Lentz Microscopy and Technology Collection

Peabody Museum of Natural History at Yale University

©Thomas L. Lentz, M.D. 03/03/2022
Professor Emeritus of Cell Biology
Yale University School of Medicine

Introduction

This collection consists of a broad range of microscopical instruments and preparations illustrating the history of microscopy from the seventeenth century to the present time. The collection begins with optical devices that preceded the microscope. The collection of simple and compound microscopes contains the major types of instruments that illustrate the evolution of the microscope over a period of 400 years. Another section contains examples of other optical devices such as spectacles, telescopes, binoculars, navigating and surveying instruments, and cameras that, besides the microscope, evolved from the simple magnifying lens. The collection also contains examples of the equipment necessary to prepare, view, and project histological slides and images. These objects include microtomes, lantern slide projectors, and projection microscopes.

Another section of the collection contains examples of non-optical scientific instruments that illustrate the development of technology and science from antiquity to the present time. These categories include astronomy, time telling, weights and measures, calculation, navigation, sewing and textiles, surveying, communication, electricity, weaponry and firearms, and medicine.

Microscope slides form a major part of the collection and comprise one of the most extensive collections in America. There are examples that illustrate the evolution of slides from 1700 to the present time. A large portion of the collection documents the development of histology as a discipline. These include the earliest histological slides and nineteenth century slides, slide sets, and cabinets of all the tissues of the body. In addition to histology, there are examples of slide preparations in pathology, microbiology, embryology, botany, mineralogy, *materia medica*, and neuroanatomy. There are also slides of diatoms, insects, invertebrates, vertebrates, and other subjects that were especially popular for the entertainment of the public during Victorian times. In all, there are over 4,000 slides in this collection including the earliest and many of great historical and scientific significance.

The collection covers the entire spectrum of microscopes, instruments, and slides used to prepare and view structures, especially those comprising the human body, that cannot be seen with the naked eye. The history of histology in scientific investigation and the microscope slides that illustrate this history have been largely ignored in American museums, so that this collection fills a gap in documenting one of the most important eras in the history of science and medicine. The collection is being donated to the History of Science and Technology Collection at the Peabody Museum of Natural History at Yale University.

Contents

History of Microscopy and Histology up to the 20th Century

A brief history of microscopy is presented here so the objects in the collection can be viewed in their historical context. Objects that appear to be lenses date from ancient Egypt, Greece, and Mesopotamia. These were made from polished crystal, often quartz, and may be ornaments instead of lenses. The Nimrud lens in the British Museum was found at the Assyrian palace of Nimrud in modern-day Kurdistan and is dated to 750-710 BC. The earliest historical references to magnification date back to ancient Egyptian hieroglyphs in the eighth century BC that depict "simple glass meniscal lenses." The ancient Greeks and Romans were aware of the magnifying effect of glass spheres filled with water. Lenses were used as "burning glasses" to start fires in sacred temples and to cauterize wounds. The word lens comes from the Latin name of the lentil, because a double-convex lens is lentil-shaped. Corrective lenses were said to have been used by Abbas Ibn Firnas, living in Spain in the 9th century, who had devised a way to produce very clear glass. These glasses could be shaped and polished into round rocks used for viewing and were known as reading stones. The earliest evidence of a magnifying device, a convex lens forming a magnified image, dates back to the *Book of Optics* by Ibn al-Haytham (Alhazen, 965-1040), Arabian mathematician, optician and astronomer at Cairo, in 1021. English Franciscan Friar Roger Bacon (c1214-1294), in his 1267 *Opus Majus*, noted that letters could be seen better and larger when viewed through less than half a sphere of glass. "If one looks at letters or other minute things through the medium of a crystal or glass or other lens put over the letters, and if it is the smaller portion of a sphere of which the convexity is towards the eye, and the eye is in the air, he will see the letters much better and they will appear larger to him . . . and therefore this instrument is useful to old men and to those having feeble sight." Reportedly, spectacles were in use in China by the rich and elderly at the time of Marco Polo's arrival in 1270 or 1271, although the Chinese credited their invention to Arabia in the eleventh century.

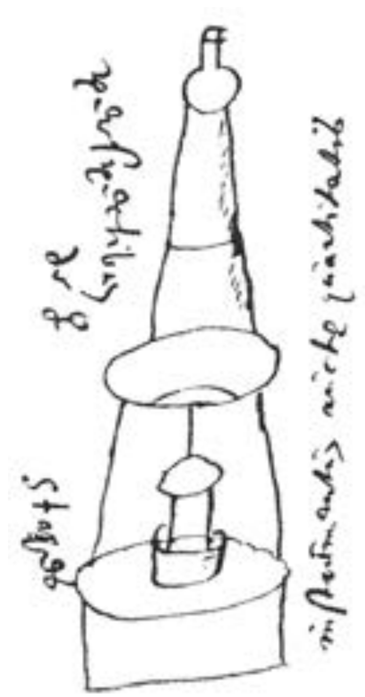
Early recorded evidence demonstrates that spectacles first appeared in Pisa, Italy about the year 1286. Magnifiers or reading stones held in the hand or in a stand were probably used by monks to assist in illuminating manuscripts between the eleventh and thirteenth centuries. These were primitive plano-convex lenses initially made by cutting a glass sphere in half. As the stones were experimented with, it was slowly understood that shallower lenses magnified more effectively. At some point, someone thought of connecting two of the glass or crystal magnifiers together so they would sit on the bridge of the nose. Most likely, this first pair of eyeglasses were invented by a lay person who wanted to keep the process a secret in order to make a profit. Two monks from the St. Catherine's Monastery, Giordano da Rivalto and Alessandro della Spina, provide the earliest documentation to support this belief. On February 23, 1306, Giordano mentioned them by stating in a sermon "it is not yet twenty years since there was found the art of making eyeglasses which make for good vision, one of the best arts and most necessary that the world has." He coined the word "occhiale" (eyeglasses) which was later also used for telescopes and microscopes in Italy. Friar Spina's 1313 obituary notice mentions, "when somebody else was the first to invent eyeglasses and was unwilling to communicate the invention to others, all by himself he made them and good-naturedly shared them with everybody." Salvino D'Armato Degli Armati of Florence was at one time thought to be the inventor of eyeglasses but this claim is now thought to be false. At that time Venice, Italy was one of the most advanced centers for the medieval glass industry, its guild of crystal workers officially created in November 1284. The use of spectacles and the method of making them rapidly spread over Europe. These early spectacles had convex lenses that could correct both hyperopia (farsightedness), and the presbyopia that commonly develops as a symptom of aging. Nicholas of Cusa in 1451 is believed to have discovered the benefits of concave lens in the treatment of myopia (nearsightedness).

The simple (single lens) microscope probably originated in the sixteenth century. Spectacles were in use since the end of the thirteenth century so that there was an awareness of the magnifying properties of glass lenses. The earliest microscope consisted of a short tube of opaque material with a magnifying lens at one end and a flat glass plate at the other end on which the object to be examined was placed. It was known as a *vitrum pulicare*, or "flea glass," because it was used to view fleas and other small insects. An early observer reported that aside from the great advantage accruing to mankind from a just appreciation of the flea, the learned men of the time declared that, with this wonderful machine, they had discovered many new monsters; and one savant affirmed that he had seen the devil himself.

It seems likely that spectacle makers or scholars experimenting with multiple lenses discovered the telescope and the compound microscope. Girolamo Fracastoro (1478-1553), an Italian physician, wrote in *Homocentricorum* (1538) "If anyone looks through two spectacle lenses, one placed on top of the other, he will see everything much larger and closer." The microscope and telescope developed together as both consist of two or more lenses held in a tube. Credit for the first compound microscope is usually given to Hans Jansen and his son Zacharias (c1580-c1638), spectacle makers in Middelburg, Holland, around the year 1590. Middelburg was a center of lens crafting in Europe at the time. There is also some evidence that the compound microscope was invented by Cornelius Drebbel (1572-1633), an inventor and optician born in Holland and working in England, between 1611 and 1619 (A. Turner, 1987). The word "microscope" was coined in 1625 from the Greek words *μικρόν* (micron) meaning "small", and *σκοπεῖν* (skopein) meaning "to view" by Giovanni (Johann) Faber (1574–1629), a member of the Accademia dei Lincei in Italy, a group of scientists that included Galileo Galilei. Galileo, better known for his work with the telescope, was one of the first scientific users of a microscope.

Photograph of microscope in Middelburg, Holland, attributed to Zacharias Jansen, c1595. The microscope is made of tin and is 2 inches in diameter and 10 7⁄8 inches long when closed. It consists of two drawtubes which can slide in and out of an outer casing tube. Lenses are in the ends of the drawtubes; the eyepiece lens is bi-convex and the objective lens is plano-convex. The microscope is hand-held and can magnify 3 to 10 times. To focus the microscope, a drawtube is slid in or out of the outer tube.

In the seventeenth century, most microscopes were made in the form of a cylindrical tube supported by a small tripod. The pattern continued in various forms for 200 years. Besides Drebbel, other early designers were Richard Reeves (1641-1689) in London, Giuseppe Campani (1635-1715) and Eustachio Divini (1610-1685) in Italy, Louis Joblot (1645-1723) in France, and Willem Homberg (1652-1715) in Holland. Around 1660, Robert Hooke (1635-1703) designed a side-pillar microscope, manufactured by Christopher Cock, that could be inclined and had a field lens, stage, coarse and fine adjustment, and an illumination system. This advanced design was not widely adopted until a hundred years later.



Drebbel's microscope, 1619

Several important scientific discoveries were made using the microscope in the seventeenth century. Francesco Stelluti's (1577-1652) drawing of a bee in *Persio Tradotto* (1630) is the first printed illustration of observations made with the compound microscope. In 1661, Marcello Malpighi (1628-1694), regarded as the founder of microscopic anatomy and the first histologist, using a Divini microscope discovered capillaries in the lung, thereby proving William Harvey's theory of the continuous circulation of blood published in 1628. In 1665, Robert Hooke (1635-1703) published his *Micrographia: or Some Physiological Descriptions of Minute Bodies Made by Magnifying Glasses with Observations and Inquiries thereupon*. This book which included the first use of the word "cell" in describing the structure of cork, generated wide public interest in the new science of microscopy. Antonie Philips van Leeuwenhoek (1632-1723), beginning in the latter part of the century, made extensive observations using simple microscopes with high quality lenses. His discoveries included the first observations of protozoa, bacteria, spermatozoa, cardiac muscle, the banded pattern of muscle fibers, and nucleated red blood cells from fish. Despite these significant discoveries, the microscope largely remained a "toy" and source of entertainment and amusement for the upper classes until the middle of the nineteenth century. The objectives of the period suffered from chromatic and spherical aberration and low resolution making them less useful for scientific investigation. Another major limiting factor was the nature of the objects to be viewed. Thin sectioning was not developed until the middle of the nineteenth century. With the preparations then available, resolution was at best five microns, although with a modern thin histological slide, the resolution is considerably better.

Hooke's microscope, from *Micrographia*

In 1658, Athanasius Kircher (1602-1680) claimed he could see "worms" in the blood of plague patients. This is thought to be the first attempt to use a microscope for diagnostic purposes. The illustration below shows a tripod microscope being used to examine a patient. It is the first known illustration of the use of a microscope for clinical examination in medicine. The tripod microscope is shown in enlarged form on the left and was designed by Joseph Campani of Bologna. The person on the right is using the microscope to examine a wound on the leg of a recumbent patient. A woman holds a candle and a mirror to provide illumination. A second observer on the left is viewing a specimen by holding the microscope up to the sun (Acta Eruditorum, 1686, p 372). It is interesting to speculate about what the examiner observed and what use was made of the observation. Nonetheless, this demonstration shows that there was a realization that the microscope could reveal structures not readily apparent to the naked eye and that this could have some relevance to medicine.

Sliders were the original carriers of objects for microscopical observation, described as early as 1691 by Filippo Bonanni (1638-1723), an Italian Jesuit scholar. Sliders are rectangular slabs, beveled at one end, usually made of bone, ivory, or ebony with round compartments cut out. Specimens were placed between two round pieces of mica and held in the compartments by brass rings. The compartments could be viewed and successively moved under the objective. Common objects for viewing were insects and their parts, plants, and minerals.

At the end of the seventeenth century, the most prominent instrument makers in London were John Yarwell (1648-1712) and John Marshall (1663-1725). Both made tripod microscopes. Marshall also made a side pillar microscope with a fish plate in which the circulation of blood in the tail fin of a small fish could be observed. The fish plate, in which Malpighi's observations could be repeated, became a standard microscope accessory for nearly 200 years. In 1702, James Wilson (1655-1730) improved the screw-barrel microscope, a simple microscope that was popular because it was inexpensive and could be carried into the field. Edmund Culpeper (c1660-1738) is credited with creating the "Culpeper-type" compound microscope around 1725. It uses the same motif as the earlier tripod microscopes but made two improvements. The stage was raised above table level making it more accessible. A concave mirror was inserted below the stage allowing for illumination of specimens from below. Culpeper's model was made and improved by Edward Scarlett (1677-1743). The Culpeper-type microscope was reproduced by many makers with modifications and improvements for the next 100 years. In 1738, Benjamin Martin (1704-1782) introduced the drum microscope which was modified and improved by a number of instrument designers. Versions of this microscope were made into the twentieth century. An important advancement in design was devised in 1743 by John Cuff (1708-1772) at the suggestion of Henry Baker, a well-known eighteenth century microscopist who found then current microscopes difficult to use. The Cuff-type microscope has a composite side pillar that gives rigidity, a delicate fine focus, and unobstructed access to the stage. Later in the century, George Adams (c1708-1773) and his son and the Jones brothers (William and Samuel) continued improvements on the Cuff design, including a flat tripod-style foot and functional limbs with adjustable stages, condensers, and mirrors. There was not a great deal of improvement in lens design during this period, but the mechanics of the compound microscope were advancing rapidly.

The first half of the nineteenth century was marked by great improvements in microscope design and function. In the mid-nineteenth century, there were three pre-eminent optical instrument makers in London. They were Andrew Ross (1798-1859), Hugh Powell (1799-1883), and James Smith (d1870). Andrew Ross began business in 1830. During the period from 1837 to 1841, Ross worked in partnership with the renowned microscopy pioneer and optics theoretician Joseph J. Lister (1786-1869). Lister perfected achromatic lenses corrected for spherical and chromatic aberration. Objectives and condensers were being built with multiple lenses that had increasing degrees of optical correction. A notable consequence of these improvements in lenses was the elevation of histology into an independent science. Now that they were no longer plagued by optical error, microscopes revealed previously unseen details in tissues of all types, greatly advancing the medical knowledge base. In fact, Lister was the first to accurately observe and report the true appearance of red corpuscles present in mammalian blood. The joint efforts of Lister and Ross helped transform the microscope from a toy or parlor oddity into an important scientific tool in medical diagnosis and biological research.

Histology is the study of the structure and composition of the tissues of plants and animals. Tissues are assemblies of cells in which one type is predominant and carries out a specific function within the organism. The term histology was created by the German scientist August Mayer (1787-1865) in 1819 and was based on the Greek root words *histos* (tissue) and *logos* (study). *Histos* originally meant any woven material. Marie François Bichat (1771-1802), a French anatomist and pathologist, was the first to introduce the notion of tissues as distinct entities comprising organs in 1800. Without the use of a microscope, he distinguished 21 kinds of "textures" or tissues that enter into different combinations in forming the organs of the body. He also maintained that diseases attacked tissues rather than whole organs. For this work, Bichat is often considered the founder of both modern histology and pathology. Histology as a separate discipline began in the first half of the nineteenth century as investigators began to examine the tissues of the body with microscopes. In 1827, Hodgkin and Lister, using Lister's improved objectives, published the first reasonably accurate microscopic descriptions of tissues. Most advances in microscopic anatomy were made in Germany by scientists such as Johannes Purkinje (1787-1869) and Johannes Müller (1801-1858). In 1839, Theodor Schwann (1810-1882) extended Matthias Schleiden's (1804-1881) theory that all plants are composed of cells to animals, stating that all living things are composed of cells. The cell theory became the foundation of modern histology.

In 1858, Rudolph Virchow articulated what became the accepted form of the cell theory, *omnis cellula e cellula* (“every cell is derived from a cell.”) He founded the medical discipline of cellular pathology, namely, that all diseases are basically disturbances of cells. It followed that if cells comprised the organism and could grow and divide and that diseases arose in cells, cells were extremely important subjects for research and teaching. Rapid advances were being made at the time in describing tissues, cells, and cell constituents. Besides the improvements in microscope objectives, these advances were made possible by improvements in tissue preparation. Sliders evolved into an all glass slider, a glass slide with mica cover, and a standardized glass slide with thin cover glass. Other important developments in the nineteenth century were the discovery and development of fixatives, embedding media, microtomes for making thin sections, stains, and Canada balsam as a mounting medium.

With the increased importance of histology, the subject was introduced into medical school curricula and professorships of histology were established. The first textbook of histology was published by Albert von Kölliker (1817–1905) in 1852. John Quekett published the first volume of his lectures on histology in 1852. The first American textbook of histology was published in 1857 by Edmund Randolph Peaslee (1814-1878), a graduate of the Yale Medical School. Microscope makers developed relatively inexpensive student microscopes. Slide makers began to offer sets of histological and pathological slides for teaching purposes. Laboratories required adequate instruments for projection of images. In the second half of the century, the photographic positive on a glass plate was developed. These plates could be projected onto a screen or wall from an instrument developed in the seventeenth century called a magic lantern, which passed a beam of light through the slide and an enlarging lens. When an adequate source of illumination in the form of the carbon arc lamp became available in the latter part of the century, the magic lantern was used for educational purposes in histology laboratories. Because the early magic lanterns used oil or kerosene lamps as a light source, the projectors were still called lantern slide projectors even after electric lamps became available. With the development of adequate illumination, projection microscopes were used to project the image of a histological slide onto a screen. The solar microscope was developed around 1740 by John Cuff. It differs little from the projection microscopes of the early twentieth century except that the source of illumination is the sun instead of a carbon-arc magic lantern or lamp. The camera obscura, known in antiquity, was the precursor of the magic lantern, camera, and projection microscope.

In 1886, the physicist Ernst Abbe (1840-1905) working with Carl Zeiss (1816-1888) and Otto Schott (1851-1935) in Germany produced apochromatic objectives based on scientific optical principles and lens composition. These advanced objectives provided images with reduced spherical aberration and free of chromatic aberration at high numerical apertures. At the end of the century in 1893, August Köhler developed Köhler illumination, an important technique in optimizing microscopic resolution power by evenly illuminating the field of view. Although many further advances in microscope design were made in the twentieth century, by the end of the nineteenth century the microscope had been perfected to the point where it achieved its theoretical limit of resolution of 0.2 μm.

Early Optics and the Precursors of the Microscope

- Ancient Glass
  - Bactrian Crystal Bead, 500-200 BC
  - Ancient Roman Glass Sphere, c200 AD
- Mirror
  - Mirror disc, Greek, fifth to fourth century BC
- Magnifiers
  - Pendant with Rock Crystal Magnifier (Visby Lens), Sweden, 11th Century
  - Reading Stone Modern
  - Meniscus Reading Stone, c1800
  - Magnifying Glass on Stand, 19th Century
  - Magnifying glass, 15th Century
  - Venetian Magnifying Glass, 17th Century
  - Nuremburg Quizzing Glass, 17th Century
  - Long-handled Reading Glass, 18th Century
  - Aynsworth Thwaites Magnifying Glass, c1750
  - Horn Pocket Magnifier, 1829
  - Coddington Magnifier, c1840
  - Stanhope Manifier, c1870
  - Burning Glass

Optics is the branch of physics that involves the behavior and properties of light, including its interactions with matter and the construction of instruments that use or detect it. A lens is an optical device with perfect or approximate axial symmetry that transmits and refracts light, converging or diverging the beam. The word lens comes from the Latin name of the lentil, because a double-convex lens is lentil-shaped. Objects that appear to be lenses date from ancient Egypt, Greece, and Mesopotamia. The Nimrud lens is considered by some to be the oldest ground lens, dating to 750-710 BC. It was found in 1850 at the Assyrian palace of Nimrud in modern-day Kurdistan, and is now at the British Museum. All of these presumed lenses are convex, made of rock crystal, and magnify 1.5 to 3 times. They could have been used as a burning glass to start fires or to cauterize wounds. It has also been suggested that lenses were used by ancient Assyrians to construct telescopes, explaining their extensive knowledge of astronomy. Some ancient engravings and filigree work by goldsmiths are extremely small and intricate and may have required a magnifying lens to produce. However, sharp images can be accomplished by the use of a pinhole and close-up work can be performed by those who are myopic. A controversy exists as to whether the presumed ancient lenses were used as magnifying lenses. Many believe that these objects were decorative pieces used in pendants, brooches, and appliqués for furniture. It is not unreasonable to assume that sometime in the ancient past, someone, holding a piece of transparent crystal or glass thicker in the middle than at the edges, looked through it and discovered that it made things appear larger. Shown here is the magnifying effect of a small Bactrian quartz crystal bead, 500 to 200 BC.

Microscopes and most other optical instruments utilize glass lenses to produce a magnifying effect. Glass is produced from a mixture of silica (SiO_2), lime ($CaCO_3$), and soda (Na_2CO_3). Glassmaking originated in Mesopotamia in the third millennium BC and soon thereafter in Egypt. The earliest glassmakers produced beads and amulets. During the 1st century BC glass blowing was discovered on the Syro-Palestinian coast, revolutionizing the industry. Around 100 AD, clear glass was discovered through the introduction of manganese dioxide. Therefore, it seems unlikely that glass magnifying lenses could have existed before that time. If there were magnifiers, they would have been quartz crystal. It appears, though, that the use of crystal as magnifying devices did not become widespread until the eleventh century with the use of "reading stones." The optical industry of grinding and polishing glass lenses began with the invention of spectacles in the late thirteenth century.

One of the earliest known magnifying devices used by the ancient Greeks and Romans was a glass globe filled with water. The earliest written record of magnification dates to the first century AD, when Seneca the Younger (3 BC-65 AD) wrote: "Letters, however small and indistinct, are seen enlarged and more clearly through a globe or glass filled with water." This effect is illustrated by this Roman water-filled glass vessel (c200 AD). The magnification is approximately 3X. This observation did not lead to the widespread use of glass for lenses because the magnification was attributed to the water, not the glass.

Roman Glass Sphere

Mirror disc, Greek, fifth to fourth century BC

One of the earliest optical instruments is the mirror, an object that reflects light in a way that preserves much of its original quality subsequent to its contact with the mirror. The first mirrors were probably pools of still water or water collected in a vessel. The earliest manufactured mirrors dating to 6000 BC are pieces of polished obsidian found in Anatolia. These were followed by polished copper or bronze mirrors in ancient Mesopotamia, Egypt, and China. In classical antiquity, mirrors were made of solid metal (bronze, later silver) and were too expensive for widespread use by common people. Due to the low reflectivity of polished metal, these mirrors also gave a darker image than modern ones, making them unsuitable for indoor use with the artificial lighting of the time. Metal-coated glass mirrors are said to have been invented in Sidon (modern-day Lebanon) in the first century AD. The invention of the silvered-glass mirror is credited to German chemist Justus von Liebig in 1835. Although mirrors are most commonly used for personal grooming or admiring oneself, concave mirrors were also used in ancient Greece and China for starting fires. Much later they came to be used in scientific instruments such as telescopes, sextants, and microscopes.

Mirror disc, Greek, fifth to fourth century BC

This is a mirror disc, Greek, fifth to fourth century BC. It is a flat disc 6.3 inches (16 cm) in diameter made of cast bronze, now oxidized. There is a corroded iron fragment riveted to the disc with two bronze rivets, indicating an earlier iron handle. The disc is bent with several dents.

Pendant with Rock Crystal Magnifier (Visby Lens), Sweden, 11th Century

One candidate for an early magnifying device are lens-shaped objects found in Gotland, Sweden. They are often referred to as Visby lenses, named for the town near where some were found. The Visby lenses are lens-shaped, manufactured objects made of rock crystal (quartz) found in several Viking graves on the island of Gotland and dating to the 11th century. Some are unmounted and others are in silver mounts with filigree and were probably used as jewelry, although it has been suggested that the lenses themselves are much older than their mounts. The largest is 50 mm in diameter and 30 mm thick. They were first described in 1950 (Ahlström Otto. 1950. *Swedish Vikings used optical lenses*. The Optician, 119: 459–469.) Their origin is uncertain, possibly Byzantium or the Near East via Russia. There is also some evidence of local manufacture of beads and lenses from rock crystal in Gotland.

Ahlström noted that the lenses have bi-aspheric surfaces, which reduces spherical aberration. The lenses were examined scientifically by Schmidt and collaborators (Schmidt, O., Wilms, K.-H., and B. Lingelbach. 1999. *The Visby lenses*. Optometry and Vision Science, 76:624-630.) The lenses are bi-aspheric and some of them have very good imaging properties. The surface of some of the lenses have an almost perfect elliptical shape and must have been made on a turning lathe. The craftsmen must have worked by trial and error, since the mathematics to calculate the best form for a magnifying lens were not discovered until several hundred years later. As with other ancient presumed lenses, the question remains as to whether they were made as jewelry and the imaging quality is an accidental by-product. If they were made as magnifiers, which would have widespread uses in many crafts throughout the world, why are they largely restricted to the relatively remote island of Gotland? On the other hand, jewelry would not have required the extensive working of the surface to produce a nearly perfect magnifying ellipse. Because of their limited distribution and the possibility of local manufacture, it seems most likely that they were made locally by the Vikings, some as jewelry and others possibly as reading stones or to start fires.

This is a Viking pendant holding a Visby lens. The lens is made of rock crystal and is 18 mm long and 15 mm wide and 9 mm thick. It is held in a silver filigree mount with a suspension loop. The crystal is bi-aspheric and magnifies two times but there is some aberration. Condition is generally good noting a number of small imperfections and inclusions in the crystal.

Pendant with Rock Crystal Magnifier

Reading Stones

The earliest accepted evidence of a magnifying device, a convex lens forming a magnified image, dates back to the *Book of Optics* by Ibn al-Haytham (Alhazen, 965-1040), an Arabian mathematician, optician and astronomer at Cairo, in 1021. The eleventh century Visby lenses may have been reading stones. English Franciscan Friar Roger Bacon (c1214-1294), in his 1267 *Opus Majus*, noted that letters could be seen better and larger when viewed through less than half a sphere of crystal or glass. In 1240, Erazm Golek Vitello (1220-1280) translated Alhazen´s book into Latin. As the Christian monasteries cultivated exchange of knowledge, his book was distributed widely. The monks began to implement Alhazen´s theoretical discoveries and manufactured reading stones, the first reading aids.

The reading stone was a segment of a rock crystal, later glass, sphere that could be laid against reading material to magnify the letters. It assisted presbyopic monks in copying and illuminating manuscripts and was probably the first reading aid. The Venetians learned how to produce glass for reading stones, and later they constructed lenses that could be held in a frame or stand in front of the eyes instead of directly on the reading material. The earliest examples of single-lens, hand-held reading devices date back to the twelfth century and were simple affairs with bone or brass handles.

The first glass reading stone shown is modern and illustrates its use. The second reading stone is a meniscus lens with a convex upper surface and concave lower, which reduces spherical aberration. It is 3 inches in diameter and 1½ inches thick. It has some surface nicks and scratches and a few internal air bubbles. Its age is uncertain, possibly c1800 or before. The lens stand is six inches high. The lens is 2½ inches in diameter. The base and top part of the stand are brass. The folding feet of the base have a raised vine decoration. It probably dates to the nineteenth century.

Modern reading stone.

Convex-concave (meniscus) reading stone.

Magnifying glass on stand.

Magnifying Glass, Fifteenth Century

A magnifying glass is a convex lens that is used to produce a magnified image of an object. The lens is usually mounted in a frame with a handle. Monks used reading stones to assist in illuminating manuscripts beginning in the eleventh century. These were primitive plano-convex lenses initially made by cutting a glass sphere in half. As the stones were experimented with, it was slowly understood that shallower lenses magnified more effectively. It is likely that someone placed a lens in a frame and attached a handle to it to form a magnifying glass. This is an early magnifying glass held in a steel frame with a short handle. The bi-convex glass lens is 65 mm in diameter and magnifies about 3 times. The magnifier is enclosed in a pastboard case 80 x 90 mm in size. The outside of the case is bound in leather and the inside in vellum. “C Sundelius” is written in ink on the inside of the cover. The origin of this magnifier is unknown but it probably dates to around 1500 and was most likely used in a monastery as an aid in writing manuscripts. It is in excellent condition noting an air bubble in the glass and a couple of fine scratches at the edges of the lens and a worm track in the vellum.

Magnifying Glass, Fifteenth Century

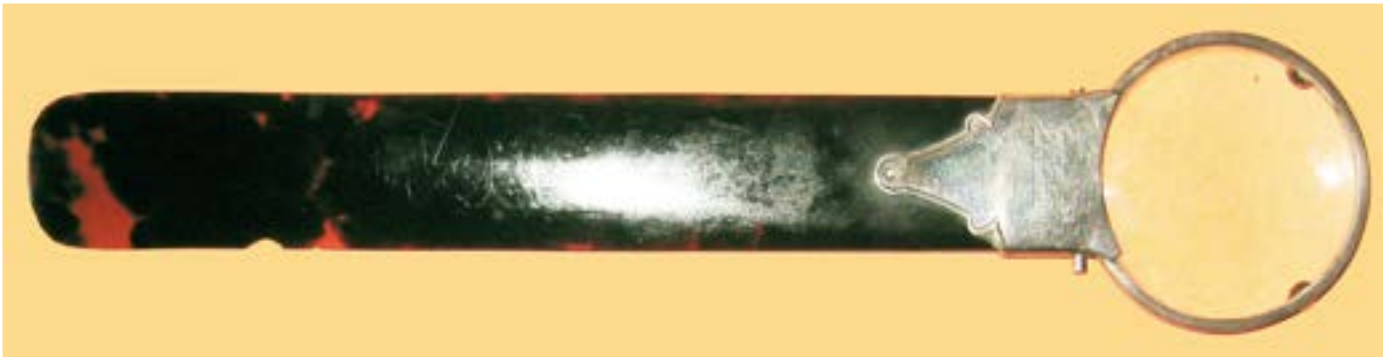
Venetian Magnifying Glass, Seventeenth Century

This is a magnifying lens of Venetian manufacture, probably seventeenth century. The lens is oval, 65 x 75 mm. The lens is enclosed by a rim and folds into a case. The rim and case are made of buffalo horn. A portion of the edge of the lens is missing. An identical magnifier, formerly from the Fritz Rathschuler collection, is in the collection of Leonardo Del Vecchio in the Luxottica Eyewear Museum, Agordo, Italy.

Nuremburg Quizzing Glass, Seventeenth Century

This rare seventeenth century Nuremburg quizzing glass is another example of a single-lens, hand-held reading device. The single magnifying lens on a handle acquired the name quizzing glass in the eighteenth century when men in a parlor used a hand held magnifier to surreptiously spy (“quiz”) on women. This early eye spectacle is made of a convex lens and copper wire frame with a handle. The lens is 50 mm in diameter and the overall length is 4 ¼ inches. The original press paper case has gilt tooled decoration and is lined with early printed paper. Nuremburg, Germany was the center of production for inexpensive quizzing glasses between 1600 and 1725. The quizzing glass later developed into a fashionable accessory designed and worn as a piece of jewelry. Many quizzers were sent to the 13 Colonies to be used as fire starting glasses in the 1700s.

Long-handled Reading Glass, 18th Century



This is another example of an early type of magnifying device. It consists of a magnifying glass in a silver frame attached to a tortoise shell handle. This item could be used as a page marker, a page turner, and as an aid for reading. It was most likely used with a very large bible, dictionary, or atlas. The metal parts are silver, the handle is tortoise shell. The silver has several hallmarks and the initials "EEB." It is probably eighteenth century. The diameter of the reading lens is three inches. Overall length is 14 inches.

Thwaites Magnifying Glass, c1750

This is a magnifying glass by Aynsworth Thwaites who is best known for making turret clocks. John Thwaites was a clockmaker at the beginning of the seventeenth century and from this extended family Aynsworth Thwaites founded the business, now known as Thwaites & Reed, in Rosoman Street, Clerkenwell, London in 1740 and continued there until 1780. The magnifying glass is three inches in diameter and folds into a brass case. The case is inscribed "AYNSTH THWAITES No 4 ROSOMAN STREET CLERKEN WELL." This instrument is in fine condition noting only a worn finish and a small chip in the glass at one edge. This is a fine eighteenth century glass by an important instrument maker. c1750.

Thwaites Magnifying Glass

Horn Pocket Magnifier, 1829

Pocket magnifiers were used from the time of their invention to the present time. This is a pocket magnifying glass with a horn case and swivel lens that is inscribed "1829 Smith W + W M M." It measures 2 ¼ inches in diameter and ½ inch thick. The lens swivels out and is intact but there is a crack in the horn surrounding the glass.

Horn Pocket Magnifier

Coddington Magnifier, c1840

A Coddington magnifier is a magnifying glass consisting of a single very thick lens with a central deep groove diaphragm at the equator. As a result, the image is formed by the central part of the lens reducing spherical aberration. This allows for greater magnification than a conventional magnifying glass although the area seen through the lens is reduced. This type of magnifier was introduced by Henry Coddington (1798-1845) in 1819. This is a Coddington magnifier shown here disassembled to illustrate the Coddington lens. The housing is brass and has a hole for a handle, which is missing. "Coll P & S N Y" is written in script on the body. The College of Physicians and Surgeons obtained an independent charter in 1807 and was later merged with Columbia College. The initials HC and a symbol are scratched onto the body. The magnifier is small, being 28 mm in diameter and 23 mm high.

Coddington Magnifier

Stanhope Magnifier, c1870

The Stanhope hand magnifier was invented by Charles, the third Earl of Stanhope (1753-1816). This modified Stanhope type magnifier consists of a single very thick plano-convex lens 40 mm in diameter. It is held in a band of nickel silver that has a short handle. The lens is ground so when its flat face is placed on a surface, it is just in focus. c1870.

Stanhope Magnifier

Burning Glass

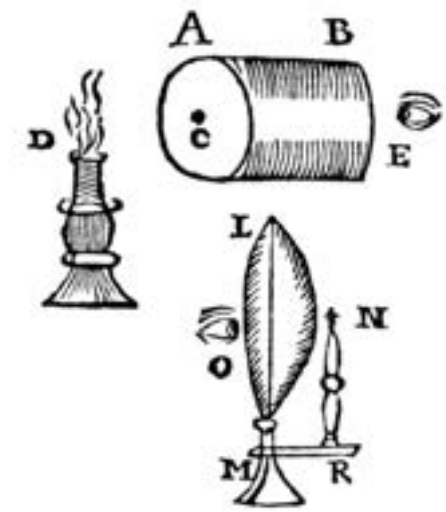
A burning glass or lens focuses the parallel light rays from the sun onto a small focal point, heating up the area and resulting in ignition of the exposed surface. Burning lenses, usually globes filled with water or mirrors, were known in the ancient world, and used to cauterize wounds or start sacred fires in temples. In more recent times, glass lenses were used by explorers, pioneers, hunters, and those in the fur trade to start fires. This is an example of a burning glass meant to be carried into the field. The biconvex lens is five inches in diameter and composed of glass with a blue tint. It has a 6 x 10 inch leather case sewn with a leather cord at the bottom. At the top, there is a broken leather drawstring and a loop that may be a belt loop. The glass is free of chips and scratches. It has been tested and will start a fire. Probably late nineteenth/early twentieth century.

Burning glass and Case

Microscopes

Simple Microscopes

Simple Microscope ("Fleaglass"), c1740
Fleaglass Simple Microscope, c1760
Optical Compendium, c1700
Replica of Leeuwenhoek Simple Microscope, 1665
Hartsoeker-type Screw Barrel Microscope, c1700
Simple Horn Microscope on Stand, c1700
Culpeper Screw-Barrel Microscope, c1710
Culpeper Screw-Barrel Microscope, c1720
Accessories for Screw-Barrel Microscope, c1704-1725
Culpeper Screw-Barrel Microscope on Stand Replica, c1720
Compass Microscope, c1750
Compass Microscope, Lieberkuhn Type Replica, c1780
Withering Botanical Microscope, c1785
Aquatic Microscope, c1790
Naturalist Microscope, c1795
Simple Microscope with Spring Object Holder Replica, c1800
Botanical Field Microscope, c1820
Dissecting Microscope, R. Field, c1855
Linen Prover, c1885
Peep Egg Viewer, Last Quarter Nineteenth Century



The first simple microscope probably originated in the first part of the sixteenth century and consisted of a short tube of opaque material with a lens at one end, and at the other a flat glass plate on which the object to be examined was placed. The instrument was called a *vitrum pulicare*, or fleaglass, and later *microscopium pulicare*, or flea microscope, because it was used to view fleas and other small insects. A second type of fleaglass consisted of a hand-held lens with a spike in front on which the specimen is placed. These simple microscopes are shown in Athanasius Kircher, *Ars Magna Lucis et Umbrae*, 1646. With the invention of this instrument, a natural world unseen by the naked eye was revealed. The public soon realized the attractions of the simple microscope. Today, while many people carry a shiny smartphone or ipod in their pocket, 300 years ago they may have carried an elegant acorn microscope or compendium like the following two instruments. In the seventeenth and eighteenth centuries, the simple or single lens microscope was a more useful instrument for scientific observations than the compound microscope. The latter suffered from chromatic and spherical aberration and it was not until around 1830 when improved lenses were developed that the compound microscope became scientifically useful.

Simple Microscope ("Fleaglass"), c1740

The first simple microscope probably originated in the first part of the sixteenth century and consisted of a short tube of opaque material with a lens at one end, and at the other a flat glass plate on which the object to be examined was placed. The instrument was called a *vitrum pulicare*, or fleaglass, because it was used to view fleas and other small insects. A second type of fleaglass consisted of a hand-held lens with a spike in front on which the specimen is placed. These simple microscopes are shown in Athanasius Kircher, *Ars Magna Lucis et Umbrae*, 1646.

This is a small fleaglass microscope housed in a turned, cylindrical mahogany case. Although it dates to the first half of the eighteenth century, it probably closely resembles the earliest simple microscope of the sixteenth century (Kircher's first example). The case measures 29mm high and 26mm in diameter while the fleaglass is 14mm high and 13mm in diameter. The microscope is housed in a brass cylinder with a small convex lens held in by a circlip at one end. A cap with a concave glass screws into the other end. Another glass disk is in the inside of the cylinder. In use, a small insect would be placed in the space between the glass disks. The microscope would be held up to the light and the specimen viewed through the eye lens. The microscope is in overall very good condition noting some loss of lacquer on the brass and a hairline crack in the case.

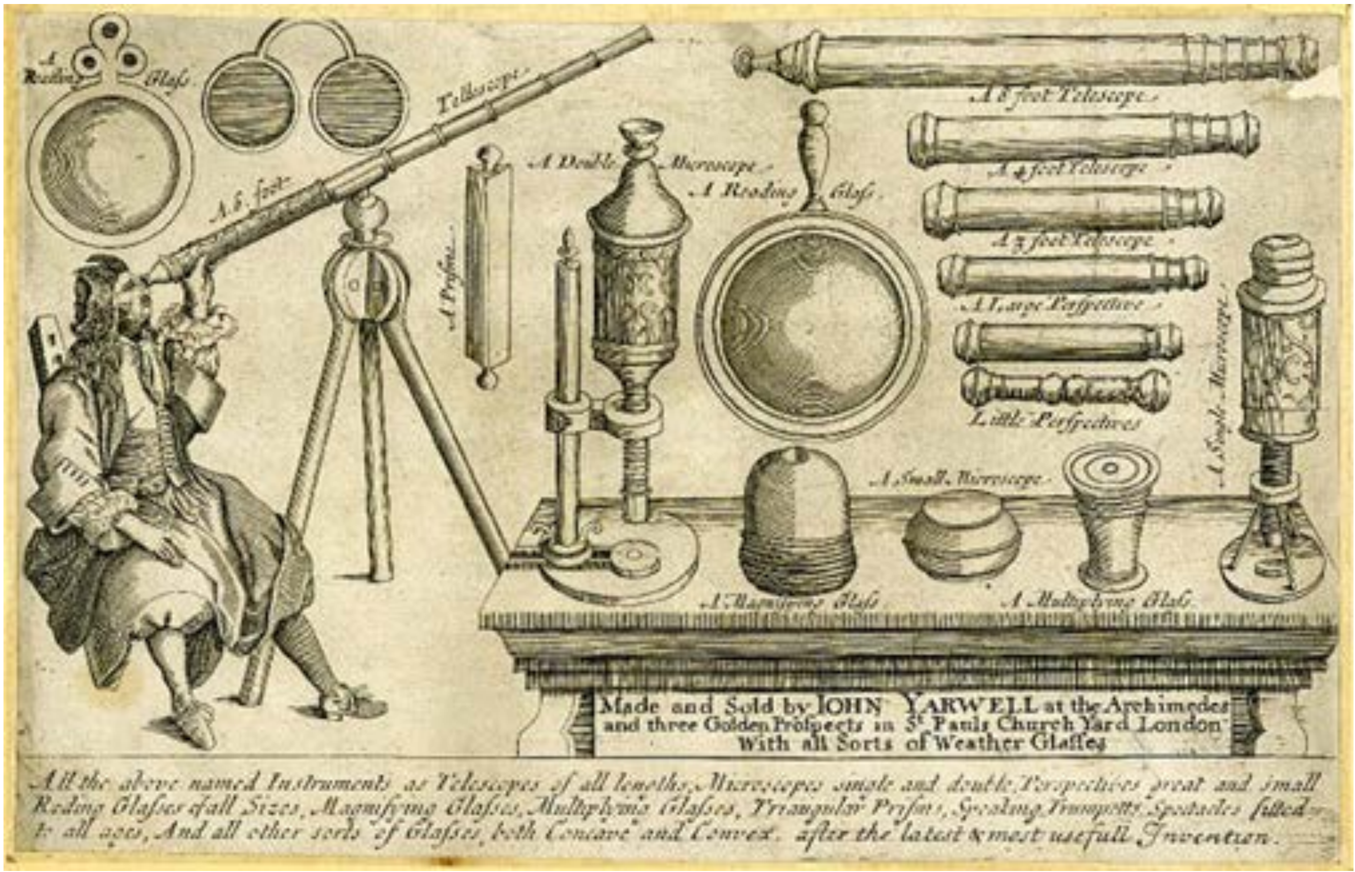
Fleaglass Simple Microscope, c1760

This instrument is a type of fleaglass, also called an acorn microscope because of the shape of the cap. It is also a miniature compendium because it contains the two types of microscopes illustrated by Kircher in 1646. It is made of ivory with some parts blackened. It is small, being about two inches high and one inch wide at the base. A center disk is threaded at both ends to accept the cap and the tubular base. A simple microscope in the form of Leeuwenhoek's microscope is located on the surface of the disk. It consists of a very small lens in a mount and a small vertical pin upon which the specimen is placed. The eye is placed very close to the lens to view the specimen. The base of the instrument is in the form of a flea glass. The bottom plate of the tubular base can be unscrewed and serves as a cell for objects. The base contains a lens at one end that serves as a condenser. Inside the base is a smaller black, slightly conical tube with an eye lens and a field lens. The base with its insert can be held in the hand to view objects placed in the base cap. The insert can also be used as a live box by unscrewing the lens and putting an insect inside. The instrument probably dates to the second half of the eighteenth century although the design is earlier.

Flea Glass/Acorn Microscope, c1750

Optical Compendium, c1700

This is a very rare bone optical compendium, English, c1700. The parts which screw together are left to right: cap, kaleidoscope and live box, simple flea glass magnifier, telescope lens and fixed microscope lens and specimen spike, telescope lens, and cap. The "kaleidoscope" is a multifaceted prism that produces a kaleidoscopic effect when viewing an object. This part is the "multiplying lens" in Yarwell's trade card shown below. The magnifier contains an eye lens and a field lens and fits inside the kaleidoscope which serves as a live box. The next part contains one of the telescope lenses and at the other end a flea glass with a small fixed lens and fixed specimen spike. The last section contains the other telescope lens and screws into the previous piece to form the telescope. The compendium is five inches long and one and one eighth inches in diameter at the widest part. The instrument is in excellent condition with two hairlines. All pieces screw together easily and are functional.



Trade Card of John Yarwell, 1683, Science Museum, London

These compendiums are difficult to date as the makers are not known. However, it appears they were made from the second half of the seventeenth century to the early nineteenth century. They are said to have been sold in large numbers at the end of the seventeenth century and were the instruments that popularized microscopy. John Yarwell's 1683 trade card in the Science Museum, London, illustrates the instruments (not drawn to scale) he marketed. Among them are "a magnifying glass" in the shape of an acorn, "a small microscope," "a multiplying glass," and "little perspectives," one of which resembles a compendium. Instrument makers, such as Yarwell and Culpeper, who made both small microscopes and telescopes most likely made these compendiums. Bone and lignum vitae instruments are probably the earliest. Later instruments were made of ivory, walnut, and brass. An identical compendium is in the Raymond V. Giordano Collection (*Singular Beauty* No. 27) and very similar ones in the National Maritime Museum, Greenwich, England, the Jacques Fouretier Collection, France, and the Billings Collection.

Bausch & Lomb replica of simple microscope by Antony Van Leeuwenhoek

Antonie Philips van Leeuwenhoek (1632-1723) was a Dutch tradesman and scientist from Delft, the Netherlands. He is best known for his work on the improvement of the microscope and for his contributions towards the establishment of microbiology. Although Leeuwenhoek's studies lacked the organization of formal scientific research, his powers of careful observation enabled him to make discoveries of fundamental importance. In 1674 he began to observe bacteria and protozoa, his "very little animalcules," which he was able to isolate from different sources, such as rainwater, pond and well water, and the human mouth and intestine. In 1677, he described for the first time the spermatozoa from insects, dogs, and man. Leeuwenhoek studied the structure of the optic lens, striations in muscles, the mouthparts of insects, and the fine structure of plants. In 1680, he noticed that yeasts consist of minute globular particles. He extended Marcello Malpighi's demonstration in 1660 of the blood capillaries by giving the first accurate description of red blood cells in 1684. A friend of Leeuwenhoek put him in touch with the Royal Society of England with which he communicated most of his discoveries by means of informal letters from 1673 to 1723. He was elected a fellow in 1680 and his letters were published in the Society's Philosophical Transactions.

The microscope of Leeuwenhoek is an extremely simple device, consisting of a single, high-quality lens of very short focal length. His microscopes could magnify up to 275X and resolve down to 2 microns. This was greatly superior to the compound microscopes of the time until the development of achro-matic lenses in the 1830s. The reason for this difference is that although the single lens produces some aberration, the aberration is magnified by the multiple lenses in the compound microscope. The entire instrument is only 3 ½ inches long. The lens is mounted in a tiny hole in the brass plate that makes up the body of the instrument. The specimen is mounted on the sharp point that sticks up in front of the lens, and its position and focus can be adjusted by turning the two screws. The microscope is held close to the eye for viewing. It requires good lighting and great patience to use. He manufactured hundreds of instruments, of which nine or ten originals survive.

A number of replicas of Leeuwenhoek's simple microscope have been produced. This functional example was made by the Bausch & Lomb Optical Company in 1933. It bears the inscription "Replica of microscope by Antony Van Leeuwenhoek about A.D. 1665." Two metal plates are riveted together and secure the glass-bead lens between them. The specimen pin is on a threaded shaft that travels through a bracket on the back of the plate in order to raise and lower the specimen in front of the lens. The focus is another threaded screw that goes perpendicularly through the specimen shaft in order to shift the specimen closer or farther from the lens. One of these Bausch & Lomb replicas was owned by Stanhope Bayne-Jones, Dean of the Yale Medical School from 1935 to 1940, and is now in the Billings Microscope Collection.

