CHAPTER 12

# Wholesale Pharmaceutical Manufacturing in London, c.1760 – c.1840: Sites, Production and Networks

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The relationship between chemistry and production was central to the development of wholesale pharmaceutical manufacturing in London in the late-eighteenth and early-nineteenth centuries. Drug manufacturing took place in a diverse marketplace united by a loose, but coherent, chemical-pharmaceutical culture. Its development benefitted from the close linkage of scientific and artisanal knowledge and practice, creating businesses from which the modern pharmaceutical industry originated. Building on the themes of this volume, this chapter will contribute to a broader history of industrialization that privileges chemistry as much as mechanics, and looks beyond innovation to provide a deeper examination of the history of productivity. Simply, pharmaceutical production can be added to the list of absentees that a focus on Newtonian mechanics has overlooked.[1] Meanwhile Mokyr's un-ashamed portrayal of an economic success story does not fit with the complex picture of development in pharmaceutical manufacturing that encompassed failure, secrecy, collaboration and competition.[2] As William J. Ashworth has commented, "the key to Britain's long term economic growth was an array of factors that lie outside the entrenched literature that has grown up around the defence of Western culture and political economy," with governmental, imperial and military factors particularly applicable to this study.[3]

Arguably even more "underappreciated" than the history of chemistry, the history of pharmaceutical manufacturing, centered as it is on the investigation and use of an extensive range of materials, plants and animals, provides a rich and relatively untouched source for studying production.[4] Much of the writing

1 Margaret Jacob, *The First Knowledge Economy*: *Human capital and the European economy, 1750-1850* (Cambridge: Cambridge University Press, 2014).

2 Joel Mokyr, *The Enlightened Economy* (London: Penguin, 2009).

3 William J. Ashworth, "The British Industrial Revolution and the Ideological Revolution: Science, neoliberalism and history," *History of Science* 52 (2014): 178-99, on 199.

4 Lissa Roberts, "Producing (in) Europe and Asia, 1750-1850," *Isis*, 106 (2015): 857-65, on 864.

about drug manufacturers operating in the period c.1760 to c.1840 is found in company histories of long-established firms. Some of these studies can downplay the extent of production at this time.[5] Furthermore, when viewed from the perspective of large, multinational firms operating today, the origins of the industry can appear "humble."[6] Analysis of the industry's development as a whole, meanwhile, tends to emphasise its retail origins or to focus on the late-nineteenth century onwards.[7] However, during the late-eighteenth and early-nineteenth centuries, manufacturers' activities stretched beyond the pharmacy and the scale and scope of production was far from humble. Moreover, an important dynamic existed between wholesale drug manufacturing in the UK and the worldwide market for drugs. It is within this much wider international trade and productivity network that the origins of the modern pharmaceutical industry can also be located.

In the context of this volume, the neglect of the period c.1760 to c.1840 is particularly significant as it means that little has been done to integrate the early history of the pharmaceutical industry within a broader history of industrial development.[8] Moreover, a narrative of innovation shapes many of the existing individual studies of firms, notably how the introduction of new drugs into pharmaceutical and medical practice directed the history of a firm and its manufacturing activities.[9] As David Edgerton has highlighted in calling for a use-centered history of technology, one should not focus unreflectively on

5 Geoffrey Tweedale, *At the Sign of the Plough: Allen and Hanburys and the British pharmaceutical industry, 1715-1990* (London: John Murray, 1990), 56.

6 John P. Swann, "The Pharmaceutical Industries," Peter J. Bowler and John V. Pickstone, eds., *The Cambridge History of Science Volume 6: Modern Life and Earth Sciences* (Cambridge: Cambridge University Press, 2009), 126-40, on 127.

7 J. Burnby, "The Early Years of the Pharmaceutical Industry," Lesley Richmond, Julie Stevenson and Alison Turton, eds., *The Pharmaceutical Industry: A guide to historical records* (Aldershot: Ashgate, 2003), 1-13; Judy Slinn, "Research and Development in the UK Pharmaceutical Industry from the Nineteenth Century to the 1960s," Mikuláš Teich and Roy Porter, eds., *Drugs and Narcotics in History* (Cambridge: Cambridge University Press, 1995), 168-86. For pharmacy in general see Stuart Anderson, ed., *Making Medicines: A brief history of pharmacy and pharmaceuticals* (London: Pharmaceutical Press, 2005).

8 There is one major exception. Roy and Dorothy Porter emphasise druggists' role as manufacturers and distributors of medicines and suggest they could be "the authentic progenitors of the pharmaceutical industry," in that they are "integral to that surge of large-scale manufacturing and marketing which we call the Industrial Revolution." Roy Porter and Dorothy Porter, "The Rise of the English Drugs Industry: The role of Thomas Corbyn," *Medical History* 33 (1989): 277-95, on 282.

9 For example, A.F.P. Morson, *Operative Chymist,* Clio Medica no. 45 (Amsterdam: Rodophi, 1997).

innovation as the motor of historical development.[10] In conjunction with a stimulus from innovation, the demands of local and international markets and existing networks of supply all shaped production. Meanwhile for the actors involved, innovation was conceptualized in terms of adapting established technological processes, utilizing existing knowledge and improving technical efficiency.

## Practitioners and Production

For much of the period under discussion, the boundaries surrounding manufacturing, wholesale and retail pharmacy were very fluid, whilst the substances produced often had utility beyond pharmacy.[11] Various terms were used to describe the practitioners who made drugs, for example chymist, apothecary, chemist, druggist, operative chemist, fine chemical manufacturer and so on. What these roles meant also evolved over time as professional boundaries shifted.[12] Many of these individuals were not just retailers, they were manufacturers and distributers of medicines, often engaged in overseas trade, and sometimes acting as government contractors. This chapter's primary concern is not with distinctions between the various actors' categories that are used or with changing professional and institutional regulation in this period.[13] Furthermore, the differences in the contexts in which these categories were used in Britain compared to other European countries also lie outside the scope of this study.[14] Instead this chapter's objective is to provide an insight into a world of production and commerce by focusing on the manufacture of medical drugs for sale in bulk; that is not medical drugs sold to the individual

10 David Edgerton, *Shock of the Old: Technology and global history since 1900* (London: Profile Books, 2006).

11 For the retailing perspective, see Louise Hill Curth, ed., *From Physick to Pharmacology: Five hundred years of British drug retailing* (Aldershot: Ashgate, 2006).

12 Colin A. Russell, Noel G. Coley and Gerrylynn K. Roberts, *Chemists by Profession. The origins and rise of the Royal Institute of Chemistry* (Milton Keynes: Open University Press, 1977), 14-54.

13 S.W.F. Holloway, *Royal Pharmaceutical Society of Great Britain, 1841-1991: A political and social history* (London: The Pharmaceutical Press, 1991).

14 Ursula Klein, "Blending Technical Innovation and Learned Natural Knowledge: The making of ethers," Ursula Klein and Emma Spary, eds., *Materials and Expertise in Early Modern Europe: Between market and laboratory* (Chicago: University of Chicago Press, 2010), 125-57, on 151-4.

consumer, but those supplied wholesale to hospitals, institutions, merchants and government departments, and also exported overseas.

