

Profiles in Cardiology

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Olof Rudbeck

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Olof Rudbeck the Elder

This Swedish man of science (Fig. 1) is best known for his discovery of the lymphatic system and for the dispute concerning priority over the Dane Thomas Bartholin who, in 1653, published his findings on the same subject just before Rudbeck. In Uppsala one year earlier, the 22-year-old Rudbeck, with his teacher, Professor Olaus Stenius, performed an anatomical demonstration of his results on a dog in the presence of Queen Christina of Sweden.^{1,2}

The Circulation

In 1652, Rudbeck, however, made another important but less well known contribution to Swedish medical science with his first dissertation, *De circulatione sanguinis*, namely, the introduction of the modern concept of the circulation of blood as described by William Harvey. This dissertation embraced experimental methods in medical research. It was printed in Västerås and defended at Uppsala University. Just as Harvey had dedicated his work on the circulation to King Charles I, Rudbeck dedicated his work to the Swedish queen. The purpose of this first paper was probably to prepare and facilitate the reception of his second and greater discovery—that of the lymphatic system—completing the physiology of the circulation. Harvey promoted his new ideas in lectures

from the beginning of 1616, but his thesis was not printed until 1628. Its acceptance was slow, but grew steadily on the European continent, mainly in the Netherlands, Germany, and Denmark. This was the premise for Rudbeck's studies on the circulation.¹⁻⁴

Rudbeck's findings were based on a number of animal dissections (he mentions cat, eel, crayfish, and fish) and experiments proving the existence of anastomoses between arteries and veins. He described the heart in systole and diastole, and the function of the valves. He observed and probed with his finger the beating hearts of different animals, and by ligatures proved the direction of the blood flow. An anatomical description of the arterial system of the body, including the coronary arteries, is also included. His results regarding circulation of the blood were concentrated into 26 statements in the first dissertation. He not only confirmed Harvey's results, but he also widened Harvey's views regarding the arterial pulse, refuted the notion that the liver was a blood-forming organ, and rebutted ancient, lingering Galenic doctrines by repudiating the production of "vital spirits" in the heart.^{1,2}

Like Harvey, Rudbeck calculated the amount of blood pumped from the human left ventricle, but a too-low approximation of the left ventricular volume ejected into the aorta resulted in underestimation of the cardiac output. His calculations were based on a heart rate of 4,000 beats per hour (67 beats per minute) and a volume of half a drachm (1.8 g) per systole or 20 libras per hour (7,126 g). According to some authors, Harvey underestimated both heart rate (33 beats per minute) and the left ventricular volume ejected (3.9 g or 500 ounces in one half hour), although he calculated with different sets of figures.^{1-3,5-7}

Apart from Harvey, Rudbeck also quotes the German Hermann Conring, at one time physician to Queen Christina and the Dutch scientist Johannes Walaëus (Jan De Wale). Both were early supporters of Harvey's ideas, and Walaëus, too, made calculations regarding cardiac output with an assessment close to that of Harvey. Conring repeated Harvey's experiments, confirming and publishing the new idea in 1640, and was the first in Germany to acknowledge the Harveyan doctrine. In 1641 in Leyden, Walaëus published the results of

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FIG. 1 Olof Rudbeck, 1630–1702. Painting from Uppsala University Art Collections.

animal experiments, further confirming Harvey's theories. He also stimulated Thomas Bartholin during his studies in Leyden to introduce Harvey's concept in Denmark. Thomas Bartholin became a professor in Copenhagen, and revised and illustrated new editions of the popular book on anatomy that his father, Caspar Bartholin the Elder, had published. Some of Rudbeck's own illustrations resemble those in Thomas Bartholin's book and were also inspired by Harvey's thesis on the circulation. Another illustration derives from a Dutch work on bloodletting^{1, 2, 7, 8} or is possibly a modification of a figure in *Filactirion della Flebotomia et Arteriotomia...* by Giovanni Maria Castellani, printed in 1619.⁹

