

HISTORICAL MICROBIOLOGY – THE VAN MUSSCHENBROEK MICROSCOPE

Introduction

After complaining in 1679 about the difficulties associated with the making and mounting of lenses for single-lensed microscopes, as well as the eye strain involved in their use, Robert Hooke (author of *Micrographia*, the first book on microscopy) continued:

“... though in truth they do make the object appear much more clear and distinct, and magnify as much as the double Microscopes: nay, to those whose eyes can well endure it, 'tis possible with a single Microscope to make discoveries much better than with a double one, because the colours which do much disturb the clear vision in double Microscopes is clearly avoided and prevented in the single.”

Single lensed microscopes were common in the 17th and early 18th centuries. Many were made by or for specific researchers according to their own designs (figure 1). However, an instrument-producing workshop owned by the Van Musschenbroek family in Leiden included microscopes for general sale in their catalogue.

Van Musschenbroek Microscopes

The Van Musschenbroeks designed and produced two types of single-lensed microscope (figure 2). They also made copies of Van Leeuwenhoek's device for watching blood flow in small fish and eels (the “aalkijker”) and dissecting microscopes for Swammerdam and Lyonette. Their 1725 trade catalogue also mentions “a microscope for looking through 2 lenses at the same time”, presumably a compound microscope.

The microscope used for the work reported here is the stronger single-lensed version (figure 2B, figure 3) from 1690-1750, and is the property of the Dutch Historical Microscopy Foundation (Stichting voor Historische Microscopie). The microscope is equipped with 4 lenses mounted in small brass plates marked with impressed dots (figure 4A,& B, table 1) and 3 sample holders (figure 4A).

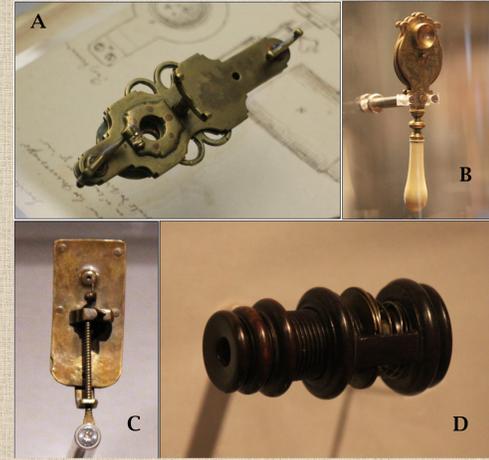


Figure 1. Single lens microscopes in use at the end of the 17th and beginning of the 18th century. Their designers and/or makers were:
A: Christiaan Huygens
B: Depouilly of Paris
C: Antoni van Leeuwenhoek
D: Nicolaas Hartsoeker

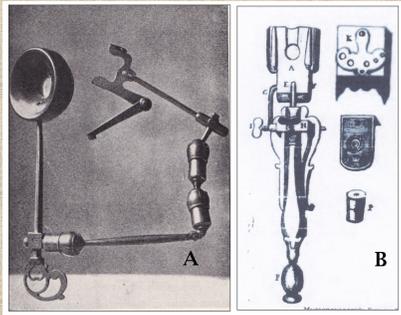


Figure 2. The two types of simple microscope designed and made by the Van Musschenbroeks.
A: low magnification. B: high magnification.
(Figure from Zahn, 1702)

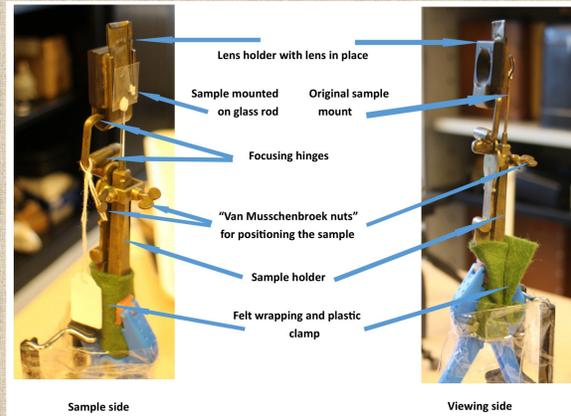


Figure 3. The Van Musschenbroek microscope set up for use in this study.



Figure 4. A: The lenses, sample holders, etc belonging to the Van Musschenbroek microscope used in this study. B: One of the lenses with the engraved dots mentioned in Table 1.

Table 1 The lenses for the microscope are mounted between two thin pieces of brass in which a small recess is hammered to hold the lenses. There are 4 original lenses in their mounts. The mounts are each marked by a row of dots, as follows:

...	f = 17.7 mm,	magnification 14×.
...	f = 12 mm,	magnification 21×.
....	f = 8.3 mm,	magnification 30×.
..	f = 4.3 mm,	magnification 58×.



Figure 5: Setup for photography

Who were the Van Musschenbroeks?

The Van Musschenbroeks were Flemish refugees in the early 1600s. Rotterdam-born Adriaen Joosten (1590-1663) moved to Leiden, where he started a brass foundry around 1610. Their range of products included domestic oil lamps which were so popular that they adopted a lighted lamp as their shop sign.

