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9

HOMES AND HOUSEHOLDS

Alix Cooper

Where did early modern natural inquiry take place? Research by historians of science has begun to suggest that many of the activities crucial to the Scientific Revolution took place not only in such recognizably new and innovative sites as botanical gardens, anatomy theaters, laboratories, and the quarters of scientific societies but also – and often simultaneously – within the seemingly humble and prosaic spaces of natural inquirers' own homes and households. These domestic spaces in fact saw the production of natural knowledge of all kinds, as their occupants used them as places not just to sleep but also to think, write, calculate, observe, and experiment on natural phenomena. Furthermore, while doing so, they frequently ended up enlisting household members in these projects. In this way, homes and households became crucial sites for the pursuit of natural knowledge in early modern Europe.

Few historians of science have paid attention to these kinds of "private" spaces. One of the main reasons for this is almost certainly the way in which, over the past several centuries, scientific work has gradually come to be conceptualized as occurring primarily *outside* the home. This particular assumption is itself a historical artifact, stemming from modern changes in the organization of work more broadly. During the nineteenth century in particular, as more and more people abandoned home-based workshops and began to travel to new places of employment, newly labeled "scientists" likewise increasingly came to work outside the home in institutional spaces that were perceived as religiously and emotionally neutral. In the process, considerable ideological boundaries were erected between work and family, and between public and private realms, which have continued to shape modern thinking.[1]

[1] See, for example, Dorinda Outram, "Before Objectivity: Wives, Patronage, and Cultural Reproduction in Early Nineteenth-Century French Science," in *Uneasy Careers and Intimate Lives: Women in Science, 1789–1979*, ed. Pnina G. Abir-Am and Dorinda Outram (New Brunswick, N.J.: Rutgers University Press, 1987), pp. 1–30; and Londa Schiebinger, *The Mind Has No Sex? Women in the Origins of Modern Science* (Cambridge, Mass.: Harvard University Press, 1989). It is important to note that much of what we now know about households and homes in early modern science results from the work of historians who have investigated the careers of women in science and discovered that their family status – as wives, daughters, or widows – significantly shaped those careers.

If we wish to understand how early modern natural inquiry was actually practiced, however, it is necessary to put aside modern preconceptions and enter the world of the early modern home, for in early modern Europe and even beyond, that was indeed where a considerable amount of all production, craft and otherwise, took place, including – as this chapter will show – the production of knowledge about the natural world. Only by examining this crucial setting is it possible to recover some sense of the wide range of people actually involved in projects of natural inquiry in early modern Europe. As a glimpse of the early modern scientific household reveals, the study of nature engaged not just learned and professional men but also a wide array of unacknowledged and (to our modern eyes) seemingly invisible collaborators to be found at home, from wives and children through domestic servants. The pursuit of natural knowledge was thus not only an individual enterprise – for "great men" only – but a collaborative and in many cases a collective one. Although individual contributions can be difficult to document – many women and servants, for example, had not been taught more than a rudimentary literacy and thus did not leave much of a paper trail, and early modern literary conventions tended to preclude the mentioning of household members in published work – enough manuscript evidence has survived in the form of handwritten laboratory notes, household recipe books, and the like to give us a window into their participation in early modern natural inquiry, though much research still needs to be done.

This chapter will examine some of the various ways in which home and household came to provide important frameworks for the gathering of natural knowledge in early modern Europe. As I will show, numerous scientific activities were performed either within the home itself (that is to say, literally within the spatial confines of a residence) or, more broadly, by members of a household, which might include not only a paterfamilias but also wife, sons, daughters, other relatives, and domestic servants. Natural inquiry in early modern Europe thus often constituted a *family* project to which a variety of household members would contribute, providing crucial support and continuity for scientific activities at a time when formal institutional support was often lacking. Indeed, the household model for natural inquiry was to demonstrate its staying power by enduring well into the nineteenth century. During the crucial years of the Scientific Revolution, however, it proved particularly important as a model for the pursuit of natural knowledge.

DOMESTIC SPACES

To examine some of the opportunities for science that the early modern home provided, let us take a brief tour through the interior architecture not, perhaps, of a rural or peasant home, which would typically have consisted of a single room for working, eating, and sleeping, but rather that of a larger, more prosperous urban residence. Here could be found all sorts of places where activities that might today be called "scientific" were avidly pursued. The study, or *studio*, for example, was one such place. Usually adjoining the bedroom, it provided virtuosi with, on the one hand, a private refuge for solitary contemplation and, on the other, a semipublic space where they could introduce distinguished visitors to the collections of books, globes, mathematical instruments, and curiosities both artificial and natural that often lined its walls (and even ceiling). French polymath Pierre Borel (ca. 1620–1671) termed his a "world within the home"[2] (see Findlen, Chapter 12, this volume). The study, which also came to be labeled a *museum* (abode of the Muses), was thus a liminal space with multiple uses that reflected and enabled the intellectual aspirations of its occupants, whether surgeons such as Ambroise Paré (ca. 1510–1590), who filled his study with monstrous specimens to illustrate his book *On Monsters*, or mathematicians such as John Dee (1527–1608), who retreated to his "private study" behind double doors to cast horoscopes and commune with angels.[3]

