

Chapter 1 The Youth of Inventive Genius

Robert Hooke was born on 18 July 1635 at Freshwater on the Isle of Wight, an island of southern England a few miles out in the English Channel (Fig.1-1: Map of Isle of Wight). Hooke's father, the Reverend John Hooke, was a curate at All Saints Church, Freshwater from, at the latest, 1628¹. According to the card index at the Isle of Wight County Record Office, Rev. Hooke married a widow, Margaret Lawson, in 1615, but she died in January of the following year². He then married Cecily Gyles (or Giles) in 1622 at Brading, where he was then curate, and they had four children.

Baptism records show that Robert Hooke was baptised on 19 July, the day after his birth, at his father's parish church³. Robert had two sisters, Katharine and Anne, and one brother, John. No baptism record has survived for Anne, but the last will of Rev. Hooke, which the author discovered at the Hampshire Record Office, strongly suggests that Anne was his eldest child⁴ (Fig. 1-2: Family tree of Robert Hooke). John, Robert's brother, became a grocer at Newport, Isle of Wight⁵, and was mayor there in 1668 and 1676⁶. But he 'died by suspending him self' in 1678⁷.

Richard Waller, Hooke's close friend in his later life, wrote in the *Posthumous Works of Robert Hooke* in 1705 that Robert 'was very infirm and weakly', and that 'for at least seven Years his Parents had very little hopes of his Life, being often sick'. In those days, Hooke's 'chief Food was Milk, or thing made thereof, and Fruits, no Flesh in the least agreeing with his weak Constitution'. But 'For his Age he was very sprightly and active in Running, Leaping', and he was 'very apt to learn any thing'⁸. When he was older, he was 'very crooked, tho' I have heard from himself, and others, that he was

¹ Recent studies showed that Rev. Hooke had a strong connection with Sir John Oglander, who was a prominent royalist resident of the Isle of Wight and served Charles I when he fled to Carisbrooke Castle in 1647. See Jardine (2002), pp. 14-23 & 488-489, note 39. For Oglander family, see Cecil Aspinall-Oglander, *Nunwell Symphony* (London, 1945).

² The author would like to thank Mr. C. D. Webster, archivist of the Isle of Wight County Record Office, for his assistance with the investigation of records.

³ Richard Waller wrote that Robert Hooke was 'Christened the twenty sixth following by his own Father Minister of that Parish' (*Posthumous*, ii). The date contradicts the baptism record and Aubrey's description (Aubrey, 1898, 1, p. 409), both of which support the date of 19 July.

⁴ Nakajima (1994). The last will and inventory of Rev. John Hooke is numbered 1648B09/1-2 at the Hampshire Record Office.

⁵ Aubrey (1898), 1, p. 409.

⁶ Eldridge (1952), p. 84.

⁷ Aubrey (1898), 1, p. 416. According to a card index at the Isle of Wight County Record Office, John the younger was 'interred privately but not in common place'.

⁸ *Posthumous*, ii.

strait till about 16 Years of Age'. Hooke had dark brown hair, and his 'Eyes grey and full, with a sharp ingenious Look whilst younger'. 'He went stooping and very fast (till his weakness a few Years before his Death hindred him) having but a light Body to carry, and a great deal of Spirits and Activity, especially in his Youth'⁹.

Hooke's father 'was not mathematicall at all'¹⁰. He expected his son Robert to follow him into the ministry, and 'took some pains to instruct him'. But Robert suffered headaches which hampered his education, and 'his Father laid aside all Thoughts of breeding him a Scholar'¹¹.

Left to himself, Hooke 'spent his time in making little mechanical Toys'¹². He made a 'diall on a round trencher; never having any instruction'¹³, and 'seeing an old Brass Clock taken to pieces, he attempted to imitate it, and made a wooden one that would go: Much about the same time he made a small Ship about a Yard long, fitly shaping it, adding its Rigging of Ropes, Pullies, Masts, &c. with a contrivance to make it fire off some small Guns, as it was Sailing cross a Haven of a pretty breadth'¹⁴.

Hooke's talent for painting manifested itself in these early days. When John Hoskins (*d.* 1664), Charles I's miniaturist¹⁵, visited Freshwater¹⁶, Hooke observed what he did, and thought 'why cannot I doe so too?' Hoskins admired Hooke's pen copies of his pictures¹⁷.

In October 1648, three months before the Interregnum and when Robert was thirteen years old, Rev. Hooke died 'having for three or four Years before his Death been much afflicted with a Cough, a Palsy, Jaundice and Dropsy'¹⁸. Rev. Hooke made his last will on 23 September 1648, which was witnessed by his friends Cardell Goodman, Robert Urrey and Nickles Hockley¹⁹. It has been said that Rev. Hooke 'left one

⁹ *Ibid.*, xxvi-xxvii. Aubrey wrote that Hooke 'is but of midling stature, something crooked, pale faced, and his face but little belowe, but his head is large; his eie full and popping, and not quick; a grey eie. He haz a delicate head of haire, browne, and of an excellent moist curle' (Aubrey, 1898, 1, p.411).

¹⁰ Aubrey (1898), 1, p. 410.

¹¹ *Posthumous*, ii.

¹² *Ibid.*

¹³ Aubrey (1898), 1, p. 410.

¹⁴ *Posthumous*, ii.

¹⁵ *DNB*, 'John Hoskins'.

¹⁶ Jardine points out that 'The most likely reason for his being on the Isle of Wight...is as part of that entourage that assembled round the King at Carisbrooke in 1647-48'. (Jardine, 2002, p. 22).

¹⁷ Aubrey (1898), 1, p. 410; *Posthumous*, ii.

¹⁸ *Ibid.* The Freshwater Parish Register records that he was buried in 17 October 1648. See Jardine (2002), p. 21.

¹⁹ Nakajima (1994), pp. 14-15. Cardell Goodman was vicar and Robert Urrey churchwarden at Freshwater church. See Jardine (2002), p. 489 note 40; Jardine

hundred pounds' to Robert²⁰. But the will shows that Robert's inheritance was only £50, including £10 from his grandmother Anne Gyles. He was also given all his father's books, and this seems to imply that Robert's studiousness had by then become apparent.