Given the diverse range of practitioners who made drugs, the examples in this chapter include firms that described themselves as fine chemical manufacturers; individuals or frequently changing partnerships who used the term chemist or druggist or both; and also a livery company undertaking collective manufacture on behalf of its members. As a result of participating in the "Situating Chemistry, 1760-1840" international network for collaborative research, information on all of these sites of pharmaceutical manufacture and the individuals linked to them is gradually being added to the project's database, currently found at <http://situatingchemistry.org/>.[15] What is common to all these sites and individuals is that, through the medium of large-scale manufacturing, they participated in and considered themselves part of the pharmaceutical marketplace.[16] Large-scale manufacturing is obviously a relative term, relative not only to the standards of the time but also to the specific industry. Given that drugs could be prescribed to patients in quantities of grains and minims, pharmaceutical production was necessarily on a smaller scale than in other chemical industries, for example the manufacture of bleaching powder, as discussed in John Christie's chapter in this volume. Multiple operations on one site could also be supervized by a relatively small workforce, in contrast to the large numbers engaged in manufacturing for military purposes in dockyards and munitions works.[17] However, as subsequent examples of the apparatus used; the quantity of raw materials consumed; and the size of the market supplied show; for pharmacy this was production on the largest possible scale for the standards of the time.

15 The Business Archives Council's survey of records of the British Pharmaceutical Industry and Derek Oddy, John Perkins and John Stewart's assistance have been invaluable in this aspect of my research.

16 The concept of a generalized "medical marketplace" can be seen as outdated, with a preference for considering "markets for medical goods and services" instead. Mark Jenner and Patrick Wallis, "The Medical Marketplace," Mark Jenner and Patrick Wallis, eds., *Medicine and the Market in England and its Colonies, c.1450-c.1850* (London: Palgrave Macmillan, 2007), 1-17, on 16. However, given the complexities and fluid boundaries of the drug trade, for this chapter "pharmaceutical marketplace" is a useful way of bringing together different aspects of the "markets" for drugs.

17 Jan Lucassen, "Working at the Ichapur Gunpowder Factory in the 1790s," Parts I and II, *Indian Historical Review* 39 (2012): 19-56, 251-71. With thanks to Andreas Weber for this reference.

## From Dockside to Drug Auction

Patrick Wallis' work on the massive growth in the use of commercial drugs in the early modern period clearly shows the importance of the drug trade at this time. Using Port Books listing ships' cargoes and, from 1696, annual ledgers of the Inspector–General of the Customs, he has presented new evidence on the scale, origins and content of English imports of medical drugs between 1567 and 1774. Wallis shows that the volume of imported medical drugs exploded in the seventeenth century and continued growing, but on a more gradual scale, in the eighteenth century. Many of these drugs were re-exported, as England's position as a leading international entrepôt developed. However, given the dosages in use in that period, Wallis demonstrates that common drugs such as senna and Jesuits' bark were available to the majority of the population in the eighteenth century.[18] This provides further evidence of the expansion of medical consumption at this time, with subsequent work by Wallis and Pirohakul underlining the growing centrality of therapeutics in patients' expectations of medical treatment.[19] However this poses the question: how did those involved in the pharmaceutical marketplace meet this substantial increase in demand for drugs? Whilst drug imports provide the first part of the answer, a focus on production provides the second part. The route from dockside to consumer was varied and could involve many sites, actors and networks. Plant-based drugs had to be processed in different ways to make them suitable for administration in various formats, whilst chemical medicines had to be either made from raw materials or refined to medicinal grade quality.

London provides the focus for this study as it was a major center for the international trade in crude drugs and the key location for large-scale drug production in the UK in the period c.1760 to c.1840.[20] By the late seventeenth century, over ninety-five percent of drug imports into the UK came through London, and the city possessed significant commercial advantages in terms of shipping, banking and insurance, as well as a reputation for reliability in terms

18 Patrick Wallis, "Exotic Drugs and English Medicine: England's drug trade, c.1550 – c.1800," *Social History of Medicine* 25 (2012): 20-46.

19 Patrick Wallis and Teerapa Pirohakul, "Medical Revolutions? The growth of medicine in England, 1660-1800," *Journal of Social History*, 49 (2016): 510-31, on 523.

20 It was not until the 1830s that T. & H. Smith, Duncan Flockhart & Co. and J.F. Macfarlan & Co. commenced alkaloid manufacture in Edinburgh. Morson, *Operative Chymist,* pp. 104-21 (see note 9).

of financing and the quality of goods.[21] As its sphere of influence expanded in the eighteenth century, Britain gained control over the sources of many drugs and other raw materials, such as camphor, niter, quicksilver and tincal, whilst trade restrictions forced these goods to be exported through London. These factors not only promoted the trade in raw drugs, but also the activities of the manufacturers who processed them. The broader history of the import and export of drugs into London lies outside the scope of this chapter, but this examination of sites, production and networks is part of a much wider history of globally situated interconnections, exchanges and translations in the drug trade.[22]

The exact route from ship to saleroom depended on who had imported the goods. Many of the commodities discussed in this chapter were imported by the East India Company. Until the East India Docks were opened in 1806, their ships were unloaded at Blackwall. Goods were then carried by lighters to the legal quays or sufferance wharves of the Pool of London.[23] From there, drugs such as aloes, cassia and nux vomica were sent to its Crutched Friars Warehouse. Here they were classified and sorted, with samples prepared for sale at East India House in Leadenhall Street.[24] Private trading networks, operating in tandem with monopoly companies, were particularly significant in the context of drug imports, as Timothy Davies has highlighted for the London drug merchants, Gammon and Chaloner.[25] Mincing Lane was known as the heart of London's drug trade in the nineteenth century, being subsequently described in

21 Anon., "London's Drug Market and the Romance of Mincing Lane," *Chemist and Druggist*, 30 June 1928, 850-67; Terry M. Parssinen, *Secret Passions, Secret Remedies: Narcotic drugs in British society, 1820-1930* (Manchester: Manchester University Press, 1983), 15-16; R.S. Roberts, "The Early History of the Import of Drugs into Britain," F.N.L. Poynter, ed., *The Evolution of Pharmacy in Britain* (London: Pitman, 1965), 165-85.

22 Harold J. Cook and Timothy D. Walker, "Circulation of Medicine in the Early Modern Atlantic World," *Social History of Medicine* 26 (2013): 337-51.

23 "The East India Docks: Historical development," Hermione Hobhouse, ed., *Survey of London: Volumes 43 and 44, Poplar, Blackwall and Isle of Dogs* (London: London County Council, 1994), 575-82, accessed 24 September 2015, <http://www.british-history.ac.uk/survey-london/vols43-4/pp575-582>. For changes to trading rights see John Keay, *The Honorable Company: A history of the English East India Company* (London: HarperCollins, 1991).

24 Anon., "A New Drug Showroom," *Chemist and Druggist,* 1 February 1913, 52-3; Anon., "London's Drug Market," p. 858 (see note 21).

