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CRITICAL FOCUS

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The Story of the Leeuwenhoek Specimens

My briefcase sat on the shelf next to Sir Isaac Newton's telescope. On the desk lay letters written by Antony van Leeuwenhoek in the 1670s. The soft sounds of climate control murmured in the background of an otherwise silent cellar. I was in the basement of the Royal Society in the center of London. It was February 1981, 30 years ago, yet it seems like last week. I was about to make one of the most thrilling discoveries one can imagine.

My pulse was racing. My spine felt tense. In front of me lay the dawn of microscopy, the birth of modern science.

I was on a mission to inspect Leeuwenhoek's letters, which he sent to the Society as a record of his pioneering microscopical observations, and the whole project was methodical and ordinary. The handwriting was becoming clearer, and the words emerged with less effort. Another page was turned. More inspection, more reading. Then, it happened.

I was checking the last folio of a letter Leeuwenhoek had written on June 1, 1674. I lifted the page to turn it, but it didn't rise from the file as it should. Something was glued to the page, weighing it down. When I turned it, I discovered a small envelope no larger than a playing card pasted to the paper. It was a plain white envelope, closed with a flap and unsealed. Cautiously, I opened it. Inside were smaller packets a little larger than postage stamps. My pulse was racing. My spine felt tense. I nervously licked my lips as the truth began to dawn before my eyes: Here, in front of me, were specimen containers—the original packets of specimens that Leeuwenhoek himself had prepared from the days when science was new. In front of me lay the dawn of microscopy, the birth of modern science.

My first concern was to ensure that the specimens were not unduly contaminated. I left the packets where they were. I took out my camera and snapped pictures of them, first using the flash to ensure I had a detailed image and then with the room's available lighting to record this historic moment. I held my breath as I tipped the contents of each packet forward and photographed them again. I slid them back inside, secured the flap of the envelope and sat in silence. Everything was unreal. Colors seemed brighter, and I could no longer hear the air conditioning. I sat in silence until I became aware of a tapping on the door.

I opened it to meet the familiar form of Prof. Thomas Allibone. He beamed as he shook my hand and said: "You have the original Leeuwenhoek letters, I hear. "Can I take a look?" We both sat down. "I have found something," I said, waving a hand toward the table. "Among the letters there are actual packets of specimens that Leeuwenhoek sent to the Society in 1674—original sections, and they seem to be untouched." Silence ensued as Allibone licked his lips. "That's 307 years ago, Brian," he said. "They still exist in their original condition after more than three centuries? Good God."

I nodded. "Well, they have certainly survived."

The author examines the original specimen packets at the Royal Society in 1981. He discovered them in an unmarked envelope glued to one of Leeuwenhoek's letters dated June 1, 1674.

Top: Leeuwenhoek's four specimen packets were each folded over twice to securely hold their contents. Bottom: The packets contained well-preserved sections of cork (top), specimens of medulla from *Sambucus nigra* the elder (bottom left) and slices of dried bovine optic nerve (bottom right). The fourth packet (top left), labeled "white from a quill pen," was empty.

"Shall I take a look?" asked Allibone, but I shook my head. "It's best that they stay in their packets until I can remove small samples under controlled conditions," I told him. "There may be spores, pollen grains, whatever, and I don't want to risk contaminating them with present-day particles. I need to perform microscopy on them, but at the present moment I have no idea what to do." He smiled back and said, "I know. Come on, tell me about it over a cup of tea."

Allibone, who died in 2003, was a distinguished physicist from Sheffield, England. He was involved in developing the radar during World War II, and had worked on atom-smashing research at the Cavendish Laboratory in Cambridge University with great names like Rutherford and Cockcroft. In the the Society dining room, we talked about the specimens over a cup of steaming tea. I was still feeling numb. The main problem was what to do with the specimens? They were priceless, unique and unprecedented. They could give us intimate insights into the birth of microscopy.

I immediately consulted the Society's archivist, Leslie Townsend, who brought in the librarian, Norman Robinson. They went off to discuss the matter with Society President Sir Andrew Huxley, who had originally proposed that I examine the letters. I expected to fill out forms and wait for authorization, but matters proved to be simpler. "You can take your samples back and examine them any way you want," Robinson said. "There's no need to check them out officially."

