Stereomicroscopes: Part 2

Understanding Stereoscopic Vision and the Evolution of Stereoscopic Devices
5th Edition

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Simple Dissecting Microscopes

In the nineteenth century, dissecting microscopes were commonly small simple microscopes, Fig 22. Although these could be a considerable size if they included hand (arm) rests, substage apparatus, and a storage base, Fig 23 (Kreindler, November 2012). This example, manufactured by C. Vérick of Paris c. 1880s, is an attractive dissecting microscope with wooden hand (arm) rests and storage drawers

Early in the 20th century, these microscopes were primarily of lacquered brass, with an increase in black enameled areas as the century progressed, Figs. 23 and 22.

At the turn of the 20th century, there were increasing demands for improved capabilities from scientists, who were, by then, frequently using microscopes for analyses. This, along with the advancement of technology, led to many single element simple microscopes being upgraded to short tube monocular instruments, containing eyepieces that were more complex. Dissecting microscopes can usually be identified by the presence of sides-of-stage screws, Fig. 22, or other attachments to connect hand (arm) rests. These rests make dissecting work more comfortable.

Figure 22. Small dissecting microscope

Figure 23 . Vérick - Simple dissecting microscope on its relatively large stand

Binocular Dissecting Microscopes

Dissecting microscopes were significantly affected by the advances made in understanding stereoscopic vision. These advances were not restricted to stereo viewers. They were extended to the development of binocular microscopes including examples by Riddell, Stephenson, and Wenham, among others.

One of the smallest and least complex of the early simple stereo microscopes was the *Collins' Lawson Binocular Dissecting Microscope,* although not the first chronologically. [Turner (Turner, 1989), identifies this as a *Collin's Lawson Binocular Microscope* (Turner's apostrophe is incorrectly placed).]

This is described by Hogg, and pictured there as Fig. 52 (Fig. 24 here).

> *This instrument is intended to supply a want, often felt in anatomical and botanical investigations, when only a moderate magnifying power is required.*
>
> *In consequence of using both eyes it can be worked with for a length of time with great comfort. A large range of field is obtained, and plenty of room for working. It consists of a neat oblong French-polished mahogany box, measuring, when closed, 6 in. by 4 in., fig. 52. The top and front let down by hinges, and on the inside of them are fitted the scissors, needles, and knives necessary for dissecting. The two sides draw out about six inches, and are hollowed out so as to serve as rests for the hands. The magnification is obtained by two lenses mounted in the eye-pieces, as represented in the diagram, and may be adjusted to the focus by a sliding bar. These show the object beautifully in relief. Beneath is a gutta-percha trough or stage, to pin the object down to, which can be filled with water if required. Under this is the mirror for transparent illumination, and the light from it is passed through a circle of glass in the centre of the trough.*
>
> — (Hogg, 1867),

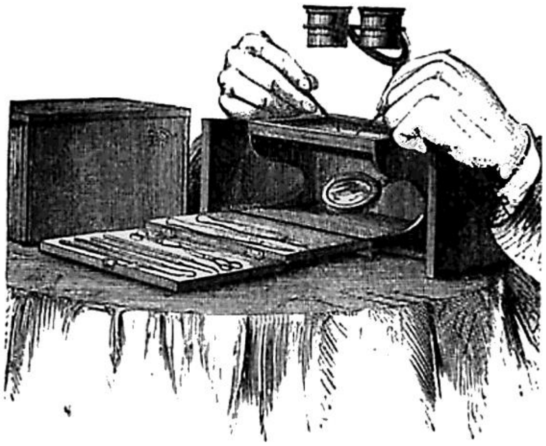

Figure 24. "Collin's Lawson Binocular Dissecting Microscope" from Hogg 1867

Fig. 25 shows an example of this dissecting microscope, in its "*French-polished mahogany*" box, as described in Hogg. This example and the one in Turner (Turner, 1989), do not include a below stage mirror. It is possible these mirrors were options, but it is more likely they were lost over time, as there is a substage fitting that allows for a mirror's attachment.

An unsigned example of the same design, but with an oak-wood frame, is attributed to Collins and described by Turner (Turner, 1989). It is shown in Fig. 300 of Turner's 1989 book, and identified as manufactured by Collins c. 1870. A similar Collins dissecting microscope is also presented in the Science Museum's disk catalog (Bracegirdle, 2005) as item 11/26, and called a "Lawson Dissecting Microscope by Collins". That example, unlike the one described in Hogg or presented here, is also made of oak with a Collins label pasted on, unlike the signed example here. The Science Museum microscope does have a substage mirror but is missing the stage, which the catalog states would be of "opal glass". It identifies Lawson as a St. Mary's Hospital Professor of Histology.

