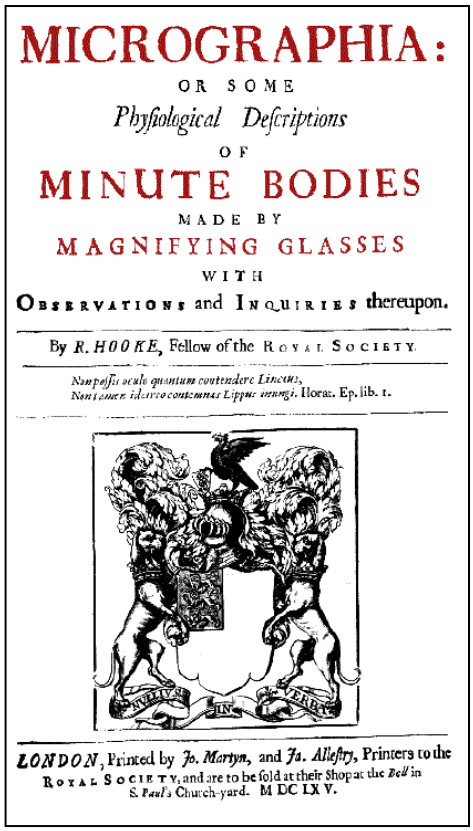
University of Reading

Micrographia

Special Collections featured item for March 2008 by Fiona Barnard, Rare Books Librarian.

Robert Hooke. *Micrographia : or, Some physiological descriptions of minute bodies made by magnifying glasses. With observations and inquiries thereupon.* London : Printed by J. Martyn and J. Allestry, 1665.

Item held in the Cole Library at the University of Reading Special Collections Service.



MICROGRAPHIA:

OR SOME

Physiological Descriptions

OF

MINUTE BODIES

MADE BY

MAGNIFYING GLASSES

WITH

OBSERVATIONS and INQUIRIES thereupon.

By *R. HOOKE*, Fellow of the ROYAL SOCIETY.

Nanoposſis oculo quantum contendere Lynceus,
Non tamen idcirco contemnas Lippus inungi. Horat. Ep. lib. 1.

LONDON, Printed by *Jo. Martyn*, and *Ja. Allestry*, Printers to the ROYAL SOCIETY, and are to be sold at their Shop at the *Bell* in S. *Paul's* Church-yard. M DC LX V.

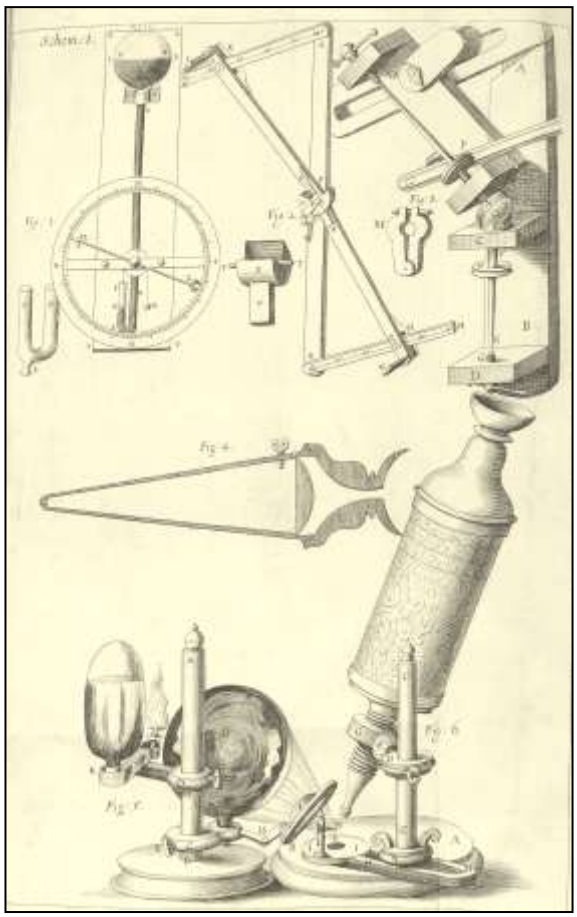
The *Micrographia,* described by the diarist Samuel Pepys as "the most ingenious book that I ever read", was the first English book to be devoted to microscopy. However, the author of this book is much less well-known than his celebrated work.