Science did not remain cloistered in the study, however, but overflowed into the rest of the house. The Renaissance anatomist Andreas Vesalius (1514–1564) was notorious for dissecting human cadavers in his own chambers, sometimes keeping them there for weeks on end.[4] Nor was this practice, apparently, that unusual; in 1519, Italian medical student Ippolito of Montereale had already reported with delight on an animal dissection he had observed at his teacher Giovanni Lorenzo's home, "so we could see the inner

[2] Quoted in Paula Findlen, "Masculine Prerogatives: Gender, Space, and Knowledge in the Early Modern Museum," in *The Architecture of Science*, ed. Peter Galison and Emily Thompson (Cambridge, Mass.: MIT Press, 1999), p. 36. On the organization and ideals of the study, see also Dora Thornton, *The Scholar in His Study: Ownership and Experience in Renaissance Italy* (New Haven, Conn.: Yale University Press, 1997); and Steven Shapin, "'The Mind Is Its Own Place': Science and Solitude in Seventeenth-Century England," *Science in Context*, 4 (1990), 191–218. The layout of residences differed, of course, from place to place and period to period, in accordance with such other factors as wealth, social status, and occupation. For an introduction to the development of house interiors during this period, see Witold Rybczynski, *Home: A Short History of an Idea* (London: Penguin, 1986), pp. 11–75.

[3] See Ambroise Paré, *On Monsters and Marvels*, trans. Janis L. Pallister (Chicago: University of Chicago Press, 1982), pp. 49, 52, 134, 141, 150; and Deborah Harkness, "Managing an Experimental Household: The Dees of Mortlake and the Practice of Natural Philosophy," *Isis*, 88 (1997), 259.

[4] C. D. O'Malley, *Andreas Vesalius of Brussels, 1514–1564* (Berkeley: University of California Press, 1964), pp. 64, 112. See also pp. 44–5 on the difficulties encountered by Renaissance anatomists seeking suitable places to carry out their dissections.

parts and the origin of the nerves."[5] Those who wished to study living rather than dead bodies, however, repaired to the homes of others, paying visits to the sick in their bedrooms. Here doctors, midwives, and other medical practitioners consulted with patients and prescribed elaborate remedies for their ills. Although hospitals, with their never-ending supply of poor patients with a wide variety of conditions (and little authority to direct their own care), were increasingly becoming the principal locus for clinical research and high-level training, physicians and surgeons nonetheless treated most of their clients at home.

Meanwhile, in the shop or workshop, which in the houses of artisanal families usually adjoined the living quarters, illustrations were drawn, apothecaries' remedies compounded, and scientific instruments designed and perfected.[6] Kitchens and basements or root cellars formed improvised laboratories for women to tinker with and write down medical recipes, whether of the more herbally based Galenic or chemically based Paracelsian kind. It was popular for English women of some means to have stills and alembics in their kitchens for making "essences"; some, such as Lady Grace Mildmay (1552–1620), turned entire rooms into still-rooms and effectively ran pharmaceutical dispensaries from their homes, leading English virtuoso John Evelyn to comment of the gentlewomen of his youth that "their recreations were in the distillatorie."[7] Even more well-to-do experimenters such as Robert Boyle (1627–1691) set up not just one but a series of rooms specially furnished with stills and other necessary equipment to conduct their "trials" and "assays."[8]

Natural inquiry could also be, and was, avidly pursued outside. In kitchen gardens, medicinal simples were cultivated and all manner of "experiments" performed on the vegetable world, while backyards served as "theaters" to investigate local flora and fauna.[9] Even the rooftops of a house might be put to use if necessary. The astronomer Johannes Hevelius (1611–1687) built first a small watchtower and then a large platform on his roof in Danzig upon which to store his telescopes, quadrants, and sextants and from which to gaze at the stars. As he proudly informed the readers of his *Machinae*

[5] Dorothy M. Schullian, "An Anatomical Demonstration by Giovanni Lorenzo of Sassoferrato, 19 November 1519," in *Miscellanea di scritti di bibliografia ed erudizione in memoria di Luigi Ferrari* (Florence: Leo S. Olschki, 1952), pp. 489, 494.

[6] Schiebinger, *The Mind Has No Sex?* pp. 66–118; see also Pamela H. Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution* (Chicago: University of Chicago Press, 2004), pp. 95–6.

[7] Lynette Hunter, "Women and Domestic Medicine: Lady Experimenters, 1570–1620," in *Women, Science and Medicine, 1500–1700: Mothers and Sisters of the Royal Society*, ed. Lynette Hunter and Sarah Hutton (Stroud: Sutton, 1997), pp. 89–107, esp. pp. 95–6; Linda Pollock, *With Faith and Physic: The Life of Tudor Gentlewoman Lady Grace Mildmay, 1552–1620* (London: Collins and Brown, 1993), pp. 98–102; and Leonard Guthrie, "The Lady Sedley's Receipt Book, 1686, and other Seventeenth-Century Receipt Books," *Proceedings of the Royal Society of Medicine*, 6 (1913), 165.

[8] Steven Shapin, "The House of Experiment in Seventeenth-Century England," *Isis*, 79 (1988), 373–404.

[9] Alix Cooper, "Inventing the Indigenous: Local Knowledge and Natural History in the Early Modern German Territories," Ph.D. dissertation, Harvard University, Cambridge, Mass., 1998.

