

EVOLUTION AND REVOLUTION IN MICROSCOPY - I

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Disney, Hill and Baker¹ in their 1928 book on the Origin and Development of the Microscope, quote the 1829 article on Optics of the *London Encyclopedia* as saying: "Microscopes, though but toys compared with telescopes, nevertheless deserve to be rendered as perfect as possible; for they yield not to them in the quantity and variety of rational amusement which they are capable of introducing to us (though not of the sublime description of the wonders of the heavens). Compound microscopes, though not so much to be depended upon for the purposes of discovery and philosophical investigation as single lenses, are still the best adapted for recreation". It is hard to imagine that this was written at about the time when Robert Brown of motion fame, was discovering the cell nucleus (1831), the repository of the genetic code and thus arguably laying the foundations for all of modern biology. The sentence quoted might be taken to suggest that there was no evolutionary connection between hand lenses and compound microscopes, since as late as the 1830s the two still competed.

In trying to follow the evolution of microscopes it is trite to state that lenses had to come first. It was known for a long time that objects seen through a glass bulb full of water appeared enlarged, but the water was thought the important factor and it was not until the time of Alhazen (962-1038) that the action of a lens was understood. Roger Bacon (1242-1292) wrote "if one looks at letters and other minute things through the medium of a crystal or glass or other lens put over the letters... he will see the letters much better and they will appear much larger to him... and therefore this instrument is useful to old men and to those having feeble sight". Spectacles seem to have been invented by Salvano d'Armento degli Amati of Florence who died in 1317, the secret process of how to make them being revealed by a contemporary, Alessandro della Spina of Pisa. The use of lenses in visualizing small objects made slow progress at first but eventually led to "macroscopy", in the form of spectacles and then to microscopy.

The origin of the first microscopes is far from clear however and seems to have been closely intertwined with the development of telescopes. When Giovanni du Pont, Seigneur de Tarde, Canon of the Cathedral of Sarlat (Dordogne, France) arrived in Florence, he let barely a day pass before visiting Galileo, on November 11, 1614. Galileo was ill in bed but that did not prevent him from showing off a microscope which could make flies look "as big as lambs". In fact, said he, flies "are covered over with hair and have very pointed nails by means of which they keep themselves up and walk on glass, although hanging feet upwards, by inserting the point of their nails in the pores of the glass". That microscope had two lenses, a convex objective and a concave eyelens and was in fact a telescope with an extra long tube. Du Pont says, "the telescope tube to see the stars is no more than two feet in length but to see objects that are near which cannot be seen because of their small size, the tube must be two or three "brasses" long" (a brasse was about 1.6 meters long). This description is supported by the statements of Wodderborn, a pupil of Galileo, who relates that Galileo used his telescope to distinguish the organs of motion and of the senses in insects. Galileo made his first telescopes/microscopes about 1610 after hearing of the invention of such a tool by a "Belgian" 10 months earlier. Just who the Belgian was is unclear at present. It all seems to have happened in the town of Middelburg, a center for working with glass, where several spectacle makers were plying their trade. Competition to be the first to make new things with lenses seems to have been intense. Credit for the first microscope and telescope is usually given to the Janssen family, and the date for the invention of the microscope set at 1590 and that for the telescope as 1609. Setting the date for the invention of the microscope relies partially on the account given by William Boreel, who became the dutch ambassador at the court of Louis XIV and had been a playmate of Zacharias Janssen, son of Hans the spectacle maker. Zacharias must have been a precocious fellow, since records suggest that he was born around 1588. His father Hans died in 1592. So if 1590 is indeed correct (and perhaps it is not, as discussed by G. L'E. Turner²) Zacharias'

contribution to microscopy would most likely have been to have played with lenses made by Hans, arranging them to his liking, thus building the first microscope much to his Papa's pride. Most authors seem to agree that this microscope was made with two convex lenses. William Boreel further says that such a microscope, given by the Janssens to Albert, Archduke of Austria and the Supreme Stadtholder of the Belgian Kingdom, was in turn given to a Cornelius Drebel, a dutchman of Alkmaar and mathematical advisor to King James, who showed it to him. The microscope, continues Boreel, consisted not "(as such things are now made)" of "a short tube, but one almost a foot and a half long, made of gilt brass two inches in diameter supported by three dolphins of brass. The base was an ebony disc, on which were placed the minute objects which we looked at from above enlarged almost miraculously...". The microscope/telescope, as discussed by Clay and Court³, was not a very good instrument. Only when the objective became a lens of relatively short focal length was progress made toward modern microscopes, and this had occurred a short time later, by 1624.

Well, the improvements judged vital for gentlemanly entertainment by the *London Encyclopedia* article quoted earlier were eventually achieved. Aberrations were gradually eliminated. The compound microscope evolved into an instrument which beat hand lenses "hands down". When Zeiss hired Abbe and collaborated with Schott to get the best glass for making lenses he had done as much as one could do at the time to improve the numerical aperture (but see a future installment of this column!). Only one route was left to follow for microscopes to evolve towards better resolution and that was to decrease the wavelength.

1. Disney A.N., Hill C.F. and Baker W.E.W. (1928) Origin and development of the microscope. Roy. Mic. Soc. Publishers, London. This reference was used for most of the quotes and data used in preparing this essay.
2. Turner L'E.G. (1990) 1590 and all that. Proc. Roy. Mic. Soc. 25,423-424.
3. Clay, R.S. and Court, T.H. (1932) The history of the microscope, Ch.Griffin & Co Publishers, London.

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