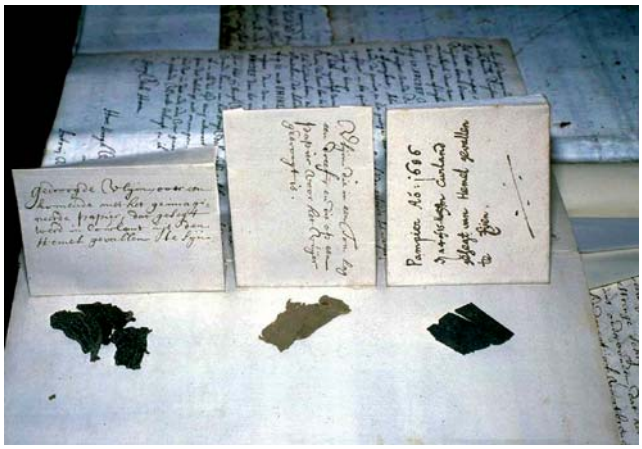
"It's simple," Townsend explained. "The specimens are not recorded in the Society's index, they aren't catalogued, and so they aren't listed among our holdings. You can find out as much about them as you wish."

This was astonishing news. Robinson leaned forward and said: "The president suggests that you publish this first in our own journal [*Notes and Records of the Royal Society*]. You can give the details of the find and your own conclusions after analyzing them under the microscope. We will then use that publication to document their existence, and from then on they will become official possessions of the Society." Sir William Paton, the Society's senior editor, was soon in touch, asking me to submit a paper on the specimens for publication in *Notes and Records*.

PIONEERS OF MICROSCOPY

Prior to that momentous day at the Royal Society, nearly a decade had passed since I had last worked on the pioneers of microscopy. That work had been de-

More specimens were found among other letters. This one from April 2, 1686, included a serial-sectioned cotton seed (top) and germinating cotton seeds, which Leeuwenhoek had meticulously dissected open.



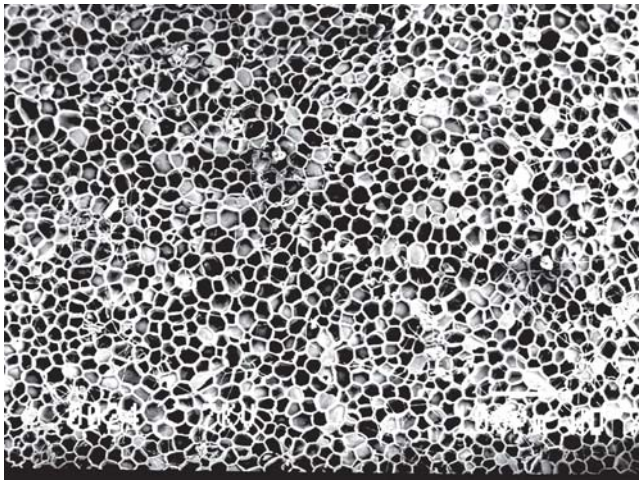
The last specimens that Leeuwenhoek mailed to London in 1687 consisted of the blackened sample of "heavenly paper" (right) he had been sent from Courland on the Baltic coast. The other two are examples that he produced by drying algal films.

scribed in two books, both published in 1973: *The Revealing Lens, Mankind and the Microscope* followed by *The Optical Microscope Manual*. Although I had regarded that research as a standalone project, my enthusiasm remained and the subject wouldn't go away. In 1980, I was given a Kodak Bursary Award grant, which funded the purchase of state-of-the-art equipment and, fired up again, I eagerly returned to the subject. I was busy with a variety of projects at the time: My book on German secret weapons of World War II was being published in a German-language edition, while another book, *Microbe Power,* was published in Japan. I was writing a new book entitled *Patterns of Sex*, relating human sexual behavior to the broader imperatives of the microbial world. I was also publishing in the journal *Nature* a paper on "Wisdom in Universities." And for *The Micoscope*, I was reviewing the book *Essays on the History of the Microscope* by Gerard L'Estrange Turner (see *The Microscope*, Vol. 29, pp 108-109, 1981). All said, there wasn't room for another project—but I can always find the time for my eternal fascination of early microscopy.

I had visited the Netherlands to see early microscopes, notably those of Leeuwenhoek at Leiden. At the Linnean Society of London, I had looked at Robert Brown's microscope, which I found in a sadly neglected state, bent and broken. The officers decided that I should restore it to working order and see what kind of images it could create. My microscopist friend, Prof. Irene Manton, who was president of the Linnean Society from 1973 to 1976, had investigated this microscope. One of her technicians had successfully imaged onion epidermal cells through one of its lenses. She wrote that the microscope's condition was "not very good." Frankly, it was a mess, and restoring it to working order proved to be a challenge. But after repairs, it functioned as well as it did in the 1820s, when Brown was using it for his research.