Figure 9.1. Hevelius's house in Danzig. In Johannes Hevelius, *Machinae coelestis pars prior* (Danzig: Simon Reiniger, 1673). Reproduced by permission of the Department of Printing and Graphic Arts, Houghton Library, Harvard College Library. Typ 620.73.451F.

coelestis (1673), these various jury-rigged observatories were all conveniently "contained within the limits of my house, so you don't even need to leave the house, or cross the street . . . to get to another observatory" (Figure 9.1). Noting further that his study was handily located just down the stairs, and that his print shop, with its engraving equipment, was even closer, on the second floor, he triumphantly concluded that his multiple observatories, despite or perhaps even because of their convenient setting right on top of his home, were lacking in nothing that he might need to make "any kind of observations whatsoever."[10]

It must be stressed, however, that natural inquiry was not confined solely to prosperous urban households. On the lowest rungs of the social ladder, peasant homes held carefully gathered herbs, and though learned physicians repeatedly expressed their scorn for home remedies, unofficial healers occasionally fired back with statements such as that of one Ann Windsor, in the sixteenth century, that "kitchen physic I believe is more proper . . . than the Dr's filthy physic."[11] Meanwhile, on the social ladder's highest rungs, kings' and princes' households or courts often served to stage especially massive and complex ventures into natural inquiry, bolstered by their patrons' much

[10] Johannes Hevelius, *Machinae coelestis* (Danzig: Simon Reiniger, 1673), pp. 446–7.
[11] Quoted in Pollock, *With Faith and Physic*, p. 94.

more substantial resources (see Moran, Chapter 11, this volume).[12] On the Danish island of Hven, for example, the noble-born astronomer Tycho Brahe (1546–1601) masterfully designed an entire palace, the famous Uraniborg, to serve not only as family residence but as his astronomical observatory and alchemical laboratory as well, on a scale far upstaging that of any other proto-scientist of the time.[13] Even on these grander scales, however, the study of the natural world was influenced by similar patterns: of familial interaction, the structuring of space, the division of labor, and the management of household affairs.

NATURAL INQUIRY AS A FAMILY PROJECT

To understand the full significance of the early modern home as a site for early modern science, it is necessary to look beyond the mere physical spaces provided by the home as a dwelling – its rooms and chambers – and to contemplate the household itself as an institution. Social historians have long emphasized the centrality of the family as a unit of economic production and inheritance in early modern Europe. In cultures in which the distinction between "public" and "private" had not yet coalesced in its modern form, and the workplace had not yet been relocated away from the home, the extended household was responsible both for its members' material maintenance and for cultural reproduction more generally – for the transmission of customs and practices from one generation to the next.[14]

The family, furthermore, had long been seen as a model for social relations more generally, guiding the roles of older and younger, male and female, superior and subordinate. Aristotle (384–322 B.C.E.) had declared the household (*oikos*) the foundation of social order. Thus it came to serve, often quite explicitly, as a model for politics and government in early modern Europe.

[12] See Mario Biagioli, *Galileo, Courtier: The Practice of Science in the Culture of Absolutism* (Chicago: University of Chicago Press, 1993); and Bruce T. Moran, ed., *Patronage and Institutions: Science, Technology, and Medicine at the European Court, 1500–1750* (Woodbridge: Boydell Press, 1991).
[13] On the design of Uraniborg, see Owen Hannaway, "Laboratory Design and the Aim of Science: Andreas Libavius versus Tycho Brahe," *Isis*, 77 (1986), 585–610. But see also Jole Shackelford, "Tycho Brahe, Laboratory Design and the Aim of Science: Reading Plans in Context," *Isis*, 84 (1993), 211–30; and William R. Newman, "Alchemical Symbolism and Concealment: The Chemical House of Libavius," in Galison and Thompson, eds., *The Architecture of Science*, pp. 59–77.
[14] The literature on this topic is vast and controversies numerous; for a historiographical introduction, see Michael Anderson, *Approaches to the History of the Western Family, 1500–1914* (New York: Cambridge University Press, 1980). General surveys of the field, from a variety of methodological and national perspectives, include Steven Ozment, *When Fathers Ruled: Family Life in Reformation Europe* (Cambridge, Mass.: Harvard University Press, 1983); Edmund Shorter, *The Making of the Modern Family* (New York: Basic Books, 1975); Lawrence Stone, *The Family, Sex, and Marriage in England, 1500–1800* (New York: Harper and Row, 1977); Jean-Louis Flandrin, *Families in Former Times*, trans. Richard Southern (Cambridge: Cambridge University Press, 1979); and Michael Mitterauer and Reinhard Sieder, *The European Family: Patriarchy and Partnership from the Middle Ages to the Present*, trans. Karla Oosterveen and Manfred Hörzinger (Chicago: University of Chicago Press, 1982). For an important early discussion of "cultural reproduction" as applied to the history of science, see Outram, "Before Objectivity."