Hartsoeker-type Screw Barrel Microscope, c1700

This instrument is an early screw barrel microscope similar to the instrument invented in 1694 by the Dutch mathematician and physicist Nicolaas Hartsoeker (1656-1725). British optician and instrument maker James Wilson is often credited with creating the screw barrel simple microscope in 1702, but it was actually Hartsoeker who first described the device in *Essay de Dioptrique*. Hartsoeker's microscope is also thought to be the first to use a condenser lens, described by Christiaan Huygens (1629-1695) in 1678. This microscope is made of boxwood and consists of three main elements; the condenser assembly, body or barrel, and eye lens cup. The condenser assembly with a plano convex condenser lens at one end screws into the barrel. The eye lens assembly screws into the other end of the barrel. The barrel has a large cutout to accommodate two brass plates that are held against the end of the condenser assembly by a coiled brass spring. The sample, a slider or glass phial, is placed between the two brass plates. Focusing is accomplished by screwing the condenser assembly in or out, which moves the sample nearer or further in relation to the magnifying eye lens. To view the specimen, the user simply holds onto the barrel of the microscope and looks through the eye lens, holding the microscope up to the light if it is a transparent object. The microscope is 77 mm long when focusing on a specimen and the barrel is 32 mm in diameter,

It is difficult to date this unsigned microscope because the Hartsoeker-type screw barrel microscope is extremely rare and there are few examples to compare it with. It is likely that few were produced because it was soon superseded by the Wilson screw barrel microscope that had a handle and multiple lenses and was more versatile. The brass plates closely resemble those illustrated by Hartsoeker in 1694 so that it is possible this microscope was made shortly thereafter. A possible maker is Georg Friedrich Brander (1713-1783) in Augsberg who is noted for his box microscopes, but if he is the maker, the microscope would date to c1750. The microscope is in very good condition noting only a chip in the wood at each end. The condenser lens is a replacement. It produces a good image with a magnification of about 10X.

Hartsoeker-type Screw Barrel Microscope with Wood Slider

Simple Horn Microscope on Stand, c1700

This type of magnifier or simple microscope was popular among naturalists and the interested public in the seventeenth and eighteenth centuries. This example is made of turned horn and consists of a circular base and an upright pillar supporting a biconvex lens in a collar and pierced for the object support. It is fitted with a movable wooden rod that carries a steel specimen spike. It is 9 cm high and the lens is 17 mm in diameter. Focus is achieved by moving the specimen mount in or out while holding the instrument before the eye. Magnification is about ten times. Its origin is unknown but a similar horn stand in the Giordano collection is from Holland and a horn hand microscope in the Science Museum, London is Italian. The specimen rod and spike are replacements. The horn stand is in excellent condition.

Edmund Culpeper Screw-Barrel Microscope, c1710

This is a screw-barrel microscope signed "E Culpeper Fecit." Edmund Culpeper (c1660-1738) was one of the most important makers of scientific instruments in London in the first part of the eighteenth century. The microscope is in very good original condition. The height with handle is 9 cm and the barrel is 3 cm in diameter and 5.3 to 6.3 cm in length. There is one objective lens, numbered 2 and a condenser lens. The end of the condenser cell is unusual in that it is flattened on four sides, probably for ease in turning. The design of the barrel and ivory handle with two bulbous enlargements is indicative of an early example of Culpeper's production.

Culpeper Screw Barrel Microscope

Culpeper Screw-Barrel Microscope, c1720

This is a rare, original screw-barrel microscope by Edmund Culpeper. The screw-barrel microscope was invented by the Dutch mathematics and physics professor Nicolas Hartsoeker (1656-1725) as early as 1689. The microscope was developed in response to a growing demand for a small, portable instrument that was practical to carry into the field, easy to use, and feasible to mass-produce at a reasonable cost. James Wilson in England published a description of it and made improvements in 1702 and it became known as the Wilson screw-barrel microscope. Edmund Culpeper (c1660-1738) was an important maker of scientific instruments. He trained as an engraver under Walter Hayes and took over Hayes's premises in Moorfields in London, before 1700, where he specialized in making mathematical instruments. He diversified into making small, simple microscopes from ivory and brass. In 1725, Culpeper turned to tripod-mounted compound microscopes, introducing major changes and improvements in their mechanical and optical systems. Such instruments were made by various makers over the next hundred years and are known as "Culpeper-type microscopes."

The screw-barrel microscope consists of a small cylinder with an external thread at both ends. The optics consist of an objective lens in a brass mount and screwed onto one end of the threaded body, and a condenser lens for specimen illumination screwed onto the other end. The sample to be examined is inserted through the opening in the side of the tube and is held in place by a spiral spring within the tube. Focusing is accomplished by screwing the outer tube in or out, which moves the specimen closer or further from the magnifying objective.

This instrument is made of bright brass with good lacquer retention. The main body with condenser in closed position measures 2 ½ inches long and 1 inch in diameter. The finely turned ebony handle is 3 inches long and screws into the bracket on the bottom of the microscope. It includes four numbered object lenses with brass caps (all beads intact). There is a magnificent four-celled brass slider for aquatic specimens (wet cells). This slider is doubly stamped "E C" on one side and exhibits Culpeper's rosette pattern on the end of the other side. There is a fish skin case containing four very early sliders. There are also two glass tubes of varying diameter for viewing large aquatic specimens. The green velvet-lined sharkskin case measures 6 x 3 x 2 inches.

Culpeper Screw- Barrel Microscope, c1720

Accessories for Screw-Barrel Microscope, c1704-1725

This collection consists of an extension tube and objectives for a screw-barrel microscope and a group of sliders. The screw-barrel microscope could be converted to a compound microscope by attaching an extension with an eye lens to the objective end of the screw-barrel (see Culpeper Screw-Barrel Microscope on Stand Replica, c1720). The microscope was held by a handle on the screw-barrel or, in some cases, was mounted on a stand. This extension tube is made of ivory and consists of two tubes. It is 88 mm long closed and 102 mm extended and has an eye lens and a locking screw. Focus is achieved by sliding the eye tube. The extension is in fine condition with a stable crack.

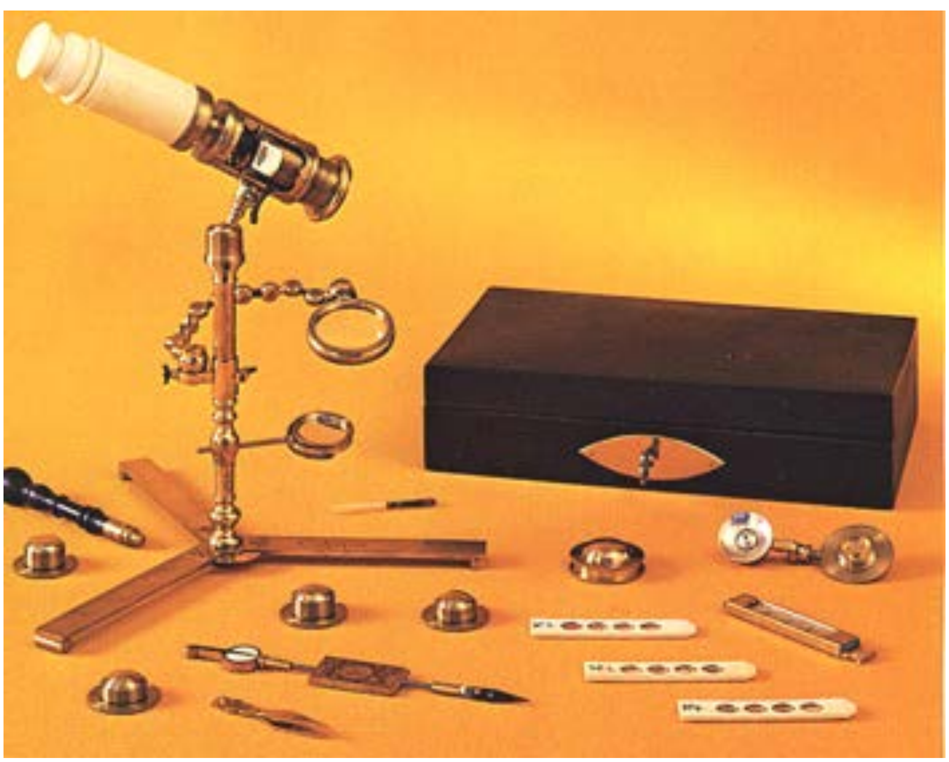
There are seven numbered ivory objectives. The objective lens is mounted in a cell of ivory consisting of a central, hollow cylindrical portion surrounded by a wide flange (30 mm). The outside of the cylindrical portion is threaded to enable it to be screwed into the end of the barrel of a screw-barrel microscope. A brass cup holding the lens fits into the cylindrical portion and is held in by a brass circlip. One objective has its bead lens and two have their caps. (One objective is with the "Objective Collection.")

There are six numbered ivory sliders and one brass slider for wet specimens. The sliders are 2 inches long and 3⁄8 inches wide and have three cells. The ends are beveled so the slider will slip easily into a spring stage on the microscope. Specimens are placed between two round pieces of mica called talcs and held in the compartments by brass rings. All specimens are intact. The brass slider lacks its sleeve.

James Wilson (1665-1730) introduced the screw-barrel microscope to the Royal Society in 1702. Possible makers of these accessories are Wilson, Edmund Culpeper (1670-1738), and Edward Scarlett (c1677-1743) who were the first opticians to make and sell screw-barrel microscopes. The objectives closely resemble objectives made by Wilson (Clay and Court, Figs. 21, 22). The sliders are identical to those accompanying the Culpeper screw-barrel microscope in this collection and those by Wilson in the Museum of the History of Science, University of Oxford and dated c1704. Based on the lettering, the objectives and sliders were made by the same maker, most likely James Wilson. The extension may be of a later date.

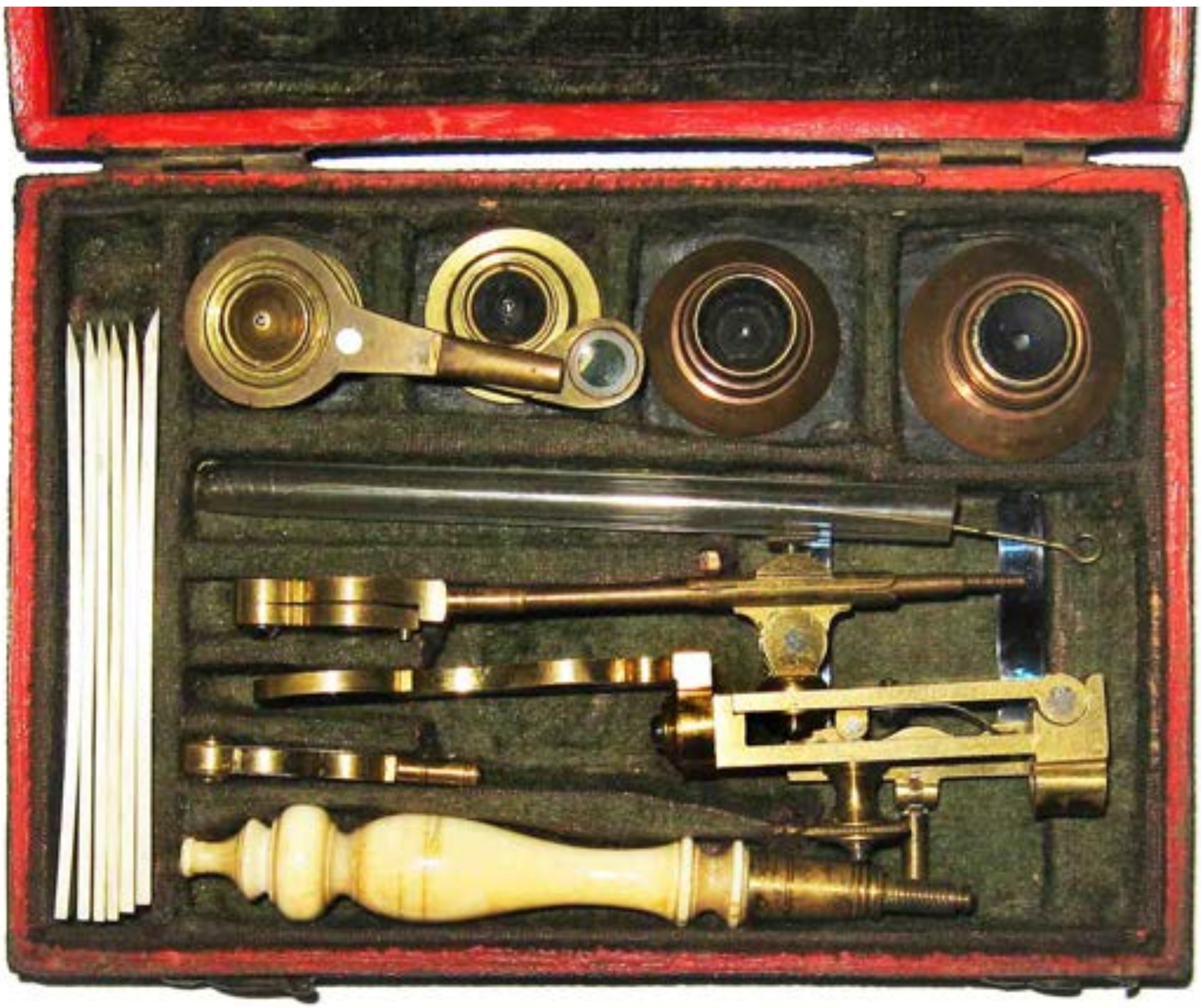
Culpeper Screw-Barrel Microscope on Stand Replica, c1720

This is a Replica Rara replica of a Culpeper screw-barrel microscope on a pillar and stand. It is provided with a tube with an eye lens that screws over the objective mount converting the instrument into a compound microscope. Microscope enthusiasts sometimes added a substage mirror and lieberkuhn lenses to these microscopes at a later date. The brass tripod foot is an adaptation of a 4 ½ inch sector. A turned pillar rises 6 ¼ inches from the sector center, terminating in a ball and socket joint with a slot cut away to permit upright position of the microscope. The modified Bonanni stage has a steel spring, two brass plates, and a third curved brass plate and leather pad to hold a slider or glass tube. A ¾ inch condenser lens exists at the screw barrel end; a 1 ¼ inch condenser lens is mounted on the stand by a knuckle jointed arm. The 13⁄16 inch single concave mirror on a gimbal attaches to the pillar. The screw barrel brass body consists of a threaded screw and hollow sleeve. The compound body is made of ivory. The compound body contains one ocular at the proximate end. The screw-barrel has six simple lenses and one lieberkuhn lens. The compound body contains one objective. Coarse adjustment is by means of a long screw and also with a draw tube for the compound instrument. Accessories include brass tweezers, pencil brush, case for lieberkuhn lens, ebony handle, extension of opaque objects, stage forceps, forceps plate, brass animalcule cage, and four ivory sliders. The black Moroccan skiver leather covered wooden case, 8 9⁄16 " l x 5" w x 2 1⁄8" h, is lined with dark green velvet. The compound microscope closed is 5 ¾ inches long. The microscope on stand in horizontal position is 7 ½ inches tall. "Culpeper Fecit" is engraved on two folding arms of the sector stand. Engraved along the hollow screw-barrel sleeve is "Culpeper Fecit." and on the forceps plate, while on the other, Culpeper's name is surrounded by a garland emblem. The sector stand has an ornamental motif at the base center. The simple lens mounts bear engraved numbers 1 through 6. The Replica Rara stamp and serial number is located on the underneath side of a sector foot. The extremely fine Replica Rara, now Science Heritage Ltd., microscopes in this collection were donated by Dr. James B. McCormick.



Culpeper Screw-Barrel Microscope on Stand Replica, c1720
Compass Microscope, c1750

This is a very fine compass microscope with all of its accessories and possibly made by John Cuff (1708-1772). A compass microscope consists of two arms linked by a hinged joint. Instruments of this type are called "Compass" microscopes because of the center hinge, reminiscent of a drafting compass. An ornate lens holder is attached to one arm. A specimen rod sleeve is mounted on a compass joint on the other arm; a spring keeps the arms apart. The specimen rod is threaded at both ends. Three accessories can be screwed onto the specimen rod: forceps with steel pincers and a black/white disc behind; a live box; and a holder for a glass tube or a slider. The forceps pincers can be turned back to hold a specimen on the black/white disc. The holder may be rotated to use either end. The whole assembly screws onto a turned ivory handle. There are four object lenses with the microscope of different focal lengths and all beads intact. Two of the lenses have a concave polished silver mirror or lieberkuhn around the lens. This allows light to be reflected from the cup-shaped mirror onto the specimen so that it is well illuminated. The lenses are screwed into a brass ring at the end of the lens holder. The microscope is 7 ½ inches (19 cm) long assembled.



For viewing, the specimen is held in front of the object lens and the lens is held close to the eye. Coarse focusing is accomplished by sliding the shaft of the specimen holder in the sleeve and moving the shaft in or out to attain the proper position in front of the lens. A milled-head screw on the first arm and acting on the second arm serves to adjust the distance between the compass arms for fine focus. Other accessories include a hand-held magnifier with an additional swing out lens for increased magnification, a glass tube with clean out rod for holding aquatic specimens, and six ivory sliders with specimens intact. One of the sliders is marked "ED. Apr. 1 1776. The microscope and accessories fit into a wooden case lined with green velvet, covered with black fish skin, and with two large C hooks. The case is 5 ½ x 3 ¾ x 1 inches in size. The microscope is in exceptional condition with all lacquer on brass and bluing on steel intact and complete with its accessories. This microscope appears identical to one in the Museum of the History of Science, Oxford that is attributed to John Cuff. Other makers of compass microscopes were George Adams and Benjamin Martin.

Compass Microscope

Compass Microscope, Lieberkuhn Type Replica, c. 1780

This is another fine replica made by Replica Rara. This type microscope has two arms connected by a hinge at the bottom. One arms holds the specimen and the other the eye lens. It is called a compass microscope because of its similarity to a draftsman's compass. It is provided with lenses introduced by the German anatomist and physician, Dr. Johann Lieberkühn in 1740. These objective lenses have a concave polished silver mirror around the lens. This allows light to be reflected from the cup-shaped mirror onto the specimen so that it is well illuminated from the eye side. These lenses became standard equipment for 150 years and became known as lieberkuhns. Both the lieberkuhn lens and the instrument's portability enhanced the use of the microscope for botanical field work.

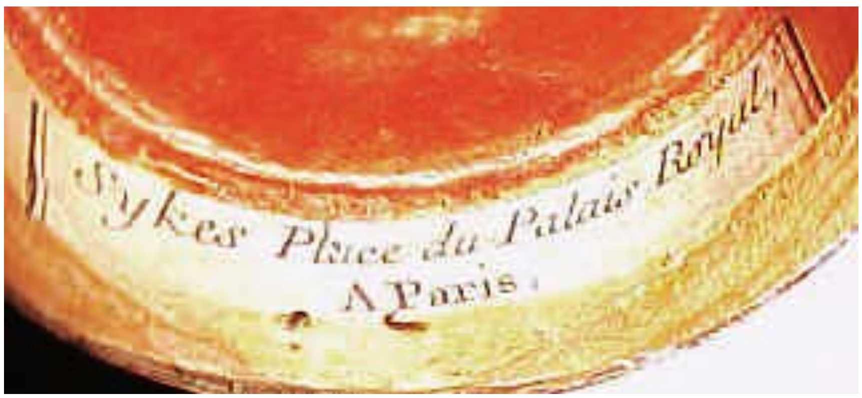
The object is held with a forceps which inserts into a brass fitting on the hinged compass arm. The forceps is turned by an L-shaped brass handle. The body, consisting of a brass circular ring, is mounted on a curved brass arm 3 inches long. A brass eyepiece, coated black on the eye side, screws into the circular ring. Four lieberkuhn lenses screw into the eyepiece. Each lens is matched in focal length with its coin silver concave mirror. Fine focusing is achieved by turning the knurled knob to adjust the distance between the compass arms. Accessories include a hand magnifying lens, in a lignum vitae mount, and brass tweezers. The rectangular mahogany case, 7 ½" l x 2 7⁄8 " w x 1 11⁄16 " h, is fitted and lined in chamois leather. The overall length with handle is 6 3⁄4 inches. The Replica Rara stamp and serial number is located on the inside surface of the hinged compass arm.

Compass Microscope, Lieberkuhn Type Replica, c. 1780

Withering Botanical Microscope, c1785

William Withering (1741-1799) was an English botanist, geologist, chemist, and physician. He is best known for his use of extracts of foxglove (*Digitalis purpurea*) to treat dropsy (edema), a condition associated with heart failure and characterized by the accumulation of fluid in soft tissues. For this he is considered the father of clinical pharmacology. In 1776, he published the landmark botanical treatise *A Botanical Arrangement of All the Vegetables Naturally Growing in Great Britain*. In the book, Withering described a portable simple botanical microscope that he designed. The microscope was popular and variations on the design, including improved models created by Withering, survived throughout the nineteenth century.

This is an all brass example of the original cylindrical form of the Withering simple microscope. The microscope measures 63 x 35 mm and consists of three rings on two supports. The upper ring holds the biconvex eye lens, the middle is the stage, and the lower is the base. An extra end plate that can be unscrewed from the base contains a lens and can be used as a hand magnifier. Focusing is achieved by simply sliding the stage up and down on the brass supports. Illumination of the specimen depends on ambient light. The accessories are a pair of brass tweezers (appears to be a replacement), a pin probe, and a scalpel. The stage and base have openings to hold the accessories.



The microscope fits into the original maroon, velvet lined card case with decorative buttons and secure push-button clasp. It bears the trade label for "SYKES Place du Palais Royale A Paris" and the number and price appear on the inside of the lower plate. H. Sykes was an English optician living in Paris and marketing instruments there in the late eighteenth century. He reportedly made bifocals for Benjamin Franklin in 1779. This microscope dates c1785.

Aquatic Microscope, c 1790

One of the great classic designs of mid-eighteenth century microscopes is the “Ellis Aquatic microscope” developed in the 1750’s by John Cuff and John Ellis. Pond life was a popular source of material for observation with the microscope throughout the eighteenth and nineteenth centuries. John Ellis (1710-1776) was an English naturalist who worked and traveled in America and the West and East Indies. He designed a microscope for the purpose of observing the movements of tiny water creatures contained by a watch glass on the stage. The first model was made for Ellis by John Cuff in 1752. The novel feature of the microscope is that the arm can swivel from side to side allowing the user to follow the wriggling movements of aquatic organisms. This design soon became one of the most popular naturalists’ microscopes and was sold by many instrument makers, notably Adams and Dolland, into the nineteenth century. The Ellis aquatic microscope can also be regarded as the forerunner of the dissecting microscope.

This microscope is an example of the original form of the Ellis-type aquatic microscope. The cylindrical pillar screws into a boss on the top of the mahogany case. The simple lens objectives are fitted into a ring at the end of a bar at the top of the pillar. Focusing is achieved by adjusting the height of the sprung-brass stage relative to the objective. The principle design advantage is that both the lens arm and the stage can be moved from side to side so the user can follow the movements of aquatic organisms. Included are two objectives, tweezers, a black/white disc, concave glass specimen dish, live/aquatic box, bug-spike, two wooden sliders, and a concave mirror. The case is 3 ½ x 5 ¼ inches and the microscope is 6 ¼ high attached to the case. c1790.

Aquatic Microscope

Naturalist Microscope

Naturalist Microscope, c1795

This instrument is a small flea/entomological/botanical microscope that can be folded and carried into the field. This simple magnifier has two stacked plano-convex lenses, an ivory handle, and forceps that fit into a knurled nut that slides in a grooved brass plate for focusing. The lens arm and handle fold against the plate. When folded, the instrument fits into a leather-covered cardboard case. Although not signed, it is similar to the naturalist microscope described by the firm of William and Samuel Jones of London in 1798. The microscope is four inches long extended and magnifies approximately 10x. c1795.

Botanical or Universal Pocket Microscope, 4^{th} quarter 18^{th} century

This is a botanical or universal pocket microscope that may be historically significant because of the name stamps on it. The botanical pocket microscope was derived from the earlier "Aquatic Microscope" designed by John Ellis (1710-1776). W. & S. Jones produced an "Improved Botanical or Universal Pocket Microscope" from about 1795 onwards. This microscope appears to date before that. It is made of brass and stands four inches high. The body consists of a square pillar that supports the stage and is topped by an arm that holds three simple magnifiers. Each of the lenses is mounted on an arm that allows it to be swung into place above the sample. From one to all three objectives may be used at one time. The stage consists of a thick brass top piece with a large aperture and a thinner spring stage below. Focusing is accomplished by sliding the stage along the main support pillar. The pillar fits into a square base and is held in by a pin. The base itself is screwed to the oval ebony base. A single concave mirror fits into a hole at the bottom of the pillar. Accessories are a stage probe, ivory pinhole stage disc, four ivory sliders, and a mahogany case with ivory bun feet.

The significant feature of this microscope is that it has three name stamps on the top of the base. One of the stamps on this microscope is that of "I. Ellis." John Ellis was an English naturalist who designed a microscope for the purpose of observing the movements of tiny water creatures contained in a watch glass on the stage. The first model was made for Ellis by John Cuff in 1752. The novel feature of the microscope is that the arm can swivel from side to side allowing the user to follow the wriggling movements of aquatic organisms. Rowbury (1982) discusses a botanical pocket microscope identical to one pictured by George Adams Jr. in his *Essays on the Microscope* in 1787. This microscope is also stamped by Ellis and it was suggested that the botanical pocket microscope was designed by John Ellis. The present microscope supports that conclusion. Because Ellis died in 1776, this microscope would appear to date prior to that, unless his stamp continued to be used to indicate the designer.

A second somewhat skewed stamp on the microscope and also on the bottom of the case is that of "W Gould. " The National Museum of American History (Smithsonian) lists William Gould as author of *The Companion to the Microscope and a Description of C. Gould's Improved Pocket Compound Microscope, Which has all the Uses of the Single, Compound, and Opaque Microscopes* (London, 1827). This was also published by Charles Gould through many editions. Thus, W[illiam] Gould could be a relative of Charles Gould. Charles Gould (c1786-1849) was the manager and head machinist for the company of William Cary (1759-1825). Around 1826, Gould designed a pocket microscope that could be used as a simple or compound microscope. Since there is no connection between Ellis and Gould, it is likely that Gould obtained this microscope at a later date and placed his stamp upon it. The third stamp is highly obscured, but appears to be that of "Adams." George Adams Sr. (c1708-1773) and George Adams Jr. (1750-1795) were manufacturers of the Ellis Aquatic microscope. Because George Adams Jr. pictured a botanical pocket microscope in 1787, he was manufacturing microscopes of this design well before W. & S. Jones who took over the Adams' business. William Jones at some point was employed by George Adams Jr. It seems likely that this microscope was designed by John Ellis and was first produced by the Adams and then by the Joneses.

Botanical or Universal Pocket Microscope

Simple Microscope with Spring Object Holder Replica, c1800

This is a Replica Rara replica of a Continental simple microscope made of fruitwood and dating to the late eighteenth and early nineteenth century. Some of these devices were manufactured by "toy makers" among whom were the wooden toy craftsmen of Nuremburg, Germany. The microscope is formed by three turned wooden components: the simple round base, pillar, and an objective lens holder. A pointed brass needle serves as the specimen mount. The coil of brass wire from which the point extends can be moved by delicate finger pressure to adjust the lens focus. The simple biconvex lens is mounted in the depression of a turned wooden ocular and secured in place with a brass ring. In use the microscope is held between the thumb and forefingers. Fine focus is achieved by depressing the spring needle specimen mount while holding the instrument before the eye. Overall microscope height is 3 1/8 inches.

Botanical field microscope, c1820

This simple microscope is a fine pocket microscope that was taken into the field to study botanical or entomological specimens. A pillar screws into the top of the reddish-brown card case. The stage attaches to the pillar and has openings for an ivory disc and live/aquatic box, forceps, and sliders. Stage adjustment is by rack and pinion. The stage pivots to accommodate the forceps for insect or flower viewing. At the top of the pillar, an arm holds a rotating turret of three lenses. This differs from most instruments of this type that have three separate swing lenses. There is a one-sided mirror below. The accessories include stage forceps, black/white ivory disc, and a live box/aquatic cell. Although this microscope is unsigned, it is of the highest quality for this type of microscope. c1820.

Botanical Field Microscope

Dissecting Microscope, R. Field, c1855.

The dissecting microscope developed from the aquatic and botanical microscopes. The dissecting microscope is very similar to the earlier forms but differs in that it has a larger stage allowing for better manipulation of the specimen. The ends of the stage are slanted to serve as a hand rest. Later, larger wings were attached to the sides of the stage. This example, c1855, has a trade label in the case "R. FIELD & Co." The stand is made of polished mahogany and stands 4 7⁄8 inches tall on its 8 1⁄8" x 4 inch base. The brass column is 5 3⁄8 inches tall overall, with internal rack and pinion focusing and a single-sided mirror mounted at the base of the column and an arm to hold the eye lens at the top. The original accessories include three screw-together simple objectives, brass live box, stage-mounted forceps, and stage-mounted bull's eye condensing lens.

Dissecting Microscope

Linen Prover, c1885.

In the mid-nineteenth century, textile merchants used standardized simple microscopes that were known as linen provers to ensure that linen weavers met specified fiber counts. Also known as counting glasses or thread counters, the handy, pocket-sized magnifiers were sometimes used for other types of inspection work as well, including art verification and forensic science. The instrument-making firm of Casartelli was a leading specialist firm which made and sold scientific and engineering instruments. The firm operated in England during the "golden decades" of her industrial power. The firm was one of the first specialist instrument firms to be established in mid nineteenth-century Manchester. This instrument fits into a velvet-lined case 2 ½ by 2 inches. It is made of brass with a lateral adjustment by screw and a pointer over a scale in inches. It is signed " J CASARTELLI & SON MANCHESTER" and RD No 523462. It shows signs of wear but is in good condition. c1885.

Peep Egg Viewer, Last Quarter Nineteenth Century

Peep egg viewers, so named because of their shape, were made for amusement during Victorian times and contained scenic views and objects such as dried flowers, insects, shells, or mineral crystals. They were part of the popular science that developed in England and parts of Europe after the Industrial Revolution due to the growing interest of the public in natural history and history. They were also used as souvenirs of popular attractions.

This peep egg viewer is a souvenir of Niagara Falls. It stands 11.5 cm tall and 6 cm in diameter. The peep egg is made of alabaster, so that light passes through the body of the device and no other source of illumination is required. The front is hand painted with flowers and an inscription "From Niagara Falls." The fixed viewing lens is 21 mm in diameter and magnifies the image about five times. The body is fitted with twin alabaster ball handles rotating an interior spindle with the objects mounted on cardboard. The objects are two scenes of Niagara Falls ringed by small colored stones and an arrangement of colored minerals. The viewer is in very good condition noting only some loss to the paint.

Compound Microscopes, 1660-1900

Compound Tripod Microscope, Italian, c1660
Compound Tripod Microscope, Italian, Second Half Seventeenth Century
Compound Microscope, Italian, 1673
Compound Tripod Microscope, Eighteenth Century
Hand-held, Bone Compound Microscope, c1680-1720
English Tripod Microscope Replica, c1680
Marshall's Double Microscope Replica, c1700
Culpeper Tripod Microscope, c1730
Side-Pillar Microscope, c1750
Compound Screw-Barrel Microscope Replica, c1750
Benjamin Martin "Universal" Microscope, c1760
Nuremberg Sentry-Box Microscope, c1765
Nuremberg Culpeper-Type Tripod Microscope, c1770
Cuff-Type Microscope by George Adams, c1770
Drum Microscope by Benjamin Martin, c1775
Dellebarre "Universal" Microscope, c1780
Culpeper Microscope, George Adams, Jr., London, c1790
Culpeper-Type Tripod Microscope, William Harris, c1810
Jones Improved Microscope, c1810
Dollond Cary-Gould Type Chest Microscope, c1820
Jones Most Improved Microscope, c1820
English Drum Microscope, c1830
Cary-Gould Pocket Microscope, c1835
Chevalier Horizontal Achromatic Microscope, c1835
Andrew Pritchard Achromatic Microscope, c1840
Chevalier Student Microscope, c1840
Drum Microscope by Camille Nachet, c1845
Ross Bar-Limb Microscope, c1849
Ross Monocular Microscope, 1847
Oberhaeuser & Hartnack Drum Microscope, 1857
Compound Monocular Microscope, English, c1860
Nachet-Type Pillar Microscope, c1870
French Toy Drum Microscope, c1880
Browning Polarizing Microscope, c1880
English Wenham Binocular Microscope, R & J Beck, 1880
Crouch Binocular Microscope, c1875
Ross-Zentmayer Compound Microscope, 1885
J. Buist & Sons Compound Microscope, c1885
Zeiss Continental Monocular Micoscope, 1892
Leitz Continental Monocular Microscope, 1888
Watson & Sons Monocular Microscope, 1898

The compound microscope and the telescope are believed to have been invented by Dutch lens crafters at the end of the sixteenth century. It is likely that a spectacle maker experimenting with two convex lenses found that one held over the other at a certain distance gave a greater magnification. By placing the lenses at the ends of a tube, the compound microscope was invented. Similarly, the original flea glass could have been converted into a compound microscope by simply replacing the glass plate at the end of the flea glass with another magnifying lens so that there were lenses at both ends of the tube. Except for the c1595 microscope attributed to Zacharias Jansen (c1580-c1638) in Middelburg, there are no surviving examples of the earliest microscopes. The microscope of Cornelius Drebbel (1572-1633), known from a 1619 drawing, is a tripod microscope in which the microscope tube is supported upright by legs. This was the predominent form of compound microscopes in the seventeenth century.

Compound Tripod Microscope, Italian, c1660

Compound Tripod Microscope, c1660

This is a seventeenth century microscope, probably Italian, on a tripod base. The microscope is 5 ¾ inches (14.6 cm) high opened. The body tube is a single piece of turned lignum vitae that is externally threaded on the objective end. The body screws into a wooden mounting ring supported above the base by three turned ivory legs. There is an eye lens and an objective in the nosepiece of the body held in by brass rings. The outside surface of the objective lens is convex while the eye lens is plano-convex. It does not have a field lens dating it to 1660 or before. A wooden ring screws in over the eye lens reducing the opening and decreasing spherical aberration. There is also a wooden dust cap. Focus is achieved by turning the body in the collar. The circular base supporting the legs is 2 ¼ inches in diameter. A circular platform in the center of the base holds an ivory disc that acts as the sample stage. Illumination is by incident light. The base sits on three wooden buttons. The microscope produces a clear image of about 10X magnification with spherical and chromatic aberration. The microscope is in excellent condition. It is unsigned but possible makers are Giuseppe Campani (1635–1715), an Italian optician and astronomer who lived in Rome, and Eustachio Divini (1610–1685), another prominent manufacturer of scientific optical instruments in Rome.

Compound Tripod Microscope, Italian, Second Half Seventeenth Century

This is an early compound tripod microscope, probably Italian, second half seventeenth century. It is 5 ⅜ inches (13.5 cm) high and the diameter of the base is 2 ¾ inches (7 cm). The body tube is made of lignum vitae and is secured to the flat round base by three turned bone legs. The base is made of a black wood that appears to be ebony and holds a bone disk for the specimen. The eye lens is embedded in a bone disk fitted into the top of the tube. A turned and ribbed bone nosepiece fits into an extension of the body tube with the objective lens secured by a brass circlip. It is not known if it has a field lens. Cosmetically, the microscope is in very good condition noting that the legs may have been re-glued. It does not produce a clear image and cannot be focused. There is dust on the lenses and inside the body tube. It appears that the nosepiece should be able to be turned for focusing but it is fixed and no attempt has been made to force it.

Compound Tripod Microscope, Second Half Seventeenth Century

Compound Microscope, Italian, 1673

This is possibly a seventeenth century Italian compound microscope. It stands 6 inches high extending to eight inches. The form (metal tripod stand, cardboard tube) is characteristic of some microscopes made by Eustacio Divini (1610-1685), one of the foremost makers of telescopes and microscopes in the seventeenth century. It also bears similarities (iron support with three legs and wooden eye and nose pieces) to a microscope attributed to Giuseppe Campani (1635-1715), the other prominent optician in Rome. The microscope is held in a sheet iron stand consisting of a ring to hold the body tube with three legs bent at the bottom. The feet are pierced with holes to affix the microscope to a wooden base. The ring is inscribed with "ROMA" and "1673." The body tube is made of pasteboard covered with vellum. The turned wooden (possibly sycamore) nosepiece is affixed to the tube and a brass ring holds the biconvex objective lens. A biconvex field lens in a circlip is on top of the nosepiece. A turned wooden eyepiece slides into the body tube and a brass ring holds a plano-convex eye lens. The aperture of the eyepiece is narrow to reduce spherical aberration. The objective lens is original but the field lens and eye lens are replacements. The objective has many tiny air bubbles, imperfections, and possibly some surface encrustation. Focus is achieved by sliding the body tube and the eyepiece. The microscope produces a somewhat distorted image of about 20X magnification. The microscope is in good condition for its age but the iron stand shows some pitting from rusting and the vellum covering has a few rust stains. Further study is needed to determine the authenticity of this microscope.

Italian Microscope, 1673

Compound Tripod Microscope, Eighteenth Century

This compound microscope has a main body tube made of wood (possibly fruitwood) covered in dark green leather with elaborate gold tooling of a vase and leaf design. The body fits into a cast iron collar suspended by three iron legs. It stands about 5 inches high and 1 3/8 inches in diameter at the widest point. The turned eyepiece and nosepiece are fabricated with blackened wood (possibly sycamore). There are three lenses, an eye lens, field lens and objective. The eye lens is 13 mm in diameter and the objective 9 mm. The field lens at the top of the body tube is larger. The objective lens is biconvex and the outer surfaces of the other lenses, which can be seen, are convex and all lenses have tiny imperfections and air bubbles. The objective is held in a cap that screws onto the nosepiece. Focusing is by sliding the body tube in the collar and finer focus can be achieved by screwing the objective cap in or out. The microscope is in excellent condition and produces a somewhat hazy image of approximately 40X magnification. It most closely resembles microscopes made by Giuseppe Campani (1635-1715) in Rome. Further research is needed on the origin and authenticity of this microscope.

Compound Tripod Microscope

Hand-held, Bone Compound Microscope, c1680-1720

This is an extremely rare hand-held bone compound microscope. It was probably made from a cow metatarsal bone, much like similar telescopes of the period (see example under telescopes). The tube is 14 cm (5 ½ in) long and 23 mm (0.9 in) in diameter. It is decorated with intricate raised carvings and appears to be composed of two pieces. The eyepiece is housed in a brass frame with the lens being protected by a sliding bar. The objective lens is held in place by a brass circlip. There does not appear to be a field lens. The focal length of this instrument is about 5 cm (2 in), providing a magnification of about 5X. Despite spherical and chromatic aberration, the microscope provides sharp images for the period. Although examples of bone microscopes, telescopes, and optical compendia from this period are known, nothing quite comparable to this instrument has been identified. It bears the closest similarity to bone telescopes and was most likely made by a maker of telescopes. The instrument is in very good condition noting only a stable hairline crack in the bone near the eyepiece holder.

Hand-held, bone compound microscope

English Tripod Microscope Replica, c1680

Most seventeenth century compound microscopes were made in the form of a cylindrical tube supported by a small tripod. The design was first known in 1619 and the pattern continued in various forms for 200 years. This microscope is a replica of one probably made around 1680 by John Marshall. It is an exact replica of the original using the same materials and measurements accurate to a fraction of a millimeter. It was manufactured in 1975 by Culpeper Instruments, an English instrument maker, and Replica Rara Ltd., now Science Heritage Ltd., under the direction of Dr. James B. McCormick, a specialist in scientific instrument design and laboratory medicine, and with the critical review of Mr. Gerard L'E. Turner, a past President of the Royal Microscopical Society and Associate Curator of the Museum of Science at Oxford University. Production was limited to six instruments at a cost of $6,000 each. The original microscope is in the Museum of Science at Oxford University. In order to avoid the replica being sold as an original, the gold embossing does not follow the original.

Replica of c1680 English Tripod Microscope

The barrel of the microscope consists of an inner pasteboard tube covered with vellum and an outer pasteboard tube covered with red morocco. The tubes are decorated with gold-impressed tooling. The wood used in the instrument is lignum vitae. The outer tube carries a wooden eyepiece with a lens. The outer tube can slide over the inner tube for coarse focusing. The inner tube is mounted on a circular turned and pierced base by three brass legs. The inner tube bears the nosepiece which holds the objective. There is a field lens at the top of the inner tube. For fine focusing, the nosepiece is screwed in and out of the collar. When not in use, the eyepiece is covered by a circular box top which holds four objectives. To observe a specimen in transmitted light, it is firmly affixed over the circular hole in the wooden stage and the microscope is then held up to a light source (the sun or a lamp) while the specimen is viewed through the ocular.

A circular ivory disc, black on one side and white on the other, fits into the opening in the base for viewing opaque objects. The microscope is stored in a Morocco leather and gold embossed pasteboard tube. For assembly, if two wooden pieces are to be screwed together, there are tiny grooves on each part that should be aligned to indicate the start point for screwing the pieces together.

At the end of the seventeenth century, the most prominent instrument makers in London were John Yarwell (1648-1712) and John Marshall (1663-1725). Apprenticed in 1662 to Richard Edwards a spectacle maker, John Yarwell became a Freeman of the Spectacle Makers' Company in 1669 and elected Master of the Spectacle Maker's Company in 1684. John Marshall (c1660-1723) apprenticed to John Dunnell of the Turners' Company and became free in 1685. He was a pioneer both in the use of commercial advertising and of the polishing of spectacle lenses in multiple groups. He was appointed optician to George I around 1715. A microscope nearly identical to this and signed I. Marshall was auctioned at Sotheby's, September 21, 2000, and previously by Christie's, October 4, 1995.

Marshall's "Double Microscope" Replica, c1700

John Marshall (1663–1725) was one of the great seventeenth century opticians and microscope makers. Marshall apprenticed under a telescope maker, and started his own workshop around 1687. There he created mostly optical instruments and machines for making these devices. He is credited with inventing a method of grinding multiple lenses simultaneously. Advertisements for microscopes came out of the Marshall workshop in 1688; and in 1693 Marshall introduced this intricately detailed compound microscope, the "Great Double Microscope." He popularized it by publishing an advertisement in the *Lexicon Techinicum*, the first technical dictionary published in 1704. Marshall called his microscope the Great Double Microscope for two reasons: he wanted to illustrate the large size of the microscope and to reinforce the fact that it was a compound microscope. The microscope has several advances over existing microscopes of the era. These include a rigid support pillar; a stage supported on the same pillar; ball-and-socket joint at the base of the support; Hevelius screw focus; base-mounted condensing lens for transparent objects; and a graduated set of objectives.

Like the English tripod microscope above, this instrument was manufactured by Culpeper Instruments, an English instrument maker, for Replica Rara Ltd., now Science Heritage Ltd., and cost $9,000 to produce. The microscope is large, standing over 24 inches extended and the body tube is four inches in diameter. Most of the barrel components are of lignum vitae of varying wood grain and color. The entire microscope is supported by a large brass pillar, which is hinged at the base by a large ball and socket that allows the instrument to be inclined. The top of the pillar is decorated with an acorn. The ball and socket is fastened to a finely-crafted octagonal wooden base of walnut with a maple top. Original microscopes are weighted with lead at the opposite end to balance the microscope. Inside the base is an oak drawer that serves to hold the objectives and accessories. The microscope has a main body tube made of cardboard and covered in green, gold-tooled vellum. The polished brass objective nosepiece is screwed to a dark lignum vitae base that itself is glued to the cardboard body. There are six interchangeable objectives having a magnification range of 4x to about 100x. The top half of the instrument consists of a cardboard drawtube covered in gold-tooled leather. It is topped with an elaborately turned lignum vitae top piece containing the field lens and eye lens. To focus the instrument, the bracket holding the body tube can be moved up and down the side pillar to one of the marks representing the power of the lens in use, and then it is locked in position. Fine focusing is achieved by means of a Hevelius screw focus consisting of a threaded rod and a large, faceted knob. On the side of the wooden base there is a brass mount that supports a condensing lens for transparent samples.

Replica "Double Microscope" by John Marshall, c1700

The microscope has two stages. One has a rectangular plate that holds a glass insert for use with transmitted light. There is a half cylinder of lead, called a coffin, to hold down the body of a small fish to observe the circulation of blood in the tail fin. When the microscope is placed at the edge of a table, the specimen can be illuminated from below with a candle. The other stage, intended for reflected light observations, holds a brass insert for a black/white ivory disk and has an opening for the stage forceps. The stages are secured to the base of the pillar by means of two forked legs that are tightened by a nut positioned just above the ball and socket assembly. Other accessories are brass tweezers and an ebony specimen spike.

There are only 17 or so known Marshall Great Double instruments in existence, all except possibly one in museums. This high quality replica is more than sufficient to represent this great microscope.

Culpeper Tripod Microscope, c1725-1730

Edmund Culpeper is credited with creating the "Culpeper-type" microscope around 1725. It uses the same motif as the earlier Campani-style tripod microscopes and the English tripod microscopes. Culpeper's design made two improvements to the tripod microscope. The stage was raised above table level making it more accessible. A concave mirror was inserted below the stage allowing for illumination of specimens from below. This avoided the necessity of holding the microscope bodily up to the light. This design is sometimes considered a regression from the pillar-style microscopes developed by Hooke and Marshall. However, the pillar-style may not have been as widely adopted because the pillar did not provide enough stability for fine focusing, whereas the rotational symmetry about the optic axis of the Culpeper design provided better stability.

This is an impressive and attractive early compound microscope clearly attributable to Edmund Culpeper and dating to around 1725 to 1730. The microscope stands 14 inches high on a circular turned base, 5 3⁄8 inches in diameter, of lignum vitae. Three turned brass pillars which hold the 3 3⁄8 inches diameter stage and a concave mirror in a brass gimbal with a turned brass back are screwed into the base. The stage holds a small bulls-eye condenser in a gimbal at the edge, two stage clips, and a sub-stage clip presumably to hold a fish plate. An opening in the center of the stage holds a Bonanni spring stage. Into the stage are screwed three further shorter pillars that rise to hold a brass threaded collar. The lignum vitae base of the sleeve that holds the body tube screws into the collar. The sleeve is made of pasteboard with red marble paper applied to the inner surface and sanded white rayskin to the exterior.

The body tube slides into the sleeve. The base of the body tube is made of a turned disk of lignum vitae in the center of which is screwed a turned, tapered boxwood nose piece with a brass thread at the far end to accept the brass objective. The main body of the body tube is pasteboard with a green velum applied to the outside with gold tooling in the form of eight cartouches and one marker presumably for the lens focus position. Above the green velum of the body-tube is a ring of sanded and polished white rayskin that is a continuation of the outside sleeve. At the top of the body tube is a delicately turned lignum vitae collar into which screws the large field lens. Above this is the turned bell shaped top that contains the bi-convex eye lens. The eyepiece has a simple lens rim in lignum vitae instead of a brass dust cap as on most Culpeper microscopes.

Many parts of this microscope have a series of four dots impressed into them with a No. 4 written in ink inside the body-tube. The objective has four slots cut into it. There is a set of 12 black stained four-cell microscope sliders, ½ x 2 7⁄8 inches, in a case. There is a list on paper entitled “A List of wood & vegatable Cuttings &c” with the specimens in each slider. A few specimens are missing. The microscope is contained within a solid oak case with some restorations and alterations. The key is present. In the base of the case is a single drawer that holds the sliders and the spring stage.

The microscope is in overall very good condition with minor shrinkage cracks to some parts of the lignum vitae. It produces a reasonably good image of about 200 times magnification with relatively low resolution. Coarse focus is achieved by sliding the body tube up or down in the sleeve. Fine focus can be obtained by screwing the sleeve with the body tube in or out of the collar. The green and gold vellum and the rayskin are in excellent condition giving the instrument an attractive appearance. Much of the coating of the mirror has been lost. The case has various restorations to it including a later set of hinges and lock. Some of the molding has been replaced at a later date. A handle at the top is missing.

Culpeper signed a few of his microscopes and sometimes pasted a trade card as a label inside the case. The construction and workmanship of this microscope are unmistakably Culpeper. The cartouches are identical to those found on labeled Culpeper microscopes. The upper pillars are set midway between, not in line with, the lower pillars. This construction is peculiar to Culpeper and was not used by other makers. This is the second form of the Culpeper microscope with split shagreen covers without brass rings and a flat stage without a central recess. It immediately followed the extremely rare first form with expanded eyecup containing objectives. The Culpeper microscope is a substantial and functional instrument and it is easy to see why it was such a popular form for over a hundred years.