Robert Hooke (1635-1703) was appointed as the first Curator of Experiments in 1662 at the newly formed Royal Society of London, a position he was to hold for over forty years. The Society was a group of distinguished gentlemen scientists, with a keen interest in inventing scientific instruments. The membership included a number of gifted individuals of the age, including Robert Boyle, Sir Christopher Wren and Sir Isaac Newton.

The group met regularly to discuss a wide range of scientific and intellectual issues, and to share information and discoveries. Many groundbreaking experiments took place at the meetings, all of which were documented in the *Philosophical Transactions of the Royal Society,* the world's longest running scientific journal.

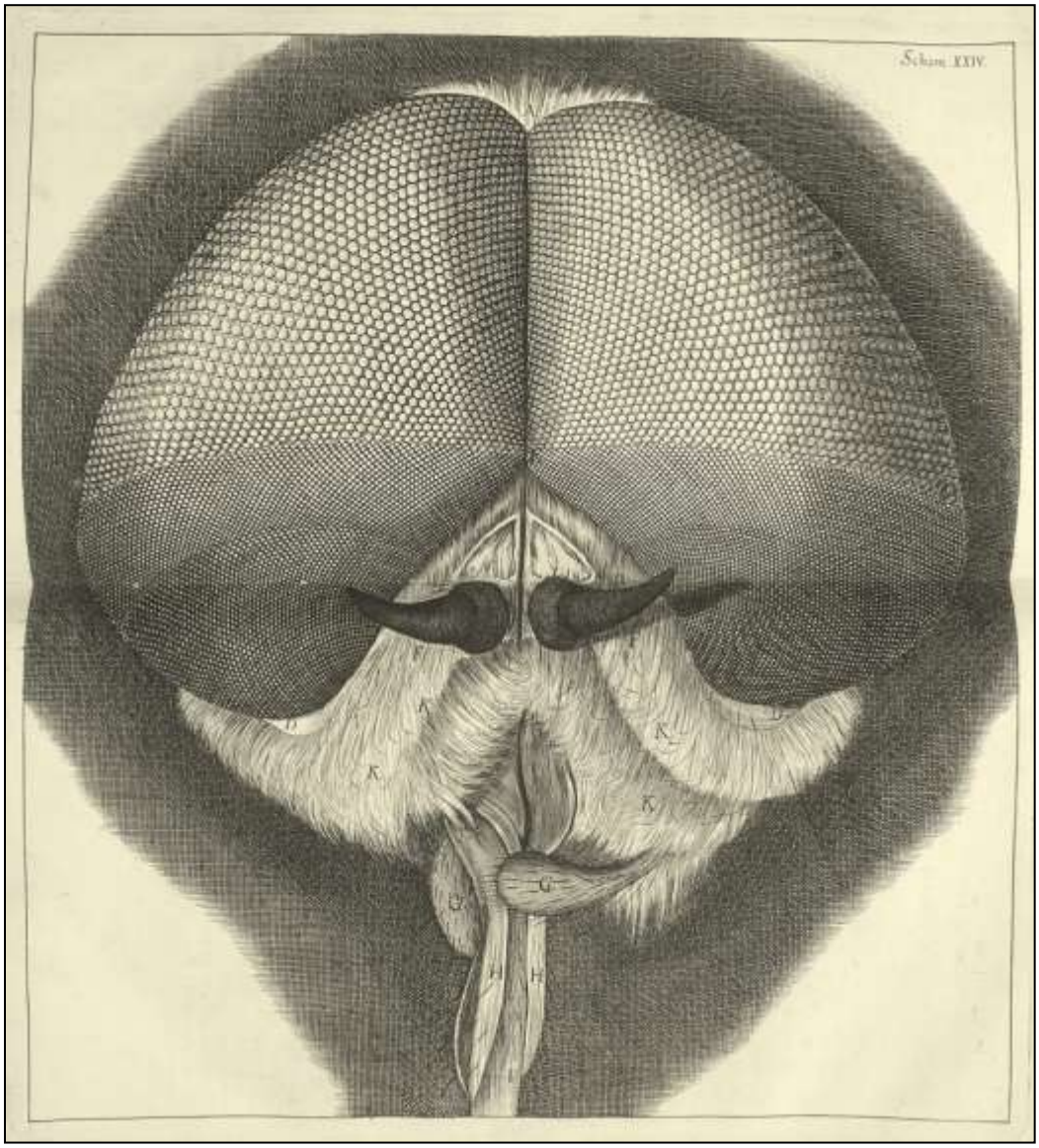
The position of Curator of Experiments kept Hooke at the centre of new scientific discovery and discussion, and he was to be involved with a number of important projects and scientific discoveries during his career. He was the inventor of the iris diaphragm in cameras, the universal joint used in motor vehicles, and the balance wheel in a watch. In 1660, Hooke discovered the law of elasticity which bears his name, and which describes the linear variation of tension with extension in an elastic spring. He was to be appointed by the City of London as Surveyor following the Great Fire of 1666, and assisted his close friend, Sir Christopher Wren, with the rebuilding of London.

