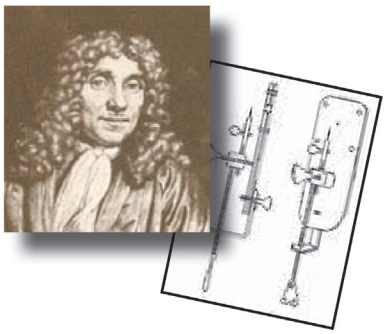
Pioneers in Optics: Hugh Powell and Jan Jacbz Swammerdam



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Hugh Powell
(1799–1883)

Hugh Powell was born in London, England, in 1799. Not much is known about Powell's early years, except that he had been producing microscopes for Andrew Pritchard since the 1830s when he formed a partnership with his brother-in-law, Peter H. Lealand, in 1841. The firm, named Powell & Lealand, remained a major manufacturer of microscopes throughout the nineteenth century.

Hugh Powell (1799-1883)

Powell was a pioneer of using very high powers in objective lens systems and advanced microscope design. Before 1831 he had made significant improvements in microscope design with the first of three microscopes produced for watercolor painter Cornelius Varley. The most advanced feature of this microscope was a revolutionary design in the spring action that was incorporated into the fine adjustment to prevent backlash when the motion is reversed.

In 1841 the Microscopical Society of London commissioned Powell to produce a standard instrument according to their own design. Powell delivered the microscope to the society in December of 1841, and it is still in the possession of the society today. Another microscope produced by Powell in 1841 was radically different from the one delivered to the Microscopic Society. This microscope was illustrated and described in Daniel Cooper's *The Microscopic Journal and Structural Record* for 1841. The article that described this microscope, "Messrs. Powell and Lealand's Newly-Constructed Achromatic Microscope," was probably the first occasion when the names of Hugh Powell and Peter H. Lealand were linked together. Cooper added a footnote: "Mr. Lealand, Mr. Powell's brother-in-law, has for some years been engaged with him in the object-glass and optical department, and is now publicly a partner with Mr. Powell."

In November 1843, the *London Physiological Journal* described and illustrated "Powell and Lealand's New Microscope." The announcement turned into a momentous one, because the design of this microscope became the basis of the firm's instruments for the next sixty years. The new design, which was to become the forerunner of the famous so-called No.1 stand, featured a complete redesign of earlier Lealand and Powell instruments. There was a true tripod support that carried the body on trunnions, and the transverse bar contained a lever that moved the nosepiece, which held a single objective. In 1861, Powell introduced the Large Compound Microscope, which was thoroughly described by the *Quarterly Journal of the Microscopical Society*. In 1869 Powell introduced his finest achievement, the No. 1 stand, which continued to be manufactured into the twentieth century. Having all the refinements necessary for high-resolution microscopy, this beautiful microscope quickly became the preferred instrument of most scientists of the period.

After Hugh Powell's death in 1883, his son, Thomas Powell, took over the business until it effectively faded out of existence by 1914. The early twentieth century saw an era of mathematical, optical, and philosophical instrument makers draw to a close. Powell's contributions to the fields of optics and microscopy were integral in the shaping of modern research, and many of his designs are still incorporated in scientific instruments today.

Microscopes by Hugh Powell

Powell Binocular Microscope

Hugh Powell produced this microscope in 1841 in response to a request from the Microscopical Society of London, which simultaneously asked for microscopes of similar design from the famous British inventors Andrew Ross and James Smith. During the next year (1842) Powell formed a partnership with Peter Lealand that became "one of the most famous associations in the history of the microscope." Powell was famous for his solidly built microscopes and this model is certainly no exception.

The Powell and Lealand No. 1.

This beautiful microscope, made in 1875 by a partnership between Hugh Powell and his brother-in-law Peter Lealand, has come to be regarded as one of the most famous microscopes of all time. The attention to detail given to the microscope is complemented by the expert craftsmanship and high-quality glass used in the lenses. The basic design remained the same for almost 40 years, and today the microscope has become a highly prized collectors item. Built with enough weight to minimize vibration, the tripod foot is a solid foundation upon which the precision optical components of this microscope are clustered.

Jan Jacbz Swammerdam
(1637–1680)

Jan Swammerdam was a seventeenth-century Dutch microscopist and naturalist who is most famous for his microscopic observations and descriptions of insect development that were published posthumously as *The Bible of Nature*, often referred

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to as *The Book of Nature* due to a mistranslation of the title. Swammerdam pioneered the use of the microscope for zoological purposes and is considered a founder of both comparative anatomy and entomology.