This simple binocular dissecting microscope was made before Collins' Wenham binocular, and some decades before Zeiss' first compound stereo Greenough microscope. These were both important instruments in the evolution of the modern stereomicroscope, and are discussed later in this paper.

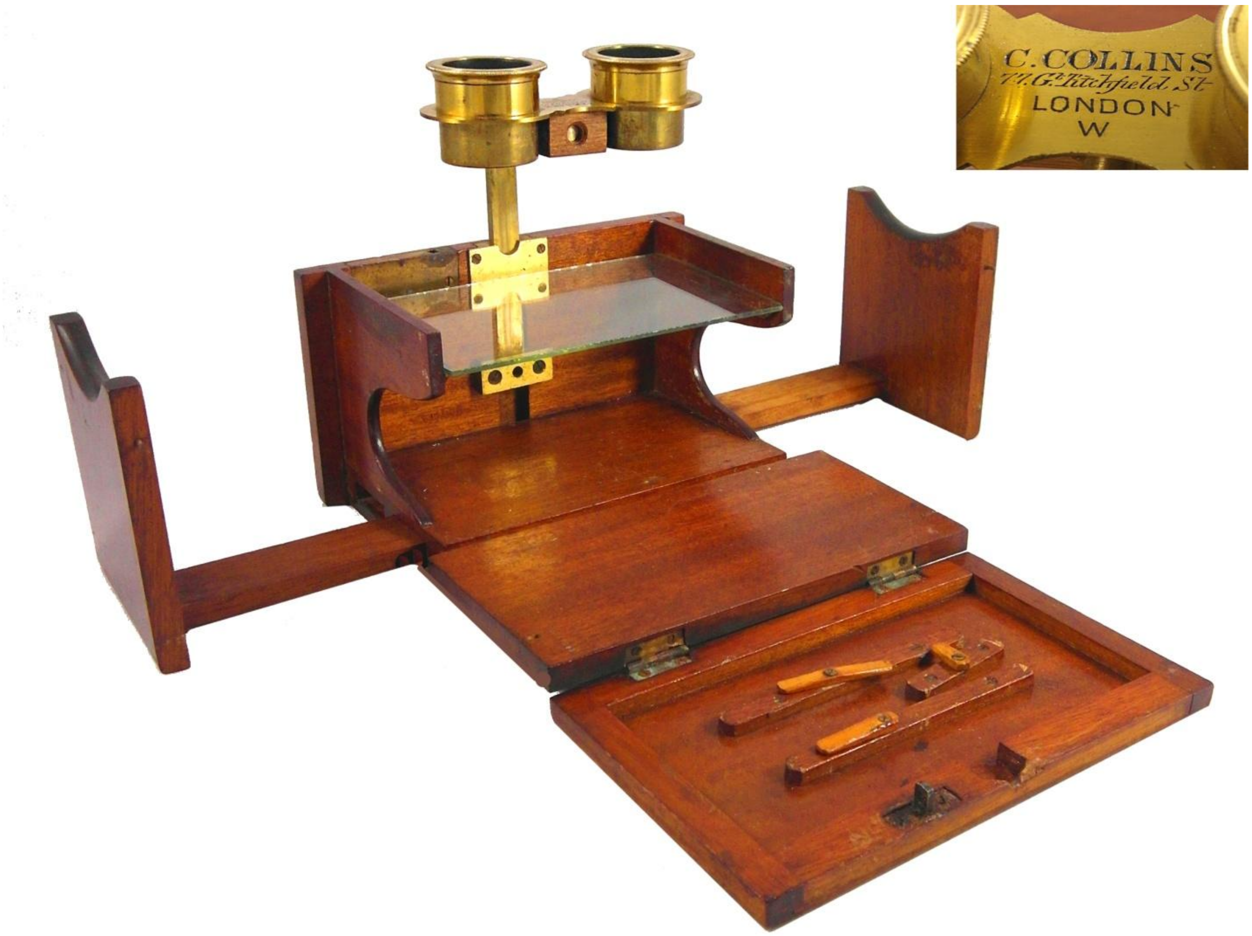

Figure 25. Collins' Lawson binocular dissecting microscope

Designs of Prof. John Leonard Riddell of New Orleans, USA

Wheatsone's publication (Wheatsone, 1838) and his subsequent work influenced researchers in England and the US to explore the development of stereo compound microscope. The first functional compound stereomicroscope was made in the U.S. by J(ulius) & W(illiam) Grunow according to Prof. J. L. Riddell's design, c. 1853. Riddell had likely been influenced, directly or indirectly, by Wheatsone's work.