With the money Hooke inherited, he was sent to London to be apprenticed to the celebrated painter, Sir Peter Lely (1618-1672). Lely was of good family from Utrecht, and came to England in 1641. He painted many portraits of the nobility, including Charles I. Lely is also 'famous for his portraits of the fair and frail beauties of Charles II's court'²¹. Aubrey wrote that Hooke 'also had some instruction in draweing from Mr. Samuel Cowper [Cooper]' who was a 'prince of limners'²². Samuel Cooper (1609-1672) was a nephew and a pupil of John Hoskins, mentioned above²³. It seems natural to suppose that Hoskins put Hooke in touch with Lely and Cooper²⁴.

Despite his good relationship with Lely, Hooke soon left him. The reason, Waller heard from Hooke, was that 'the smell of the Oil Colours did not agree with his Constitution, increasing his Head-ach, to which he was ever too much subjected'²⁵. Aubrey gave another reason, that 'Mr. Hooke quickly perceived what was to be done, so, thought he, "why cannot I doe this by my selfe and keepe my hundred pounds?"'²⁶ Then, Hooke decided to become a pupil at Westminster School. There he lived with Richard Busby (1606-1695), a headmaster of the School who was well known as a strict disciplinarian.

Westminster School

Westminster School is an ancient public school standing next to Westminster Abbey. Its origins can be traced back to 1179, when the Pope required the Benedictine monks to provide a small charity school. After the dissolution of the monasteries in 1540, Henry VIII ensured the School's survival by means of a statute²⁷.

Queen Elizabeth I, his daughter, confirmed the royal patronage in 1560, and she is celebrated as the School's official foundress²⁸. She granted it a large estate and

(2003), pp. 24 & 55.

²⁰ Aubrey (1898), 1, p. 410.

²¹ *DNB*, 'Sir Peter Lely'.

²² Aubrey (1898), 1, p.410.

²³ *DNB*, 'Samuel Cooper'.

²⁴ Cooper (2003), p.3.

²⁵ *Posthumous*, iii.

²⁶ Aubrey (1898), 1, p.410.

²⁷ Sargeant (1898), p. 4. For a brief history of Westminster School, see also the internet web page of the School: <http://www.westminster.org.uk>.

²⁸ Sargeant (1898), pp. 9-10.

established scholarships (Queen's or King's Scholars). She wished to extend the selection of pupils beyond a single social class, so children of tradesmen sat with the sons of squires, the clergy and lawyers at the School. The Queen envisaged bringing Westminster School into close alliance with Christ Church, Oxford and Trinity College, Cambridge, both of which had been founded by her father in 1546. It was decided that at least three students annually would be elected to the foundation of each college²⁹. However, the ties to Christ Church tended to dominate. From the beginning, students preferred Oxford to Cambridge³⁰.

After the death of Elizabeth, Westminster School became involved in a turmoil of religious and political controversy. The survival of the School during the period from the Puritan Revolution to the Glorious Revolution was due principally to Richard Busby. He was provisionally appointed Headmaster of Westminster School in 1638, and his position was confirmed in 1640. He kept it for more than fifty years until his death in 1695. Among his pupils were John Dryden (1631-1700), John Locke (1632-1704), Christopher Wren (1632-1723) and Robert Hooke.

It is not certain exactly when Hooke began at Westminster School; it may not have been long after he left Freshwater for London following his father's death in 1648. Nor is it known who introduced Hooke to the School. One possibility is Cardell Goodman, one of the 'worthy and well beloved friends'³¹ of Hooke's father who witnessed his last will. Goodman was the vicar at Freshwater, and had been educated at Westminster School and Christ Church³². Another possibility lies in the friendship between Lely and Busby. A documentary record shows that Lely designed the engraving of a chair for Busby³³, which suggests that they knew each other well and it may have been that Lely perceived Hooke's academic promise and introduced him to Busby. In the author's view, these explanations of Hooke's transition from artist's apprentice to Westminster School seem much more plausible than Hooke's own, of headaches from the fumes of oil paint or saving the cost of his apprenticeship.

Hooke was not a King's Scholar of the School³⁴, and if we consider that the boarding fee in Busby's time was never less than £24 a year³⁵, Hooke's legacy of £50 does not seem enough to cover his expenses. Hooke might have been taught gratis.

²⁹ *Ibid.*, p. 21.

³⁰ *Ibid.*, pp. 13, 31 & 77.

³¹ Nakajima (1994), p. 15.

³² Cooper (2003), p. 3. See also note 19 above.

³³ Westminster School, *Commemoration of the Bicentenary of the Death of Richard Busby* (London, 1895), A. No. 17.

³⁴ Aubrey (1898), 1, p. 410.

³⁵ Sargeant (1898), p. 110. See also Barker (1895), pp.95ff.

Busby sometimes waived fees, if he thought a boy had special promise³⁶. Hooke's schoolfellow, Sir Richard Knight, later said that 'he seldome sawe him in the schoole'³⁷. Hooke was probably given private tuition by Busby, simply because he was boarding in Busby's house³⁸.

The core of Busby's curriculum was the classics³⁹. He wrote standard textbooks of Greek and Latin grammar which were used until the middle of the nineteenth century. He also composed texts of Hebrew and Arabic grammar, though they remained unpublished.

It is important in the history of science that Busby introduced geometry and arithmetic into Westminster School. Among the textbooks Busby employed were *Clavis Mathematicae* by William Oughtred (1575-1660) and *Euclidis Elementa* by Isaac Barrow (1633-1677)⁴⁰. Although they were intended for the study of Latin, they also represented new trends in mathematics.

Oughtred was a priest from King's College, Cambridge. In 1631, he published *Clavis Mathematicae* in London, which introduced the algebra of François Viète (1540-1603)⁴¹. *Clavis Mathematicae* is his 'best-remembered work', and exerted considerable influence on English natural philosophers including Robert Boyle, John Wallis and Isaac Newton⁴². Isaac Barrow's *Euclidis Elementa* was published in 1655 in Cambridge, and it systematically used Oughtred's mathematical notation.