Robert Hooke was also preoccupying me, and I was looking closely at the engravings published in his great work, *Micrographia*, which appeared in 1665, followed by a second edition in 1667. It was reissued as *Micrographia Restaurata* in 1745. How many of the plates in this new edition had been re-engraved? I was investigating this, too, and it was agreed that I should take the Linnean Society's copy for further examination. The original Robert Brown microscope was packed ready for transportation, and the *Micrographia Restaurata* was wrapped in protective paper, which allowed me to safely transport it to my laboratory.

A Cambridge Stereoscan 600 SEM captured this image at low power of one of Leeuwenhoek's cork sections. Even by modern standards, this is an astonishingly regular and evenly cut section.



Higher magnification shows the evenness of this cork specimen. Leeuwenhoek used an open shaving razor to cut sections of materials. Present-day sections rarely meet this high standard.

LOST IN TRANSLATION

At the Royal Society in 1981, Huxley had been following this work with interest, and I told him that we might find spores or hairs from Leeuwenhoek's wig within the pages. However, when I received the files, I found that the letters had been painstakingly mounted and bound in large folio-sized volumes and the chances of finding any contemporaneous particles appeared slight. The letters had all been studied by Dutch scholars since 1930s and had been painstakingly transcribed and translated into English, so the discovery of original specimens seemed impossible. Surely, the translators would have already seen them?

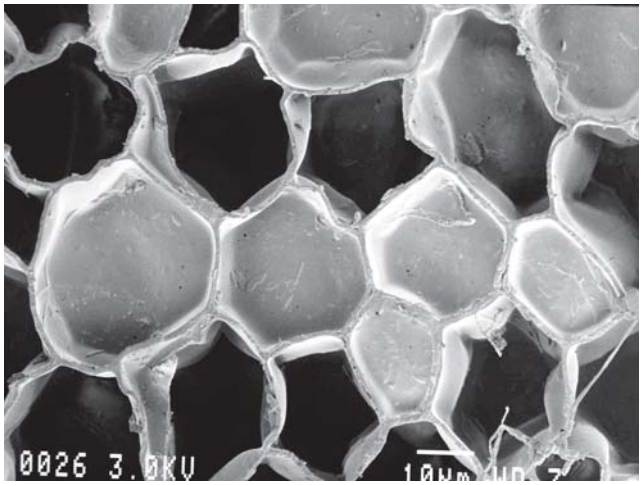
It turned out that the scholars from the Netherlands never had access to Leeuwenhoek's original letters. All of them were kept safe and secure in London, while the Dutch translators worked from microfilm copies, not the originals. The photographer didn't even include the crucial page in his copies. Why should he? The specimens were in a blank, white envelope on a sheet of blank, white paper. There was nothing to photograph, so the envelope containing the specimens was overlooked. And yet, something rang a bell. I looked at my notes from 1972 for my book *The Optical Microscope Manual* and saw that I had written that Leeuwenhoek had sent specimens to London. If I had been methodical, I would have gone to search for these specimens at the time, but I had forgotten all about them and their discovery came as a complete surprise.

Back at the Royal Society I searched for other specimens among Leeuwenhoek's letters. Most of the Dutch that I understand relates to buying beer and sausages, and it was hard to pick out the meaning of the words. I had the transcriptions of the letters to guide me, published in Amsterdam and beautifully bound in a mottled gray cloth. I followed the letters line by line. One of them contains a fascinating account of the structure of biological materials under the microscope. Leeuwenhoek challenges the view of nature set out in Hooke's *Micrographia*. The roots of the words that are common both to Dutch and English can be discerned. Leeuwenhoek writes that he "*can sein, inde pit van het houk, inde kurk, int pit van viler, alsmede int wit van een schrijffpen*." You can see the similarities between English and his early modern Dutch: "*sein*" is seeing, "*inde pit*" is in the pith, "*wit*" is white, "*schrijffpen*" is writing (or scribing) pen. He adds: "*ende aende Heeren curiuse Lieffhebbers hier neven sende*"—he is sending some materials for the curious enthusiasts to study. This was intriguing stuff. Leeuwenhoek was writing of his intention to send specimens to London—and here lay the very same specimens. This was an astonishing revelation.