The two Grunows were brothers, and were joined briefly by a third brother Charles. The formal designation "Grunow Bros." was used only briefly as the company's name. (Over time, the brothers went their separate ways.) The Grunows were known for the quality of their instruments, which compared favorably to those of British manufactures. The Riddell microscope and the design of its prisms is shown in Figs. 26 and 27. An example of Riddell's microscope can be found in the Billings collection, Fig. 257 (Purtle, 1987).

The description in Billings describes the Riddell microscope in their collection as 16 inches tall, and it includes the inscription *"Invented by Prof. J. L. Riddell, University of Louisiana, Made by the Grunow Broths. New Haven, Conn*"

One of the interesting features of the original Riddell microscope is itd use of two substage mirrors, i.e., two light sources to illuminate each of the microscopes independently. This dual illumination feature would continue to be used. For example, it is used in conjunction with stereomicroscopes made by both Vickers and Watson, and of necessity in the Bausch & Lomb Stereo 240 microscope designed for photo interpretation. These examples are later discussed in this paper.

The prisms atop each eyepiece tube in Fig. 26 not only negate the need to look directly down into the eyepiece tubes, but are also used to produce a normal orientation of the image. They vertically erect the images, which were corrected horizontally by the lower set of prisms. The final result, for the user, are images where movements at the stage is shown correctly and not inverted. That is, movement to the right is shown as movement to the right, and movement upward is shown as movement upward (Ferraglio, 2008).

The Riddell microscope in Fig. 26 uses two independent light paths through a common relatively small objective using prisms above that objective to divide the circle of rays coming through the objective into two eyepieces.

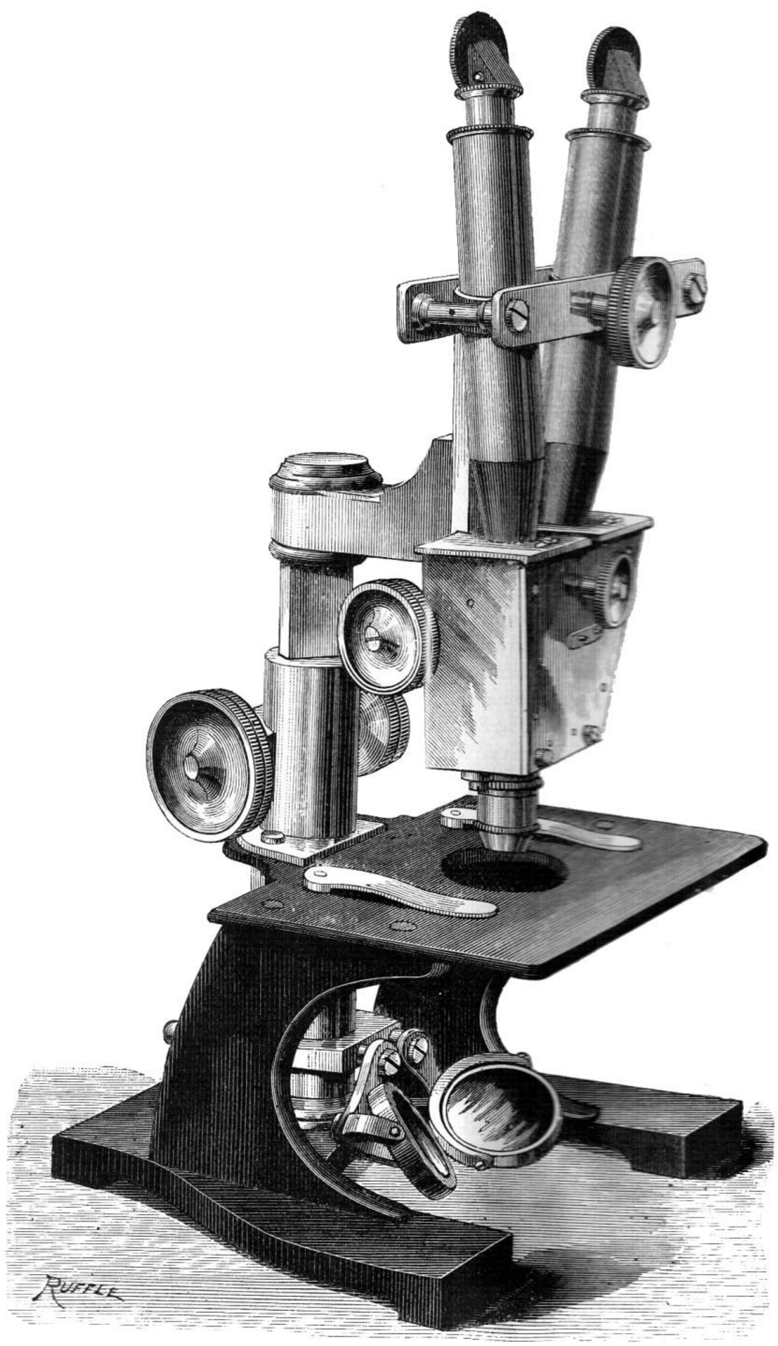

Figure 26. A representation of Riddell's original microscope, slightly software enhanced, by the author (Carpenter, 1901)