Patterns of authority within the family, it was believed, formed the basis for relations between ruler and subjects, with the monarch or prince as paternal and benevolent head not only of his own household or court but of the social body on a broader scale.[15] Likewise, the model of the household anchored many early modern conceptions of economic activity, especially with the rise of the economic philosophy of cameralism, which saw the state as a household, requiring proper management to ensure its prosperity and self-sufficiency.[16]

The intellectual sphere, including many of the more formal institutions of early modern science, likewise reflected this family model. This is perhaps most obvious in the case of the princely court, which functioned as a household writ large and saw competition for the favor of the paterfamilias – in this case, the prince – generate considerable interest in the pursuit of nature's more spectacular forms[17] (see Chapter 11, this volume). Famous physicist and astronomer Galileo Galilei (1564–1642), for example, parlayed his eye-catching telescopic accomplishments into a successful bid for the patronage of the Medici court, thus enabling him to exchange his own resource-poor household for a greater one when he moved to Florence as philosopher and mathematician to Cosimo II.[18]

The dominance of the family model can also be seen in early modern university training as images of the solitary scholar, derived from clerical and monastic ideals of celibacy, yielded to a new vision of the scholar as married and participating fully in society as paterfamilias in his own right.[19] Professors in the early modern university often fulfilled the paternal role by taking

[15] See, for example, Jean Bethke Elshtain, ed., *The Family in Political Thought* (Amherst: University of Massachusetts Press, 1982); Ernst H. Kantorowicz, *The King's Two Bodies: A Study in Medieval Political Theology* (Princeton, N.J.: Princeton University Press, 1957); Joan B. Landes, *Women and the Public Sphere in the Age of the French Revolution* (Ithaca, N.Y.: Cornell University Press, 1988), pp. 17–22; Simon Schama, *The Embarrassment of Riches* (Berkeley: University of California Press, 1988), pp. 375–98; and Lynn Hunt, *The Family Romance of the French Revolution* (Berkeley: University of California Press, 1992).

[16] See Albion W. Small, *The Cameralists: The Pioneers of German Social Policy* (Chicago: University of Chicago Press, 1909); Erhard Dittrich, *Die deutschen und österreichischen Kameralisten* (Darmstadt: Wissenschaftliche Buchgesellschaft, 1973); Kurt Zielenziger, *Die alten deutschen Kameralisten* (Jena: Gustav Fischer, 1914); and Keith Tribe, "Cameralism and the Science of Government," *Journal of Modern History*, 56 (1984), 263–84. For the intersection of cameralism and science, see Pamela H. Smith, *The Business of Alchemy: Science and Culture in the Holy Roman Empire* (Princeton, N.J.: Princeton University Press, 1994); R. Andre Wakefield, "The Apostles of Good Police: Science, Cameralism, and the Culture of Administration in Central Europe, 1656–1800," PhD diss., University of Chicago, 1999; and Alix Cooper, "'The Possibilities of the Land': The Inventory of 'Natural Riches' in the Early Modern German Territories," in *Oeconomies in the Age of Newton*, ed. Margaret Schabas and Neil DeMarchi (Durham, N.C.: Duke University Press, 2003), pp. 129–53.

[17] See note 13.

[18] Biagioli, *Galileo, Courtier*.

[19] Gadi Algazi, "Scholars in Households: Reconfiguring the Learned Habitus, 1400–1600," *Science in Context*, 16 (2003), 9–42. See also A. A. MacDonald, "The Renaissance Household as Centre of Learning," in *Centres of Learning: Learning and Location in Pre-Modern Europe and the Near East*, ed. Jan Willem Drijvers and A. A. MacDonald (Leiden: E. J. Brill, 1995), pp. 289–98. I would like to thank Dr. Algazi for alerting me to this reference.

in students as boarders; it was thus common for students to lodge with their professor or *Doktorvater* and eat dinner at his table, assuming the role of sons[20] (see Grafton, Chapter 10, this volume). In addition to dissecting sheep at the home of his teacher Giovanni Lorenzo in Perugia, Ippolito of Montereale lived with him, and Galileo, before he was fortunate enough to obtain Medici patronage, had to take in student boarders to supplement his income.[21] Even the scientific academies that came to be formed over the course of the seventeenth century can themselves be seen as following a family model, as members of the Royal Society under the presidency of Isaac Newton (1642–1727), for example, sometimes mirrored the behavior of squabbling siblings, to be publicly rebuked from the head of the table.[22] The household, in short, served in early modern Europe as a general pattern – social, emotional or affective, and physical – for many other kinds of "fictive families" or ersatz households, including but not limited to those of the court, university, and scientific academy, with which it coexisted and overlapped.

This model proved highly suited to the production of natural knowledge in many ways. One of the most important was by enabling activities that could not be carried out entirely by a single individual but rather required cooperative work and support, as was the case for so many of the new empirical sciences, such as natural history and observational astronomy. Structuring the division of labor among household members, the household also ensured the continuity of knowledge and skills and their transmission into the next generation. When Prussian physician and botanist Christian Mentzel (1622–1701) decided it was time to teach his son botany, for example, he "imposed on" him as an "exercise" the time-consuming task of constructing a global multilingual index of plants; his confidence that his son's "juvenile age" would make him "apter for work" paid off, as the boy produced an extremely thorough index, which his father was then able to publish in the confidence that he had also contributed to passing down his own skills.[23]

This transmission of scientific projects from one generation to another often also took place on what could be termed a material as well as an intellectual plane. Sons and daughters inherited not only a close familiarity with the activities of their parents, and the skills and networks of social connections necessary to continue practicing them – what might be termed the "intellectual capital" of a family project – but also its physical capital. Workshops,

[20] William Clark, "From the Medieval Universitas Scholarium to the German Research University: A Sociogenesis of the German Academic," Ph.D. dissertation, University of California, Los Angeles, 1986, p. 257; Rainer Müller, "Student Education, Student Life," in *Universities in Early Modern Europe, 1500–1800*, ed. Hilde de Ridder-Symoens (Cambridge: Cambridge University Press, 1996), pp. 345–6. For the example of Linnaeus and his own flock of students, see Lisbet Koerner, *Linnaeus: Nature and Nation* (Cambridge, Mass.: Harvard University Press, 1999).