Culpeper Tripod Microscope, c1725-1730

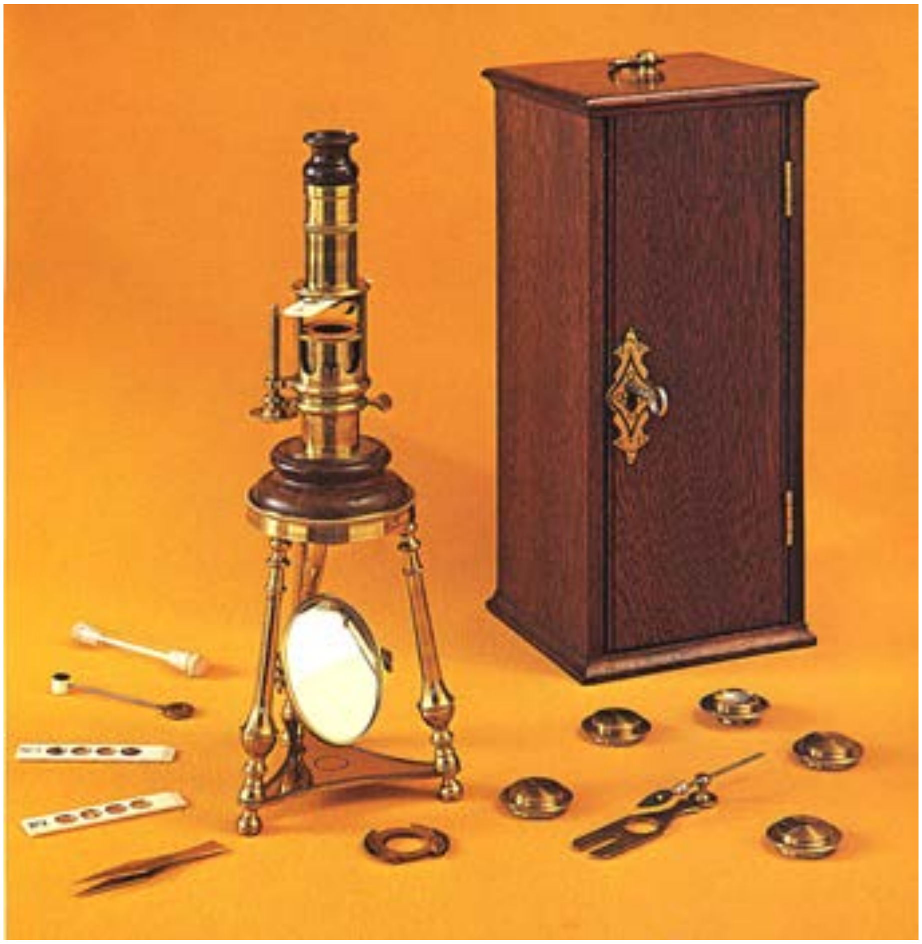
Side-Pillar Microscope, c1750

The side-pillar microscope consists of a pillar that is attached to a base and supports the body tube. The pillar microscope was first designed by Robert Hooke around 1660. They were made around the end of the seventeenth century by John Yarwell and John Marshall. Although the design was an improvement over the tripod microscope, the side-pillar did not gain wide acceptance until the mid-eighteenth century when the Cuff-type microscopes appeared. With the improvements made by the Adams's and the Jones Brothers, the inclined side-pillar became the forerunner of the modern microscope.

This instrument is an example of a side-pillar microscope. The microscope is 11 ¼ inches tall. A 4 ½ inch high square pillar is attached to a folding tripod base. The nose of the body is screwed into an arm attached to the top of the pillar. The body tube is 6 inches long and 1 ¾ inches wide. A stage with a circular hole to accommodate a Bonanni spring stage is attached to the pillar. A flat steel spring in the clamp on the pillar allows the stage to slide on the pillar serving for focusing. There is a substage mirror (glass replaced) mounted on one of the legs of the instrument. The microscope has an ocular, a field lens, and one objective. The objective lens drops loosely into a brass cap which screws into the end of the cone nose of the body. The cap has a small aperture to act as a diaphragm for the objective lens. The eye lens is one inch in diameter and the eyepiece screws into the body tube. The only accessory is a live box that fits into the opening in the stage. The microscope produces a sharp, low magnification image.

Nothing is known about this unsigned microscope and nothing exactly comparable to it has been identified. The all brass construction, substage mirror, and folding tripod base appeared in the first part of the eighteenth century. It bears some similarities to the Cuff-type side pillars of the second half of the eighteenth century and the Cary-type field microscopes of the first part of the nineteenth century. It also resembles some microscopes by Francis Watkins of Charing Cross, London who worked from 1747 to 1784. It also has some similarities to microscopes made in the eighteenth century in Holland. However, it is not nearly as elaborate as any of these microscopes and could be a transitional form. It is tentatively assigned a date of 1750 until further information is obtained.

Compound Screw-Barrel Microscope Replica, c1750



This Replica Rara replica, which converts to a solar microscope, is an unusual modification of the screw-barrel microscope. It was made by the Scottish instrument maker, William Robertson, who worked in Edinurgh from about 1730 to 1760. He issued a pamphlet describing this "New Catadioptric Microscope." The top part of the instrument with the attached mirror can be unscrewed from the tripod stand and used as a solar microscope.

The ornately engraved base plate, supported by three ½ inch feet, forms the mounting base for three scrolled brass legs 4 ⅛ inches tall. A brass ring receives the legs and is a seat for the turned wooden section on which the body sits. A modified Bonanni type stage is fixed with two brass plates on both sides of a central curved plate. A set of leaf springs are riveted to press against their respective set of brass plates located below. A 15⁄16 inch diameter plano convex lens screws into the brass and wooden mount in the optical axis. The plane oval mirror is on a gimbal hanging from the curved brass arm. The screw-barrel incorporates a 1 ⅞ inch plain brass tube and two open brass sleeves which slide over the inner tube. A brass tube, 1 ¾ inch long, with a wooden eye piece, forms a compound body. It screws to the upper end of the screw-barrel body when a single lens is in place. The compound body wooden mount has a ⅜ inch diameter ocular. Any of the five simple objectives in brass mounts or the lieberkuhn lens screw into the screw-barrel sleeve. Coarse adjustment is obtained by sliding the middle sleeve on the inner tube; a thumb screw sets its position. The Cuff-like screw actually has a two start thread which gives rather rapid movement to the outer sleeve. Accessories consist of a fish tube, stage forceps, micrometer with a wire 1/60 inch, carrier for forceps or micrometer, pencil brush, 4 ivory sliders, and a pair of tweezers. The wooden case (10 ⅝ inches h) with a decorative latch, has a bottom accessory drawer and 2 small top drawers. Simple microscope is 8 ¼ inches tall; compound is 10 ¾ inches. "W.R. Fecit" is engraved along the outer sleeve. Each objective is engraved with a Roman numeral 1 through 5. The Replica Rara stamp and serial number are engraved underneath the triangular base plate. The serial number is also etched underneath the brass mounting ring.

Benjamin Martin "Universal" Microscope, c1760

This is a compound microscope by Benjamin Martin (1714-1782). Benjamin Martin, an eighteenth century English instrument maker, is considered one the greatest designers and manufacturers of microscopes of his time. He had a significant influence on the development of the microscope and optical instruments in general. He introduced several innovations into compound microscope design the most notable of which was the addition of a long focal length lens between the objective and field lenses. This "between lens" acted as the back objective lens, slightly reducing spherical and chromatic aberration thereby increasing the usable aperture and slightly increasing resolution. In addition, Martin was the first to use the term "Universal" to describe a microscope that can be used as a simple or compound microscope, in both the upright and "aquatic" (horizontal) position, and for viewing transparent and opaque objects. This microscope dates from between 1759 when Martin introduced the between lens and 1768 when he used rack and pinion focusing.

The microscope is supported by three folding feet that form a tripod base. Above the center of the base rises a baluster-shaped turned pillar on top of which is a rectangular pillar. The plano-convex two-sided mirror is attached to one of the legs. The pillar attaches via a hinge to a short extension on the optical tube. The optical tube can then be positioned in a variety of configurations including horizontal; the extension also allow a small degree of adjustment forward or backward. The stage has a central large opening for a Bonanni slide holder and also a smaller opening to one side that accepts an opaque disk for examining opaque objects. There is also a keyhole slot on the stage that accepts a fishplate, and an additional hole in front with a compression fitting to accept an above-stage bulls eye condenser. Coarse focusing is achieved by loosening a set screw and sliding the stage up or down, with graduations on the pillar for different focal lengths. Fine focusing is achieved by a Hevelius screw. The two-lens eyepiece has a sliding dust cover. There is a field lens in the body tube. The between lens is at the top of the cylindrical objective snout. There is one objective. The only accessory is a stage condenser. The microscope is approximately 11 inches tall. Imaging resolution with the single objective is approximately 10x total magnification. The finish of the microscope is worn but it is otherwise in very fine condition. The microscope is unsigned but is identical to signed instruments and is identifiable by the presence of the between lens.

Nuremberg Sentry-Box Microscope, c1765

Craftsmen in Nuremberg (Bavaria) Germany are famous for their superb wooden toys. Among these toys were wooden microscopes fashioned with pasteboard and soft wood such as fruitwood. These were made beginning around 1750 and continuing for a century, making dating difficult. Several styles were manufactured that were designed to mimic some of the brass microscopes of the period. There were four styles: Culpeper-type, sentry box-type, solar, and side pillar-type.

This is a wooden "Sentry-Box" type of compound microscope. It is constructed of a wooden oak box base with an enclosed single-sided mirror. Two side cut-outs provide space for inserting sliders. The pasteboard body tube attached to the top of the base consists of three sections separated by turned fruitwood ornamental rings. The bottom section is covered in paper imitating shagreen, the middle section by plain paper, and the top section with painted paper. The top section is a draw tube for focusing. Optically, this microscope has the typical three lenses of the eighteenth and nineteenth centuries; the eye, field, and objective lenses. The field and eyepiece lenses are mounted in the top body tube. The field lens is not original. The objective is mounted to the bottom tube. All three are held in place with metal rings. The eyepiece and objective can be protected with screw-on wooden dust caps. The height of the microscope is about 28 cm. The underside of the box base is monogrammed "IM." The design of this instrument was probably based on Benjamin Martin's "Pocket Reflecting Microscope" of 1738.

Nuremberg Sentry-Box Microscope

Nuremberg Culpeper-Type Tripod Microscope, c1770

In this case, the Nuremberg microscope is of the Culpeper type. This Nuremberg Culpeper-style compound microscope is supported by three turned wooden legs, attached to a round wooden base with three bun feet. The support tube is made of pasteboard, covered in fish skin. It has a Bonanni spring stage at its base for holding sliders. Two pasteboard body tubes fit inside the support tube. The outer one is covered with paper and has a turned wooden endpiece that provides mounting for the eyepiece and a flat piece of glass probably acting as a dust cover. The inner tube has at its end a tapered fitting for the objective and a field lens at the top. The body tubes are moved up and down in the support tube for focusing. There is a plano mirror in a tiltable wooden mount attached to the center of the base. Sometimes the bases of these microscopes were branded with the initials of the maker, but this example is not signed. The microscope is missing a screw-on dust cap for the objective. The lenses are not original. The microscope produces a good image of about 100X magnification.

Cuff-type Compound Microscope by George Adams, c1770

This important design was devised in 1743 by John Cuff at the suggestion of Henry Baker, a well-known eighteenth century microscopist who found then current microscopes difficult to use. It represents a considerable advance over the earlier tripod design. The novelty of the microscope is the composite side pillar that gives rigidity, contains a delicate fine focus, and provides unobstructed access to the stage. Although the pillar-style microscope was developed much earlier by Hooke and Marshall and had the advantage that the microscope could be inclined, the Culpeper tripod design was more popular, probably because it was more stable and cheaper to produce. The construction is of brass, except for the box-foot which is made of mahogany and which has a drawer containing the accessories. The main supporting limb is constructed of two pillars: one fixed and one sliding. The body tube has a conical collar that fits into the arm carried by the sliding upright pillar. The stage is attached directly below the body tube to the fixed pillar. The two pillars fit into a brass foot that is attached to the wooden base. A scroll support to the foot serves to increase the rigidity of the stationary pillar, as well as to form a handle for lifting the instrument. Coarse focusing is achieved by unclamping the body tube and sliding the assembly up or down, while fine focus adjustments are performed by means of a small thumbscrew that acts by moving the sliding pillar in small increments.

Cuff-type Compound Microscope

The microscope is equipped with a concave mirror at the base that acts to concentrate illuminating light rays onto a sample mounted on the stage. The stage is in the form of a cross. One arm of the stage is attached to the fixed pillar, the opposite arm holds the condensing lens for focusing light on opaque objects, and the right arm carries either the fish plate for strapping down a small fish so that the blood circulation in the tail fin can be observed or the forceps for holding specimens. The large hole in the center of the stage can hold a live box (used to restrain small animals and large insects) or accommodate a Bonanni spring stage for holding sliders. The eye lens is in a screw setting at the top of the body tube. There are six objectives numbered 1 through 6 whose focal lengths range from 1 inch to 1⁄11 inch. These provide magnification from about 3X to 250X. Most accounts in the literature state that the chromatic and spherical aberration and low resolution of the objectives of the period made them unsuitable for scientific investigation. However, another major limiting factor was the nature of the objects to be viewed. With the preparations then available, resolution was at best five microns. Thin sectioning was not developed until the middle of the nineteenth century. When a modern histological slide is viewed with this microscope, all of the major structural details of the tissue are visible at a resolution of one micron.

The extensive and complete accessories are a fish plate, stage forceps, live box, condensing lens, cone diaphragm that fits under the spring stage, lieberkuhn reflector for illuminating opaque specimens, a sleeve that fits over the lower end of the body tube to hold the lieberkuhn, two hand magnifiers, tweezers, ivory talc box with talcs (mica) and brass clips, glass vial, concave glass for stage opening, flat glasses to place specimens on, and six sliders. The instrument is housed in a pyramidal mahogany cabinet with another drawer.

John Cuff (1708-1772) was one of the finest craftsmen of his time. Despite the popularity of his microscope, he was a poor businessman and went into bankruptcy. His microscope design continued to be made by other makers at least until the end of the century. George Adams Sr. (c1708-1773) and George Adams Jr. (1750-1795) were skilled and innovative opticians and makers of microscopes. The Adams's were Instrument Makers to George III and George Junior was later appointed Optician to the Prince of Wales. This instrument is signed "G. ADAMS At No 60 Fleet Street LONDON." It was made between 1760 and 1780 and represents the first satisfactorily useful microscope and which today produces adequate images at moderate magnification.

Drum Microscope by Benjamin Martin, c1775

This is a drum microscope by Benjamin Martin. Although unsigned, the design is unmistakably Martin's. Benjamin Martin (1704-1782) was an English lexicographer and maker of scientific instruments. He introduced his "Pocket Reflecting Microscope" in 1738. The word “reflecting” refers to the mirror below the stage that allowed light to be directed through transparent objects. The description “drum” probably derives from the drum-shaped section below the stage that incorporated the substage mirror. These microscopes were made throughout the eighteenth century and were very popular between 1820 and 1860 and continued to be made into the early twentieth century. Inexpensive microscopes were made in France as toys and exported in large numbers. This microscope was made around 1775.

This vertical microscope is sturdily constructed of brass and opens from 7 ½ to 9 inches (19 to 23 cm) by drawtube focus. The main tube tapers toward the eyepiece. It has a fixed stage with insertion slots and springs for use with sliders. There is a swiveling plane mirror below, with portals on both sides for convenience of illumination. The base of the instrument unscrews as is typical of such early high quality drums. The ocular is a doublet, the objective a high-power singlet, and there is an additional lens mounted midway between the two - Martin¹s biconvex "between lens." Condition is fine, the brass with a nice patina but only traces of original lacquer.

Martin Drum Microscope

Dellebarre “Universal” Microscope, c1780

This unsigned microscope is of the characteristic Dellebarre design. Louis-François Dellebarre (1726–1805) was born in Paris and worked for many years in Holland (mainly Delft, but also Leyden and the Hague). The style exemplified by this instrument was developed in 1771 and continued into the early 19th Century. Dellebarre's instruments were attractive and distinctive in design, but had relatively poor optics. Nevertheless, his microscopes were very popular toward the end of the 18th century, where they sold for about 360 francs.

The microscope is 20 inches tall, is all brass, and stands on folding tripod legs. A double mirror (missing the concave side), condenser lens, and large circular stage are attached to the square support pillar. A compass joint in the pillar allows for inclination of the body. The arm is attached to the top of the pillar so that it can be moved from side to side. The sliding arm holds the body tube by a split ring. The body tube is in three sections; the first with screwed nosepiece for the lieberkuhn and the objective, the second being the central section that can be drawn along the first tube for focusing, and the third supporting the eyepiece tube. The eyepiece contains four biconvex lenses and a screw on dust cap. The multiple sections in the eyepiece are used to change magnification. Fine focusing is by rack and pinion movement of the stage. The microscope is in fine cosmetic and functional condition.

Dellebarre "Universal" Microscope, c1780

Culpeper Microscope, George Adams, Jr., London, c1790

Edmund Culpeper (1670-1737), a mathematical instrument maker based in London, created the "Culpeper-type" microscope around 1725. Culpeper's design made two improvements to the tripod microscope. The stage was raised above table level making it more accessible. A concave mirror was inserted below the stage allowing for illumination of specimens from below. Focusing was achieved by sliding the telescopic microscope body in and out of a support tube. The Culpeper microscope was so popular that it was made by almost every instrument maker over the next hundred years. The Culpeper microscope reached the pinnacle of its development in the late eighteenth century. It was a decorative piece of craftsmanship made of shining brass with elegantly curved legs and a wealth of accessories, all housed in a shapely pyramid case of mahogany.

This brass microscope is an elegant representative of the final form of the Culpeper-style microscope. It is remarkable for its exceptional condition and numerous accessories. It is 12 inches tall and housed in an 18-inch tall pyramidal mahogany case with a lock and handle at the top. The case has a drawer at the bottom. The microscope features scroll-style supports. The top set supports the body tube. The bottom set supports the round stage and is fastened to the square wooden base with a drawer. It has rack and pinion focusing replacing the sliding action of the tubes of its predecessors. Accessories in the drawers include four objectives, a fish plate, live-box, brass tweezers, a stage condenser, Bonanni spring stage to hold sliders, substage cone, a brass tube, and stage glasses. Five ivory sliders with specimens are present. There is a box containing micas and brass circlips for sliders. The microscope is signed "Adams London" in script. George Adams Sr. (c1708-1773) and George Adams Jr. (1750-1795) were skilled and innovative opticians and makers of microscopes and other instruments. The Adams's were Instrument Makers to George III and George Junior was later appointed Optician to the Prince of Wales.

Culpeper Microscope by Adams

Culpeper Tripod Microscope, William Harris, c1810

The Culpeper-type microscope was manufactured and sold by many instrument makers in the eighteenth century and first part of the nineteenth. The microscope underwent changes in the types of materials used from pasteboard, rayskin, wood, and brass, through brass and wood, to all brass. However, the basic pattern of the double tripod remained unchanged and all were stored in a wooden pyramidal box.

The Culpeper microscope reached the pinnacle of its development in the late eighteenth century. It was a decorative piece of craftsmanship made of shining brass with elegantly curved legs and a wealth of accessories, all housed in a shapely pyramid case of mahogany with a lock on the door and a handle at the top. This microscope is an elegant representative of the final form of the Culpeper-style microscope. It is remarkable for its excellent condition and completeness of components and accessories. It is 16 inches tall, and features scroll-style supports. The top set supports the body tube. The bottom set supports the round stage and is fastened to the square wooden base. It has rack and pinion focusing replacing the sliding action of the tubes of its predecessors. The eyepiece is a two lens Huygenian-type and screws into the top end of the inner tube. The objective screws into the end of a long brass nosepiece at the bottom of the inner tube. The microscope comes with five objective lenses numbered 1 through 5. All lenses work perfectly considering the 200-year old age. The microscope has a stage bullseye condenser lens, and sub-stage mirror. Two substage spring clips and a slot on the stage are for attaching accessories. The accessories in a drawer beneath the stage include a fish plate, fish tubes and wire, live-box, lieberkuhn and case with sleeve, stage-forceps, brass tweezers, Bonnani spring stage to hold sliders, substage cone, and stage glasses. Five bone sliders are present with a contemporary list of the objects. There is a bone double-ended canister containing micas and brass circlips. The microscope and stand fit in a mahogany pyramidal case. An unusual detail is that instead of a handle on the top of the case there is an Egyptian revival brass piece. It is rare to find a microscope of this age and type in such fine condition, and so completely accessorized.

The microscope is labeled inside the case and on the stage William Harris & Co, 50 High Holborn, London. Mr. Harris, after working for Sir David Brewster in Edinburgh until about 1800, began to produce instruments under his own name. In about 1800, he opened premises at 50 Holborn in London, marking his output as William Harris & Co. In 1840, the firm was renamed William Harris & Son. This microscope probably dates from around 1810. Although an early nineteenth century instrument, its technology, style and performance are firmly rooted in the eighteenth century.

Culpeper-type Tripod Microscope

Jones Improved Compound Microscope, c1810

The "Jones Improved" microscope has its origin in a microscope introduced by George Adams Jr. in the late 18th century and described in his 1787 publication, *Essays on the Microscope*. In 1795, the copyright to Adams' books and designs were purchased by the firm of W. & S. Jones of London. William and Samuel Jones began, in 1798, the production of a microscope with a similar design, which they called the "Jones Improved Microscope." This design became very popular and was produced by many other English opticians during the first part of the nineteenth century. It was followed by the more elaborate Jones Most Improved Micro-scope.

This unsigned microscope is made of lacquered brass and stands 11 ¼ inches tall closed. A circular pillar screws into a brass plate screwed onto a square mahogany base. The base plate has an opening for a mirror on a gimbal. The stage with extensions for holding a fish plate and stage forceps is mounted on the pillar. A bar that holds the sliding body tube is mounted on top of the pillar. Focusing is by rack and pinion on the tubes that moves the inner tube up or down. The optics consist of a two-piece eye lens, a field lens, and four non-achromatic objectives numbered 1 through 4. The accessories include a Bonanni spring stage, stage forceps, fish plate, live box, brass tray with glass bottom, glass stage disc, ivory stage disc, glass depression dish, brush, bone probe, ivory talc box with talcs, and five ivory sliders with specimens. The mahogany pyramidal case is 19 ½ inches high. The upper compartment holds the microscope and a drawer. The square bottom section holds a large drawer. A key works on locks for the door and lower drawer. The microscope is in fine condition with most of the original lacquer and complete with accessories.

Dollond Cary-Gould Type Chest Microscope, c1820

An innovative variation on the Cary-Gould type microscope, this chest microscope is signed "Dollond, London" and probably dates to circa 1820. The Dollond family made high-quality optical instruments for five generations beginning in 1750. In a chest microscope, the microscope is attached to a wooden chest for support and can be inclined. The microscope can be folded into the chest along with the accessories for portability.

Dollond Chest Microscope

This instrument stands 11 inches tall. The rectangular pillar is mounted to a compass joint in a mahogany case that measures 9 x 5 ¾ x 2 ⅛ inches. The biconical body tube with an eye lens and a field lens screws into a short arm at the top of the pillar. The microscope has a circular objective lens mount, 1 inch in diameter, that contains four separate lenses numbered 1 through 4. The lens mount clicks into place for each focal length and displays the lens number in a small window on top. The entire adapter unscrews from the microscope and can be replaced with another lens containing a lieberkuhn. The focus knob moves the stage up and down via a rack and pinion gear. The sub-stage mirror is concave. Additional accessories include a stage forceps, brass tweezers, an adjustment tool that tightens the inclination joint, a light-dark ivory disc, two glass discs for holding specimens on the stage, an ivory talc box with talcs and circlips, and two ivory sliders with specimens. The instrument and its accessories are in excellent functional and cosmetic condition.

Jones Most Improved Compound Microscope, c1820

William and Samuel Jones were skilled instrument makers in London in the late eighteenth century. The Jones brothers bought the stock of George Adams Jr. in 1795. They made a number of popular microscope models including the Improved and Most Improved brass compound microscopes, although these were of Adams's designs. The Most Improved Microscope incorporated all of the then-modern features found on compound microscopes of the period. The style continued to be made through the first third of the nineteenth century by other manufacturers. It was the best microscope prior to the introduction of achromatic lenses and represents the real beginnings of the scientifically practical modern microscope.

This English Jones Most Improved-type microscope is unsigned but the lid of the case bears the label "JOHN ARCHBUTT, Mathe-matical Instrument Maker, Established 1795." It is a later example dating around 1820. It is made of polished brass and stands 18 inches high on its folding 3-leg base, with a 6 inch tall pillar and compass joint supporting the 8 inch long column. The deep full mechanical stage focuses by pinion drive on a rack cut on the front of the column. The 8 inch long body tube screws into the top of the bar limb and the objective lenses screw into the bottom of the bar limb. The double-sided substage mirror is mounted on an adjustable bracket on the column. The accessories include two eyepieces, an objective labeled "Aplanatic 1 Inch," an objective labeled "Aplanatic 1⁄4 Inch," slip-on lieberkuhns for the objectives, one lieberkuhn objective, one high power objective with screw on cap, stage-mounted bull's eye condensing lens, fish plate, live box, compressorium on brass plate, and stage forceps. The live box, compressorium, and stage forceps are later replacements. In the first part of the nineteenth century, the large, flat mahogany case, holding the folded stand surrounded by its accessories was very popular.

Jones Most Improved Compound Monocular Microscope

Jones Most Improved Microscope in case

English Drum Microscope, c1830

This microscope was made around 1830. It is made of brass and consists of a sliding body tube containing compound lenses and a base housing a stage for the sample and a concave substage mirror to provide illumination. Focus is achieved with a rack attached to the knob on the side of the base housing. The stage is fitted with slots to accept sliders. The stage has two fittings, one for the bulls-eye condenser and the other for the stage forceps. There is a pair of holes alongside the stage to carry a glass specimen phial. The microscope was made for viewing sliders and objects held in the stage forceps and containers, but it would accommodate the first small rectangular slides. The accessories comprise a complete kit of the instruments considered necessary for viewing specimens in the late 18th and early 19th centuries. There are six numbered objectives in cells and an objective with Lieberkuhn reflector for observing opaque specimens. The stage condenser and stage forceps are included. Other accessories are two live boxes, a hand magnifier, a fluid tray, a brass can for talcs and split rings, and tweezers. There are five ivory or bone sliders and four wood sliders. There is a small drawer within the case containing a dissecting needle on ivory handle, a scalpel on ivory handle, two glass pipettes, and small slip carrier made of card. Everything fits into a mahogany case lined with velvet. The microscope is unsigned. It is the same as one in the Billings Collection described as having Dollond characteristics. Peter Dolland opened an optical business in 1750 and was joined by his father John in 1752. John was appointed optician to King George III and the Duke of York. The firm made high-quality optical instruments and continues to this day as Dolland and Aitchison.

English Drum Microscope

Cary-Gould Pocket Compound Microscope

William Cary (1759-1825) was a prominent maker of "Mathematical Instruments," including microscopes, located on the Strand, London. After Cary's death, the firm was managed by Cary's nephews and continued using Cary's name. Charles Gould (c1786-1849) was the manager and head machinist for the Cary business. Gould designed the popular pocket microscope and published a booklet on it in 1826. This is a small format, signed, Gould-type botanical microscope. It is signed on the racked upright "Cary, London." The pillar screws into the front edge of the flame Honduran mahogany case. The conical body tube has two eye lenses and a set of three interchangeable objectives of varying magnification. Focusing is achieved by rack and pinion movement of the stage. The semi-circular stage moves on a pivot for "aquatic" observation. The substage mirror is planar and detachable for storage, similar to the rest of the components for this microscope. This microscope can be assembled to function as a compound microscope, simple microscope, or a flea glass using the forceps. The microscope is seven inches high in the compound configuration. c1835.

Cary/Gould Pocket Compound Microscope

Chevalier Horizontal Achromatic Microscope, c1835

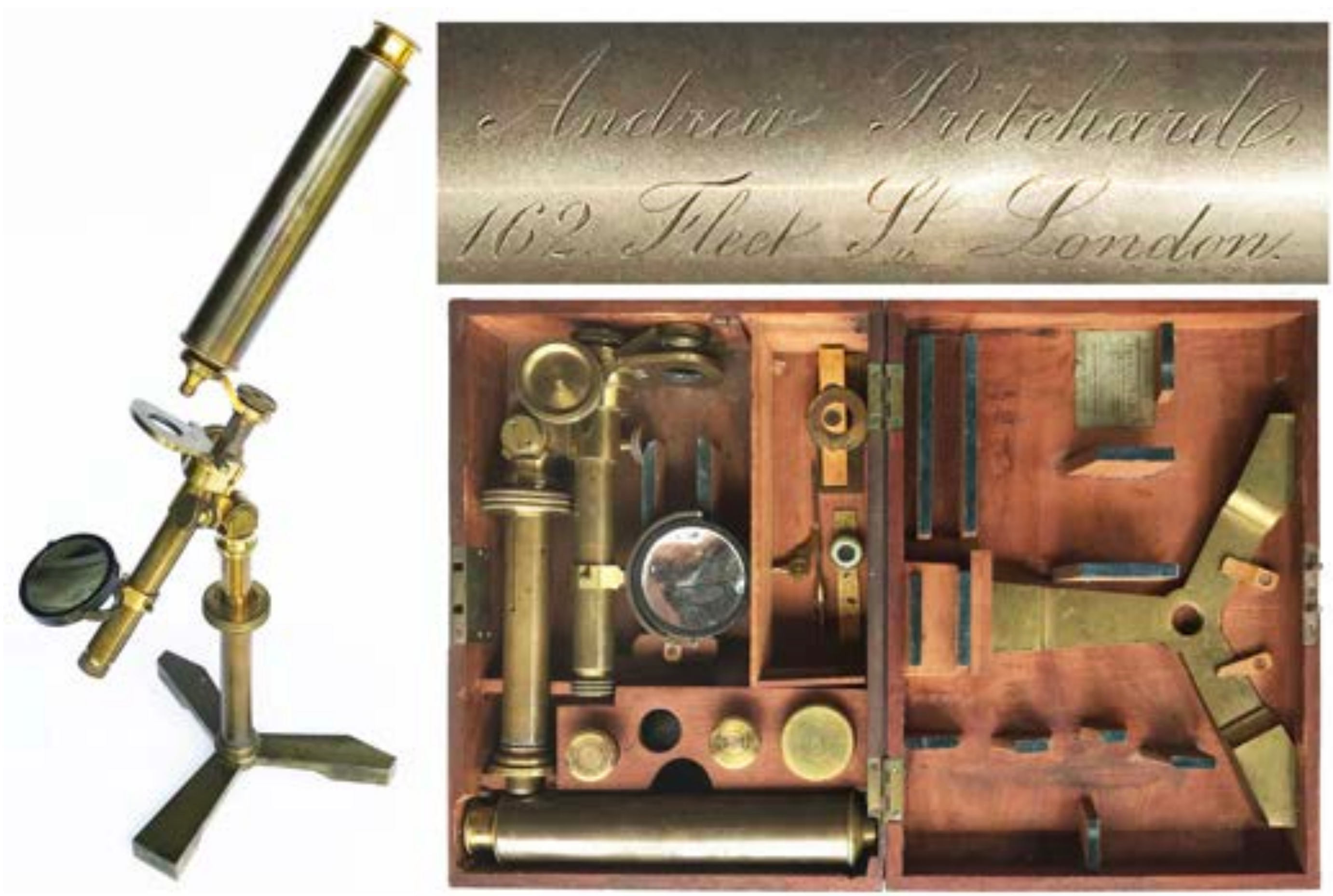
This is a large horizontal/vertical compound microscope by Charles Chevalier. It bears the inscription *Microscope Achromatique de Charles Chevalier Ingenieur Opticien Brevete Palais Royal 163 a Paris* on the body tube. Charles Chevalier (1804-1859), an optician in Paris, was one of the first to use multiple lenses screwed together to achieve higher magnifying power. He also made microscope objectives that were relatively achromatic. In 1830, Chevalier started to make horizontal microscopes, after a design shown to him in 1827 by Giovanni Amici, an Italian instrument maker.

The microscope is 47 cm tall mounted in the horizontal mode. The instrument is supported by a round pillar that screws into a boss on the top of the large flat case. A bar, attached to the pillar by a compass joint, holds the square sectioned limb and the body. The body tube is attached via a second compass joint. The microscope body can be set horizontally or vertically. The optical tube has interchangeable nosepieces; one straight for the vertical position and the other right-angled with a 90 degree prism for the horizontal position. The eyepiece is set in a drawtube. The square stage can be racked up and down on the limb for coarse focusing and a vertical screw adjusts the fine focus. A plano-concave mirror slides on the limb below the stage. There is a wheel diaphragm below the stage. The mahogany case measures 39 x 27 x 12 cm and has a drawer and a lock. Two velvet-lined trays hold the accessories. The complete set of accessories are three eyepieces, three objectives, a Lieberkühn (cracked), camera lucida, bullseye lens, stage micrometer, glass stage disc, etepiece cap, and livebox (missing glass). There are six small-sized microscope slides by Chevalier and seven others. The microscope is in excellent condition noting only loss of lacquer on the body tube.

Andrew Pritchard Achromatic Compound Microscope, c1840

Andrew Pritchard and his microscope, c1860

The maker of this microscope is Andrew Pritchard (1804-1882) who was one of the most innovative microscopists of the first half of the nineteenth century. He was one of the first British opticians to offer an achromatic microscope. He experimented with jewel and doublet lenses. He was one of the earliest established commercial providers of microscope slides in London, being in business from the mid 1820s until the late 1850s. He was primarily known and highly respected as a skilled instrument maker, microscopist, and optician, as well as a prolific author. His popular and influential books on optics and microscopy, published beginning in 1827, are considered by many to have played a pivotal role in the further development and commercialization of the microscope. At the same time, they encouraged the popular interest in and investigation of the natural world. His books also contained some of the first lists and descriptions of interesting microscopic objects for study, with methods for their preparation.



Pritchard Achromatic Microscope

This brass instrument stands on a cylindrical pillar on a flat tripod base. An inner pillar telescopes upward and is held in place by a tightening collar. The microscope can extend to over 20 inches high. A short arm on a compass joint and with ring casing and screw clamp holds the tubular limb. The stage is fixed at the top of the limb. A bracket to hold slides is missing. For coarse focusing, a rack and pinion extends a bar, with a triangular cross section, from within the limb. A short arm at the top of the bar carries the body tube. The body tube is engraved with Pritchard's 1838-1854 address "Andrew Pritchard 162 Fleet St London." The eyepiece pushes into the top of the body and the nose has an internal thread to take an objective. The optics consist of a single button objective and a triple button objective and a Huygens eyepiece. A sliding sleeve carries the concave mirror in a horseshoe mount on the lower end of the limb. A plaster disk is on the reverse of the mirror for use in diffuse light. Accessories are a stage forceps, a combination live box and micrometer for measuring specimens engraved with the Pritchard's 1836-1838 address "A. Pritchard 263 Strand London," a Bonani spring stage with a slider, and a Lieberkuhn minus its objective. The microscope disassembles and fits in the original mahogany box. Inside the case is a little paper advertisement for "The Natural History of Animacules" "Just published" and which appeared in 1834. The microscope is in good working condition but has lost most of its lacquer. This important instrument represents an intermediate stage in the development of microscopes between the earlier Cuff-type microscopes and the later more advanced microscopes by Andrew Ross and others.

Chevalier Compound Student Microscope, c1840

The house of Chevalier in Paris won widespread fame in the nineteenth century as manufacturers of high-quality microscopes. The first instrument maker of the Chevalier family was Louis-Vincent Chevalier (1734-1804) who established a shop in 1765. His son Vincent Jacques Louis Chevalier (1770-1841) inherited the firm in 1804. Vincent and his son Charles (1804-1859) were leading opticians who contributed greatly to the development of achromatic lenses (corrected for two colors). Together in 1823 they invented the first useful achromatic objectives by combining a number of small lenses, each of which had been corrected separately for chromatic aberration. In 1825, Vincent Chevalier made the "*Microscope Achromatique Perfectionne*." In 1834 after separating from his father's business, Charles Chevalier brought out his "*Microscope Achromatique Universel*" which was the first commercially successful achromatic microscope. In 1826, the first permanent photograph was made using a sliding wooden box camera made by Charles and Vincent Chevalier. On the death of Charles in 1859, his son Dr. Arthur Chevalier (1830-1874) carried on the tradition of the family.

This is a student model microscope dating from around 1840 to 1850. Although microscopes of this type are usually unsigned, they are commonly attributed to the workshop of Charles Chevalier. A brass pillar with a cradle-joint at the top is screwed to a characteristically green-painted, iron tripod base. From the moveable part of the joint an arm extends carrying a round column. The stage, attached to the column, is a flat plate, having a central opening and small spring clips moveable up and down in sockets. There is a hole in the stage-plate for receiving the spring forceps and a socket for the condenser. A revolving disc of diaphragms, a Chevalier innovation, is attached to the underside of the stage. The plane mirror is held in a circular brass frame and attached to a sliding tube fitting the column. The body tube is screwed to an arm having a square bar which fits into the round column. Focusing by turning the milled head is by rack and pinion moving the body tube. There is one eyepiece and one achromatic objective. The velvet-lined case has five drawers on one side. The microscope stands 14 inches high closed and is in excellent condition with most of the lacquer intact.

Drum Compound Microscope by Camille Nachet, c1845

Camille Sébastien Nachet (1799-1881) worked for Vincent and Charles Chevalier before establishing his own firm in 1840. His first microscopes were drum microscopes modeled after those of Georges Oberhauser. This is an early model signed on the arm "NACHET, *Opticien a Paris*." Later models included an address and the firm became Nachet et Fils. The microscope stands about 14 inches high, has a lead-filled base, and weighs 8 ½ pounds. The circular pillar is affixed to a projection at the rear of the stage plate. An arm is affixed to the pillar and holds a sprung tube into which the body tube slides. The body tube has a screw ring division in the central section. The cylinder body between the circular stage plate and circular base carries a double-sided mirror on a pivot and has an opening in front. A unique feature of Nachet microscopes is a pull-out substage carrier that can hold stops and a polarizer. It is moved up or down by a lever. The objective is an achromatic doublet. The double lens eyepiece is contemporary but not original. Coarse focusing is achieved by sliding the body tube; fine focus is by a fine-threaded screw below the pillar acting on the pillar and arm. The microscope is in very good condition and retains most of its lacquer. It has its original fitted wooden case with a handle.

Nachet Drum Microscope

Ross Bar-Limb Microscope, c1849

Andrew Ross began business in 1830. During the period from 1837 to 1841, Ross worked in partnership with the renowned microscopy pioneer and optics theoretician Joseph J. Lister (1786-1869). Lister perfected achromatic lenses corrected for spherical and chromatic aberration. The joint efforts of Lister and Ross helped transform the microscope from a parlor oddity into an important scientific tool in medical diagnosis and biological research and elevating histology into an independent science. Both Ross and Lister were founding members of the Microscopical Society of London (later the Royal Microscopical Society).

Andrew Ross Microscope

One of the most important microscopes ever designed was the large "bar limb" model by Andrew Ross in the middle of the 19th century. Ross reached a pinnacle of design in both the stand and objectives that has rarely been equaled, even today. The microscope is quite large, standing 18 inches when closed. The model features a heavy Y-shaped, flat tripod base for support. The vertical flat pillars hold the limb by means of trunnions, and an arm attached to the top of the bar supports the optical tube. Incorporated into the limb is rackwork to a rectangular bar for coarse focusing. There is an unusual fine focus with a conical radial drive lever at the base of the tube. The stage, condenser, and mirror are attached to the limb.

The microscope features a full mechanical stage with X/Y positioning. A rotating slide platform accommodates slides and accessories. There are three substage condensers which fit into a slot under the stage. The first is one of two achromatic condenser lenses. A separate mechanical control adjusts the condenser height. A second is a wheel of stops and the third is a Nicol prism polarizer (invented in 1828). The analyzer fits in the tube. There is a 2 ½ inch diameter plano-concave mirror. There are five objectives with their original brass canisters; a 2 inch, 1 inch, ½ inch, ¼ inch, and ⅛ inch. The ¼ inch and ⅛ inch objectives have covered/uncovered correction collars. The correction collar was invented by Ross in 1837 and served to adjust for the differences in the thickness of the coverslips of the time. The microscope is pre-RMS thread standard, and has its own unique lens thread. The Royal Microscopical Society adopted a screw thread standard for objectives in 1858 that was adopted by virtually all makers thereafter. There are three eyepieces. Accessories include two live boxes, a micrometer that fits in the eyepiece, a stage forceps, a fish plate that fits on the stage, and tweezers. There is a separate condenser lens on a stand. The instrument is finished in lacquered brass with almost all of the lacquer present. The microscope disassembles for storage in its own mahogany case with brass carry handle. It is an excellent example of one of the finest and most important microscopes ever made.

This model is signed, "F. L. West, 39 Southampton Street, Strand, London. Francis West described himself as a successor to George Adams and supplied Ross instruments under his own signature. The microscope appears to predate 1850 when Ross added a complete substage assembly.

F. L. WEST,

Optician,

39, SOUTHAMPTON STREET, STRAND, LONDON.

Microscopists, and the Public generally, are respectfully invited to an inspection of F. L. WEST'S Stock of Microscopes, comprising those of the most perfect construction to the simple and inexpensive instrument adapted to the first use of the Amateur; also to his ACHROMATIC OBJECT GLASSES for the Microscope, from one-eighth to two inches focus, of enlarged aperture, beauty of definition, and penetrating power.

MICROSCOPIC OBJECTS in Great Variety, of which a Large Stock is kept—Animal, Vegetable, Mineral, and Fossil. Anatomical Injections, &c., &c., with every novelty that may be produced in the Microscopic World, of the best Preparers, both British and Foreign.

All kinds of Apparatus and Material for preparing and mounting objects for the Microscope. Glass Cells of every size and shape, Glass Slips, Circles and Squares of thin Glass, Troughs, Capillary Tubes, Collecting Cases, Canada Balsam, Writing Diamonds, Mahogany Cabinets, &c., &c.

PRICES SENT ON APPLICATION.

INSTRUMENTS TAKEN IN EXCHANGE.

Trade Card for F. L. West, 1855

Andrew Ross Monocular Microscope, 1847

This is an Andrew Ross portable microscope. It is signed on the bar "A. Ross, LONDON, No. 272" dating it to 1847. The microscope is equipped with two oculars, extension tube, unusual fine focus with a conical radial drive, bar limb mount with rack and pinion coarse focus having knurled pinion adjustment, manually rotatable mechanical stage, wheel of stops on dovetail fitting, and double mirror. There are two achromatic objectives with signed canisters, a one inch and a fine ¼ inch, signed and dated 1853, with correction collar and lieberkuhn mirror. The microscope can be disassembled by hand into a compact mass. When fully assembled, it extends to 15 inches. The microscope is in excellent condition with almost all original lacquer and noting only two rough spots on the rack. The wooden case is contemporary but not original.

Oberhaeuser and Hartnack Drum Microscope, 1857

This is a brass drum microscope signed "G. Oberhaeuser et E. Hartnack, Place Dauphine 21, Paris." The drum microscope is derived from the "pocket microscope" developed by Benjamin Martin in 1738. In 1830 Georges Oberhaeuser (1798–1868) formed an instrument firm in Paris with Trécourt and Bouquet. After c1835, Oberhaeuser worked alone making, among other instruments, drum microscopes. He established a partnership in 1857 with his nephew Edmund Hartnack (1826–1891). In 1860 Georges relinquished control of the firm to Edmund. The microscope has a circular lead-filled base and a cylinder body with a substage cutout containing the plano-concave mirror on a pivot. The stage with spring clips is fixed to the top of the cylinder body and has a projection at the back supporting the circular pillar. Below the stage plate is a revolving disc of diaphragms. An arm at the top of the pillar holds the sliding body tube. On the body tube is a ring that carries a two-jointed arm with a bull's-eye condenser. A spring-loaded focusing mechanism is contained within the pillar and is actuated by a knurled knob beneath the pillar. The optics consist of two eyepieces and a cone-shaped objective with two button lenses. This microscope comes with a fitted mahogany storage case. The case is stamped with the serial number "3341." Accessories are two glass tubes, a concave glass dish, a scalpel, and some microscope slides. The microscope is ten inches (25 cm) tall. It is in excellent condition with most of the original lacquer remaining.

Compound Monocular Microscope, English, c1860

This microscope is unsigned but it is similar to Andrew Ross's bar limb microscope, a design used by numerous other manufacturers. It serves as an example of a typical mid-nineteenth century microscope style. The claw-footed base of this brass microscope has two uprights with compass joints attached. The stage, incurved at the back, has a sliding slide holder, openings for a condenser and forceps, central aperture, and fitting for a substage condenser. The tubular tailpiece has a single mirror on a gimbal. A triangular bar with rack is contained within a cylindrical limb and is activated for coarse focus by two milled-head pinions. The arm is attached to the top of the bar and the body tube screws into the arm. The fine adjustment on the arm activates a projecting bar that extends from the rear of the body tube. There is a drawtube holding the ocular. A single Smith and Beck objective screws into a spring loaded extension of the body tube. The microscope is in fine condition mechanically and optically but has lost most of its lacquer. The microscope, 14 ½ inches tall closed, is mounted on a wooden base and is held in the original mahogany case.

Nachet-Type Pillar Microscope, c1870

Nachet Pillar Microscope

This intriguing ball and socket pillar design began to appear in the 1860s. The microscope is unsigned but instruments of this type were made by Nachet in Paris. Camille Nachet (1799-1881) and his son Alfred (1831-1908) formed the company "Nachet et Fils" which was one of the most prestigious microscope manufacturers in Europe. Similar instruments were made by Edmund Hartnack. Edmund Hartnack (1826-1891) joined the firm of his uncle, Georges Oberhaeuser (1798-1868), in Paris in 1857, and assumed full control of the firm in 1860. These microscopes were imported by Queen & Co. in Philadelphia.

This small microscope has a circular, green-painted bronze base, and supports the 5 inch high tubular pillar with a ball and socket foot. The lower section of the pillar has a single mirror on a gimbal and pin and fixed stage. The stage has a central aperture. Beneath the stage is a revolving disc of diaphragms that may be moved from the right side or from the front. Above the stage is a sliding casing on a pillar with a U-shaped slide holder. The arm is attached to the pillar and has a ring front and a fixed tube with a milled-head pinion at the back. On the tube s is a ring that carries a two-jointed arm with a condenser. The body tube is 5 ¼ inches long with a cone nose and rack at the back. The upper section with milled-edge ring is 1 ½ inches long. The single eyepiece screws onto the barrel and contains a field lens inside. There are three stackable, dividing objectives resulting in a variety of focal lengths. The instrument is 9 inches high when closed. The microscope is finished in lacquered brass. The lacquer coverage is 100% with no signs of wear. In fact, this microscope is close to mint.

French Toy Drum Microscope

This is a small French drum microscope often referred to as a "toy" microscope. It stands six inches tall closed and is constructed of brass. The microscope consists of a base, a cylinder with cut outs for a swinging mirror and the stage. The body tube fits into the top of the cylinder and focusing is accomplished by sliding the tube. There is an eye lens and three button objectives. These microscopes enjoyed widespread popularity between 1820 and 1880, and continued to be sold into the early twentieth century. They were exported in large quantities to the United States. This microscope is in excellent condition with bright brass and no defects. It is stamped France on the body tube. It fits in an original wood case that also contains original tweezers. c1880.

Browning Polarizing Microscope, c1880

The polarizing microscope was invented in 1828 by William Nicol (1768-1851). In a polarizing microscope, a polarizer filter which produces a plane of polarized light is placed in the light path beneath the sample. If the sample is anisotropic or birefringent, it will rotate the plane of polarized light. A second rotatable polarizer filter, called the analyzer, is located between the objective and eyepiece. When the analyzer is at right angles to the polarizer (crossed polarizers), it can detect the light rotated by the specimen. When an isotropic material such as air, water, glass, or most tissues, exists between the filters, all light is blocked. Many of the high end microscopes of the second half of the nineteenth century have accessory polarizers and analyzers (see the Ross and Beck microscopes). These were used for viewing birefringent materials such as horn, hooves, hair, bone, and minerals. These slides are usually marked "For Polariscope," meaning they were to be viewed using a microscope with polarizing filters.