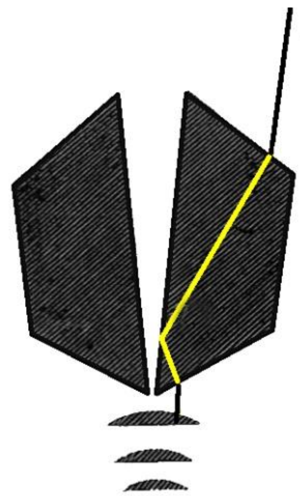

Figure 27. Riddell's Trapezoidal Prisms (Carpenter, 1901*)* Modified by the author

As can be seen in Fig. 27, both light paths go through a common objective. The use of a common objective would evolve in the 20th century into the Common Main Objective (CMO) stereomicroscope discussed in more detail in the CMO section of this paper.

As Ferraglio notes,

> *Despite its useful features, novelty, and production by America's premier microscope maker of the time, Riddell's binocular microscope seems to have failed in the marketplace. Only one example survives: Riddell's own microscope ... It seems demand for such a microscope was very low during these early years of microscopy in America.*
>
> — (Ferraglio, 2008)

Stephenson Stereomicroscopes

Fortuitously, the basic design of Prof. Riddell's microscope was discovered independently, several decades later, by John Ware Stephenson, R.M.S., F.R.A.S of England. Stephenson was elected to the Council of the Royal Microscopical Society and was its Treasurer c. 1880s. He was also a contributor to the Encyclopaedia Britannica.

One of Stephenson's modifications used Riddell-style prisms (possibly made by Browning), that were much smaller, and were mounted inside a small tube that projected from the microscope and extended into the objective housing in close proximity to the back element of a lens. That is, the prism and its housing stayed with the microscope and not with the objectives. The Riddell-Stephenson design, with various modifications, was used in some 19th and early 20th century British binocular microscopes. These microscopes were produced by various British makers, including Ross, John Browning, Charles Baker of London, and James Swift & Son of London. Ross is the maker least commonly seen, while J. Swift stereo instruments are more common. (Ferraglio, 2008).

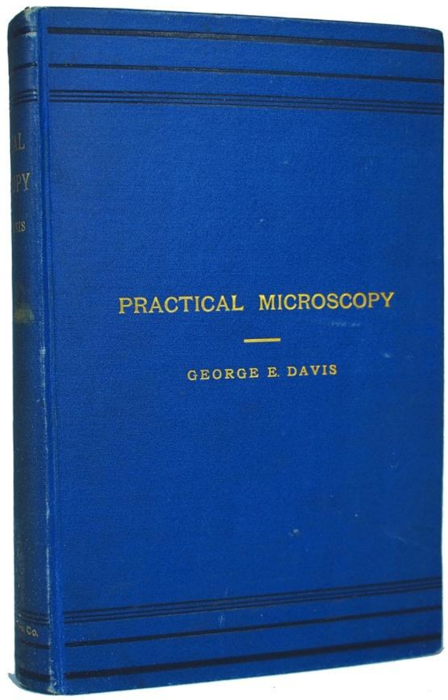

Figure 28. George E. Davis. *Practical Microscopy*, 1882

See, Kreindler and Goren (Kreindler, March 2011) for the differences between the unrelated Swift companies in England and the US.

A picture of a Stevenson style binocular microscope, made by Swift, can be found in the Truman G. Blocker, Jr. History of Medicine Collections, *Fig. 1.020,* (Blocker 2012), as well as in the article, *Introduction to Stereomicroscopy* (*Fig. 1.)*, at NikonU (NikonU, undated).

The Riddell-Stephenson design can be considered the precursor of the modern common main objective (CMO) stereomicroscope, discussed later in this paper.

A picture of a Riddell-Stephenson binocular made by John Browning, along with a brief discussion is given in Davis, Fig. 28 (Davis, 1882). Figures 29 and 30, taken from Davis, show this microscope and its prisms. Fig 31 shows one of the implementations of this design by Swift and Son.