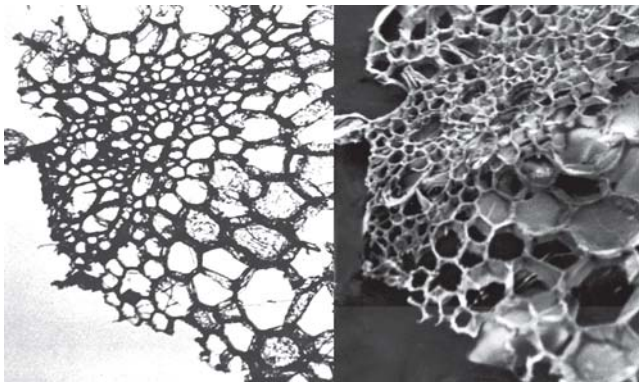
The little specimen packets were similarly labeled in Dutch. One clearly was labeled as "*kurk,*" or cork. Another said "*Pit van vlier,*" pith from elder; the third was labeled "*T'witte van een schrijffpenne*," the white from a writing pen; and there was a fourth packet, "*Stuckjens vande gesichte senuwe van een koebeest over dwars afgesneden,*" which translates to "pieces of the optic nerve of a cow (beast) cut into transverse slices." What a treasure trove! One of the packets was empty. As luck would have it, this contained the specimens of the quill pen, which is not of microscopical interest. Feath-

ers are secreted like hairs, and the white material within the shaft of the feather that Leeuwenhoek had chosen is not cellular in nature. The cork, elder pith and optic nerve specimens were all important, and they remained intact.

As I continued searching, I found more specimen packets. The next were two packets with a letter dated April 2, 1686. One was identified as containing "a cotton seed cut into 24 slices," and the other said, "9 seeds from the cotton tree which have been stripped of their involucres and in which the leaves have been separated." Here we were faced with the first example of serial sectioning in the history of microscopy and the earliest surviving example of microdissection. Because the packets were pasted alongside the signature of this letter, they were visible on the microfilm copy provided for the Dutch translators, but these people had not realized they were envelopes. The transcription describes them as "drawn rectangles" and laments that the "slides are now missing from the Royal Society." But they couldn't have been slides. Slides weren't introduced until more than a century later. It is strange to relate that the specimens were *not* missing but were safely stored within the packets. Because the translators were viewing photographic copies, all they could see were "drawn rectangles"—not actual specimen packets.



This JEOL JSM-840 SEM image of a hand-cut elder pith specimen is approximately 10 µm in thickness — a testimony to Leeuwenhoek's remarkable patience and dexterity.



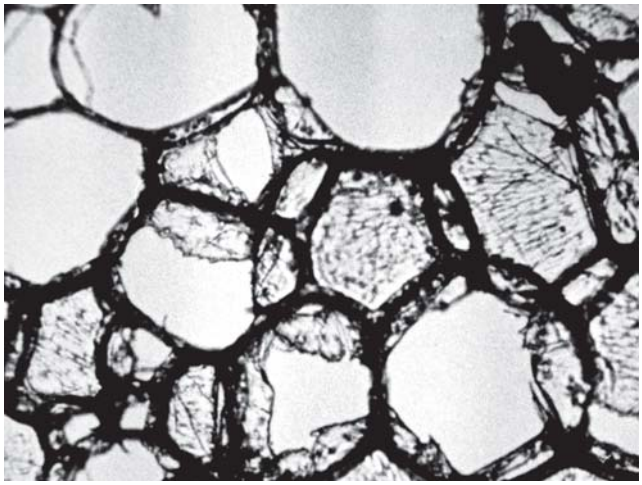
Correlated microscopy was performed to clarify the details of Leeuwenhoek's sections. A light microscope captured a brightfield image of elder pith (left). The same cells were seen with the SEM (right) and imaged a second time at a higher resolution.

MESSAGE FROM HEAVEN?

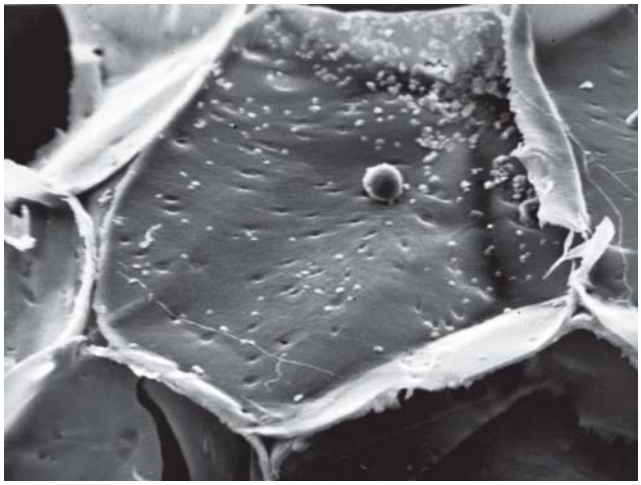
On October 17, 1687, Leeuwenhoek wrote the third letter that he sent with the specimens to London. He describes amber, a poisonous millipede, rotifers and insect larvae, the stinging hairs of *Urtica* (the nettle), and the strange story of "heavenly paper." Leeuwenhoek had been sent a sample of what looks exactly like charred paper by a correspondent on the Baltic coast in the state of Courland (now in western Latvia), who was convinced that it was a message from the heavens (an early anticipation of the modern space-age concept of atmospheric heat of re-entry). With his microscope, Leeuwenhoek soon determined that the sample was actually a dried algal film and not paper. Alongside that packet were two others containing homemade versions of heavenly paper that Leeuwenhoek produced to confirm his theory. These are pioneering examples of experimental microscopy and the entire investigation is an object lesson in forensic science. The translators did not note any of these specimen packets.