John Browning (1835-1925) was an English inventor and scientific instrument maker. After taking over his family's business in 1856, Browning became a leading maker of scientific instruments, including spectroscopes, telescopes, microscopes, barometers, photometers, cameras, ophthalmoscopes, and electrical equipment such as electric lamps. In 1873, he installed the first electric light in London. As Optical and Physical Instrument Maker to Her Majesty's Government, he supplied telescopes to the Royal Observatory in Greenwich, London. He also wrote numerous articles and books on his craft. The Browning business flourished as interest in astronomy grew among both amateurs and professionals throughout the nineteenth century. The company was taken over by W. Watson and Sons in 1900.

John Browning Polarizing Microscope, c1880

This is a fine polarizing microscope, c1880. It is signed on the body tube "John Browning, 63 Strand London 884." The all brass instrument is supported by a flat tripod base and two uprights. A short square limb is carried on trunnions. The limb has an inner triangular bar with rack and a double milled-head pinion and holds the 3 ¼ inch circular stage. An arm is attached to the top of the rack and holds the body tube and nosepiece. The arm carries the fine adjustment. The stage has a rotating slide plate. The mirror is attached to a sliding case fitting over the tubular tailpiece.

There are two eyepieces and two objectives, a 1 inch and ¼ inch in signed brass canisters. A collar on the underside of the stage holds the substage attachments. There is a Nicol polarizer, a condensing lens, and a revolving disc of diaphragms. An eyepiece with a Nicol prism analyzer fits over the conventional eyepiece. The instrument stands 17 inches high arranged for use. It can be mounted onto a wooden platform and is held in an original mahogany case with openings for the eyepieces, objectives, and condensers and a drawer containing forceps. The instrument is in very fine condition with only some spotting to the lacquer on the body tube. It is fully functional and produces fine polarizing images.

English Wenham Binocular Compound Microscope, R & J Beck, 1880

The signature microscope of Victorian England was the large Wenham binocular compound microscope. These microscopes were elegant and impressive, and often accompanied by a large number of lenses, condensers, and accessories. For a while, they were in great demand, mostly by the comfortably leisured class for amusement in parlors. However, they were expensive and difficult to use because of their complexity and were gradually supplanted by the smaller, more practical Continental form of microscope.

Francis Herbert Wenham (1824-1908) was a British marine engineer who studied the problem of manned flight and wrote a perceptive and influential academic paper that he presented to the first meeting of the Royal Aeronautical Society in London in 1866. In 1860, he designed the first truly successful binocular microscope by utilizing an achromatic prism to split the light beam at the rear of a single objective into the two body tubes, one tube straight and the other inclined. The Wenham prism was one of the simplest and most successful of the early solutions to binocular vision with a microscope. It continued as a mainstay of binocular design until the turn of the century. Manufactures of Wenham binocular microscopes in the latter part of the nineteenth century included R & J Beck, Charles Collins, J. B. Dancer, Henry Crouch, M. Pillischer, Powell & Lealand, Ross, and James Swift & Son.

R & J Beck was a renowned British optical company based in London. It had its origins with Joseph Jackson Lister (1786-1869), whose son became Lord Lister the discoverer of antiseptics, and James Smith (d1870). Lister published a paper in 1830 entitled "*On Some Properties in Achromatic Object-Glasses Applicable to the Improvement of the Microscope*." This was the first scientifically-based design for microscope lenses. He asked James Smith, a mathematical instrument maker and employee of the instrument-making firm of William Tulley, to make a microscope to suit his new lenses. Smith set up on his own in 1837, later taking on Richard Beck (1827-1866), a nephew of Lister, as an apprentice. Beck became a partner in 1847 when the company was renamed "Smith & Beck." In 1851, Joseph Beck (1828-1891) joined his brother in the firm having served an apprenticeship with Troughton & Simms. By 1853, the demand for the firm's products had risen to such a degree that they established a factory in Kentish Town, Holloway and called it "Lister Works." In 1857, Joseph became a partner and the name was changed to "Smith, Beck & Beck." In

1864, James Smith retired and the name was changed again to "R & J Beck." Joseph Beck's son, Conrad, beginning in 1879 continued to operate the firm into the early years of the twentieth century. The company produced a wide range of optical products: microscopes, telescopes, cameras, camera lenses, optician's equipment, trench periscopes for army officers in the First World War, and other optical equipment.

R & J Beck Binocular Microscope

This R & J Beck "New National" microscope is a fine English example of the grand Wenham binocular microscope manufactured primarily for the American market. It signed Beck London Philadelphia and the serial number of 10,201 dates it to 1880. It closely resembles Zentmayer's U. S. Army Hospital binocular microscope. At that time, R & J Beck, Manufacturing Opticians had a branch at 1016 Chestnut Street in Philadelphia, W. H. Walmsley, Manager.

The lacquered brass microscope has a heavy tripod base. A cylindrical pillar terminates in a compass joint which supports the Jackson limb carrying the binocular body. Coarse focus is rack and pinion and fine focus with an indicator micrometer knob located on the rear of the limb. Eyepiece width is rack and pinion adjustable. The glass stage can be rotated. There is an object holder with an opening and a glass circle. Beneath the stage is a tube movable by rack and pinion and into which a nicol prism polarizer or a shutter diaphragm can be inserted. The swinging substage allows the condenser and mirror to swing for oblique lighting. A graduated circle is provided for registering the degree of obliquity. There is a plano-convex mirror. There are two pairs of binocular eyepieces, an analyzer, and three objectives; an unmarked low power, an R & J Beck 1/6 inch, and a HOMOGENOUS IMMERSION 105° ERNST GUNDLACH PAT^D DEC 2 1879 D 1/16. The case is original and all accessories are present. In closed position, the microscope is 17 inches high.

Crouch Binocular Microscope, c1875

This fine binocular microscope outfit is typical of the English Victorian microscopes of the fourth quarter nineteenth century. It is signed "Henry Crouch, London, 1794" and dates to around 1875. Henry Crouch began his career as an optician and mathematical instrument maker with Smith, Beck & Beck. In 1866, he published his first catalogue entitled, "*Catalogue of Achromatic Microscopes, Telescopes, Race & Marine Glasses, Etc.*" He operated at various locations in London until about 1905. The microscope stands 15 inches (38 cm) tall, extending to 19 ½ inches (50 cm) by rack and pinion coarse focus. The microscope inclines a full 90°. The English style curved tripod base, designed by Crouch, and Lister limb are black japanned brass. The main tubes and other fittings and accessories are lacquered brass. The Wenham binocular prism is removable for monocular use. Eyepiece width is rack and pinion adjustable. Fine focus is by thumbwheel and front lever acting on the objective lens and prism assembly. The stage top has a glass inset with a slide-around frictional slide carrier, and the whole stage assembly is rotatable. A condenser holder under the stage holds a revolving disk of diaphragms. A bar at the base of the limb holds the moveable plano-concave mirror. There are two pairs of matched eyepieces and three objectives; 2 inch with a lieberkuhn mirror, 1 inch, and ¼ inch, plus a canister for a 4 inch. Accessories include a Nicol prism, specimen forceps, live box, camera lucida, filter, glass slides, and free standing bullseye condenser. The microscope is held in an original fitted clamshell mahogany case with a brass carrying handle. The case interior contains a wood rack that holds the eyepieces, objectives, and accessories. The microscope is in very fine condition noting only some slight spotting to the lacquer.

Crouch Binocular Microscope

Ross-Zentmayer Compound Microscope, 1885

Joseph Zentmayer (1826-1888) was born in Germany and left for America in 1848 to become an instrument maker in Philadelphia. In 1876, the Centennial year, he introduced and patented a swinging substage assembly in what was named the "American Centennial Microscope." The swinging substage assembly allowed light to be focused onto a specimen at an oblique angle. The effect of this is to improve contrast in the specimen by accentuating phase gradients. The firm of Ross took out a patent in the name of "John Stuart, of No. 7, Wigmore Street [the Ross Optical Works] for Improvements in Microscopes. A communication from abroad by Joseph Zentmayer, of Philadelphia." Ross and Company made a microscope with the Zentmayer swinging stage that was known as the Ross-Zentmayer. The swinging substage was used by a number of manufacturers for several years until improvements in the resolving power of objectives made it obsolete.

This is a magnificent example of a Ross-Zentmayer microscope. The microscope stands about 17 inches closed and can be extended five more inches by a drawtube. It weighs about 19 pounds. The lyre or 'A' shaped foot bears the words 'ROSS' and 'LONDON' surrounding the serial number of 5356. Two round pillars support the trunnion inclination joint that can be tightened in any position from vertical to horizontal via a tightening handle on the right side of the joint. The Lister-Jackson limb supports an optical tube that has a coarse focus adjustment by diagonal rack and spiral pinion. The fine adjustment is via long lever within the limb controlled at the rear by a knurled knob. The fine focus knob is graduated. A conical pin passes through the limb to support the stage and swinging substage. The tension is adjusted via a knurled knob in the rear, so that any position selected can be secured. The substage assembly rides on a tailpiece that carries both the condenser assembly and the mirror. The ring at the top of the tailpiece is calibrated in 15 degree intervals, labelled every 45 degrees. The rack and pinion condenser assembly features adjustable centering via two knurled knobs. The entire condenser assembly can be removed from the tailpiece by pulling it out of its dovetail fitting, using the brass knob. The gimbaled mirror has both flat and concave sides and is attached to a tube which slides up or down inside the tailpiece. The axis of rotation of the swinging substage is around the plane of the specimen, which allows the focus of the condenser to be maintained regardless of the angle chosen. The tailpiece can be rigidly locked in the vertical position by a screw with knurled knob that passes through the limb at about the level of the dovetail fitting of the condenser assembly. The mechanical stage has controls for X and Y movement (X manual and Y by pinion) and the entire assembly can rotate around the stage. The stage has two clamps to hold a slide. There is a single eyepiece and two Ross objectives, a 1 inch and a 1/5 inch. The microscope is in superb condition. The mahogany case with handle and lock may not be original but was made for this microscope.

Ross-Zentmayer Microscope

J. Buist & Sons Compound Microscope, c1885

John Brown Buist (1846-1915), a Scottish pathologist, is credited with being the first person to see virus particles. He was for a time medical superintendent of the smallpox hospital at Barrow-in-Furness, England. In 1886, Buist presented to the Royal Society of Edinburgh an account of a study he had carried out in the surgical laboratory at the University of Edinburgh. He called his paper "The life-history of the micro-organisms associated with variola and vaccinia" (Proc. Roy. Soc. Edinburgh, 1886, 13:603). Buist had been able to fix and stain with Koch's aniline methyl-violet stain samples of lymph from variola and vaccinia pustules. His method had allowed him to see what he called "spores of micrococci," but which were almost certainly elementary bodies or aggregates of the pox viruses. Vaccinia is a large enveloped virus with dimensions of 360 × 270 × 250 nm. Since the limit of resolution of a good compound microscope is 200 nm, it is entirely possible that Buist was able to observe them, although they were not known as virus particles at the time.

This microscope is signed "J Buist & Sons Edinburgh" on the body tube. Microscopes by Buist are very rare and apparently few were made. There is the number 31 on the underside of the stage. The microscope stands 12 inches high and has a black, japanned iron base. The stand is black while the fittings are lacquered brass. Vertical flat pillars hold the rectangular limb by means of trunnions. The square stage plate is attached to the limb. There are three aperture stops that fit into the central aperture of the stage. Beneath the stage is a tube for the cylinder condenser with a lens and iris diaphragm. A double mirror on a gimbal is attached to the tailpiece. A short angular arm is affixed to the limb and holds a sprung tube into which the body tube slides. Course focus is by the sliding body tube and fine focus by a micrometer knob on top of the limb. There are two eyepieces marked A and B. There is a 1 ½ inch objective convertible to 2/3 inch with a screw-on button objective, and a 1/7 inch objective. The accessory is a bulls eye condenser on a stand. Everything fits into a 12 x 7 x 4 inch mahogany case. There is a magnification table on the inside of the lid. The microscope is complete and in excellent condition producing good images.

J. Buist Compound Microscope

Zeiss Continental Monocular Microscope, c1892

In Germany, the firms of Leitz and Zeiss eventually became the largest manufacturers of microscopes in the world. In Jena, the remarkable combination of Carl Zeiss, a machinist, Ernst Abbe, an optical theorist, and Otto Schott, an optical glass maker, resulted in the development of microscopes with unsurpassed optics.

Carl Friedrich Zeiss (1816-1888) grew up apprenticed in the machinist shop of Dr. Friedrich Körner, becoming well familiar with the operation of fine tools and machinery to make microscopes and scientific instruments. He completed his practicals at the Physiological Institute in Jena under Professor Schleiden. In 1846, Carl Zeiss opened a mechanical workshop in Jena and began to make improvements in microscopes, offering simple microscopes and in 1857 introducing his first compound microscope, the "Stand I". In 1861, Zeiss compound microscopes were declared to be "among the most excellent instruments made in Germany" and he was awarded a Gold medal at the Thuringian Industrial Exhibition. In 1866, the 1000th microscope was delivered.

Ernst Abbe (1840-1905) went to graduate school at the University of Göttingen where he received a Doctorate in thermodynamics. In 1863, Abbe joined the faculty at the University of Jena where he lectured on physics and mathematics, and later where he would serve his professorship. Up to this time, advances in optical designs and materials relied heavily on inefficient trial and error efforts and Zeiss realized that the improvement of optical instruments demanded advances in optical theory. Introduced to Carl Zeiss in 1866, Abbe became very interested in the optical challenges facing microscopy. Late in 1866, Zeiss and Abbe formed a partnership where Abbe became the director of research of the Zeiss Optical Works. Abbe devised the mathematical formulas to characterize the physics of optics. Among Abbe's most significant breakthroughs was the formulation in 1872 of a wave theory of microscopic imaging that became known as the "Abbe sine condition." This approach made possible the development of new microscope objectives based on sound optical theory and the laws of physics. Abbe also invented the Abbe condenser, used for microscope illumination.

Zeiss Continental Monocular Microscope

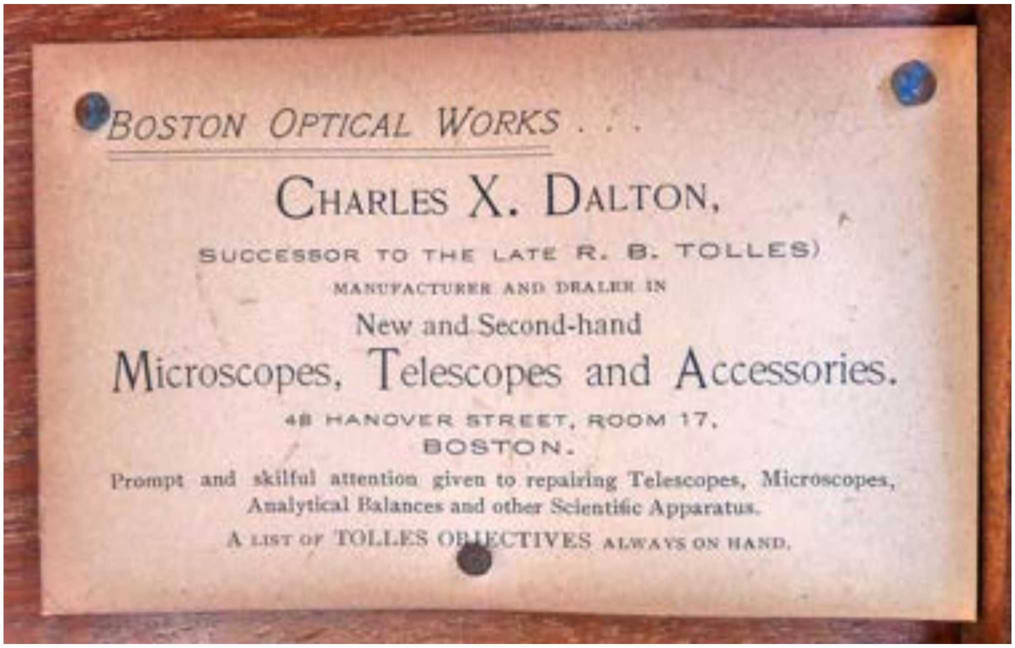
Otto Schott (1851-1935) grew up in a family that introduced him to making window glass. He became the father of modern glass science and technology. Schott earned his Doctorate at the University of Jena in 1875 for his work about defects in window glass manufacturing. In 1881, Schott met with Dr. Abbe who encouraged Schott to employ a scientific approach to the determination of raw ingredients to be used in glass formulations. In 1882, Schott moved to a new glass-making laboratory set up for him in Jena. In 1884, Schott joined Carl Zeiss and developed many new glass types, a number of which are still in use including Borosilicate Crown. Schott's glass innovations made possible the use of the Abbe sine condition. In 1886, Zeiss introduced the first apochromatic microscope objectives that were totally color corrected. These first true apochromatic objectives were so superior to the competition that Zeiss gained nearly the entire high-end microscope market. Zeiss delivered his 10,000th microscope in 1888.

This is a Zeiss IVa Continental model microscope, c1892. The instrument sits on a horseshoe base and a slotted rectangular pillar supports the stage and tubular limb. The body tube moves by rackwork. Below the stage are a rotating double mirror, a swinging platform for the iris diaphragm which moves on the platform by rackwork, and an Abbe condenser. The substage moves vertically by rackwork. The objectives are a C. Zeiss A, ¼ In., and C. Zeiss Homog. Immers. 1⁄12 N. Ap. 1.20. It comes with a non-original wooden carrying case. Signed Carl Zeiss Jena 19146. These simple but elegant and functional Continental microscopes set the pattern for the microscopes of the twentieth century.

Leitz Continental Monocular Microscope, 1888

In 1849, Karl Kellner founded the Optical Institute in Wetzlar, Germany. Telescopes were the original emphasis, but within a few years microscopes took over as the main product. The company hired a very capable engineer named Ernst Leitz in 1865, who soon became a partner. In 1867, the Optical Institute manufactured its 1000th microscope. Leitz took over the company in 1869 and renamed it Optical Institute of Ernst Leitz. Leitz's organizational talent and extensive experience together with an expanding market for microscopes led to the growing success of the company. One of the major decisions he made as an entrepreneur was to switch from the slow, labor-intensive manufacturing by hand to serial manufacturing, which would soon became the industry standard. In addition to its economical efficiency, the new production techniques improved the quality standards of the microscopes, which in turn made them more reliable for scientific research. In the last decades of the 19th century the use of microscopy increased rapidly with the rising popularity of natural sciences. By 1900 the Leitz company consisted of several facilities, oversaw 400 employees, and produced yearly about 4,000 microscopes of which there were many types. In 1907, the 100,000th Leitz microscope was shipped to German bacteriologist and Nobel Prize Laureate Robert Koch.

This all brass Continental microscope was made in 1888. It has objectives # 3 and # 7, eyepieces #1 and #3, and two condensers. It has a horseshoe base, inclinable pillar with micrometer fine focus on top. The arm has the coarse focus knob and holds the body tube. The mirror and condenser are below the square stage. The microscope is engraved "E Leitz Wetzlar No 12530" and "Educational Supply Co Boston." There is a card in the case that says "Boston Optical Works, Charles X. Dalton, Successor to the late R. B. Tolles." Robert B. Tolles met Charles A. Spencer in Canastota, New York in 1843 and apprenticed with Spencer in making microscopes until 1858. Tolles then left Spencer's employ to establish his own business. In 1867, Charles Stodder and several other Boston businessmen offered Tolles a partnership if he would move his business to Boston. Tolles agreed, and moved to Boston to supervise Boston Optical Works. Tolles produced a number of inventions and patents for improvements to the microscope and was renowned for his high quality objectives. Tolles died in 1883 at the age of 61. Charles X. Dalton continued the business, advertising as late as 1895. Dalton had worked with Tolles since their time with Charles Spencer in Canastota.



Leitz Continental Monocular Microscope, 1888

W. Watson and Sons Compound Monocular Microscope

William Watson set up an opticians firm in London in 1837. The name was W. Watson & Son 1867-1882, W. Watson & Sons 1882-1908, and W. Watson & Sons Ltd 1908-1957. They supplied all types of optical and scientific instruments including microscopes, binoculars, cameras, and telescopes. They began supplying slide preparations in 1884 when they took over the business of Edmund Wheeler. They offered very fine slides on a wide variety of subjects and there are many slides in this collection by this firm.

Toward the end of the nineteenth century, Watson and Sons manufactured a distinctive style of microscope. Instead of a horseshoe base, these microscopes have an English tripod base. Models included the Edinburgh, Royal, and Van Heurck microscopes. These instruments were very well received and manu-factured well into the twentieth century. The Edinburgh microscope, fol-lowed a design first proposed by Dr. A. Edington, professor of Bacteriology at Edinburgh University. The Van Heurck microscope was introduced in 1891 at the suggestion of the renowned Belgian diatomist Henri van Heurck (1838-1909). The model of this microscope is uncertain as the models are very similar with varying size, features, and accessories. It is most likely a large Edinburgh or the Royal.

Watson and Sons Monocular Microscope

The microscope is constructed in lacquered and black-painted brass and is about 15 inches tall when set up for use. The main focus and calibrated drawtube for setting tube length are by rack and pinion. The fine focus is by micrometer thumbwheel-lever. The mi-croscope has a double nosepiece changer with a Watson and Sons ⅙ inch objective. The microscope has a mechanical stage with thumb-wheel X-Y control. The substage is focused by rack and pinion. There is a substage Abbe condenser with lateral centering adjustments, a filter holder, and variable diaphragm. The plano-convex mirror on a swing-out limb for oblique illumination is not original. It is labeled "W. WATSON & SONS, 313 High Holborn, London" on the base. The serial number of 4208 would date it c1898.

Bausch & Lomb Microscopes

Excelsior Pocket and Dissecting Microscope, 1874
American Agriculturist Microscope, 1877
Student Microscope, 1877
Research Microscope, 1878
Library Microscope, 1878
Investigator Microscope, 1880
Physician's Microscope, 1885
Family Microscope, 1886
Harvard Microscope, 1889
Model Microscope, 1892
Library Microscope, 1893
Universal Microscope, 1895
Continental AA Microscope, 1897
Continental BB Microscope, 1899
Continental CC Microscope, c1895
Laboratory Dissecting Microscope, 1895
Jug Handle Microscope, 1911
Binocular Microscope, 1945
Dissecting Microscope, 1946

In 1850, John Jacob Bausch, an immigrant from Germany, began a business of making and selling spectacles in Rochester, New York. He was joined by Henry Lomb, also from Germany, in 1853. In 1866, the partnership became incorporated as the Vulcanite Optical Instrument Company. In 1874, the name was changed to the Bausch & Lomb Optical Company and the first microscope was produced. Ernst Gundlach was hired to head up the microscope department but left in 1878. The earliest microscopes were relatively simple Gundlach type stands but were optically excellent. These were replaced by the more sophisticated American type stands around 1882. Toward the end of the nineteenth century, the Continental type stand was adopted by most manufacturers around the world. By 1900, Bausch & Lomb along with Leitz and Zeiss were the largest producers of microscopes in the world. The history of the Bausch & Lomb Optical Company can be found in Padgitt (1975). The microscopes in this collection represent the basic types of stands made in the nineteenth century.

Bausch & Lomb Excelsior Pocket and Dissecting Microscope 1874

This microscope was sold from 1874 to 1895 as a portable dissecting microscope for botanical and entomological work. It is a tiny instrument in a walnut case measuring 3 inches wide, 1 ½ inches deep, and 7/8 inch high in folded position and meant to be carried in the pocket. It is 3 ¾ inches high when assembled. The gutta-percha instrument is erected on the underside of the sliding cover which is then slid back into place over the small mirror There are four lenses and a stage with a glass insert. Two dissecting needles are stored in channels in the cover's underside. This example is signed on the lid "J. J. Bausch Pat. June 9 '74." It is numbered 50 in two places. This means it must have been manufactured shortly after the patent date making it one of the earliest microscopes produced by the Bausch & Lomb Optical Company. The instrument is in excellent original condition.

American Agriculturist Microscope, 1877

In 1877, The American Agriculturist magazine owned by the Orange Judd Company announced that every subscriber could receive a microscope with their 1878 subscription for an additional 40 cents. Non-subscribers could purchase the microscope for $1.50. The publisher claimed that 125,000 of these hard rubber stand, 3 lens microscopes were manufactured for the 1878 mailing. Unlike the great variety of "household" and small drum microscopes that were being imported from France in the 1870's, the American Agriculturist microscope was made in America and designed by Bausch & Lomb. The microscope was proclaimed to be valuable to farmers to detect disease in plants and animals, the degree of goodness of seeds, adulteration of fertilizer, insect pests, etc. It was used to examine pork for trichina cysts. In addition to farmers, it was also claimed useful to all classes to detect adulteration of coffee, tea, spices and sugar. It probably introduced thousands of children to microscopy and science. For a time, The American Agriculturist ran a column entitled "The Young Microscopists' Club," in which techniques for using and modifying this microscope were presented. Stands made from wood, or even a window shade fixture, were offered up as ways to provide the American Agriculturist microscope with an inclination joint. A cigar box mount allowed for the use of a mirror under the microscope for transillumination. A cardboard eyepiece collar was devised to remedy an acknowledged defect; the upright holding the lens tended to poke users in the eye.

This example is signed "Bausch & Lomb Optical Co. Rochester, N. Y." and "Pat App'd For" so that it predates the patent date of Jan. 8, 1878. The tiny microscope consists of a gutta-percha stand, a stage, and three lenses on a pillar. The height is 5 cm. The stage is square glass slides held by clips. There is a pair of tweezers. This microscope has its original cardboard box printed on the cover "American Agriculturist Microscope From Orange Judd Company, 245 Broadway, New York." The cover is scuffed and some of the letters are missing, otherwise the instrument is in very good condition.

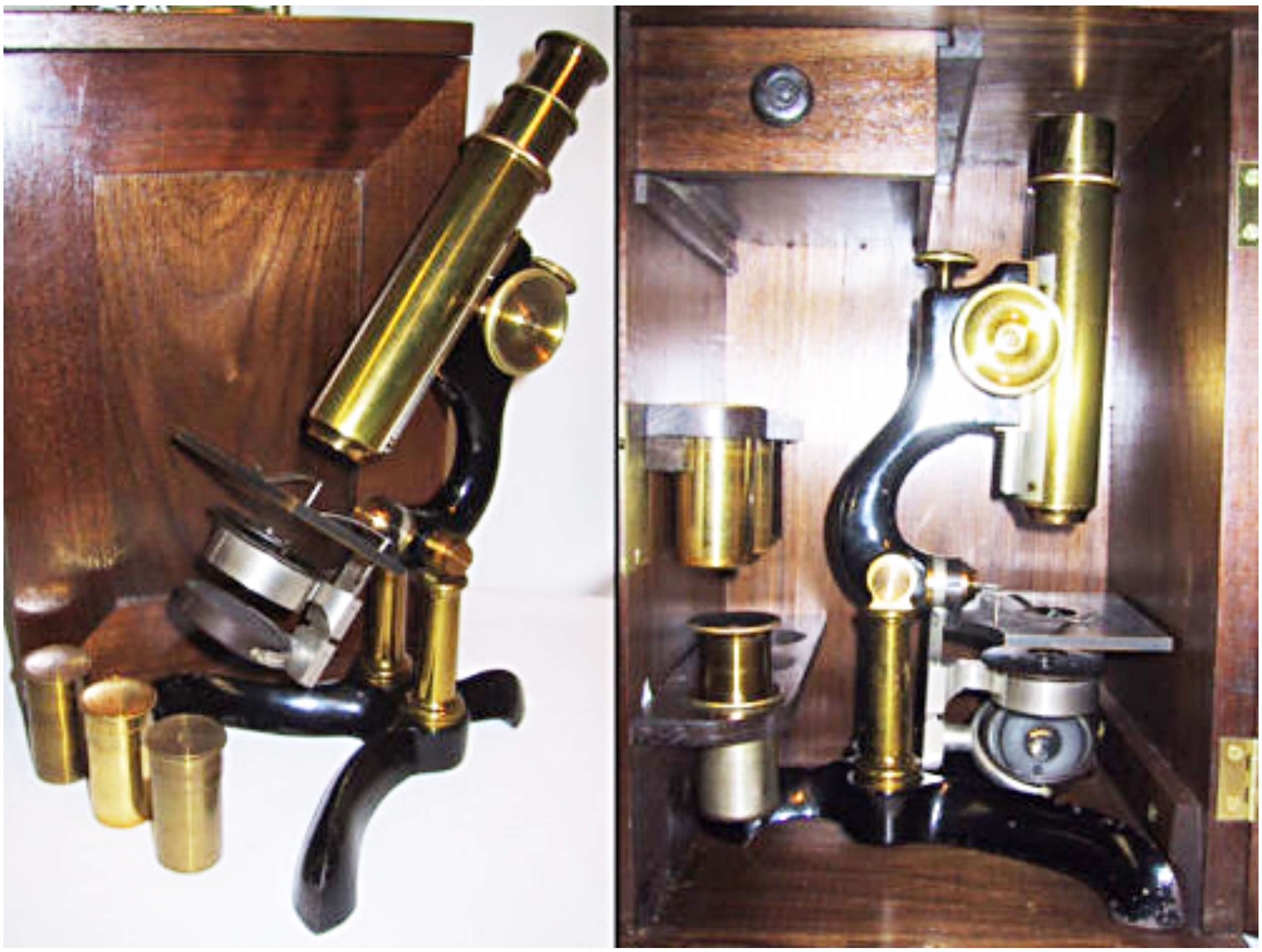
Bausch & Lomb Student Microscope, 1877

This is a Bausch and Lomb "Student's" microscope. Ernst Gundlach was largely responsible for the form. It is inscribed Pat. Oct 3. 1876 on the arm and this model was made until 1879. A tag in the case has the number 159 indicating this microscope was made in early 1877. The microscope stands about 15 inches tall in the closed position. This microscope features a Japanned Y-shaped foot that supports dual brass pillars that rise to a trunnion joint. This joint supports the Gundlach-type limb, which holds a brass tube and square stage. The body tube slides into the outer tube. There is a substage wheel of diaphragms and a mirror on a gimbal, which bayonets onto the tailpiece. Coarse focus is by rack and pinion and fine focus by a micrometer wheel at the top of the limb. There is a single objective, a B & L 1/6 inch in a hard rubber canister. The eye lens is set in a hard rubber eyepiece. The case is a modern reproduction of the original. The microscope is in excellent condition with almost all original lacquer and paint. It is a fine example of an early Bausch & Lomb production microscope.

Student Microscope

Bausch & Lomb "Research" microscope, 1878

This is a Bausch & Lomb "Research" microscope. "Bausch & Lomb Optical Co Rochester" is inscribed on the body tube. This Gundlach-style model was made from 1878 to 1880. The case is a modern reproduction of the original and bears the serial number 656 indicating the microscope was made in 1878. This microscope stands 11 inches tall closed. It features a Japanned Y-shaped foot that supports dual brass pillars that rise to a trunnion joint. This joint supports the Gundlach-type Japanned limb with arm holding the body tube, which has a nickeled inner draw tube. The rectangular stage and arm screw onto the limb. A revolving disc of diaphragms and double mirror slide onto the arm. Coarse focus is by rack and pinion and fine focus by a micrometer wheel at the top of the limb. The single eyepiece is marked 2 inch. There are three objectives in cannisters; 2 inch, ¾ inch, and ⅙ inch with a correction collar. The microscope is in exceptionally fine condition with all of the original lacquer. It cost $45 when new.



Research Microscope

Bausch & Lomb Library Microscope, 1878

This is an early Bausch & Lomb production compound microscope. The serial number is 648 indicating it was made in 1878. This model of the Library microscope was made from 1878 to 1885. It is a small microscope only 7 inches tall closed. The microscope is in excellent condition and seems to have received little use. It is original and complete and includes the camera lucida. This was the least expensive of the Bausch & Lomb microscopes which ranged in price from $10 to $200 in 1879. The ability of the Bausch & Lomb Optical Company to mass produce relatively inexpensive but functional microscopes was a major reason for the success of the company.

The microscope is described in the 1879 price list as follows:

"The Library Microscope has a finely finished and japanned foot, arm with joint to incline, a nickel plated body or tube, carrying the optical parts of the instrument and adjustable by rack and pinion, with draw tube to increase magnifying power; a concave mirror, swinging so as to give oblique illumination when desired, and capable of being brought above the stage for illumination of opaque objects. The screw at the lower end of the tube is so arranged as to permit the attachment of achromatic triplets, so that if desired a much higher magnifying power than the above can be obtained. The stage is made of hard rubber, which is not injured by water or ordinary fluids, and is provided with spring clamps for holding object slides. The camera lucida, which accompanies this microscope, although exceedingly simple, is a valuable addition for the same, and greatly adds to its usefulness. It is very easily managed and a little practice will enable anybody to make by the aid of it drawings of the magnified image of microscopic objects. The microscope has one eyepiece and a divisible two-lens objective, giving, in combination with the draw tube, magnifying power of from 50 to 125 diameters.......$10"

Bausch & Lomb Investigator Microscope 1880

This is a Bausch and Lomb "Investigator" microscope. It is inscribed Bausch & Lomb Optical Co Rochester N. Y. on the body tube and Pat. Oct 3. 1876. on the arm. The serial number of 1118 on the floor of the original walnut case dates this instrument to 1880. It retailed for $80 with the gliding glass stage. The microscope stands 14 inches tall in the closed position. A gold-painted tripod base supports the pillar that is capped by a cradle joint. Except for the base, the microscope is lacquered brass. The tubular limb with angular arm has an extension in front of the lower end and a grooved, swinging tailpiece. The swinging double mirror slots into the back of the tailpiece and the substage into the front. The substage holds a condenser. The circular stage has a milled edge and concentric revolving motion. A glass plate with gliding slide holder fits over the stage. The body tube has a nickeled drawtube. Course focus is by rack and pinion and fine focus by a screw at the top of the limb. The optics are two eyepieces and a 1 inch and ¾ inch objective. The microscope has its original wooden carrying case. It is in near mint condition with all of the original lacquer remaining.

Bausch & Lomb Physician's Microscope 1885

This is a Bausch and Lomb "Physician's" microscope. Ernst Gundlach was largely responsible for the form. It is inscribed Pat. Oct 3. 1876 on the arm. The serial number 3597 on the floor of the case dates this instrument to 1885. The microscope stands about 12 inches tall in the closed position. The claw-shaped base is black japanned iron. Except for the base, the microscope is lacquered brass. The base supports the pillar that is capped by a cradle joint. The tubular limb with angular arm has an extension in front of the lower end holding a swinging tailpiece, a substage, and the base of the stage. The double mirror slots into the front of the tailpiece. The substage holds a condenser with apertures. A rectangular glass plate is screwed onto the stage base. The glass plate is inscribed ”Bausch & Lomb Optical Co.” A gliding slide holder fits over the stage and is engraved with “PAT. DEC. 25 1877.” The body tube has a nickeled drawtube. Course focus is by rack and pinion and fine focus by a micrometer screw at the top of the limb. There are two original eyepieces. A double nosepiece holds 2/3 inch (Series I, 0.25 NA) and 1/6 inch (0.75 NA) Bausch & Lomb objectives. The microscope has its original walnut carrying case with an interior accessory drawer, magnification card on the inside of the door, and brass carry handle. The accessories are a stage forceps, camera lucida (missing the glass), and a micrometer marked 5 Mm and Div 1-10 Mm that fits into one of the eyepieces. The microscope appears to be missing a collar at the top of the body tube to hold the drawtube. Otherwise, it is in near mint condition with all of the original lacquer remaining.

Investigator Microscope

Physician’s Microscope

Bausch & Lomb Family Microscope, 1886

This is the Family Microscope made from 1877 to 1888. This microscope bears the serial number 3954 and was made in 1886. It is described in the 1879 Price list as follows: “The Family

Family Microscope

Microscope base and pillars are of cast iron, neatly japanned. They support the axis, which carries the arm in such a way that the instrument may be inclined to any angle. Rack and pinion for adjustment of focus, made with such exactness as to leave no perceptible jar, and neither lost or lateral motion while adjusting. In order to give greater sensitiveness to the adjustment, the milled heads of the pinion have been made of large dimensions, in consequence of which the lower and medium powers can be adjusted and used with great ease. The tube is supplied with standard Society screw. The mirror, which is concave, is so arranged that it can, if desired, be swung above the stage for the illumination of opaque objects. A revolving diaphragm is fixed beneath the stage. This stand is accompanied by one eyepiece, "B", mounted in either hard rubber or brass, and one objective, ½ inch, which divides so as to permit the separate use of the posterior combination, thus giving the power of an excellent 1 ½ inch. Range of magnifying power from 50 to 100 diameters.....$20." In this microscope, the eyepiece is not numbered and the objectives are a 1 inch and ¼ inch.

Bausch & Lomb Harvard Microscope, 1889

The Harvard microscope was made between 1884 and 1896. It was the first Continental type stand with a horseshoe base. This microscope has the serial number 6550 showing it was made in 1889. It stands 11 inches high. It is a brass basic stand with sliding-tube coarse focusing rather than rack and pinion. There is a screw fine adjustment at the top of the limb. It has two eyepieces and a Student ¾ objective and matching brass canister. The microscope is in very fine condition with complete coverage by the original lacquer. It was named the Harvard microscope because it incorporated suggestions made by the faculty of Harvard Medical School. The microscope is inscribed on the case and on inside of the base "Donated by Charles H Hamlin, M.D. 1980."

Harvard Micoscope

Bausch & Lomb Model Microscope, 1892

The Model microscope was made from 1883 to 1896. The serial number on this microscope is 11688 indicating it was made in 1892. It is signed, "Chas Lentz & Sons Philadelphia" and "Bausch & Lomb, Optical Co." on the stage. Chas Lentz was a seller of scientific instruments and an agent for Bausch & Lomb. At the top of the limb are "PAT. OCT. 3.1876" and "PAT. OCT 13.1885." The closed height of the microscope is 12 ½ inches. This microscope features a nicely sculpted Japanned Y-shaped foot that supports dual pillars that rise to a trunnion joint with extra strong bearings. This joint supports a very attractive sculpted curved limb of the microscope and the stage. The limb, in turn, supports the remainder of the microscope including the focus mechanisms and the body tube. The trunnion joint allows the microscope to be tilted at any angle from the vertical to allow for the comfortable viewing of specimen slides.

The limb design is attributed to Gundlach when he was with the Bausch & Lomb firm. This design was both practical and popular and lasted into the twentieth century. The microscope has one original eyepiece and two objectives in a double nosepiece. The eyepiece is a 1 inch. The B & L objectives are a ¾ inch and 1/5 inch with signed brass canisters. The objectives are marked as the "student" series for an 8 ½ inch tube length. The lenses produce excellent images of high contrast, sharpness, and bright color. Coarse focus is rack and pinion, and fine focus is achieved with a micrometer knob on top of the limb. The mirror is plano-concave and can rotate on a compass joint so that it can be used above the stage for oblique illumination of opaque subjects. The substage condenser is a hemisphere of stops. The microscope is finished in lacquered brass with a black painted base. There is spotting to the optical tube and stage and small chips in the black paint. A mahogany case with brass carry handle and interior accessory drawer holds the microscope and its accessories. On the inside of the door, there is a cardboard table showing the "Linear Magnifying Powers of Objectives and Eyepieces."

Model Microscope

Bausch & Lomb Library Microscope, 1893

A new model of the Library microscope came out in 1886 and was made until 1896. This example has the serial number 13826 indicating it was made in 1893. The microscope is considerably larger standing 8 ¾ inches closed. This microscope features a Japanned Y-shaped foot that supports dual pillars that rise to a trunnion joint. This joint supports the Gundlach-type limb which holds the brass body tube and circular stage. The stage and tube are lacquered brass. The round stage is signed Bausch & Lomb Optical Co., Rochester N. Y. and New York City. This microscope is in exceptional condition with no spotting of the brass and only one or two small chips in the black paint. It has two objectives, one a large unsigned brass objective marked ½ Special.

Bausch & Lomb Library Microscope, 1893

Bausch & Lomb Universal Microscope, 1895

The Universal microscope was the last of the classical American stands. It was called "universal" because the optical tube is adjustable and could use the English "long tube" objectives or the objectives of the shorter Continental tube. The microscope is signed on the base "Bausch & Lomb Optical Co., Rochester, N. Y. and New York City." The serial number is 19052 indicating the microscope was manufactured in 1895. The instrument is 13 ¾ inches tall when fully closed. The original finish is lacquered brass with a gold painted base. Coverage is largely complete with typical age wear. The base is a heavy fixed tripod foot on which a single pillar is attached by wing screw under the foot. The limb is held to the pillar by compass joint. Coarse focusing is by rackwork on the body tube and fine focus is by micrometer screw at the top of the limb. The body tube has a drawtube graduated from 170mm to 230mm. Both the substage and the plano-concave. mirror are on swinging arms with internal dovetails. Both ride vertically by rackwork on separate arms connected by rotating drum plates attached above the compass joint. The arms give individual axial movement to both the substage and mirror. The circular drum plates are graduated separately, and are numbered with the angle of radius for a total of 180 degrees (90 degrees each direction). The dome-shaped substage carries a rotating inner hemisphere of five iris diameters. The circular stage can be rotated. A nickel-plated slide carrier sits on the stage and is attached underneath by metal tabs acting as springs to provide effortless but firm movement. The slide carrier is engraved " Pat. Dec. 25 1877. " The microscope has a triple nosepiece with three Bausch & Lomb brass objectives, a ¾ inch, 4mm, and 1⁄12 inch. There are two original eyepieces, a 1 inch and a 2 inch. The optical system produces very clear, sharp images of good contrast. The original pine case has a paneled door, brass carry handle, and interior accessory drawer. This is an elegant representative of the best American microscopes before 1900.

Bausch & Lomb Universal Microscope, 1895

Bausch & Lomb AA Continental microscope, 1897

This is a relatively simple microscope first made in 1892. It was probably meant for student use. The serial number on this example is 26361 dating it to 1897. It stands 11 inches high closed. It has a black japanned iron horseshoe base. It has a straight arm attached to the pillar. The pillar and body tube are brass. There is a revolving disc of diaphragms under the black stage. Coarse focus is by rack and pinion with one knob. There is a screw fine adjustment at the top of the limb. It has two objectives.

Bausch & Lomb BB Continental microscope, 1899

This is a turn-of-the-century continental model BB microscope. It is signed "Bausch & Lomb Optical Co., New York, Rochester, N.Y., Chicago and Chas. Lentz & Sons, Philadelphia, PA on the base. The instrument measures 12 ½ inches high in closed position. The serial number 31833 on a disk on the base dates it to 1899. It has a brass body, a stage with a hard rubber top, and a brass U-shaped base. The microscope has three objectives, a 16mm, 4mm and 1.9mm Oil Imm. The eyepiece is a 2 inch. There is a detachable mechanical stage marked Patent Aug 24, '97. Beneath the stage is a swing-out Abbe sub-stage condenser with variable iris diaphragm and filter holder. Coarse focus is rack and pinion, fine focus with a micrometer dial and indicator on top of the limb. The mirror is plano-concave. The finish is lacquered brass. The wood case has a metal carry handle and two slide-out drawers for objectives and eyepieces. This is a fine example of the Bausch & Lomb continental style microscope that was popular at the turn of the century.

Bausch & Lomb Continental AA, 1897

Bausch & Lomb Continental BB, 1899

Bausch & Lomb Continental CC Microscope, circa 1895

This is a very fine Bausch & Lomb Continental CC microscope. The microscope lacks a serial number, indicating it may have been a prototype or presentation microscope. The microscope was restored by James A. Rendina, Kansas City, Missouri.

Bausch & Lomb Continental CC Microscope

This is a very substantial microscope standing 14 inches tall when closed. It is labeled Bausch & Lomb Optical Co., Rochester N. Y. and New York City on the base. The microscope is constructed largely of highly finished heavy brass. The horseshoe type base allows stability with the microscope at full inclination. The pillar consists of a rectangular brass column to support the body. The optical tube consists of a brass body tube with revolving brass triple nose piece and a nickel-chrome draw tube graduated in millimeters from 160 to 220mm. Coarse focus is rack and pinion; fine focus by a micrometer knob on top of the limb. The revolving slide stage is 3 ¾ inches in diameter. The stage is made of brass and fitted with a vulcanite top and is provided with two centering screws. The substage parts are the Abbe condenser lens with rack and pinion for vertical adjustment, iris diaphragm, and mirror. The diaphragm can be moved horizontally or swung out of the way to modify the type of illumination. The microscope has one eyepiece and six Bausch & Lomb brass objective lenses. The objectives are 1 inch, ⅔, 4mm, 48mm, ⅙ and 1/12 with brass canisters. The optics are excellent.

Bausch & Lomb Laboratory Dissecting Microscope, 1895

This model microscope was made between 1893 and 1896. This example has the serial number 17236 and was made in 1895. It is complete with the original case, mirror, three lenses, and a glass circle with micrometer rulings. It has a round brass base and pillar, rectangular stage, and rack and pinon focusing. The articulated arm at the top of the rack has ring mounts to hold the magnifiers. One lens is marked Bausch & Lomb Optical Co., Rochester, N.Y. U.S.A., 19mm Coddington. The Coddington lens is a double convex lens with a circular incision in the middle which is blackened and thus acts as a diaphragm, shutting out the marginal rays and correcting the spherical aberration.

Laboratory Dissecting Microscope, 1895

B & L Jug Handle Microscope, 1911

This instrument is signed on the base, "Bausch & Lomb Optical Co." and "Arthur H. Thomas Co., Philadelphia, PA," with a serial number of 83942, the serial number dating the instrument to 1911. The base plaque is the post-1909 Triple Alliance logo reflecting the union between Bausch & Lomb, Zeiss, and Saegmuller. Bausch & Lomb and Arthur H. Thomas had entered into an association in 1900. The microscope stands 11 ⅛" tall when fully closed, and opens to typical continental size and has a variable tube length. It has Continental style rack and pinion coarse focus and fine focus by a micrometer knob on top of the limb. The substage Abbe condenser has two variable iris diaphragms – one on top and one below the condenser lens. A circular filter slot is located on the bottom. The plano-concave mirror is excellent on both sides. There are three Bausch & Lomb objectives, a 16mm., 4mm, and 1.9mm fluorite oil immersion, all with original signed brass canisters painted black. Two original eyepieces, a 5x and 10x, are included, along with two filters, a blue glass and a center dark spot. Optics are clear and sharp with good color and contrast. The instrument is finished in lacquered brass and painted black brass. The finish is complete with some wear. The microscope comes in its original wood case with brass carry handle, lock and key. The profile of this instrument is one the most stylized of the jug handle designs. It features an integrated carry handle cut into a squared off limb, and looks sleek and sophisticated against the black and brass finish. The jug handle style is a variation of the Continental style that began around 1900 and ended around 1920.

B & L Binocular Microscope, 1945

This is a fine Bausch & Lomb binocular compound microscope with a stand CTAV in the original carrying case. The serial number BD 5658 dates it to 1945. It is equipped with a large binocular body with a revolving triple nosepiece, a mechanical stage, a blackened U-shaped base, and a curved arm. A condenser with an iris diaphragm on an adjustable support and mirror are located beneath the stage. The coarse adjustment on this instrument is by rack and pinion. The fine adjustment is a knob located on the side of the arm. There is also a monocular body tube. There is a pair of 10X and a pair of 5X eyepieces. The objectives are Bausch & Lomb Achromat 10X 16mm, 43X 4mm, and 97X 1.8mm. The microscope is in excellent condition and a fine representative of mid-twentieth century microscopes.

B & L binocular compound microscope, 1945

B & L Dissecting Microscope, 1946

Bausch & Lomb Dissecting Microscope, 1946

This is a Bausch & Lomb dissecting microscope made of iron with a pebbled finish. Dissecting microscopes were designed for low power observations and fine dissections. The serial number of TL5996 dates it to 1946. It rests on a horseshoe base and stands 13 inches high and has rack and pinion focusing, a glass stage, and substage mirror. There are two pairs of eyepieces, 10X and 15X. There are three pairs of parfocal objectives, 0.7X, 1.5X, and 2.0X, which are mounted on a drum nosepiece that can be turned to select the desired power. The microscope has its original wood case and is in excellent working condition.