25 Timothy Davies, "British Private Trade Networks and Metropolitan Connections in the Eighteenth Century," Maxine Berg, ed., *Goods from the East, 1600-1800: Trading Eurasia* (Basingstoke: Palgrave Macmillan, 2015), 154-67. For the broader context see Emily Erikson, *Between Monopoly and Free Trade: The English East India Company, 1600-1757* (Princeton: Princeton University Press, 2014).

the weekly trade periodical, *The Chemist and Druggist*, as "once the undoubted centre of exchange for the world's botanical drugs and essential oils."[26] Drug sales, meanwhile, were held at Garraway's coffee house in Exchange Alley, near Cornhill, until shortly before it was demolished in 1866.[27] Here brokers auctioned the lots in their catalog to an audience of wholesale druggists, export merchants and dealers. Although individual firms' buying arrangements differed, it was from this audience that significant quantities of raw materials were purchased and then processed by wholesale manufacturers.[28]

## Expanding Markets

Prior to exploring the development of sites of bulk drug manufacturing in London, it is important to discuss what drove the early development of the industry in the UK. British pharmaceutical manufacturers had specific strengths in terms of their access to worldwide markets and the economic, imperial and social networks they belonged to. In this context, the industry's expansion was not only driven by increasing demand from customers for medical drugs but also facilitated by improved access to resources from Britain's empire. The growth in demand for medical drugs to supply the Army, Navy, and East India Company was particularly important, as this expenditure provided a significant stimulus for growth in production – a point that provides further evidence against explanations of British economic growth at this time with reference to 'the free market'.[29] The Garnier Family, which secured a patent in 1715 to hold the post of Apothecary General to the Army in perpetuity, was rumoured to have earned profits of £10,000 a year in the late-eighteenth century.[30] These profits derived from the lucrative terms of the post, an

26 Anon., "A Century of Commerce in Drugs," *Chemist and Druggist*, 10 November 1959, 160-6, on 160.

27 Anon., "London's Drug Market," pp. 862-3 (see note 21); Anon., "The Drug Sales," *Chemist and Druggist,* 21 August 1886, 230-2.

28 Corbyns bought direct from the auctions. The Society of Apothecaries posted a list of drugs required at Apothecaries' Hall and any merchant or druggist could offer samples to be viewed by the Society's buying committee. Howards purchased through the wholesale druggists David Taylor and Sons.

29 John Brewer, *The Sinews of Power: War, money, and the English state, 1688-1783* (Cambridge: Harvard University Press, 1988); Ashworth, "The British Industrial Revolution" (see note 3).

30 Arthur Edmund Garnier, *The Chronicles of the Garniers of Hampshire during Four Centuries, 1530-1900* (Norwich and London: Jarrold and Sons, 1900), 21.

appointment that paid ten shillings a day, to which was added a sum equal to ten percent of the value of medicines supplied. Between 1795 and 1806, the money spent by the Army on medicines amounted to over £800,000, including £70,000 on surgical instruments. The orders were placed via the Apothecary General with a range of "civil firms."[31]

More is known about drug supply to the Navy and the East India Company. The Society of Apothecaries, a city of London livery company with responsibilities for examining apprentices and regulating apothecaries' activities, primarily supplied these institutions.[32] The Society began manufacturing drugs at its premises at Apothecaries' Hall, Blackfriars, in 1672.[33] Its chemical laboratory was soon described as "the largest and the best," with supply to the Navy starting in 1703 and to the East India Company in 1766.[34] In the eighteenth century, the Society benefitted enormously from its unique position as a livery company, with a role as an arbiter of quality, situated between the trade and government spheres. This position helped to open up lucrative contracts of drug supply and such trading relationships were strengthened when, as William Ashworth has highlighted, "the events of the 1790s temporarily halted Britain's move to reform and, in fact, reinforced its existing institutions."[35]

During the Napoleonic Wars demand for the Society's drugs grew further, with an estimated 120,000 men engaged in the Royal Navy in 1801. Parallels can be drawn between the advantages for the Navy of purchasing drugs from the Society and the strengths of the contractor system of government supply that Roger Knight and Malcolm Wilcox have described in their study of the

31 Neil Cantlie, *A History of the Army Medical Department, vol. 1* (London and Edinburgh: Churchill Livingstone, 1974), 61, 187; Unfortunately I have not yet been able to consult the Garnier family papers to see if any of these "civil firms" are named.

32 E.A. Underwood, ed., Cecil Wall and H.C. Cameron, *A History of the Worshipful Society of Apothecaries of London, vol. 1, 1617-1815* (London: Oxford University Press, 1963), 8-22; Patrick Wallis, "Medicines for London: The trade, regulation and lifecycle of London apothecaries c.1610-1670" (D.Phil. Thesis, Oxford University, 2002), 23-50.

33 Anna Simmons, "Medicines, Monopolies and Mortars: The chemical laboratory and the pharmaceutical trade at the Society of Apothecaries in the eighteenth century," *Ambix* 53 (2006): 221-36.

34 W.H. Quarrell and Margaret Mare, eds., *London in 1710 from the travels of Zacharius Conrad von Uffenbach* (London: Faber and Faber, 1934), 111.

35 William J. Ashworth, "Quality and the Roots of Manufacturing 'Expertise' in Eighteenth-Century Britain," *Osiris* 25 (2010): 231-54, on 234. In the 1810s the Society supplied the army in Ireland and hoped to supply the main army as well. Cantlie, *Army Medical Department,* p. 449 (see note 31).

Victualling Board.[36] For the decade up to 1810, the Navy spent an average of £18,072 per annum with the Society for the supply of drugs, chemicals and galenical medicines, in addition to bottles, phials and mortars. For the same period, the East India Company spent an average of £20,160 per annum on medical supplies for its substantial army, plus ships, hospitals and trading posts, even though some medicines were sourced locally.[37] As the Society of Apothecaries held a monopoly of supply for all of the drugs purchased in Britain by the East India Company until its demise in 1858, some raw materials such as quicksilver were shipped from areas under the Company's control to London, processed at Apothecaries' Hall and then re-exported to South Asia.[38] Similar circular trading networks via London manufacturers existed across the Atlantic with drugs such as Barbados aloes.[39] Other destinations for the Society's medicines included hospitals in Ceylon, Malta and Mauritius, a convict establishment in Australia and the Hudson's Bay Company, in addition to numerous hospitals and institutions in London.[40] Not all of the drugs manufactured at Apothecaries' Hall were supplied direct. A great number of the Society's preparations were sent via merchants to the West Indies.[41] In addition, individual apothecaries built up extensive Transatlantic trading activities, supplying drugs, including some purchased from the Hall, to contacts in New England and the West Indies.[42]

Chemists and druggists also developed impressive overseas export markets, which drove the expansion of their businesses. William Jones traded as a drug-

36 Roger Knight and Malcolm Wilcox, *Sustaining the Fleet, 1793-1815: War, the British Navy and the contractor state* (Woodbridge: Boydell Press, 2010), 10-11, 29.

37 Apothecaries' Hall Archive (hereafter AHA), MS 8200/1-18, 1617-1926, Court of Assistants Minute Books (hereafter CM) CM 29 March 1811. For local sourcing see Pratik Chakrabarti, *Materials and Medicine: Trade, conquest and therapeutics in the eighteenth century* (Manchester: Manchester University Press, 2010), 33-44.

