Writing the history of "microscopy" in the twenty-first century

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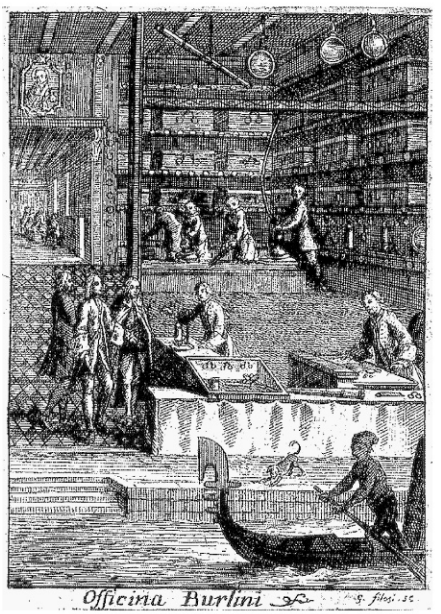
FROM MAKERS TO USERS

Microscopes, Markets, and Scientific Practices in the Seventeenth and Eighteenth Centuries

DAGLI ARTIGIANI AI NATURALISTI

Microscopi, offerta dei mercati e pratiche scientifiche nei secoli XVII e XVIII

edited by DARIO GENERALI and MARC J. RATCLIFF



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WRITING THE HISTORY OF "MICROSCOPY" IN THE TWENTY-FIRST CENTURY

This book is based on the proceedings of a workshop held in Milan, Italy, in October 2004. In addition, it offers contributions from invited authors. As its design took shape, the better understanding of the relationships between microscope makers and users gradually took centre stage. We became aware that the interaction of practitioners with scholars was a suitable means to analyse the production and activities of both types of actors: makers and users of the microscope. Alberto Lualdi provides an image of this key interaction for our frontispiece, showing the workshop of the Venice maker Biagio Burlini and presumably Burlini himself demonstrating a microscope to three gentlemen. Our investigation has proven much more rewarding than originally expected. Nevertheless, it was a challenge to join two scholarly traditions as different as those of the history of science and the history of the instruments. In this book we examine the history of microscopes, their markets and scientific practices using a wide range of methods: case-studies, quantitative analysis, history of the instrument and the workshops, rhetorical analysis, experimental history, etc.

From the first observations performed by Francesco Stelluti in the *Accademia dei Lincei* to the research by Malpighi, Swammerdam, Leeuwenhoek and Hooke, microscopes swiftly became a central tool for investigation in the life sciences, and they profoundly changed the image of nature. Nature became more complex; it displayed more layers to the observer's gaze; and it revealed the existence of a new world inside the old world, thereby opening new roads for research. Historians and philosophers of science including Catherine Wilson and Edward Ruestow have analysed this process thoroughly. But this historiography has not really investigated the eighteenth-century activities and therefore failed to deconstruct several long-standing beliefs, such as the decline of microscopy in the eighteenth

century after the initial discoveries made by the so-called fathers; the chromatic aberration that hindered research; the microscope as a toy for the amusement of the elites; and the use of simple microscopes as the only resource for scientific research. For instance, many historians of the instrument have claimed that the main problem of microscopes in the Ancien Régime was chromatic aberration. This has long been regarded as one of the principal reasons of the so-called decline of microscopy in the eighteenth century. Focusing on the interaction of the makers with the users appears as a potent heuristic tool for both the deconstruction of those beliefs and the understanding of the fate of microscopes and scientific practices during the Ancien Régime. As a consequence, in this book, several authors propose that the really important problems were in fact the following: the lack of standardisation of microscopes; their concrete availability, the how and why of their circulation in Europe; their practical use by scholars; and the methods that were applied to share the particular visual knowledge that microscopes were meant to secure. The main goals of this book are thus to identify the networks, the various uses of, and the markets for microscopes.

