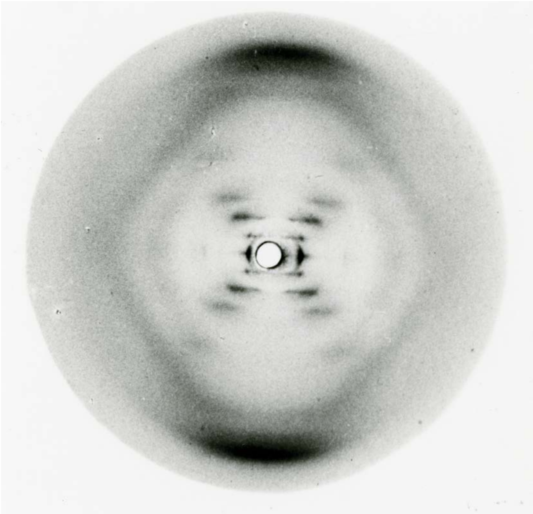

Figure 11.2a 'Photograph 51' an X-ray image of a crystalline fibre of DNA taken at King's College London in May 1952. Image credit: reproduced with permission of King's College London Archives, King's College London: Department of Biophysics records KDBP 1/1.

Figure 11.2b 50 pence piece issued by the Royal Mint in 2020 marking the centenary of Franklin's birth. The design, by Dave Knapton, is based on Photograph 51. Image credit: The Royal Mint (2020).

Analysis

Born into a wealthy Anglo-Jewish family (her father was a merchant banker), Franklin grew up in West London. In the 1930s she attended St Paul's Girls' School, Hammersmith, before going to Newnham College, Cambridge, to read the Natural Sciences Tripos, taking her part two in chemistry in 1941. Wartime exigencies meant that she was directed to undertake her PhD research with the Coal Utilisation Research Association. One of the many inter-war research associations, this Association was established from other organisations brought together shortly before the war began. Its experimental station was in West Brompton and there Franklin undertook the research for her thesis, *The Physical Chemistry of Solid Organic Colloids, with Special Reference to the Structure of Coal and Related Materials,* for which University of Cambridge awarded her a PhD in October 1946.

She realised that to build on this work, particularly to understand the internal structure of coal, she would need to learn the techniques of X-ray crystallography and, to that end, the following year she moved to Paris to work with Jacques Mering at the Laboratoire Central des Services Chimiques de l'État. There she successfully learnt the techniques and undertook fundamental studies of the structure of coal, graphite and other materials, some of which laid the foundations for constructing carbon fibres. On the basis of this work, she was invited to return to London to work at King's College with the specific intention of building up an X-ray crystallography laboratory to study the structure of DNA working with, among others, Maurice Wilkins. She accepted the invitation and began work in 1951, having taken a flat in Drayton Gardens, Chelsea. At King's, Franklin, with her student Ray Gosling, began taking ever clearer images of crystallised DNA (Photograph 51 was taken in May 1952), determining that there were two types of DNA (which she named A and B) and measuring (within limits) the distances between its atoms. Despite such success, there were tensions between Franklin and her colleagues at King's, especially Wilkins. This was partially related to her (probably justified) unwillingness to compromise with her (male) colleagues and partially a result of their perception (perhaps tinged with touches of misogyny and anti-Semitism) of her single-minded 'dedicated, austere life'.[32] This was hardly fair; her friends and relations frequently commented on her sense of fun, her strong cultural interests – especially languages – outside science and her other activities, such as mountaineering.[33] Nevertheless, the outcome of the clashes at King's resulted in her moving to work with John Desmond Bernal at Birkbeck

College in March 1953. There, leading her research group, she concentrated on the structure of tobacco mosaic virus, determining, via its structure, how its infection was transmitted – another fundamental piece of work.[34] She died of cancer (did she over-expose herself to X-rays during her career?) a few months short of her 38th birthday in 1958.

In the early 1950s, Francis Crick was a difficult and arrogant research student in his mid-thirties (he had spent the war as an Admiralty experimental officer) at the Cavendish Laboratory in Cambridge directed by Lawrence Bragg. He later claimed that since the agent responsible for the transmission of genetic information must have evolved early in the development of life, it was liable to be relatively simple. DNA was an obvious candidate, though by no means the only one. Nevertheless, at King's College, at the Cavendish, and at the California Institute of Technology under Linus Pauling, in the late 1940s and early 1950s enormous effort was devoted to establishing the structure of DNA. In 1951, Crick was joined at the Cavendish by a brash, young, American post-doc, James Watson, who also developed an interest in DNA. Without Franklin's knowledge, Wilkins showed Watson a copy of Photograph 51 and Max Perutz (Crick's supervisor) gave him some of Franklin's data, again without her authorisation.[35] Using this information, Crick and Watson quickly determined the double helical structure of DNA and its probable role in transmitting genetic information. Their paper was published in *Nature* on 25 April 1953 under the generic title of 'Molecular Structure of Nucleic Acids' including also a paper by Franklin and Gosling and one by Wilkins and his collaborators. Crick and Watson acknowledged that they had 'been stimulated by a knowledge of the general nature of the unpublished experimental results and ideas' of Franklin and Wilkins.[36] Nevertheless, no one at the time seems to have appreciated the enormous contribution that Franklin's work had made to determining the structure of DNA, and because of the underhand way her work had been obtained and used, she may not have realised it herself. In a later edition of *Nature*, John Maddox (husband of one of Franklin's biographers), claimed that he would have looked more thoroughly into the background before publishing the papers.

As the structure of DNA and all that flowed from it became increasingly important (Crick, Watson and Wilkins jointly won the 1962 Nobel Prize for Physiology or Medicine), in the mid-1960s Watson decided to tell the story of the work in the form of an autobiography initially entitled *Honest Jim*. But as the controversy surrounding the circulating typescript mounted, it was eventually published, somewhat amended, as *The Double Helix* (1968). In his placatory 'Foreword' Bragg reflected on the ethics of working in the same scientific area as others.[37] Unable to ignore her, but presumably intending to minimise the importance of her contribution to determining the structure of DNA, Watson set about demeaning Franklin, who had died 10 years before, in a most egregious, unkind, unprofessional character assassination. He consistently referred to her throughout with the dismissive diminutive 'Rosy' (which she never used), implied that she was a 'blue-stocking', did not have even a 'mild interest in clothes' and so on.[38] If Watson's intention had been to minimise her contribution, it backfired spectacularly. As a result of *The Double Helix* it was soon appreciated, for example in Anne Sayre's 1975 book, that Franklin had indeed fundamentally contributed to understanding the structure of DNA.[39]

As a result of all this, Franklin quickly became a major feminist icon for science and has been commemorated in several ways, thus constructing and developing, from almost nothing, her now enormous reputation. Several universities, some with no connection to Franklin, have named buildings after her. Of those where she worked, Newham College named an accommodation building after her, while King's Waterloo Campus has the Franklin-Wilkins building housing the dental school and Birkbeck the Rosalind Franklin Molecular Biology Laboratory. More recently the interdisciplinary Rosalind Franklin Institute has been founded at Harwell. But, perhaps most spectacularly, in 2003, that 90 per cent male bastion of science, the Royal Society of London (founded 1660, but only admitting women since 1945), established the Rosalind Franklin Award for women in science. She had, of course, died before there would have been any possibility of her being elected a Fellow. Finally, in the late 2010s, she was a strong contender to appear on the Bank of England's new £50 note issued in 2021 (featuring Alan Turing). For the time being, one must be content with the image of Photograph 51 on the 50 pence coin – at least more people will see that than the note.

Questions

1. Had Franklin lived, might she have shared the 1962 Nobel Prize instead of Wilkins? (NB: the prize can only be awarded to at most three individuals a year). Note also that Jocelyn Bell Burnell did not share in the 1974 Nobel Prize for Physics for the discovery of pulsars.
2. Is it useful to emphasise prominent individuals when seeking to expand the role of under-represented groups or could it be a distraction from addressing broader issues?