Hooke's education at Westminster School, as reported by Waller, closely followed Busby's curriculum. Waller wrote that Hooke 'apply'd himself to *Latin* and *Greek*', and 'at the same time got some insight into the *Hebrew* and some Oriental

³⁶ Cooper (2003), p. 3. Though Cooper wrote in the same paragraph that 'Hooke's £50 legacy might have been just enough to cover the fees and other costs of his time at Westminster School', the author feels this to be rather optimistic.

³⁷ Aubrey (1898), 1, p. 410.

³⁸ Sargeant (1898), p. 122; *Posthumous*, iii.

³⁹ See Sargeant (1898), Chap. VII 'The Curriculum Under Busby'.

⁴⁰ *Ibid.*, pp. 120-122.

⁴¹ The exact title of the first edition was *Arithmeticae in numeris et speciebus instituite*, and its later title 'Clavis mathematicae' was printed as the heading of the text pages. On Oughtred's mathematics, see, for example, Cajori (1916).

⁴² *DSB*, 'Oughtred', 10, pp. 254-255 (p. 254). Robert Wood published an English translation of *Clavis Mathematicae* in 1647. Another English translation was published in 1694 by Edmund Halley. Before Wood's translation, Christopher Wren had already translated its appendix at Charles Scarborough's suggestion (Bennett, 1982, p. 17). After Oughtred's death, Scarborough revised and published the mathematical manuscripts of Oughtred (Cajori, 1916, p. 16). As Cajori wrote, among the pupils of Oughtred were Seth Ward, Charles Scarborough, John Wallis, Christopher Wren, William Foster, Robert Wood, Lawrence Rooke, and William Gascoign, most of whom played important roles in the early stages of the Royal Society (*ibid.*, pp. 58-59).

Languages. While he liv'd with *Dr. Busby*, he fell seriously upon the study of Mathematicks, the Dr. encouraging him therein, and allowing him particular times for that purpose. In this he took the most regular Method, and first made himself Master of *Euclide's Elements*'⁴³. Aubrey added that 'He there in one weeke's time made himselfe master of the first VI bookes of *Euclid*, to the admiration of Mr. Busby'⁴⁴. Though Waller did not mention Oughtred, Hooke's signature and annotations can be seen in a copy of the third Latin edition of *Clavis Mathematicae* which is now held in the British Library⁴⁵. It is certain that Hooke read the book, even if it is not possible to specify the exact date. It is very probable that Hooke studied it during his Westminster School days, because the third Latin edition was published in 1652 when Hooke was almost certainly a pupil at the School.

Hooke became a lifelong friend of Busby, whose name appears frequently in Hooke's diary. Diary descriptions confirm that Hooke designed and built a church at Willen, in Buckinghamshire, in about 1680 at Busby's expense⁴⁶. Near the end of Busby's life, Hooke began the repair of the chapel of Lutton Church at Busby's birthplace. Hooke's restoration work was recorded in Busby's will⁴⁷.

Aubrey wrote that during Hooke's time at the School he 'invented thirty severall wayes of flying, which I have not only heard him say, but Dr. Wilkins'⁴⁸. Thus Hooke ventured into mechanics, which was 'the application' of mathematics and 'his first and last Mistress'⁴⁹.

Hooke at Oxford

From Westminster School, Robert Hooke went up to Christ Church, Oxford, in 1653⁵⁰. As we saw above, Westminster School had strong ties with Christ Church, and it may have been a natural progression for Hooke to enter the College. He was then eighteen years old, about the average for freshmen from the middle classes⁵¹.

Waller wrote that Hooke was not a student 'of the Foundation, but was, I have

⁴³ *Posthumous*, iii.

⁴⁴ Aubrey (1898), 1, p. 410.

⁴⁵ British Library, shelf mark 529.b.19. Hooke's memoranda are restricted to its main text, and did not reach the appendix.

⁴⁶ Batten (1936-37), pp. 96-97. The church now is near modern-day Milton Keynes. A photograph of it appears in Cooper (2003), p. 4.

⁴⁷ Busby's will and codicils are annexed as Appendix I to Barker (1895). For Hooke's involvement with the Chapel at Lutton in Lincolnshire, see p. 146.

⁴⁸ Aubrey (1898), 1, p. 410.

⁴⁹ *Posthumous*, iii.

⁵⁰ *Ibid.*

⁵¹ See the table of Stone (1974), p. 97.

heard, a Servitor to one Mr. Goodman⁵². The servitor system was spreading through the Oxford colleges in Hooke's time, having been established first at Wadham College in 1650. The servitor was a table position, which carried the privilege of eating the leftovers for a small fee. In return, the servitor performed menial duties for dons or affluent gentleman-commoners⁵³. Aubrey wrote that Hooke also 'had a chorister's place (in those dayes when the church musique was putt-downe), which was a pretty good maintenance'⁵⁴.

There is no remaining record to illuminate Hooke's education at Oxford. In his article on Hooke in the *Dictionary of Scientific Biography (DSB)*, Westfall asserted that 'Apparently Hooke never took a bachelor's degree'⁵⁵. It is true that many of the students did not take the degree⁵⁶, but Hooke matriculated in 1658, five years after he went up to Oxford⁵⁷. Before 1660, freshmen matriculated either immediately upon taking residence, or at some later date when, for example, they sought admission to the bachelor degree⁵⁸. It is highly probable that Hooke did take the degree.

At Oxford, Hooke met natural philosophers who were to play a part in forming the Royal Society⁵⁹. At the centre of the group was John Wilkins (1614-1672), who was made warden of Wadham College by the Parliamentary Visitors in 1648. John Wallis (1616-1703), Seth Ward (1617-1689), Thomas Willis (1621-1662), Lawrence Rooke (1622-1675), William Petty (1623-1687), and Christopher Wren (1632-1723) were other

⁵² *Posthumous*, iii. According to Mr. Mark Curthoys, a librarian at Christ Church, the only person in Hooke's time who had the family name of Goodman was Gabriel Goodman of Wadham. University records of 'caution money books' and 'battels books' for that time are missing, so we cannot trace any data on Hooke from them. Cooper identified the Goodman as Cardell Goodman, the friend of Hooke's father mentioned earlier. Goodman was educated at Christ Church and he 'provided for Hooke at Christ Church' (Cooper, 2003, p. 4).