There were a total of nine surviving packets, curiously the same as the number of surviving microscopes associated with Leeuwenhoek. I took fresh acetate sheets and used these as a base on which to take close-up photographs of the specimens and their packets. Then I removed samples of about 10% of each specimen for microscopical examination. The remainder was left in the original packets for safe keeping.

I put the little specimen folders into the top pocket of my jacket and walked from the Royal Society through the dark London streets to the Linnean Society in Piccadilly. They had the copy of Hooke's *Micrographia Restaurata* ready for me, so I stowed it securely in my briefcase. The small box containing the little microscope that Robert Brown had owned went into my coat pocket. And so I stepped out into the evening gloom and into a taxi headed to the train sta-



In this light micrograph of *Sambucus* medulla, a minute rounded body is apparent (right of center). Light microscopy was insufficient to resolve the details, and so the same cells were painstakingly located under the SEM.

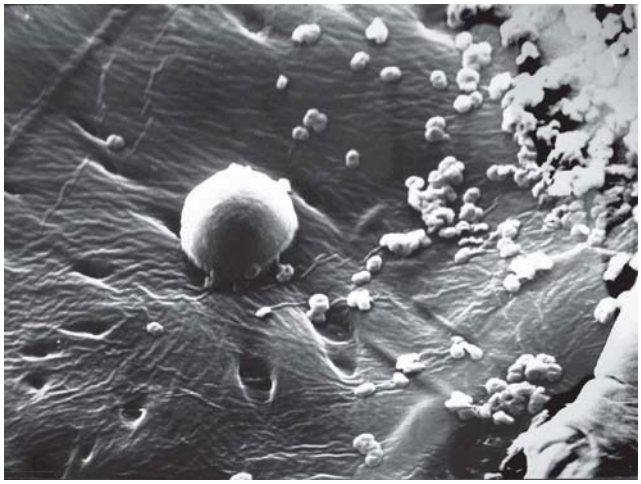


The rounded body is clearly seen with the SEM under low magnification. The large central medullary cell here is approximately 125 µm across. Numerous ovoid bodies are scattered around it, and more than 100 of them are distributed across the cell wall.

tion with Hooke in my briefcase, Leeuwenhoek's specimens in my jacket, and Brown's microscope in my coat. In the train, I laid them on the table within my permanent sight and then carefully placed them into my car as I drove from the station to my home. I have never traveled anywhere feeling so preoccupied with the value of what I was carrying. The trip home was a relief. When I got there, I secured these priceless objects in my laboratory and poured myself a large scotch.

The first task was to see exactly what the specimens looked like. At Cardiff University, I was given the official designation of Research Associate, a title that allowed me to book the scanning electron microscope (SEM) at a nominal cost. I made some preliminary SEM examinations of the specimens with the help of Carol Winters, a most able and experienced technician. In Leeuwenhoek's specimens of heavenly paper I could observe the transverse septa within each fiber, which were characteristic of an algal mat, though not of paper. Winters had spent many years at Wiggins Teape Ltd., Britain's leading paper producer, and was skilled at identifying paper under the electron microscope. As I brought the heavenly paper specimen back into focus, she said: "Oh, it's a paper specimen." I smiled, and pointed out the transverse cell walls within the algal filaments. It seemed so natural that Leeuwenhoek would be able to use his skills to distinguish the true nature of the specimen, when a modern technician could miss the key features. Truly, he was the consummate microscopist.

There was another experiment I was eager to try.



Higher magnification shows a rounded central body <20 µm, surrounded by what appear to be cocci or diplococci, small rounded bacteria. Did Leeuwenhoek cough a leukocyte and related pathogens onto the section as he prepared it?