3. How important are commemorative practices in drawing attention to and understanding the role of science in society and culture?
4. Has the ethical framework for scientific research and publication improved, stayed the same or got worse since the early 1950s?
5. Why do some men dislike clever women?

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Part XI notes

1 Fara, *A Lab of One's Own*.
2 Rossiter, 'A Twisted Tale', 65.
3 For the experience of women during and after the First World War, see Fara, 'Women, Science and Suffrage in World War I', 2015, 11–24. For the position of women in science during the second world war in the United States, see Jack, *Science on the Home Front*.
4 For an example from the field of chemistry see Horrocks, 'A promising pioneer profession?' 2000, 351–367.
5 Yet as Aileen Fyfe and Camilla Mørk Røstvik have shown, inclusion within the Fellowship of the Royal Society does not necessarily entail full participation. See Fyfe and Røstvik, 'How female fellows fared at the Royal Society', 2018.
6 Crowther, 'Prominent Yorkshire Workers', 1913, 291–293.
7 Staff file E. M. Wakefield (1/Staff/59). The Archives of the Royal Botanic Gardens, Kew.
8 Staff file E. M. Wakefield (1/Staff/59). The Archives of the Royal Botanic Gardens, Kew.
9 Blackwell, 'Elsie M. Wakefield, O.B.E., M.A.: 1886–1972', 1973, 167–174.
10 Wakefield and Dennis, *Common British Fungi.*
11 Anon, 'Elsie M. Wakefield', 1972.
12 Stanley, 'Women in the UK Civil Service – History'.
13 Green and LaDuke, *Pioneering Women in American Mathematics*.
14 Keller, *Reflections on Gender and Science*; Milam and Nye, 'An Introduction to Scientific Masculinities'.
15 Jones, *Femininity, Mathematics and Science*; Oldenziel, *Making Technology Masculine*.
16 Rossiter, *Women Scientists in America,* 53.
17 Rossiter, *Women Scientists in America,* 73.
18 Parshall and Rowe, *The Emergence of the American Mathematical Research Community*.
19 Rogger, *Der Doktorhut im Besenschrank,* 164. Translated by Stefan Reiners-Selbach.
20 Beiser, 'Gustav Theodor Fechner', 2020 and Kim, 'Wilhelm Maximilian Wundt', 2016.
21 Makkreel, 'Wilhelm Dilthey', 2016.
22 Jánoska, 'Die Methode der Anna Tumarkin', 156–159.
23 Contribution written while at the University of Sussex.
24 Bundy et al., 'Man-made Diamonds', 1955, 51.
25 University College London, Lonsdale Papers, Autobiographical and Biographical, Box A14, handwritten Curriculum Vitae.
26 For discussion of Quaker approaches to both women's education and the sciences, see Cantor, *Quakers, Jews, and Science.*

27 Baldwin, 'Where Are Your Intelligent Mothers To Come From?', 2009, 93.
28 University College London, Lonsdale Papers, Autobiographical and Biographical, Box A48, Letter to the Governor of HMP Holloway.
29 BBC Woman's Hour, 'Dame Kathleen Lonsdale'.
30 Julian, 'Dame Kathleen Lonsdale (1903–1971)', 1982, 965.
31 While some of her papers remain in private hands, there is a significant deposit of Franklin's manuscripts in the Churchill Archives Centre, Churchill College, Cambridge. Images of much of this archive were digitised as part of the 'Codebreakers: Makers of Modern Genetics' project and can be accessed via the Wellcome Collection online catalogue: https://wellcomecollection.org/collections (accessed 16 December 2022).
32 Watson, *The Double Helix,* 17.
33 Glynn, *My Sister Rosalind Franklin*, 32 (which includes a splendid photograph of her among Norwegian peaks), 76, 85, 116, 148 (for her mountaineering exploits).
34 Creager and Morgan, 'After the Double Helix', 2008, 239–272.
35 Maddox, *Rosalind Franklin,* 196–199.
36 Watson and Crick, 'A Structure for Deoxyribose Nucleic Acid', 1953, 737.
37 Bragg, 'Foreword', vii-ix.
38 Watson, *The Double Helix,* 17.
39 Sayre, *Rosalind Franklin and DNA*.

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Part XII

Embodied female experiences of science (1965–present)

Timeline: individuals, events and publications in the history of science	Timeline: individuals, events and publications in this part
	b. 1947 Margaret 'Peggy' Ann Lucas, American electrical engineer and Assistant Scientific Director of the Tektite II mission, an underwater living experiment off the coast of Saint John, one of the Virgin Islands in the Caribbean Sea.
1950s The drug Thalidomide is developed in West Germany and is used to treat a range of conditions including morning sickness in pregnant women. It is several years before the connection is made between pregnant women taking the drug and the impact on their babies. This discovery leads to changes in drug testing and the way that side effects are reported.	
1951 Carl Djerassi, Austrian-born Bulgarian-American chemist, and his group working at the company Syntex in Mexico City, synthesise the first effective oral contraceptive.	

Timeline: individuals, events and publications in the history of science	Timeline: individuals, events and publications in this part
1951 Cervical cancer cells are taken from African American woman Henrietta Lacks, from which the immortal HeLa cell line is derived. The cells were given to a medical researcher without Lacks's knowledge or consent.	
1955 The beginning of the Space Race between the United States of America and the Soviet Union (USSR).	
1961 Yuri Gagarin, Soviet pilot and cosmonaut, becomes the first person to travel into outer space.	
1963 Valentina Tereshkova, Soviet cosmonaut, becomes the first woman to travel into outer space.	
	1978–2005 cynomolgus monkey breeding programme at the RIVM (Dutch National Institute of Public Health and Environment), where monkeys were bred to be used in the production of the polio vaccine.
	c. 1980s a handwritten recipe is passed down to friends and family by a British working-class woman.
1983 HIV-1 is discovered by French medical researchers Luc Montagnier and Françoise Barré-Sinoussi at the Pasteur Institute in France.	
1990–2003 The Human Genome Project seeks to determine the base pairs that make up human DNA, and identify all the genes in human DNA.	

Timeline: individuals, events and publications in the history of science	Timeline: individuals, events and publications in this part
1996 Dolly the sheep is created by cloning as part of a series of experiments at the Roslin Institute at the University of Edinburgh.	
	2009–15 'An Oral History of British Science', a National Life Stories project, is completed in collaboration with the British Library. It is a collection of audio interviews capturing the life stories of many British scientists, including Stephanie Shirley (b. 1933), Janet Thomson (b. 1942), Sue Vine (fl. 1960s) and Charlotte Armah (b. 1970).

Introduction

This part grapples with some of the ways science has defined female bodies – both human and animal – from the 1960s onwards. Women's bodies have prompted intense scientific debate within much of the period covered by this sourcebook. In nineteenth-century Europe, differences in male and female bodies were cited as evidence for the physical and mental inferiority of womankind.[1] Moving into the twentieth century, these gendered conceptions of ability continued to plague scientific understanding of women's bodies, as well as autonomy over them.

Although 'sexually liberated' women in the 1960s and 1970s gained some autonomy over their sex lives, by the late twentieth century women were still regarded as unequal within wider society. Part of this bias was informed by scientific constructions of gender differences.[2] As a result, women have been considered less reliable scientific witnesses; when women first reported experiencing side effects from oral contraceptives, their personal experiences were dismissed as inaccurate.[3] Scientists have also considered women's bodies as unsuitable research subjects; women were and continue to be excluded from medical testing because normal and natural female hormone fluctuations have supposedly unpredictable effects on clinical trials. This exclusion has continuing consequences for women's medical care.[4] Meanwhile, women's abilities as producers of scientific knowledge have continued to be questioned, with scientific research used to bolster racist and patriarchal views. Richard Herrnstein and Charles Murray's early 1990s research into intelligence, race and gender, published in their 1994 work *The Bell Curve: Intelligence and Class Structure in American Life,* disparaged female intelligence, especially the intelligence of low-income Black women.[5] The persistence of these kinds of views mean that Black women and women of colour in particular continue to be systematically underrepresented within science and technology industries, including academia.