Shaping the Markets

Several papers in this volume cast new light on the microscope markets in Europe. These markets were characterized above all by their diversity and cultural differences, and there was no single way to make, advertise, circulate and sell microscopes. The study of these cultures of instrument makers supplies important data about instruments, the nature of scientific research and the social networks of both makers and scholars. Yet although vital to research as well as to the sharing of knowledge, instruments were not always readily available. For instance, from the end of the seventeenth century the well-known physician Antonio Vallisneri did not believe that spermatic animalcules existed. He changed his mind in 1713 once he could see them thanks to a pocket Wilson microscope lent by a British traveller, as Francesco Luzzini and Dario Generali show in their papers. This case emphasises the difficulty in obtaining a microscope – either Italian or British – in Northern Italy at the beginning of the eighteenth century. Even though many scholars obviously depended on makers to get instruments suitable to their needs, there was no unified market for microscopes in Europe. The so-called British optical empire was limited to England and to a few elites on the Continent. By no means we wish to deny the importance of the British, and especially London, practitioners for the

making of microscopes. But we have to check whether there was really nothing apart from the London market, as the standard historiography maintains. Actually, the proportion of microscopes made in England and referred to by Continental scholars out of more than 1700 sources is almost insignificant, as Marc J. Ratcliff shows in his paper. Maria Teresa Monti reminds us that a brilliant user of the microscope, Bonaventura Corti, received a compound microscope made by Dollond as a gift from the Duchess of Este in the 1770s. But this was not the rule, and his friend Lazzaro Spallanzani had his microscopes made by Catholic monks, like many of the instruments used by Italian observers during the Enlightenment. Numerous local markets existed on the Continent where many practitioners gained international reputation. As Inge Keil shows, Augsburg was one of those cities where the production of optical instruments and particularly microscopes lasted for more than two centuries. Michela Fazzari's paper discusses the excitement about making and using microscopes in the scholarly Roman world at the end of the seventeenth century, while Marian Fournier highlights the importance of the Musschenbroeks setting up their workshop in Holland at the same time. Other papers by Jutta Schickore, Lualdi, Ratcliff and Fournier take up the issue for the eighteenth century. They show how makers of microscopes ran workshops in Venice and Milan, in London, and in French and German cities. Microscopes circulated much thanks to local networks, and they travelled mostly in scholars' bags.

The markets for microscopes were culturally determined also because practitioners did not manage advertising everywhere the same way. In France, the makers lacked the advertising tools – especially leaflets and trade cards – used in other countries, as they were prohibited by French corporations during the Ancien Régime. Ratcliff's example of a «competition in communication» of two French makers in Paris and Rouen shows that advertisement was credited with moral value. By comparison, Schickore reminds us that certain British makers along with scholars were engaged in a competition for their products, in which advertisement as well as prestige came first. Keil sheds new light on the origins of both advertising microscopes and the specialisation in making these devices. It was not in England nor in the Dutch Republic that microscopes were first turned into merchandise, but rather in the free city of Augsburg near Bavaria. Johann Wiesel, a German maker specialised in making optical instruments was probably the first professional maker of microscopes. As early as 1630, he dispatched a price-list for his microscopes, which was soon copied to circulate in other countries. More than a century later, during the

second half of the eighteenth century, the Augsburg instrument maker Georg Friedrich Brander launched an advertising campaign for his many instruments. At this time, German scholars sought to rescue their national makers by comparing German to British microscopes thanks to a test of their optical properties. In Venice, the spectacle maker Lorenzo Selva also wrote several pamphlets to promote his microscopes, as Lualdi shows. Therefore, at a time when the industrial revolution was on its way and scholars and societies experienced new economic systems – such as Turgot's attempt to free the market and destroy the French corporations in 1776 –, instrument makers invented new skills, new tools and new solutions to survive in an ever-more competitive environment.

Nevertheless, unofficial production had a considerable share in converting microscopes into scientific instruments especially on the Continent. In the two centuries after the birth of the microscope in the early seventeenth century, two groups of outsiders played a significant role for the making of microscopes. These were religious makers and scholars who made their own microscopes. Regarding the latter, Fournier discusses the well-known case of Leeuwenhoek, and also Huygens, who both designed and made their own microscopes. Similarly, thanks to his homemade instruments, Father Buonanni in Rome became a strong competitor to renowned makers such as Giuseppe Campani and Carlo Antonio Tortoni. Generali points out that in 1713 the Brescian physician Bernardino Bono made a simple microscope with two interchangeable lenses that was more efficient than the Wilson instrument. There are many other examples of scholars who made, but not marketed, microscopes. Making a simple microscope could be very easy. The technique of making spherular lenses from a drop of molten glass was heavily used from the 1670s to the end of the Enlightenment. During the second half of the eighteenth-century Neapolitan scholars made their own simple microscopes and performed numerous valuable observations. Many sources also show that monks skillfully handled the lathe, and ground lenses in France, Germany and Italy. These two groups, religious men and self-made makers provided cheaper microscopes that circulated mostly on the Continent; they were valid competitors to professional instrument makers because they had created sideline markets. Above all, they were closely connected with the scholarly networks and played a large part in the scientific uses of the microscope. But they left the stage with the arrival of the achromatic and standardised microscope in the early nineteenth century.