⁵³ Stone (1974), pp. 9-11.

⁵⁴ Aubrey (1898), 1, p. 410; Andrade (1960), p. 138. Cf. Kassler and Oldroyd (1983), p. 590.

⁵⁵ *DSB*, 'Hooke', 6, pp. 481-488 (p. 482). In the same article, Westfall recorded the year of Hooke's death as 1702. It is apparently a mistake, and should have been written as 1702/3 or 1703.

⁵⁶ Upper-class students usually went to universities for a year or two merely as a kind of finishing school before embarking on a public career in, for example, politics. See Stone (1974), p. 9. In the 1640s, with the onset of political turmoil, the matriculation rate fell by 50 percent in some colleges in Oxford (*Ibid.*, p. 85).

⁵⁷ *The University Matriculation Register*, 31 July 1658, Bodleian Library, Oxford. Ward wrote that 'no entry of his admission being now to be found in the college registers', but that is not correct (Ward, 1740, p. 170, note b). Aubrey confused the year of Hooke's matriculation with the year he went up to Oxford (Aubrey, 1898, 1, p. 410).

⁵⁸ Stone (1974), pp. 15 & 90.

⁵⁹ For natural philosophers at Oxford, see Frank Jr. (1980), pp. 51ff; Hunter (1981), p. 35.

members of the group⁶⁰. Wilkins and Wallis had been members of a group of natural philosophers who met weekly in London, beginning in about 1645. Around 1648 or 1649, some members of the London group moved to Oxford, and started their own meetings with natural philosophers there⁶¹.

According to a manuscript left to Waller, Hooke joined the Oxford meetings in about 1655, and at 20 years old he was one of the youngest members of the group. The manuscript recorded that at the meetings 'divers Experiments were suggested, discours'd and try'd with various successes, tho' no other account was taken of them but what particular Persons perhaps did for the help of their own Memories'⁶². Waller mentioned an experiment with a barometer in 1655 or 1656. It was suggested by Wren 'in order to find whether the Hypothesis of *Des Cartes* for giving the Reason of the Tides from the pressure of the Moon upon the Air in its passage by the Meridian, were true or not'. Waller reported that Hooke said 'it was first observ'd, that the height of *Mercury* in the *Barometer* did not conform itself to the Moon's motion'⁶³.

At Oxford Hooke served Willis as an assistant in chemistry⁶⁴, and Willis afterwards recommended him to Robert Boyle (1627-1691)⁶⁵. Boyle had moved to Oxford in 1655 or 1656⁶⁶, almost the same time as Hooke joined the Oxford group. Hooke 'read to' Boyle 'Euclid's Elements, and made him understand Des Cartes' Philosophy'⁶⁷.

In 1658, soon after Hooke became his assistant, Boyle learned of the air pump of Otto von Guericke (1602-1686) at Magdeburg through Caspar Schott's *Mechanica hydraulico-pneumatica* (Würzburg, 1657)⁶⁸. Boyle ordered a pump from Ralph Greatorex (1625-1712), a London instrument maker; it 'was too gross to perform any

⁶⁰ Table 3 of Frank Jr. (1980), pp. 63ff gives us a comprehensive list of Oxford natural philosophers from 1640 to 1675.

⁶¹ *Birch*, vol. 1, pp. 1-2. See also John Wallis, *A Defence of the Royal Society* (London, 1678), pp. 7-8; McKie (1960), pp. 25-26.

⁶² *Posthumous*, iii.

⁶³ *Ibid.*, vii-viii.

⁶⁴ According to Jardine, Dr. Samuel Fell, Willis' father-in-law, was rector at Freshwater when Hooke's father was curate there in the 1620s. She cites a manuscript of Hartlib in November 1654 saying that Willis communicated 'every weeke some experiment or other to Mr. Boyles chymical servant, who is a kind of cozen to him' (Jardine, 2002, p. 116). For the manuscript, see Frank Jr. (1980), p. 165.

⁶⁵ Aubrey (1898), 1, pp. 410-411.

⁶⁶ Hunter (2000), p.3; Frank Jr. (1980), p. 64.

⁶⁷ Aubrey (1898), 1, p. 411.

⁶⁸ *New Experiments*, in *Boyle Works*, 1, p. 6; *Boyle New Works*, 1, p. 158. See also Shapin and Schaffer (1985), pp. 231 & 278.

great matter', and Hooke 'contriv'd and perfected' it in 1658 or 59⁶⁹.

The completed pneumatic engine was brought from London to Oxford in March 1659⁷⁰. With the machine Boyle performed experiments which were described in his *New Experiments Physico-Mechanical, Touching the Spring of the Air* (Oxford, 1660; hereinafter *New Experiments*). Boyle's law (the volume of air varies inversely with pressure) first appeared in an appendix to the second edition of *New Experiments* (1662), which has the title of *A Defence of the Doctrine Touching the Spring and Weight of the Air* ⁷¹.

About the same time, Hooke had 'an opportunity of acquainting my self with Astronomy by the kindness of Dr. *Ward*, I apply'd my self to the improving of the *Pendulum* for such Observation, and in the Year 1656, or 57, I contriv'd a way to continue the motion of the *Pendulum*, so much commended by *Ricciolus* in his *Almagestum*'⁷². *Almagestum novum* was a work published in Bologna in 1651 by Giovanni Battista Riccioli (1598-1671). It was a review of astronomy up to 1650, and is one of the most important astronomical books of the seventeenth century⁷³. Riccioli was a Jesuit astronomer who believed in a modified version of the Tychonic system⁷⁴. He succeeded in perfecting the pendulum as an instrument for measuring time⁷⁵, and Hooke's mechanism seems to be related to this. Success with the pendulum made him 'farther think of improving it for finding the Longitude' with precision clocks⁷⁶. Hooke deepened his studies of astronomy, and about 1658-59 he 'contriv'd several Astronomical Instruments for making Observations both at Sea and Land', which were later shown to the Royal Society⁷⁷.