The first source in this part is an interview with Margaret 'Peggy' Ann Lucas (b. 1947) about her role in the NASA mission Tektite II, exploring women as subjects in scientific trials when they themselves are scientists. In this context, we see Lucas and her Tektite colleagues demonstrating the feasibility and importance of using female bodies in scientific exploration and experimentation. The second source is an image of female monkeys used in a breeding programme for polio vaccine testing. Although non-human, this source allows us to explore the role of gender in relation to animal bodies used within science. The third source is a handwritten family recipe which, as in part three, raises questions about the gendered nature of what we consider to be scientific knowledge production. Particularly since science has become so sharply defined in the twenty-first century, this source challenges us to continue to question where the boundaries are drawn between scientific and other forms of knowledge.[6] The final source in this part is a series of excerpts from the British Library's National Life Stories project (2009–15). These extracts reveal the experiences of women working in science, including their treatment by colleagues, and their interactions with the infrastructure of science. The 'what', the 'where', and the 'who' of science and knowledge production, and the complex historical position of women within this amalgam, are all drawn together as themes within this final source, which looks at the lived experience of women in science today.

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Margaret ‘Peggy’ Ann Lucas (b. 1947): 2013 interview with Spaceflight Insider about the Tektite II mission (1970)

Dr Antony Adler

Introduction

In the summer of 1970, Margaret ‘Peggy’ Ann Lucas (b. 1947) participated in an underwater living experiment off the coast of Saint John, one of the Virgin Islands in the Caribbean Sea. Together with four other women, Lucas lived and worked in an underwater habitat named Tektite. Lucas was Assistant Scientific Director of the Tektite II mission and served as the engineer. The underwater project was managed by the United States Department of the Interior in partnership with the National Aeronautics and Space Administration (NASA). An important goal of the 10-day mission was to study the effects of isolation on the ‘aquanauts’ in preparation for future missions to space. The successful completion of Tektite II helped lay the groundwork for the inclusion of women astronauts in the U.S. space programme. The other four members of the Tektite mission included Ann Hartline (b. 1947), Alina Szmant (b. 1946), Renate True (1936–2017) and team leader Sylvia Earle (b. 1935). The following is an interview with Lucas conducted by staff of the website Spaceflight Insider and published online 9 December 2013.

Source

'NASA's Tektite II Undersea Habitat: An Interview With Aquanaut & Engineer Peggy Lucas Bond', *Spaceflight Insider*, 9 December 2013. Accessed 15 February 2022. https://www.spaceflightinsider.com/space-flight-news/nasas-tektite-ii-undersea-habitat-an-interview-with-aquanaut-engineer-peggy-lucas-bond/

Spaceflight Insider: It seems unusual that a female chose to study engineering in the 1960s. Tell me how that came about.

Peggy Lucas: There were not that many engineers. However, during World War II there were quite a few women that went into engineering. Then things fell off. For me, it was quite unscientific! In my freshman year of high school, my family moved from Washington, D.C. to the Philadelphia area, and we drove by a college. I said. 'That's a really cool campus, that's where I'm going to go to school!' My father said, 'You can't, it's an all-male school.' The school was Villanova, and in my sophomore year I found out they were taking female engineers. I was good at math and interested in computers. If you were interested in computers in 1964, you became an electrical engineer. So that's what I did! There were only two other female engineers at the time. Now a third of the class is female.

Spaceflight: What made you apply for or wind up doing this mission?

Lucas: Well, 'wind up' is the appropriate thing! I was at grad school at the University of Delaware, and I was on a sea grant fellowship, which at that time was administered by the National Science Foundation. The assistant director of the sea grant at NSF, Hal Goodwin, was the scientific member on the board of the Tektite II project, and he was responsible for finding all the scientists and approving their scientific programs. He had been a real promoter of the women's team. In fact, he wanted a team of couples as well and Hal just really wanted women in there however he could. They wouldn't allow a mixed team, but they figured that they could also kill the female team by saying, 'We don't have a female engineer.' It came down to telling Hal Goodwin one day, 'If you can find a female engineer, we'll have a female team.' And he called my thesis adviser one day and said, 'Do you think Peggy swims?' It so happened I'd been a lifeguard!

Spaceflight: What was it like down there? Were you claustrophobic? Afraid?

Lucas: The reason we were underwater, and we were at a depth where after a day, you could not surface without getting the bends. That was the NASA design requirement. What they wanted to do was recreate a working environment that you couldn't escape from. That was why these were really, really important psychological things. You were down there until they brought the bathyscaphe down and you went in the compression chamber and came up to the surface. Typically anyone who dives is not claustrophobic. Probably the worst thing of the whole thing was the food.

Spaceflight: Tell me about that. Were you able to cook? What did you eat?

Lucas: We had an electric stove or an electric burner that you could heat things up with, but they were also trying some of the new space food. Some of it was pretty bad. I think we wound up eating a lot of peanut butter and jelly. We had freeze-dried food, it was the beginning of freeze-dried and we had a lot of powdered food. We had freeze-dried spaghetti, I do remember that, and we had powdered eggs. I don't think we had fresh milk or fruit, it was all pretty much packaged kinds of things we ate. A lot of it was frozen, we had a refrigerator with frozen food.

Spaceflight Insider: As an engineer, did you get to go out in the water a lot?

Lucas: One of the things that is probably true to any minority group, ours was bound and determined to do everything better than the men could do. So the women logged in more hours in the water than anyone. Typically the teams were two people who worked together on a project. The women's team was quite different. We had two women, Ann Hartline and Aline Szmant, who worked on one project. Sylvia Earle and Renate True had their own projects, so very often I would wind up being a partner for one or the other of them. So I did go out a lot.

Spaceflight: In addition to the isolation study, what other types of things were going on?

Lucas: Alina and Anne's experiments had to do with fish and their responses to shadows. At the moment I can't remember what Sylvia's experiments were, but Renata had a really interesting one. She put down artificial grasses on the ocean floor, and determined that the grass attracted the fish not necessarily because it was something for them to eat, but that it was protection from the larger animals.

Spaceflight: I met Scott Carpenter a few months before he passed. Were there similarities between SEALAB [experimental underwater habitats developed by the United States Navy] and Tektite?

Lucas: We were only fifty feet down – they were over two hundred feet. The ramifications of the dangers on that were unbelievable. They were in the Pacific as opposed to the Caribbean. It was a totally different environment and they were doing totally different things, and a lot of theirs was geared towards manipulating tools undersea, basically things that would help rescue submarines or help with offshore drilling. Theirs was more a rescue-based concept. Scott [Carpenter] was down at Tektite for about a month, around the time the women's team was there.

Spaceflight: One of the aims of *Tektite II* was dealing with isolation. We're hearing about Dennis Tito and his plans to go to Mars with his wife, what's your sense of it?

Lucas: I think it has to be an individual choice, and you have to make it because you really want to do it. And then somebody has to determine if you can handle it. But I think if you're motivated enough, there's no reason why you couldn't do it. Mike [Lucas' husband] and I talk occasionally about the concept of going to Mars, and what it would take to get somebody to volunteer knowing they probably wouldn't come back. I suppose that physically if I were younger, had children that were grown and those kinds of things, I might seriously think about doing it. But I think I'm too old to do it, and space was never one of my things.

Spaceflight: What was the hardest thing, and your favorite moment?