Other American Microscopes

Charles A. Spencer Horizontal/Vertical Microscope, c1845 (First American Microscope)
Grunow Educational Microscope, c1857
Pike & sons Drum Microscope, c1860
E & J Bausch Microscope, c1860
Craig Microscope, c1865
Thomas H. McAllister Household Microscope, c1875
William Y. McAllister Universal Microscope, c1870
Geneva Optical Company Microscope, c1888
Zentmayer U. S. Army Hospital Binocular Microscope, c1880
George Wale New Working Microscope, 1878
John W. Sidle & Co. Acme No. 4 Microscope, 1881
Gundlach Optical Company Compound Microscope, c1885
Queen & Co. Acme No. 5 Microscope, c1885

E. H. & F. H. Tighe Microscope, c1890
McIntosh Professional Microscope, c1890
Gundlach-Manhattan Optical Co. Simplex Model, c1905
Spencer Lens Company Continental Microscope, c1903
Spencer Lens Company Microscope, 1917

Microscopy in America

Microscopes were almost nonexistent in America until the middle of the nineteenth century. There were makers of scientific instruments in the eighteenth century but they manufactured surveying and navigational instruments needed for the settlement of the country. The few microscopes that existed were imported from England. Cotton Mather used a microscope as early as 1684 and believed "animalcules" were the cause of smallpox. Harvard College obtained a Wilson screw-barrel microscope in 1732. Yale College purchased a Culpeper/Loft tripod microscope in 1734. This was the first known compound microscope in America and is preserved in the Peabody Museum of Natural History at Yale. There are a few references to microscopes made by accomplished amateur opticians in the first part of the nineteenth century, but the first lasting impact was made by Charles A. Spencer. He published an advertisement in 1838 announcing his ability to make reflecting telescopes and reflecting microscopes. He became well-known for the quality of his achromatic objectives. The next significant manufacturer of microscopes was the firm of Julius and William Grunow who began making microscopes around 1852. By 1880, there were over 20 firms dealing in microscopes although some were primarily importers of microscopes from England and Europe. The Bausch & Lomb Optical Company produced its first microscope in 1874. While most makers hand crafted their instruments individually, Bausch & Lomb employed methods for the large scale mass production of microscopes. By 1900, Bausch & Lomb along with Leitz and Zeiss were the largest producers of microscopes in the world. The only American makers to survive after the first part of the twentieth century were the Bausch & Lomb Optical Company and the Spencer Lens Company.

Charles A. Spencer Horizontal/Vertical Microscope, c1845 (First Amrican Microscope)

History of Spencer Microscopes

Charles Achilles Spencer (1813-1881) is known as America's first microscope maker. Spencer's was the only microscope manufacturing firm in America until 1849. By 1880 it had been joined by 19 others, including Bausch & Lomb, but by 1903, Spencer and Bausch & Lomb were the only two remaining American firms making microscopes. Charles Spencer was born in 1813, in Madison County, New York, in what would later become Canastota on the banks of the Eire Canal. In 1838, he had an ad printed, announcing his ability to make and deliver various reflecting telescopes and reflecting microscopes. By 1840, he published a catalog listing numerous microscopes, reflecting telescopes, and other instruments. Spencer is thought to have made the first American achromatic objective, and, by the late 1840's, had acquired a reputation for his excellent quality objectives of great angle of aperture. His objectives were considered superior to those of European opticians and were not surpassed until those of Carl Zeiss produced with Ernst Abbe

Charles A. Spencer (1813-1881)

and Otto Schott in the 1880s. Spencer apparently had no formal training in optics and learned from reading books and experimenting with glass. Spencer's first microscope was a horizontal type modeled from eminent French instrument maker Charles Chevalier's "Universal" microscope developed in 1834. This was followed by a "Pritchard" type microscope. Microscopes made by Spencer in the 1840's, signed "C. A. & H. Spencer" refer to Charles' cousin, Hamilton, not his son, Herbert. In 1854, Spencer formed a partnership with Professor E. K. Eaton of Troy, New York, under the firm name of Spencer & Eaton. They produced a large "Trunnion" microscope. Herbert R. Spencer (1849-1900) worked in his father's shop and became a partner after Eaton left the business, around 1865. Until 1875, the instruments were marked "C. A. Spencer & Sons, Canastota." In 1873, a fire destroyed the workshop in Canastota and in 1875, the Spencers moved to Geneva, NY, to build microscopes for the Geneva Optical Co. During the next three years, their instruments were marked, "C. A. Spencer & Sons for Geneva Optical Company." In 1877, this association was terminated and their stands were marked, "C. A. Spencer & Sons, Geneva."

After Charles's death in 1881, the business was carried on by his son Herbert under the name H. R. Spencer & Company. In 1889, he moved to Cleveland, Ohio, and then, in 1890, to Buffalo, New York, where the company remained. He formed a partnership with Fred R. Smith and between 1890 and 1895 the firm was known as Spencer & Smith Optical Company. The Spencer Company was incorporated in 1895, using the name Spencer Lens Company. The Spencer Lens Company was successful and over the years produced tens of thousands of microscopes. It was acquired by the American Optical Company in 1935. For several years after the acquisition, the Spencer Lens Company continued operation under its own name before becoming known as the Instrument Division of American Optical Company in 1945.

Description of Microscope

This is Charles Spencer's first microscope, the large version of the convertible horizontal/vertical microscope modeled after Charles Chevalier's horizontal microscope. It is signed "C. A. & H. Spencer, Canastota, N. Y." and dates to between 1840 and 1850. This extraordinary and massive brass instrument weighs 13 pounds total, and stands 14 inches (36 cm) high overall in the horizontal mode. It is transformable to a vertical instrument, extending by drawtube to a maximum height of 20 ¾ inches (53 cm). It stands on a large, stable three-legged base that fills a 12-inch diameter circle. In the horizontal mode, the stage, which dovetails into place and remains horizontal, has rack-and-pinion motion for coarse focusing. The huge double mirror cell, 3 ⅝ inches in outside diameter, has similar geared motion along the same rack. There is an ingenious fine focus motion to the stage, by knob and long screw (located just below the coarse motion controls) driving a brass wedge against a steel slope. The microscope itself has a two-element eyepiece assembly that bayonets on, a push-on dust cover, a 90° prism box that bayonets on, and an achromatic objective that bayonets in place on the prism box. The objective canister is marked "1 inch" but the unmarked objective is a ⅛ inch. The objective has knurled-ring adjustment of the separation of lenses, to compensate for different thicknesses of microscope slide cover slips; it has an index position marked "Uncov'd." The system gives fine images of high magnification. At the base of the pillar is a pin release to allow inclination of the limb, when converting to a vertical instrument. With the prism box removed, an adapter fits into the end of the body tube and holds the objective. Several of the microscope parts are internally numbered "9" (or 6) and one is numbered "4." The outfit is in good condition noting that the brass is rather browned, with spotting, although it still retains a portion of its lacquer. Purchased from David Coffeen, 2014.

Information on Microscope

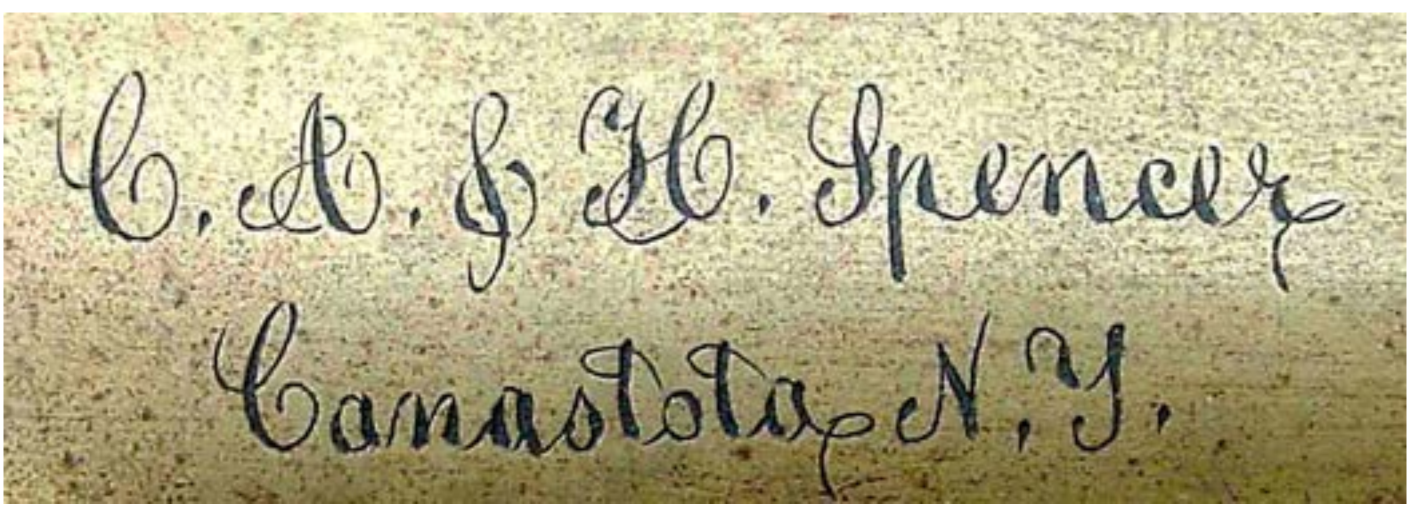
Charles Chevalier made a large and a small version of his universal microscope. In 1848, Spencer wrote to the Smithsonian Institution stating that he was "making microscopes of the model of the Large and Small Chevalier..." This indicates that he was making two sizes of his horizontal microscope, the present example being the large type. The Smithsonian ordered a microscope in 1848 but, typical of Spencer's perfectionism, it was not delivered until 1854 and was of the later trunnion type. It is believed this microscope was destroyed in a fire in 1865.

Oscar W. Richards, a Yale graduate and an authority on microscopes, spent over 40 years searching and studying the microscopes of Charles Spencer (Rittenhouse, 1988). Only about 15 microscopes of all types by Charles A. Spencer have been identified. On the other hand, microscopes made by the Spencer Lens Company after 1895 are common. It is surprising that in view of the high regard in which Charles Spencer's microscopes were held, that so few exist today. One explanation is that Charles was a perfectionist and, despite a backlog of orders, made very few microscopes and did not release them until completely satisfied with them.

Spencer did not have serial numbers on his microscopes but he numbered several of the internal parts. He probably made around 20 of the horizontal microscopes. In 1988, six were known; numbers 2, 11, 12, 16, 19, and one unspecified. This example is the seventh microscope known (unless it is the unspecified microscope) and has parts numbered 9 or 6 and one part numbered 4. Some of the surviving microscopes have been modified, and number 2 is missing the base and mirror so that the present example is the earliest surviving intact American microscope.

Spencer Microscope in Horizontal Position

Spencer Microscope in Vertical Position



Signature on Microscope Body Tube

Grunow Educational Microscope, c1857

Julius and William Grunow emigrated to New York from Germany in 1849. The brothers formed a business partnership under the name J. & W. Grunow & Co. and began to make microscopes in 1851 or 1852. Around 1854, the brothers had moved to New Haven, Connecticut. Little information is available about the early career of the Grunows, but according to an 1880 account, Julius was induced by Dr. Henry Van Arsdale and Dr. Chandler R. Gilman to study optics and manufacture microscopes. It was said that Julius taught himself optics and constructed a microscope in 1852 for Dr. Van Arsdale and soon afterward a second one for Dr. Gilman. Dr. Van Arsdale was an authority on microscopical pathology and histology and President of the New York Pathological Society in 1853. Dr. Gilman was Professor of Obstetrics at the Columbia College of Physicians and Surgeons. Charles A. Spencer had completed an achromatic microscope for Dr. Gilman in 1847. At the same time, the Grunow brothers produced two innovative microscopes. The first was the first workable binocular microscope made in 1853 and designed by Professor John Leonard Riddell, Professor of Chemistry at the University of Louisiana (now Tulane University). The second was a chemical or inverted microscope designed by Professor J. Lawrence Smith, a prominent American chemist then also at the University of Louisiana. In the New York Crystal Palace Exhibition in 1855, the Grunows received the second prize for microscopes, the first going to Charles A. Spencer. The Grunows produced several types of stands, high quality objectives, and microscope accessories. In 1864, the brothers moved back to New Yolk City and later formed their own separate businesses. Given the innovative nature and high quality of the microscopes produced by the Grunows and their association with prominent academicians, it seems unlikely that they learned how to manufacture microscopes entirely on their own. They first worked for the optician Benjamin Pike in New York. It is possible they may have received instruction from a microscope maker such as Charles Spencer or Robert Tolles who apprenticed with Spencer. In 1859, Tolles was fabricating microscopes with Charles E. Grunow, another brother. The Grunows produced microscopes with serial numbers up to 1048.

This is Stand No. 1, the Educational Microscope, the smallest of the stands made by the Grunow brothers. The microscope is signed "J. & W. Grunow Co., New Haven, Ct., N◦ 138." It stands around 13 inches arranged for use. The tripod base and two uprights are japanned cast iron. The japanned cast iron limb is attached to the uprights by a trunnion joint allowing the instrument to be inclined. A brass cylinder is attached to the limb and holds the brass body tube. Coarse focus is achieved by sliding the body tube. The stage is two by three inches with stage clips. A milled-head screw to the right of the stage provides fine focus by raising or lowering a stage plate. There is no substage diaphragm or condenser. A concave mirror is held in a cradle joint. There are two eyepieces with lens caps. There are three objectives; a 1/2 inch in a marked brass canister, a 2 inch, and an objective with three screw-on lenses. The latter two objectives are held in a long cylindrical brass canister marked Grunow II[IN]. The instrument is held in an original fitted mahogany case with a drawer. The microscope shows signs of extensive use with wear to the lacquer and chips to the paint. It functions well and provides a clear, sharp image. It is a fine example of one of the earliest microscopes manufactured in America.

The 1857 *Illustrated Scientific and Descriptive Catalogue of Achromatic Microscopes, Manufactured by J. & W. Grunow & Co., New Haven, Conn*. describes the microscope as follows: "This microscope is designed, as its name implies, for educational purposes, for schools, private families, and for young people generally. Farmers, mechanics and merchants, who desire to devote some of their leisure hours to intellectual improvement, or to the investigation of those branches of natural science more or less connected with their several avocations, will find this at once a cheap, substantial and efficient microscope." The price of the microscope was $45.

Pike & Sons Drum Microscope, c1860

This small drum microscope is signed on the drawtube in cursive script " B. Pike & Sons 518 Broadway New York." Benjamin Pike (1777–1863) was born in London, moved to New York in 1798, and set up shop as an optician. By mid-century, Pike and his sons were the leading dealers of mathematical, optical, and philosophical instruments in America. Some instruments with a Pike signature were made by craftsmen working under the direction of the Pikes. Others were made in workshops and factories elsewhere in the United States, and many were made abroad and imported. Based on the name of the firm and its location, this instrument was sold between 1855 and 1867. It was cataloged as a Beginners microscope, No. 231 and cost $5. The brass microscope is six inches high. The tubular body screws into a circular base and has a cutout for the mirror on a pivot. There is another cutout above the circular stage. A condenser on an arm is mounted to the upper part of the body. The body tube slides for coarse adjustment. There is a single eyepiece and three objectives marked 1, 2, and 3. The microscope, objectives, forceps, and a small microscope slide fit into an original walnut case. The microscope bears a few marks and scratches but is otherwise in fine condition with most of the original lacquer. The microscope closely resembles those by French makers but is significant in bearing the name of an important American nineteenth century scientific instrument firm.

Pike & Sons Drum Microscope

E & J Bausch Microscope, c1860

John Jacob Bausch emigrated to America from Germany in 1849. After several unsuccessful business ventures, Bausch opened a retail optical shop in Rochester in 1853 and hung out a sign offering his services as "J. J. Bausch, Optician." Eyeglasses were then a relative luxury, and business was slow. At a local German social club he became friends with Henry Lomb, a fellow immigrant. Trained as a cabinetmaker, Lomb had emigrated to the United States in 1849 and settled in Rochester. In exchange for a loan of sixty dollars to help Bausch's business, Lomb apprenticed himself to Bausch to learn the optician's trade and became a boarder in the Bausch family home. By 1856, Bausch's business, now renamed the J. J. Bausch Optical Institute, had improved. Bausch's wares had expanded, and he now offered other products in addition to spectacles including thermometers, field glasses, telescopes, magnifiers, opera glasses, microscopes, and hour glasses. Most products were imported from Germany. Bausch's brother, E. E. Bausch, emigrated to America in 1854. In 1857, E. E. Bausch joined J. Bausch and Lomb as a clerk where he remained for about five years. E. E. Bausch went on to form the optical firm of Bausch & Dransfield, later E. E. Bausch & Son. J. Bausch and Lomb formed the Vulcanite Optical Instrument Company in 1866 and in 1874 the Bausch & Lomb Optical Company which specialized in microscopes.

This microscope measures 8 ⅛ inches tall on a 4 ⅝ inch diameter base. The circular base is made of cast iron overlaid with a sheet of nickel-plated brass, and bears underneath the cast signature in relief "E. & J. B 5." The microscope itself is made of relatively thin brass with remains of a clear lacquer finish. It features a vertical cylindrical rear pillar with internal racked motion to the stage, compound optics, above-stage condenser on an articulated arm mounted to the main tube, and plane gimbaled substage mirror. Condition is reasonably good noting losses to the finish, a crack in the mirror glass, and a couple of small cracks in the sheathing of the base. It is likely this instrument was made between 1857 and 1862 when E. Bausch was associated with J. Bausch. It appears to be a French microscope mounted on a base made by the Bausch's. As such, it is an important instrument in the history of American instrument manufacture.

Craig Microscope, c1865

The Craig microscope was the first inexpensive American microscope. In 1861-62, Henry Craig was working as a janitor in the Western Homeopathic College in Cleveland and living at the school. In 1862, he patented his fused glass lens and began manufacturing microscopes. This 4 ⅞ inch (12.4 cm) tall microscope is made of thin sheet brass, with vertical design and articulated plane mirror. A gutta percha cell holds the special tiny lens, with its domed top and plane base. It is signed around the lens "Craig's Lens, Pat'd Feb'y 18, 1862." A key feature of the patent was the lens, made with a globule of flint glass fused to a plate of crown glass. The focal point was at the bottom of the crown plate itself, which would have been in direct contact with the specimen on a slide, or fluid droplet specimen. No focus adjustment was necessary. The present example is complete with the original green card case, noting a bit of scuffing. The case bears directions and an illustration of the microscope. Included with the microscope are five original small slides (Humming Bird's feathers, Fly's eye, Bee's tongue, Flea, and Sweet William Anther) and a copy of a sheet showing an enlarged microscope in use. The price of the microscope was $2.00 in brass and 50 cents for the more common hard rubber version. Condition is fine noting minor spotting to the original lacquer finish on the brass. The instrument is in good working order.

Craig Microscope

In the second half of the nineteenth century, American optical and scientific instrument firms began offering small compound microscopes. These were probably meant to compete with the small French drum microscopes that were being imported in large numbers, even though many of the microscopes they offered were also made in France. Shown below are three examples of small microscopes offered by American firms.

The McAllister Family formed a dynasty of opticians and optometrists that continued on into the early years of the twentieth century and lasted some five generations. John McAllister, Sr. (1755-1830), arrived in America from Scotland in 1775 and established a shop in Philadelphia selling whips and canes in 1783. In 1796, he added spectacles to his inventory forming the first optical shop in America. He is now recognized as the Father of optometry and opticians in the

United States. John McAllister, Jr. (1786-1877) joined the business in 1807. In addition to spectacles, they sold spyglasses, magic lanterns, camera lucidas and obscuras, lenses, and other photography equipment. The shop was frequented by the earliest practitioners in photography who became John Jr.'s friends and colleagues. Renamed McAllister & Brother when it was taken over by John Jr.'s sons, William Y. McAllister (1812-1896) and Thomas H. McAllister (1824-1898) in 1853, the enterprise became the country's first major dealer in lanterns.

Thomas H. McAllister Household Microscope

In 1865, Thomas H. McAllister moved to New York City and set up his own business. In 1880, he listed eye glasses, spectacles, spy glasses and telescopes, opera glasses, field glasses, compasses, camera lucida, camera obscura, microscopes, magnifiers, magic lanterns, stereopticians, anomorphoscope, and zoetrope. He came to specialize in magic lanterns (see T. H. McAllister lantern in this collection), slides, and related supplies. T. H. McAllister would subsequently deal in motion-picture projectors and films as well. While the early McAllister Brothers' scientific instrument business in Philadelphia did not make microscopes, Thomas began making microscopes as early as 1867 after he moved to New York City. This first effort was the "Household Microscope," a small and very inexpensive compound microscope. The claw foot base of the microscope supports two columns holding the curved limb that supports the stage and the body tube. The body tube is bright brass and the rest of the microscope is gold-painted iron. The tube is signed "T. H. McAllister New York." There are two objectives. Focus is by sliding the eye tube. There are stage clips and a substage mirror. The microscope stands seven inches high and has its original wood box. c1875.

William Y. McAllister Universal Microscope

William Y. McAllister in Philadelphia sold spectacles, opera glasses, telescopes, microscopes, magic lanterns, globes, drawing instruments, surveyor's equipment, barometers, thermometers, chemistry supplies, medical equipment, and a host of other scientific instruments. Many of these instruments were imported from Europe. This microscope is labeled "Universal Microscope, Wm Y McAllister, Phila" on the green-painted, curved Y-shaped cast iron base. It stands seven inches high closed. The body tube is brass and focuses by sliding the eye tube in an outer brass tube. There are two unmarked objectives and a substage mirror. The microscope was imported from France and is stamped "Déposé," French for registered. c1870.

Geneva Optical Company

This microscope is labeled "GENEVA OPT Co. 57 WASHINGTON ST CHICAGO" on the stage. The Geneva Optical Company was founded in 1869 by Andrew L. Smith as the A. L. Smith Optical Company of Geneva, New York. The company primarily made spectacles and tools for opticians. A branch known as the Geneva Optical Company of Chicago was opened in 1888. The microscope presumably dates to after 1888 when the Chicago branch opened although it follows an earlier design. The claw-footed base supports two uprights into which are screwed the Lister limb and trunnion. These parts are of black japanned cast iron. The circular stage is fixed to the limb but there is no tailpiece or mirror. The body tube has a short cone nose, a rack at the back, and a drawtube with a field lens. The single eye lens screws into the tube. There are three objective lenses that screw into one another so different magnifications can be obtained.

T. H. McAllister Household

Wm. Y. McAllister Universal

Geneva Optical Company

Zentmayer U. S. Army Hospital Binocular Microscope, c1880

Born in Germany, in 1826, Joseph Zentmayer (1826-1888) emigrated to the United States in 1848 as a young man, already trained in optics and instrument making. After working for several American instrument makers, including Young & Sons, he opened his own business in 1853 in Philadelphia, making his first large stand, the Grand American, sometime before 1858. As many as ten different types of stands were made over the next 30 years. The U. S. Army Hospital microscope was first made in 1862. The government was in urgent need of microscopes for use in military hospitals during the Civil War. Zentmayer was one of only four American microscope makers at the time and was called upon to supply quality instruments. The American Centennial Stand, introduced in 1876, is a large and elaborate instrument that cost $765. His large stands were comparable in quality to the finest English microscopes. They were also very expensive so the simpler and less expensive American Histological Model and Student Microscope were also introduced in 1876. Zentmayer was an innovator in the design of instruments and optics. His shop on Walnut Street was a gathering place for scientists, physicians, and professors of the day. After Joseph's death in 1888, his sons carried on the business until at least 1895.

Zentmayer U. S. Army Hospital Binocular Microscope

This is a binocular U. S. Army Hospital microscope made after 1876. This model cost $173 in 1879. It is labeled J. Zentmayer, Phila., Pat. 1876, and numbered 3774. It is made of polished brass and stands 16 inches high when arranged for use. It is in excellent condition with almost all of the lacquer intact. It has a Y-shaped base, round column, and Jackson limb. There is a Wenham binocular body, rack and pinion coarse adjustment, long-lever fine adjustment, graduated revolving stage, and swinging substage assembly. The swinging substage, patented in 1876, allows the condenser to swing and the mirror to be positioned at any point under or over the stage. This provides for oblique lighting or directing light from above onto an opaque object. A graduated circle is provided for registering the degree of obliquity. The substage consists of a centerable condenser with rack and pinion adjustment and mirror. The microscope has an early E. Leitz Wetzlar brass mechanical stage attached to the circular stage. There are four unnumbered eyepieces. There are two objectives, a Zentmayer 1 ½ inch and one numbered 2. The microscope is housed in its original walnut case but the drawer is missing. Large, early American binocular microscopes are rare and seldom seen on the market today. Except for Zentmayer's more elaborate Centennial microscope, this is probably the finest American microscope of the nineteenth century.

George Wale New Working Microscope, 1878

This is a "New Working Microscope" by George Wale (1840-c1903). It earned a Medal of Excellence at the 1880 Exhibition of the American Institute of the City of New York. The microscope stands 10 ½ inches high closed. It has a black japanned iron base, a curved nickel-plated limb, and a brass body with a drawtube. The microscope is stamped on the rear of the round stage "GEO. WALE PAT APP. FOR"' and on the housing for the stage diaphragm "GEO.WALE, PAT. JUNE 6, 1876." George Wale was an innovator of microscope design and his most famous innovation is the "Wale Limb" or radial limb as seen on this microscope. This is a method of inclination that allows the body to be inclined in any position without changing the center of gravity. It is formed by a unique foot formed of two parts, each of which was cast with a groove in which slides the molded sides of the limb. The two sides are held together by a fine screw controlled by a knurled brass knob. The limb can be angled to any position and locked by the knob. This method of inclination was later copied by major microscope manufacturers. At the bottom of the C-shaped limb, the stage and the swinging tailpiece are held in place by screws. The tailpiece carries a gimbaled plano-concave mirror. The patented diaphragm is of a unique form. As the diaphragm is turned, its iris leaves are pushed up into a paraboloid-shaped cone and come closed together making the opening smaller. Another innovation is a rotating stage clip that can be rotated around the stage allowing a slide to be placed in the optimal position for incident light. Coarse focus is by rack and pinion, fine by a micrometer knob atop the limb. There are two original objectives, a ⅔ and a ⅕ inch, signed "Geo. Wale" and two oculars. The microscope is in good condition and has its original black walnut case.

John W. Sidle & Co. Acme No. 4 Microscope, 1881

This is a rare and finely-made American microscope. It is labeled on the stage "John W. Sidle & Co. Lancaster PA. Acme 104." The Acme line of microscopes was first introduced in 1879 by the firm Sidle and Poalk of Philadelphia. The first microscope made by the firm was called "The Acme." By 1880, the firm was located in Lancaster Pennsylvania under the name John W. Sidle & Co. or the "Acme Optical Works." Subsequently, the entire output of the Acme factory was consigned to the retailer and manufacturer of scientific instruments, James W. Queen of Philadelphia. Five models of the Acme microscopes were produced numbered 2-6.

The microscope stands 12 inches high closed. The black japanned iron tripod foot of this instrument supports a brass tubular pillar capped by a cradle joint. A curved, black, japanned iron limb with a circular plate and a projection at the base is screwed to the joint. A swinging tailpiece is attached to the plate. The tailpiece carries a gimbaled double mirror and can be swung above the stage for oblique lighting. The circular stage is screwed to the limb projection. The stage has a central opening into which screws a tube for carrying accessories. A revolving disc of diaphragms on a swing out arm is below the stage. The front section of the limb has a micrometer screw at the base for fine focusing and is fixed to a brass section that holds the body tube. Coarse focus is by rack and pinion. The body tube has a short cylinder nose and a drawtube. The microscope has two eyepieces and three objectives; a Bausch & Lomb 1 inch, a Bausch & Lomb, ¼ inch, and one unmarked. The accessories are stage clips, a camera lucida, a live box, and a lens that fits into the substage tube. The microscope is housed in a modern wooden case. It is in exceptional functional and cosmetic condition.

Sidle Acme #4

Gundlach Optical Company Compound Microscope, c1885

Ernst Gundlach (1834-1908) was one of the more inventive, skilled, and restless opticians of the nineteenth century. He was an apprentice to C. F. Belthe who took over the Optical Institute in Wetzlar Germany from Carl Kellner's estate and before the Institute was purchased by Ernst Leitz. Gundlach established his own Berlin workshop in partnership with the Siebert brothers and gained a reputation as a maker of highest quality objectives and microscopes. In 1871, he sold his Berlin shop and came to America where he set up as a sole proprietor making microscope objectives in Hackensack, New Jersey. In 1876, Henry Lomb induced Gundlach to head up the newly formed microscope department for Bausch & Lomb. Gundlach designed a full product line of microscopes and patented a variety of stands and accessories. Apparently, Gundlach's desire for perfection instead of economical production led to losses for Bausch & Lomb and he was let go from the firm in 1878. For a brief period, Gundlach worked with Philip Yawman and Gustav Erbe, who were also former employees of B&L, in the production of microscopes. In 1879, Gundlach and Lewis R. Sexton set up and operated an optical goods establishment in Rochester. He was then in Hartford where he was listed as an optician from 1880 to 1884. In August 1884 Lewis R. Sexton died and Gundlach immediately returned to Rochester where he, along with several other new business partners, including H. H. Turner, J. Zellweger, and J. C. Reich, established the "Gundlach Optical Company," which produced microscopes and cameras. Gundlach had no connection to the company after 1895 and, instead, produced photographic lenses including the celebrated Rapid Rectigraphic and Perigraphic lenses under the name Gundlach Photo-Optical Co. In 1902, Gundlach Optical Company acquired Manhattan Optical Co. They manufactured microscopes and cameras under their new name, Gundlach-Manhattan Optical Co. In 1904, Gundlach returned to Berlin and founded another company. Ernst Gundlach died in Berlin, Germany in the year 1908.

Gundlach Microscope

This is a relatively rare and important microscope made by Ernst Gundlach around 1885. It is notable in that it has a unique fine focusing system. This microscope stands 10 inches closed. It features a black Japanned Y-shaped flat tripod foot that supports dual pillars that rise to a trunnion joint. This joint supports a sculpted curved limb and a round stage. The stage is signed "GUNDLACH OPTICAL CO., ROCHESTER, N.Y." The limb supports the coarse focus mechanism and the body tube. The body tube is focused via an angled brass rack and pinion system affixed to the limb and the body tube. A pair of brass milled heads is used to control the coarse focus. The body tube is equipped with a nickel-plated brass drawtube. At the top of the drawtube is a traditional "top-hat" style ocular (unmarked). At the distal end of the body tube is a ⅙ inch RMS objective presumably by Gundlach, but it is not marked. The microscope is equipped with a 70mm diameter round stage with a 15mm diameter central aperture. Under the stage is a yoke mounted single-sided concave mirror assembly (mounted in brass) found at the end of a flat brass mirror bar. The mirror bar is able to pivot about the stage on a compass joint (the axis of which lies in the plane of the stage) such that it can be adjusted to any angle below the stage for oblique illumination and also above the stage to provide incidental illumination to opaque objects. The microscope has its original wood case. It is missing one stage clip and a disc of apertures under the stage. Otherwise, it is in excellent condition retaining most of its lacquer and producing a good image.

The unique fine focus mechanism is found at the lower end of the body tube and is partly enclosed within the tube itself. It consists of a spring-loaded double brass cylinder that is screwed into a brass ring, which is press-fit into the lower end of the body tube. At the lower end of the inner brass cylinder is an attached brass flange with an internal RMS thread that is designed to accept an objective lens. At the lower end of the outer brass cylinder is an internally threaded nickel-plated brass focusing wheel. This focusing wheel is threaded onto the outer brass cylinder and, when it is turned, it impacts and moves the inner spring-loaded brass cylinder inside the outer cylinder either up or down. In turn, this action moves the attached microscope objective slightly up or down thereby providing a very precise form of fine focus. The system was apparently not patented by Gundlach and is not known on other microscopes.

Queen & Co. Acme No. 5 Microscope, c1885

One of the largest American sellers of scientific instruments in the nineteenth century was Queen & Co. James W. Queen (1813-1890) began working for the McAllister Brothers in Philadelphia, as a boy, around 1825. From 1836 to 1852 he was a partner in the McAllister business, leaving in 1853 to start his own company selling optical and philosophical apparatus. In 1859, he became associated with Samuel L. Fox and the firm became James W. Queen & Co. James Queen retired in 1870 and the business was continued by Fox until 1893, when it was incorporated as Queen & Co. Queen & Co. imported and sold a great variety of microscopes by many other makers. By the end of the third quarter of the nineteenth century, much of the American demand for microscopes was being met by imports from Nachet in France, Hartnack in Potsdam, and R. & J. Beck and Henry Crouch in London, among others. Later, Queen & Co. manufactured their own microscopes. By the 1880s, the firm sold mathematical instruments, optical instruments including spectacles, microscopes, and telescopes, magic lanterns and slides, physical and chemical apparatus, and meteorological instruments. The headquarters of the company was at 924 Chestnut Street, Philadelphia, and there also was a branch office in New York City. Queen & Co., Inc. existed until 1912 at which time it was reorganized as the Queen-Gray Co. by John G. Gray and continued as such until Mr. Gray's death in 1925.

Quenn & Co. took over the production of John Sidle's Acme line of microscopes. This is the Acme No. 5 microscope. It is 9 ½ inches high closed. It has a cast iron Y-shaped foot and twin pillars painted with black enamel. The curved limb supports the lacquered brass body tube that moves by rackwork. The body is fitted with a nickel-plated draw tube. There is a single objective with three button lenses that screw into one another so different magnifications can be obtained. A swinging mirror is attached to the tailpiece. It is signed on the circular brass stage "Jas. W. Queen & Co. Philadelphia." It has its original dovetailed cherry case. The case bears the numbers "76" and "82" and the microscope "VIII" on the bottom. The microscope is in used but very good condition. c1885.

Queen & Co. Acme No. 5, c1885

E. H. & F. H. Tighe Microscope, c1890

This is a continental microscope, once owned by a Yale graduate, signed ,"E.H. & F.H. Tighe, Detroit, Mich." on the base. When closed, it is 11 inches high. The brass microscope has a horseshoe base supporting a tubular pillar. There is a cradle joint and a U-curved tubular limb. At the upper end of the limb is a fixed tube that has a micrometer screw at the base for fine adjustment. A rectangular fitting with a pinion is attached to the front of the tube. The body tube has a diagonal rack at the back, a draw tube, and a short cone nose. The circular stage with apertures for spring clips is screwed to a slotted extension at the base of the limb. Beneath the stage is a sprung tube holding a cylinder diaphragm. A swinging tailpiece supports a gimbal for the concave mirror. The microscope has a single eyepiece and a divisible objective that is marked 1/8 & 2/3. Unscrewing the front lens element reveals the second lens. The microscope has its original wooden case. Instructions for care of the microscope are on the inside of the lid. A strip of tape has written on it "Belonged to

Edward Weir Smith, M.D." The microscope is in good condition with spotting and loss of lacquer in places.

Edward and Frederick Tighe were born in Canada and emigrated to the US in the 1870's where they later set up an optical business. The design of their microscopes is considered to have an aesthetically pleasing sculptural quality. It is believed that they worked closely with the Gundlach Optical Co. of Rochester, New York. Edward Weir Smith received a BA degree from Yale University in 1878 and an MD degree from McGill University in 1882. He was a surgeon who practiced in Meriden, Connecticut and published articles in medical journals.

McIntosh Professional Microscope, c1890

This is a relatively rare brass American microscope by Lyman D. McIntosh. It is marked on one of the feet "MC INTOSH BATTERY AND OPTICAL CO CHICAGI, ILL. PAT. MAR. 13. '83" and is numbered 328. It rests on a tripod base supporting a tapered brass pillar that terminates in a compass joint, which allows the microscope to be tilted to any angle. A Jackson limb is attached to the compass joint. Attached to the lower part of the limb is a circular rotating stage with a glass top. There is a swinging substage mirror. The body tube has a nickel-plated drawtube. Course focus is by rack and pinion. Fine focus is by a micrometer screw at the midpoint of the limb. There is a single top hat eyepiece. The objective is marked "D" and "1/5 186°" and signed "Gundlach Optical Co Rochester N Y." A unique feature of this microscope, described in the 1883 patent, is that the limb with its attached body tube and stage can be removed from the base by loosening a brass thumb screw found at the back of the limb. Once removed, the working part of the microscope can be used as a solar microscope, or incorporated into a magic lantern apparatus for projection of microscopic images for public viewing. The microscope stands 15 inches high when closed and 19 inches high with drawtube extended. The microscope has been restored by William Burnett. It is missing a slide carrier, condenser, and case. It is in excellent cosmetic, mechanical, and optical condition.

Dr. Lyman D. McIntosh was a physician-surgeon, inventor, electrician, and entrepreneur. He received his medical degree from Caledonia Medical College in Caledonia, Vermont in 1863. After graduation, he served as a surgeon in the Union Army during the Civil War. After the war, he practiced medicine in Sheboygan, Wisconsin before moving to Chicago, Illinois in 1872. There, he formed several companies that produced both electrical and optical instruments.

Gundlach-Manhattan Optical Co. Simplex Model, c1905

Ernst Gundlach (1834-1908) was one of the more inventive, skilled, and restless opticians of the nineteenth century. He was an apprentice to C. F. Belthe who took over the Optical Institute in Wetzlar Germany from Carl Kellner's estate and before the Institute was purchased by Ernst Leitz. Gundlach established his own Berlin workshop in partnership with the Siebert brothers and gained a reputation as a maker of highest quality objectives and microscopes. In 1871, he sold his Berlin shop and came to America where he set up as a sole proprietor making microscope objectives in Hackensack, New Jersey. In 1876, Henry Lomb induced Gundlach to head up the newly formed microscope department for Bausch & Lomb. Gundlach designed a full product line of microscopes and patented a variety of stands and accessories. Apparently, Gundlach's desire for perfection instead of economical production led to losses for Bausch & Lomb and he was let go from the firm in 1878. In 1879, Gundlach and Lewis R. Sexton set up and operated an optical goods establishment in Rochester. He was in Hartford where he was listed as an optician from 1880 to 1884. In 1884, Gundlach returned to Rochester and reorganized the business as the Gundlach Optical Company which produced microscopes and cameras. Gundlach had no connection to the company after 1895 and, instead, produced photographic lenses including the celebrated Rapid Rectigraphic and Perigraphic lenses under the name Gundlach Photo-Optical Co. In 1902, Gundlach Optical Company acquired Manhattan Optical Co. They manufactured microscopes and cameras under their new name, Gundlach-Manhattan Optical Co. In 1904, Gundlach returned to Berlin and founded another company.

This is a small case-mounted portable microscope manufactured by Gundlach-Manhattan Optical Co. and called the "Simplex" model. The main focusing is by push-tube and the fine focus mechanism utilizes a micrometer screw that tilts a thin plate slide support on the stage. The six inch draw tube slips inside a nickel-plated split tube mounted on a six inch nickel-plated pillar. The minimum microscope height above the box is 9 ¾ inches. The eyepiece is signed GMO Co. There are three Bausch & Lomb objectives, a 1 inch, 16 mm, and 4 mm in a cannister. The nosepiece holds two objectives. There is a substage mirror and stage clips. The black fabric covered carrying case is 10 ¼ x 3 ¾ x 4 ¼ inches with a handle, and a purple felt-lined interior. Both the microscope and case are in very fine condition. The microscope cost $12 in 1910.

Spencer Lens Company Continental Microscope, c1903

Charles A. Spencer (1813-1881) is known as America's first microscope maker. Spencer's was the only microscope manufacturing firm in America until 1849. By 1880 it had been joined by 19 others, including Bausch & Lomb, but by 1903, Spencer and Bausch & Lomb were the only two remaining American firms making microscopes. Charles Spencer was born in 1813, in Madison County, New York, in what would later become Canastota. In 1838, he had an ad printed, announcing his ability to make and deliver various reflecting telescopes and reflecting microscopes. By 1840, he published a catalog listing numerous microscopes, reflecting telescopes, and other instruments. Spencer is thought to have made the first American achromatic objective, and, by the late 1840's, had acquired a reputation for his excellent quality objectives of great angle of aperture. In 1854, Spencer formed a partnership with Professor E. K. Eaton of Troy, New York, under the firm name of Spencer & Eaton. Microscopes made by Spencer in the 1840's, signed "C.A. & H. Spencer" refer to Charles' cousin, Hamilton, not his son, Herbert. Herbert R. Spencer (1849-1900) worked in his father's shop and became a partner after Eaton left the business, around 1865. Until 1875, the instruments were marked "C. A. Spencer & Sons, Canastota." In 1873, a fire destroyed the workshop in Canastota and in 1875, the Spencers moved to Geneva, NY, to build microscopes for the Geneva Optical Co. During the next three years, their instruments were marked, "C. A. Spencer & Sons for Geneva Optical Company." In 1877, this association was terminated and their stands were marked, "C. A. Spencer & Sons, Geneva."

After Charles's death in 1881, the business was carried on by his son Herbert under the name H. R. Spencer & Company. In 1889, he moved to Cleveland, Ohio, and then, in 1890, to Buffalo, New York, where the company remained. He formed a partnership with Fred R. Smith and between 1890 and 1895 the firm was known as Spencer & Smith Optical Company. The Spencer Company was incorporated in 1895, using the name Spencer Lens Company. The Spencer Lens Company was acquired by the American Optical Company in 1935. For several years after the acquisition, the Spencer Lens Company continued operation under its own name before becoming known as the Instrument Division of American Optical Company in 1945. Microscopes made by the Spencer Lens Company are relatively common whereas Spencer microscopes made before 1895 are extremely rare.

Spencer Lens Company, c1903

This is a Spencer Lens Company continental microscope. The serial number of 2943 dates it to around 1903. It is signed SPENCER LENS CO BUFFALO N.Y. on the base. When closed, it is 11 ½ inches high. The brass microscope has a horseshoe base, short tubular pillar capped with a compass joint, square fixed stage with central aperture and vulcanite top, and a double mirror attached by a gimbal to a swinging arm. There is a mechanical stage with X and Y controls and verniers in the X and Y axes. A screw substage with iris diaphragm holds a condenser with iris diaphagm and filter holder. It has a continental limb, arm, and body tube with a graduated, chrome-plated drawtube. Course focus is by diagonal rack and pinion and can be adjusted by a small, silver-colored knob. The screw micrometer fine adjustment is at the top of the limb. It has an 8X and a 4X eyepiece. There are three Spencer Lens Co. objectives on a triple nosepiece: 16MM, N.AP. 0.25; 4MM, N.AP. 0.85; and 1.8MM, N.A. 1.25, 95X HOM. IMM. The microscope is in excellent condition with all lacquer intact. The mirror is clouded. The wooden case is in excellent condition with a brass handle and lock with key.

Spencer Lens Company Microscope, 1917

Spencer Lens Company, 1917

This microscope by the Spencer Lens Company has an iron horseshoe base, a tubular pillar, square fixed stage, screw substage condenser, and a double mirror. It has a continental limb, arm, fine adjustment at the top of the limb, and a rack and pinion coarse adjustment. The body tube has a graduated drawtube and triple nosepiece. There are three eyepieces, 6X, 10X, and 20X; and three objectives marked Spencer Lens Co., 10X, 44X, and 95X. The limb, arm, and body tube are brass. It stands 12 inches high closed. It is signed Spencer Microscope, ALOE CO Sales Agents, 38775. The A. S. Aloe & Company in St. Louis supplied surveying, optical, mathematical, and surgical instruments from 1860 to 1959. The company resold the instruments of other makers, a common practice of the period, and engraved them with the Aloe name and the true maker's name. This is model 40H and was made from about 1900 to 1920. The serial number dates this instrument to 1917. The microscope is in exceptionally fine condition.

Twentieth Century Microscopes

Leitz Compound Microscope, 1907 (Yale University)
Waechter Trichinoscope, c1910
Ernst Leitz Wetzlar, Binocular Microscope and Accessories, 1923
Leitz III M Petrographic Microscope, 1928
Zeiss Binocular/Monocular Microscope, 1932
Ernst Leitz Wetzlar Binocular Microscope, 1947
AO Spencer Binocular Microscope, 1947
Nikon S-Cb Binocular Microscope, c1970
Leitz SM Phase Contrast Microscope, c1965
Reichert CSM Binocular Microscope, 1952
Leitz Ortholux I Trinocular Research Microscope, 1960
Wild M11 Microscope, c1965
Olympus EH Binocular Microscope, c1970
Olympus CK Inverted Microscope, c1970
Nikon Alphaphot-2 Binocular Microscope, 1988
Olympus BH-2 Binocular Research Microscope, 1982
Children's Microscopes
- Reg'lar Fellers Junior's Microscope Set, c1925
- Gilbert S-15 Monocular Microscope, 1954
- Adams Student Microscope
- Gilbert Junior Microscope & Lab Set
- Milben Projection Microscope

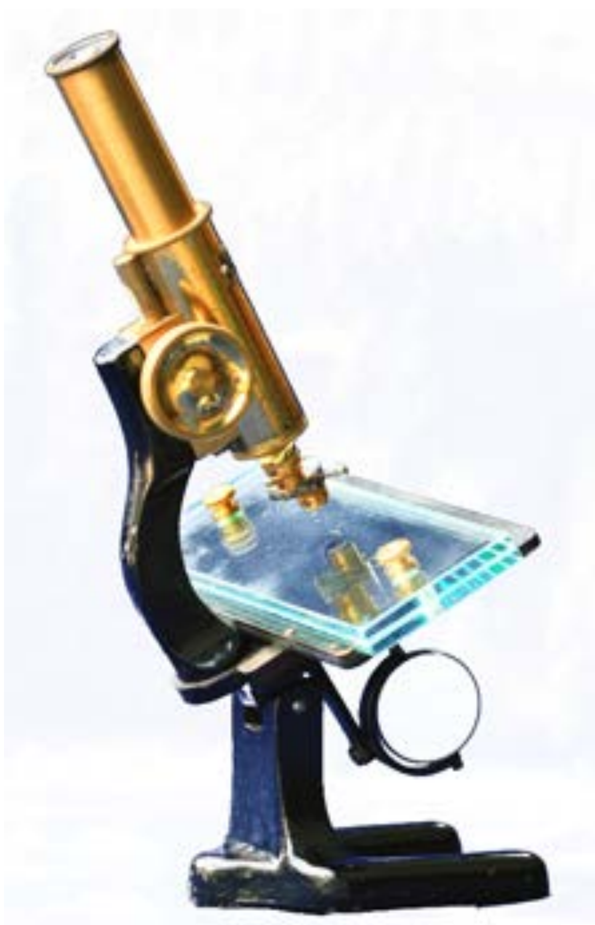
Twentieth century microscopes should not be overlooked in a microscope collection as they will become antiques in the future. At the present time, complete, high quality instruments in good condition are readily available at a reasonable cost. In addition, most of these microscopes are easy to use and produce excellent images. The twentieth century experienced many advances in microscope technology with the introduction of new contrast enhancing techniques such as phase contrast, Hoffman modulation contrast, differential interference contrast, and fluorescence and confocal microscopy. Photographic technology achieved a high level of sophistication, but this progress has been largely eclipsed by rapid advances in digital imaging technology.

Leitz Compound Microscope, 1907 (Yale University)

This is an all brass Leitz compound laboratory microscope with stand IIa. It has a horseshoe base and cylindrical post that terminates in a hinge. The post above the hinge carries the stage and the arm that holds the body tube. The ocular tube is a drawtube that is nickel-plated and divided into millimeters. The triple nosepiece is also nickel-plated. The coarse adjustment is by rack and pinion. The fine focus is by a non-graduated knob on top of the post. The square brass stage is topped with vulcanite. There is an E. Leitz Wetzlar brass mechanical stage. Beneath the stage is a swing out Abbe condenser raised and lowered by a knob and an iris diaphragm and filter holder. The substage mirror is plano-concave and mounted on a swing arm that slides on its own track. The objectives are E. Leitz Wetzlar 3, 6, and 1/12 Oel Immersion with matching brass canisters. The oculars are Leitz 2, 4, and 10X. One foot of the base is marked "E. Leitz Wetzlar New York" and with the serial number 103497 that dates the instrument to 1907. The other foot is marked "Yale University." The number 5 is stamped on the heel of the foot. The microscope has its original mahogany dovetailed case without the key. There is a magnification table on the inside of the door. There is a brass label on the top that reads "E. Leitz-Wetzlar, New-York= Chicago." The microscope is in good condition and functional but was polished at some time in the past. It is not known where this microscope was used at Yale. It could have been used at the Zoological Laboratory or at the medical school. The number on the heel suggests it may have been part of a set. It possibly was a student microscope and preceded the 1923 Leitz microscopes that were used in the histology laboratories at the medical school.