Rethinking Historiography

According to the standard historiography, nothing really significant occurred during the eighteenth century until the arrival of the achromatic microscope. But in fact, at that time, two issues came to play an important role for scholars who sought to obtain reliable data while using a microscope: the standardisation of the instrument and the organisation of the scholar's and practitioners' work.

It is known that the optical parts of Ancien Régime microscopes were not standardised. Artisan grinding of lenses strongly limited their standardisation, but sometimes helped to highlight the virtuosity of certain makers. Yet, while lacking standardisation, scholars used several microscopes to have better control of the image, as shown in several papers.

Moreover, roads to a modern conception for the making of microscopes were actually opened by Ancien Régime scholars and makers. Many users were also designers of microscopes. Henry Baker helped John Cuff to improve his microscopes. Lieberkühn showed his mirror and two models of microscopes to the British makers who soon adopted it. Abraham Trembley met John Cuff in his workshop in 1745 thanks to his connection with Martin Folkes P.R.S. He designed the aquatic movement for a microscope, and had Cuff make it. This instrument was the predecessor of the Cuff-Ellis microscope.

Makers and mathematicians also worked in research teams. Campani and Tortoni in Rome, Cuff in London, Magny in Paris, the Selva in Venice, Brander in Augsburg, Nicolaus Fuss in St Petersburg and many others collaborated with scholars to design and build microscopes. Therefore a common feature of the practice of microscopy was division of labour. There was on the one hand a designer, aware of the users' needs, and on the other hand a maker running a workshop and marketing his products. To be sure, many of the makers, among them the Musschenbroeks, George Adams, Benjamin Martin, the Dollonds, Marc Mitouflet Thomin, Abbé Nollet, Georg Friedrich Brander, Louis-François Dellebarre, Joseph Fraunhofer, Giovanni Battista Amici and others were skilled both in optics and in making instruments. But the collaboration between makers and scholars was already cultivated during the Ancien Régime. Generally it appears that Continental scholars and makers had a real influence on the design, construction, and marketing of microscopes.

Intertwining systems of patrons and scholars, religious and secular makers, clients and users, designers and amateurs, bourgeois and elites thus

characterised the markets and uses of the microscope. But were all those energies just targeted at the making of luxury goods to be circulated in Europe, at providing devices only designed for the amusement of ruling classes, as the standard historiography has it? Directly or not, several authors in this volume tackle this issue. Schickore claims that the common distinction between 'amusement' and 'scientific work' is not a helpful conceptual tool for the analysis of eighteenth-century microscopy. With the subtle example of a British maker, Benjamin Martin, performing research on the insect eye, she breaks down the stereotype of the British maker whom the historiography has pictured only as a pragmatic practitioner. In the same vein, Ratcliff portrays the threshold between market, amusement, and scientific investigation. Scholars used a procedure, a rite of passage – testing the visual performances of their instruments – to transform a microscope from an artefact coming from the market into a scientific device ready to operate in a laboratory, among other instruments. Passing this threshold drew up a limit between an object from the market and a scientific instrument.

The use of the microscope for scientific research rather than for amusement is also discussed in a series of case studies focusing on the unique situation of the Italian observers during the Ancien Régime. Italian scholars heavily used the microscope for the purpose of scientific research, as pointed out in five Italian texts by Gianni Micheli, Fazzari, Luzzini, Generali and Monti. Over a period from the 1660s to the 1770s the anatomist Marcello Malpighi, the Jesuit Filippo Buonanni, the physician Antonio Vallisneri, the priest Bonaventura Corti and their respective networks illustrate well how the Italians developed a tradition of naturalist microscopical investigation that culminated in the works of Lazzaro Spallanzani. Italy was a country where the microscope was never dismissed as a mere toy. Yet it shows the curious paradox of the most limited and scattered optical instrument market of Europe combined with the largest number of brilliant users of the microscope. Valid for a pre-industrial society, this *longue durée* example helps to break away from the stereotype of a causal relationship between the productivity of a given scientific instrument market – such as London's market of microscopes – and the level of quality of scientific research. Once more, the activity of unofficial markets closely linked to scholarly networks helps explain this paradoxical situation.