Lucas: The hardest moment was telling everybody they had to slow down and do things right. There was one spot in the entire habitat where you could go without being seen or heard, and two of us went in there and talked about, "What do I do next?" That was the worst. Actually, there was one other thing that wasn't scary until you actually thought about it. We actually had an earthquake when we were down there. It was about 3.5 on the Richter scale. It shook the whole habitat and alarm bells went off inside, and then it was over. We didn't know what it was, we found out about twenty minutes later! My favorite moment? It was just all fun. It was work, and you had to pay attention and you had to be aware, but nothing was a highlight. The whole ten days was a highlight.

Analysis

Lucas, Earle, True, Hartline and Szmant completed the two-week *Tektite II* mission to live and conduct scientific work in an underwater habitat and laboratory in July 1970. The all-female mission was one of several which collectively made up the first government funded scientists-in-the-sea program in the United States. The name of the underwater habitat, Tektite, symbolised the dual function of the programme to connect both ocean and space exploration. Tektites are small, glassy, meteorite fragments sometimes found on the seabed. The Tektite II mission was one of several experiments in saturation diving conducted during the 1960s and 70s.[7] Supporters of the project proclaimed that habitat technology heralded a new era in which humans would eventually colonise the seafloor. The programme was a collaborative effort between the U.S. Navy, NASA and the Department of the Interior. However, unlike the navy's SEALAB program, the Tektite habitat was staffed by civilian scientists and intended as a proof of concept for future underwater experiments. Scientists, engineers and popular writers made predictions of underwater cities and the opening of a new underwater frontier.[8] 'Tektite points toward man's eventual control of the ocean,' announced a journalist for the *New York Times*.[9]

The site chosen for the habitat was Lameshur Bay in the U.S. Virgin Islands. The area provided access to the nearby coral reef where researchers could conduct biological studies in situ. Astronaut-turned-aquanaut Scott Carpenter visited Tektite and was given a tour of the site as the female team was making preparations for their mission. In an editorial for *Popular Science*, he described the 'rare and somewhat eerie sight' of 'five girls clad in bright-orange wetsuits, with stark white backpacks, working on their projects in brilliant blue-green water'.[10] Despite their academic qualifications, the female team faced chauvinistic hostility. Peggy Lucas recalled that even the director of the Tektite program, Dr James W. Miller, had publicly opined, 'You can always expect behavioral problems where women are involved,' while one of the male divers from an earlier mission predicted, 'Let's face it; girls just don't get along as well as men'.[11] As we can see in Lucas's interview above, these disparagements only spurred on the women's team to prove their detractors wrong.

Underwater habitats did not lead to the colonisation of the seafloor, but the female-led Tektite II mission proved women were equally capable when carrying out demanding scientific work under extreme conditions. A central aim of the Tektite II mission was to conduct psychological tests to aid future space missions. By the mid-1960s, plans were in motion to develop the first orbiting space station and researchers hoped to study the psychological difficulties of living in remote and confined spaces. The mission was thus an important step toward the inclusion of women in NASA's astronaut corps in 1978. As project psychologist Robert Helmreich reported, 'the high work output of the female team implies that females are capable of maintaining a work pace equal to that of males in an underwater habitat.' In fact, the research output of the women's team outpaced that of the men. Helmreich suggested this was 'an indication of the natural superiority of women', though he also noted that the publicity surrounding the female mission gave added motivation to the team.[12] As Sylvia Earle later recalled:

> Many predicted that we would not get along or that, in more ways than one, couldn't handle the pressure … In fact, we bonded quickly and took seriously the unique opportunity to use the ocean as a laboratory… Our success, we were later told, helped open the way for NASA to accept women as full-fledged astronauts, an unintended but welcome outcome.[13]

Questions

1. How could NASA's interests in underwater habitats in the 1960s and 1970s be connected to American military and imperial interests?
2. How did the members of the all-female Tektite II mission see their roles as part of the Tektite program?
3. What does Lucas' interview tell us about the mechanisms for women's inclusion in science in the 1970s?
4. Does the Tektite programme challenge or reinforce narratives about gender identities, work and science?
5. What do contemporary comments about the Tektite II mission tell us about wider perceptions of female scientists in this period?

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50

Unnamed female monkey: Image of monkeys in a breeding programme for polio vaccine testing (1978–2005)

Anne van Veen

Introduction

This image is from the image bank of the Dutch National Institute of Public Health and Environment (RIVM in Dutch). It shows two young cynomolgus monkeys named Fred and Chris with their (unnamed) adoptive mother in a cage in the breeding facility of the RIVM, where monkeys were bred to be used in the production of the polio vaccine. This breeding programme existed from 1978 until the early 2000s, when a cell line replaced the monkeys. The picture was taken by the animal technician that hand reared Fred and Chris after their mother died, until they were old enough to be adopted by the female cynomolgus monkey shown in the picture. This was common practice in cases of orphaned monkeys; according to the animal technician, the female monkeys were very eager to adopt them. The exact date of the picture is unfortunately unknown.

Source

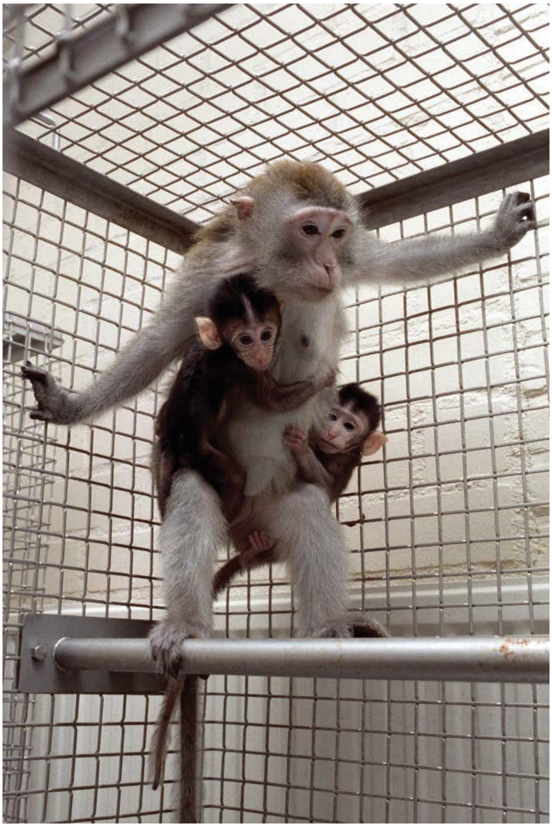

Figure 12.1 Photograph of an unnamed female monkey who was part of a breeding programme for polio vaccine testing at the Rijks Instituut voor Volksgezondheid en Milieu (RIVM), taken by an anonymous laboratory technician. Image credit: Rijks Instituut voor Volksgezondheid en Milieu (RIVM).

Analysis

This source raises questions about the intersection of species and gender in the use of nonhuman female bodies as resources for scientific practices. This image is part of a larger series of images of monkeys in the breeding programme. Most of these images are 'cute' pictures of young monkeys with their mothers or playing. There is only one picture of a monkey on an operating table and there are a few of monkey kidneys in a jar.[14] We can say that the images reflect a human gaze, showing what humans enjoy looking at, but leaving out many (negatively) impactful moments in the monkeys' lives. The experiences of female monkeys in the breeding programme differed from that of male monkeys, not only because of their role as mothers (they stayed with their babies until weaning, fathers did not), but also because of measures taken to 'improve conditions and procedures to get to an optimal production and supply of cynomolgus monkeys', which led to more intimate human-monkey interactions for female than for male monkeys.[15] For example, after an unsuccessful first mating, animal technicians conducted a daily vaginal flushing of the macaque with 0.2 cc of saline solution and collected the mucus on a clean glass plate. The second mating was then planned based on the fern pattern in the mucus, the appearance of which was thought to be indicative of rising oestrogen levels. For the same purpose, daily urine samples of female monkeys were also collected.[16]

The opportunities for a female monkey to have intercourse were thus strictly controlled by humans, both timewise and regarding choice of partner. When female monkeys became pregnant, they lived either alone or with another pregnant female. The latter was preferred by humans, because they had found that babies from two mother monkeys housed together were in a better physical condition than babies from females kept individually. This made it possible to wean the baby monkeys at an earlier age.[17] The mothers' babies were taken away from them after five to six months and then the cycle of mating, pregnancy and motherhood would start again. Based on this information, we can see that the lives of female monkeys were rather different from those of male monkeys, whose job was done once the female monkey was impregnated.[18] We can also see that many of their experiences were not reflected in the images humans chose to take and save.