[21] Dava Sobel, *Galileo's Daughter* (New York: Penguin, 2000), p. 23. On Ippolito, see note 5.

[22] See, for example, John Heilbron, *Physics at the Royal Society during Newton's Presidency* (Los Angeles: William Andrews Clark Memorial Library, 1983), pp. 16, 35–6.

[23] Christian Mentzel, *Pinax botanonymos polyglottos katholikos* (Berlin: Runge, 1682), sig. (a).

tools, scientific instruments, collections of naturalia and scientific curiosities, and, last but not least, book collections were usually private property in societies where lending libraries and public museums only became common well into the eighteenth-century Enlightenment; before then, few universities, courts, or scientific academies could count on well-stocked libraries, let alone the proper facilities and equipment with which to conduct science (see Grafton, Chapter 10, this volume). During the early modern period, individual practitioners of natural philosophy or natural history therefore often found themselves forced to draw upon their own family resources, both intellectual and material, unless they managed to persuade a patron to share with them some of the resources of his or her own household.[24]

The sheer number and prominence of families involved in the early modern study of nature testifies to their centrality to the enterprise. In astronomy, for example, the Cassini family at the Paris Observatory initiated a quasi-dynasty, with successive generations of Cassinis reigning over astronomical observation in France from the late seventeenth century until the fall of the Bastille in 1789;[25] and in early eighteenth-century Prussia, astronomy likewise became a "family business" for Gottfried Kirch (1639–1710), his wife, Maria Winkelmann (1670–1720), their son Christfried (1694–1740), and their daughters Christine (ca. 1696–1782) and Margaretha (dates unknown).[26] The contemporary literature of natural history is likewise rich with scientifically oriented households, such as the Camerarius and Volckamer families in the Holy Roman Empire, the Bauhins in Switzerland, and, perhaps most notably, the household of the renowned Swedish naturalist Carolus Linnaeus (1707–1778), whose daughter published an independent observation on the luminescence of nasturtiums.[27] Medical vocations also tended strongly to "run in

[24] Yet again Galileo Galilei (1564–1642) is a case in point. Before he succeeded in attracting the patronage of the Medici family (see Biagioli, *Galileo, Courtier*), he literally turned his own household into a workshop in a number of ways: drawing on his father's mathematical training to develop his own talents; self-publishing a book touting a geometric and military compass he had invented, with its place of publication listed as "In the Author's House"; and hiring a full-time live-in instrument maker to produce these compasses under his own roof. See Sobel, *Galileo's Daughter*, pp. 18, 26, and 27.

[25] So many Cassinis rose to prominence that, to clear up the potential confusion, authors sometimes resort to giving them the dynastic labels of Cassini I, II, III, and IV; see, for example, the *Dictionary of Scientific Biography*, ed. Charles Coulton Gillispie (New York: Scribner, 1981), 3: 100–9. It is perhaps worth noting that the Cassinis themselves intermarried with another prominent astronomical family, the Maraldis, resulting in yet another intergenerational collaboration (see Gillispie, ed., *Dictionary of Scientific Biography*, 9: 89–91).

[26] Schiebinger, *The Mind Has No Sex?* pp. 82–99. This pattern continued well into the nineteenth century, as witnessed by the well-known astronomical contributions of William Herschel (1738–1822), his sister Caroline Herschel (1750–1848), lauded for her observations of comets, and William's son John Frederick William Herschel (1792–1871). See Rob Iliffe and Frances Willmoth, "Astronomy and the Domestic Sphere: Margaret Flamsteed and Caroline Herschel as Assistant-Astronomers," in Hunter and Hutton , eds., *Women, Science, and Medicine, 1500–1700*, pp. 235–65; in the Herschel household, as Caroline Herschel noted, William Herschel had had "almost every room turned into a workshop" (p. 258).

[27] See Ann B. Shteir, *Cultivating Women, Cultivating Science: Flora's Daughters and Botany in England, 1760 to 1860* (Baltimore: Johns Hopkins University Press, 1996), p. 51.

the family," as seen, for example, in the Platter dynasty in sixteenth-century Basel.[28]

This may have been partially because of the increasing tendency of university professors, especially from the seventeenth century on, to form families closely linked by intermarriage, with professorships and other posts often handed down from fathers to sons or, more indirectly, to sons-in-law.[29] This formed part of a more general pattern of the traditional inheritance of both occupations and avocations, which was not confined to the learned elite but flourished in artisanal and craft families more generally, such as those of the Musschenbroeks in Leiden, who spent several generations manufacturing air-pumps and microscopes before finally breaking into the physics professoriate.[30] In the family-structured world of early modern Europe, what might look like nepotism to modern eyes was rather viewed as a legitimate transmission of valuable traditions and skills; and, as the examples cited show, some of the most well-known figures of the era passed on their knowledge not just through the impersonal means of institutions and written work but in this most "personal" way.