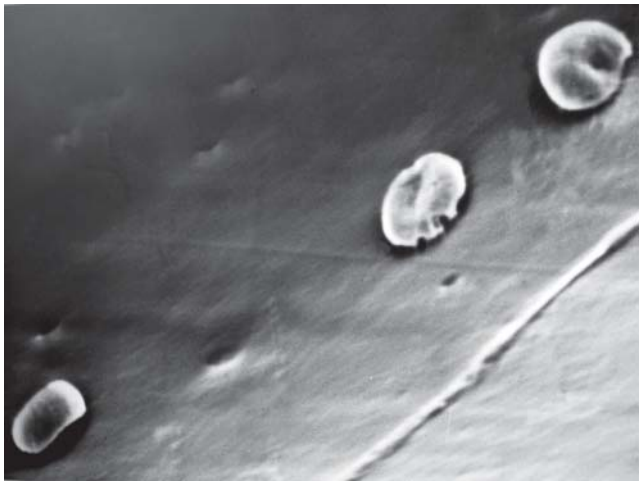
How would the specimens have appeared to Leeuwenhoek? What could his lenses reveal? There has been a pervasive attitude of condescension toward the pioneering microscopists, and Leeuwenhoek is regularly dismissed as a casual amateur or dilettante. There had always been widespread skepticism about whether he could see fine detail with his single-lensed microscopes. I used to be one of those skeptics. My guess at the time was that he had probably used more than one lens, but that point remained unproven.

LEEUWENHOEK'S MICROSCOPE

In the Netherlands, the best surviving Leeuwenhoek microscope was in the collections of the Utrecht University Museum. The director, Peter Hans Kylstra, was an amiable and avuncular man, who invited me to Utrecht so I could look at some of Leeuwenhoek's specimens through the original microscope. I would be the first person to use the microscope since Leeuwenhoek himself three centuries earlier. When I arrived, Kylstra introduced me to a group of experienced microscope enthusiasts: Robert Frederik, Jaap Stolp, Pieter Smiesing and Karel Snethlage, all of whom willingly agreed to collaborate on this exciting project. Kylstra showed me the Leeuwenhoek microscope stored in its exhibition case on the museum's second floor. I asked if he had the key for the cabinet, but he smiled and shook his head. "This is not the original, but a copy," he said. "The real microscope is too precious to leave on display. It is in the basement, locked in the safe."

We settled into the common room, where fine Dutch coffee was poured. Kylstra sauntered off to retrieve the original microscope from a small, dark brown fiber box. He tipped it out gently onto the table and rested it among our coffee cups. I made a holder for the microscope by adapting the hood of an SLR camera lens and took a kidney-donor card from my wallet and cut it to fit on the hood. This would make the perfect support for the diminutive instrument. With a paper punch, I made a hole in the card where the lens would rest. Kylstra then remembered that they had a forensic photomicrographic stand stored in the basement that might be useful. I measured it and sketched a bracket that could hold the camera and the microscope supported on its card. The bracket was made for me in the museum workshop during lunch.

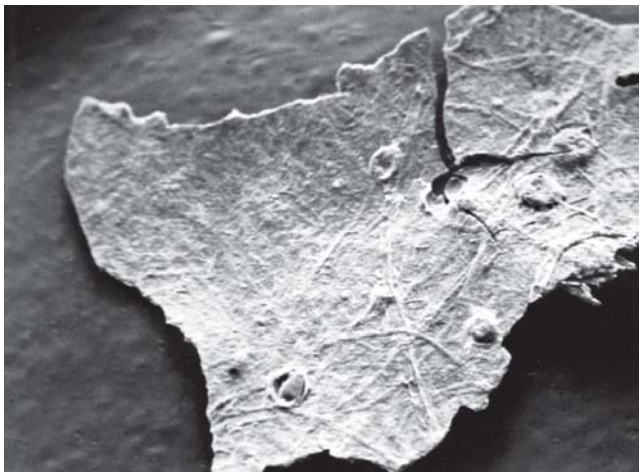
At 2:00, p.m. all was ready. I carefully unscrewed the attachments from the little rectangular microscope and set them to one side. I placed the microscope on the kidney-donor card, with its tiny lens centered on the punched hole, and then slid it into the bracket holder on the camera, effectively replacing the camera lens. I held my breath as I focused the image of an elder pith section and took photographs on black and white 35 mm film. Detail beyond my wildest hopes was immediately visible—this was an astonishing sight. Then the specimen was changed so that I could focus a cork section. The pressing concern was to avoid putting the ancient microscope through too much use, so I changed to color film before taking pictures of some other ready-made preparations as a calibration aid. One was a transverse section of *Tuber*, the truffle, with characteristic spines on the spores.