Biography

Olof Rudbeck was born in 1630 in the Swedish city of Västerås, the son of Bishop Johannes Rudbeckius. After medical studies at Uppsala beginning in 1648, and after publishing his two medical dissertations, Olof Rudbeck spent the years 1653 and 1654 at the University of Leyden with the support of the Swedish queen. Beginning in 1655, he served for five years as a lecturer at Uppsala University and was then appointed professor, a post he held until 1691 when he was succeeded by his son, Olof Rudbeck the Younger. Together with his colleague, Professor Petrus Hoffvenius, Rudbeck the Elder modernized medical education at Uppsala University. Both Rudbeck and Hoffvenius were strong defenders of modern ideas in science based on Cartesian philosophy, and Rudbeck's teacher, Stenius, initially professor of astronomy and later of medicine, may have been the first



FIG. 2 Illustrations from Rudbeck's thesis on the circulation.¹¹ The drawings are by Rudbeck and the copper engravings by Magnus Nicolai Helsingius.

Swedish Cartesian. The French man of science René Descartes (Cartesius) was another protagonist of Harvey; he died in 1650 after brief service at the Swedish court under Queen Christina.¹⁻³

Apart from anatomy, Rudbeck's lecturing capacity also covered chemistry, physics, mathematics, astronomy, and botany. Although his interest in medical education waned, he was active within many other fields, such as architecture and construction, mechanics, archaeology, and industrial enterprises. For a time he was the despotic administrator of the university. He also built an anatomical theatre at Uppsala University between 1662 and 1663, founded and financed a botanical garden at Uppsala, and fulfilled various governmental assignments. He had remarkable skills in drawing and music.^{2, 10}

In the 1670s he started work on *Campus Elysii*, a monumental edition of botanical illustrations in 12 volumes that aimed to describe all known plants in the world. In 1702, after completing two volumes, most of his personal belongings, including several thousand wood carvings, were lost in a disastrous fire; he died that same year. Another project of characteristically heroic dimensions was the publication of his *Atlantica* in four volumes between 1679 and 1702. This work, identifying Sweden as the mythical Atlantis, was a mixture of historical knowledge and pure speculation in a truly patriotic spirit. It met with considerable interest on the

European continent.^{1, 2, 10} Rudbeck is buried in Uppsala Cathedral.

References

1. Hagelin O: *Rare and Important Books in the Library of the Karolinska Institute*. Stockholm: Contributions from the Karolinska Institute Library and Museum Collections, Vol III, 1992
2. Rudbeck O: *Disputatio Anatomica de Circulatione Sangvinis*. Facsimile reprint (foreword in English) Stockholm: Rediviva Publishing House, 1977
3. Lindroth S: Harvey, Descartes, and Young Olaus Rudbeck. *J History Med Allied Sci* 1957;XII:209–219
4. Bayon HP: William Harvey, physician and biologist: His precursors, opponents and successors. Part II. *Ann Sci* 1938;3:83–118
5. Kilgour FG: William Harvey. *Sci Amer* 1952;186:58–62
6. Kilgour FG: William Harvey's use of the quantitative method. *Yale J Biol Med* 1954;26:410–421
7. Pagel W: *New Light on William Harvey*. Basel: S. Karger, 1976
8. Gotfredsen E: The reception of Harvey's doctrine in Denmark. *Acta Med Scand* 1952;(suppl 266):75–86
9. Castellani GM: *Filactirion della Flebotomia et Arteriotomia* 1619. Louise M. Darling Biomedical Library (biomed-ref@library.ucla.edu) under "Bloodletting."
10. Lindroth S: *Svensk lärdomshistoria*. Stormaktstiden (in Swedish). Norstedts, 1975
11. Minnesskrift utgifen å tvåhundraårs-dagen av Olof Rudbeck den äldres död (in Swedish). Stockholm: P.A. Norstedt & Söner, 1902