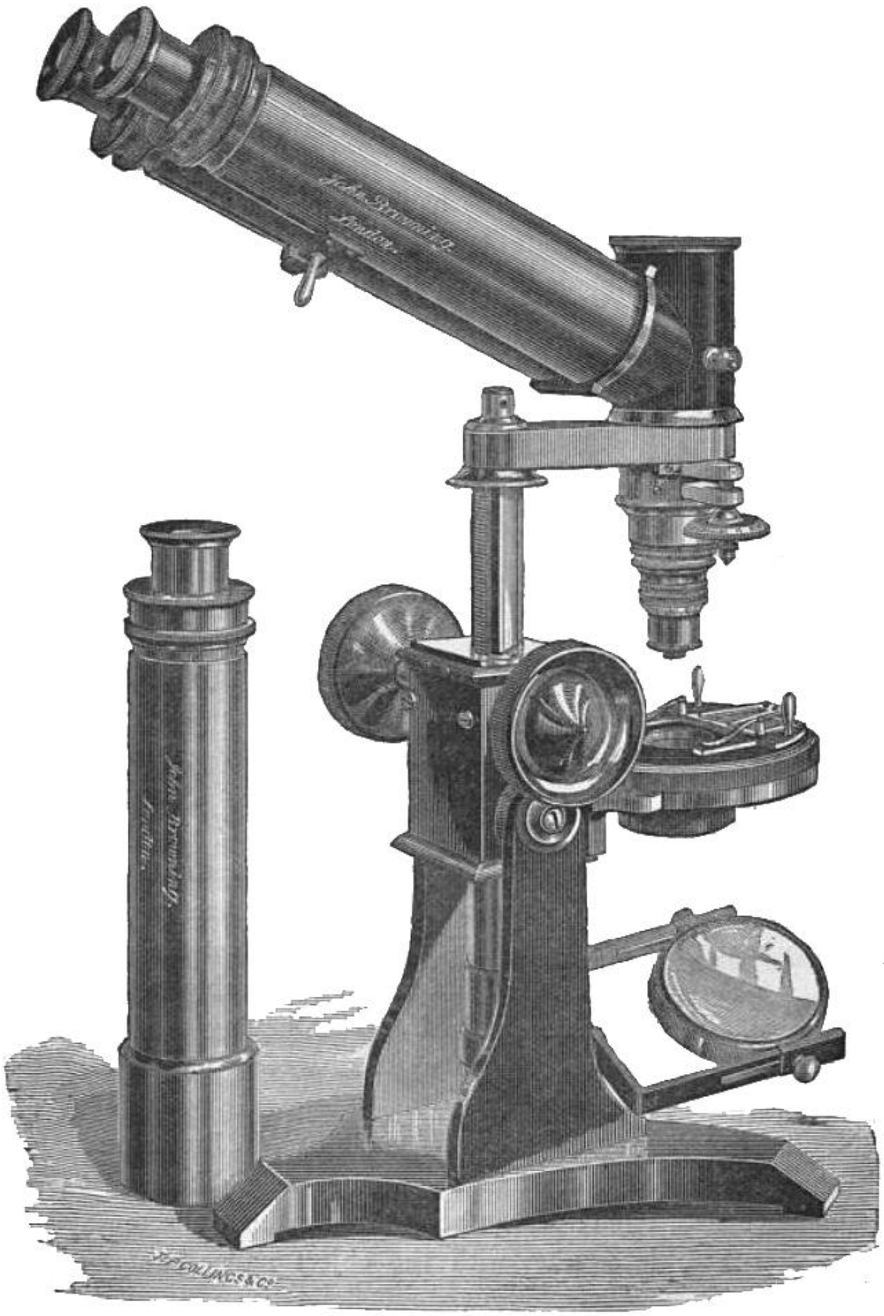

Figure 29. Riddell-Stephenson stereo binocular microscope made by Browning. (Davis, 1882)

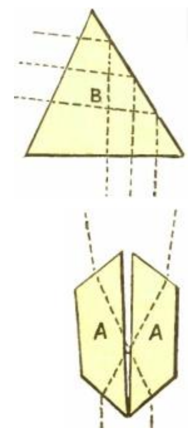

Figure 30. Prism designs for the Stephenson Stereo Binocular shown at left. *Modified and colored from Davis (Davis, 1882)* by the author

Figure 31. Riddell-Stephenson style stereomicroscope made by J. Swift and Son

Wenham Stereomicroscopes

It was the development of the Wenham binocular, Figs. 33 through 37, which led to the rapid distribution of stereomicroscopes. [Author aside: It should be mentioned that Francis Wenham's interests were many. He was a microscopist, but his contributions to aviation were many and profound. He received high praise from Wilbur Wright]. In 1870, after the death of Thomas Ross, Wenham joined the maker Ross as a consultant.