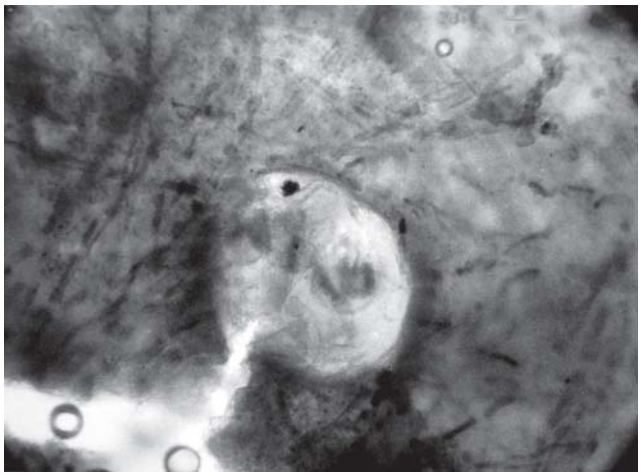
Sections of botanical material cut with a razor that was first used to shave are likely to include blood cells. This elder-pith section reveals inclusions that bear the concave contours characteristic of erythrocytes (red blood cells), each approximately 7.2 µm across.

I decided to take some final pictures of human blood cells. I snapped a glass microscope slide in a handkerchief and used a shard to prick my finger. The small drop of blood was drawn across a slide to produce a thin smear, which I allowed to air dry. Then I brought it into focus and gulped with amazement at the result. Each cell was shown with pin-sharp clarity. This was like an image from a modern light microscope, not from something handmade some three centuries earlier. I took several photomicrographs of the erythrocytes (red blood cells) and one of a leukocyte (white blood cell) before calling it a day. Carefully, I removed the microscope and placed it on a sheet of paper to take close-up photos of it. Some were taken with a calibration scale in shot, while others were taken with a flash at a glancing angle to reveal the tooling marks of the manufacturing process.

I reassembled the fragile little microscope by reinserting the delicate brass screws and then gave it to Kylstra, who restored it to its box. The entire procedure took no more than an hour, but I was extremely pleased to see the instrument returned to safe keeping in the strong room after its historic appearance. We all retired to the director's office and toasted our successful experiments with Geneva gin. After the incredible sense of tension at recreating those historical demonstrations with the priceless microscope, there was now an air of convivial relaxation. Kylstra showed me a drawer with several of the replica Leeuwenhoek mi-



Leeuwenhoek was the first to perform experimental microscopy when he produced his own sample of "heavenly paper" by drying down a sample of aquatic algae from a cistern. Under the SEM, four or five rounded bodies can be seen within the specimen.



When the paper sample is reconstituted overnight with sterile pond water, the rounded bodies can be discerned. They are specimens of a common water flea, *Chydorus sphaericus*, a specie similar to (though somewhat smaller than) the familiar *Daphnia*.

croscopes made years earlier in his department and invited me to choose one as a souvenir. I regularly show it to those who are interested in what a Leeuwenhoek microscope is really like.

A CLOSER LOOK

The next week I booked several sessions with the SEMs at Cardiff University. I sputter coated the same sections of cork, elder and optic nerve with gold and set out to locate the same fields of view that had been photographed through Leeuwenhoek's lens in Utrecht. This took much time and diligence, but eventually I was able to find the same characteristically shaped cells and take correlated photomicrographs. I specifically looked for a few cells in which small particles were visible in the micrographs. The SEM now revealed these at a far higher resolution, and one seemed to be a leukocyte sitting on one of Leeuwenhoek's sections of elder. There are rounded bacteria adjacent to the cell. This looked like a specimen contaminated by someone with a sore throat. Had Leeuwenhoek been unwell and coughed on his specimen as he cut the section?

Leeuwenhoek used a shaving razor to cut his sections, and it is impossible to use a cut-throat razor blade without transferring cells. Should there be erythrocytes on the sections Leeuwenhoek had prepared? I spent much time scanning methodically across the section surfaces until I eventually found what I sought: On one of the sections are several biconcave disks characteristic of erythrocytes. They are eroded in part, as one would expect after three centuries in storage, but their appearance seemed to be unmistakable.

What else could we find from the specimens? The JEOL microscope company offered me use of their electron microscope facilities in London. Leeuwenhoek's studies of bovine optic nerve proved to be particularly interesting; he described the histological structure accurately. There are lacunae between the dura and arachnoid layers which he accurately portrays. He prepared these slices from a dried optic nerve. As a result, the nerve fibers of the fasciculi are missing, most having crumbled away. Leeuwenhoek had written of mites in his house, and he had instructed his limner to portray them in drawings that were sent to London. In his specimens, I found some mite fragments among the sections of dried optic nerve. The SEM micrographs were identified for me by Prof. John Phillips of the Zoological Society of London and Dr. D.A. Griffiths at the Department of Agriculture. The mites I viewed are *Tyrophagus*.