Leitz Compound Microscope, 1907

Waechter Trichinoscope, c1910



This microscope is a Paul Waechter Stand Va (Stativ Va) Trichinoscope ("Trichinoskop"). It is especially designed for the examination of raw or cooked pork for the presence of Trichinae. *Trichinella spiralis* is a tiny nematode worm that is responsible for the serious parasitic disease, trichinosis. Humans as well as dogs, cats, rats, and hogs can be infected and the cysts of *Trichinella* are found in raw or poorly cooked pork. Trichinosis is a very serious public health problem that has plagued mankind for centuries. The cause was finally discovered in the 1870s and specialty microscopes were developed mainly in Germany for the microscopic examination of pork and pork products (Germans love sausages made with pork) for the presence of the parasite.

The microscope is a monocular compound microscope equipped with an extra large stage plate. The horseshoe base, pillar, and curved arm are finished in black enamel. The body tube is brass. The stage plate is designed to accommodate a large (2.5 inch by 8 inch) dual plate glass compressorium. This compressorium is used to squeeze meat samples between the two glass plates thereby making the meat samples transparent in thin section. Brass thumbscrews are provided at each end of the compressorium to facilitate the compression of the meat sample. A low power objective is the prime objective. For greater magnification of a sample, a supplementary objective lens can be rotated into position with a hand knob making for a high power objective combination. Beneath the stage is a circle of apertures and a mirror. In the closed position, the microscope stands 11¼ inches tall.

Paul Waechter (1846-1893) was trained to be an optician and mechanic at the Zeiss Optical Works in Jena. In 1872, Waechter founded his own optical workshop in Berlin. Between the years 1872 and 1892, Waechter produced over 20,000 microscopes, mostly for the examination of trichinae in meat. Rudolph Virchow, in circa 1870, succeeded in inducing various German states to make compulsory the testing of pork for trichinosis in abattoirs (slaughter houses). Waechter and several other German microscope manufacturers designed and produced microscopes especially to meet this need. Many of these instruments were exported outside of Europe including to the United States. The Henry Heil Chemical Company of Saint Louis, Missouri, USA imported Waechter's instruments.

Ernst Leitz Wetzlar, Binocular Microscope and Accessories, 1923

This binocular microscope dates from 1923 based on the serial number #212339. It represents the finest microscopes available at that time. This microscope was used by the instructors of the histology course at the Yale Medical School from 1923 until about 1950. The eyetubes, focus rack, and focusing knobs are polished brass. The modified curved horseshoe base, curved limb, and binocular body are painted black. The circular stage with stage clips can be rotated. It has 4X and 10X oculars and 3 10X, 6LG, and 1/12 Oel 1.30 objectives. There is an achromatic substage condenser and a plano-convex mirror. The microscope has its original wooden case.

Ernst Leitz Wetzlar binocular microscope

Leitz III M Petrographic Microscope, 1928

The polarizing microscope proved to be useful in petrology and optical mineralogy to identify rocks and minerals in thin sections. Microscopes were developed specifically for study of minerals in rock sections and are called petrographic microscopes. Petrographic microscopes are constructed with optical parts that do not add unwanted polarizing effects due to strained glass, or polarization by reflection in prisms and mirrors. In addition to modifications of the microscope's optical system, petrographic micro-scopes allow for the insertion of specially-cut oriented filters of biaxial minerals (named the Quartz Wedge, quarter-wave mica plate, and half-wave mica plate), into the optical train between the polarizers to identify positive and negative birefringence, and in extreme cases, the mineral order when needed. These special parts add to the cost and complexity of the microscope.

This is a Leitz III M petrographic microscope, one of the classical microscopes of the twentieth century. Serial number is 268328, (1928), with three eyepieces (two listed on the original label in the case), four objectives (three listed on the original label in the case), ¼ wave plate, quartz wedge, and two centering wrenches. The objectives have their own wooden case. The horseshoe base and curved pillar are finished in black enamel. The body tube is brass and holds the analyzer. The substage condenser holds the polarizer. This is a beautiful and functional microscope, with all original lacquer and the original wooden case.

Leitz III M Petrographic Microscope

Zeiss Binocular Microscope, 1932

Leitz Binocular Microscope, 1947

AO Spencer Binocular Microscope, 1947

Nikon S-Cb Binocular Microscope, c1970

Carl Zeiss Jena Binocular/Monocular Microscope, 1932

This is a Carl Zeiss Jena compound laboratory microscope with stand DSG 2 and serial number 253028. The microscope stand is constructed with a heavy cast iron frame that is polished and coated with a hard coat of black enamel. It has a blackened U-shaped base, a rectangular mechanical stage, and a curved arm. It has interchangeable binocular and monocular heads. The eye tubes on the binocular head can be turned to adjust the interpupillary distance. A nickel-plated quadruple nosepiece is located above the stage. Beneath the stage is a condenser, NA 1.2, with iris diaphragm and filter holder. There is a substage mirror, three stops for the illuminating apparatus (r, 1, and one with two apertures), an Elmer & Amend substage lamp, and two card slide boxes with slides and various accessories. The objectives are Zeiss 3; 8, 0.20; D 40, 0.65, 0.17; and 1/12, HI 90, 1.25. Coarse focus is by rack and pinion. Fine focus is by the Meyer geared slow-motion device operated by two knobs, one having a divided drum. One interval on the drum corresponds to 0.002 mm of vertical motion of the optical assembly. The eyepieces are Zeiss single 2X 90mm, paired 5.5X, paired 7X Mobimi, paired 10X Mobimi, and paired K15X Mobimi. The microscope is carried in a wood case with a leather handle covered with embossed black paper. The case is stamped Elmer and Amend Third Ave. 18th to 19th St New York City. The microscope is in excellent condition.

Ernst Leitz Wetzlar Binocular Microscope, 1947

This is a Leitz binocular compound microscope of the BS design, serial number 385582. It has an inclinable stand with a V-shaped cast-iron base. The arm is a curved handle attached to an upright rectangular support that carries the rack and pinion and focusing knobs. The end of the arm carries an inclined binocular tube marked 1.25x. The interpupillary distance is adjustable by means of a calibrated knob. The microscope has a mechanical stage, substage condenser with a small swing-out lens in addition to the large central lens, removable iris diaphragm and a swing out glass filter, and a plano-concave mirror. There is a chrome-plated quadruple, revolving nosepiece. The objectives are 1h, 3.5:1; 3, A=0.25, 10:1; 3R, A=0.25, 10:1; 4, A=0.45, 20:1 (two); 6L, A=0.65, 45:1 (two); and 1/12 Oel, A=1.30, 100:1. Eyepieces are two 6XB and two 10XB. The microscope is in excellent condition and complete with Scopelite lamp by Clay-Adams Co. N.Y. and original case. The microscope is in excellent condition.

AO Spencer Binocular Microscope, 1947

A similar microscope is an AO Spencer binocular microscope #253484, Model 13MLHW, 1947. It has a blackened horseshoe-shaped base of cast iron, a curved arm, square Bakelite stage, and an inclined binocular body with converging eyepieces. The coarse adjustment is by rack and pinion. The fine focus is by a micrometer screw. The focus knobs and objectives are chrome plated. A revolving triple nosepiece is attached to the body. The objectives are AO 3.5X; Spencer Lens Co., Buffalo, N. Y. 16mm-N. A. 0.25-10X; 4mm-N.A. 0.66-44X; Hom. Imm-1.8mm-N. A. 1.25-95X; and AO 3.5X. Eyepieces are two 6X 834 K and two 10X W. F. 587. The substage is fork-type rack and pinion with Abbe NA 1.25 condenser in mount with iris diaphragm. The microscope is in excellent condition and complete with a mechanical stage, mirror, American Optical Co. substage lamp, and original case.

Nikon S-Cb Binocular Microscope, c1970

In the second half of the twentieth century, the traditional microscope manufacturers began to experience competition from microscopes made in Japan, particularly by Nikon and Olympus. The Japanese microscopes were of high quality and considerably less expensive than those by the

American and German manufacturers. The Nikon Optical Company, a Japanese firm, was established in he United States in 1953. This is a Nikon S-Cb clinical/laboratory microscope. The S models microscopes were made from 1967 to 1978. There is a rectangular base with built in illuminator with dimmer knob. The arm extends up from the base and curves forward to hold the binocular body. There is a quadruple nosepiece. There are 4X, 10X, 40X, and 100X objectives and HKW 10x eyepieces. This model has a preset lever that locks the coarse focus. The microscope is in excellent condition with a mechanical stage, substage condenser, original booklet, and original case. These microscopes were the student microscopes in the histology laboratory at Yale beginning around 1970. In 1985, they were replaced by Nikon Alphaphot microscopes that are still present in the laboratories.

Reichert CSM Binocular Microscope, 1952

Leitz SM Phase Contrast Microscope, c1965

Reichert CSM Binocular Microscope, 1952

Carl Reichert (1851-1922) founded "Optische Werke C. Reichert" in 1876 in Vienna. The Reichert firm was one of the principal microscope manufacturing firms in Europe in the late 19th century and, by 1900, the company had produced 30,000 microscopes. Reichert employed some Leitz technicians which may explain why his microscopes were so similar to those of Ernst Leitz. The company was later led by his two sons Karl (1883-1953) and Otto (1888-1972). The firm was partially sold to American Optical in 1962 and fully taken over in 1972.

This is a fine deco style microscope signed on the inclined binocular body, "REICHERT, AUSTRIA, Tubusvergröß. 1.5 x." It is model CSM and the serial number of 236 587 dates it to 1952. It stands 13 inches tall in closed position. Coarse focus is rack and pinion, with fine focus via dual micrometer knobs. It comes with an original mechanical stage and Abbe substage condenser with variable iris diaphragm and swing out filter holder. The plano-concave mirror is in excellent condition on both sides. There is a substage illuminator "LUX TB" that can be substituted for the mirror. Four original Reichert achromatic objectives are a 4x, 10x, 45x, and a 100x oil immersion. Two pairs of Reichert eyepieces, 5x and 10x, complete the optical system which is of excellent quality, producing sharp images of good contrast. The microscope is finished in black and silver. The microscope was retailed by and bears the label of William J. Hacker & Co., Inc. 82 Beaver Street New York. A packing list and "Instruction Manual for Reichert Microscopes" is included. Condition of the microscope is good with minor wear to the finish. The microscope comes with its original wooden case which is lined inside and outside with cloth and has brass corners. The case shows signs of wear. Inside is a rack and compartment to hold the four plastic lens canisters, extra eyepieces, and original stage clips.

Leitz SM Phase Contrast Microscope, c1965

Phase contrast microscopy, first described in 1934 by Dutch physicist Frits Zernike, is a contrast-enhancing optical technique that can be utilized to produce high-contrast images of transparent specimens such as living cells, microorganisms, thin tissue slices, lithographic patterns, and sub-cellular particles (such as nuclei and other organelles). In effect, the phase contrast technique employs an optical mechanism to translate minute variations in phase into corresponding changes in amplitude, which can be visualized as differences in image contrast. The phase shifts themselves are invisible to the human eye, but become visible when they are shown as brightness changes. One of the major advantages of phase contrast microscopy is that living cells can be examined in their natural state without being killed, fixed, and stained. As a result, the dynamics of ongoing biological processes in live cells such as the cell cycle can be observed and recorded in sharp clarity and high contrast. The phase contrast technique proved to be such an advancement in microscopy that Zernike was awarded the Nobel prize in physics in 1953.

This is a Leitz binocular phase contrast microscope, model SM, serial number 680185. The microscope dates around 1965. The microscope is made of black enameled metal. A curved arm rests on a triangular base and supports the binocular head. The base is 7 ½ inches long and the microscope 13 inches high. There is a square stage with a mechanical stage. It has single-knob focusing control in which coarse and fine focusing motions are combined in a single operating control. A lamp is attached to the base. The most important feature of this type of microscope is the condenser. This has a Leitz phase contrast condenser system according to Zernike in a configuration known as 402a. It consists of a brightfield condenser with a condenser lens for low powers, an aperture diaphragm, and a top Achr 0.90 swing out condenser. Below is an annular six position turret with stops for phase 1, phase 2, phase 3, open, darkfield, and brightfield. The eyepieces are Leitz 10X periplan. The four objectives are 3.5 0.10, Phaco 10 0.25, Phaco 40 0.65, and Phaco Oel 100 1.30. The objectives are designed for a 170 mm mechanical tube length. A 1.25X magnification is built into the head. Trinity College Biology is marked on the base. The microscope is in excellent cosmetic and functional condition.

Leitz Ortholux I Trinocular Research Microscope, 1960

This is a fine example of a Leitz Ortholux I trinocular microscope, the classic research microscope of the mid twentieth century. The Ortholux was designed to take an extremely wide variety of optics and accessories and was one of the earliest models to use a trinocular head for photography. The microscope stands 18 ½ inches tall to the top of the trinocular eyepiece and 11 inches deep without the lamp attached. It is signed on the base "Ernst Leitz, Wetzlar Germany Nr 526114." The serial number indicates it was made in 1960. The microscope consists of a T-shaped base, curved limb holding the body tube. The body tube holds a tube at the top for camera attachment and the binocular head. The microscope has coarse and fine focus, an X/Y adjustable stage, and swing out achromatic NA 0.90 condenser. There is a Periplan GF 10X eyepiece for the phototube and a pair of 10X eyepieces for the binocular. The quadruple revolving nosepiece has a 1.25X tube lens and four Leitz objectives (3.5:1 A0.10 170/-, 10/0.25 170/-, 25/0.50 170/0.17 spring-loaded, 45/0.65 170/0.17 spring-loaded). The microscope can be used for transmitted and incident light. For transmitted light, the lamp attachment is inserted in the lower aperture of the stand. For incident light, it is inserted in the upper aperture. The light intensity is controlled by a transformer. The microscope is in excellent condition. A copy of the manual is included.

Leitz Ortholux Microscope

Wild M11 Microscope, c1965

Olympus EH Microscope, c1970

Wild M11 Microscope, c1965

The firm of Wild Heerbrugg was established in 1921 in Switzerland. It began primarily as a maker of theodolites and other surveying instruments. Their first microscope was made in 1939. Their microscopes and stereomicroscopes are of the highest quality. In 1987, Ernst Leitz Wetzlar GmbH and Wild Heerbrugg AG merged to form the Wild Leitz group. In 1990, Wild Leitz merged with the Cambridge Instrument Company to form the Leica Holding B. V. group.

This is a Wild model M11 microscope that was first made in 1954 and produced until 1976. The serial number is 24014. This instrument features a binocular head and also an inclining monocular tube with a 45 degree prism inside a rotating housing. It also features a revolving nosepiece that holds four objectives. Present are three Wild objectives having magnifications of 10X, 40X and 100X. There are three Wild eyepieces with magnification of 10X. The coarse focus adjustment is by rack and pinion acting on the body tube. Fine focus movement acts on the stage with micrometer screw adjustment. The circular stage measures five inches in diameter, and holds a mechanical stage. Below the stage is an adjustable Abbe condenser having a NA of 1.30. The circular base measures 6 ⅞ inches in diameter. A lamp fits onto the center of the base and has an external transformer. The microscope is 11 ½ inches high with the binocular head and bears

Wild's distinctive cream color. It has its dome-shaped case. The microscope is functional and in excellent condition.

Olympus EH Binocular Microscope, c1970

The forerunner of Olympus was founded in Japan by Takeshi Yamashita in 1919 and produced its first microscope in 1920. In 1956, Elgeet Optical in Rochester, New York, became the exclusive U.S. distributor for the microscope product division of Olympus Optical of Japan. The microscopes were all branded Elgeet-Olympus. Olympus began marketing scientific products in the United States in 1968 and is known as The Olympus Corporation of the Americas. Olympus microscopes became increasingly popular because of their high quality and lower cost relative to comparable American and German microscopes. Olympus now offers a complete range of microscopes from student microscopes to state of the art research imaging systems in both the life and materials sciences.

This is an Olympus Tokyo model EH binocular microscope serial number 253318, c1970. It is a heavy and substantial microscope standing 15 inches high. It has an oval base supporting the curved arm with binocular head. There are two 10X WF eyepieces. The nosepiece holds five objectives; Olympus 4X, !0X 0.10, 40X .65, and 100X 1.30. Coarse and fine focus operate on the stage. The rectangular stage holds an Olympus mechanical stage. There is a substage Abbe condenser, NA 1.25. The illumination system is built into the base and there is an external transformer. There is no case. The microscope is in excellent original condition with only a few nicks to the finish.

Olympus CK Inverted Microscope, c1970

As the name suggests, an inverted microscope is upside down compared to a conventional microscope. The light source and condenser lens are on the top above the stage pointing down and the objectives are below the stage pointing up. As a result, one is looking up through the bottom of the specimen sitting on the stage rather than looking at the specimen from the top as on a conventional microscope. The large accessible stage allows for manipulation of specimens or viewing large objects that would not fit on a conventional stage. An inverted microscope is commonly used in chemistry, metallurgy, tissue cell culture, and for viewing aquatic specimens. In 1853, Julius and William Grunow produced a chemical or inverted microscope designed by Professor J. Lawrence Smith, a prominent American chemist then at the University of Louisiana. The Grunows had shown the design of the microscope to Camille Sebastien Nachet in France who proceeded to manufacture inverted microscopes without acknowledging the Grunows.

This microscope is an Olympus CK inverted microscope which was introduced in 1966. The serial numbers are 215560 (body) and 301094 (binocular). Overall the microscope is about 15 inches long and 18 inches high. The base is 8 x 5 ½ inches and supports the stage and binocular body tube. The lamp housing pillar fits into the stage and holds an arm for the lamp and condenser with an iris diaphragm. A ring allows for focusing the condenser. The transformer for the lamp is built into the base. Controls for illumination are located on the front of the base. The stage is 6 x 7 inches, large enough to hold a tissue culture dish or Petri dish. A 2 ¾ x 5 ½ extension can be attached to the stage. The eyepieces are Olympus CK 10X and the Olympus objectives are 4X, 10X, and C20X in a triple nosepiece. The focus knob is on the base beneath the stage. This was a very popular and successful microscope. This example is in exceptional condition without any blemishes and is fully functional.

Nikon Alphaphot-2 Binocular Microscope, 1988

The last microscope used in the histology laboratories at the Yale Medical School was the Nikon Alphaphot. Most were Alphaphot Y5 microscopes and there were a few Alphaphot-2 YS2 microscopes. The Alphaphot-2 is shown here. The stand consists of a rectangular base and an arm with upright and inclined sections. The base is 7 x 8 ½ inches in size. The inclined arm holds the binocular eyepiece tube and revolving nosepiece. The microscope stands 15 inches high. There is a stage, mechanical stage, and substage condenser with aperture diaphragm and focus knob. The lamp with a field lens and field diaphragm and the brightness control dial with on/off switch are built into the base. Coarse focus is on the sides with the fine focus built through the center of it. The eyepieces are CFWE 10X/18 and there are four objectives; 4X 0.1, 10X 0.25, 40X 0.65, and 100X 1.25. The objectives are for a 160 mm tube length. One side of the base is inscribed "Property of Yale University Student Teaching Lab." The Alphaphot microscopes were excellent teaching microscopes giving clear images and being reliable, durable, and requiring little maintenance.

Olympus BH-2 Binocular Research Microscope, 1982

Olympus introduced the successful and popular BH-2 binocular research microscope in 1980. This is the BHS model purchased in 1982 and used in the laboratory of Thomas L. Lentz. The microscope is equipped for brightfield and fluorescence microscopy and photography. It consists of a BHS-F stand, 100 watt halogen lamp, binocular tube, and graduated mechanical stage. It has a quintuple nose piece with Olympus objectives DPlan 4 (0.10, 160/0.17), SPlan 10 (0.30, 160/0.17), SPlan 20 (0.46, 160/0.17), SPlan 40 (0.70, 160/0.17), and DPlan Apo 60 (0.90, 160/0.11-0.23). The eyepieces are widefield WHK 10X/20 L and the condenser an Abbe 1.25 NA brightfield. It has an automatic exposure control photomicrographic and cinemicrographic camera system. It has a reflected light fluorescence illuminator with a high pressure 100 watt mercury vapor arc lamp and a blue/green dichroic mirror set. An Olympus catalog and instruction manuals are included with the microscope. The microscope is in excellent condition and fully functional.

Olympus BH-2 Microscope

Reg'lar Fellers Junior's Microscope Set, c1925

Boxed set containing a microscope, slides, collecting jar, lens paper, forceps, glass rod, and probe. *Reg'lar Fellers* was a newspaper comic strip about a gang of kids created by Gene Byrnes (1889–1974) and syndicated from 1917 to 1949. The illustrated box top shows staining but the set is complete and appears unused. c1925.

Gilbert S-15 Monocular Microscope, 1954

A. C. Gilbert graduated from Yale's School of Medicine in 1909. He did not practice medicine, but instead founded a company first making magic supplies. This company would later become the A. C. Gilbert Company that was one of the largest manufacturers of toys in the world. Gilbert added microscope kits to his popular lines of Erector and Chemistry sets in 1934. Gilbert was not the first or only manufacturer of microscopes for young scientists. But he was unique in his training and in the authority he could borrow from experts like Yale's Oscar W. Richards, a leader in microscope science at that time. This is a 1954 Gilbert monocular microscope model S-15. The base and limb are aluminum. It has a 10x ocular and 12X, 20X, and 45X objectives. It comes with its original green alligator case with handle. The case measures 4.5 x 5 x 10 inches. The instruction manual is present. The microscope and case are in excellent condition with only minor scuffing at the corners of the case.

Gilbert S-15 Microscope

Adams Student Microscope

This is another microscope for children and students. It is an Adams Student Microscope sold by Montgomery Ward in the mid twentieth century. The microscope is eight inches high and has an eyepiece and four objectives. The magnifications are 100X, 200X, 300X, and 500X. It has coarse focus, fine focus at the rear of the limb, stage with clips, and single-sided substage mirror. There is an instruction manual and a folding case for instruments. The microscope fits into a metal case and both are in mint condition. This is a well-built and functional instrument that is more than a toy.

Adams Student Microscope

Gilbert Junior Microscope & Lab Set

This is a Gilbert Junior Microscope & Lab Set. The box is 18 x 10 inches. The set contains a 60 power microscope and various accessories, all of which are present. There is an informative booklet *Exploring the World with the Microscope* explaining microscopes and their uses and describing experiments to be performed with a microscope. The booklet is edited by Oscar W. Richards, Ph. D., University of Oregon B.A. 1923, M. A. 1925, Yale University, Ph. D. 1931 in collaboration with Alfred C. Gilbert, M. D., Yale University, 1909, Copyright 1938 by The A. C. Gilbert Company, New Haven, Conn., USA. The box and set are in excellent unused condition.

Gilbert Junior Microscope

Milben Projection Microscope

This is a child's microscope labeled "Milben T.V. Type Microscope Projector." It projects an object on a slide onto a small screen. It has 50X and 100X objectives and comes with 18 microscope slides. It operates on two D batteries. The microscope operates and has its original box. It probably dates to the 1950s.

Milben Microscope

Microscope Objective Lenses

Objective for screw barrel microscope, c1710
Objective for a Culpeper-type or Cuff-type microscope, 1760-1790
Objective for Nuremberg microscope, c1780
Objective for Cary-Gould and drum microscopes, 1820
Andrew Pritchard, c1835
Andrew Ross, 1839-1843
Hugh Powell, c1840
Smith & Beck, c1850
Andrew Ross, 1852
Moritz Pillischer, 1859
Powell & Lealand, c1860
Ernst Gundlach, c1870
William Wales, c1870
Robert B. Tolles, c1875
C. A. Spencer & Sons, c1880
Carl Zeiss, c1890
Bausch & Lomb Optical Co., c1890
Ernst Leitz, c1890
Zeiss, c1980
Olympus, c1990
Jewel Lenses, English, c1830

The most important imaging component in the optical microscope is the objective, a complex multi-lens assembly that focuses light waves originating from the specimen and forms a primary image that is subsequently magnified by the eyepiece. The quality of the image, magnification of the specimen, and the resolution under which fine specimen detail can be observed heavily depends on the objective. Objectives received their name from the fact that they are, by proximity, the closest component to the object, or specimen, being imaged. They are the most difficult component of an optical microscope to design and assemble. The development of the microscope as a usable scientific instrument depended on improvements to the optical properties of objectives over a period of two hundred years.

For two hundred years after the invention of the microscope around 1595, the objective was a single lens, usually biconvex. The objectives of the period suffered from chromatic and spherical aberration and low resolution making them of limited value for scientific investigation. Resolution of early microscopes was 2 to 3 microns. In 1758, John Dollond (1706-1761) patented an achromatic lens for telescopes corrected for two colors, although he did not discover it. An achromatic lens is a compound lens composed of a concave lens made of flint glass and a convex lens made of crown glass. The dispersions of the two lenses partially compensate for each other producing reduced chromatic aberration. This discovery was not immediately applied to the microscope because of the difficulty in manufacturing the tiny lenses necessary for microscope objectives.

The first chromatically corrected microscope lenses were made in the first part of the nineteenth century by Vincent Chevalier (1770-1841) and others. These microscopes resolved 0.5 to 1 micron. The first scientifically-based optical system was developed by optics theoretician Joseph Jackson Lister (1786-1869). He was the first to describe in 1830 a both achromatically and spherically corrected optical system for the compound microscope. Lister was not an instrument maker, so he worked with craftsmen such as Andrew Ross (1798-1859) to produce the lenses and microscopes. The joint efforts of Lister and Ross helped transform the microscope from a parlor oddity into an important scientific tool in medical diagnosis and biological research and elevating histology into an independent science. In 1858, the Royal Microscopical Society adopted a screw thread standard that was adopted by virtually all microscope makers thereafter.

In 1886, the physicist Ernst Abbe (1840-1905) working with Carl Zeiss (1816-1888) and Otto Schott (1851-1935) in Germany produced apochromatic objectives based on scientific optical principles and lens composition. These advanced objectives provided images with reduced spherical aberration and totally free of chromatic aberration at high numerical apertures. Achromatic objectives are corrected for two colors while apochromatic lenses are corrected for three. These first true apochromatic objectives were so superior to the competition that Zeiss gained nearly the entire high-end microscope market. By the end of the nineteenth century, the microscope had been perfected to the point where it achieved its theoretical limit of resolution of 0.2 μm. The best modern objectives combine multiple functions such as various combinations of bright field, dark field, flat field (plan), achromatic, apochromatic, polarized light, ultraviolet light, phase contrast, and differential interference contrast microscopy. Some of these objectives can cost a few thousand dollars. In 2014, Stefan W. Hell, Eric Betzig, and William E. Moerner, were awarded the Nobel Prize in Chemistry for the development of super-resolved fluorescence microscopy with which a resolution as low as 30 nm can be achieved.

The Lentz microscope collection contains over 160 objectives by different makers from 1700 to the present time. They illustrate the development of objectives and also provide a history of microscope manufacturers and microscopes over this time. Some important objectives are shown here (see separate file for complete collection.)

 Objective for a screw barrel microscope. Ivory with cap and button lens. c1710. This closely resembles objectives made by James Wilson (1665-1730) (Clay and Court, Figs. 21, 22). Other possible makers are Edmund Culpeper (1670-1738) and Edward Scarlett (c1677-1743). 30mm wide.	 Unmarked. 1760-1790. An objective for a Culpeper-type or Cuff-type microscope. 17mm w x 15mm h.	 Wooden objectives for Nuremberg microscopes with and without dust cap. c1780. Nuremberg microscopes were wooden microscopes made in the 18th and 19th centuries in Nuremberg, Germany. They were designed to mimic some of the brass microscopes of the period. 15mm.	 Unmarked five button objective with a ¼ in female thread. c1820. The buttons of these objectives could be added or subtracted to give different focal lengths. This type of objective was used on some Cary-Gould and drum microscopes. 13mm.

 Three element, early achromatic objective by Andrew Pritchard. c1836. Pritchard (1804-1882) was one of the earliest established commercial providers of microscope slides in London, being in business from the mid 1820s until the late 1850s. 28mm.	  ¼ In, Andw. Roſs & Co., Opticians, 33 Regent St., Piccadilly” on canister lid. One of the first achromatic objectives, made between 1839 and 1843. One of the foremost microscope makers in London, Andrew Ross (1798-1859) began business in 1830 and collaborated with Joseph J. Lister (1786-1869) who perfected achromatic lenses. 26.7mm.	 Uncovered, covered. “1/16” on canister. c1840. Unsigned but engravings are those of Hugh Powell. Powell (1799-1883) began producing microscopes around 1830 and formed a partnership with Peter H. Lealand in 1841. 36.5mm.	  Unmarked pre-RMS objective. “1 ½ Smith & Beck, 6 Colman St. London on canister lid. c1850. James Smith (d1870) produced some of the first achromatic microscopes with Joseph J. Lister. He took Richard Beck as partner in 1847 and the firm was known as Smith & Beck until 1857. 45mm.

A. Roſs, 1852. Uncov-ered, Covered. "¼ In. A. Roſs , London" on canister lid. With correction collar for variations in coverslip thickness, invented by Ross in 1837. 51mm.

M. Pillischer, London, 1859, Uncovered, Covered. ½ inch. Early RMS thread. Moritz Pillischer made microscopes from about 1851 to 1887. 59mm.

Powell & Lealand, N.A. 0.71. c1860. Correction collar. Hugh Powell (1799-1883) formed a partnership with his brother in law Peter H. Lealand in 1841. Hugh Powell, Andrew Ross, and James Smith produced the finest microscopes of the mid nineteenth century. 50mm.

N° VI, E. Gundlach. "1/12 in" on lid. c1870. Correction collar. Ernst Gundlach (1834-1908) worked in Berlin from 1865 to 1871 before coming to America. He worked for Bausch & Lomb from 1876 to 1878 and operated the Gundlach Optical Company in Rochester from 1884 to 1895. 49mm.

			
W. Wales, N. Y., 1/10. c1870. William Wales was a maker of high quality microscope objectives in New York beginning in 1860. In 1865, he received a patent for "an objective with a correction collar and alternating back lenses." His first-class 1/10 inch objective has an angle of aperture of 170° and cost $45. 50mm.	Tolles. "4 In." on canister. c1875. 4 inch continuously variable to 3 inch by internal draw-tube. Robert B. Tolles (1822-1883) apprenticed with Charles A. Spencer and supervised the Boston Optical Works from 1867 to 1883. He was renowned for his high quality objectives. 80mm extended.	C. A. Spencer & Sons, 1-2. 65°. c1880. Charles A. Spencer (1813-1881) is known as America's first microscope maker. Herbert R. Spencer (1849-1900) worked in his father's shop and became a partner around 1865. 44mm.	C. Zeiss CC. Correction collar. c1890. Carl Zeiss (1816-1888) opened a mechanical workshop in Jena Germany in 1846 and offered his first compound microscope in 1857. With Ernst Abbe (1840-1905) and Otto Schott (1851-1935), he produced the first apochromatic objectives in 1886. 53mm.

Bausch & Lomb Optical Co., 1/6, 140°. Correction collar. c1890. The Bausch & Lomb Optical Company founded by John Jacob Bausch (1830-1926) and Henry Lomb (1828-1908) began producing microscopes in 1874 in Rochester, New York. 52mm.

7, E.Leitz, Wetzlar. c1890. In 1849, Karl Kellner founded the Optical Institute in Wetzlar, Germany. Ernst Leitz (1843-1920) took over the company in 1869 and renamed it Optical Institute of Ernst Leitz. 41mm.

Zeiss, West Germany, Planapo 40/1.0 Oel m.l., Ph 3, 160/-, 46 17 47-9903. Iris diaphragm. c1980. This phase contrast, 40X oil immersion, plan apochromatic objective is one of the finest and most complex objectives ever made. 48mm.

Olympus Japan, DApo 100 UV PL, 1.30oil, 160/0.17, 100, 102311. c1990. A darkfield (D), apochromatic (Apo), 100X, ultraviolet light transmitting (UV), phase contrast positive low (PL), spring-loaded objective with iris diaphragm. A complex and versatile objective. Olympus, a Japanese company, began marketing scientific products in the United States in 1968 and is known as The Olympus Corporation of the Americas. 50mm.

Jewel Lenses, English, c1830

A major limitation of early microscopes was distortion of the image caused by chromatic and spherical aberration. In 1813, Sir David Brewster, an authority on physical optics, proposed that lenses should be made from materials, i.e., jewels, of high refractive index to reduce chromatic and spherical aberration and increase the resolution of the microscope (Nuttall and Frank, 1972). Jewel lenses were produced by several makers, most notably Alexander Adie and James Veitch in Edinburgh, and Andrew Pritchard (1804-1882) working with Dr. C. R. Goring in London. Pritchard described the difficult and laborious process of making a diamond lens (Pritchard, 1832). He made other jewel lenses of sapphire, ruby, and garnet and a stand to use with them. He also experimented with another recent innovation, doublet lenses; one lens a jewel the other of glass. Two lenses in the proper configuration can further reduce aberration. Some of his lenses appear to have been successful but had the disadvantages of being difficult to make because of their hardness and flaws and being very expensive. They were abandoned by 1835 after improvements in the design of objectives published in 1830 by J. J. Lister resulted in achromatic glass objectives with much less aberration. Nonetheless, jewel lenses remain an interesting chapter in the efforts to improve the quality of microscope images. Besides these, fewer than 20 jewel lenses are known to exist and all are in major museums.

These are three extremely rare jewel lenses, probably by Andrew Pritchard, c1830. The three lenses are each set in a 7⁄16 " (11 mm) diameter brass cell, secured by a brass disk and retaining pins. All three tiny, highly-curved lenses are pinkish, one so more than others (ruby, garnet, or pink sapphire); one is a biconvex singlet, the other two are doublets, plano-convex, with one pink element and one clear (colorless diamond, sapphire, quartz, or most likely glass) element.

Jewel Lenses

Other Optical Instruments

The discovery that convex glass or crystal had magnifying effects had a profound effect on how the world was viewed and led to the advancement of science and technology over the next several centuries. Microscopes allowed a previous unknown world of previously unseen objects to be observed and telescopes revealed the depths of the universe. The use of magnifying lenses expanded to almost every area of technology including microscopy, astronomy, photography, navigation, surveying, and medicine. Opticians and manufacturers usually made a wide range of optical instruments. In this section, examples are shown of instruments that besides microscopes evolved from the simple magnifying glass.

- Spectacles
  - Pince Nez, late 18th century
  - Nuremberg Spectacles, 17th century
  - Scarlett Spectacles, c1730
  - Temple Spectacles, c1755
  - Steel-framed Spectacles, late 18th century
  - Child-sized Wire Rim Spectacles, early 19th century
  - Chinese Temple Spectacles, c1800
  - Magnifying Spectacles, c1920
- Telescopes
  - Galilean Bone Telescope (Perspective Glass), c1690-1730
  - English Single Draw Telescope, mid 18th century
  - Venetian Three Draw Telescope, early 18th century
  - Italian Three-Draw Telescope, c1720
  - Culpeper Gregorian Reflecting Telescope
  - James Short Reflecting Telescope, c1758
  - Transit of Venus Viewer
  - Gregorian Reflecting Telescope, c1770
  - Dollond Refracting Telescope, c1790
  - Dollond Table Telescope, c1790
  - Ramsden "Day or Night" Telescope, c1795
  - Dollond Military Telescope, c1800
- Binoculars
  - Twin Telescope Binoculars, 1881
  - Negretti & Zambra British Navy Field Glasses, 1864
  - Lemaire/McAllister Opera Glasses
- Navigational Instruments
  - Sextant by John Omer, c1860
  - Whitbread Box Sextant, c1840
  - Box Sextant, Cary, London, 1851
  - Octant for U. S. Navy by Stackpole & Brother, c1860
  - Azimuth Circle, first half twentieth century
- Surveying Instruments
  - Surveyor's Y Level, George Adams, Sr., c1760
  - W. & S. Jones Altazimuth Theodolite, c1800
  - B. Pike & Sons Transit Theodolite, c1855
  - Gurley Telescopic Alidade, 1919
  - Bianchi Level, c1840
  - Berger & Sons Transit Theodolite, c1904
- Cameras

- Camera Obscura replica
- Scioptic Ball, c1730
- Sliding Box Camera Obscura replica
- Giroux Camera 1839 replica
- Sliding Box Daguerreotype Camera
- Daguerreotype by Mathew Brady, 1852
- Watson & Sons Side-Wing Tailboard Camera, c1885
- Eastman Kodak No. 1 and No. 3 Brownie Box Cameras
- Gundlach-Manhattan Optical Company
- Korona Petit Camera, c1905
- Argus 35mm Film Camera
- Polaroid Land Camera Model 95, 1948
- Keystone 8 mm Movie Camera, c1956
- Kodak DC50 Digital Camera, 1996

Other Instruments

- Charles Bush Kaleidoscope, 1873
- Georgian Multiplying Glass
- Holmes Stereoscope and Stereocards, c1880
- Henri J. Noè Stereoscope, c1890
- Morton's Ophthalmoscope, c1890
- Geneva Optical Company Ophthalmoscope-Retinoscope, 1902
- Ophthalmic Trial Lens Set, c1880
- Spencer Spectroscope, c1940
- Spencer Abbe Refractometer, c1940
- Bausch & Lomb Dust Counter, c1938
- Welch Allyn Ophthalmoscope Otoscope Set, c1960
- Zograscope, c1780
  - Optical prints for zograscope
- Praxinoscope, c1890
- Zoetrope, 1992

Spectacles

The first spectacles at the end of the thirteenth century were two magnifying glasses connected together. Each lens was surrounded by a frame with a short handle. These were then connected together through the ends of their handles by a rivet. They secured to the face by clamping the nose between the two riveted lens rims. Even then the wearer could only keep them in place by remaining relatively still. The early spectacles contained convex lenses for the correction of presbyopic long-sightedness. They were not really an invention per se but instead a bright idea or adaptation of the earlier simple glass magnifier. Only five or six of the early rivet spectacles have survived. However, these later folding nose spectacles (pince nez) exemplify the early eyeglasses. The round lenses are set in frames joined at the bridge so they can be folded. The frame is silver with hallmarks. The frame has a loop for attaching a chain. This pair dates from the end of the eighteenth century.

Rivet spectacles were followed by bow spectacles with the lenses joined by a bow-shaped bridge, made in wood, horn, bone or leather and clamped or held to the nose. The middle of the fifteenth century saw Florence emerge as the world leader in the production and sale of spectacles. Following the invention of the printing press around 1450, the demand for spectacles increased as books became more readily available. By the end of the fifteenth century, spectacle peddlers became common on the streets of Western Europe. People would try on various pairs of spectacles until a pair was found which gave them the best vision. The following years saw big improvements in the manufacture of spectacles and the creation of regulations to govern how glasses were made. In Germany, the Nuremberg Spectacle Makers Guild was formed in 1535 and later in London, the Worshipful Company of Spectacle Makers became incorporated by a charter from King Charles I in 1629.

Folding Nose Spectacles

Nuremberg Spectacles, Seventeenth Century

Around 1600, Nuremberg spectacle makers began making frames from a single length of stiff grooved wire, usually copper, which forms both the rims and the bridge. At each end, where the wire meets the bridge, it is bent sharply back to form a hook and the lens is held firmly in place by a binding between the hook and the adjacent part of the bridge. A sprung steel bridge, gripping the nose, was introduced later in the seventeenth century. The Nuremberg-type, one-piece nose spectacles were very common and persisted into the eighteenth century. Dating individual examples is almost impossible without additional contextual evidence.

This is a rare pair of Nuremberg nose spectacles made from steel wire that is rusted and pitted but still strong. The lenses have air bubbles and other imperfections. Overall width is 3 inches extending to 3 ½ inches. The lenses measure 32 by 26 mm. No attempt has been made to clean these early spectacles. Seventeenth century.

Nuremberg Spectacles

Temple Spectacles

The first spectacles were simply perched precariously upon the bridge of the nose. They could not be used while walking or doing anything that involved motion as they would fall off. It was not until the first part of the eighteenth century that Edward Scarlett put arms on eyeglasses, to hold them on the ears. This (left) is a pair of steel Scarlett-type spectacles, c1730. The round loop at the end of each temple arm is called a wig loop. One coil of a wig could be wound through these loops so that the wig and the spectacles could be put on at the same time. Also, wig loops helped to hold the spectacles in place. The loops were also used for a cord tied behind the head. The spectacles are marked on the frame "09 CAM." These spectacles come with their original steel flip-top case. 4 ¾ inches wide, 4 ¼ inch temples.

Scarlett-Type Temple Spectacles

Folding Temple Spectacles

The double folding temple spectacles (right) were the first improvement over the short temple style used by Edward Scarlett. This type of spectacle was introduced by James Ayscough (d1759) in 1752. Ayscough was an English optician and designer and maker of scientific instruments including microscopes. This is a fine example of a pair of spectacles with double folding frames and wig loops, c1755. The frame of these spectacles are marked "08 CAM." This piece measures 4 5⁄8" across the front from frame to frame and 6 ½" long frame length. Other spectacles in the collection are steel-framed spectacles, late 18th century, and child-size wire rim spectacles, early 19th century.

Edward Scarlett (1677-1743) was apprenticed in 1691 to Christopher Cock of Long Acre, a member of the Worshipful Company of Spectacle Makers. Scarlett was made free of the Spectacle Makers Company in 1705 when he first opened his shop called the Archimedes & the Globe on Dean Street, near St. Anne's Church, Soho, London. He then became Master of the Spectacle Makers Company in 1720. John Marshall had been optician to the reigning monarch so when he died Scarlett was then appointed in 1727 to become "Optician to his Majesty King George the Second". Around 1730, Scarlett advertised that he "Grindeth all manner of Optick Glasses, makes spectacles after a new method, marking the Focus of the Glass upon the Frame, it being approv'd of by all the Learned in Opticks as ye Exactest way of fitting different Eyes." The marks on these spectacles may be the focal length. He was a distinguished and highly respected optician and he remained at his shop until his death in 1743. "Opticians" made and sold all types of optical instruments including microscopes and telescopes. The "Yale microscope," a Culpeper/Loft tripod, was purchased from Edward Scarlett in 1734.

Chinese Temple Spectacles, c1800

The origin of spectacles in the Far East is uncertain. Chinese historians claim that eyeglasses came to China from Arabia in the eleventh century. Two centuries later in 1271, on his first voyage to the Orient, Marco Polo reported that eyeglasses were being used. Other sources indicate that spectacles were invented in China or brought into China from the West in the fourteenth century. Development of spectacles in the Orient paralleled that of those in the Western world. Lenses were round and usually had no magnification power. To the Chinese, wearing spectacles was generally thought to establish the wearer as intelligent, affluent, and influential. Spectacles, therefore, became a status symbol.

This is a pair of Chinese temple spectacles, c1800. The spectacles are 5 inches wide and the arms 5 inches long. The lenses are round, 1 ¼ inches in diameter. The lenses are dark and produce no magnification. The lenses are enclosed in wide (3⁄8 inch) tortoise shell rims. The tortoise, a sacred animal to the Chinese, is believed to be endowed with the ability to bring good luck and long life. The metal frame is crafted from paktong, a metal somewhat similar to German silver. Paktong is an alloy of zinc, copper, and nickel that has the lustrous sheen and color tone of silver, is appreciably harder than silver, and does not tarnish. The paktong rivets attaching the nose bridge and earpieces have an ornate design resembling ruyi clouds, symbolizing power and good fortune. The arms are doubly hinged, next to the lens and then again in the area just in front of the ears. The arms end with a circle enclosing a symbol. The glasses are stored in a wooden case covered with yellow and brown tortoise shell veneer. The case is 6 ¾ inches long and 2 ¾ inches wide.

Magnifying Spectacles, c1920

This is a pair of magnifying spectacles as would be used by a jeweler, watchmaker, or surgeon for hands free close work. A pair of lenses is extended out 3 inches from the user’s face. The frame is made of silver and is 7 ½ inches long and 4 ½ inches wide. The distance between lenses can be adjusted by a thumbscrew. The frame is marked HCK.

Telescopes

The microscope and telescope were developed around the same time by lenscrafters in Middelburg, Holland. Hans Lippershey (1570-1619), a master lens grinder and spectacle maker, is generally credited with the earliest recorded design for an optical telescope (a refracting telescope) in 1608, although it is unclear if he invented it. Lippershey applied to the States-General of the Netherlands on October 2, 1608, for a patent for his instrument "for seeing things far away as if they were nearby.” Others who claimed to have made the discovery were Zacharias Janssen, also a spectacle maker in Middelburg and credited with inventing the microscope, and Jacob Metius of Alkmaar. The design of these early refracting telescopes consisted of a convex objective lens and a concave eyepiece. Galileo used this design the following year.

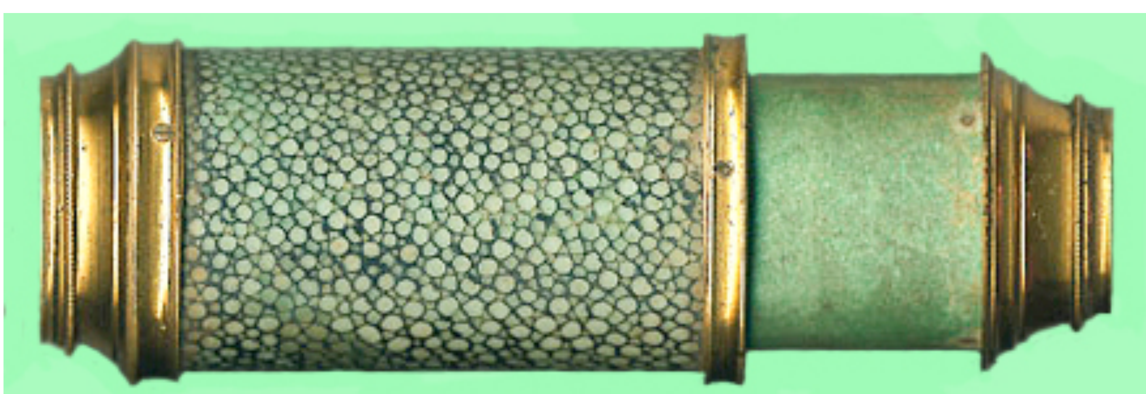
Galilean Bone Telescope (Perspective Glass), c1690-1730

This is an early bone and brass Galilean monocular telescope or perspective glass. It is 9.5 cm long and 2.8 cm in diameter at its widest. The Galilean system of this telescope has a plano-convex objective (16 mm diameter) and a plano-concave ocular (12 mm diameter) and produces an upright image. The tube is made from a bovine metatarsal bone, the long cylindrical bones above a cow's hoof. The ends of the tube are carved on the inside to form a platform for the lenses. The object lens is held in by a brass circlip and lens cap. It has a brass screw-on dust slide. The eye lens is missing its lens cap. Besides the missing lens cap, the tube has hairline fractures and chipping at the ocular end. The lenses show a few chips at the edges and numerous tiny bubbles not impairing vision. The instrument is optically in good order offering a magnification of about three times. The origin is unknown, most likely England based on the style of the bone turning and brass object glass shutter.

These small telescopes were probably pocket telescopes for personal terrestrial use and amusement. The craftsmanship required to make them, both the bone carving and the lens grinding, suggests that they were luxury items. Very few of these bone instruments are known. In 2012, five such telescopes and fragments discovered in Amsterdam, two in cesspits, were described. Only one of these contained both lenses. They were dated to the mid eighteenth century although their rarity and construction suggests an earlier date. John Yarwell's trade card of 1683 shows "Little Perspectives," so-called because they show objects in the upright position.