38 AHA, MS 8261, India Orders, 1827-8, state 3,011 lbs. of calomel, was sent to Bengal, Madras, Canton and Prince of Wales Island.

39 S. Stander, "Transatlantic Trade in Pharmaceuticals during the Industrial Revolution," *Bulletin of the History of Medicine* 43 (1969): 326-43, on 340-2.

40 AHA, Annotated *Pharmacopoeia Collegii Regalis Medicorum Londinensis* (London: Longman, 1809); United Stock Account Books, MS 8224, vol. 1 (1812-30), vol. 2 (1831-46); Penelope Hunting, *A History of the Society of Apothecaries* (London: Society of Apothecaries, 1998), 164-87.

41 J.F.A. Göttling, "Einige Bermerkungen über Chemie und Pharmazie in England," *Almamanach oder Taschenbuch für Scheidekünstler und Apotheker,* 1789, 128-44, on 129. With thanks to Ursula Klein for this reference.

42 I.K. Steele, *Atlantic Merchant Apothecary: Letters of Joseph Cruttenden, 1710-1717* (Toronto: University of Toronto Press, 1977).

gist in Bloomsbury in the mid-eighteenth century and had a UK-wide wholesale trade, whilst also exporting drugs to Nova Scotia, Gibraltar, and the West Indies.[43] Thomas Corbyn, who traded from 300 High Holborn, had, in addition to a substantial provincial market, a significant overseas trade, predominantly with Quakers in North America and also in the West Indies.[44] Ledgers and letter books dating from 1776 to 1780 demonstrate that another Quaker, Joseph Gurney Bevan of Plough Court (the business that ultimately became Allen and Hanburys), had forty regular customers across the Atlantic, mostly in Jamaica and Barbados, plus a secondary trade shipping bales of textiles to Europe.[45] Such activity was undoubtedly fostered by close ties between the Quaker merchant community on both sides of the Atlantic and its established networks of commerce and credit.[46] It also underlines how this story of production feeds into a broader history linking therapeutics with colonial expansion and international trade.[47]

## Sites of Bulk Drug Manufacturing

It is now necessary to return to the question of how those involved in the pharmaceutical marketplace met the substantial increase in demand for medical drugs. This was achieved by firms expanding their premises (initially on site and later elsewhere) and by scaling up production. Thomas Corbyn, in addition to his premises in Holborn, had a separate laboratory, and owned a large warehouse at Cold Bath Fields. His warehouse stock book or inventory dated December 1761 included 2,500 items of materia medica, some of which were stored in very large quantities.[48] A surviving recipe book consisted of over 650 preparations and contained instructions for large-scale pharmaceutical production.[49] Samuel Towers commenced manufacturing at a laboratory in

43 G.M. Watson, "Some Eighteenth Century Trading Accounts," F.N.L. Poynter, ed., *The Evolution of Pharmacy in Britain* (London: Pitman, 1965), 45-78.

44 Porter and Porter, "The Rise of the English Drugs Industry," pp. 290-1 (see note 8).

45 Simon S. Stander, "A History of the Pharmaceutical Industry with Particular Reference to Allen and Hanbury, 1775-1843" (M.Sc. Econ. Thesis, London University, 1965), 55, 125.

46 Margaret Stiles, "The Quakers in Pharmacy," F.N.L. Poynter, ed., *The Evolution of Pharmacy in Britain* (London: Pitman, 1965), 113-30; Renate Wilson, "Trading in Drugs through Philadelphia in the Eighteenth Century: A transatlantic enterprise," *Social History of Medicine* 26 (2013): 352-63.

47 Chakrabarti, *Materials and Medicine,* pp. 19-51 (see note 37).

48 Porter and Porter, "The Rise of the English Drugs Industry," p. 288 (see note 8).

49 Wellcome Library, Corbyn and Co., Manufacturing Recipe Book, 1748-1847, MS 5446.

Oxford Street in the late 1600s. In the eighteenth century, this business moved to more extensive premises at Mount Pleasant, and sites were subsequently added in Cold Bath Fields and Maiden Lane, Battle Bridge. The latter location was used for manufacturing chemicals including ammonia (then known as hartshorn as it was obtained from distilling stags' horns and bones) and oxalic acid.[50]

However it was the Society of Apothecaries that had the greatest capacity to process and manufacture huge quantities of drugs. Their premises at Blackfriars housed the largest pharmaceutical manufacturing laboratories in London in the late-eighteenth and early-nineteenth centuries, with plans dating from 1771 and 1823 illustrating the extent of expansion during this period (see figures 12.1 and 12.2). The German apothecary Johann Göttling visited Apothecaries' Hall whilst in England in 1787 and 1788, shortly after a major extension to the trading premises had been completed. He praised the Society's manufacturing capabilities, describing two large laboratories, a still house and hand mill room, and highlighted how "all chemical preparations are prepared in large quantities."[51] His description of the apparatus for making calx of mercury is indicative of this. The brick furnace was six to seven feet long and four feet wide, with its upper part containing a sand bath, where twenty to twenty-five phials were buried. Each phial held about two pounds of water and was half-filled with quicksilver.[52] Göttling remarked that certain processes operated more efficiently when carried out in bulk. For example, he noted that the large-scale purification of ammonium carbonate was less arduous than when performed with smaller distillations.[53] A device for distilling stag horn in order to obtain the spirit (aqueous solution of ammonia) also impressed him. This used two large upturned pots, about three and half feet high, placed on top of each other to serve as a distillation receiver. The device overcame a number of the problems associated with the distillation and Göttling commented that he was surprized that a similar arrangement was not yet found in German laboratories.[54] His remarks suggest that the Hall's production method was not widely known in England either, as Göttling noted that Robert Dossie's *The Elaboratory*

50 Gustave L.M. Strauss, Charles W. Quin, John C. Brough, Thomas Archer, William B. Tegetmeier, and William J. Prowse, *England's Workshops* (London: Groombridge and Sons, 1864), 160.

51 J.F.A. Göttling, "Einige Bermerkungen," p. 129 (see note 41); See also Ursula Klein, "Apothecary-Chemists in Eighteenth Century Germany," Lawrence Principe, ed., *New Narratives in Eighteenth Century Chemistry* (Dordrecht: Springer, 2007), 97-137, on 115-16.

