HIDDEN REALITIES

Robert Brown's Microscope

One of the Linnean Society's greatest treasures is packed in a small mahogany box. It gave us a term commonly used in cell biology—the nucleus—and it also revealed a phenomenon known to all scientists, Brownian Motion. This little instrument is a single-lensed microscope belonging to Robert Brown (1773–1858), a physician, pioneering botanist, and the Society's President 1849–53. It had been made for him by an instrument maker named Robert Bancks who lived and worked at 441 The Strand, in central London. Bancks set up in business in 1796 and was joined by his son in 1820, later moving to New Bond Street.

Some Astonishing Observations

This modest microscope played a key role in the early days of microscopy, though it was simply made. A brass column screwed into a boss fitted into the box lid, and a circular stage bearing a concave glass was fitted into a tapering support. At the top went a brass rod supporting the lens arm, while below the stage was a mirror to reflect light up through the specimen. Stage forceps were provided to hold a solid object, like a small insect or a flower. A set of six lenses was provided, ranging in magnification from 5x to 170x, two of which had Lieberkühn mounts—silvered reflectors that cast light downwards onto the top of an opaque specimen, such as a rock sample or a fragment of leaf. It was this instrument that launched Brown's remarkable career in botanical microscopy. He discovered the naked ovule of the gymnosperms, an extremely difficult demonstration even today, and recorded the streaming flow of cytoplasm within the cells of *Tradescantia*.

Yet it was in his observations of orchid epidermis that he made one of his best-known coinages. He wrote in 1831:

I shall conclude my observations on Orchideae, with a notice of some points of their general structure, which chiefly relate to the cellular tissue. In each cell of the epidermis of a great part of this family, especially of those with membranous leaves, a single circular areola, generally somewhat more opaque than the membrane of the cell, is observable … There is no regularity as to its place in the cell; it is not unfrequently, however, central or nearly so. As only one areola belongs to each cell, and as in many cases where it exists in the common cells of the epidermis, it is also visible in the cutaneous glands or stomata, and in these is always double—one being on each side of the limb—it is highly probable that the cutaneous gland is in all cases composed of two cells of peculiar form, the line of union being the longitudinal axis of the disk or pore.

After this meticulous observation, Brown adds the historical words: "This areola, or nucleus of the cell as perhaps it might be termed, is not confined to the epidermis …" It is here that the term first appeared; Brown's "areola" was thereafter known as the cell nucleus. As he recorded, others had seen it previously; indeed, the pioneering amateur Antony van Leeuwenhoek had drawings made in 1719 that showed the erythrocytes of fish, each containing a well-defined nucleus, so the feature had been observed more than a century before Robert Brown named it. These were astonishing observations recorded by Brown, yet all were made with a simple, single-lensed microscope.

A Gift of Great Importance

The instrument was in use from 1810 and, after Brown's death on 10 June 1858, his estate was administered by John Bennett, who had been his assistant since 1827. The year after Brown's death, on 5 February, Bennett penned a letter to the surgeon and naturalist Thomas Bell, who served as the Society's President from 1853–61. "I have been looking round for some trifling memorial of our late dear friend Rbt. Brown …," he wrote, adding that it was an object of

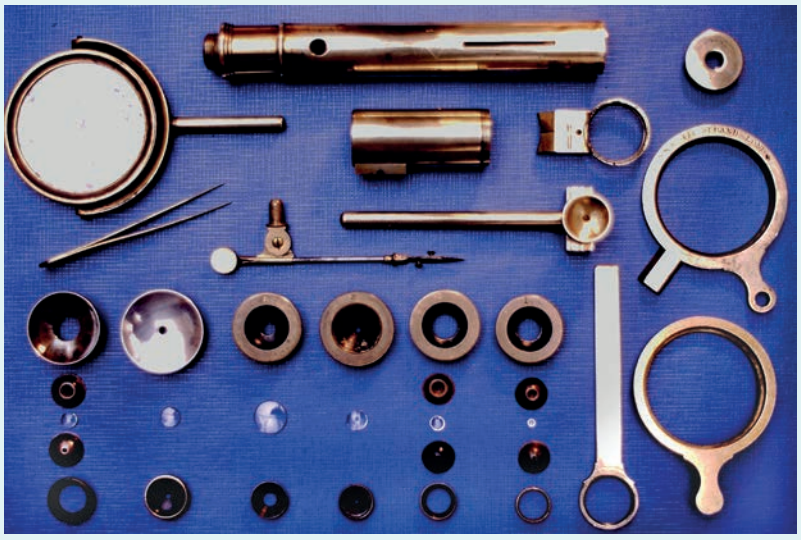
LEFT:
Council resolved that Brian J. Ford should restore Brown's microscope to use and it proved possible to observe microscopically fine structures as Robert Brown had done in Regency times.