Galilean Bone Telescope

English Single Draw Telescope



This is an unsigned English eighteenth century, single draw telescope. It is made of green shagreen (rayskin)-covered pasteboard with lacquered brass lens holders and dust sliders. It is 1 ¼ inches in diameter x 3 ¼ inches long (closed) and extending to 4 ¾ inches. The eyepiece is 3⁄8 inches in diameter and the objective lens 5⁄8" in diameter. It has a pasteboard slipcase.

Venetian Three-Draw Telescope

This is a Venetian three-draw telescope, early eighteenth century and restored in the nineteenth century. The telescope extends from 12 ¼" to 32 ½" (31 - 83 cm), and has the main tube bound in mottled brown vellum with fine floral stamped decoration, three drawtubes bound in white vellum, horn binding rings and lens mounts, one (of two) lens covers, singlet objective lens with 7⁄8" diameter clear aperture, and three-element eyepiece system giving erect images. There are various inked focal positions on the drawtubes. Condition is fine throughout. The telescope is unsigned but is of the style made in Venice by Semitecolo, Olivo, and Selva. It bears a manuscript annotation on one drawtube "Restaure par Perchereau Louis, 25 aout 1847," and with the remains of perhaps similar inscriptions on the other two drawtubes.

Venetian Telescope

Italian Three-Draw Telescope, c1720

This is an eighteenth century, painted, Italian three-draw telescope. It has a round parallel cardboard barrel covered in red leather hand-painted with floral and vine designs. It has three cardboard draws covered in vellum. The draws have protective rings of horn on their ocular ends. There are various inked focal positions on the drawtubes. None of the draws have retention. The lens mounts are made of turned horn. The single plano-convex objective lens has a clear aperture of ¾ inch. The erector lens is inserted at one end of the smallest tube, while the other end contains the eyepiece lens. The telescope is 12 inches closed and 36 inches extended. It is unsigned but is of the style made in Venice. The optics are good but the body is in somewhat rough condition. It is lacking the screw-on caps and there is wear to the paint. A similar telescope is at The University of Arizona, College of Optical Sciences.

Italian Three-Draw Telescope

Culpeper Gregorian Reflecting Telescope

This brass telescope, dating to the first half of the eighteenth century, is 20 inches long overall and 3 inches in diameter. It is fitted with speculum metal mirrors, long side screw focusing to the secondary mirror, and two-element eyepiece. The barrel has two sighting pins mounted on top. It is mounted by a compass joint on a pillar with three folding cabriole legs and stands 15 ½ inches high when mounted. The compass is engraved with Edmund Culpeper's logo with the signature "C" and crossed daggers representing his address (Cross-Daggers, Moor Fields). Culpeper (1660-1738), one of the most important instrument makers of the early eighteenth century, is best known for his microscopes, but he made many other scientific instruments including telescopes. His sons continued making instruments, at least until 1759. The telescope is in excellent working condition. There is considerable spotting to the lacquer but despite this the telescope is attractive. It should be noted that Culpeper Instrument Ltd. made high quality reproductions of microscopes and other instruments that were indistinguishable from the originals. Further study should be done on this telescope.

Culpeper Gregorian Reflecting Telescope

James Short Reflecting Telescope, c1758

Chromatic aberration is the inability of a glass lens to bring all of the wavelengths comprising white light into focus at a single focal point. It manifests itself as fringes or halos of color along boundaries that separate dark and bright parts of the image, because each color in the optical spectrum cannot be focused at a single common point. In a refracting telescope, a bright star or planet viewed through a refractor with a single objective lens would have a bright red and violet halo around it. This sort of extreme color aberration in an objective lens reduces the contrast of the images, blurs the focus, and obscures detail in the image. In the eighteenth century, it was found that chromatic aberration could be reduced by combining two lenses made of different types of glass, one in front of the other, for the objective lens (see Dollond telescope).

The reflecting telescope was invented in the 17th century as an alternative to the refracting telescope because the curved mirrors used in reflecting telescopes focus white light to a single point and do not produce chromatic aberration. The Gregorian telescope is a type of reflecting telescope designed by Scottish mathematician and astronomer James Gregory (1638-1675) in the 17th century, and first built in 1673 by Robert Hooke. The design pre-dates the first practical reflecting telescope, the Newtonian telescope, built by Sir Isaac Newton in 1668, but was not successfully built until five years after Newton's first reflecting telescope. The Gregorian telescope consists of two concave mirrors, the primary mirror (a concave paraboloid) collects the light and brings it to a focus before the secondary mirror (a concave ellipsoid) where it is reflected back through a hole in the centre of the primary mirror and thence out the bottom end of the instrument where it can be viewed with the aid of the eyepiece. The Gregorian design solved the problem of viewing the image in a reflector by allowing the observer to stand behind the primary mirror. This design of this telescope renders an upright image, making it useful for terrestrial observations.

This brass telescope is 12 ¾ inches (32 cm) long overall and 2 inches (5 cm) in diameter, fitted with speculum metal mirrors, long side screw focusing to the secondary mirror, two element eyepiece, dust cap, and pillar mounting by iron screw to tree or fence post, or to the brass fitting on the wood base. Condition is fine, the brass cleaned, and the wood base a replacement. There is no box. The optics give very good images, even in daylight. The telescope is signed "James Short London 149/1032=7." James Short (1710-1768) was a renowned optical instrument maker who worked in his hometown of Edinburgh from 1734 to 1738, when he transferred to London, producing a wide range of reflecting telescopes over the next 30 years. He used an informative numbering system throughout. Thus, the present telescope is the 1032nd which he produced, and is the 149th to have a focal length of seven inches. The Museum of the History of Science at Oxford holds Short #1077, the 154th of this focal length, also c1758.

James Short Reflecting Telescope

Transit of Venus Viewer, c1760

Solar viewer, English, second half eighteenth century. It is made of turned dark hardwood and is 7.7 cm long and the lens cell is 2.6 cm across. It is set with a very dark greenish/grayish, clear aperture glass filter 14 mm in diameter The glass is held in place with a brass spring ring as used on eighteenth century simple microscopes and telescopes. This astronomical implement is in excellent, all original condition, noting one age "check" in the disc.

Designed for public use, it is likely that the viewer was prompted by the interest in the transits of Venus in 1761 and 1769. To an observer on earth, Venus would appear as a dark slowly moving spot on the sun's disk. Edmond Halley (1656–1742) had advocated observations of the timing of the transits from various locations on earth for determining the sun's parallax, and thus the distance from the earth to the sun. Major expeditions were mounted, particularly in 1769. The previous transit had been in 1639, the next not until 1874. No total solar eclipse was visible from England between 1724 and 1927. Thus, it appears these eighteenth century viewers were used to observe the transit of Venus.

Transit of Venus Viewer

Adams Gregorian Reflecting Telescope, c1770

This is an exceptionally fine Gregorian reflecting telescope on altazimuth mount signed on the eyepiece "G. Adams, Mathematical Instrument Maker to His Majesty, Fleet Street, London." George Adams Sr. (1709-1773) and George Adams Jr. (1750-1795) were among the most prominent makers of instruments in the eighteenth century. George Adams Sr. founded his workshop in 1734 on Fleet Street, London. They were highly skilled and innovative opticians and makers of telescopes, microscopes, and many other scientific instruments. The Adamses were Instrument Makers to George III and George Junior was later appointed Optician to the Prince of Wales. This brass telescope is 31 ½ inches long overall and four inches in diameter, fitted with speculum metal mirrors, long side screw focusing to the secondary mirror, two element eyepiece with solar filter, and dust cap. It is mounted by two butterfly wing nuts on a heavy pillar with folding cabriole legs and stands 20 inches high when mounted. It produces an excellent image and condition is excellent noting only minor spotting of the lacquer finish.

Adams Reflecting Telescope

Gregorian Reflecting Telescope, c1770

This brass telescope is 23 inches long overall and 3 ½ inches in diameter, fitted with speculum metal mirrors, long side screw focusing to the secondary mirror, two element eyepiece, and dust cap. The barrel has two sighting pins mounted on top. It is mounted by two butterfly wing nuts on a pillar with folding cabriole legs and stands 15 ½ inches high when mounted. The telescope is not signed but is after the manner of George Adams. It produces an excellent image and condition is very good noting considerable loss of lacquer finish to the brass. There is no case.

Gregorian Reflecting Telescope

Dollond Refracting Telescope, c1790

This is a brass Dollond Day & Night refracting library telescope. It is marked "Dollond, London" on the collar. The main body is 44 inches long with a 2 ¾ inch achromatic objective with a fitted end cap. Assembled, the telescope is over five feet long. The stand is a tapered column with folding cabriole leg tripod. The height of the stand to the telescope bracket is 20 inches. The telescope is equipped with three landscape (day) eye pieces, engraved L1, L2, and L3 and two astronomical (night) eye pieces, engraved A1 and A2, with sun filters. There is a lens cap and focusing tube cap. Focusing is by rack and pinion. Condition is excellent, with original dark golden lacquer finish throughout, some small insignificant handling dents and scratches, and the lid of the 45-inch long mahogany case with shrinkage and stress splits, now sound and solid. Optics are clear and sharp throughout.

Dollond Refracting Telescope

Dollond Table Telescope, c1790

John Dollond (1706-1761)

The Dollond family made scientific instruments for five generations. On April 21, 1750, Peter Dollond (1731-1821) opened a small optical business in Vine Street, near Hatton Garden in London. He was joined by his father John Dollond (1706-1761) in 1752. John Dolland patented the achromatic lens in 1758, although he did not discover it and the invention was hotly disputed for years. Chromatic aberration occurs because light of different wavelengths, e.g., red, blue, is refracted at different angles by lenses and have different focal points. An achromatic lens is a compound lens composed of a concave lens made of flint glass and a convex made of crown glass. The dispersions of the two lenses partially compensate for each other producing reduced chromatic aberration. In 1761 shortly before his death, John Dollond was appointed optician to King George III.

The discovery of achromatic lenses heralded a new era for telescope makers, but the same did not apply to the microscope. This was primarily due to technical difficulties in manufacturing the tiny achromatic compound lenses necessary for microscope objectives. The only successful objectives had very low magnifications and long working distances. In 1768, John Dollond, Jr. (1730-1821), now a partner in the business, was appointed optician to King George III and the Duke of York. The Dollonds produced telescopes, microscopes, and other optical instruments of the highest quality. In 1781, Peter Dollond made bifocal spectacles. Dollond & Co merged with Aitchison & Co in 1927 to form Dollond & Aitchison which continued until 2009.

This is a small brass Dollond single draw telescope on a stand. The telescope is 4 ¾ inches long closed and extending to 6 ¾ inches. The barrel is 1 9⁄16 inches in diameter. The objective lens is 1 ¼ inches in diameter. A dust cover screws on over the objective lens. The eyepiece has four lenses on a rotating disk that clicks into place. The tripod base consists of three scroll-shaped legs and a round pillar. It folds up and is stored in the inside barrel. The telescope is signed in script "Dollond London" on the drawtube. The finish on the tubes is worn. The optics are functional and in good condition. c1790.

Ramsden "Day or Night" Telescope, c1795

English telescope, late eighteenth century, made of glass with three drawtubes, the main tube partially bound in mahogany and mounted with a sliding sun shade/dew cap of reduced aperture. The telescope opens from 11 ¾ to 37 ¾ inches (30-96 cm) fully extended. It has dust slides at each end, and is equipped with a 1 ½ inch diameter air-spaced achromatic doublet objective, and erecting eyepiece system of four biconvex elements. Condition is fine, with a few small dents, the brass is cleaned. It is complete with the beautiful original card case (lacking end pieces) with its fine gilt-stamped decoration. An inked inscription survives on the back of the objective dust slide. Several aspects suggest this is a late Ramsden product, from the very late in the eighteenth century, in particular the general construction, the tapered eye cup design, and the unusual form of signature. As a "day or night" glass it was certainly appropriate for terrestrial use, with its sunshade and erect image of modest power. And for use at night it offered a relatively large objective with improved light gathering ability. It was a successful form of naval telescope that continued well into the nineteenth century. Jesse Ramsden (1735-1800) was London's leading maker of instruments of astronomy, navigation, and surveying.

Ramsden Day or Night Telescope

Dollond Military Telescope, c1800

In 1780, Peter Dollond introduced the Military or "Improved Achromatic Telescope," also called the Army telescope. This is a standard type with a mahogany body and brass draw-tubes and was manufactured well into the nineteenth century. They were between 14 and 52 inches long with a lens aperture of between 1 and 2.75 inches. They cost from 2.5 to 12 guineas. This c1800 example has a round parallel mahogany barrel. It measures 11 inches closed and 41 inches extended. The objective lens is an achromatic doublet 2 ¼ inches in diameter. It has four brass draws, a four-lens eyepiece, and a flared eyecup with a swivel cover. It is signed in script "Dollond London" on the eyepiece tube. The telescope is in excellent condition with bright lacquered brass and good optics. The telescope has a shagreen case.

Dollond Military Telescope

Binoculars

Binoculars, field glasses or binocular telescopes are a pair of identical or mirror-symmetrical telescopes mounted side-by-side and aligned to point accurately in the same direction, allowing the viewer to use both eyes when viewing distant objects. They give viewers a three-dimensional view. When Hans Lippershey applied for a patent on his instrument in 1608, the bureaucracy in charge, who had never before seen a telescope, asked him to build a binocular version of it, with quartz optics, which he is reported to have completed in December 1608. The first type of binoculars created by putting telescopes together were known as Galilean binoculars and used a convex lens and a concave eyepiece lens together. This design provided an erect image of the subject, but a main disadvantage was that it had a narrow field of view. The alternate solution for obtaining an erect image in a pair of binoculars was to use two Keplerian telescopes with Schyrle erecting lenses (terrestrial telescopes). The Keplerian telescope uses a convex lens as the eyepiece instead of Galileo's concave one. Both binocular types had the difficulties of alignment, focusing, and magnification. Nonetheless, they were made from Lippershey's time to the present.

The Galilean binoculars were simply two telescopes side by side and were never satisfactory until they were improved in 1823 by Johann Voigtlander in Vienna. He added eye tubes to the binoculars that were used for focusing each telescope independently. Two years later in Paris, Pierre Lemiere improved on this design and created a center focus wheel allowing the two lenses to be focused together. After this development, opera glasses and theater binoculars grew in popularity because of the superior view they facilitated in opera and theater houses. They were also beautifully designed and used coverings such as pearls, enamel, silver, gold, bone, mother of pearl, and colored leather. By the 1850's, opera glasses and theater glasses had become a must-have fashion accessory for all opera- and theater-goers.

Binoculars were greatly improved with the development of prism binoculars. Convex lenses are used for both objectives and eyepieces. A wider field of view and higher magnification can be attained than is the case with Galilean binoculars. An erecting prism system is incorporated in the optical path to rectify the image. Also, employing prisms has the effect of making the length of such binoculars shorter. The Italian optician Ignazio Porro patented his technology in the year 1854; this was the technology that was further refined by makers like Carl Zeiss in the 1890s. Another type of prism is the roof (dach) prism system. With the improvements in binoculars, their use extended from theater-goers to the military.

Twin Telescope Binoculars, 1881

This is a very fine pair of nickel silver, taper-barreled telescope binoculars. They measure 10 ½ inches drawn in, 14 inches when out, and 17 inches when the sun visors are extended. Focus is pull/push with final focusing via the central thumb wheel. The barrels and sun visors are covered with diamond patterned black leather that is very much still intact. The binoculars give a very good, clean, sharp image. They are contained in an original leather case showing wear. They are signed around the eyepieces "Adie & Wedderburn." The Adies were a notable family of instrument makers in the eighteenth and nineteenth century. The renowned partnership of Adie & Son (Alexander and John) was succeeded by Richard Adie in 1857 but continued under the same name Adie & Son in Edinburgh. Thomas Wedderburn was employed as foreman at Richard Adie's workshop and became a partner in Adie & Wedderburn in 1881.

Negretti & Zambra Binoculars, 1864

This is a very fine pair of brass Negretti & Zambra British Navy field glasses. They measure 4 ½ inches in length extended and 4 ¼ inches in width. There are engravings in script on each of lens shafts. One reads "Negretti & Zambra, Opticians, London." The other lists the addresses of the firm's shops; "1 Hatton Garden, 59 Cornhill, 122 Regent St, 153 Fleet St." Negretti and Zambra was located at these addresses in 1864 indicating the binoculars were made around this time. The condition of the binoculars is exceptional. The lenses work and adjust beautifully. There is very little wear to the brass and no nicks or scratches.

The firm of Negretti & Zambra (active 1850–c1999) was a producer of scientific and optical instruments and also operated a photographic studio based in London. Henry Negretti (1818–1879) and Joseph Zambra (1822–1897) formed a partnership in 1850, thereby founding the firm that would eventually be appointed opticians and scientific instrument makers to Her Majesty Queen Victoria, Prince Albert and Edward VII of the United Kingdom, the Royal Observatory and the British Admiralty.

Lemaire/McAllister Opera Glasses

This a pair of mother of pearl opera glasses, a type of Galilean binoculars, with an American connection. One eyepiece bears the signature “Lemaire Paris” and the other “McAllister Philad.” The LeMaire trademark bee with outstretched wings and the number 63 are etched on the underside of the middle bridge. The firm of LeMaire has a long history of making optical instruments and were probably the largest manufacturers of opera glasses in the nineteenth century. John McAllister opened the first optical shop in America in 1796 and the business was carried on by subsequent generations. It is likely these opera glasses were imported by William Y. McAllister who placed his name on them. The glasses measure 3 7⁄8" wide and 2 1⁄16" high closed and 2 ¾" extended. The glasses are in excellent condition. The lenses and iridescent mother of pearl are in excellent condition with no cracks or chips. The opera glasses come with their original leather case that also bears the bee logo on the brass push button release of the lid. c1885.

Navigational Instruments

From the time men sailed beyond the sight of land, the ability to determine one’s position became of paramount importance. Many instruments were devised over the centuries culminating in the sextant, an optical instrument, as the main instrument of navigation. Celestial navigation is the use of angular measurements between celestial bodies and the visible horizon to locate one's position on the globe. An octant is a doubly reflecting navigation instrument used to measure the angle between any two visible objects. The principle of the instrument was first implemented around 1730 by John Hadley (1682–1744) and Thomas Godfrey (1704–1749) but it was also found later in the unpublished writings of Isaac Newton (1643–1727). The primary use of an octant is to determine the angle between an astronomical object and the horizon for the purposes of celestial navigation. Common uses of the octant, and sextant that followed it, include sighting the sun at solar noon or Polaris at night (in the Northern Hemisphere) to determine latitude.

The octant consists of a 45 degree arc (one eighth of a 360 degree circle) while a sextant consists of a 60 degree arc (one sixth of a circle) and thus can read a larger angle. An alidade or index arm carries a small mirror (index mirror) at its top while the bottom is moved across the calibration scale at the periphery. A sighting telescope is mounted on one arm of the sextant while the other arm holds a fixed mirror (horizon mirror). Light from the celestial body strikes the index mirror and is reflected to the silvered portion of the horizon glass, then back to the observer's eye through the telescope. The observer manipulates the index arm so the reflected image of the body in the horizon glass is just resting on the visual horizon, seen through the clear side of the horizon glass. The angle, read on the scale, can be used on a chart to determine the navigator's position.

Octant for U. S. Navy by Stackpole & Brother, c1860

This is an American Naval octant in brass, c1860, signed "Stackpole & Brother, New York, #552" and "U. S. Navy." William (1819-1895) and Robert (1823-1873) Stackpole, both emigrants from Ireland, were in business under the present name in New York City, from 1851. The Stackpole brothers were fine craftsmen and a major supplier of nautical instruments to the U. S. government. The octant measures 9 ½ inches (24 cm) overall, with 7 ½ inch radius to the inlaid silver scale. It has index mirror arm with clamp and tangent screw, adjustable horizon mirror, four colored (red and green) index filters, three colored horizon filters, removable erect-image telescope with achromatic objective, silver scale reading from -5 to 120 degrees in one minute increments and vernier reading to 30 arc seconds, scale magnifier, three tapered brass legs, and an ebony handle with thread provision for use on stand. There are no other accessories except the early keystone-shaped case (perhaps not original but bearing the fascinating 1874 trade label of "Black and Murray, 6-1 Hastings Street, Calcutta," with its headquarters in London and branch in Melbourne.) Condition of the instrument is fine, the brass with a black finish to minimize reflections. There is loss of silvering on the mirror and laquer on the telescope.

Stackpole & Brother Octant

Sextant by John Omer, c1860

This is a fine mid-nineteenth century brass sextant signed "J Omer 99 Minories London." It is 10 ½ inches wide with a nine inch radius. The ladder frame has four index and three horizon shades, index and horizon mirrors, a mahogany handle on the reverse, and is supported on three feet. The index arm holds a swinging magnifier. The scale with a venier is 0 to 150 degrees with a five degree extension on either side. There is one telescope, a sighting tube, and an adjusting pin. It has a fitted mahogany box. The sextant is in excellent condition with some loss of silvering on the mirrors. John Omer succeeded his uncle George Bradford on Minories Street in 1851. They were "Real Makers of Mathematical Instruments" and manufactured optical instruments, including sextants, quadrants, and telescopes. They also supplied charts, navigational books and flags.

Omer Sextant, c1860

Whitbread Box Sextant, c1840

A box, pocket, or lifeboat sextant works in the same way as a traditional sextant but is small and compact so that it could be carried easily while traveling, on horseback, or in a lifeboat. William Jones, a leading instrument maker in London, introduced the form in 1797. The German explorer, Alexander von Humboldt, had an early example that he described as being "very useful for travelers when forced in a boat to lay down the sinuosities of a river, or take angles on horseback without dismounting." By the mid-nineteenth century, box sextants were said to be particularly useful for military reconnaissance. They were still available in the early twentieth century.

This is a fine all brass box sextant by G. Whitbread, London. It is three inches in diameter with silver 120 degree scale and vernier adjusted by a knurled knob, hinged arm with magnifying glass, the maker's name and city engraved above the scale, a removable knob for adjustment of the horizon mirror, extendable telescope with sun filter and peep option, slot cover to two sun filters, and a screw fit cover. The brass finish is very good with a few small spots. The mirrors and optics are excellent. George Whitbread was in London from 1828-1877 and the construction of this instrument is quite early.

Box Sextant, Cary, London, 1851

The two brothers William (1760-1825) and John (1754-1835) Cary formed a partnership in 1789 manufacturing both scientific apparatus and globes. William Cary served his apprenticeship under Jesse Ramsden, one of the finest instrument makers in England. The brothers were among the foremost London map and globe makers of the late 18th and early 19th centuries. Their scientific instruments included telescopes, microscopes, navigation and surveying equipment, mechanical calculators and measuring instruments. When William died, John's sons George and John, Jr. continued the business. Instrument making passed to Henry Gould in 1852 who formed a partnership with Henry Porter in 1863. Porter later took over the firm, which survived into the 20th century.

A box, pocket, or lifeboat sextant works in the same way as a traditional sextant but is small and compact so that it could be easily carried while traveling, on horseback, or in a lifeboat. This is a brass box sextant signed in script "Cary, London." It is 3 1/8 inches in diameter with inlaid silver 120-degree scale, silver vernier on the index arm adjusted by a knurled knob, and hinged arm with magnifying glass. It has a removable knob for adjustment of the horizon mirror, peep site, slot cover to two sun filters operated by lever, and a screw fit cover. The lid can screw on to the opposite side to act as a handle. On the side are scales for angles and multipliers/divisors up to 90 degrees. The lid is inscribed "Royal Military College, Presented to Gentleman Cadet Rich^{d} J Hereford for Attention to and Progress in Military Surveying, May 1851." The sextant is in excellent condition with all the interior lacquer. The Global Positioning System (GPS) satellites made celestial navigation with a sextant obsolete. Nonetheless, some navies and many ships still carry a sextant in the event the electronic equipment fails.

Box Sextant

Azimuth Circle, first half twentieth century

This is an azimuth circle used to measure the bearings of bodies on the earth's surface and the azimuth of a celestial body. The azimuth circle was made by Jones & Woodland Co., Newark, N. J. The ring and original wooden box are numbered 2049. It is complete and in fine condition noting a crack in the box lid. This type of azimuth circle was used by the US Navy in World War II.

The azimuth is the angle between the north vector and the perpendicular projection of the star down onto the horizon. Azimuth is usually measured in degrees and the concept is used in navigation, astronomy, engineering, mapping, mining and artillery. The azimuth circle is a nonmagnetic metal ring 10 inches in diameter. The inner lip is marked in degrees from 0° to 360° counterclockwise. A compass card is placed inside the ring. The azimuth circle is fitted with two sighting vanes. The forward or far vane has a vertical wire and the after or near vane has a peep sight. A finger lug is used to position the instrument while aligning the vanes. A hinged reflector vane mounted at the base and beyond the forward vane is used for reflecting stars and planets when observing azimuths. Beneath the forward vane are mounted a reflecting mirror and the extended vertical wire. The bearing or azimuth is read from the reflected portion of the compass card. For taking azimuths of the sun, an additional reflecting mirror and housing are mounted on the ring, each midway between the forward and after vanes. The sun's rays are reflected by the mirror to the housing, where a vertical slit admits a line of light. This admitted light passes through a 45° reflecting prism and is projected on the compass card from which the azimuth is directly read. In observing both bearings and azimuths, an attached spirit level is used to level the instrument.

Azimuth Circle

Surveying Instruments

Surveying is another area in which optical instruments play a major role. The need for land surveying dates back to at least 3000 BC when the civilizations of Egypt and Babylon required the setting down of distances, the division of land into plots, and the construction of road systems. A wide variety of tools were devised over the centuries to perform measurements, with the theodolite, an instrument for measuring horizontal and vertical angles, and the level for measuring the height of distant points eventually becoming the most important. In the early eighteenth century, a telescope was added to these instruments and, with the introduction of achromatic lenses for telescopes by John Dolland (1706-1761) in 1758, the practicality and accuracy of the instruments was greatly increased.

Surveyor's Y Level, George Adams, Sr., c1760

This is a surveyors Y level made by George Adams, Sr. around 1760. A Y or Wye level is a level with a telescope supported in Y-shaped rests and as a result capable of being rotated around its own axis or of being taken out of the supports and turned end to end for purposes of adjustment. George Adams and his son were among the premier instrument makers in London in the 18th century. The telescope measures 21 inches long mounted over a 7 ⅜ inch bubble level. It has non-achromatic lenses and push-pull focusing. The telescope is held in two uprights fixed to the main limb. The height of the uprights can be adjusted. The bubble level retains its fluid and bubble. The compass box is 3 ¾ inches in diameter and holds a silvered compass rose with single vernier. The vernier arm is signed in script "G Adams London." The instrument gives a good, clear inverted image with cross hairs. The level has its own original 22 x 7 x 4 ¼ inch oak box with two hooks and eyes. It is in excellent functional and cosmetic condition and was cleaned sometime in the past. One original Y pin is present the other replaced with a pin.

George Adams Y Level

W. & S. Jones Altazimuth Theodolite, c1800

W. and S. Jones were among the most successful scientific instrument makers in London during the late 18th and early 19th centuries. By 1776, John Jones (1736/7-1808) was in business in the Holborn area, trading as an optician. His son William was apprenticed to his father around this time. By 1784, William was in partnership with his father and in 1791 William's brother, Samuel, joined the business on the retirement of their father. In 1795, George Adams Jr. died and the Joneses obtained his stock and copyrights of his books from his wife. The firm was extremely prolific, selling a wide range of optical, mathematical, and philosophical instruments and apparatus, as detailed in their comprehensive catalogues issued at frequent intervals. The firm continued to trade at 30 Holborn until Samuel's death in 1859.

This altazimuth theodolite is made of brass, with brass fittings, and stands 11 inches high. It is signed "*W. & S. Jones, Holborn, London.*" on the horizontal circle. The telescope is 13 inches long, with erecting eyepiece, 1 inch diameter objective with cap and rack and pinion focusing, draw-tube movement to the eyepiece, and a 3 5⁄8 inch long bubble level mounted underneath. Two A-frame supports hold the telescope and the vertical half circle, which have fine screw adjustment and clamp. The half circle is marked with a 60°-0-60° scale and vernier on one side and with a 30°-0-30° Links scale on the other. The 6-inch horizontal circle has a chamfered edge with silvered 0-360° scale and vernier and fine screw adjustment and clamp. It holds the 3 inch compass having a silvered rose calibrated in four quadrants 0-90° and edgebar needle and clamp. The 4-screw leveling base has a threaded tripod mounting and fine screw adjustment and clamp. The instrument has its original mahogany fitted case with key. It is complete and in very fine working condition. It is an early Jones theodolite lacking some of the refinements of later instruments.

W & S Jones Theodolite

B. Pike & Sons Transit Theodolite, c1855

This transit theodolite is signed in script on the compass face "B. Pike & Sons, 518 Bdway, N. Y.," dating it to around 1855 to 1860. A transit theodolite is a theodolite in which the telescope can be rotated completely around its horizontal axis in the vertical plane. Benjamin Pike (1777-1863), born in London, established himself as an optician and manufacturer of mathematical and philosophical instruments in New York in 1798. Benjamin and his sons, operating under various names, became the most prominent manufacturer of scientific instruments in America in the nineteenth century. The telescope is signed in script by the original owner "A.W. Ferreira D'Aguira" who graduated from the Rensselaer Polytechnic Institute, Troy, N. Y., in 1867. The theodolite is made of black-painted brass, with lacquered brass fittings, and stands 13 ½ inches high on its 4-screw leveling base. The telescope is 9 ½ inches long, with erecting eyepiece, 1 ⅛ inch diameter objective, rack and pinion focusing and draw-tube movement to the eyepiece, and a 5 ¼ inch long bubble level mounted underneath. The vertical circle is 5 ⅛ inches in diameter, graduated on silver and mounted on a 6 ½ inch tall support attached to the top plate. The horizontal circle is 7 inches in diameter under the top plate, with silvered scale, two opposing verniers, and tangent screw control; the compass housing is 6 ¼ inches in diameter, with a 5 inch needle. The transit is complete and in very good overall condition. The original 9 ½ x 9 ¾ x 16 ½ inch fitted mahogany case is worn and missing its carrying strap.

Pike Theodolite

Gurley Telescopic Alidade, 1919

This is a telescopic plane table alidade that can be placed on a solid and level surface to make field drawings, charts and maps in the horizontal plane. The instrument is labeled "W. & L. E. Gurley, Troy, N. Y., 19372." It is model 592C ("Explorers Alidade," so named because it is relatively small and light so it can be carried into the field. The firm of W. & L. E. Gurley was established in 1852 by the brothers William Gurley (1821–1887) and Lewis Ephraim Gurley (1826–1897). It soon became the largest manufacturer of engineering and surveying instruments in the United States and remained in the family until 1968. The serial number indicates this was the three hundred seventy second instrument manufactured in 1919.

The alidade is made of brass with some parts blackened. It has a brass ruler 10 inches long and 2 ¾ inches wide, with the edge beveled and ruled. A circular spirit level and a trough compass having a four inch needle are mounted on the blade. The telescope which is mounted on the blade is eight inches long and equipped with an objective, platinum cross wires and stadia wires, and a detachable striding level with revolving shield. The telescope is furnished with an inverting eyepiece and is fitted with an erecting eyepiece and diagonal prism. The telescope can be revolved on its longitudinal axis. The telescope is equipped with a Beaman stadia arc and a gradienter attachment. It is carried in a wooden leather covered box with brass reinforcements and a carrying strap. The leather of the case is separated from the wood at the edges and the finish of the alidade is worn in places. The instrument is complete and produces a clear image and is a fine representative of this important surveying instrument.

Bianchi Level, c1840

This is an example of a brass surveyor's level. It is engraved on the level in script "Bianchi Opticien Rue du Coq St Honoré 11 à Paris." The instrument is approximately 15 ½ inches long. It consists of a telescope fitted with a spirit level and leveling base. Eyepiece focus is by rack and pinion. There are alignment and locking screws. The bubble level is filled with a clear light green liquid. The level has seen use and little lacquer remains. However, it functions well and the optics are clear. It comes with a lens hood, lens cap and its own original fitted worn wooden case that measures 16 x 8 x 5 inches.

There are several instrument makers named Bianchi in the eighteenth and nineteenth centuries. The maker of this instrument was an optician whose shop was on the same street as that of Alphonse Giroux who produced Daguerre's original camera in 1839 (Bianchi at 11 and Giroux at 7 Rue du Coq). Bianchi produced a similar sliding box camera at the same time, probably with his own lenses. There is an 1839 catalogue of mathematical, physical, chemical, mineralogical and other instruments made by Bianchi & Son, opticians, in Paris. His son, Barthélémy-Urbain Bianchi, was a maker of instruments until 1898.

Berger & Sons Transit Theodolite, c1904

This is a very fine example of a transit theodolite which has a telescope that can describe a complete revolution (transit) on a horizontal axis. It is American, early 1st quarter twentieth century, signed in script on the compass face "C.L. Berger & Sons, Boston," serial numbered 3845, and listed in their 1904 catalog. Made of black painted brass, with lacquered brass fittings, and standing 13 ¾ inches high on its 4-screw leveling base. The telescope is 11 3⁄8 inches long, with erecting eyepiece, 1 3⁄16 inch diameter objective, internal rack and pinion focusing, and a 4 ¼ inch long bubble level mounted underneath. The vertical circle is 5 inches in diameter, graduated on silver and mounted on a 6 ¼ inch tall support attached to the top plate. The horizontal circle is 6 ¼ inches in diameter under the top plate, with silvered scale, a single vernier, and tangent screw control; the compass housing is 5 inches in diameter, with a 4 ¼ inch needle. The transit is in very good overall condition. The original 10 x 11 3⁄8 x 15 ¾ inches fitted mahogany case is worn, but is still fully serviceable. Christian Louis Berger (1842-1922), born in Stuttgart, Germany, formed a partnership with George L. Buff in 1871 which became the firm of Buff & Berger. The firm manufactured "all kinds of surveying, astronomical, mathematical and philosophical instruments." It was dissolved on October 18, 1898 and Berger founded a new firm, C. L. Berger & Sons, taking into partnership his two sons, William A. and Louis H. Berger.

Cameras

A camera is an optical instrument that records images. With a camera, light enters an enclosed box through a converging lens and an image is recorded on a light-sensitive medium. A shutter mechanism controls the length of time that light can enter the camera. The modern camera is derived from the camera obscura (Latin for “dark chamber).

Camera Obscura Replica

The term "camera obscura" was first used by the German astronomer Johannes Kepler in 1604, although its origins date back to Roman times. The camera obscura in its simplest form consisted of a darkened room with a small hole in a window shutter through which light passed to fall on the opposite wall giving a diminished and reversed image of the scene outside. In the thirteenth century, Roger Bacon described the use of a camera obscura for the safe observation of solar eclipses. Later a lens was placed in the hole to make the picture brighter and clearer. If a convex lens and a concave mirror were used, the picture could be seen enlarged and erect. The dark room of the camera obscura was reduced to a large box and then a small box with a lens. These were used extensively by professional and amateur artists. The scioptic ball, magic lantern, solar projection microscope, and camera are all derived from the camera obscura.

This is a replica of a late eighteenth century box camera obscura. It is made of mahogany. A brass lens tube moves in and out to focus on objects from about one foot away to infinity. It has a front-surface mirror, ground glass screen, a clear acrylic glass screen, and a tripod mount. It is about 7 inches wide x 6 ½ inches high x 6 inches long. High quality camera obscuras and camera lucidas are manufactured by master craftsman and expert Les Cookson.

Scioptic Ball, c1730

The scioptic (scioptric) ball or "sky optick", a type of camera obscura, is a universal joint that allows an optical instrument attached to the ball to be swiveled into any position. Daniel Schwenter (1585-1636), professor of mathematics and oriental languages at the University of Altdorf, developed the scioptic ball in 1636. Its invention was inspired by his studies of the human eye. The scioptic ball, mounted on the south wall of a darkened room, provided an anchor for a microscope or telescope while allowing the telescope to be swiveled in all directions in order to follow the course of an eclipse or for drawing panoramic views. Scioptic balls have been used as camera obscuras, projecting images from the outside on walls in darkened rooms or used simply as a light source.

This is a rare and fine scioptic ball of the early Georgian period. Usually these are part of a microscope compendium and set in a window frame, but this example shows no signs of being in a cradle or mount of any sort. Being hand-held, it could have been used to condense light from an external source but has little magnifying capability, i.e., the one end glass is plane, the other slightly concave. It may have been used as a camera obscura for projecting and drawing outside scenes. It is constructed from a solid block of Honduran flame mahogany with beautiful graining. The screw-on end caps are free of damage. There is a fine shrinkage crack (no more than a hair in thickness) that runs the full length of the body, but it is very stable. 70 x 70mm. (55mm at ends).

The camera obscura was the forerunner of the photographic camera. Before the invention of photographic processes there was no way to preserve the images produced by the camera obscura apart from manually tracing them. The first photograph was taken around 1817 by Nicéphore Niépce (1765-1833) using camera obscuras of his own making; the photographs though were not permanent, and faded away. Later, in 1827, he made permanent images, called heliographs or sun prints, using a sliding wooden box camera obscura made by Charles and Vincent Chevalier in Paris, France. The images were made by coating a pewter plate with bitumen and exposing the plate to light. The bitumen hardened where light struck. The unhardened areas were then dissolved away.

Sliding Box Camera Obscura Replica

The sliding box camera obscura consists of two boxes. The outer box contains the lens and the inner box fits into the outer box. The inner box contains the mirror and ground glass. In the simpler camera obscura, focusing is achieved by moving the lens piece in or out. In the sliding box camera, the inner rear box is moved in or out. This is another replica by Les Cookson.

Starting in 1829, Niépce began collaborating on improved photographic processes with Louis Daguerre (1787-1851). The partnership lasted until Niépce's death in 1833. Daguerre continued with experimentation, eventually developing the first practical photographic process that he named the "Daguerréotype." In 1836, Daguerre coated a copper plate with silver, then treated it with iodine vapor to make it sensitive to light. The image was developed by mercury vapor and fixed with a strong solution of sodium chloride.

Giroux Camera 1839 Replica

The Daguerreotype camera is essentially a sliding box camera obscura in which a light-sensitive plate is substituted for the ground glass screen. In 1839, Daguerre signed a contract with his brother-in-law Alphonse Giroux and the Susse Brothers. In the contracts, the two companies were given the exclusive rights to produce and sell the Daguerreotype camera and the other necessary equipment. Charles Chevalier who had hoped to receive the contract for the camera was given the commission of producing the lenses for the cameras made by both companies. The first production camera was made by Giroux in 1839. The selling price of 400 Francs was very high, representing approximately the annual income of a normal working man. There are only a few of these cameras known to be in existence and all are stored in public museums except for one recent find that was auctioned for $899,000 in 2010.

Sliding Box Camera Obscura

Giroux Daguerreotype Camera

The sliding camera obscura consists of two boxes which slide into each other. The larger of the two, which has the lens attached to it, is fixed to the base plate. The smaller box the back of which is the ground glass plate slides into the outer box. The interior of the boxes is black. In order to bring the image into focus, the rear box is moved back or forwards along the wooden camera base. A fold-out mirror behind the ground-glass screen allows the image to be seen upright.

This is a 1/3 scale replica of a Giroux daguerreotype camera. It was made by Jerry Smith of Missouri in the 1970's for museum display and fewer than 20 were made. It is a functional camera except it does not have plate holders. It is wood-cased with a brass barrel lens. It has a golden oval label on the side bearing the maker's mark and Daguerre's signature. The size is a 4 ¼ x 4 x 5 inch box on a 5 x 7 inch base.

Sliding Box Daguerreotype Camera

This is a box in box daguerreotype camera of early design. It is essentially a sliding box camera obscura with a holder for a photographic plate. It is 25 ¾ inches long, 10 inches high, and 8 inches wide. There is an inner box that can be moved in and out by a hand crank on the side. There is a trap door in the middle of the top. A spring-loaded frame to hold a plate is located on the back of the inner box. There is a mirror at the rear. The brass lens is unsigned and has two washer stops. The lens produces an image at the level of the plate holder. The image is viewed upright in the mirror.

Nothing is known about the origin of this instrument except that it has the form of the earliest cameras. When purchased, it had numerous devices of unknown function attached to it including hinged flaps, a front extension, two levers, metal pieces, and two electric light bulbs in front. These obviously later additions were removed. The silvering on the mirror is crazed and the wood has an alligator finish. There are numerous small holes from the attachments. The wood is unknown.

Daguerreotype by Mathew Brady, 1852

The daguerreotype was the first publicly available photographic process, widely used during the 1840s and 1850s. It was invented by Louis-Jacques-Mandé Daguerre and introduced worldwide in 1839. A daguerreotype is a direct positive process with a silver-coated copper plate support and a silver-mercury amalgam image. Image highlight areas are composed of silver-mercury, while dark areas remain silver metal. Daguerreotypes are easily identified by a mirror-like, highly polished silver surface and its dually negative/positive appearance when viewed from different angles or in raking light. Daguerreotypes are typically housed in small, hinged cases behind glass. The cases are made of wood covered with tooled leather, embossed paper, or cloth and lined with silk or velvet. The image may sometimes exhibit subtle dry pigment hand-coloring. Daguerreotype images are very delicate and easily damaged and should not be displayed for any long period of time. When on display, they should be protected from exposure to natural light, which contains high levels of UV radiation.

Mathew B. Brady (1822-1896) is best known for his photographs of the Civil War. Earlier, however, he studied under inventor Samuel F. B. Morse, who pioneered the daguerreotype technique in America. In 1844, Brady opened his own photography studio at the corner of Broadway and Fulton Street in New York, and by 1845, he began to exhibit his portraits of famous Americans. Brady's early images were daguerreotypes, and he won many awards for his work. In

1852, he opened another gallery at 359 Broadway. In the 1850s, ambrotype and tintype photography became popular and these gave way to the albumen print, a paper photograph produced from large glass negatives. The albumen prints were most commonly used in Civil War photography.

This is a half plate (4.25 x 5.5 inches, 11 x 14 cm) daguerreotype of a family taken in New York in 1853 at Brady's Gallery at 359 Broadway between Leonard and Franklin Streets. His gallery was located at that address from 1852 to 1859. It is housed in a full leather case measuring 6 x 4 ¾ inches. "BRADY'S GALLERY 359 BROADWAY NEW YORK" is embossed on the velvet on the inside cover. The sharp image is in an oval brass mat trimmed with gold braid. There is faint pink shading to the skin of the subjects. The daguerreotype is graded very good (VG). The image has a tarnish ring and has been resealed and there is slight wear to the case. Purchased from Jeffrey Krause, Antique Photographics.

Mathew Brady Daguerreotype

Watson & Sons Side-Wing Tailboard Camera, c1885

In subsequent years, cameras underwent improvements and additions including photographic plates, bellows replacing the sliding box, shutter mechanism, iris aperture, and lens construction. However, as illustrated by this c1885 camera, the camera retained its basic similarity to the camera obscura. This is a beautiful Watson side-wing tailboard camera for 4 ¾ x 6 ½ inch plates. It is characterized by large front and rear standards fitting onto a baseboard and joined by parallel bellows. The camera is made rigid by folding side wings attached to the front standard and baseboard. It is of mahogany construction with brass fittings. The serial number 10722 is stamped on the base. The brass lens piece is marked "W. Watson & Sons 313 High Holborn London."

Watson & Sons Side-Wing Tailboard Camera

Eastman Kodak No. 1 and No. 3 Brownie Box Cameras

The Eastman Kodak Company, commonly known as Kodak, was founded by George Eastman (1854-1932) in 1888. During most of the 20th century Kodak held a dominant position in photographic film, and in 1976, had a 90% market share of photographic film sales in the United States. Among the innovations introduced by Eastman Kodak were roll film cameras of the box form and of fixed focus. The simple cameras did not require burdensome apparatus and processes, were inexpensive, and made photography available to the amateur. In 1900, Kodak introduced a low-priced, point-and-shoot, hand-held camera, called the Brownie. The Brownie was named for the impish little characters illustrated by Palmer Cox, a popular children's author and artist. It was a very basic cardboard box camera with a simple meniscus lens that took pictures on roll film. The Brownie camera, simple enough for even children to use, was designed, priced, and marketed to have wide appeal. It made photography accessible to the masses and millions of these cameras were sold into the 1980s.

This is a Brownie No. 1 model B, box rollfilm camera. It was introduced in 1904 and produced through 1916. The No. 1 Brownie is a leatherette covered card box with a wooden film carrier. The camera is 5 x 3 x 3 ¼ inches in size. It has a meniscus lens. It uses film type 117 roll film and produces a 2 ¼ x 2 ¼ image size. The original price was $1.00. The camera is fully functional and the body coverings and finishes are in excellent condition.

Brownie No. 1B Camera

This is a Brownie No. 3 box rollfilm camera that was introduced in 1908 and discontinued in 1934. This model produced a larger image than the earlier models. The leatherette card case with handle is 6 x 4 3⁄8 x 5 inches in size. It has a meniscus achromat lens and rotary shutter. The camera has two finders (one for vertical and the other for horizontal exposures), three aperture stops, and a slide for timed exposures. It uses film type 124 size roll film and produces a 3 ¼ x 4 ¼ image size. The camera has an exposed roll of film in it. The original price was $4.00. The camera comes with a 1909 instruction manual ("Picture Taking with the Brownie Camera No. 3") and original carrying case. The camera is fully functional and the body coverings and finishes are in excellent condition. The case is missing the shoulder strap.

Brownie No. 3 Camera

Gundlach-Manhattan Optical Company Korona Petit Camera, c1905

Ernst Gundlach (1834-1908) was one of the more inventive, skilled, and restless opticians of the nineteenth century. His history is described in the section on Other American Microscopes. The Gundlach Optical Company was founded by Gundlach in 1885 in Rochester, New York. The company acquired the Milburn Korona Company in 1896 and the Manhattan Optical Company in 1902. The company manufactured microscopes and cameras under their new name, Gundlach-Manhattan Optical Co.

This is a Korona Petit Model folding-bed plate camera manufactured by the Gundlach-Manhattan Optical Company around 1905. It was described as an excellent compact and complete camera for making negatives for prints, lantern slides, and enlargements. It is constructed of a cherry wood body, maroon bellows, and a leather covered case. Metal parts are nickel-plated. There is a spring-actuated ground glass focusing screen to accept Korona petit plate holders, a reversible finder, and two tripod sockets. The brass shutter mechanism is by the Wollensak Optical Company with T, B, and I settings. Aperture settings are marked F8 to 128. With the camera is a new pneumatic shutter release bulb and tubing. The outside dimensions of the folded camera are 2 ¼ x 4 ¼ x 5 inches. The camera is in very good condition noting only some slight scuffing to the edges of the case.

Korona Petit Camera

Argus 35mm Film Camera

The **A**rgus C3 was a low-priced rangefinder camera mass-produced from 1939 to 1966 by Argus in Ann Arbor, Michigan. The camera sold about 2 million units, making it one of the most popular cameras in history. The camera measures 5 x 1 ¾ x 2 ½ inches. Due to its shape, size, and weight, it is commonly referred to as "The Brick" by photographers. The C3 was constructed primarily of Bakelite plastic and metal castings. It is equipped with a 50mm f/3.5 Cintar anastigmat triplet lens. The design featured an unusual but simple diaphragm shutter built into the camera body, so the camera could make use of interchangeable lenses without the need for a complex focal plane shutter. The rangefinder was separate from the viewfinder and was coupled to the lens through a series of gears located on the outside of the camera body. The camera has electrical plugs on the left side for a battery-powered flash, synchronized to the shutter. The profusion of knobs, gears, buttons, levers, and dials on the camera lent it a "scientific" look that was found in customer surveys to be one of the things buyers most liked about the camera. This camera is in excellent condition and has the flash unit with bulb, manual, and original box. Film cameras were largely replaced by digital cameras and smart phones equipped with cameras.

Argus Camera

Polaroid Land Camera Model 95, 1948

The original Polaroid Corporation was founded in Cambridge, Massachusetts, by Edwin Land (1909-1991) and George W. Wheelwright III in 1937. Polaroid's initial market was in polarized sunglasses. Land Cameras are instant cameras with self-developing film named after their inventor. They were manufactured by Polaroid between the years of 1947 and 1983. Though Polaroid continued producing instant cameras after 1983, the name 'Land' was dropped from the camera name since Edwin Land retired in 1982. The first commercially available model was the Polaroid Land Camera Model 95, which produced sepia-colored prints in about 1 minute, and was first sold to the public in November, 1948.

