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Anton van Leeuwenhoek (1632-1723): Father of micromorphology and discoverer of spermatozoa

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ABSTRACT

The Dutch merchant and naturalist Anton van Leeuwenhoek is considered to be the father of optic microscopy and the precursor of bacteriology. Among others, he discovered and studied the spermatozoon.

Key words: Leeuwenhoek, microscope, spermatozoon

RESUMEN

Anton van Leeuwenhoek (1632-1723): padre de la micromorfología y descubridor de los espermatozoides. El comerciante y biólogo holandés Anton van Leeuwenhoek es considerado el padre de la microscopía óptica y el precursor de la bacteriología. Entre otros, descubrió y entendió a los espermatozoides.

Palabras clave: Leeuwenhoek, microscopio, espermatozoides

INTRODUCTION

Leeuwenhoek's reputation is due to the great Dutch anatomist, embryologist and physiologist Régnier de Graaf (1641-1674) who drew the doctors' attention to microbes.

In 1673, De Graaf wrote to Henry Oldenburg (1615-1677), secretary of *The Royal Society of London*, to inform him that one of his Dutch compatriots had constructed a magnificent microscope with which he was able to see very tiny objects in detail. It is doubtful whether De Graaf had reported to the secretary that Leeuwenhoek was not a professor of medicine, but a tradesman without formal education that only spoke his native Dutch language (1).

After De Graaf's letter, Oldenburg asked Leeuwenhoek to send the reports of his inventions with the aim of publishing them in the *Philosophical Transactions of The Royal Society*.

Who was Leeuwenhoek?

Leeuwenhoek, a son of a craftsman, was born in Delft in 1632 and died in 1723, at the age of 91 years. At the age of 22, he was married to Barbara and got involved in commerce (2). Widowed twelve years later, he did not remarry for several years. Of the five children from his first marriage, only his daughter Maria died after him and stayed with him until his last breath. After his death, Maria erected a monument to his memory that can still be visited in Delft. Although he lacked a formal education, Leeuwenhoek was a man respected in his hometown for

his integrity. His passion was microscope observation and even on the verge of death he begged his doctor to translate into Latin some letters he had not yet sent to *The Royal Society*.

Several years before his death, Leeuwenhoek had built a nice wooden cabinet with shelves designed to accommodate twenty-six different models of microscopes. After his death, his daughter sent the precious furniture to *The Royal Society of London*, where it remained for a century before disappearing mysteriously. Except for the microscopes that were sent to London, Leeuwenhoek possessed another 247, as well as 172 lenses mounted in gold, silver or copper frames (3).

Leeuwenhoek's work

In his shop, Leeuwenhoek (Figure 1) learnt to handle the magnifier "weaver's glass" which served for counting fabric threads. Being curious by nature, he applied his magnifying instrument to examine everything he could lay his hands on and he described exactly what he saw, without any interpretation.

In anatomy, he studied the epidermis, the hair, the nails, the teeth and the muscle structure. He noted the fascicular nature of nerves and described the striation of muscular fibres, the internal structure of the crystalline as well as that of the optic nerve. He discovered the red blood cells in 1674, which had already been seen by Jan Swammerdam (1637-1680) in 1658. He studied the structure of insects, their metamorphoses, as well as those of human and animal parasites. In Botany, he attempted to



Figure 1. Portrait of Anton van Leeuwenhoek (1632-1723).

understand the structure of plants, grains, and to follow their germination cycle, structure and root development. In Chemistry his studies concentrated on crystals, not forgetting the calcium concentrations found in gout. Also he noticed the nematodes in vinegar and the vibrios in tartar. In male semen he discovered “the animalcules”, small motile elements with the help of which fertilization occurs. Leeuwenhoek’s collaboration with *The Royal Society* lasted almost 50 years. It was in fact to that particular Society that he communicated all his observations. His reports written in Dutch and enriched by figures with rare perfection in design were translated into English or Latin in order to be published in the *Philosophical Transactions*. Leeuwenhoek’s letters were collected and published under the title: *Arcana naturæ detecta* (4) in 1695.

Although his discoveries left his compatriots indifferent, they provoked the admiration of scientists from other countries and the sympathy of prominent men. Leeuwenhoek was visited by Kings Charles II, George I and Queen Anne of England, as well as by Tsar Peter I of Russia in 1698.