Thus when Hooke 'began to shew himself to the World', 'he was soon taken notice of', and found 'his Facility in Mechanick Inventions much priz'd' by 'extraordinary Persons at *Oxford*'⁷⁸. It should also be noted that Hooke had already begun his commitment to astronomy in Oxford. This is discussed further in the

⁶⁹ *Posthumous*, pp. iii-iv. Boyle wrote at the beginning of *New Experiments* that he asked both Grotius and Hooke 'to contrive some air-pump', and that 'after an unsuccessful triall or two of ways propos'd by the other, the last nam'd Person fitted me with a Pump, anon to be describ'd' (*Boyle Works*, 1, p. 7; *Boyle New Works*, 1, p. 159).

⁷⁰ Shapin and Schaffer (1985), p. 231.

⁷¹ Part 2, Chap. V (*Boyle Works*, 1, pp. 156-161; *Boyle New Works*, 3, pp. 57-65).

⁷² *Posthumous*, iv.

⁷³ Helden (1974a), p. 53.

⁷⁴ His system is clearly displayed in the frontispiece of *Almagestum novum*. The frontispiece can be seen also in Cohen (1980), p. 45.

⁷⁵ *DSB*, 'Riccioli', 11, pp. 411-412.

⁷⁶ *Posthumous*, iv.

⁷⁷ *Ibid.*, viii.

⁷⁸ *Ibid.*, iii.

following Chapters.

Curator of the Royal Society

As the Restoration approached, a number of the Oxford natural philosophers moved to London and 'they usually met at Gresham College at the Wednesday's lecture upon astronomy by Mr. CHRISTOPHER WREN, at the Thursday's upon geometry by Mr. LAURENCE ROOKE'⁷⁹. Many of the London natural philosophers joined them. After Wren's lecture on 28 November 1660 those attending the meeting withdrew to Rooke's residence and discussed 'a design of founding a college for the promoting of physico-mathematical experimental learning'. They agreed to continue their meetings weekly on Wednesdays, but to cover the expense they decided to levy a joining fee of ten shillings and a weekly fee of one shilling. Forty names were listed as members. At the next meeting on 5 December, Sir Robert Moray (or Murray) (1608-1673) brought word from court that the King 'well approved' their society, 'and would be ready to give an encouragement to it'⁸⁰. On 15 July 1662, a charter was granted for 'the incorporation of the society under the title of the Royal Society'⁸¹. A second charter was granted the following April⁸².

Hooke was not a founding member of the Royal Society. His name was mentioned for the first time at the Society meeting on 10 April 1661, as the author of a tract entitled *An Attempt for the Explication of the Phaenomena Observable in an Experiment* (London, 1661)⁸³. It discussed capillary action, which was the topic of Experiment XXV of Boyle's *New Experiments*. Hooke's ability had already become known, not only through his mechanical inventions at Oxford but also through his work for Willis and Boyle. This tract added considerably to his reputation⁸⁴.

The Society was just recognising that 'scribes and craftsmen could not be transformed into productive philosophical servants'⁸⁵, that is, into able experimenters.

⁷⁹ *Birch*, 1, p. 3; Sprat (1667), pp. 57ff. For an official history of the Royal Society, see *The Record of the Royal Society of London* (4 ed., London, 1940, repr. 1992).

⁸⁰ *Birch*, 1, pp.3-4.

⁸¹ *Ibid.*, pp. 88-96.

⁸² *Ibid.*, pp. 221-230.

⁸³ *Ibid.*, p. 21. Though the year 1661 is printed as the year of publication on the front page of the tract, Waller stated that the tract was printed in 1660 (*Posthumous*, viii). *Birch* also wrote 'Mr. Robert Hooke's tract, printed in 1660'(1, p. 21). Ward noticed the contradiction, and gave an explanation that 'it is well known, that books, when printed, are often antedated' (Ward, 1740, p. 189). In 1662 a Latin edition of the tract, *Canatus ad explicanda*, was published in Amsterdam.

⁸⁴ *Posthumous*, viii-ix.

⁸⁵ Cooper (2003), p. 9.

So Sir Robert Moray proposed they find a curator for the Society, who would offer 'three or four considerable experiments' at each meeting. On 12 November 1662, Moray 'proposed Mr. HOOKE as a curator of experiments to the society...it was ordered, that Mr. BOYLE should have the thanks of the society for dispensing with him for their use'⁸⁶. Hooke conducted his first experiment for the Society on 19 November, just a week after his appointment⁸⁷. It demonstrated the breaking of glass bubbles by air pressure.

John Waller tells us that, in the same period when Hooke's first tract on capillary action appeared, he also published a quarto tract entitled *A Discourse of a New Instrument to Make More Accurate Observations in Astronomy* (London, 1661)⁸⁸. Aubrey confirmed this report, writing that the month after the first tract 'he published another little 4^{to} pamphlet' on new apparatus which could perform more exact observation than 'all the chargeable apparatus of the noble Tycho Brache or the present Hevelius of Dantzick'⁸⁹. Unfortunately no copy of the pamphlet has yet been found⁹⁰. But its publication suggests that Hooke's interest in precision measurement for astronomy went back at least to the early 1660s.

Hooke was elected Fellow of the Royal Society by the Council on 3 June 1663, about six months after his appointment as Curator. It was announced that he would be exempted from all the fees⁹¹.

Two Professorships

At the beginning of June 1664, Sir John Cutler (1609-1693), a prominent member of the Grocers' Company of London, communicated to some members of the Royal Society his idea 'of founding a Mechanick Lecture'⁹². On 22 June, it was recorded by the Society that 'it might be most proper for Sir JOHN CUTLER to put in execution his promise of giving fifty pounds a year to Mr. HOOKE during his life for the reading of the histories of trades in Gresham-College'⁹³.

⁸⁶ *Birch*, 1, pp. 123-124. The proposal to find a curator was made on 5 November, a week earlier. Aubrey mistakenly wrote that 'Mr. Robert Boyle recommended Mr. Robert Hooke to be Curator of the Experiments of the Royall Society' (Aubrey, 1898, 1, p. 411).