However, the role of Curator of Experiments placed a great number of demands on Hooke's time, and he had to manage not only the demands of his own multiple interests and research projects, but also the demands of Society members. He often found himself moving rapidly from subject to subject, without finding the time to finish any of his projects or devote himself to one area of study. He suffered greatly with ill-health for much of his life, and was notorious for being cantankerous and difficult to work with. Hooke's reputation suffered during his lifetime, and beyond, from his many disputes with other scientists, who he often accused of plagiarising his ideas. The most famous of these disputes is Hooke's feud with Newton, first over optics in 1672, and secondly over priority in the formulation of the inverse square law of gravitation in 1686. However, in many respects, Hooke appears as a rather maligned figure, who was perhaps denied any proper credit and recognition for his discoveries and inventions.



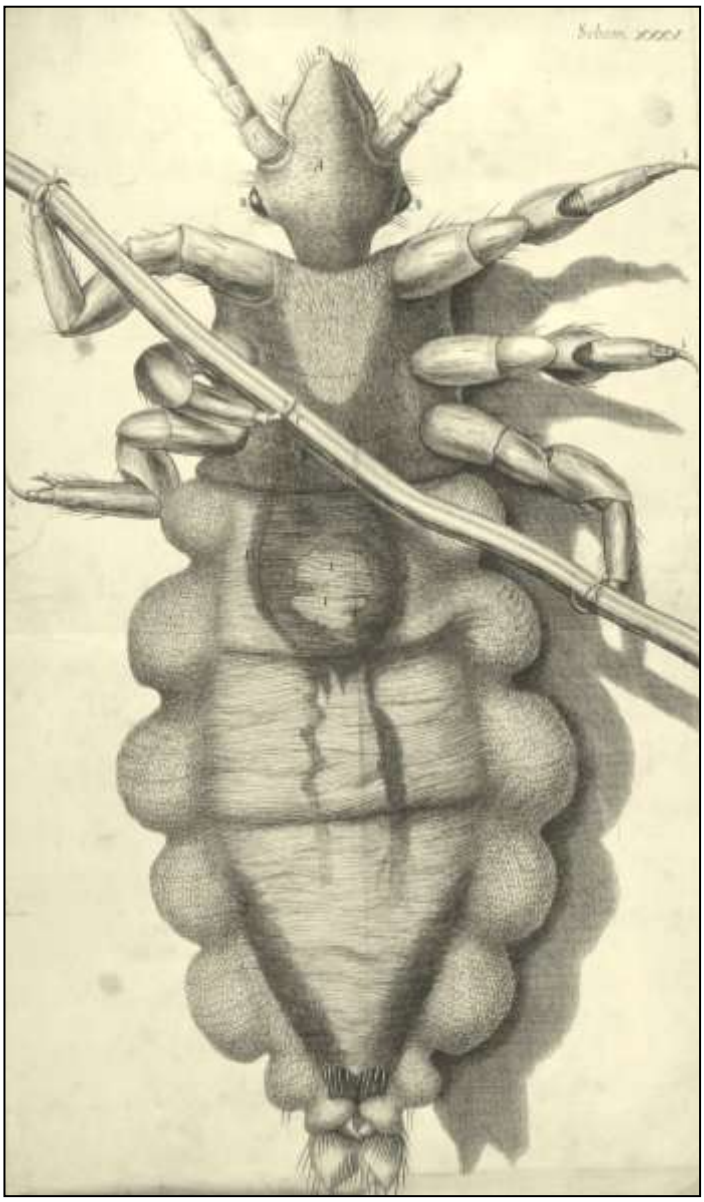
The *Micrographia,* which is the Latin word for 'little pictures', was published in 1665 under the auspices of the Royal Society, whose coat of arms features on the title-page [*see first image*]. The work begins with a preface on the state and aims of contemporary science, in which Hooke encourages "the gentlemen of our Nation" to take up experimental science by emphasising the "high rapture and delight of the mind" enjoyed by scientists.