In writing nonhuman animal histories, we face the challenge of dealing with sources created by humans in a world where anthropocentrism is omnipresent. To write a history inclusive of other animals as subjective beings, we have to actively look for the 'animal in the archive'.[19] As Benson and Woods argue, traces of the nonhuman animal can still be found in human sources, as both human and animal are co-constructed.[20] The human-animal distinction is not a natural given, but a construction that can be reproduced as well as challenged. Constructions of 'the human' are by definition relational; what it means to be human is constructed in relation to what it means to be nonhuman animal (and vice versa).[21] Therefore, 'Everything we do, including writing, is shaped by our long evolutionary history of interactions with other animals and our present lived interdependence with them'.[22] Consequently 'human' sources are already always interspecies sources. The image above, though obviously taken from a human perspective, can still give us information about the lived experiences of the depicted monkeys. While the image reproduces a human/animal dichotomy, it can also challenge this dichotomy by eliciting an empathetic response in the human viewer. We do not (only) see a breeding instrument, but also a fellow primate and relational being, who cares for her adoptive children Fred and Chris. However, what we can see goes beyond the individual experiences of the three monkeys. Historian Joshua Specht, in writing about documenting animal histories, reminds us of the importance of accounting for constraining structural forces:

> The emphasis on individual autonomy - human or otherwise - provides voice and power to neglected groups, but risks obscuring the structural forces that constrain their actions and explain different actors' historical marginality in the first place. An investment in proving animal agency can actually have the effect of minimizing the profound ways that humans have circumscribed and dominated animal life.[23]

These structural forces are also visible in this picture. The cage in the picture indicates that interspecies power relations (both within the laboratory and in society in general) played a major role in this female monkey's life, making it possible for humans to exert control over virtually every aspect of her life.

Questions

1. How can historians write non-anthropocentric accounts of nonhuman animal histories? How can images be helpful with this compared to textual sources?
2. Can you find other images of female nonhumans, where structural forces constraining their actions are visible?
3. To what extent is the treatment of female nonhumans, as opposed to male nonhumans, a reflection of human constructions of gender roles?
4. What do images like this add to wider discussions of scientific discovery and vaccination development in the twentieth century?
5. Can the use of nonhuman animals in medical research be linked to nineteenth-century ideas about biological hierarchy?

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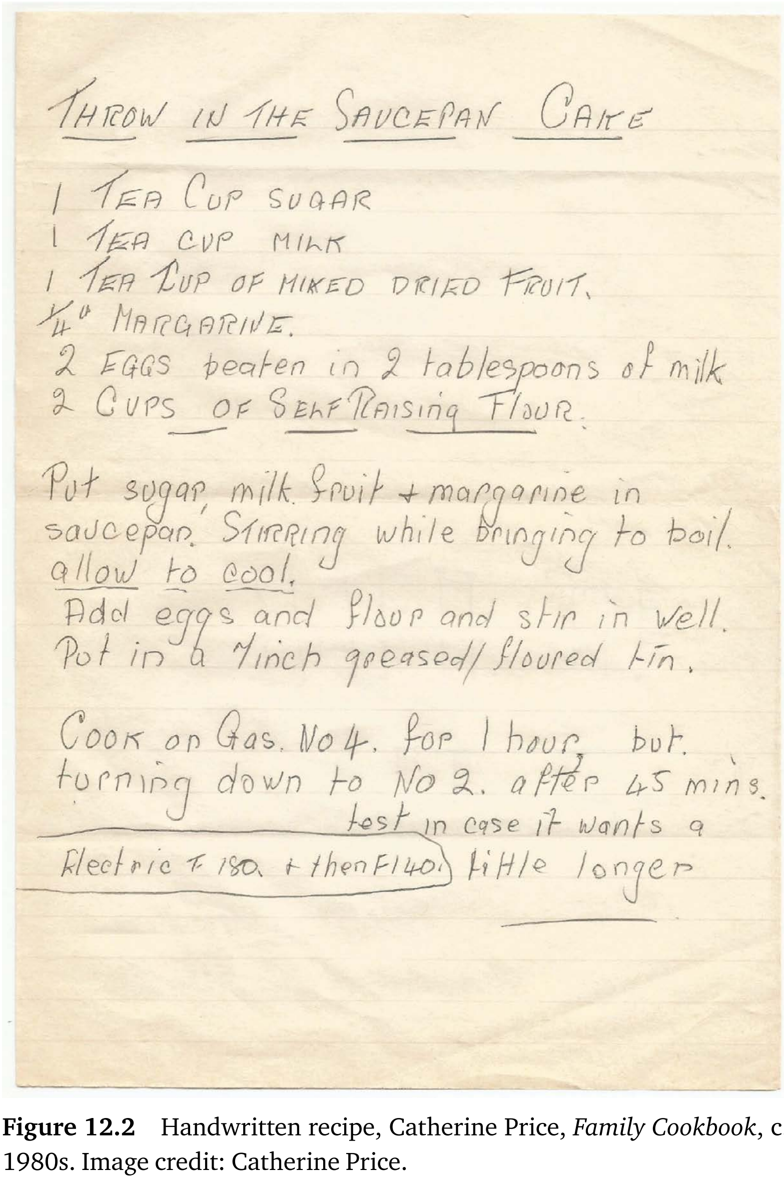
51
Unnamed working-class woman: Handwritten family recipe (1980s)

Dr Catherine Price

Introduction

Many women learn to cook from mothers, grandmothers, mothers-in-law or female friends and neighbours. Associated with this is the passing down of recipes and of knowledge. The source below is a recipe from a homemade cookbook. The handwritten recipe was written by a family friend of the author. This recipe was created by a working-class woman in the 1980s and it was written down and passed to family members and friends. The act of writing and passing on recipes through female networks of family and friends is one with a deep history (consider Mary Chantrell's seventeenth-century recipe book included in part three). This act is one of knowledge production and communication that challenges and expands on what we consider science.

Source



THROW IN THE SAUCEPAN CAKE

1 TEA CUP SUGAR
1 TEA CUP MILK
1 TEA CUP OF MIXED DRIED FRUIT.
1/4" MARGARINE.
2 EGGS beaten in 2 tablespoons of milk
2 CUPS OF SELF RAISING FLOUR.

Put sugar, milk, fruit + margarine in saucepan. STIRRING while bringing to boil. allow to cool.
Add eggs and flour and stir in well.
Put in a 7inch greased/floured tin.

Cook on Gas. No 4. for 1 hour, but turning down to No 2. after 45 mins. test in case it wants a little longer
Electric F 180. + then F140.

Figure 12.2 Handwritten recipe, Catherine Price, *Family Cookbook*, c. 1980s. Image credit: Catherine Price.

Analysis

Cookbooks can either be purchased from the myriad which are available, or they can be homemade. Modern homemade versions can include clippings collected from magazines and newspapers, and handwritten recipes passed between family, friends and neighbours. Homemade cookbooks can also facilitate and embody family history, providing opportunities to share knowledge, often intergenerationally. There are often also stories in or behind the recipes. Well-thumbed pages indicate those recipes which have been used for special occasions and celebrations, while pages in a more pristine condition indicate either disinterest or the ability to memorise recipes for everyday cooking. Everyday cooking, once mastered, usually does not require a recipe as it can be performed from instinct and memory, whereas speciality cooking such as cakes, desserts and pastries often require a recipe in order to ensure correct measurements of ingredients are being used.