During the 1660s, Samuel (1640-1681), the grandson of Adriaen, began specialising in scientific and medical instruments, and gained a reputation for making some of the finest instruments in Europe. Among his most famous products were vacuum pumps, telescopes and microscopes as well as special tools required by medical students. They can be recognised by the company logo, an engraving of an Oriental brass lamp with the crossed keys of the Leiden city arms. When Samuel died, his younger brother Johannes Joosten (2 August 1660 – 10 January 1707) took over the business.

Johannes made instruments for, among others, Renier de Graaf, Jan Swammerdam and Christiaan Huygens. He had two sons, Jan (1687-1748) and Petrus (1692-1761). Jan took over the instrument workshop, with great success. His friendship with Willem Jacob 's Gravesande was one of the factors that spread the fame of the company internationally because 's Gravesande used images of Van Musschenbroek's equipment to illustrate his famous textbooks. 6 months after Jan's death, his books and instruments were sold by auction and the business was closed. Petrus became Professor of Mathematics, Physics, Astronomy, and Medical Science at Leiden University.

The experiments

One cannot work with a microscope roughly 300 years old without feeling responsible for its subsequent condition. For example, surgeon's gloves were worn during the experiments and the handle of the microscope was wrapped in felt before being held in a plastic clamp. The clamp was then taped to a table-top tripod to keep the microscope in position for photography. For the first samples, the original sample holder was used (figure 3, right), but for later experiments, a glass rod was used (figure 3 left) to reduce handling of the holders. Samples mounted on coverslips were attached to either sample mount with soft glue. They included diatom fossils, the wing of a lacewing and NaCl crystals.

The samples were lit with a LED lamp. The light level was controlled using a diaphragm and simple diffuser.

Photographs were taken using a Canon EOS M10 fitted with an adapter so that the microscope served in place of an objective (figure 5).

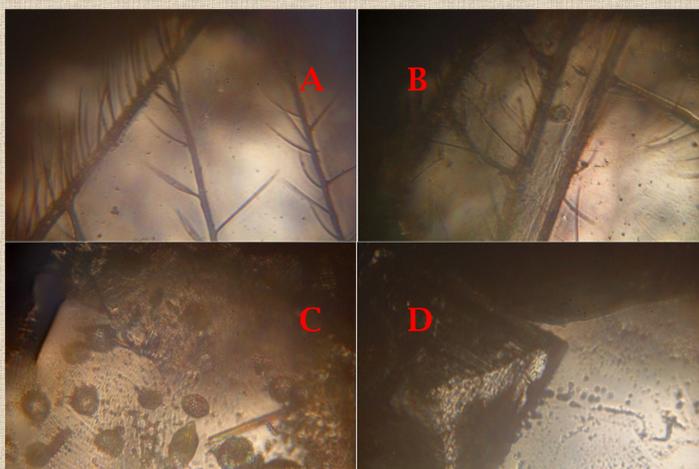


Figure 6: Images obtained with the Van Musschenbroek microscope.
A: Wing of lacewing, 4-spot lens
B: Wing of lacewing, 2-spot lens
C: Fossil diatoms, 2-spot-lens
D: NaCl crystal, 2-spot lens.

Results and Conclusions

Figure 6 shows examples of the photos obtained using two of the lenses. The images were a little clouded, presumably because of the age of the lenses. As with previous experiments with facsimile Van Leeuwenhoek microscopes (ref), the view through the microscope with the naked eye was always better than that obtained while using a camera, largely because of technological limitations including depth of field. The images shown in figure 6 are all combinations of 2-4 photographs to reduce this problem.

The greatest gain from these experiments is the determination of exactly how such microscopes were used. Some have speculated that one of the two Van Musschenbroek nuts (figure 3) was intended for focusing. This is not the case. They are both used to position the sample mount. Focus is achieved by means of the hinges at the top of the sample holder and the bottom of the lens holder (figure 3).

Comparing the use of the Van Musschenbroek and Van Leeuwenhoek styles of microscope design, they each have their stronger and weaker points:

The ability to change lenses by simply replacing one lens holder for another on the Van Musschenbroek (figure 3) is a major advantage over the need with most Van Leeuwenhoek microscopes to detach the sample and attach it to another microscope for another magnification (figure 1C).

Similarly, sample changing is more convenient and less damaging with the Van Musschenbroek model.

Focus is less precise with the Van Musschenbroek's hinges (figure 3) than with the simple screw of the Van Leeuwenhoek (figure 1C). Sample manipulation is also more precise with the Van Leeuwenhoek's simple screw (figure 1C) than with the Van Musschenbroek's loose sample mounts (figures 3, 4).

In some ways, this comparison is unfair. We are comparing Van Musschenbroek microscopes made for general sale to the interested public with those made by the end user, Van Leeuwenhoek, for his own exacting needs, in much the same way as one might compare modern compact and single lens reflex cameras. They are both good, but for slightly different purposes. Sadly, the microscopes made by the Van Musschenbroeks for equally exacting end users such as Swammerdam do not seem to have survived. Perhaps, one day, it will be possible to obtain a facsimile for comparative studies.

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Original concept,
Jan van
Musschenbroek¹ (left).

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