Some insight into Wenham's view of his binocular microscope may be gained from his writings. The following excerpt predates Greenough's microscope design, c. 1886, discussed later in this paper.

> *I have been frequently asked why I have not termed my binocular the "Stereoscopic Microscope?" I may reply that the prevailing idea of stereoscopic vision is more connected with the combined effects of two separate objects, or pictures, than the solid appearance of a single body, having bulk or thickness. What I should term a " Stereoscopic Microscope" would be literally two microscopes, with their object-glasses, placed side by side, like an opera glass, with similar adjustments for the distance between the eyes. If such an instrument were furnished with erecting-glasses and draw-tubes, for varying the magnifying power, only one power of object-glass would be requisite, and I have no doubt that in many applications it would be found serviceable, as for the detection of forged trade-marks, &c, and irregularities of pattern.*
>
> — (Wenham, 1861).

Wenham suggests, in the above 1861 quote, that magnification changes could be made using "draw tubes", rather than by using eyepieces or objectives of different power, as is done today.

As can be seen in Fig. 30, Wenham used a single prism, different from that used in Riddell's microscope, to reflect half the semicircle of light entering the objective into an angled tube. The remaining half of the semicircle of light passed unobstructed, and without reflection by Wenham's prism, into the other eyepiece tube.

As the images from the objective are reversed, as in a normal microscope, to obtain a stereoscopic effect, the image from the right-side of the objective must be sent to the left eye, and the image from the left-side of the objective to the right eye. If these images had not been redirected the resultant image would have been pseudoscopic, as in the binocular microscope of Père d'Orleans, Fig. 8.

The use of Wenham binoculars for stereoscopic examination has a number of difficulties in addition to the reduced image illumination obtained with a single small aperture objective. (1) Relief is naturally reduced as most objects are cut into thin sections. (2) These microscopes have a relatively short working distance, which mean that many objects cannot be placed "whole" under the objective. (3) Since these are designed for use with thin sections and cover slips, potential relief is further reduced (4) Spatial separation of images is relatively small and effects relief. (5) Depth of field is quite shallow with higher magnification (5) Due to the small diameter of the back lens of high power objectives, compared to the size of the Wenham prism, images are somewhat distorted by the edge of the prism at high powers. (6) Relief seen at low powers is significantly diminished, if present at all, when high powers are used.

Wenham binocular microscopes have prisms that can be slid out of the optical path, Fig. 31b. This allows more light into the eye when high magnification objectives are used. However, when this is done the binocular microscope becomes a non-stereo monocular microscope, with all the light from the objective going into a single body tube. That is, the image is 'flat'.

At low powers, Wenham binocular microscopes show relief, but not as significantly as modern stereomicroscopes, and their working distances are insufficient to accommodate larger whole specimens. As the light paths are not similar, the image brightness is different for the left and right eyepieces. This can make these microscopes more fatiguing to use.

Nonetheless, the Wenham binocular microscope, in various versions, dominated the production of British, and American, binocular microscopes in the 19th century. Most major British makers had several Wenham models, usually bench top versions.

Although relatively uncommon, Wenham binocular microscopes were also made as field portable microscopes. Fig. 35 shows a Beck Wenham that folds for traveling and stores in a luggage-like case for field trips.

Fig. 36 shows a large J. Swift Wenham binocular microscope, over 23 inches tall. This maker's Riddell-Stephenson style stereomicroscope is shown in Fig. 29. This microscope is typical of the bench top Wenham's that were popular acquisitions for the British aristocracy. It was relatively expensive, and available with many accessories. Its cost restricted it to those with considerably more wealth than average. As can be seen, it makes an impressive display, but would have exceeded the budget of most scientists (unless independently wealthy).

Fig. 37 shows another large Wenham. Here made by a more obscure maker of Wenham's binocular microscopes, B. Cooke and Son. This, Hull England, company sells microscopes today. However, the company is not discussed in Bracegirdle (Bracegirdle, 1996). This Wenham is relatively heavy. It weighs almost 14-1/2 pounds, and is approximately the same height as the J. Swift Wenham shown earlier. It is also typical of the bench top Wenhams that were popular in the 19th century.