52 Göttling, "Einige Bermerkungen," pp. 131-2 (see note 41).

53 Göttling, "Einige Bermerkungen," pp. 136-7 (see note 41).

54 Göttling, "Einige Bermerkungen," pp. 132-6 (see note 41).

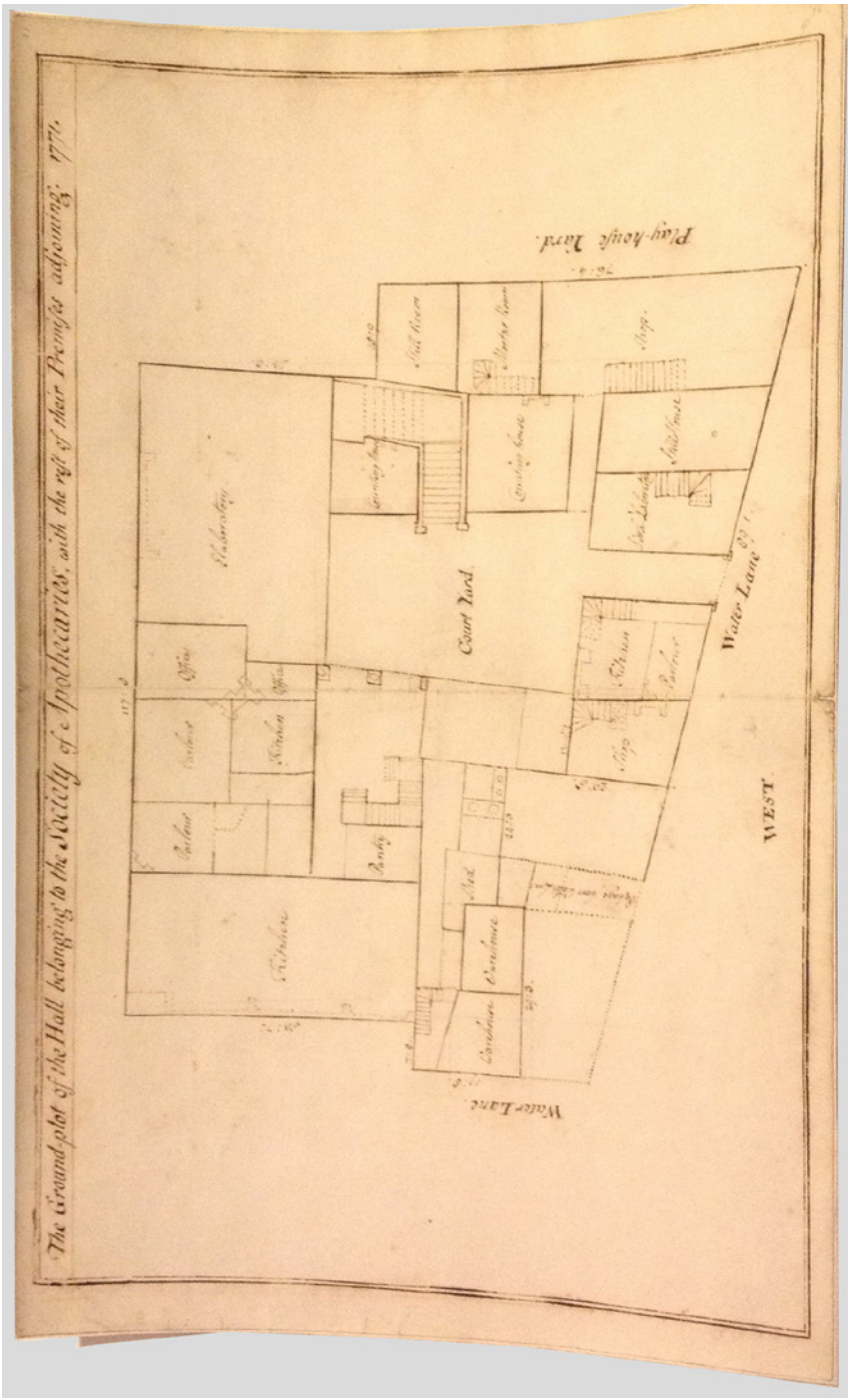


FIGURE 12.1 *Ground Plan of Apothecaries' Hall, including the Trading Premises, 1771.* IMAGE USED BY KIND PERMISSION OF THE WORSHIPFUL SOCIETY OF APOTHECARIES.

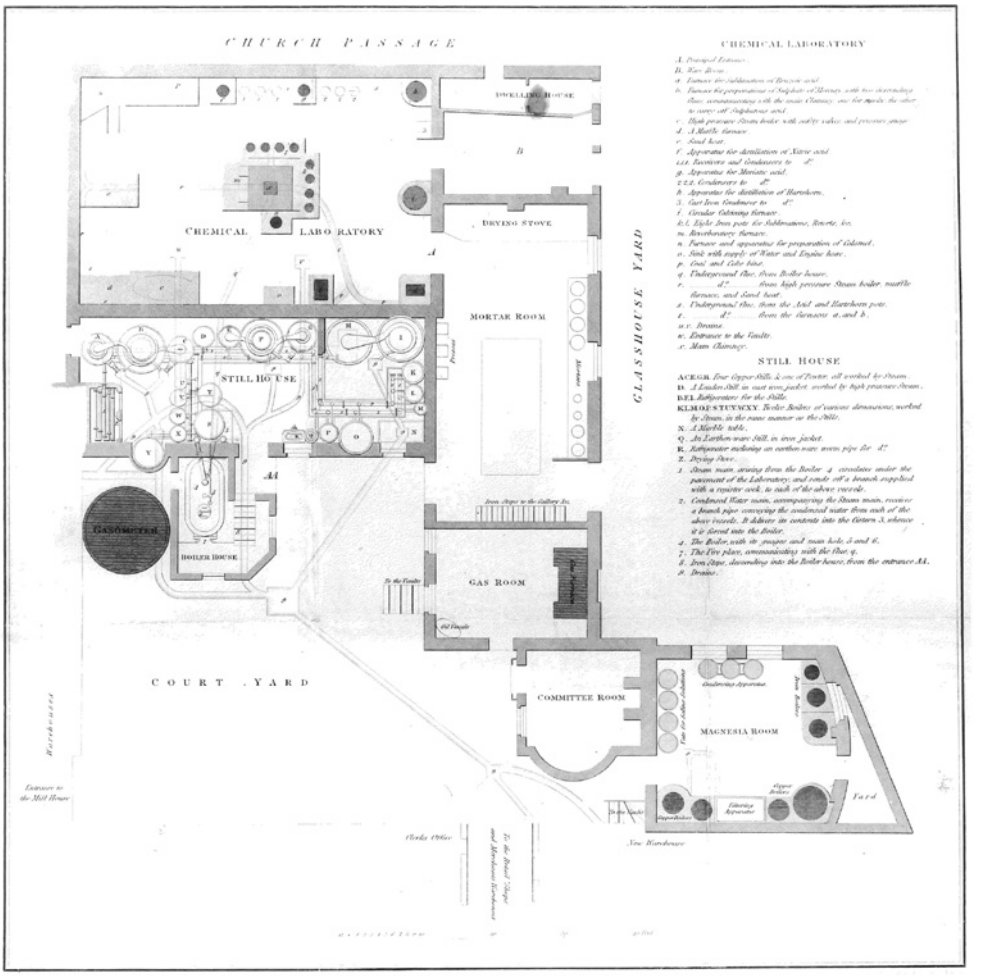


FIGURE 12.2 *Plan of Hall laboratories taken from* The Origin, Progress, and Present State of the Various Establishments for Conducting Chemical Processes, and Other Medicinal Preparations, at Apothecaries' Hall (*London: R. Gilbert, 1823*). IMAGE USED BY KIND PERMISSION OF THE WORSHIPFUL SOCIETY OF APOTHECARIES.