These cookbooks and the women who contributed to them are also key sources of knowledge and information. Cookbooks and recipes are about more than creating a plate of food; they also provide information about community knowledge of and cultural understandings about food. Recipes are also as much about science as they are about cooking. In the 1850s, Mrs Beeton's recipes approached cooking quantitatively by providing ingredient lists, cooking times, cost and number of portions. These recipes were intended to be carried out with precision, just as was expected with scientific experiments. However, as Elizabeth Fleitz argues, recipes are more important than just existing as a list of measurements and rules.[24] 'Cookbooks are a genre that often includes examples of technical proficiency, misogynist rhetorics, humour, identification and more. In short, they are complex documents that have potential to do many different kinds of work'.[25]

Firstly, cooking is and has always historically been a gendered practice.[26] Cooking is an ordinary, mundane and basic part of our everyday lives, but globally it is still mainly women's lives which are dominated by caring for and feeding others.[27] Cookbooks and recipes are part of the toolkit in the kitchen which help women produce food for their families. However, the work of cookbooks and recipes goes beyond practical cooking. An important point to note is how the 'spatial, temporal, and social positioning of cookbooks… produces understandings of what women are or what they should be'.[28] Not only does this imply certain expectations of what a woman's work should be, but also excludes trans women and non-binary people. Purchased cookbooks often represent women as a monolith: middle class, white, heterosexual and normatively gendered. This assumption fails to acknowledge the diversity of gender. As a result, gender roles are deeply and openly embedded in these cookbooks, and gender-based divisions of domestic labour are reinforced.

Secondly, science and scientific knowledge have always been important to cookery and recipes.[29] Women have been able to take on the role of scientific interpreters through cookery, a legacy of scientific authority which, as demonstrated by some of the other sources in this volume, has persisted through time. However, as Katherine Durack argues, science and technology have traditionally been viewed as masculine activities while domestic activities conducted within the household have been labelled feminine activities. Any technical writing by women which occurs in a domestic setting has therefore been refused the title of scientific work.[30] From the outset, recipes and cookbooks have been predominantly authored by women and for women.[31] They have also existed in the private space of the home and therefore rarely been considered pieces of scientific or technological writing. However, other ways in which women have been excluded from science have also worked to deny recipes the status of scientific writing: denying women's identities as inventors and women's work aids the status of 'tools'; denying women access to knowledge necessary for inventing and protecting tools and ideas; diminishing the significance of women's technological skills in areas in which they are expected to have expertise; defining women's unpaid labour as 'not work'; and defining traditional women's work as not 'technological'.[32]

All five of these methods of exclusion intersect in the dismissal of recipes as scientific and technical writing. However, women's cookery knowledge is transformative. It requires a level of competence and confidence which can only be achieved through practice. Once a woman is competent at cooking, she can create her own recipes and make her own dishes. The recipe in the source above is an example of a woman creating her own recipe using this acquired knowledge and skill.

Questions

1. What are the implications of dismissing recipes and cookbooks as forms of scientific and technical writing?
2. What can recipes and cookbooks tell us about knowledge sharing throughout history?

3. How important are aspects of everyday life when discussing the history of science?
4. What comparisons can be made between this source and other examples of recipes found within this volume (for example, the perfumery recipes of Tappūtī-bēlat-ekallein in part one, and the book of receipts produced by Mary Chantrell in part three)?
5. How do sources like this help us reflect on the so-called 'laboratory revolution' of science in nineteenth-century Europe?

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52

Stephanie Shirley (b. 1933), Janet Thomson (b. 1942), Sue Vine (fl. 1960s), and Charlotte Armah (b. 1970): Extracts from 'An Oral History of British Science' transcripts (2009–2015)

Dr Sally Horrocks, Dr Thomas Lean and Dr Paul Merchant

Introduction

This source consists of a number of extracts taken from transcripts of life history interviews with British women scientists that were collected for 'An Oral History of British Science', a National Life Stories project that operated in collaboration with the British Library between 2009 and 2015. This project set out to create a national collection of in-depth life story interviews with scientists and engineers from across a range of disciplines and including diverse voices from across the scientific workforce, not just those in high status positions.[33] The experiences recounted here cover a significant period: from the 1940s, when Stephanie Shirley (b. 1933) began work at the Post Office Research Station in Dollis Hill, to 2014 when Charlotte Armah (b. 1970), a second-generation migrant to the UK, was interviewed while working at the Institution of Food Research in Norwich, UK. Between these periods are interviews with Janet Thomson (b. 1942) who worked for the British Antarctic Survey and in 1983 became the first female BAS scientist to work inside the Antarctic Circle, and an interview with Sue Vine (fl. 1960s), who worked in the Department of Geodesy and Geophysics at the University of Cambridge between 1963 and 1965.

As well as reading the transcripts, students are encouraged to listen to the original audio in order to appreciate the orality of these sources and to learn more about the lives of these women. For example, additional meanings can be conveyed by tone of voice, pauses and silences. Some extracts are available via the interviewee pages on the Voices of Science website, while full interviews are accessible on British Library Sounds.[34] Links and timestamps for each of the specific extracts below are available in the corresponding endnotes.

Source

Stephanie Shirley interviewed by Thomas Lean, British Library C1379/28.[35]

Extract 1

One of the things that happened during that period was that I did get my degree, and therefore really went up for the next bit of promotion, which was to a grade called the Scientific Officer. And that was much more formal because this was a graduate status position, and the assumption was that you would not stay in it, you would go up from Scientific Officer to Senior Scientific Officer, to Principal Scientific Officer, to Senior Principal Scientific – I mean, you know, really that structure of bureaucracy. And I don't know how I applied, but the way in which interviews were done was that people would put together a panel of four, five, six people who would jointly interview you, so that you came in and took questions from a range of people. And anyway, I was waiting for my panel to be called, and it didn't come, and it didn't come, and I thought wasn't it about time I actually had my interview, and so on. And I discovered that the panel, which was made up by people all over the station and indeed outside, were refusing to serve on the panel, for the honourable reason really that they did not think any woman could do a Scientific Officer job. So they were saying, 'I'll never appoint her, no matter what.' And so they were resigning from the panel. So eventually, there was a big delay, and I did get a panel and then I did get through.

Extract 2

This business of having different restaurants and canteens for different grades of staff, which one did you get to eat in?

Oh the general one. And, it was quite exciting because – the big one. Because when I first walked in there, about 200, you know, handsome, intelligent men turned round and looked at this new female that had sort of turned up [laughs]. So, and that, you know, took – it was quite, you know, you were … it was almost scary to go into a big place like that, 100, not quite 100 per cent but ninety-nine per cent men. And, as the years have gone on, sort of, got used to it and can give as good as I get, but … from the management point of view, it's always much better to have a group of women rather than a sole woman trying to break into the board or whatever it is, because the stress is just so high. And also if you're the only one, if you fail, you fail for all women, and they say, 'Well we tried one of those and she was awful.' Whereas if you succeed, it's also remembered, but somehow the presumption is that, 'We had her and she was good; at least we'll try another one and see if it works again.' Ugh! Yeah. Sexism is – is not quite as bad as anti-Semitism, but it's pretty tough.

Janet Thomson interviewed by Paul Merchant, British Library C1379/20.[36]

So at this time you're reconstructing where a male geologist has been to collect samples that you're working on, you're hearing stories of Antarctic travel, how did you feel at that stage about the fact that you didn't have access to Antarctica?

Pretty cross. [Laughs] I just wanted to get there and actually do, go over the same terrain myself and sort of see where this person had been and, erm, get a better feel for how the different rocks related to each other. Well I thought it was daft that, erm, somebody would – should be expected to work on samples that hadn't been collected by that person. Because I had done geology because it was a field subject and that you needed to sort of get your hands dirty [laughs] collecting the samples and relating to the environment from which they'd been collected, and to, erm, sort of almost trying to research the geology blindfolded, not having collected them for myself. So I did find it very frustrating and illogical, really, that I should be expected to do it. And I was also cross because it was the gender issue that was sort of dawning on me [laughs] really, and I thought that was, erm, stupid too. So I wanted to go for the reason of seeing it for myself, that particular location, but also going because they shouldn't stop me because I'm a woman. [Laughs] You know, I think that was the start of feeling that it was a rather improper segregation of, erm, of scientists because they were male or female, depended, you know, whether they could go to the Antarctic or not.