The preface also includes a technical discussion of microscopes and Hooke's own inventions, such as the scotoscope, for improving their performance. This instrument is shown in the image above, together with the compound microscope which Hooke devised, and its lighting apparatus. Hooke used a compound microscope because it offered a wider field of view that a simple, single lens microscope, although with a greater degree of distortion. For investigations requiring higher magnification, Hooke used a single lens instrument which produced a clearer, more detailed image, and built up a drawing of a subject through careful examination of each of its separate regions.



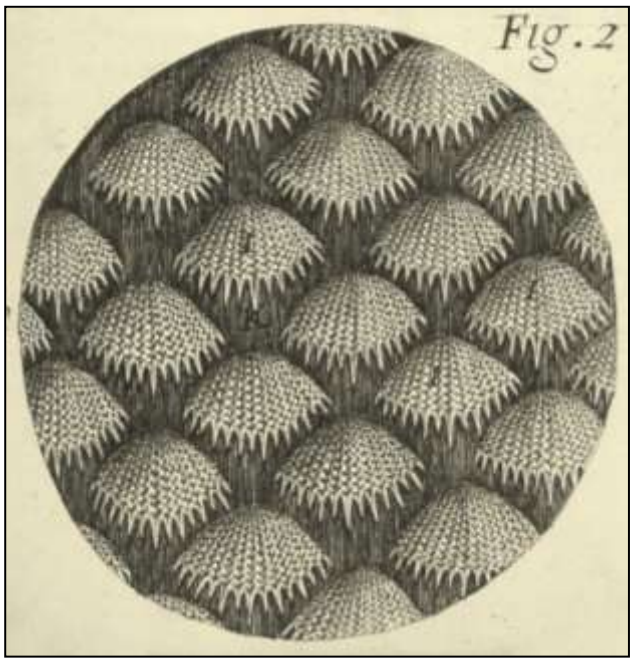
The book is divided into sixty Observations, or scientific explanations, largely based on the magnified structure of a range of objects and natural phenomena, including the sting of a bee, the point of a needle, and extraordinary images of a fly's head [*shown above*], a flea and a louse [*shown below*]. The Observations are lavishly illustrated with one hundred fine engraved

plates, which display the full diversity of Hooke's discoveries and research. As the historian Lisa Jardine has observed, the field of microscopy "required exactly Hooke's combination of instrument-making ability, experimental dexterity and sheer showmanship of which his flair as a draughtsman made a further important contribution".



The writer Margaret Espinasse has identified four of the most important contributions that *Micrographia* makes to science. The first is his work in optics, and his observations on the "fantastical" colours of thin coloured films, and it was this work which stimulated Newton to begin similar investigations into optics and dispersion, or the separation of light into a spectrum of its component colours. In *Micrographia,* Hooke investigated the colours of membranes and of thin plates of mica, and established the variation of the light pattern with the thickness of the plates.