DIVIDING LABOR IN THE SCIENTIFIC HOUSEHOLD

How then did the early modern household function to enable natural inquiry? To explore this further requires examination of the different roles that members of the household played at different times. An early modern household often embraced not only a "nuclear family" of parents and children but also a range of other possible members. At any point in time, these might include close relatives and other kin and, depending on the wealth and status of the family, other individuals of various kinds, from lodgers, boarders, guests,

[28] See Emmanuel Le Roy Ladurie, *The Beggar and the Professor: A Sixteenth-Century Family Saga*, trans. Arthur Goldhammer (Chicago: University of Chicago Press, 1997), esp. pp. 48–9, 114–7, 342, and 344–6. Although Thomas Platter, Sr., began his career as an illiterate peasant boy, his sons Felix and Thomas, Jr., fulfilled their father's medical aspirations, with the former becoming one of the most renowned physicians of sixteenth-century Basel. Each of the three left behind a journal; see, for example, Sean Jennett, trans., *Beloved Son Felix: The Journal of Felix Platter, a Medical Student in Montpellier in the Sixteenth Century* (London: Muller, 1961).

[29] See Friedrich W. Euler, "Entstehung und Entwicklung deutscher Gelehrtengeschlechter," in *Universität und Gelehrtenstand, 1400–1800*, ed. Helmuth Rössler and Günther Franz (Limburg: C. A. Starke Verlag, 1970), pp. 183–232; Clark, "From the Medieval Universitas Scholarium to the German Research University," pp. 372–3; and Algazi, "Scholars in Households," p. 25.

[30] Maurice Daumas, *Scientific Instruments of the Seventeenth and Eighteenth Centuries*, trans. and ed. Mary Holbrook (New York: Praeger, 1972), pp. 84–5. For some further examples of multigenerational families of mathematical practitioners, scientific instrument makers, botanical illustrators, and cartographers, respectively, see E. G. R. Taylor, *The Mathematical Practitioners of Tudor and Stuart England* (Cambridge: Cambridge University Press, 1954), pp. 166–7, 169, 171, 173, 176, 177, 185, 192–3, 199, 200, 201, 203–4, 207; Daumas, *Scientific Instruments of the Seventeenth and Eighteenth Centuries*, pp. 64, 65, 67–8, 68–9, 70, 73, 75–6, 77–8, 83, 84, 85, 87; Wilfrid Blunt and William T. Stearn, *The Art of Botanical Illustration* (Kew: Royal Botanic Garden, 1994), pp. 94, 108–12, 128, 145, 151–3; and Norman J. W. Thrower, *Maps and Civilization: Cartography in Culture and Society*, 2nd ed. (Chicago: University of Chicago Press, 1999), pp. 120, 279, n. 45.

acquaintances, and clients to domestic servants such as cooks, farmhands, chambermaids, stable boys, gardeners, manservants, apprentices, clerks, and personal secretaries.[31] Domestic servants were not generally seen as independent "employees" in the modern sense; rather, living in the household, they were regarded as part of it, subject to the authority of its common head, and were often given quasi-familial status.[32] In their capacity as low-ranking household members, they were assigned a variety of tasks, often menial or manual, and some of these assistants, hired for their mechanical or other useful skills, became the "invisible technicians" whose labor was indispensable in an emerging culture of observation and experiment.[33] At a time when few universities or scientific academies could boast of extensive (or indeed any) official laboratory space, a few wealthy natural philosophers such as Boyle built laboratories in their homes and staffed them with "operators," manservants chosen specifically for their ability to carry out the kinds of manual work (such as experiment) their masters felt would be inappropriate for "gentlemen" (see Smith, Chapter 13, this volume). In the experiments that Boyle and others conducted in their home laboratories, their chambers were far from private; gentlemanly "witnesses" were invited to view experiments, but generally only *after* servants had already perfected their skills in carrying them out.[34] Thus the home was not just an innocuous substitute for floor space not available elsewhere; experiments conducted in the home reflected the resources of the householder, with the "invisibility" of the technicians a direct result of their position within the household not as significant individuals in their own right but as contributors to the family project.

Wives and other female relatives, such as sisters and daughters, likewise performed crucial roles in the early modern scientific household that have often been invisible to modern historians (see Schiebinger, Chapter 7, this volume). Wives did not necessarily distance themselves from their husbands' work, as in the later Victorian ideology of separate public and private spheres; rather, each was expected to serve as her husband's "helpmeet" or companion, helping him accomplish what needed to be done.[35] In this capacity, wives

[31] Demographers still debate the currency of the "nuclear family" relative to other forms of families, such as the larger "stem family," in early modern Europe. It is not disputed, however, that the early modern family, especially in prosperous households, might include considerably more individuals than the family of today. For a discussion of this issue, see Anderson, *Approaches to the History of the Western Family*, pp. 4–24.

[32] On the lives and roles of domestic servants in early modern Europe, see, for example, Marjorie McIntosh, "Servants and the Household Unit in an Elizabethan English Community," *Journal of Family History*, 9 (1984), 3–23; Cissie Fairchilds, *Domestic Enemies: Servants and Their Masters in Old Regime France* (Baltimore: Johns Hopkins University Press, 1984); and Ann Kussmaul, *Servants in Husbandry in Early Modern England* (Cambridge: Cambridge University Press, 1981).