Another factor commonly thought to affect the quality of research is the optical performances of microscopes. Historians of the instrument sometimes used mathematical analysis to describe the optical features of

microscopes. Gerard l'E. Turner claimed that the optical parts of the microscope were the most important one, and Brian Bracegirdle, Edward F. Frison, and Erich Hintzsche analysed optical properties of historical microscopes. Using geometrical optics to determine the magnification and resolving power of lenses, Francesco Andrietti discusses in his paper the optical features of a series of seventeenth-century famous Italian and English compound microscopes. He casts doubt on established ideas by showing that the field lens could increase *or* diminish the magnification in a microscope.

A number of papers deal with research by microscopical observers, makers or not, from countries other than Italy and England. Fournier analyses the Dutch observers in the late seventeenth century, particularly Swammerdam, Leeuwenhoek and Huygens, and how they dealt with microscopes and makers. Their scientific research styles closely interlocked with the type of instruments used and with the ways to make them. Ratcliff and Fournier investigate the unknown face of a famous scholar, showing that the scientific activity of a well-known naturalist such as Abraham Trembley was also rooted in the world of practitioners for whom he conceived microscopes, and in his lively involvement in dealing with and buying scientific instruments for his Continental friends and his patron William Bentinck. Keil analyses scholars from Augsburg, including Conrad Cosmus Cuno – both a maker and a scholar –, the Regensburg naturalist Jakob Christian Schaeffer, and she brings to light the latter's connections with Augsburg instrument maker Georg Friedrich Brander. Particularly the German scholars were influenced by Trembley's research on the regeneration of the Hydra, and many among them reproduced his experiments. A paper by Ratcliff discusses the microscopical research of Horace-Bénédict de Saussure in Geneva, George Leclerc de Buffon and Michel Adanson in Paris, and other French and German mid- and late eighteenth-century scholars. Lualdi discusses the scholarly network of Venice maker Lorenzo Selva that included Lazzaro Spallanzani, the physicist Giovanni Poleni and the mathematician Ruggero Boscovich among his customers.

Experimental Procedures and Scientific Instruments

Microscopes were therefore used in the seventeenth *and* eighteenth centuries for the sake of scholarly and particularly naturalist research. Papers in this volume portray several examples of how scholars constructed scientific phenomena while dealing with experiments, microscopes, and

scientific practices. Sharing knowledge with non-standardised instruments called for particular strategies, such as using several microscopes, calling for witnesses, improving one's writing skill, standardising the description of phenomena, or testing one's microscopes. But in order to transform salient observations into scientific phenomena, scholars also had to reduce their diversity and complexity, as well as including their research project into a tradition. A research project takes place in cultural, social and practical contexts; it depends on many factors, such as practical skills, theoretical speculations, research traditions, the management of observation, social networks, and the material availability of instruments. Availability of suitable instruments is material to start a research, while cognitive, social, practical and writing skills allow carrying it out successfully. Therefore, several papers show that the use and management of instruments was as important as theoretical knowledge for the shaping of a community of scholars.

Historians of science have shown that the final version of a research project diverges from the first drafts as it is being adapted to the logical and rhetorical needs of the author and balanced by the demand of the public. Obviously manuscripts evidence such as lab notes and letters are topical to follow closely the scholar's path while experimenting and using instruments. A comparison of the trajectories going from the first manuscript drafts to the final publication helps to understand the origins and development of visual and speculative knowledge and know-how. Many authors in this volume reconstruct the debates about microscopical research, looking for the reasons that enticed scholars to deal with certain objects, and, last but not least, the reasons for self-censorship in their printed works.

To capture the making of the visual knowledge constructed in microscopical investigations, historians of sciences and historians of instruments share their methods in this volume. They describe instruments; scrutinize the printed and manuscript material that circulated in Europe; follow maker's products and scholars in their daily elaboration of lab notes; and track slight changes that could yield strong effects both in the maker's workshop and in the scholar's laboratory. The reconstruction of these complex stories calls for the understanding of these intersections while maintaining the unity of these events. Mostly, the interaction between the maker and the user has proven to be a good tool to map scholarly activity in a world missing the standardisation of the instruments. The use of all types of sources, lab notes, correspondences and printed material, all while keeping in mind

a larger scope from maker's know-how to user's practices has supplied valuable tools for the understanding of the pragmatic conditions of work of the scholars and of their competences. In addition to the use of classical tools, such as biographies, analysis of works, of their reception, and of the social networks of scholars, the study of the interaction between the maker and the user has unlocked new issues. We hope that this tool will not only serve the purposes of the history of microscopy, but also those of history of science and history of instruments more generally.