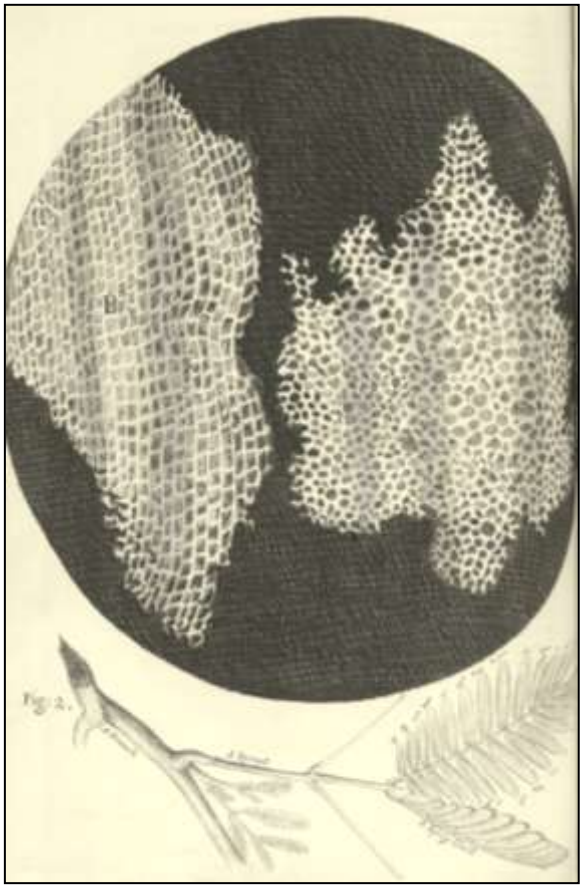
Newton also pursued the wave theory of light proposed in Hooke's work, which influenced Newton's final statement of his theory. Hooke compared the spreading of light vibrations to that of waves in water, and later, in 1672, suggested that the vibrations in light might be perpendicular to the direction of propagation.



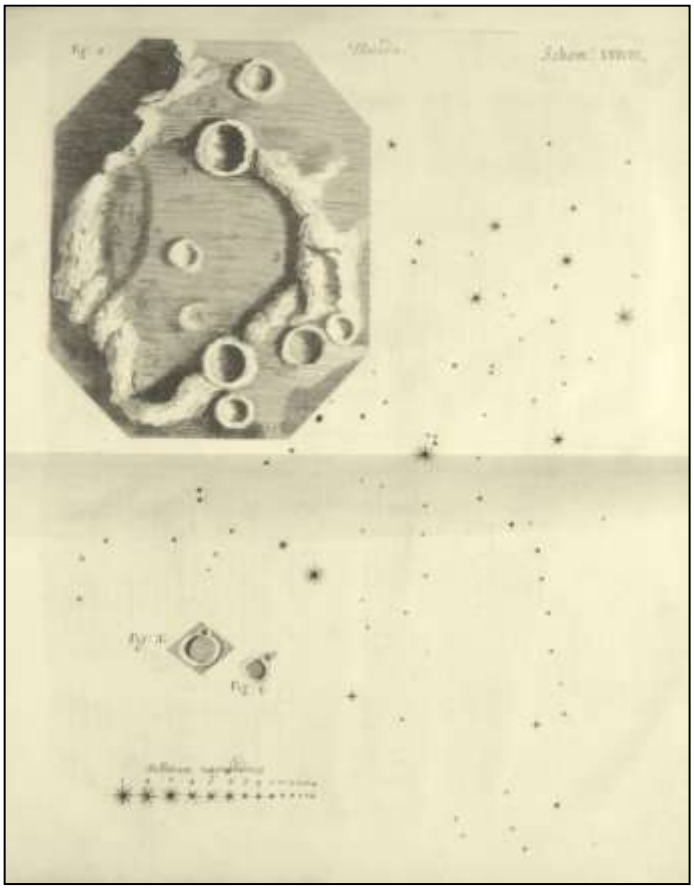
The "beauteous form" of magnified fish scales from plate Scheme 21 of *'Micrographia'*.

In Observation 16, Hooke set out his view of combustion, his second important piece of theory, stating that combustion "is made by a substance inherent, and mixt with the Air". The third important contribution relates to his theories on the history of the Earth's surface. In Observation 17, 'Of Petrify'd wood, and other Petrify'd bodies', Hooke questions the view that fossils are "Stones form'd by some extraordinary *Plastick virtue latent* in the Earth it self". After examining fossils under the microscope, Hooke suggests that the objects are "the Shells of certain Shel-fishes, which, either by some Deluge, Inundation, Earthquake, or some such other means, came to be thrown to that place". The fourth major contribution in *Micrographia* relates to biology. In Observation 18, Hooke describes how he examined sections of cork under the microscope *[shown below]*, and identified the cellular structure of plants. This was to be the first time that the word 'cell' had been used in a biological context, a word coined by Hooke to describe the "infinite company of small Boxes" he saw under the microscope:

> "I Took a good clear piece of Cork, and … cut off … an exceeding thin piece of it, and placing it on a black object Plate, because it was it self a white body, … I could exceeding plainly perceive it to be all perforated and porous … these pores, or cells, … were indeed the first *microscopical* pores I ever saw, and perhaps, that were ever seen, for I had not met with any Writer or Person, that had made any mention of them before this".