BELOW:
United after almost two centuries, Bancks microscopes made for (LEFT to RIGHT) Robert Brown (this instrument is currently at Kew), Joseph Hooker, George Bentham, and our microscope.

little intrinsic value, but was, "simply a relic." After Bell's death in Selbourne in 1880, the microscope was privately purchased and remained lost to scholarship until 1922, when the purchaser's daughter inherited it and decided to present it to the Society.

She was Miss Ida Silver of Reigate, who would later donate the glass-topped cabinet in the Society's entrance hall which still bears her name. On 19 January 1822 she wrote to the Society saying: "I have much pleasure in offering Mr Brown's microscope to the Linnean Society should they care to accept it." It was delivered next day to the office. Nobody showed much interest: when the centenary of Brown's naming of the nucleus was celebrated in 1932, the microscope was described in an article for the Journal of Botany as "surprisingly simple, being little more than a dissecting-microscope". In 1951 the organisers of the Festival of Britain asked to exhibit the microscope as an example of British scientific achievement, but Council declined. The microscope was considered insufficient for its task and, when I first saw it, it had been neglected and was dirty, distorted and had been wrongly assembled. It now seems surprising that this important artefact was so casually dismissed by academics, though (until I demonstrated the remarkable capacity of single lenses to reveal minutiae) it was universally accepted, in the era of the achromatic lens, that the images generated by those early simple microscopes were too poor to be useful. When the BBC produced their series with Adam Rutherford entitled "The Cell" in 2011, they used the No 2 lens of Brown's microscope to visualise the cell nucleus though little detail could be seen. Rutherford still gasped in wonderment, even though the results were so disappointing. Yet I was able to demonstrate that the same lens can create startlingly clear images of the same orchid tissue when carefully adjusted; the nucleus can be clearly seen, and so can the minute cytoplasmic inclusions that dot the contents of each cell.

This was not Brown's only microscope. Another is held in the Herbarium of the Royal Botanic Gardens, Kew, which bears a silver plate attesting to its owner; Brown also had high-powered single-lens microscopes manufactured by John Dollond. Bancks, father and son, became renowned for their skill and went on to provide similar microscopes for many luminaries including George Bentham, William Hooker, Charles Darwin and the Prince of Wales himself (later King George IV). Yet the doubts remained; in 1991 an American scientist insisted that Brownian Motion could never have been seen with such a primitive instrument, though I succeeded in reprising Brown's original observations and published them in Nature. Even so, the reference sources continue to err, claiming that Brown could see the movement "of pollen grains". Not so—the flickering grains that he observed were minute particles within particles of pollen.



Robert Brown was a diligent microscopist who used state-of-the-art equipment with consummate skill. Today's investigators, with everything automated and digitised, too easily conclude that previous generations could not match today's endeavours. In many ways the pioneers reached standards that few could emulate today. What Brown achieved was extraordinary—a fact that should perhaps be more widely appreciated.

Brian J Ford FLS

LEFT:
Dry specimens were mounted between slivers of mica in ivory sliders, the ancestors of today's slides. Around the circular brass stage was engraved the name of the manufacturer.
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BELOW LEFT:
Most conspicuous among the disassembled components are the body pillar (TOP), the substage mirror (LEFT) and the stage assembly (RIGHT). Six lenses provided a range of magnifications.
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BELOW RIGHT:
TOP: The BBC used our microscope in an attempt to resolve the cell nucleus (as Brown had done) for their documentary programme "The Cell". The results were blurred and indistinct.

BOTTOM: When the lighting and focus of the diminutive microscope were correctly adjusted, it did prove possible to show fine detail (with a nucleus visible in each cell and three stomata).
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