[33] See Steven Shapin, "The Invisible Technician," *American Scientist*, 77 (1989), 554–63, and, for a further development of these ideas, his *A Social History of Truth: Civility and Science in Seventeenth-Century England* (Chicago: University of Chicago Press, 1994), pp. 355–407.

[34] See Shapin, "The House of Experiment."

[35] Considerable debate exists concerning the role of the wife in the early modern household. Many histories of family change in Europe have argued that the emergence of the modern world (variously dated) also saw the rise of the "companionate marriage" and a shift from the family as a place of economic production to a place for love, affection, and "sentiment"; see, for example, Shorter, *The Making of the Modern Family*; Stone, *The Family, Sex and Marriage in England, 1500–1800*; and Flandrin, *Families in Former Times*. But see also Ozment, *When Fathers Ruled*, for a challenge to this view, with his argument that both companionate marriage and signs of affection are visible even in the earlier forms of the "patriarchal" family.

often played active roles in family projects, generally in accordance with a gendered division of labor. One of the most important ways they did so was by "managing" the household. It has been shown, for example, how Jane Dee, wife of the sixteenth-century British astrologer and communer with angels John Dee (1527–1608), worked to ensure his professional success by managing the entrance of visitors and potential patrons into the rooms where he worked and by coping with the assortment of peculiar and unreliable assistants he brought into their household.[36] The *salons* or social gatherings that elite seventeenth- and eighteenth-century French women directed in their drawing rooms can be seen as continuing in this tradition, enabling wives to garner patronage for their husbands' careers while creating intellectual spaces in the home.[37]

Women contributed to family projects in other ways as well. In craft settings, masters' wives and daughters were expected to take part in common tasks.[38] Here, too, gendered divisions of labor manifested themselves. In natural history, for example, wives, daughters, and other female members of the household were often trained to paint or otherwise illustrate plants or other specimens rather than formally "describing" them in Latin, a task allocated to their fathers and brothers. In Danzig, on the shores of the Baltic Sea, the early eighteenth-century physician and naturalist Johann Philip Breyne (1680–1764), himself the son of a naturalist father, had his daughters illustrate the exotic specimens he collected.[39] Meanwhile, across the Atlantic Ocean, Jane Colden (1724–1766) used her artistic training to produce one of the first local floras in North America, with the support of her father.[40] In astronomy, tasks were less obviously gendered during this period, and the activity of astronomical observation seems, in itself, to have been one regarded as suitable for women. Scholars have noticed that many of the observations written down in the notebooks of the English astronomer John Flamsteed (1646–1719), for example, are in the handwriting of his wife, Margaret; many similar cases have been found.[41] Alternatively, wives might contribute to

See also Ozment, *When Fathers Ruled*, for a challenge to this view, with his argument that both companionate marriage and signs of affection are visible even in the earlier forms of the "patriarchal" family.

[36] Harkness, "Managing an Experimental Household."

[37] Dena Goodman, *The Republic of Letters: A Cultural History of the French Enlightenment* (Ithaca, N.Y.: Cornell University Press, 1994); and Outram, "Before Objectivity."

[38] Merry E. Wiesner, *Working Women in Renaissance Germany* (New Brunswick, N.J.: Rutgers University Press, 1986), pp. 152–7.

[39] On wives and daughters as illustrators, see Shteir, *Cultivating Women, Cultivating Science*, pp. 178–82. On women's botanical painting and drawing more generally, see Madeleine Pinault, *The Painter as Naturalist*, trans. Philip Sturgess (Paris: Flammarion, 1991), pp. 43–6. Shteir notes that in the "botanical dialogues" that women began to publish in the eighteenth and early nineteenth centuries, they usually set their fictive conversations at home in the parlor or breakfast room (see pp. 81–3, 110, 174).

[40] Shteir, *Cultivating Women, Cultivating Science*, p. 52.

[41] Lesley Murdin, *Under Newton's Shadow: Astronomical Practices in the Seventeenth Century* (Bristol: Adam Hilger, 1985), p. 64; Iliffe and Willmoth, "Astronomy and the Domestic Sphere," pp. 244–57.

the maintenance of the household by practicing various professions of their own, such as those of midwifery and other medical specialties; such women often handed down their roles from mother to daughter.[42] If a woman's husband died, leaving her widowed, she often carried on the family craft or business (for example, printing or the apothecary trade), sometimes with resistance from guild officials but also with a degree of independence from male control that was almost impossible in early modern Europe for women from the artisanal classes to achieve in any other way[43] (see Schiebinger, Chapter 7, this volume).

Finally, sons had roles of their own to play in the workings of the scientific household. As has already been mentioned, they had a strong tendency to "inherit" the occupations of their fathers, not only in the university but also in craft or guild settings. This was reflected in their education, both formal and informal; sons were often exposed to their fathers' work and from a very early age were trained in the necessary skills. At the beginning of the early modern period, for example, Jacopo Berengario of Carpi (ca. 1460–ca. 1530) worked with his father as an apprentice surgeon before becoming a renowned anatomist at the University of Bologna, and at the end of it, the renowned Swiss physician Johann Jakob Scheuchzer (1672–1733) shared numerous botanizing field trips with his father and grandfather (both physicians) and was also included in many of their daily rounds.[44] Although a father might take on an apprentice or other students, in many cases his son would be his primary student and would be expected to learn to support the family and to carry on the family name after the father's death. To ensure that this process would occur smoothly, sons would gradually be exposed to various aspects of their fathers' work, and, in many cases, ended up helping

See also the discussion of Elisabetha Koopman, wife of the astronomer Johannes Hevelius, by Londa Schiebinger in Chapter 7 of this volume, and her portrayal of Maria Winckelmann in *The Mind Has No Sex?* pp. 82–99. For the case of Sophie Brahe, who helped her older brother Tycho observe a lunar eclipse in 1573, see John R. Christianson, *On Tycho's Island: Tycho Brahe and His Assistants, 1570–1601* (Cambridge: Cambridge University Press, 2000), pp. 57, 258–64.