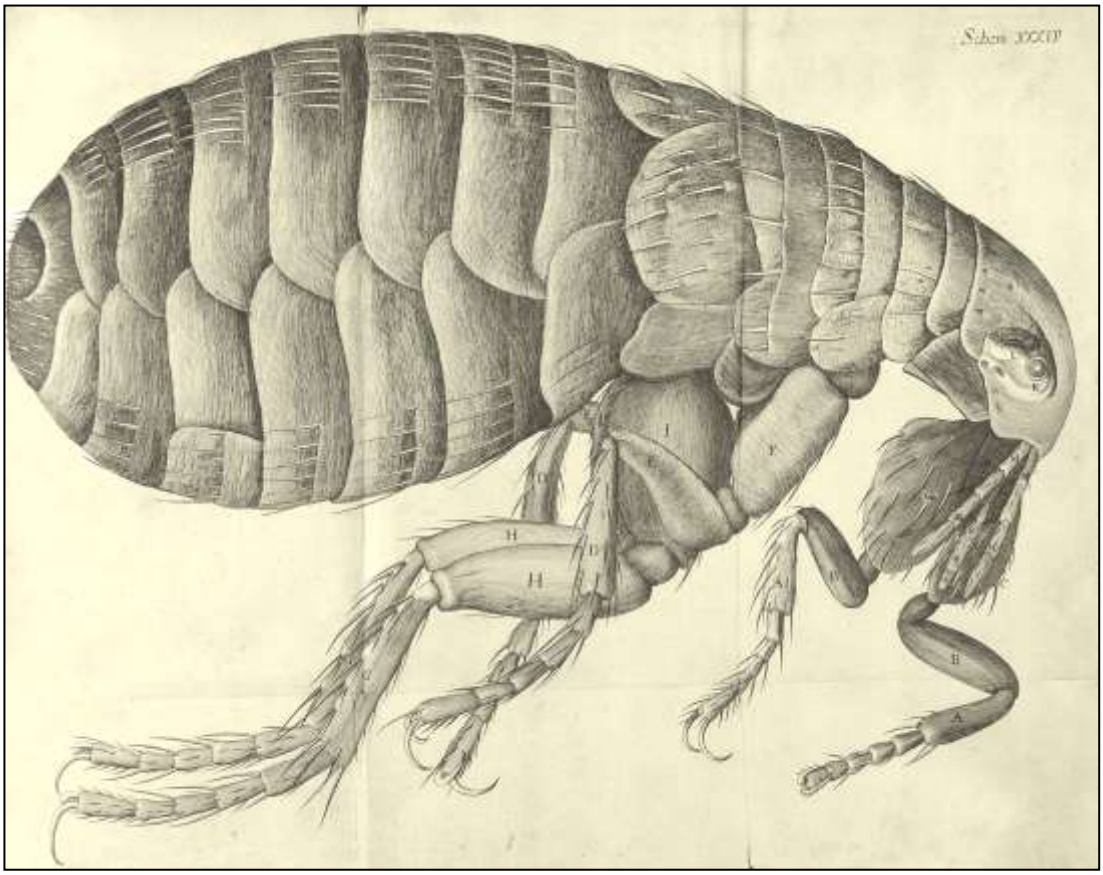


Hooke's discovery was to open up a new field of study, and the examination of plant tissue was to be carried out by several biologists, including Nehemiah Grew (1641-1712), who also discovered the sexuality of plants.