*Laid Open* also referred to the problems experienced when carrying out the distillation.[55] It seems likely that in contrast to the Enlightenment ideals of openness and freedom of knowledge, the Apothecaries' Hall laboratories at this point were a closed environment.[56] Göttling observed that it was "very difficult to gain entry here without a special recommendation."[57]

In the early nineteenth century, further development occurred to the manufacturing premises at Apothecaries' Hall, with the construction of a mill house, initially horse-powered, which enabled large quantities of drugs to be ground on site.[58] This was followed by a state of the art still house, which was significant for the novel steam technology it incorporated; a new laboratory with furnaces; new warehouses; and an eight horse-power steam engine, which powered machinery for grinding, sifting, triturating and pounding drugs.[59] As the stove for making calx of mercury illustrates, the laboratories contained existing chemical-pharmaceutical apparatus scaled up for bulk production and multiplied in number. When this was combined with mechanized drug mills and a larger workforce, consisting of a chemical operator, a galenical operator (until 1826), a foreman and around eight to ten laboratory workmen, the Society was able to manufacture and process huge quantities of drugs for a non-local market. The speed of production was such that in 1810 the Society claimed that "medicines for an Army of 30,000 men could be provided in the course of ten days in the case of an emergency."[60] The scale of production, meanwhile, is illustrated by an East India Company indent from 1827-8. The orders included 879 pounds and 5 ounces of mercury pills shipped to Bengal and Madras; 3,112 pounds of powdered cinchona *lancifolia* bark sent to Bengal, Bombay and Canton; and 36,962 pounds of magnesium sulphate dispatched to Bengal, Bombay, Madras, Canton and Prince of Wales Island.[61] Ursula Klein has highlighted how similar conditions elsewhere enabled "a continuous transition from small-scale pharmaceutical manufacture to large-scale pharma-

55 Robert Dossie, *The Elaboratory Laid Open: Or the secrets of modern chemistry and pharmacy revealed* (London: J. Nourse, 1756), 85-93.

56 Contrastingly, the Hall laboratories were publicized in an attempt to boost the Society's scientific status in the 1810s. Anna Simmons, "Stills, Status, Stocks and Science: The laboratories at Apothecaries' Hall in the nineteenth century," *Ambix* 61 (2014): 141-61.

57 Göttling, "Einige Bermerkungen," p. 129 (see note 41).

58 AHA, CM 23 October 1801, 16 September 1803.

59 Anon., *The Origin, Progress and Present State of the Various Establishments for Conducting Chemical Processes, and Other Medicinal Preparations, at Apothecaries Hall* (London: R. Gilbert, 1823).

60 AHA, CM 24 October 1810.

61 AHA, MS 8261, India Orders, 1827-8.

ceutical industry," with comparable development occurring at other sites of wholesale pharmaceutical manufacturing in London.[62]

The majority of apothecaries, chemists and druggists who began manufacturing drugs in the capital in the seventeenth and eighteenth centuries were located in the City of London, particularly around its boundaries, with clusters also situated around Oxford Street, Covent Garden and Holborn.[63] However, this changed in the period c.1760 to c.1840. As London expanded westwards and the City of London became a business rather than a residential area, the distribution of manufacturing sites began to shift.[64] Many businesses that had been founded in or near the City of London (with combined production and retail facilities on one site) constructed separate manufacturing premises outside of this area. For example, in 1795 the Quaker, Joseph Jewell, began manufacturing chemicals on a larger scale than was possible at the Plough Court pharmacy (where he was employed as an "elaboratory man"), at a new laboratory in Plaistow, Essex.[65] Luke Howard joined fellow Quaker, William Allen, in partnership at Plough Court in 1797 and together with Jewell concentrated on developing the Plaistow laboratory. A laboratory journal from the turn of the nineteenth century provides an insight into its daily operation, as well as highlighting the range and extent of production.[66] It indexes seventy-one principal products, including ammonia, borax, nitric and citric acids, camphor, ether, mercurials and potassium salts.[67] The entry for 7 February 1800 records that 3,403 ½ pounds of rough camphor were treated yielding 3,120 ½ pounds of the sublimed. Costings of labor, glassware and fuel, alongside yields and technical details are all noted, illustrating how a paper record of commercial factors and experimental observation was increasingly used to manage workers and the processes under their supervision.

62 Ursula Klein, "Apothecary's Shops, Laboratories and Chemical Manufacture in Eighteenth Century Germany," Lissa Roberts, Simon Schaffer and Peter Dear, eds., *The Mindful Hand: Inquiry and invention from the late renaissance to early industrialisation* (Chicago: University of Chicago Press, 2007), 247-76, on 275.

63 A detailed analysis of the location of sites for wholesale pharmaceutical manufacturing in London will form the focus of a separate article.

64 Michael Ball and David Sunderland, *An Economic History of London, 1800-1914* (London: Routledge, 2001) 121, 171-3, 182, 361-2.

65 A.W. Slater, ed., "Autobiographical Memoir of Joseph Jewell, 1763-1846," *Camden Miscellany* 22 (1964): 113-78, on 115.

66 London Metropolitan Archives, Records of Howards and Sons, Laboratory Journal, ACC 1037 291/1.

67 Anon., "Howards of Stratford and Ilford," *Chemist and Druggist*, 25 April 1914, 115-23, on 116.

Allen and Howard's partnership was amicably dissolved in 1807 and around this time the laboratory was relocated to larger and more accessible premises at Stratford.[68] Here, with Jewell as a junior partner, Howard specialized in fine chemicals. At Stratford the large-scale refining of crude Tibetan tincal, niter and camphor imported by the East India Company expanded further, with, for example, five tons of saltpeter purchased on 7 September 1819.[69] By 1821 Howards employed over thirty workmen, increasing to forty-three by the 1830s. Despite fluctuating economic conditions, with a boom during the Napoleonic wars, followed by a post-war slump, sales grew to a peak of £44,916 in 1825. A severe economic downturn followed and Howard and Jewell retired at the end of 1830, but sales only once dipped slightly below £30,000 in the years 1826-37.[70] Allen and his successors, meanwhile, continued manufacturing at Plough Court, with a remarkably consistent turnover of around £15,000 per annum for much of the period 1816-40.[71] They undertook cod liver oil production on site from the 1840s, before later establishing processing plants in Norway, with refining carried out at Plough Court.[72] It was not until 1878 that a new factory was opened at Bethnal Green.

For many businesses founded in the early nineteenth century, a shift from shop-based to factory-based manufacture tended to happen more rapidly, with the introduction of new product ranges often driving expansion. Having gained experience in Paris, Thomas Morson started his business in Fleet Market in 1821, and was the first to manufacture quinine sulphate and morphine salts on a commercial scale in England. His price list from 1821 featured seventeen "new chemical preparations employed as medicine" and included morphine, strychnine, emetine and quinine sulphate.[73] Demand was such that he moved to bigger premises in Southampton Row in 1826, where a 300-square-foot laboratory was built at the rear of his shop.[74] Morson erected works in the Hornsey Road shortly afterwards. There he began manufacturing creosote, which had

68 A.W. Slater, "Howards, Chemical Manufacturers, 1797-1837: A study in business history" (M.Sc. Econ. Thesis, London University, 1956), 179, states that the Stratford laboratory opened in 1807. However most other sources give 1805.