It was also possible to carry out experiments with heavenly paper. In the springtime, you can find growths of chlorophyte algae in shallow rainwater pools and puddles. As the water evaporates and soaks away under the warm spring sunshine, these algal mats become stranded on grass stems and eventually consolidate to form gray sheets of a papery material. It functions much like paper, but it is comprised of algal filaments rather than angiosperm fibers. Under the microscope, the resulting structure is comparable with what Leeuwenhoek studied in 1686. In his original algal preparations we can discern diatoms, rotifers and

cyanophytes. Some of the algae, when reconstituted with sterile water, have a remarkably lifelike appearance. Can we hope to revive rotifers after so long a time? The experiment has yet to be attempted, however, Dr. Alan Tunnacliffe at the University of Cambridge published a paper in 2002 suggesting it would work.

POWER OF THE SINGLE LENS

The Utrecht microscope is the best that survives from the hands of Leeuwenhoek. It exquisitely resolved the fungal hyphae traced across the specimens as testimony to their centuries in storage. One of the features that I observed and succeeded in photographing was a fine fiber projecting from a cork section which was just resolved by the Leeuwenhoek lens; it lay at the limit of resolution. In time, I found the same structure under the SEM, and this gave us the opportunity to calibrate the Leeuwenhoek lens: It was capable of resolving this fiber at 0.7 μm in diameter. What a remarkable result this is. If we consider any modern product, from a zipper to a wood saw, from a plane to an ocean-going ship, the modern version is greatly improved on the first in the field, perhaps a million-fold. Yet the resolution of a conventional light microscope is only four times better than the results we obtained with the Leeuwenhoek lens in Utrecht. This must be unique, and it confirms my belief that most of the key microscopical discoveries made with light microscopes could have been accomplished with a Leeuwenhoek lens, if only he had known what to look for.

At the end of this new phase of research, we had hundreds of photographs, including color photomicrographs. For the first time, we had been afforded the opportunity to observe specimens from the dawn of microscopy through one of the original instruments. This was all so exciting. In a book entitled *A History of Microtechnique* (1978), author Brian Bracegirdle claims, "No preparations from the seventeenth century have survived . . . they have so little resemblance to life that scientific interpretation is almost impossible." His statement was proven wrong. Indeed, we should all have known about these specimens. F.J. Cole mentioned specimens of optic nerve associated with the Leeuwenhoek letters in his paper published in 1937 (*Annals of Science*, Vol. 2:1, pp 1-46, 185-235). And, even more to the point, Clifford Dobell wrote that specimen packets from June 1, 1674, "have remained intact to the present day" (*Antony van Leeuwenhoek and his Little Animals*, p 333, 1932). Had we all read and noted those crucial words, the discovery of the specimens would have fitted more logically into a historical sequence.

In his letters, Leeuwenhoek referred to minute insects that infested his house. In a section of the bovine optic nerve specimen viewed under the SEM, it is possible to see that they are the remains of the mould mite *Tyrophagus*.

I wrote my research in a lengthy paper for *Notes and Records of the Royal Society* (36:1, pp 37-59), and the publication date was set for July 1, 1981—the day of the royal wedding of Prince Charles to Diana. The ceremony at Westminster Abbey broadcast on the BBC news was followed by an interview with me by Sir Robin Day. Rarely has the microscope received such prominent attention. On the same date, a report appeared in *New Scientist* (p 301) and *Nature* (p 407), and it later appeared worldwide, including in *Scientific American* (January 1982, pp 79-80). It is recorded in my book, *Single Lens: Story of the Simple Microscope* (1985). The scientific findings are detailed in my book *Leeuwenhoek Legacy* (1991), which I regard as a modest supplement to Dobell's great biography. Within days of the announcement, a French TV crew came to film a documentary; the latest TV crew (from Korea) have just been here.

The revelation that Leeuwenhoek's specimens had survived for more than three centuries was a dramatic and revealing event. Analyzing the sections and performing correlated microscopy on this material proved to be an exacting and exhilarating task. The results show what a great microscopist Leeuwenhoek truly was and how assiduously he perfected his craft. The breadth of his life had been portrayed in meticulous detail by Dobell. And how strange it is to reflect that if we all had read Dobell's words more carefully and noted what he wrote, the Leeuwenhoek specimens could have been unearthed decades earlier.