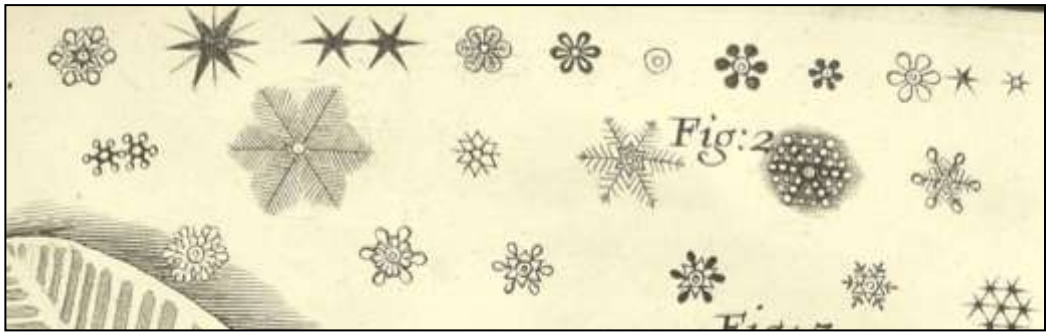
The *Micrographia* also includes a series of telescopic observations of distant planets and lunar craters, and speculation as to the origin of these features. Observations 59 and 60 are illustrated with an engraving showing the Pleiades star cluster, commonly known today as the Seven Sisters, and the craters of the Moon as viewed through a telescope [*shown above*]. Hooke observes that the surface of the moon has "several kinds of pits, which are shap'd almost like a dish". He describes how he conducted experiments to investigate how these craters might have formed by making up a mixture of pipeclay and water, and bombarding it with bullet-like objects.

However, it is the engravings which are a particularly memorable feature of this lavish volume, and gained the work its widespread renown. There are a number of fold-out plates, which fold out larger than the folio volume itself, of which the most impressive is perhaps the magnificent engraving of a flea [*shown below*], "adorn'd with [its] curiously polish'd suit of sable Armour", as seen through a microscope. The engravings are based on Hooke's original drawings. However, Jardine has suggested that the drawings for the flea and the louse, the other large fold-out plate, were drawn by Sir Christopher Wren, rather than by Hooke.



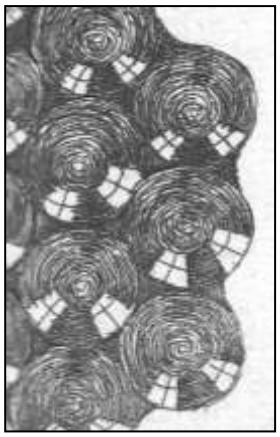
Despite his protests at other scientists copying his ideas, it appears that Hooke was not above plagiarism himself, as the writer Brian J. Ford has pointed out. At the top of Scheme VIII, a plate depicting ice crystals drawn from life, Hooke depicts a group of snowflakes [*shown below*]. Ford claims that these images were not in fact drawn by Hooke, but copied from a book by the Danish scientist Thomas Bartholin (1616-1680), entitled *De Nivis usu Medico Observationes Variae*, published four years earlier in 1661. These images were the first illustrations of snowflakes which appeared to present them in magnified form. However, as most of these images bear little resemblance to ice crystals in nature, they appear to be stylised caricatures or artistic impressions of what snowflakes might actually look like under magnification. As Ford observes, "despite Hooke's complaint that contemporaries frequently misappropriated his work, his silent adoption of Bartholin's snowflakes in

Micrographia suggests how unstable the concept of intellectual property was in the early modern world as well as the variety of second-hand materials that contributed to the authority of an "objective" scientific investigation".



Espinasse has noted that Hooke's writing displays a lively poetic style, and a keen appreciation and enthusiasm for the aesthetic qualities of natural phenomena, which makes the book both enjoyable and accessible to read. In fact, Espinasse refers to the work as "one of the best embodiments of the peculiar delight and warmth of its period". Hooke refers to the louse in wonderfully lively terms, describing it as "so impudent … [and] so saucy" in his description in Observation 54. Elsewhere, he notes "these pleasing and lovely colours", when discussing the iridescence that "I also sometimes with pleasure observ'd even in Muscles and Tendons". He notes the care with which Nature guards the seeds of plants and "in what delicate, strong and most convenient Cabinets she lays them". In Observation 43 he wrote of "Nature's course", and how the microscope enables the scientist to observe Nature without disturbing her:

> "Through these delicate and pellucid teguments of the bodies of Insects acting according to her usual course and way, undisturbed, whereas, when we endeavour to pry into her secrets by breaking open the doors upon her, and dissecting and mangling creatures whil'st there is life yet within them, we find her indeed at work, but put into such disorder by the violence offer'd, as it may be easily imagin'd, how differing a thing we should find, if we could, as we can with a Microscope, in these smaller creatures, quietly peep in at the windows, without frighting her out of her usual byas".