[42] Wiesner, *Working Women in Renaissance Germany*, pp. 37–73, discusses women in the healing professions. She notes, for example, that when summoned before authorities to defend their medical practice, women cited their "feminine skills" (p. 54); in a further example of the division of medical labor, Jewish women enjoyed particular success as "eye-doctors," or oculists, in southern German cities before they were ousted by barber-surgeons (p. 50).

[43] See Olwen Hufton, "Women Without Men: Widows and Spinsters in Britain and France in the Eighteenth Century," *Journal of Family History*, 9 (1984), 355–76, and her *The Prospect Before Her: A History of Women in Western Europe, 1500–1800* (New York: Alfred A. Knopf, 1995), pp. 221–54; see also Wiesner, *Working Women in Renaissance Germany*, pp. 157–63. Although single or separated women were often stigmatized in early modern Europe, they, too, might end up with similar arrangements. For the case of Maria Sibylla Merian, see Natalie Zemon Davis, *Women on the Margins: Three Seventeenth-Century Lives* (Cambridge, Mass: Harvard University Press, 1995); and Schiebinger, Chapter 7, this volume.

[44] Vittorio Putti, *Berengario da Carpi: Saggio biografico e bibliografico seguito dalla traduzione del "De fracturis cranei sive cranei"* (Bologna: L. Cappelli, 1937); Hans Fischer, *Johann Jakob Scheuchzer (2. August 1672 – 23. Juni 1733), Naturforscher und Arzt* (Zürich: Leemann, 1973), pp. 14–15; and Rudolf Steiger, *Johann Jakob Scheuchzer (1672–1733). 1. Werdezeit (bis 1699)* (Zürich: Leemann, 1927), p. 21.

with it, before or after leaving the family home to pursue further education or apprenticeships elsewhere. Like servants, children (including daughters) might be called upon to perform especially manual or menial work; Felix and Ursula Platter prepared and folded paper for their father's print shop "till their fingers bled."[45]

In a final gesture, sons might be called in to complete projects left unfinished by their father's deaths. In natural history, for example, it was all too common for the publication of local floras, herbals, and other encyclopedic publications to be delayed indefinitely as more and more information was assembled, and upon the illness or death of the prime compiler, his son would be an obvious choice to finish the job and thereby ensure the project's long-delayed entry into the public world of natural knowledge. Thus, in seventeenth-century Königsberg, when physician and naturalist Johann Loesel (1607–1655) fell sick and was unable to publish his work on the local flora of the region, he had his son (also called Johann) publish the book in his stead; a year later, the elder Loesel died.[46] This kind of arrangement ensured that a life's precious work would not be lost but carried on into the next generation.

Early modern homes and households thus served to provide an important element of continuity in an age in which support for scientific activities tended to be inconstant, financially meager, and unevenly distributed. Only with the full support of the household, and in particular with the participation of family members, could many of the laborious, "Baconian" tasks of early modern science, which tended to require extensive information gathering and many years of labor, be brought to fruition. With the rise of scientific academies and other such institutions in the second half of the seventeenth century, the domestic model came gradually to be eclipsed by other, more visible sites for the production of natural knowledge in specialized research facilities. This process was a very slow one, however, and even after middle-class ideologies of the nineteenth century proclaimed science a creation of the public sphere, separate from the private sphere of home and household, family settings continued to offer useful, often crucial resources for the pursuit of science.[47]

[45] Le Roy Ladurie, *The Beggar and the Professor*, p. 133.

[46] Johann Loesel, *Plantas in Borussia sponte nascentes e manuscriptis Parentis mei divulgo* (Königsberg: Mensenius, 1654), dedication. See also Alix Cooper, "The Death of the Naturalist: The Labor of Posthumous Publication in Early Modern Natural History," paper presented at the History of Science Society annual meeting, Pittsburgh, Pennsylvania, November 1999.

[47] On the modern persistence of the family in science, see Abir-Am and Outram, eds., *Uneasy Careers and Intimate Lives*; and Helena M. Pycior, Nancy G. Slack, and Pnina G. Abir-Am, eds., *Creative Couples in the Sciences* (New Brunswick, N.J.: Rutgers University Press, 1996). Science was later, of course, brought back into the "private sphere" of the home both through the late nineteenth- and twentieth-century "domestic science" movements, aiming to instruct women on the principles of cookery, housekeeping, and other feminine disciplines, and, even earlier, through the popularization of science for women and children. On the latter, see James A. Secord, "Newton in the Nursery: Tom Telescope and the Philosophy of Tops and Balls," *History of Science*, 23 (1985), 127–51.