In his last letter to *The Royal Society* on 20th November 1719, he stated: “I am turning 80 years old; my hands are weak and trembling. This is my farewell to you; I want to thank you again for the honour that was made to me by making me a member of your renowned society in 1679” (5).

The discovery of the microscope and optical microscopy

Lenses were developed around the 16th century when they were able to reconstitute the anterior view, permitting a more realistic vision. The first glasses revealed their capabilities in Galileo Galilei’s hands (1564-1642) who used them for the observation of celestial phenomena.

The mediocre quality of the lenses, which required a more perfect image clarity than the telescope postponed the development and dissemination of this instrument by half a century. Since then, the microscope had allowed anatomists to significantly expand the scope of their investigations, creating the microscopic anatomy (6).

The art of working the glass, cutting and polishing gemstones dates back to antiquity. However, it was the Arab Alhazen Ben (12th century) who indicated the magnifying action of plane-convex glass for the first time and Roger Bacon (1214-1292) who demonstrated the amplifying power of plane-convex lenses and the practical applications that could derive from them. He also pointed out the usage of cut and sharpened magnifying lenses applied to the construction of reading glasses. The use of the magnifying glass had spread towards the end of the 13th century: it was used by jewellers, watchmakers, etc. The cloth merchants counted the thread of their fabrics with small magnifying instruments (7).

The work on eyeglass lenses, however, led to the manufacturing of more convex and therefore more powerful lenses, resulting in a very simple device which could be considered the first microscope. The word “microscope” (mikros = small; skopo = observe) was created by Demisiano in 1618. The most ancient of these magnifying devices initially consisted of a small cylindrical box in the lid of which a lens was embedded and whose bottom was formed by two small glasses placed between the object under investigation. Another form of primitive microscope consisted of a magnifying glass held in a frame supported by a foot. A needle was attached at a small distance from the lens and the object under investigation was pricked on the tip of the needle. The magnifying glass could still be embedded between two sheets of metal. Leeuwenhoek’s instrument resembles this type of microscope.

All these instruments that were not very complicated in design were named “simple microscopes”. The compound microscopes were made from a number of lenses that were placed at the two extremities of a tube with which the object under investigation could be brought closer or moved further away. The first compound microscope was invented by Sacharias Janssen around 1590 (1580-1638) (8).

Leeuwenhoek manufactured his own microscopes from scratch and he ended up in the possession of several similar microscopes (Figure 2). He took extreme measures in the choice of lenses; knowing how to cut and polish them he immediately obtained excellent results. The amplifying power of these microscopes was 40 to 160 times, they were all extremely simple in design, and it is still amazing how they allowed him to make such important and numerous discoveries.

The discovery of spermatozoa

In 1677, a remarkable discovery was made: Leeuwenhoek described the human spermatozoon. In a letter

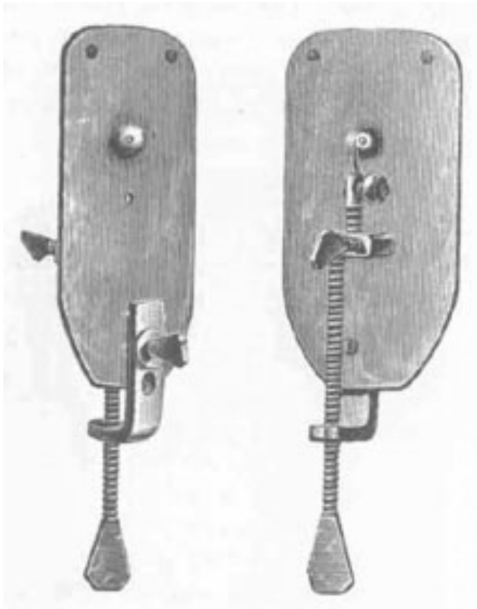


Figure 2. Anton van Leeuwenhoek's simple microscope.