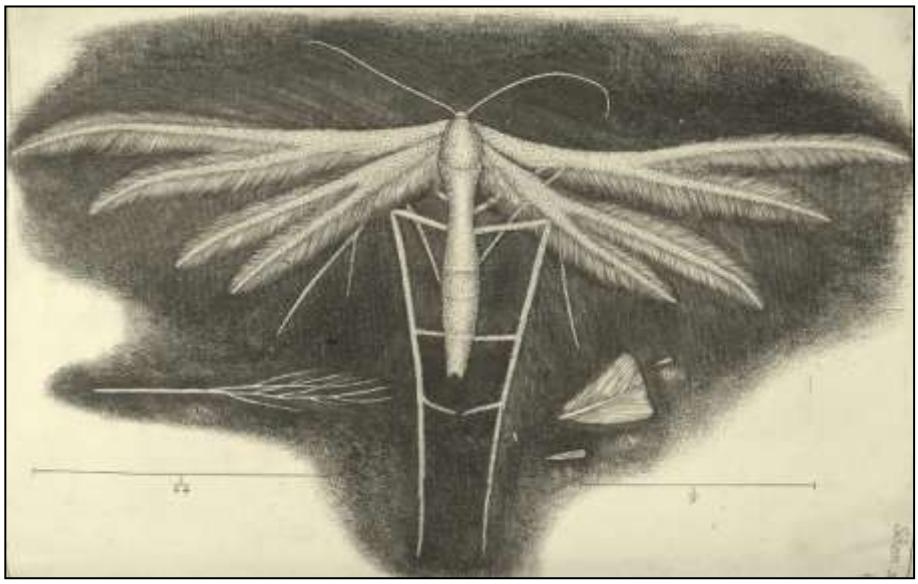
In his description of the compound eye of a fly, he notes that it has thousands of separate facets or 'hemispheres'. He notes that these facets "reflect the Image of the two windows of my Chamber", and as a little ornamental joke he includes a drawing of nineteen of these facets as Fig. 3 on the plate Scheme 23, showing the two windows reflected in each one *[shown in the detail of Fig. 3 left]*.

The attractive and accessible nature of the book made it an immediate bestseller. It was received with much acclaim from Hooke's contemporaries, and was of great interest to the general public as well as to the scientific community. The striking images captured the public's imagination in particular, and encouraged a number of amateur gentlemen scientists, including Samuel Pepys, to purchase their own microscopes in order to observe such natural phenomena for themselves. The accuracy and high quality of the draughtsmanship also set new standards for microscopy, and many of the illustrations were still being used up until the nineteenth century for illustrating books on microscopy.

The University of Reading also holds a second edition of *Micrographia* in the Cole Library, as well as copies of other works by Hooke. These include his publications *Lectiones Cutlerianae* of 1679 and *Philosophical collections,* published between 1679 to 1682, as a record of the Royal Society's activities on the model of the Society's *Philosophical Transactions.* A run of the *Philosophical Transactions of the Royal Society* from the first volume dated 1665 onwards is also held in the Cole Library collection.

References

- Espinasse, Margaret. *Robert Hooke*. London : William Heinemann Ltd, 1956.
- Ford, Brian J. *Images of science : a history of scientific illustration.* London : The British Library, 1992.
- Jardine, Lisa. *The curious life of Robert Hooke : the man who measured London.* London : Harper Perennial, 2004.
- Robert Hooke website (hosted by Westminster School in honour of Robert Hooke) www.roberthooke.org.uk [Accessed March 2008].



Engraving of a white feather winged moth, or *Tinea argentea*, from '*Micrographia*', described by Hooke as "a lovely object both to the naked Eye, and through a Microscope".