69 Ibid., pp. 56-7 (see note 68).

70 Slater, "Autobiographical Memoir," pp. 121-2 (see note 65); Slater, "Howards," pp. 320-1 (see note 68).

71 Stander, "A History of the Pharmaceutical Industry," pp. 164-5 (see note 45).

72 A plant founded in Newfoundland in 1860 was short-lived. Tweedale, *At the Sign of the Plough*, p. 75, p. 78 (see note 5).

73 Wellcome Library, Records of Thomas N.R. Morson Ltd., Product and Price Lists, 1821-1900, SA/MORH 1.

74 Morson, *Operative Chymist,* p. 44 (see note 9).

again been recently discovered. In the longer-term, Morson failed to exploit his early entry into the quinine market. Production continued until the middle of the nineteenth century, but in 1866 the German firm, Böhringer, supplied Morson with significant quantities of quinine, suggesting that manufacture had ceased.[75] However, this did not affect the firm's growth in other areas. By the 1860s, Morson was producing over 500 different chemical substances, made in all grades of purity. There were also more than 250 extracts, essences and tinctures, in addition to proprietary preparations and gelatine.[76]

The acquisition of new sites did not only signal an expansion of laboratory premises or the manufacture of new products. Larger premises might also be needed for preparing and packaging orders; bigger warehouses were required for storage; or new partnership agreements meant different properties were leased or owned. George Maw started in the London pharmaceutical trade by entering into a partnership in 1807 with his cousin, William Hornby, who was already established as wholesale druggist at 20 Fenchurch Street. Maw left this partnership in 1814 to purchase a surgical plaster factory in Whitecross Street, near Shoreditch. This factory later expanded to produce druggists' sundries, toiletries and pharmaceutical products. Maw then acquired larger premises in Aldermanbury in 1820 and at Aldersgate Street in 1834, as various relatives joined the firm and its range of activities diversified.[77]

As the industry grew, a new sort of manufacturer emerged, of which Maw was an example. Although the need to refine chemicals to medicinal grade quality was not new in the pharmaceutical trade, manufacturers had commonly carried out these steps themselves to guarantee purity.[78] However, increasingly firms specialized in fine chemicals or manufactured semi-prepared products to supply the pharmaceutical trade. In 1833, Stafford Allen, a miller at Amersham and the nephew of William Allen of Allen, Hanburys and Barry (as the firm was then styled), went into partnership with Charles May, a druggist and herb grower from Ampthill, Bedfordshire. They opened drug mills in Cowper Street, City Road, London and the site at Ampthill was used to provide the London business with raw materials. The firm processed these materials into semi-manufactured products, such as powders, distilled oils,

75 Morson, *Operative Chymist,* p. 79 (see note 9).

76 Morson, *Operative Chymist,* p. 225 (see note 9).

77 Anon., "More Historic London Wholesale Houses," *Chemist and Druggist*, 31 January 1914, 155-7, on 156; Anon., "London Pharmaceutical Industry," *Chemist and Druggist,* 24 June 1933, 667-95, on 677.

78 For the Society of Apothecaries' purification of magnesium sulphate see AHA, E/7 Loose Papers, Box 3. Evidence for similar practices exists at William Jones' Bloomsbury business.

extracts and emulsions, which were supplied to major London manufacturers and wholesalers.[79] Similarly, a cost price book from Allen, Hanburys and Barry illustrates how supplies were purchased from various manufacturers and drug merchants, with substances used in the firm's own pharmaceutical production or sold on directly to customers.[80]

## Networks of Supply

As increasing specialization developed within wholesale pharmaceutical manufacturing, firms adapted their business methods to utilize various networks of supply based on established familial, social, religious and economic connections. In this context, the price and purchasing arrangements between manufacturers that regulated the availability and cost of bulk chemicals became more significant. Howards had private arrangements with firms nationwide, which helped the newly formed firm survive price-cutting in the 1810s. For example, Thomas and William Henry of Manchester bought large quantities of tartaric acid from Howards, whilst Howards purchased most of its magnesium sulphate from the Henrys. It is not surprizing that in some cases, price and purchasing arrangements led ultimately to 'mergers' or 'acquisitions.' Luke Howard had come to a price agreement with John Towers of Cold Bath Fields, regarding potassium salts in 1808, but Towers subsequently sold out to Howards in 1816.[81] Quaker ties were also important in this respect. In the 1830s Howards began to produce iodine compounds on a large scale and purchased iodine (made from kelp) from their "'respected Friend' Patrick Miller, in the North." In 1832 Howards agreed to take 2,500 ounces of iodine every three months on condition that Miller "agreed not to sell to any house at a lower price than that charged to the Messrs Howards, or to send any 'hydriodate of potash' to London while the contract ran."[82]

Changes to duties and existing mercantilist laws also had a major impact on what was manufactured by a firm or purchased from other suppliers.[83]

79 Anon., "Centenary of Stafford Allen and Sons," *Chemist and Druggist*, 1 July 1933, 22-3; Entry for Stafford Allen & Sons Ltd in Richmond et al., eds., *The Pharmaceutical Industry,* p. 83 (see note 7).

80 Royal Pharmaceutical Society, Allen, Hanburys and Barry Cost Price Book, 1822-44, IRA 1997.008.

81 J. Burnby, "The Early Years," pp. 8-9 (see note 7).

82 Anon., "Iodine," *Chemist and Druggist*, 19 June 1897, 974.

83 Most drugs and chemicals were dutiable in the UK until 1845 (Anon., "The Good Old Times," *The Chemist and Druggist*, 19 June 1897, 967), with quinine sulphate bearing duty

A broader examination of the trade in cinchona bark and quinine sulphate production in Europe lies outside the scope of this study.[84] However quinine sulphate provides an interesting example of firms' different responses to the introduction of a new drug into the marketplace. It illustrates how innovation, in terms of the adoption of new chemical knowledge and practice, was not exclusively the motor of pharmaceutical development. Pierre-Joseph Pelletier and Joseph Caventou had first isolated quinine from cinchona in Paris in 1820.[85] John Warrick, an importer of foreign drugs and chemicals based in Blackfriars, reputedly sold the first ounce of quinine in England.[86] The purchaser was Thomas Morson, who then manufactured and sold quinine sulphate from Fleet Market in 1821. However it was Howards, not Morson, who went on to dominate quinine production in Britain. Howards first manufactured quinine sulphate on a commercial scale in 1823,[87] but faced strong competition from French producers, such as Pelletier and Levaillant, selling through London drug merchants. Luke Howard and Joseph Jewell evolved an extraction process which produced quinine sulphate of reasonable purity from cinchona bark at their Stratford factory. However, Howards' production capabilities were hampered by the relatively high import duties charged on crude drugs compared to those incurred on imports of the finished product.[88] In such circumstances, it is not surprizing that other manufacturers decided against developing production themselves. Some production was undertaken at Apothecaries' Hall in the early 1820s, but for reasons of quality, price, and the nominal import duty of one penny per ounce on quinine sulphate, by 1834 the Society of Apothecaries preferred to import it directly from France.[89] Howards lobbied HM Privy Council for Affairs of Trade and Commerce regarding the discrepancy in duty

up to 1870. For the complications arising from the Navigation Acts for Howards' importation of camphor see Anon., "Quinine and Camphor," *Chemist and Druggist*, 19 June 1897, 974.