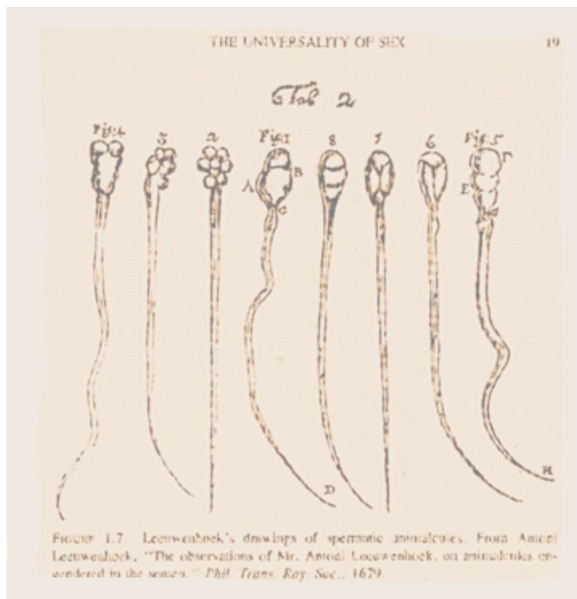


Figure 3. Spermatozoa by Anton Van Leeuwenhoek published in *Philosophical Transactions*, 1678.

dated November 1677 and addressed to Lord Brounker, secretary of *The Royal Society*, he mentioned that he had observed a multitude of “small animals” which he named “animalcules”. “I had observed enough material coming from a sick person ...but also from a healthy one, imme-

diately after ejaculation”. “I had seen such a multitude of live animalcules more than a million, having the size of a grain of sand and moving in a space ...those animalcules were smaller than the red blood cells. They had a round body, foam in the front, terminated in a point at the back; they were equipped with a tail with five to six times the body length. They progressed in a snake-like motion helped by their tail” (9).

The history of the discovery of spermatozoa as it was told by Leeuwenhoek is the following: Professor Cranen had entrusted a young student, Johan Ham, to Leeuwenhoek. Ham announced that he had observed tiny living creatures, animated due to their tails, in a small quantity of semen from a man suffering from gonorrhoea. Leeuwenhoek wanted immediately to verify Ham's observation, which was easily made because the young man had brought the remainder of the man's semen in a flask (8).

Leeuwenhoek finished his letter to *The Royal Society* by saying that if his observation was considered repugnant or scandalous by he members, they could decide not publish it. On the contrary, Secretary Brounker encouraged him to repeat the same observations on the sperm of various quadrupeds. On 18th March 1678, Leeuwenhoek told his correspondent that he had noticed a number of “animalcules” in the semen of dogs and rabbits and he was expecting to find them in all male animals. Leeuwenhoek's observations would be repeated by other scientists. All of them confirmed what Leeuwenhoek had seen. Slowly “the animalcule ” became fashionable and high society found amusement in observing it under the microscope (Figure 3). Leeuwenhoek also noticed in a dog's seminal liquid kept in a glass tube, that spermatozoa died gradually: seven days after their collection, few spermatozoa were still alive and capable of “swimming”. Leeuwenhoek was the first to discover the presence of spermatozoa in the fallopian tubes and female uterus and he also demonstrated that the spermatozoon was produced in the testicles and became mobile in the epididymis (10).

In 1677, date of the discovery of spermatozoa, the theory of “animalculisme” was developed: the foetus was formed by the spermatozoa and there was therefore no need for eggs, but only an environment for fertilization.

His opponents said that Leeuwenhoek's discovery on spermatozoa was not novel, referring probably to the work of German Jesuit scholar Athanasius Kircher (1602-1680) (11).

In his letter dated 9th October 1676, after describing his observations, Leeuwenhoek tried to defend himself against these accusations: “Several times, already, disputations were made to me regarding the fact that it is my imagination that extraordinarily small living beings exist, which are invisible to the bare eye and which can only be seen with the help of special magnifiers or telescopes; they say that these living creatures have already been

observed in Rome. For my part, although I have conducted research in this direction, it was not possible to see animalcules moving in air so large as to observe them with bare eyes" (12).

Leeuwenhoek was never interested in Athanasius Kircher or other scientists' works and he did not have enough education to come to proper conclusions from his research. He was simply an observer who limited himself to writing just what he observed.

CONCLUSION

While scientists of his days had a profound education, a vast erudition or knew ancient languages, especially Latin, Leeuwenhoek only knew his language and never had any formal education. He only had charisma, intelligence and patience as well as a dominant thought: to see and discover. For more than 50 years, this ingenious man with an uncultivated but searching spirit, examined liquids and solids without any order or methodology, making incomparable discoveries. He is rightly considered the father of microbiology.

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