⁸⁷ *Birch*, 1, p. 125.

⁸⁸ Ward (1740), p. 189.

⁸⁹ Aubrey (1898), 1, p. 412.

⁹⁰ Keynes (1960), p. 12.

⁹¹ *Birch*, 1, p. 250. See also Hunter (1994), pp. 160-161.

⁹² *Posthumous*, x. For the details of the establishment of the Cutler Lectureship and Hooke's commitment to the Lectures, see Hunter (1989), Chapter 9.

⁹³ *Birch*, 1, p. 442.

On 27 July, while the establishment of the Cutler Lecture was proceeding, a Council meeting of the Society ordered 'That at the first opportunity Mr HOOKE be put to the scrutiny for the place of curator: That he should receive eighty pounds *per annum*. as curator to the society by subscriptions of particular members, or otherwise: That he forthwith provide himself of a lodging in or near Gresham-College'⁹⁴. Hooke's curatorship was finally authorised by the Council, which itself was actually established on 13 May under the second Royal Charter granted the previous month⁹⁵. Hooke could now be paid a salary by the Society. He settled into Gresham College at the end of August or the beginning of September 1664⁹⁶.

The Society did pay Hooke's salary, but until 1675 it was irregular and often late⁹⁷. In addition, the Royal Society deducted Cutler's promised payment from Hooke's salary, expecting that Cutler would make good Hooke's loss. To make matters worse, Cutler did not keep his promise to pay Hooke an annual salary of £50 for the Cutler Lectures. He claimed that the Royal Society and Hooke, contrary to his intention, changed the subject of the lectures from the history of trade and mechanics to the history of natural philosophy⁹⁸. Although Hooke continued his lectures, Cutler completely stopped paying the annuity from midsummer 1670⁹⁹. Thus, in the early life of the Royal Society, Hooke had to perform the duties of curator and deliver the Cutler Lectures without proper payment.

On 20 March 1665, less than six months after he had been appointed to the lectureship (professorship) of the Cutler Lectures, Hooke was also appointed Professor of Geometry of Gresham College¹⁰⁰.

Gresham College was founded by Sir Thomas Gresham (c. 1518-1579), who is well known for his dictum 'bad money drives out good' (Gresham's Law)¹⁰¹. Gresham was affiliated to the Mercers' Company, and he was one of the greatest merchants of Tudor Britain. In 1565 he proposed that, if the City would provide the site, he would build a financial market. The offer was accepted the next year. When Queen Elizabeth visited the building in 1571, it was named the 'Royal Exchange'¹⁰².

⁹⁴ *Ibid.*, p. 453.

⁹⁵ *Ibid.*, p. 236.

⁹⁶ *Ibid.*, p. 453, note o.

⁹⁷ Cooper (2003), p. 13.

⁹⁸ Hunter (1989), pp. 310-311 & 317.

⁹⁹ *Ibid.*, p. 306.

¹⁰⁰ Ward (1740), p. 174; Cooper (2003), pp. 22-24.

¹⁰¹ For the beginnings of Gresham College, and for the College's relationship to the Royal Society, see Hartley & Hinshelwood (1961); Hill (1965, 1997), Chap. 2; Johnson (1940); Adamson (1975); Adamson (1980).

¹⁰² On the history of the Royal Exchange, see, for example, Saunders (1997).

Sir Thomas Gresham began to build his own mansion, Gresham House, between Broad Street and Bishopsgate Street in 1563. In 1575, he made a will¹⁰³ under which, after he and his wife died, Gresham House and the rents from the tenants in the Royal Exchange were to be entrusted to a joint body of the Corporation of the City of London and the Mercers' Company in order to found a college. Gresham stipulated that seven professorships were to be established, in divinity, astronomy, music, geometry, law, physic and rhetoric (Table 1: List of Gresham Professors).

Table. 1

List of Gresham Professors of Geometry, Astronomy and Physic until 1700

Transcribed by the author from Ward's memorandum into Ward (1740) stored at the British Library (shelf mark 611.m.16). Ward used the old style calendar, and took his year from 25 March: Mar. 1596 below means Mar. 1597 in modern style.

Geometry	from	to
Henry Briggs	Mar.1596	25 Jul.1620
Peter Turner	25 Jul.1620	20 Feb.1630
John Greaves	22 Feb.1630	15 Nov.1643
Ralph Button	15 Nov.1643	13 Jun.1648
Daniel Whistler	13 Jun.1648	7 Aug.1657
Lawrence Rooke	7 Aug.1657	27 Jun.1662
Isaac Barrow	16 Jul.1662	20 May 1664
Arthur Dacres	20 May 1664	20 Mar.1664
Robert Hooke	20 Mar.1664	3 Mar.1702
Astronomy		
Edward Brerewood	Mar.1596	4 Nov.1613
Thomas Williams	11 Nov.1613	4 Mar.1619
Edmund Gunter	6 Mar.1619	Dec.1626
Henry Gellibrand	2 Jan.1626	9 Feb.1636
Samuel Foster	2 Mar.1636	25 Nov.1637
Mungo Murray	25 Nov.1637	26 May.1641
Samuel Foster	26 May.1641	Jul.1652
Lawrence Rooke	23 Jul.1652	7 Aug.1657

¹⁰³ The will was published in Ward (1740), pp. 19-25.

Christopher Wren	7 Aug.1657	8 Mar.1660
Walter Pope	8 Mar.1660	21 Sep.1687
Daniel Man	21 Sep.1687	31 Jul.1691
Alexander Torriano	31 Jul.1691	13 May 1713

Physic

Matthew Gwinne	Mar.1596	Sep.1607
Peter Mounsell	Sep.1607	Oct.1615
Thomas Winston	25 Oct.1615	13 Jun.1643
Paul De Lawne	13 Jun.1643	20 Aug.1652
Thomas Winston	20 Aug.1652	24 Oct.1655
Jonathan Goddard	7 Nov.1655	24 Mar.1674
John Mapletoft	27 Mar.1679	10 Oct.1679
Henry Paman	10 Oct.1679	21 Jun.1689
Edward Stillingfleet	21 Jun.1689	13 Jan.1692
John Woodward	13 Jan.1692	25 Apr.1728

The Gresham professorship carried a salary of £50 per annum¹⁰⁴, the same amount as for the Cutler lectureship. In fact the Cutler Lectures had been designed as another Gresham professorship; the lectures were delivered between the terms of Gresham College, and both sets of lectures were held in the same Reading Hall of the College on the same day of the week at the same hour¹⁰⁵.

