Recreating the pioneer microscopists' view

Using unpolished beads of melted glass, the author has attempted to examine microscopic specimens in a manner similar to that used by pioneer microscopists over three centuries ago. The image quality can be surprisingly high even with the most primitive "lens"

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It is very difficult to find out details of early microscopes. The overwhelming majority of the earliest instruments that survive have long since had their lenses removed. The grinding of lens elements took so long in those non-automated days that a finished lens was more valuable than the instrument in which it was mounted, and they were generally taken out for use in successive models. Very few of the very early microscopes remain anyway (of Leeuwenhoek's output—exceeding 400—only about seven are known to exist) and there are time-dependent changes to which glass, like any super-cooled liquid, is subject.

Though we tend to distinguish between the single lens (a "magnifying glass") and a microscope these days, in the first years of microscopy the two were synonymous. Leeuwenhoek's microscopes were all, apparently, made as single lenses and the first successful production-line instrument—the Wilson screw-barrel—used only a single lens as the magnifying element too. Many workers have since stated how difficult it is to imagine that detailed investigations could have been carried out with such primitive equipment.

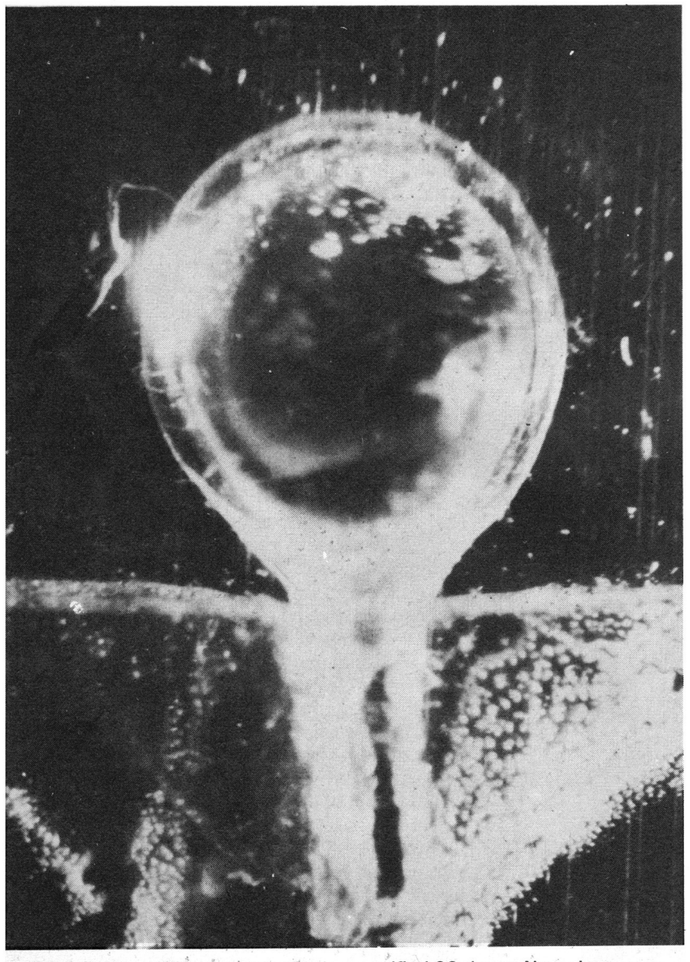


Figure 1 Lens used in the microscope, magnified 20 times. Note the imperfections and bubble inclusions, which bothered the pioneer microscopists

Not only this, but the majority of those pioneer microscopists seemed to use melted beads of glass, and not ground lenses at all. The first English pioneer of note, Robert Hooke, spoke very highly of the results that such little spheres of crude glass could give. He described how one can draw out-glass into "very fine hairs or threads, then holding the ends of these threads in the flame, 'til they melt and run into a Globule or drop, which will hang at the end of the thread' and then, after removing the apical "tail", use the resulting spherule as a lens. Though most of his work was done with a compound microscope, no doubt this method was used by workers who contented themselves with the single-lensed instrument. This gives the clue to the technique—and it is enough to enable us to reconstruct the same procedure in the laboratory.

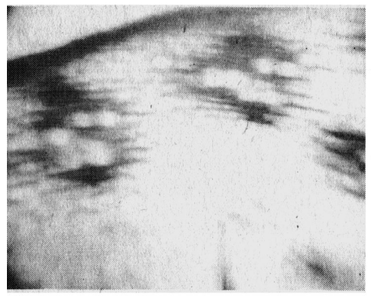
In exactly this way, I prepared some bead lenses by drawing out a glass rod in the bunsen flame and then carefully running it into a small droplet. For our first experiments it was decided to make the reconstructed microscope as simple as possible, as any seventeenth century worker would inevitably have done.

The appearance of the bead-lens itself shows that the flaws and bubbles in the glass were not removed. In fact I tried to carry out the melting as rapidly as possible in order to retain irregularities of this sort, rather than allowing them time to work out; this is perhaps a fairer imitation of earlier conditions, when good quality glass was hard to come by.

As a test object a mounted section of Zea mais stem was used since, like many such monocotyledenous structures, the histology is well-marked and easily identified. The first image we obtained, using a 500 watt bench light, was hazy and indistinct—but the cell walls could be discerned well enough. It was at least enough encouragement to go further and the clarity of the image was, to me at least, rather exciting.

At this stage I had the lens itself stopped down to around f/3, since a greater aperture caused a disastrous deterioration in image quality. But there were clear benefits attached to a similar narrowing of the illuminating beam, and some experiments on the bench showed that a stopped-down collimator improved the image noticeably.

But the most readily accessible light source that gives a high-intensity beam that is also very narrow is, of course, the sun. And so, using a small bench in the open air with the optical equipment aligned to the sun, some further photographs were taken.



igure 2 Zea mais, transverse section. The rst crude image obtained with the ead-lens microscope. Only the largest of ıe cell-wall structures are visible

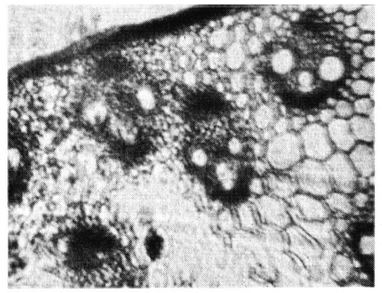


Figure 3 The same specimen shown in Figure 2 observed with sunlight as illuminant. The detail of the image is surprisingly good, considering the primitive nature of the lens

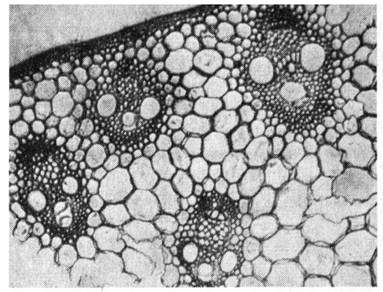


Figure 4 For comparison, the same specimen photographed using a modern microscope

The results were most gratifying. The histological organisation of the Zea section was clearly visible and the results were a marked improvement on the first pictures obtained with artificial light. Comparison with the same specimen photographed through a modern microscope proves the point.

And it also indicates that even the crudest of optical equipment can give reasonable results—if used in the correct way. No doubt that explains why it was the method of observing, rather than the apparatus itself, which the first microscopists guarded so closely. Leeuwenhoek, surely the greatest of them all, often said to visitors that—though he much regretted the fact—he could not divulge his methods of illumination and observation.

The secret died with him. But at least we can attempt to reconstruct the conditions under which he worked, and perhaps uncover something of the truth.