Jan Jacbz Swammerdam (1637-1680)

Born in Amsterdam in 1637, Swammerdam was the son of a pharmacist who always wanted him to earn his living either as a practicing physician or as a member of the Calvinist ministry. Although he trained as a medical doctor at the prestigious University of Leiden, Swammerdam preferred scientific research to the medical practice and was supported by his father for the majority of his life. In his later years, Swammerdam fell under the influence of a religious mystic, Antoinette Bourignon, and abandoned his scientific work for a time. He died in 1680 at the age of 43 from a recurrence of malaria with much of his work largely unknown and unacknowledged. Ownership rights, translation difficulties, and other complications prevented the publication of Swammerdam's collective papers until 1737, when Dutch doctor Hermann Boerhaave finished translating the opus into Latin.

There are no known paintings or other images of Swammerdam, but often a likeness taken from an oil portrait attributed to Rembrandt (like the one illustrated here), is labeled with his name. The man in the full painting is holding up a copy of Swammerdam's mayfly study, *Ephemeri vita*, but because the work was published in 1675 and Rembrandt died in 1669, the portrait is considered a fake. The image is most likely that of Hartmann Hartmanzoon (1591–1659) and is believed to have been lifted and reworked by the artist Jan Stolker from a Rembrandt painting of a dissection with Dr. Nicolas Tulp, head of the Leiden Medical School.

During his medical and anatomical studies, Swammerdam examined the heart, lungs, and muscles and is believed to be the first person to describe red blood cells. He also conducted important observations on how nerves function, described the anatomy of the human reproductive system, and discovered valves in the lymphatic system, which are now called Swammerdam valves. Anticipating the role of oxygen in respiration, Swammerdam suggested that air contained a volatile element that could pass from the lungs to the heart and then to the muscles, providing energy for muscle contraction.

Swammerdam's entomological work involved the life history of insects and the anatomy of mayflies, butterflies, beetles, dragonflies, and bees. The first to describe the queen bee, which had previously been incorrectly referred to by scientists as the king bee, Swammerdam developed a classification of insects based on their type of development. Three of the five major groups he described are still retained in modern classification schemes. His detailed study of the development of flies via delicate dissections led him to the revolutionary conclusion that insects undergo metamorphosis through various life stages.

To aid him in his observations, Swammerdam developed a variety of original and highly effective microscopic techniques. For instance, he injected wax into specimens to hold blood vessels firm, dissected fragile structures under water to avoid destroying them, and used micropipettes to inject and inflate organisms under the microscope. Swammerdam preferred simple microscopes to compound ones and used small bead-like lenses that he made himself. He also preferred to only observe specimens under direct natural light, and his research was occasionally delayed in the fall and winter months when sunlight was scarce. Without a camera to capture images, Swammerdam made detailed drawings of his specimens, and his collective microscopic work is often considered to be the most comprehensive of any single person.

In March of 1678, Swammerdam included drawings of the microscope illustrated here in a letter to his mentor that described several experiments and observations. The single-lens microscope bears a striking resemblance to instruments made during this period by Johan Jooster van Musschenbroek in Leiden. Effectively a very small magnifying glass, the microscope is designed to be held in one hand while observing specimens. In practice, microscopes having this design are very difficult to use because the specimen almost touches the lens, while the observer has to place their eye close to the lens in order to view the specimen. Typically, it is very difficult to discern much of the specimen detail. Swammerdam warned the readers of his *Book of Nature* that the lens "must, for this purpose, be carefully managed, for as it is turned one way or another, different things are seen; one cannot bring the lens nearer, or remove it further, by the least distance, but something is immediately perceived by the sight, which was not observed before."

Swammerdam Single-Lens Microscope (circa 1670s)

In his book, Swammerdam indicated that he only observed specimens visible under direct natural light, generally outdoors on summer mornings. Prior to his microscopic observation of specimens, Swammerdam carried on painstaking dissections with a variety of tools including fine pairs of scissors, a saw made from a small section of watch spring, a fine sharp-pointed pen knife, feathers, glass tubes, small tweezers, needles, and forceps. He used a variety of original and highly effective techniques to clean the specimen and to dissolve unwanted tissues and highlight those of interest. Without a camera to capture images, Swammerdam made drawings of his specimens, first in red crayon, then completed in black ink or pencil. Many of the drawings were ultimately transferred to copper plates for printing.

The microscope illustrated above is accompanied by a specimen holder designed for examining blood samples. The glass tube is filled with blood, which is then observed through the small bead lens mounted in ebony. A small flexible copper clasp is used to position the lens assembly with respect to the specimen for focusing. The instrument sports an ebony handle that is used to position the microscope and specimen near the observer's eye.

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