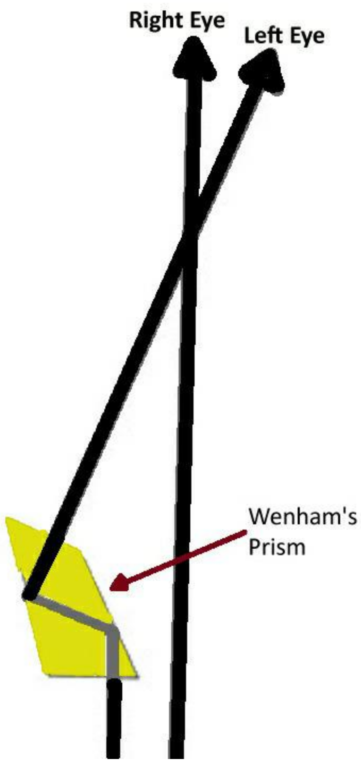

Figure 32. Wenham binocular light path

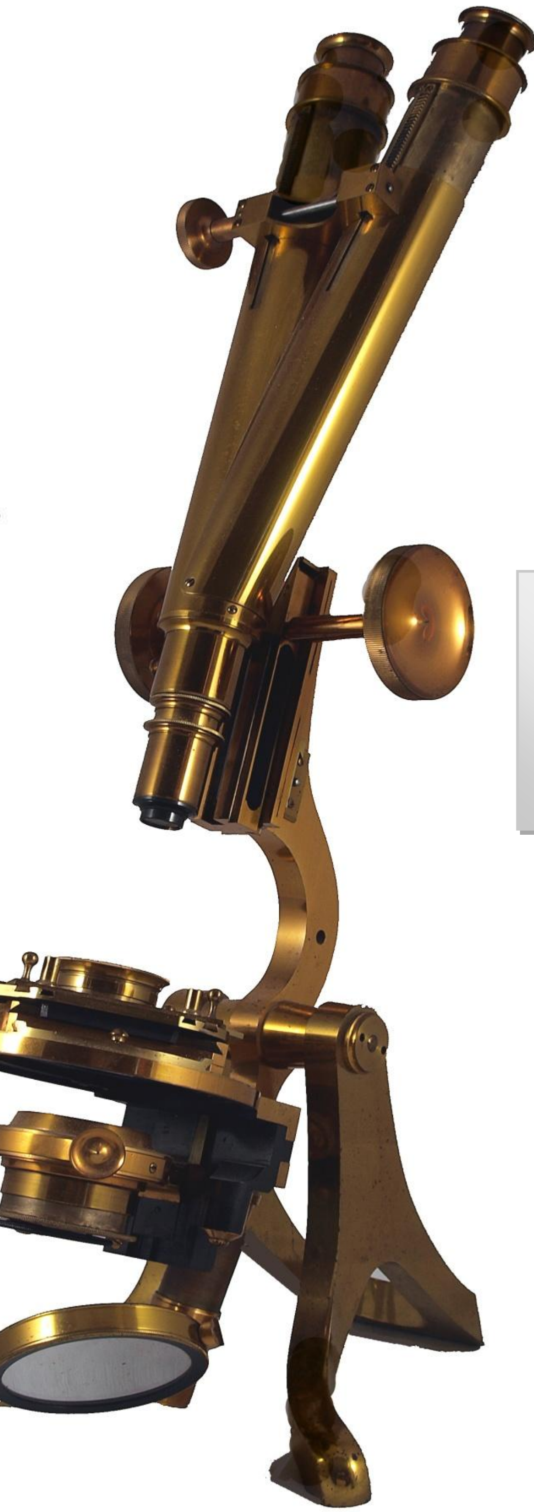

Figure 33 - Crouch Wenham Binocular

a. Left: Complete view

b. Above: Close-up with Wenham prism moved out of light path

Figure 34. Collins Ladderback Wenham Binocular

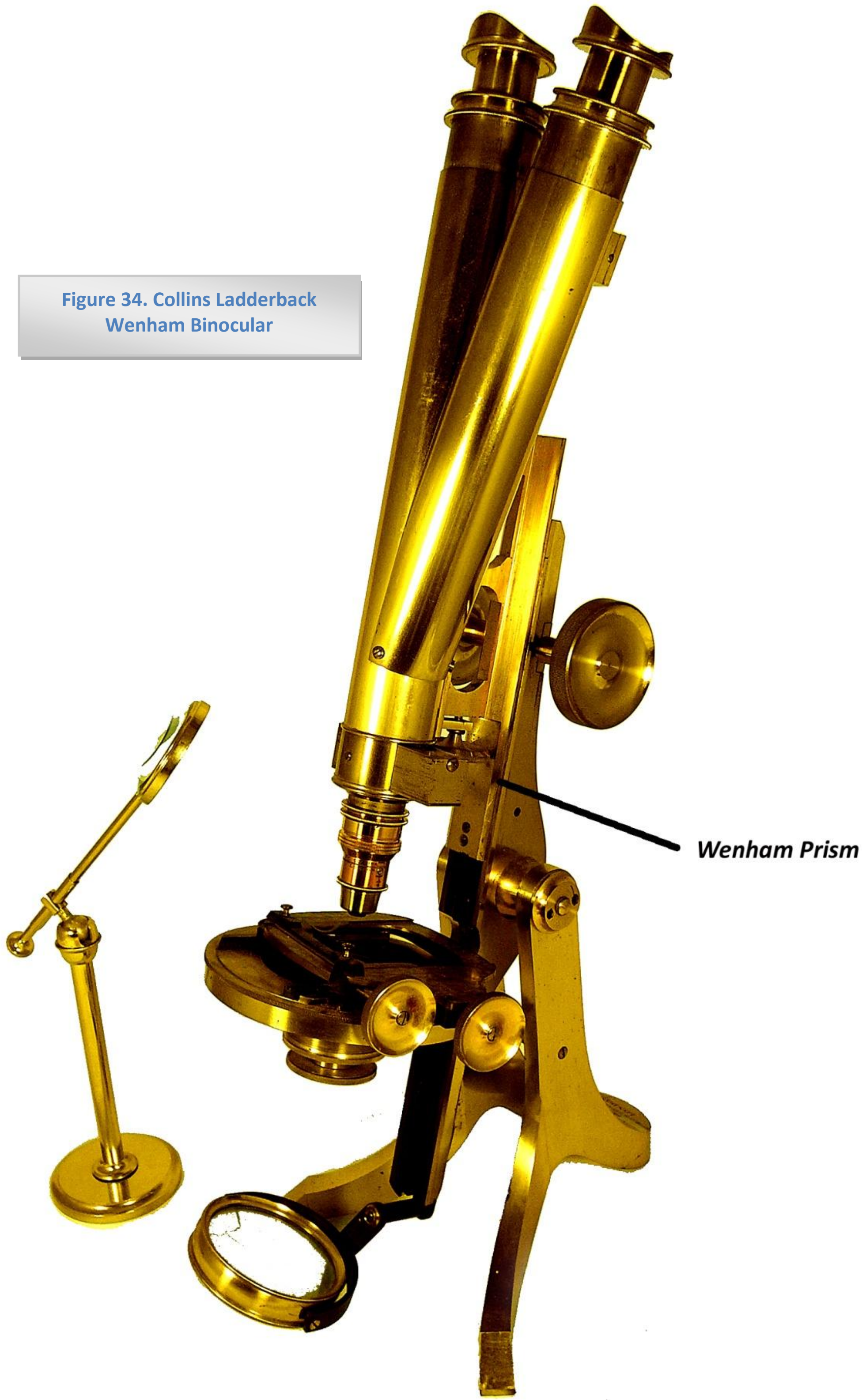

Figure 35. Beck field portable Wenham stereo binocular with its unusual travel case

Figure 36. J. Swift large Wenham stereo binocular, over 23 inches tall as shown

Figure 37. J. Large Wenham stereo binocular sold by B. Cooke and Son

Wenham English binocular microscopes are easily identified by their one straight and one angled tube, Figs. 33 - 37. Wenham's binocular microscopes were suited to the longer English tube length of 10 inches. However, this prism design did not work well for continental microscopes with their shorter tube lengths, slightly over six inches.

The wide acceptance of the Wenham's binocular design may not have been due to its stereoscopic capabilities but its being a binocular, instead of a monocular, microscope. Using both eyes, as occurs in a binocular microscope, is usually more comfortable for users. Wenham's are quite attractive in brass, so they appealed to aristocratic amateurs, who at the time, were the purchaser's of the most expensive instruments, and took pleasure in their display.

The stereoscopic limitations of Wenham binocular microscopes were, in part, the motivation for the development of the modern low power stereomicroscope, where whole objects can easily be seen in outstanding (some would say spectacular) three-dimensional relief. Most objects can be quickly placed under a stereomicroscope (i.e., without thin section preparation or staining) for examination. An object's image is not reversed by a stereomicroscope. That is, moving an object to the left moves its image to the left, and moving an object downward moves its image downward. Thus, "abc" seen under a stereomicroscope appears as "abc".

As noted, the Wenham binocular presents dissimilar light paths to each eye. Light not going through the prism provides relatively greater intensity to its eyepiece than light traveling through the prism does to its eyepiece. Thus, the Riddell-Stephenson design, rather than the Wenham design, should be considered the predecessor of modern Common Main Objective (CMO) stereomicroscopes. A discussion of CMOs is given later in this paper.

Wenham's prism design proved inappropriate for continental instruments. Therefore, other style stereomicroscopes were developed in Europe, initially by the French firm Nachet, (Moe, 2004).

A discussion of the Greenough stereomicroscope starts the next Part of this paper.

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