Sue Vine interviewed by Paul Merchant, British Library C1379/39.[37]

The – the atmosphere at Madingley Rise was extremely lively and everybody was very keen to discuss what everybody else was doing, and they had a teatime and a coffee time where everybody gathered and discussed everything and it was a very stimulating and lively environment, principally created by Edward Bullard who was head of it at that time and he was always – every – you know interested in what everybody was doing and encouraging other people to come and have a look and it was a very nice atmosphere to work in and so, you know, we did have chance to discuss what we were doing with everybody else and see what they thought and … we didn't work in little isolated capsules.

Was – was gender significant in any way there in terms of …?

I … I wasn't aware of it I don't think. I don't think anybody … I mean I – I think I was in – in – I'm just trying to think who else was there but … there were one or two other women there but – I don't think it was a problem, hmmm, but I don't think the – the ratio was any better than it was in the rest of the university, I think it was similar. I think I felt … I don't know how to put it … I think the – the place was full of bright – bright young research students and I think I thought I wasn't quite up to that grade but I don't think that was to do with being a woman, I think it was just that I wasn't quite on that level intellectually, you know, I was sort of at a more mediocre sort of level.

What made you think that, what about the way that they …?

Just – just – just the way they were sort of so … just thought they seemed more able really, more – a lot of them, but it made – you know, it – you can't tell now, now that I'm mature, you know, whether all of that is just bluster or whether they're actually more clever, you know, now when I look back, but that's how it seemed at the time that they were – because they were more sort of full of it.

Charlotte Armah interviewed by Paul Merchant, British Library C1379/107.[38]

I wish I could say I had a little chemistry set at home and I would tinker with it, but no, the only kind of chemistry I did at home was just baking really, stuff like that. I can't say I had like a whole lab, you know I built a lab in my bedroom and I would kind of nick things, bits of bleach, and perfume, no, I'm afraid not, it was just my interest in chemistry was at school, and when I wasn't in school, well I just did other stuff like other teenage girls would do. Singing to my hairbrush, watching Top of the Pops, make clothes, other stuff.

When you say you wish you could say this, what does that mean?

Would be a more interesting story if I could say this , if you know, from the age of 4 I was really interested in chemistry and I begged my parents for a chemistry set, but it wasn't like that. I feel as if it might be a better story, but it's not my story I'm afraid. I enjoyed chemistry at school, I put a lot of effort into my chemistry work, my homework, but outside of school I would just do other things and I would enjoy baking, cooking, making clothes, designing clothes, stuff like that. Then Monday, back to school, back into it.

Analysis

Oral history within the history of science often explores specific significant moments or individual contributions. In contrast, interviewing individuals about their extended life history captures insights that enable historical researchers to better understand women's lives and careers over an extended period. Life history interviews allow historical researchers to place women's working lives within the wider context of childhood and education, family, beliefs, hobbies and interests, external pressures and opportunities.[39] This approach also ensures that interviewees tell researchers not only about what they did, but 'what they wanted to do, what they believed they were doing, and what they now think they did'.[40] This subjective quality of oral history is particularly valuable when exploring the experiences of women scientists. Life histories enable women to speak about their feelings and experiences of working in male-dominated spaces, often as the only woman present.[41] Life histories also can reveal strategies that women deployed to navigate frequently challenging and hostile working environments in ways that other written sources do not capture.

These extracts present four women's experiences in the workplace from the 1940s until the 2010s. During the interviews, the women revealed that they were treated differently to the men they worked with. Moreover, some did not feel that their work fit with their own and others' expectations of a scientist's life and career. For example, Stephanie Shirley suggested that bureaucratic structures and ingrained assumptions, rather than her actual abilities, acted as formidable barriers to her promotion. This theme was echoed by Janet Thomson's experience of being denied the opportunity to collect her own samples in the field. Rather, she was required to work on samples collected by her male colleagues. These structural barriers have been explored extensively by historians of women in science, for example in Margaret Rossiter's work on the United States, and continue to be a focus of contemporary initiatives to improve the representation of women in scientific professions.[42]

Shirley also hinted at the psychological toll inflicted on women who sought to challenge workplace gender stereotypes and assumptions. Critically, women's self-confidence was persistently undermined. Thomson experienced these barriers as 'frustrating and illogical' and challenged them with quiet persistence.[43] For Sue Vine, the barriers were internal as well as external; the gendered workplace environment caused her to doubt her own abilities and to view the men around her as 'more able' than she was. The interview provided a valuable space for her to reflect on her experiences; she concluded that perhaps her impression was mistaken, however much sense it made at the time. Charlotte Armah also revealed a sense of unease that her recollections of what attracted her to science marked her out as an outsider. As a woman, her place in science was less secure than those of men whose experiences and life stories fit more closely with established narratives of scientific lives. These psychological barriers to women's participation in science have been less fully explored by historians than structural and institutional barriers, perhaps because evidence for them is harder to find in written sources, but they were acknowledged as significant as early as 1970 by social psychologist Martha White.[44] In using oral history interviews we can access these less explored though significant histories.

Questions

1. What do these oral history sources reveal that is often missing from written sources in the history of science?
2. What strategies did these women adopt to challenge and overcome the barriers they faced?
3. Why might it have been easier for women to recognise these barriers at the time of the interview, than it was when the events took place?
4. To what extent might Charlotte Armah's feelings of exclusion be linked to ethnicity as well as gender? Consider also Stephanie Shirley's comment about anti-semitism.
5. Many women scientists from the 1960s and 1970s were very reluctant to identify themselves as feminists. What can these sources tell us about why women scientists may have felt this way?

Further reading

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Part XII notes

1 Saini, *Inferior*, 17–22.
2 Note that birth control methods have a long history as a tool for white racial advancement and eugenics before they were a tool for female liberation. See Carey, 'The Racical Imperatives of Sex', 2012, 733–752.
3 Liao and Dollin, 'Half a Century of the Oral Contraceptive Pill', 2012, 757–760.
4 McGregor, *Sex Matters.*
5 Mirza, 'Race, Gender and IQ', 1998, 109–126.
6 See also Newman, Germs in the English Workplace, c.1880–1945, for a discussion of microbiology in the early twentieth century kitchen.
7 A diver's body tissues become 'saturated' with the gases that they breathe while at depth. For every 100 feet of depth at which a diver's body is fully saturated, approximately 24 hours are needed for safe decompression. However, a 'saturated' diver can remain safely at depth for as long as their life support system will allow.
8 Rozwadowski, 'Arthur C. Clarke and the Limitations of the Ocean as a Frontier', 2012, 578–602.
9 Thomas and O'Hara, 'Tektite Revisited'.
10 Carpenter, 'Come Dive With Me to Tektite II', 1970*,* 142.
11 Lucas, 'My Summer Vacation', 1970, 47.
12 Helmreich, 'Patterns of Aquanaut Behavior', viii–40.
13 Earle, 'The Sweet Spot in Time', 2012, 63–64.
14 The kidneys were harvested, because kidney cells were used for the cultivation of the polio virus.
15 RIVM Archives, File no.1050042 Proefdiervoorziening 1970–1980, Project 13b: Ontwikkeling Apenkweek by R. Boot, October 1979, March 1980 and March–October 1979, and November 1978–March 79. 78–80.
16 RIVM Archives, File no. 1050042, Herstel cyclus na spenen; paringsinduktie. 29/01/1979. A. Kamer/F vd Sluijs, Dr. LG Huis in 't Veld, BC Kruijt, R. Boot.
17 RIVM Archives, File no. 1050041, Project report 94.83.02/13.01.01 Monkey Breeding by R. Boot on 2/3/1981.
18 After mating, male monkeys were either kept alive for another round of mating, or killed for their kidneys. Since one male can impregnate many females, a lot fewer male monkeys were part of the breeding programme compared to female monkeys.
19 For more on this see Duxbury, 'Animals, Science and Gender', 2016.
20 Benson, 'Animal Writes' and Woods et al., *Animals and the Shaping of Modern Medicine.*
21 For more on this see Derrida, *The Animal That Therefore I Am.*