The process of Hooke's election to the professorship was not straightforward. Arthur Dacres M.D., not Hooke, was given the position first, on 20 May 1664¹⁰⁶. On 8 June 1664, however, the Royal Society challenged his election. They discovered 'that the lord mayor of London was not of the committee, and yet by his presence had carried the election by a casting vote'¹⁰⁷. The Society, which was looking for an opportunity to

¹⁰⁴ *Ibid.*, pp. 20-21.

¹⁰⁵ Cooper (2003), pp. 12 & 26; Hunter (1989), p. 297.

¹⁰⁶ Cutler's endowment of his Lectureship for Hooke could be a response to Hooke's failure to win election, because Cutler intimated his idea at the beginning of the next month. Hooke expressed his disappointment to Cutler when they met by chance in a 'Publicke house neere Burchin lane'. Or alternatively, Cutler had expected to appoint Hooke professor of his lectures, and he tried to obstruct Hooke's election to the Gresham professorship. See *Pugliese*; p. 2, Hunter (1989), p. 287; Cooper (2003), p.24.

¹⁰⁷ *Birch*, 1, p. 435.

get Hooke's lodging in Gresham College¹⁰⁸, and which explicitly supported Hooke's election, investigated the legality of the decision. It found that 'Mr. HOOKE, who had five votes, whereas Dr. DACRES had but four¹⁰⁹'. Now the Gresham Committee 'did unanimously Declare that Robert Hooke was the person legally elected and accordingly ought to enjoy the same with the Lodgings proffits and all accomodations to the place of Geomitry Reader appertaining'¹¹⁰.

Micrographia

Hooke published his major work *Micrographia* in about January 1665, around two months before he was elected Geometry Professor of Gresham College. It firmly established his reputation both in England and on the Continent¹¹¹. *Micrographia* was the first book to illustrate microscopic observations. As Charles Singer pronounced about fifty years ago, the book 'was a messenger from the newly revealed minute world, as Galileo's *Sidereus Nuntius* of 1610 had been a message from the newly revealed heavens'¹¹². Two book reviews on *Micrographia* soon appeared, in England and in France¹¹³. A second English edition and a German translation were published in 1667. Newton made notes on *Micrographia*, with his own thoughts¹¹⁴.

Strictly speaking, Hooke was not the first natural philosopher to publish microscopic observations. For example, Henry Power (1623-1668) had published observations in his *Experimental Philosophy* (London, 1664) the previous year¹¹⁵. But these were mainly verbal descriptions of observations, with only a few simple illustrations. *Micrographia* was the first book to use copious illustration to record microscopic observations, and the number of illustrations is in excess of one hundred (Fig. 1-3: A Flea from Schem. XXXIV; Fig. 1-4: A Fly, and Eyes & Head of a Grey

¹⁰⁸ Cooper (2003), p.11.

¹⁰⁹ *Birch*, 1, p. 435.

¹¹⁰ Mercers' Company Gresham Repertory II, p. 218 cited in Cooper (2003), p.24.

¹¹¹ Andrade (1954), p. 95; Andrade (1950b), p. 445; Koyle (1952), p. 313, note 9. Even though the importance of *Micrographia* has been well recognised, it has been the subject of few academic papers. As far as the author knows, there are only three papers specifically targeted on it: Singer (1955); Harwood (1989), Dennis (1989). Hall published a public lecture on *Micrographia* as A. R. Hall (1966a).

¹¹² Singer (1955), p. 12.

¹¹³ *Phil. Trans.*, 1 (1665), pp. 27-32; *Journal des Sçavans*, 42 (1666), pp. 738-749.

¹¹⁴ Cambridge University Library, MS Add. 3958. It was transcribed by Keynes (1960), pp. 97-108.

¹¹⁵ In the Preface of *Micrographia*, Hooke emphasised the difference between their books (sig. 2gr). For books on microscopy before Power, see Webster (1967), pp. 158-159. Singer mentioned Malpighi's book of 1661, which published observations on capillary blood vessels (Singer, 1955, p. 12). But the book, *De pulmonibus* (Bologna, 1661), did not contain any illustrations.

drone-Fly from Schem. XXIV and XXVI).

On 2 January 1665, Samuel Pepys (1633-1703), a naval administrator and future president of the Royal Society, visited 'my bookseller's and at his binder's saw Hooke's book of the Microscope, which is so pretty that I presently bespoke it'. He collected the book on 20 January. Pepys wrote in his diary that, on the next day, 'Before I went to bed I sat up till two o'clock in my chamber reading of Mr. Hooke's Microscopical Observations, the most ingenious book that ever I read in my life'¹¹⁶.

The impact of *Micrographia* went beyond intellectual circles. Not only natural philosophers but also the public were excited by this revelation of the hitherto-unknown microscopic world. In May 1676, Thomas Shadwell's comedy, *The Virtuoso*, was produced by the Duke's Company at Dorset Garden¹¹⁷. This was a satire on the new science, and *Micrographia* was not spared¹¹⁸. Indeed, when Hooke went to see the play on 2 June, 'People almost pointed', and on the next day 'Sir J. More, Flamsteed, Hill from Play Floutingly smiled'¹¹⁹.

Micrographia contains 118 figures. Insects and plants are the largest categories of objects represented, at 23 and 15 respectively¹²⁰. Hooke examined a cross-section of cork, and discovered its cell structure¹²¹. He also illustrated blue mould (Fig. 1-5: Cells of Cork from Schem. XI and Blue Mould from Schem. XII). Artefacts were also included in Hooke's observations (Fig. 1-6: The Point of Needle from Schem. II; Fine Waled Silk from Schem III). He showed that the point of a needle, commonly reckoned sharp and precise, was actually uneven and irregular¹²². In contrast to the roughness of artefacts, nature exhibited order. Hooke was interested in the regular patterns of minerals, and formulated a hypothesis on the causes of their regularity¹²³ (Fig. 1-7: Observation of Crystal and Hooke's explanation of its regularity based on globular microstructure from Schem. VII).