84 I am very grateful to Laurence Brockliss, John Cardwell and Michael Moss and for sharing their research on this trade, which will be published in due course as part of a project on the health of the Navy.

85 Marcel Delépine, "Joseph Pelletier and Joseph Caventou," *Journal of Chemical Education* 28 (1951): 454-61.

86 Anon., "London Wholesalers in 1863 and Now," *Chemist and Druggist*, 26 July 1913, 143-9, on 148.

87 Anon., *Howards, 1797-1947* (Ilford: Howards & Sons, 1947), 7.

88 Similar problems existed with opium duty. Anon., "Cinchona and Opium Duties," *The Chemist and Druggist*, 19 June 1897, 975.

89 *Report of the Select Committee on Medical Education, Society of Apothecaries, part III* (602), P.P. 1834, XIII, 64-5.

levels in 1836 and until 1860 British quinine manufacturers were protected by an import duty of six pence per ounce.[90] This mirrors aspects of the complex history of British industrialization abetted by government protection and regulation that William J. Ashworth has described for the eighteenth century.[91] It also underlines the importance of strategic political action to support the development of chemical production, as John Christie has highlighted in his chapter in relation to Charles Tennant's efforts to abolish salt duty. Howards' production of quinine increased steadily: in 1836 it was 6,000 ounces, rising to 15,000 ounces in 1838 and never falling below 100,000 ounces a year after 1847.[92] By the 1860s over 200 workmen were employed at Howards' Stratford factory and more than a ton of bark was processed each day – the transition to large-scale pharmaceutical industry had taken place.

Borax refining had been a key part of production for Howards since the Plaistow laboratory opened at the turn of the century. Both Tibetan tincal imported via the East India Company, and borate of lime from Peruvian coastal saline deposits had been used as raw materials.[93] In the late 1820s a new source from Italy, exploited by Count Lardarel, came onto the market and almost wiped out the Tibetan tincal trade in Europe.[94] John Eliot Howard obtained a sample of this Tuscan boracic acid in 1830 from the wholesale druggist David Taylor and Sons of Mincing Lane. Analysis showed the sample was of high quality and free from muriatic acid.[95] The firm subsequently inquired how it would be imported. Taylors' reply underlines the value, scale and complexity of the networks of supply involved in the international borax trade:

> We can now tell you [write Grant & Co. on March 14, 1836] how the operation stands. Larderell is bound to deliver to Hepburn, Pullars & Co. 21,000,000 lbs. of boracic acid at a price somewhat above Liv. 41 (per ton) in seven lots from 1st January 1837 to the end of June, 1839. Six months before the end of that period H., P. & Co. can denounce the contract and pay down Liv. 200,000 as *Caparra*, [deposit] which is to be discounted

90 Anon., "Quinine and Camphor," p. 974 (see note 83); Strauss et al., *England's Workshops,* p. 146 (see note 50).

91 William J. Ashworth, "The Intersection of Industry and the State in Eighteenth Century Britain," in Roberts et al., eds., *The Mindful Hand,* 348-77 (see note 62).

92 Redbridge Information and Heritage Service, Archives of Howards and Sons, B.F. Howard, *Howards 1847-1947: A Treatise*, 1956, 3.

93 Strauss et al., *England's Workshops,* p. 146 (see note 50).

94 N.J. Travis and E.J. Cocks, *The Tincal Trail: A history of borax* (London: Harrap, 1984), 24-6. With thanks to Andreas Weber for this reference.

95 Anon., "An Analysis by John Eliot Howard," *Chemist and Druggist*, 19 June 1897, 975.

> gradually at each delivery as usual when advances are made. Besides these advances H., P. & Co. lend Larderell Liv. 400,000 for 10 years at 5 p.c. Larderell issues notes of Liv. 5,000, payable 10 years hence and paying 5 p.c. interest. H., P. & Co. expect to negotiate these notes and be freed actual disbursements. The first three millions of acid they have resold to W. Lloyd (the refiner) at about 50 Liv.[96]

Such arrangements ensured that prices remained high for those in possession of the raw material after the original supply began to be exploited. They also underline the relationship between the worldwide commodity market and bulk manufacturing in the UK at this time. In the 1860s, Howards were amongst the largest consumers of Tuscan boracic acid worldwide.[97] However while Howards' consumption was at a globally significant level, the firm did not deal directly with overseas customers. By the late 1820s, Allen, Hanburys and Barry also had few transatlantic contacts.[98] Difficulties with shipping and obtaining payment for goods meant that agents played an increasingly important role in the networks of supply. When Howards received an enquiry from Mr H.J. Esszingh in Cologne for refined borax in 1841, they quoted a price of seventy-two shillings per hundredweight and requested that he place his order via an agent in London.[99]

## Conclusion

The economic drivers of growth in the London pharmaceutical marketplace in the late-eighteenth and early-nineteenth centuries stemmed from the industry's location at the center of an international network of drug supply and processing, with productivity at its heart.[100] As Britain's empire increased in size, the balance of the push and pull relationship between production and supply became central: sources of raw materials for production expanded, but the markets for processed drugs and chemicals also grew. Rather than inventing new technologies, it was the scaling up of existing chemical-pharmaceutical

96 Anon., "Borax Reminiscences," *Chemist and Druggist*, 19 June 1897, 975.

97 Strauss et al., *England's Workshops,* p. 146 (see note 50).

98 Stander, "Transatlantic Trade," p. 333 (see note 39).

99 Anon., "Borax Reminiscences," p. 975 (see note 96).

100 On London as an industrial center, see Thomas Misa, *From Leonardo to the Internet: Technology and culture from the renaissance to the present* (Baltimore: Johns Hopkins University Press, 2004), pp. 59-73.

apparatus and expansion in terms of workforce, site and product range that were significant factors in the development of bulk drug production in London, as a transition from shop-based to factory-based manufacture occurred. Instead of the Enlightenment ideals of openness and the free dissemination of knowledge, tension between the relative values of publicity and secrecy persisted and pricing agreements between rival manufacturers were commonplace. Long-standing networks of supply based on colonial, economic, social, familial, and religious connections provided a strong framework for industrial development and drove the expansion of the industry. Such continuity provided a context for gradual change and allowed incremental innovations in practices, techniques and processes to occur.

Wholesale pharmaceutical manufacturing operated in an environment characterized not by clichés of a British 'free' market, but instead characterized by a market 'organized' around interactions between sites through networked exchanges and circulation. In this market, both cooperation and competition between producers were significant; British governmental policies, contracts and expenditure provided a major stimulus for growth; and the ability to utilize the resources of empire whilst also responding to its demands was paramount. Although this story has a London base, its reach was global as wholesale drug manufacturing functioned in an intricate productivity network of empire and international trade.

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