22 Benson, 'Animal Writes', 4.
23 Specht, 'Animal History After Its Triumph', 2016, 332.
24 Fleitz, 'Cooking Codes', 2010, 1–8.
25 Moeller and Frost, 'Food Fights', 2016, 8.
26 Fleitz, 'Cooking Codes', 2010, 1–8 and Moeller and Frost, 'Food Fights', 2016, 1–11.
27 Supski, 'We still mourn that book', 2005, 85–94.
28 Moeller and Frost, 'Food Fights', 2016, 5.
29 Lieffers, 'The Present Time is Eminently Scientific', 2012, 936–59.
30 Durack, 'Gender, Technology and the History of Communication', 1997, 249–260.
31 Fleitz, 'Cooking Codes', 2010, 1–8.
32 Durack, 'Gender, Technology and the History of Communication', 1997, 255.
33 See British Library, 'About the Project'. We would like to acknowledge the contributions of the whole project team and all our funders including Arcadia Fund, Royal Commission for the Exhibition of 1851, Royal Society, Worshipful Company of Armourers and Brasiers.
34 See British Library, 'Voices of Science' and British Library, 'Oral history of British Science'.
35 You can listen to these extracts at timestamps [28:09] and [26:00], respectively, at https://sounds.bl.uk/Oral-history/Science/021M-C1379X0028XX-0005V0 (accessed 16 December 2022).
36 You can listen to this extract as timestamp [38:40] at https://sounds.bl.uk/Oral-history/Science/021M-C1379X0020XX-0005V0 (accessed 16 December 2022).
37 Note this is a short interview that was recorded to complement the life story interview with Fred Vine, British Library C1379/25. You can listen to this extract at timestamp [35:00] at https://sounds.bl.uk/Oral-history/Science/021M-C1379X0039XX-0001V0 (accessed 16 December 2022).
38 You can listen to this extract at timestamp [25:24] at https://sounds.bl.uk/Oral-history/Science/021M-C1379X0107XX-0002V0 (accessed 16 December 2022).
39 British Library, 'In Defence of the Long Interview', 2016.
40 Portelli, 'What Makes Oral History Different', 52. See Gunn Allen, *Pocahontas,* 2004 on the removal of Indigenous women from the 'matrix of their lives' and how oral and narrative histories seek to combat this.
41 Bornat, 'Remembering and Reworking Emotions', 2010, 43–52.
42 Rossiter, *Women Scientists in America*. See also *The Lancet*, 'Advancing women in science, medicine, and global health', 393, a special issue devoted to examining evidence of institutional and systemic barriers to women's careers.
43 Merchant, 'A Woman's Place is in Antarctica'.
44 White, 'Psychological and Social Barriers to Women in Science', 1970, 413–416.

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Epilogue: Going forward and liberating the curriculum

This sourcebook reinforces the importance of exploring new ways of approaching the teaching of the history of science, technology and medicine, including broadening what is considered science. Scholars and students understand and engage with history through primary sources, and an expansion in our understanding of what constitutes a source offers more diverse and inclusive narratives for future study. By bringing lesser-known sources to light, this volume provides university lecturers and students with the foundational building blocks for a more considered approach to teaching and learning within the history of science. The analysis provided by experts in their respective areas of study, the prompts for class discussion and the suggested further readings all draw on a number of key themes and raise important central questions within the discipline. What is a source? What is science? And how do power and positioning affect access to science? We encourage readers to continue to reflect on these broader themes and to compare sources across the parts of this book, aided by some general discussion questions at the end of this epilogue.

The limitations of our positioning are reflected in the sources we have included within this book. We have not specifically addressed sexuality and gender identity, which we acknowledge as a significant shortcoming and would encourage readers to seek out further reading in this area.[1] Furthermore, this book is not as global as we originally envisioned, and we recognise that broader geographic perspectives are needed to properly reveal the complexities of the history of science. Working towards liberating the curriculum, we encourage the production of further historical sourcebooks in this style. More needs to be uncovered and discussed about the history of women and their role in the production of knowledge, especially historical sources that recognise the experiences of the Global Majority – Black women, Indigenous women and women of colour.[2] The project of telling the history of science, technology and medicine in a way that includes women and goes beyond white Euro-centric experiences requires continued study and attention. This book is only a part of that greater effort and we support future endeavours that would add to and expand upon this volume.

There is still much work to do within the academy to achieve the aims of liberating the curriculum.[3] Texts such as this one and others can help to reframe core modules to include women in fields otherwise dominated by a white, male, Euro-centric historiography, and to champion and teach new courses with a focus on women in the history of science. However, the understanding of science must also be reframed, with different ways of knowing and making knowledge recognised and celebrated. Liberating the curriculum also means facing institutional problems of a lack of diversity within teaching staff and university administrators. Space must be made for individuals of the Global Majority within American and European universities at all levels. As part of this effort, university students, educators and administrators must progress toward a liberated university as a whole. Liberating the curriculum is an important starting point for this wider change and we hope that our readers can begin to make changes towards this bigger goal in their own spheres of influence.

General questions

1. How would you define ‘science’?
2. What do you consider a valid source for studying the history of science?
3. How far has society come in recognising the work of women in science? A long way, or not very far?
4. Comparing and contrasting across this sourcebook, what role has class played in determining who has access to science and whose work is acknowledged and celebrated within the history of science?
5. What role have colonial power dynamics played in shaping whose stories are told within the history of science, and the stories that continue to be told?
6. Many of the sources included within this volume are translations. What impact does this have, if any, on our interpretation of them? Does it matter if you as a student or scholar cannot read the source in its original language?

Further reading

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Notes

1 For example see Oram, Alison and Turnbull, Annmarie. *The Lesbian History Sourcebook: Love and Sex Between Women in Britain from 1780–1970*. London: Routledge, 2001; also Lady Science. 'Episode 9: Trans and queer histories of science' (podcast), first aired 12 June 2018. Accessed 11 May 2022. https://www.ladyscience.com/podcast/episode9-trans-and-queer-histories-of-science

2 Here we use the term the 'Global Majority', as coined in response to the work of Rosemary Campbell-Stephens MBE. For more on this term, see Campbell-Stephens, Rosemary M. *Educational Leadership and the Global Majority*. Cham: Palgrave Macmillan, Springer International Publishing, 2021.

3 Smeeth, Liam. 'Independent review to address discrimination and advance anti-racism and equality at LSHTM', *London School of Hygiene and Tropical Medicine*. Accessed 25 February 2022. https://www.lshtm.ac.uk/aboutus/organisation/governance/equity-diversity-and-inclusion/racial-equality/independent-review

Index

Women in the History of Science brings together primary sources that highlight women's involvement in scientific knowledge production around the world. Drawing on texts, images and objects, each primary source is accompanied by an explanatory text, questions to prompt discussion, and a bibliography to aid further research. Arranged by time period, covering 1200 BCE to the twenty-first century, and across 12 inclusive and far-reaching themes, this book is an invaluable companion to students and lecturers alike in exploring women's history in the fields of science, technology, mathematics, medicine and culture.

While women are too often excluded from traditional narratives of the history of science, this book centres on the voices and experiences of women across a range of domains of knowledge. By questioning our understanding of what science is, where it happens, and who produces scientific knowledge, this book is an aid to liberating the curriculum within schools and universities.

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