The microscope most used by Hooke consisted of a six- or seven-inch tube with

¹¹⁶ Henry B. Wheatley (ed.), *The Diary of Samuel Pepys*, 10 vols. (1899-1920), 4, pp. 323 & 338. Pepys was elected Fellow of the Royal Society the following month.

¹¹⁷ See 'Introduction' to Thomas Shadwell, *The Virtuoso* (Lincoln and London, 1996) edited by Marjorie Hope Nicolson & David Stuart Rodes, especially pp. xii & xx. The King, Charles II, attended the play on 25 May 1676.

¹¹⁸ *Ibid.*, xx; Lloyd (1929); Jones (1951).

¹¹⁹ *Diary 1672-1680*, p. 235. Hooke had been given an account of the play by Mr. Hill a week before (*Ibid.*, p 234).

¹²⁰ Harwood (1989), p. 128. They are numbers of topics, not of figures.

¹²¹ Hooke considered that liquid or juice in plants moved through cells. See Matzke (1943), p. 14 and *Micrographia*, p. 114.

¹²² *Micrographia*, pp. 1-2. Andrade pointed out that Hooke was the first to examine metals with a microscope (Andrade, 1954, p. 96).

¹²³ *Micrographia*, pp. 82-88.

two lenses (Fig. 1-8: From Schem. I of *Micrographia*). He sometimes inserted a third lens for a wider view¹²⁴. The tube was in four telescoping sections, and so could be extended. A glass globe was used to illuminate objects from the light of a lamp¹²⁵. The magnification of the illustrations in *Micrographia* varied, but did not exceed 150 diameters¹²⁶.

Most of the observations in *Micrographia* were presented by Hooke to the meetings of the Royal Society in advance of publication. The earliest presentation was made on 19 November 1662, and the last on 24 August 1664¹²⁷. On 25 March 1663, six months after he started his presentations, 'Mr. HOOKE was solicited to prosecute his microscopical observations, in order to publish them'. At the next meeting, 'Mr. HOOKE was charged to bring in at every meeting one microscopical observation at least'¹²⁸. Indeed, almost all the observations were made after the official direction in March.

Among the Fellows of the Royal Society, not only Hooke but also Boyle and Wren performed observations with microscopes¹²⁹. As early as 1655, Wren planned to publish a book of microscopic observations and selenography with illustrations¹³⁰. Wren was commanded by the King to submit figures of microscopic observations and the moon in 1661¹³¹. He presented Charles II with his drawings of a louse, a flea and the wing of a fly, probably within the year¹³². Hooke's microscopic research succeeded Wren's. Hooke himself wrote at the end of the Preface of *Micrographia*:

'I was to follow the footsteps of so eminent a Person as *Dr. Wren*, who was the first that attempted any thing of this nature; whose original draughts do now

¹²⁴ *Ibid.*, sig. f1v.

¹²⁵ *Ibid.*, sig. d2v-e1r.

¹²⁶ Singer (1955), note on p. 18.

¹²⁷ See the Table 1 of Harwood (1989), pp. 124-125. This Table shows that the earliest observation published in *Micrographia* was, in reality, reported on 14 August 1661. It was the observation on 'sensible plants' (sensitive plant), which was printed in the latter part of Observ. XVIII. However, the observation was not made by Hooke, but by Lord Brouncker *et al.* For details, see *Birch*, 1, p. 42.

¹²⁸ *Ibid.*, pp. 213 & 215.

¹²⁹ Turnbull (1952-3), pp. 112 & 122; Bennett (1982), p. 73.

¹³⁰ Turnbull (1952-3), p. 114.

¹³¹ Wren (1750), pp. 210-211. The command was communicated to Wren by Robert Moray. In the same letter, Moray wrote that 'we have moved his Majesty to lay his Commands on another, one *Vander Diver*; and we have also persuaded Mr. *Hook*, to undertake the same Thing' (*Ibid.*, p. 211).

¹³² Bennett (1982), p. 73.

make one of the Ornaments of that great Collection of Rarities in the *Kings Closet* ¹³³.

Though Hooke was reluctant to publish a book on microscopy, both Wren and Wilkins encouraged him and assisted him to publish it.

At first glance, Hooke's arrangement of topics and observations in *Micrographia* seems to lack any clear structure, but on closer inspection this is not so. In the Preface, he points out the limitations of the human senses and recommends 'the adding of artificial Organs' or the use of instruments, the theoretical background to his use of microscopes. 'By the means of Telescopes, there is nothing so far distant...and by the help of Microscopes, there is nothing so small'¹³⁴. Then, the main text begins with microscopic observations of artefacts. The text consists of sixty 'Observations', and it progresses up the great chain of being from minerals through the plant kingdom to the animal kingdom. The book ends with the highest material realm of all, that is, with the observation of the heavens with telescopes.

'Observ. LX', the last Observation, is titled 'Of the Moon'. Several illustrations of telescopic observations were included, and the picture of the surface of the moon here was from Hooke's telescopic observations in October 1664. As we shall see, Hooke succeeded Wren not only in microscopy, but also in astronomical observations.

¹³³ *Micrographia*, sig. g2r. See also Wren (1750), p. 213. Webster wrote that Henry Power's demonstration of microscopy at the Royal Society on 24 June 1663 triggered the publication of *Micrographia* (Webster, 1967, pp. 160-161). This interpretation is wrong, because Hooke had already been ordered to make observations on 25 March, three months before Power's visit. Hooke himself claimed that it was after he had completed pictures and observations that he was informed of Power's microscopic observations (*Micrographia*, sig. g2v). Collaboration between Wren and Hooke was also suggested by Power (Power, 1664, p.83).

¹³⁴ *Micrographia*, sig. a2.