The first roll film instant cameras required the photographer to use a light meter to take a reading of the light level, then to set the exposure setting on the lens. Then the lens was focused and the subject framed and the picture was taken. The film was put on two spools, one with the negative roll, and one with the positive paper and reagent pods. The photographer flipped a switch and pulled the large tab in the back of the camera to pull the negative over the positive, through some rollers to spread the developing agent. After the picture developed inside the camera for the required time, the photographer opened the small door in the camera back and peeled the positive from the negative. To prevent fading, the black and white positive had to be coated with a fixing agent, a potentially messy procedure that led to the development of coaterless instant pack film.

This is a Polaroid Land Model 95 made by Polaroid in the United States from 1948 to 1953. Approximately 900,000 cameras were produced, making it one of the best-selling cameras of all time. It measures 12 x 24.5 x 6 cm in closed position. It features a 135mm f11 lens that has 3 simple elements, the focus being controlled by moving the front end of the bellows forward and back. For the shutter, the 95 features a simple 4 speed leaf design, featuring adjustable shutter speeds of 1/8th of a second to 1/60th, each being designated by a different exposure value for Polaroid film called "Polaroid Numbers." It processes roll film (3 ¼ x 4 ¼ inches), 8 exposures per roll. Also included are Polaroid Capacitor Flash Gun, Polaroid Exposure Meter, and Polaroid Close-Up Lens Kit, all in their original boxes, and numerous manuals, tips, and advertisements. The entire set is in a metal carrying case.

The 1990s saw the advent of new technologies that profoundly changed the world of photography — one-hour color film processing, single-use cameras from competitors, videotape camcorders, and digital cameras. In 2008, Polaroid filed for Chapter 11 bankruptcy protection for the second time and announced it would discontinue production of its instant films and cameras.

Polaroid Land Camera

Keystone 8 mm Movie Camera, c1956

This is an 8 mm triple turret, movie camera made by the Keystone Camera Company. The Keystone Camera Company was an American manufacturer of consumer photographic equipment that began in 1919 in Boston. The company filed for Chapter 11 protection in January 1991. 8 mm film is a motion picture film format in which the film strip is eight millimeters wide. Film developed by Eastman Kodak in 1932 was relatively inexpensive and proved ideal for amateur family movies. This Keystone camera is model Capri K-27 8mm movie camera made around 1956 (serial number 14089). It measures 5 ¾ with lens x 2 x 4 ¾ inches. It features a turret that rotates through three lenses. To use the camera, it is wound with a recessed handle on the side and loaded with film. The field to be filmed is viewed through a viewfinder with a ½ inch lens. The photo lens is selected and the f stop set. The Elgeet lenses are 13mm f:1.9 standard lens, 9mm f1.9 wide angle lens, and 25mm f:1.9 telephoto lens. To film, an operating lever on the side is pressed. The camera is in excellent working condition and has the instructions, other paperwork, lens caps, and original box. It has film in it. Since the 2000s, film-based movie cameras have been largely replaced by digital movie cameras.

Keystone 8mm Movie Camera

Kodak DC50 Digital Camera, 1996

The Eastman Kodak Company (referred to as Kodak) is a technology company that produces camera-related products with its historic basis in photography. Kodak was founded by George Eastman and Henry A. Strong on September 4, 1888. During most of the 20th century, Kodak held a dominant position in photographic film. Kodak began to struggle financially in the late 1990s, as a result of the decline in sales of photographic film and its slowness in transitioning to digital photography, despite developing the first self-contained digital camera, invented by Steven Sasson an electrical engineer at Kodak in 1975. The product was dropped for fear it would threaten Kodak's photographic film business. In the 1990s, Kodak planned a decade-long journey to move to digital technology. The Kodak DC series was Kodak's pioneering consumer-grade line of digital cameras. Cameras in the DC series were manufactured and sold during the mid-to-late 1990s and early 2000s. Some were branded as "Digital Science." Most of these early digital cameras supported RS-232 serial port connections because USB hardware was not widely available before 1998. For a time, Kodak ranked No. 1 in the U.S. in digital camera sales. Despite the high growth, Kodak failed to anticipate how fast digital cameras became commodities with low profit margins, as more companies entered the market in the mid-2000s. Its digital cameras soon became undercut by Asian competitors that could produce their offerings more cheaply. The film business, where Kodak enjoyed high profit margins, continued to fall. The combination of these two factors resulted in disappointing profits overall and in 2012 Kodak filed for Chapter 11 Bankruptcy Protection.

This DC50 is an early digital camera released by Kodak in 1996. Although marketed by Kodak, the camera was made by Chinon. It was the first digital camera priced below $1,000 ($979) and one of the first with a zoom lens. In spite of its initial hefty price tag, the Kodak DC50 was the first step into digital photography for many amateurs and professionals with a strong interest in both photography and personal computers. The camera has an unusual horizontal body with a strap on the side and is held much like binoculars. The Kodak DC50 features a 3:1 zoom lens (38 mm to 114 mm equivalent), built-in photo flash and a PCMCIA slot for CompactFlash external memory. It has a black and white text LCD to report basic camera settings, but did not come with a graphical LCD for picture review. The Kodak DC50 has a 756x504 pixel color CCD sensor. It did not support the JPEG image file format and stored images in Kodak's proprietary KDC file format. It has autofocus and provides for automatic shutter control at speeds of 1/15 second to 1/500 second. The camera dimensions are 6.0 x 4.7 x 2.5 inches (152 x 119 x 64 mm) and weighs 1.16 lb (525 g) without batteries. It is in near mint condition in its original box and appears to never have been used. It comes with a user guide, four AA batteries, a serial cable for Windows and one for Macintosh systems. A limited edition of PhotoEnhancer, for Windows 98 and for Macintosh operating systems is included.

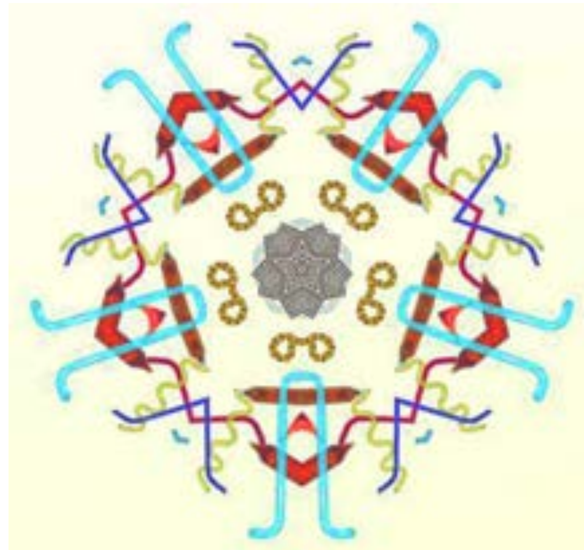
Kodak DC50 Digital Camera

Other Instruments

Charles Bush Kaleidoscope, 1873

A kaleidoscope is a cylindrical optical instrument that when rotated the viewer sees a succession of radial designs. The designs are produced by a set of mirrors reflecting constantly changing patterns made by small translucent objects, often bits of colored glass, in a chamber at one end of the cylinder. The kaleidoscope was invented by Sir David Brewster (1781-1868) in 1816. Brewster was studying polarization optics and the properties of light. While looking at some objects at the end of two mirrors, he noticed patterns and colors were recreated and reformed into beautiful new arrangements. He named this new invention after the Greek words kalos - beautiful, beauty; eidos - shape, form; and skopos - to examine, to look at; thus "observer of beautiful forms." His initial design was a tube with pairs of mirrors at one end, pairs of translucent disks at the other, and beads between the two. Brewster chose Philip Carpenter, maker of optical instruments and achromatic lenses, as the manufacturer of the kaleidoscope in 1817. It proved to be a massive success with thousands of kaleidoscopes sold in London and Paris in just three months. Fascination with multiple images occurred long before the kaleidoscope. In the seventeenth century, opticians produced "multiplying glasses" (see 1700 optical compendium). These consisted of a lens one side of which is plane and the other convex. The convex surface has a number of plane surfaces inclined to one another each of which presents a separate image of the object viewed through it, so that the object is "multiplied." These early instruments are often called kaleidoscopes as well.

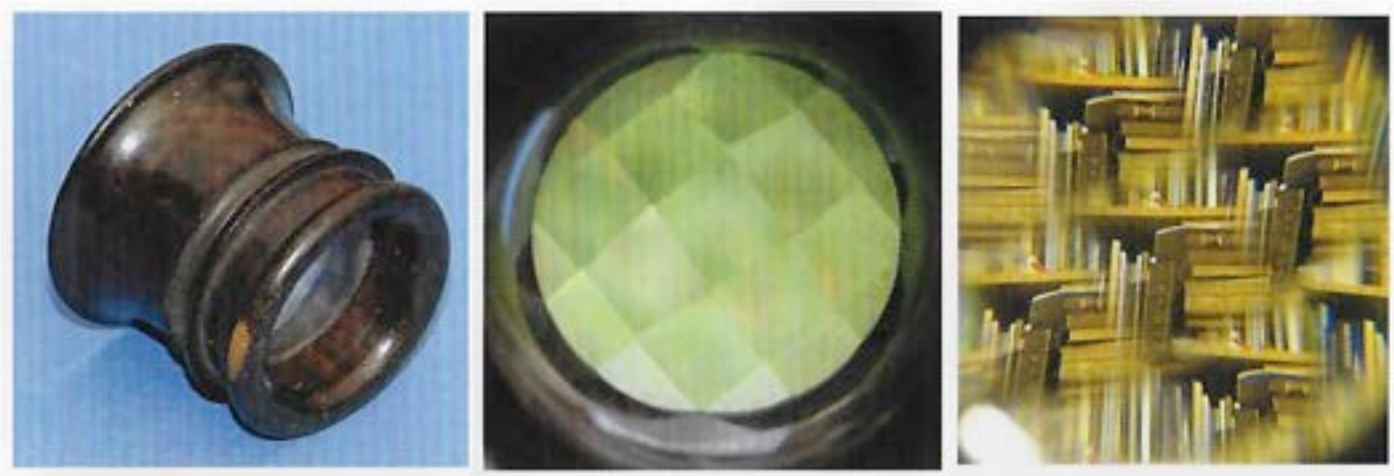
In America, the most prominent maker of kaleidoscopes was Charles G. Bush (1825-1900). Untrained in any of the physical sciences, he arrived in Plymouth, Massachusetts, in 1847 from Culberg, Prussia. He had worked in his father's hemp manufacturing business and proceeded to establish a successful rope business in Plymouth. In later years, after moving to Boston, he pursued interests in microscopes, telescopes, astronomy, and photography. In the early 1870s he began developing kaleidoscopes. Bush manufactured his parlor kaleidoscopes by the thousands and they were recognized as extraordinary even then. These instruments had a barrel of black hardboard with a spoked brass wheel rotating an object cell, mounted on a turned wooden stand. Most noteworthy about the Bush kaleidoscopes were the glass pieces contained in the object case. Bush had a basic mix of about 35 pieces, a third of which were liquid filled. Inside the liquids were air bubbles that continued to move even after the object case was at rest. Both the solid and liquid-filled glass pieces were of brilliant and well-chosen colors, and the patterns they formed were the finest of any nineteenth century kaleidoscope. One unusual piece that comes into view in a very few of the original Bush scopes is a clear glass disk embossed with a swan. But it is the liquid-filled ampules that are by far the most distinctive feature of the Bush kaleidoscope.



This is a kaleidoscope by Charles Bush. The instrument is supported by a turned wooden pedestal mounted on a tripod base. The tripod is the rarest of the Bush bases. It has a barrel 10 inches long and is 14 inches tall. The main cylinder is made of cardboard covered with black pebbled stamped paper. There is a cardboard eyepiece at one end. It secures an aperture stop and a square cover glass over the end of the inner tube with the mirrors. There are two mirrors of thick greenish glass (about 5⁄16 inch thick) with rear surface silvering. The third side of the triangle formed by the mirrors is made of wood. The mirrors are held together by twine. The cell or chamber box at the far end of the tube is made of brass and can be turned by means of six brass spokes. The chamber houses multi-colored glass twists and rods, cuts of German sheet glass in various forms, and colored liquid-filled ampules. The image formed is a pattern of five points and the measured angle between the mirrors is 36 degrees. The kaleidoscope is marked "C. G. Bush, Claremont, N.H., Pat. Nov. 11, 1873." The instrument is missing one spoke (can be replaced) but is otherwise in fine condition and produces beautiful images.

Georgian Multiplying Glass

A multiplying glass or prismatic viewer is a multifaceted prism set in a mount. When viewing through it, it produces multiple images around a central one. When the viewer is turned it produces a kaleidoscopic effect. John Yarwell's trade card of 1683 illustrates a "multiplying lens." These remained a popular form of entertainment through Victorian times. This example has a turned lignum vitae mount having a tapered shape suitable for holding to the eye and rotating, or even fixing in the eye like a jeweler's loupe and surveying one's environment. There are 21 facets giving up to 20 identical images around a central one. The viewer is in excellent condition throughout.



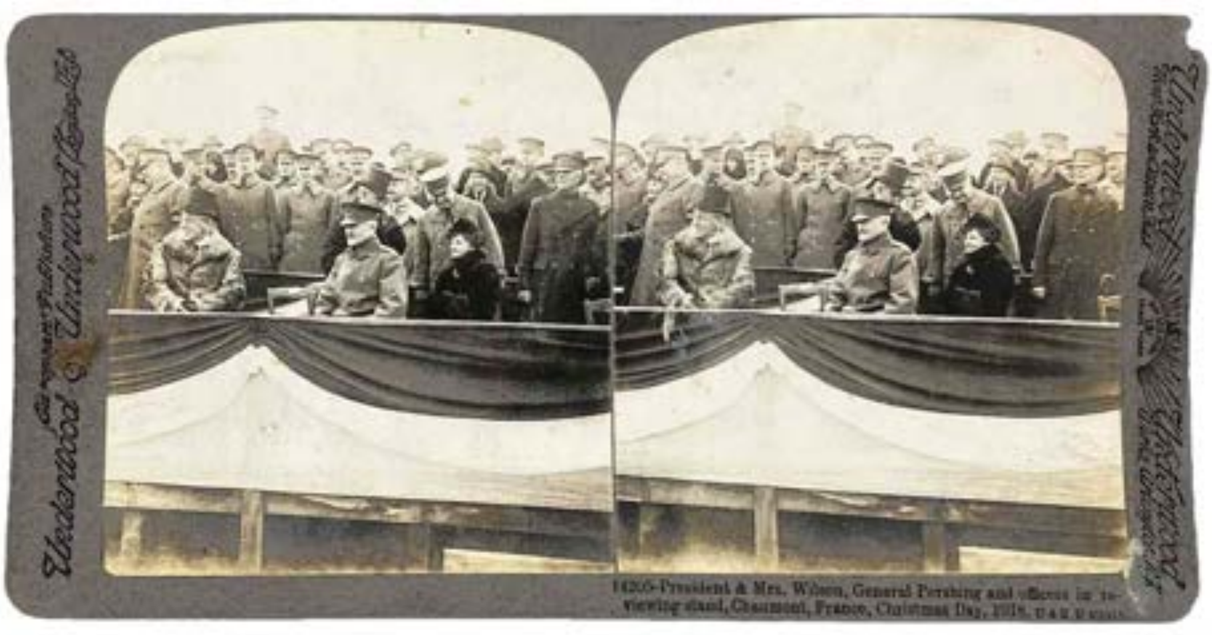
Multiplying Glass

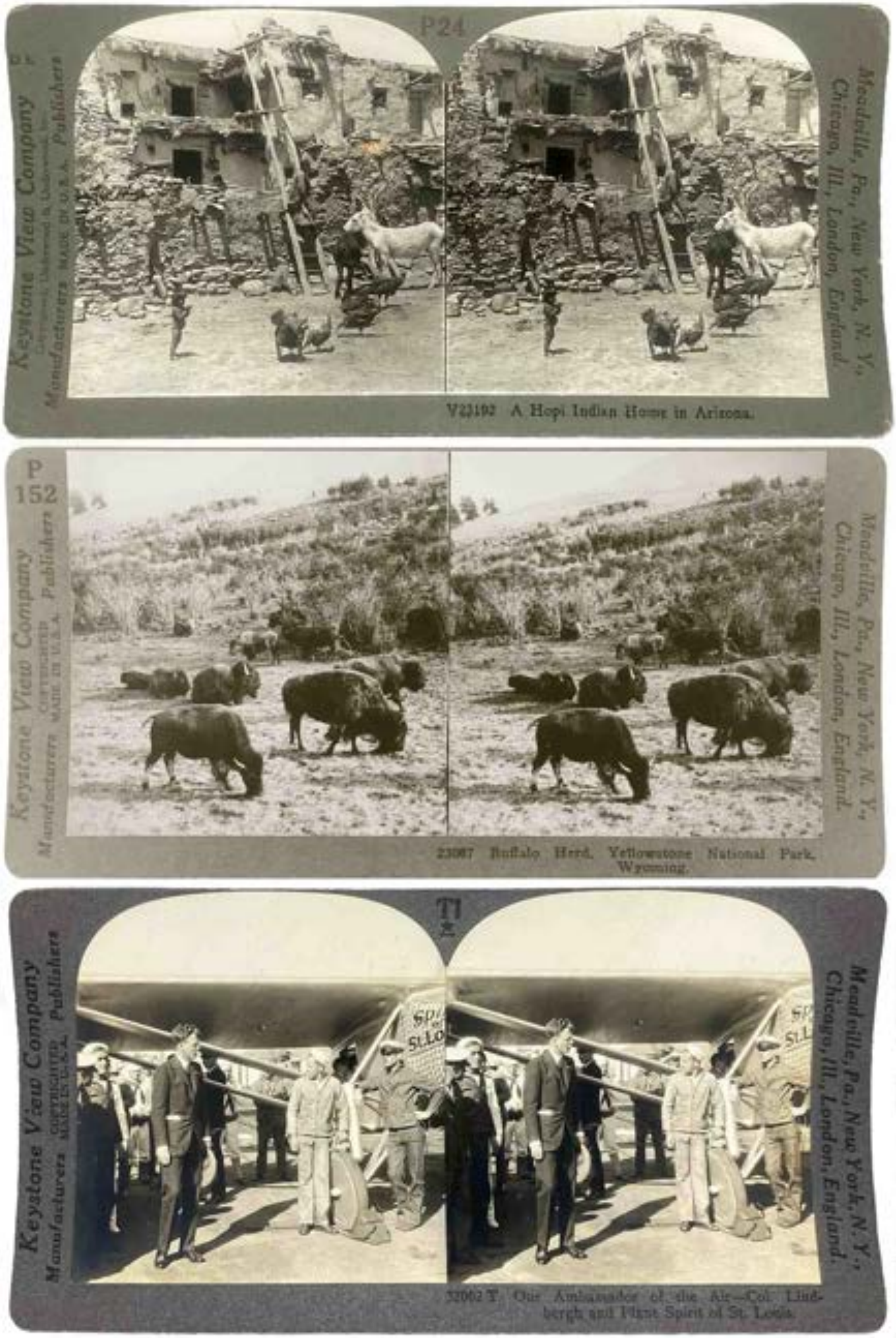
Holmes Stereoscope and Stereocards, c1880

Stereoscopes, also known as stereopticons or stereo viewers, were one of the most popular forms of entertainment in the late 1800s and early 1900s. The first patented stereoscope was invented by Sir Charles Wheatstone in 1838. It was improved in 1849 by Sir David Brewster (1781-1868), the inventor of the kaleidoscope. In 1861, Oliver Wendell Holmes developed an economical handheld stereoscope that remained in production for a century. It consisted of two prismatic lenses and a wooden stand to hold the stereo card. The stereo card has two images taken from slightly different angles that are presented to the left and right eye of the viewer. These two-dimensional images are then combined in the brain to give the perception of three-dimensional depth. The stereoscope became a popular photographic medium in Europe in the mid-1800s, and through mass production methods became widely distributed in the United States by the 1880s. They reached their peak of popular distribution in the years 1902-1935. This is a Holmes type stereoscope made of maple. It is stamped with a patent date of 1868 and reissued in 1877.

Stereo cards were made of almost every imaginable topic. Many of them represent a valuable photographic record of sites and events at the end of the 19th and beginning of the 20th centuries. Prominent makers included B.W. Kilburn & Co. started in Littleton, New Hampshire in 1876 by the Kilburn Brothers, Benjamin West and Edward Kilburn. Underwood & Underwood was established at Ottawa, Kansas in 1882. The Keystone View Co. was formed in 1892 in Meadville, Penn. by B. L. Singley, a former salesman at Underwood & Underwood. Included with the stereoscope are 12 cards by these and other makers on a variety of topics. They date from about 1880 to 1930.

Mother of the Forest, 327 feet high. A giant sequoia tree.
Working No. 4 Bonanza, Klondike. Griffith & Griffith. Alaska gold rush.
Buffalo Herd, Yellowstone National Park, Wyoming. Keystone View Company. (shown below)
City Hall Ruins. World Series. 1906 San Francisco earthquake.
Niagara. Horseshoe Falls from Goat Island. Winter. Griffith & Griffith.
"Gee Whiz! Doctor, Did Any of Them Get away?" Keystone View Company.
Union Stock Yards, Texas Cattle, Chicago, Ill., U. S. A. Keystone View Company.
Interior of Throne Room, Forbidden City, Peking, China. Keystone View Company.
Great Falls 360 Feet. Yellowstone Park Scenery. Haynes, Publisher.
Setting up large search light in advance lines, Vosges, France. Underwood & Underwood. WW I.
President & Mrs. Wilson, General Pershing and officers in interviewing stand, Chaumont, France, Christmas Day, 1918. Underwood & Underwood. (shown below)
A Hopi Indian Home in Arizona. Keystone View Company. (shown below)
Cotton is king-plantation scene with pickers at work, Georgia. Underwood & Underwood.
Jacob's Ladder, Mt. Washington Railway. Kilburne Brothers. The Mt. Washington Cog railway.
Profile House, Franconia Notch. Kilburn Brothers.
Morehouse's Comet, Yerkes Observatory. Keystone View Company.
Majestic El Capitan, Calif. Rising Sheer 3,604 Feet and Twice as Great as Gibraltar. Keystone View Company.
Our Ambassador of the Air – Col. Lindbergh and Plane Spirit of St. Louis. Keystone View Company. (shown below)





Holmes Stereoscope and Stereocards

Henri J. Noè Stereoscope, c1890

This is a French folding stereoscope, c1890. It folds compactly by means of brass hinges into a box form, then ingeniously unfolds to form a fully functional Brewster style stereo viewer. It was made by Henri J. Noè of Paris who first obtained a patent in 1857. It was produced in great numbers from 1860 to 1900. The folded mahogany case measures 7 3⁄8 x 4 1⁄8 x 1 ½ inches. The viewer unfolds to two wood side panels, a wood flap on top, a wood frame holding the prisms, and a black cloth down the middle separating the images on the stereocard. The unfolded viewer is 6 ½ inches long. The top flap bears Noè 's monogram "NH" in script and "BREVETE S.G.D.G." It is in excellent condition noting a crack in the top.

Stereoscope

Shown here is a 3 ½ x 7 inch stereocard that would be viewed with a stereoscope. It is titled "As in an Old Cathedral Town, the Towers and Turrets of Yale University Rise Above the Tree Tops-New Haven, Conn." A brief history of New Haven and Yale College is printed on the back. The card was produced by the Keystone View Company which operated from 1892 through 1963. It was the world's largest stereographic company and by 1935 Keystone had approximately two million stereoscopic negatives. c1930.

Stereocard of Yale University

Ophthalmic Equipment

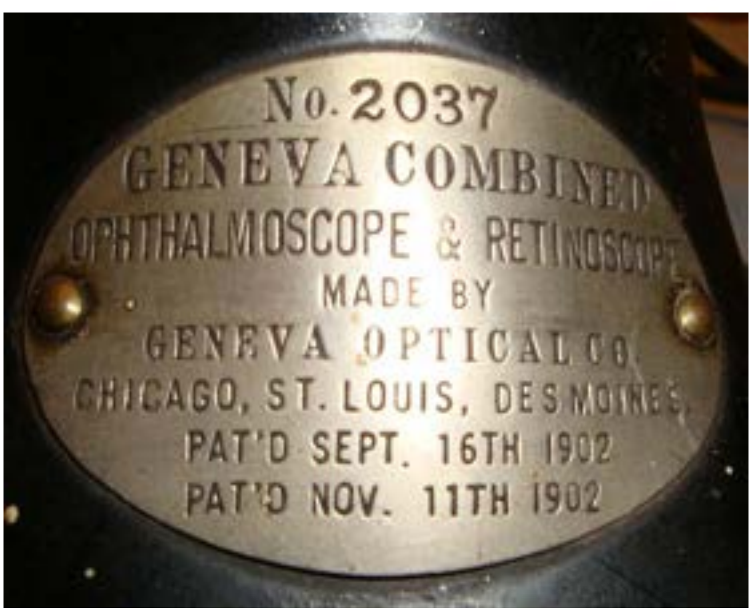
Morton's Ophthalmoscope, c1890

Another type of magnifying device is the ophthalmoscope used for observing the retina in the eye. The ophthalmoscope was originally invented by Charles Babbage in 1847, but it was not until it was independently reinvented several years later by Hermann von Helmholtz (1821-1894) in 1851 that its usefulness was recognized.

This is Morton's non-luminous ophthalmoscope made by the optical instrument makers Curry & Paxton in London. Andrew Stanford Morton (1848-1927) described his very successful and popular ophthalmoscope to the Ophthalmological Society of the United Kingdom in 1885. The instrument consists of a chain of 29 lenses that move by rotating the lower disk. There are twelve convex lenses and seventeen concave ones. The lenses allow for the estimation of refraction before the days of retinoscopy. The middle disk indicates the strength of the lens in the sight-hole. The upper disk has an empty opening and lenses of plus 0.5 and 20 as well as minus 10 and 30 diopters. On the reverse side are two circular mirrors fixed to a plate that can be rotated around a central pivot. The large mirror is slightly concave on one side and plano on the other and is on a spring hinge and can be flipped. There is also a small angled concave mirror with a short focus distance that can be rotated. The ophthalmoscope, which screws into an ivory and brass handle, is stamped "MORTON'S OPHTHALMOSCOPE CURRY & PAXTON LONDON." The base of the handle rotates four different size openings to test color vision. There is a separate hand held auxiliary condensing lens. The instrument is held in an embossed leather case lined with blue velvet. The lining is signed in gold "Curry Paxton." The instrument is 7 ⅞ inches long. The case is 4 ¾ x 2 ⅜ x 1 ¼ inches. The ophthalmoscope is in fine condition with all parts functioning noting wear to the velvet lining.

Geneva Optical Company Ophthalmoscope-Retinoscope, 1902

This is a combined ophthalmoscope and retino-scope made by the Geneva Optical Company. An ophthalmoscope is used to view the retina of the eye directly. A retinoscope is used to illuminate the internal eye and to measure the rays of light as they are reflected by the retina. Errors of refraction, such as in short- and long-sightedness, as well as astigmatism can be determined. This instrument is 23 inches long and 18 inches high. It consists of a heavy iron base painted with black enamel and stenciled. The base supports two pillars, one for a headrest and the other a frame holding the ophthalmoscope at one end, the illuminator in the middle, and optical tube at the other end. The frame can be focused by rack and pinion. The instrument was patented in 1902 making it one of the earliest to use an incandescent light. The light bulb is a GE Mazda that was introduced in 1909. The Geneva Optical Company was founded in 1869 by Andrew L. Smith as the A. L. Smith Optical Company of Geneva, New York. The company primarily made spectacles and instruments for opticians and ophthalmologists. The instrument is in excellent condition and fully functional.



Ophthalmoscope-Retinoscope

Ophthalmic Trial Lens Set, c1880

A trial lens set was used by optometrists to determine the proper prescription of lenses to correct defects in vision. The trial set consists of a large number of calibrated lenses. These are placed in a trial frame and interchanged until the best vision is obtained. After 1875, trial lenses were marked in diopters of power (1/focal length in meters). Convex lenses have positive dioptric value and are generally used to correct hyperopia (farsightedness) and presbyopia (the limited accommodation of advancing age). Concave lenses have negative dioptric value and generally correct myopia (nearsightedness).

This is a trial lens set consisting of 100 lenses and a trial frame. The lenses are held in nickel and brass bezels. The spherical lenses bear a tab with the dioptric value. There are four groups of lenses: spherical concave and convex and cylindrical concave and convex. Other lenses include black, frosted, slit, prism, and plane lenses. The lenses and trial frame are held in a velvet-lined wooden box measuring 14 x 8 x 2 ½ inches. The set is unmarked and dates to around 1880. A few lenses are missing and there are a few additions from another set but overall the set is in very good condition except for a crack in the case lid.

Ophthalmic Trial Lens Set, c1880

Spencer Spectroscope, c1940

Spectroscopy which allows for the identification of elements and substances was introduced as an analytical method in the 1860s. The spectroscope uses a slit and a collimator to collect a parallel beam of light emitted by a substance or from a broad spectrum light passed through an absorption medium. The beam is dispersed by a prism or a grating. The resulting spectrum, emission or absorption, is then observed through a telescope or projected on a screen or photographic paper.

Spencer Spectroscope

This is a Spencer Student Spectroscope or Spectrometer. It consists of a heavy iron base with three legs. The instrument is 8 ½ inches high, the telescope and collimator each 7 ½ inches long, and the telescope table 6 inches in diameter. It can use either a prism or grating to produce the spectrum. In this spectrometer, the prism table, the collimator, and the telescope positions may be determined relative to a high resolution graduated circle with verniers. There are leveling screws for the collimator, prism table, and telescope. The telescope is supplied with a Gauss eyepiece which contains an opening on the side of the tube giving access to a semi-transparent diagonal mirror. The light is inserted into the opening to illuminate the cross hairs in the telescope which must be brought into focus. The instrument can be used for the determination and analysis of spectra, in the measurement of angles between prism faces, and the determination of angles of refraction and reflection. The spectroscope bears the serial number 1187 and has its original wooden case. The instrument is in exceptional condition with no defects. The spectroscope is marked “Spencer Buffalo USA.” A manual for its use was issued in 1938. The Spencer Lens Company was acquired by the American Optical Company in 1935 and operated under its own name until 1945. c1940.

Spencer Abbe Refractometer, c1940

Refractometry has been a major tool in the chemical laboratory to determine concentrations of solutions and as an aid in identifying unknown substances since the late nineteenth century.

The most common and universal refractometer for laboratory use is the Abbe refractometer and its variations. The Abbe refractometer provides a quick and easy means for determining refractive index and dispersion for liquids and solids. It is used in the examination of organic compounds (oils, solvents, etc.), solutions, food products, and serum protein concentration. The refractive index is measured by aligning the cross hairs in the telescope with the line of total reflection (seen as the edge between light and dark fields in the telescope). This line is moved by rotating the prism assembly with the alidade. Reading at constant temperature is important, thus the prisms are enclosed in a water jacket which are connected to a constant temperature bath.

This is an Abbe Refractometer by Spencer Buffalo. The instrument stands 11 ¾ inches high. The triangular base and pillar are of cast iron with black crinkle finish. The scale and telescope arm, bearing the Spencer logo and serial no. 637, are attached to a vertical bar attached to the pillar. The vertical bar, telescope, and alidade arm are of black enameled brass. All of the control knobs and the alidade handle are in heavy chrome plating. The prism alidade has a tangent screw fine adjustment. The scale is finely engraved on an inlaid German silver strip with scale divisions of 1.300 to 1.710. The readout is viewed with an adjustable magnifier. The Amici color compensating prism scale on the telescope is finished in brushed chrome with black filled engraved divisions (0-60-0) and adjusted with a knurled wheel. The water-jacketed prism holder is finished in brushed chrome with polished chrome tubulatures for connecting to a circulating bath for temperature control. There is a chromed brass thermometer shield and mercury-filled thermometer. The instrument has its original hardwood case which contains the dispersion table. The instrument is in excellent condition except that the screw for the wheel adjusting the color compensating prism is broken.

Bausch & Lomb Dust Counter, c1938

When it became apparent that breathing air that contained particles such as silica, coal dust, and asbestos was hazardous, dust counters became important tools to monitor air quality in the workplace. This is a Bausch & Lomb dust counter, No. 257084, used for counting the number of dust particles in a sample of air. The instrument consists of an upright microscope tube and moistening chamber tube, horizontal piston, base, and dust chamber. The dust chamber is fastened to the underside of the base by three wing nuts and holds the circular specimen slide. To use the instrument, moistened blotting paper is placed in the moistening chamber tube and an attached rubber atomizer bulb is squeezed to clear the chamber of old air and bring a new air sample into the tube. Then pulling the piston handle will impinge the dust in the air sample onto the specimen slide. Twelve samples can be taken on the same specimen slide. There are two windows on the top of the base, one marked “dust” to indicate the number of the sample, and the other marked “micro” to show the sample to be viewed. A knob on the top of the base turns the sample slide. The microscope can be raised on two swing out legs and a lamp slid under the dust chamber. The number of dust particles with the squares of an eyepiece graticule are counted to determine the number of particles per cubic foot of air.

The dust counter has the original wooden carrying case, a wooden slide box to hold the instrument, and a drawer holding twelve specimen slides. There is the instruction manual and a booklet of data sheets with one filled out and dated 11-28-38. The instrument is in excellent condition and missing only the rubber bulb.

Bausch & Lomb Dust Counter

Welch Allyn Ophthalmoscope Otoscope Set, c1960

Welch Allyn, Inc. was founded in 1915 and is an American manufacturer of medical diagnostic devices and patient monitoring systems. Headquartered in Skaneateles Falls, New York, it was family-owned until it was acquired in 2015 by Hill-Rom. In 1915, Dr. Francis Welch and William Noah Allyn developed the world's first handheld, direct illuminating ophthalmoscope. The ophthalmoscope is used to look into the back of the eye and observe the health of the retina, optic nerve, vasculature and vitreous humor. It consists of a handle holding D batteries, a detachable head that contains a light bulb, a set of apertures for the light source, and a set of lenses. An otoscope is used for examining the ear canal and tympanic membrane (eardrum). The head contains a light source and a simple low-power magnifying lens, typically around 8 diopters (3 x mag.). The front end of the otoscope has an attachment for plastic ear specula. Present-day instruments are little changed except for rechargeable batteries. The set is held in a leather case with instructions and is in excellent condition.

Zograscope, c1780

A zograscope is an optical device for magnifying flat pictures that also has the property of enhancing the sense of the depth shown in the picture. It consists of a large magnifying lens through which the picture is viewed. The lens is mounted on a stand in front of an angled mirror. This allows someone to sit at a table and to look through the lens at the picture flat on the table. A print specifically developed to provide the illusion of depth when viewed through a zograscope is called a *vue d'optique*, perspective view, or optical print. These usually consist of scenes chosen for their strong linear perspective, for example, diagonal lines converging to a horizon. They have bright hand-coloring. The subject matter is that generally appealing to armchair travelers; shipping, cities, palaces, gardens, and architecture. Some have reversed type in some or all of the text, for viewing through a mirrored apparatus. Zograscopes were popular during the later half of the 18th century as parlor entertainments. Most existing ones from that time are fine furniture, with turned stands, moldings, brass fittings, inlays, and fine finishes. The visual mechanisms by which a zograscope enhances depth perception are explained in optical textbooks.

This is a fine, large scale late 18th century Georgian mahogany zograscope. It stands on a 9 inch turned mahogany base with concentric circle detailing. The base also has a circle of lead inlaid into its underside to ensure that the instrument remains stable. A 12 inch high turned wooden column with threaded end is screwed into the base and supports the zograscope frame. The frame is inserted into the centre of the column and the height adjusted by means of a mahogany screw key to the side. It measures from 26 ⅜ to 31 ½ inches extended. The frame holds a 9 x 7 inch mirror with original silvering intact. In front is a second frame holding a large 4 ½ inch double convex lens. Both frames are decorated with Sheraton type ebony and satinwood boundary inlay with star type motifs leading the eye to the centre of the lens. The lens is in superb condition while the mirror has some mild foxing and loss to the silvering not affecting its use

Vue d'optique, perspective view, or optical print is an etching specifically developed to provide the illusion of depth when viewed through a zograscope. They usually consist of scenes chosen for their strong linear perspective, for example, diagonal lines converging to a horizon. They have bright hand-coloring. The subject matter is that generally appealing to armchair travelers: shipping, cities, palaces, gardens, and architecture. Some have reversed type in some or all of the text, for viewing through a mirrored apparatus. There are four optical prints with this zograscope.

Vue du Port de Marceille prise de l'Hôtel de Ville dessiné du temps de la peste en 1720. Optical print showing a waterfront scene in Marseilles, France in 1720 showing plague victims on the docks in the foreground. 18.7 x 11.2 inches. Anonymus, c1770.

Joseph recita ses Songes a ses Freres. Optical print in which Joseph tells about his dreams to his brothers. A reversed legend at the top. Georg Balthasar Probst (1732 - 1801), artist, engraver, publisher, in Augsburg, Published by Jean François Daumont, publisher, printer, 1740-1775 fl, Paris. 17.5 x 13 inches. c1770.

Vue perspective d'un combat Naval. Optical print showing people watching a naval combat from the shore. A reversed legend at the top. André Basset, Engraver and publisher, 1749-1787 fl, Paris. 18.5 x 12.4 inches. c1770.

L'Hotel du Lord Maire de Londrea. Optical print of the Lord Mayor's Mansion House in London. Jean François Daumont, publisher, printer, 1740-1775 fl, Paris. 20.9 x 13.6 inches. c1770.

Vue d'un Temple Chinois. Optical print of the inside of a temple in China. Anonymous artist, 19.7 x 13.1 inches. c1750.

Ruines de Palmyre, in Syrie. Optical print of the ruins of Palmyra in Syria. Anonymous artist. In Paris chez HOCQUART, Rue St Jacques No. 6[4], printer 1834-40. 20.5 x 12.2 inches, c1770.

Optical Prints

Praxinoscope, c1890

A praxinoscope is a pre-cinema optical animation toy. It was invented in France in 1877 by Charles-Émile Reynaud (1844-1918). It was a successor and improvement on the Zoetrope. It consists of a strip of pictures placed around the inner surface of a cylinder and an inner circle of mirrors. As the cylinder rotates, the rapid succession of images on the strip reflected onto the mirrors gives the illusion of a single image in motion.

This is a praxinoscope with seven strips of images and the original box. It stands 8 inches high on a wooden stand and the metal cylinder is 9 inches in diameter. A plaque on the base reads "A Pichlers Wve & Sohn, Buchhandlung und Lehrmittel Anstalt, Wien, V, Margaretenplatz 2." A. Pichlers Witwe & Sohn (A. Pichler's Widow & Son) was an Austrian publisher and printer based at 2 Margaretenplatz, Vienna. It was founded in 1793 by Anton Andreas Pichler (1770 –1823) who, in 1807, married Elisabeth Praller (1783 –1865). It first published classic literature and later educational literature, teaching aids, and children's games. The praxinoscope is in good working condition.

Praxinoscope
Zoetrope

A zoetrope is one of several pre-film animation devices that produce the illusion of motion by displaying a sequence of drawings or photographs showing progressive phases of that motion. The device was created with the name Doedaleum in 1833 by English mathematician William George Horner (1786-1837). Various versions were introduced in subsequent years, with the most popular version being invented by William Ensign Lincoln in 1865. The zoetrope consists of a cylinder with narrow slits vertically in the sides. On the inner surface of the cylinder is a band with a set of sequenced pictures. The user looks through the slits at the pictures on the opposite side and rotates the cylinder. As the drum spins, the slits provide broken views of the drawings or photographs, creating a strobe effect and the illusion of a moving image.

This is a zoetrope designed by Fred DaMert and Bill Hanlon and made by the DaMert Company, San Leandro, California in 1992. It is made of plastic and is 3 ½ inches high and 4 inches in diameter. It has 12 animation strips of Disney characters including Donald Duck, Mickey Mouse, and others. There are 12 blank strips for creating your own. There is a booklet "MovieMotion Zoetrope" by Ruth Hayes. The booklet explains how a zoetrope interacting with our visual system produces the illusion of motion. The zoetrope has its original box that has ©Disney and the Disney Store logo on it.

Ruth Hayes is professor emeritus in animation at The Evergreen State College in Olympia, Washington. She taught animation theory and developed strategies of incorporating animation into the teaching of a variety of disciplines including the fine arts, sciences, history, literature, and media studies. Her research involved animated experiments in film, video and digital media as well as flipbooks, the zoetrope, the praxinoscope, and other pre-cinema formats. Ruth earned her BA in Visual and Environmental Studies at Harvard/Radcliffe College in 1978 and a MFA in Experimental Animation at California Institute of the Arts in 1992.

Zoetrope

Non-Optical Scientific Instruments

With the exception of a few instruments like the astrolabe, instruments capable of making accurate scientific observations did not appear until the late thirteenth century. In the Renaissance, tools became more complex and accurate and led to a scientific revolution in mathematics, physics, astronomy, biology, medicine, and chemistry. The nineteenth and twentieth centuries saw a seemingly exponential increase in technological and scientific advancement. The nineteenth century saw the practical development of steam power, electricity and the invention of machines such as the locomotive, sewing machine, typewriter, internal combustion engine, and electric motor. The twentieth century saw advances in communication, transportation, and medical technologies with the development of the telephone, radio, television, computer, automobile, airplane, rocketry, nuclear power, and recombinant DNA. This section contains examples illustrating the advancement of science and technology in some of these fields. The instruments in this section do not utilize optical devices, although many reley on observations made by the eye. Some later had optics such as telescopes and magnifiers added to them.

- Verge and Fusee Single-Handed Pocket Watch, French, c1670
- English Silver Pair Case Verge and Fusee Pocket Watch, c1690
- Verge Fusee Gold Pocket Watch, French, 1759-1760
- "Memento Mori" Pocket Watch, English, 1781
- Open Face, Hour and Quarter Hour Repeater Pocket Watch, French, c1850
- Tiffany Patek Philippe Pocket Watch, c1884.
- Ladies Pocket Watch, Tiffany & Co., Edouard Koehn and Patek Philippe, 1886
- Railroad Standard Watch, Waltham Clock Company, 1915
- GUCCI Moon Phase, Pointer-Triple-Calendar Complication Wrist Watch
- Apple First Generation (Series 0) Sport Watch, 2015
- Spherical Polar Sundial, French, second half 18th century
- Universal Equinoctial Sundial, French, c1760
- Diptych Dial, Chinese
- Universal Equinoctial Sundial for South America, c1870
- Sundial, Japan, 19th Century
- Equinoctial Sundial, Chinese, 19th century
- Universal Equinoctial Sundial, French, c1840
- Lodestone, Early Eighteenth Century
- American Pewter Window Sundial, c1762
- Noonday Canon Sundial, French, c1820
- Gothic Style Verge and Foliot Mechanical Clock
- Hourglass
- Elgin Chronometer, c1918
- Ansonia Figural Clock "The Artist," 1904

Navigation

- American Backstaff, Clark Elliott, New London, 1761
- Octant, Eighteenth Century, American Provenance

Weights and Measurements

- Roman Balance Scales
- Jewelers Scale, Martinus de Backer, Amsterdam, c1690
- Clarke's Hydrometer, c1770
- Réaumur Thermometer
- DeGrave, Short & Co Diamond Balance, c1860
- Chinese Opium Scale (Dotchin)
- Fairbanks Postal Scale, 1859
- Georgian Stick Barometer by Thomas Wright
- Wheel Barometer, c1840
- Sikes Hydrometer, c1880
- Lionel CD V-700 6B Geiger Counter, 1962

Calculation

- Chinese Suanpan Abacus
- Napier's Bones
- Proportional Dividers by Cary
- Protractor by Edmund Culpeper, c1700
- Protractor by Michael Butterfield, c1700
- Protractor by Nicolas Bion, c1700
- Sector by Nicolas Bion, c1700
- Georgian Mathematical Drawing Instrument Set by R. B. Bate
- English Ivory Sector, c1780
- Gunter's Rule (Scale) Signed Merrifield & Co.
- English Six Inch Boxwood Rule

- Abacus-form Financial Calculator, English, 1856
- Underwood Adding Machine, Hartford, CT, 1960
- Texas Instruments SR-10 Handheld Pocket Calculator, 1973
- Apple Macintosh 512K Model M0001W Computer, 1985
- iPad, First Generation, 2010

Sewing and Textiles
- Flax Wheel, 1854
- Great Wheel, Walking Wheel, or Wool Wheel
- Yarn Winder
- Needlework Sampler, 1817, Old Lyme, CT
- Milliner"s Paper Mache Doll, c1840
- Rag Dolls
  - Black Rag Doll
  - Christening Doll

Surveying
- Gunnery Level, 1588
- Graphometer, Henry Macquart, c1680
- Compass by George Adams, Sr., c1745
- Waywiser, English, Eighteenth Century
- Alidade, Italian, 1789
- Miners Dial, English, 3rd quarter 19th century
- Compass, Denison Olmsted, Yale, 1858
- Chinese Geomancer Compass
- American Surveying Waywiser
- Gunter's Surveying Chain
- Plumb Bob Level, c1800

Geography
- Newton's Terrestrial Globe, English, 1823
- Miniature Terrestrial Globe, c1830
- Dissected Map (Puzzle), England and Wales, c1810
- Comparative Chart of Waterfalls, Islands, Lakes, Rivers and Mountains, 1850
- Satellite Orbiter Globe, 1967

Communication and Writing
- Illuminated Manuscript Book of Hours Leaf in Latin, Paris, c1420
- Telegraph Key and Sounder, c1920
- Edison Cylinder Phonograph, c1907
- Blickensderfer No. 5 Typewriter, 1893
- Western Electric Candlestick Telephone, 1918
- Atwater Kent Model 40 Radio, 1928
- Hallicrafters Television Set Model T-54, 1948
- Crosley AM Tube Radio, 1949
- RCA 45 RPM Record Player, 1950
- Royal Typewriter, Hartford, CT, 1957
- RCA Videocassette Recorder, 1978
- Motorola DynaTAC 8000 Series Handheld Brick Cellular Phone, 1986
- Sony Walkman, 1988
- PalmPilot 5000 Personal Digital Assistant, 1996
- BlackBerry Wireless Handheld 7510, 2004
- Apple iPhone, First Generation, 2007
- Apple iPhone 3GS, 2009

- Electricity
  - Nairne-Type Electrostatic Generator, c1790
  - Davis & Kidder's Patent Magneto-Electric Machine
  - Edison Mazda Incandescent Light Bulb, c1919
  - Edison Incandescent Light Bulb, 1929
  - Bradley & Hubbard Slag Glass Lamp, 1908
- Machines
  - Axes (Simple Machine)
    - Medieval Iron Bearded Axe Head, 1000-1300 AD
    - Cooper's Broad Axe Head, c1700
    - Broad Axe Head, Isaiah Blood, c1860
    - Ten-Inch Broad Axe Head
    - Collins & Co. "Legitimus" Carpenter's Hatchet Head, c1880
    - Hatchet, Estwing Manufacturing Company, 2014
  - Hand Crank Centrifuge, c1910
  - Steam Engine Cutaway Model, c1920
  - Electric Motor, General Electric Fan, 1923
    - Singer Model 12 Sewing Machine, 1885
  - Gasoline Engine, Maytag Hit-and-Miss Model 92, 1930
- Weaponry (not all illustrated here, see separate "Weaponry" file)
  - Axe
    - Apache Stone Tomahawk
    - British Native American Trade Axe Head, c1700-1750
    - Bearded Axe, c16th Century
  - Spear
    - Native American Spear Point
    - Pike Head, Revolutionary War Period
    - Pike Head, French and Indian War, Fort Carillon (Ticonderoga)
  - Atlatl
    - Atlatl Bannerstone
    - Dalton Atlatl Point
  - Bow and Arrow
    - Algonquin Longbow
    - Wampanoag Flatbow
    - Chippewa Arrow
    - Pequot Arrowheads
  - Crossbow with Scrimshaw, American, 1794
    - Crossbow Bolt Head, German, c1550
  - History of Firearms, 1300-1900
    - Hand Cannon (Handgonne), Ming Dynasty, China, 1368-1398
    - Matchlock Musket/Arquebus, Germany, c1590
      - Powder Flask
      - Powder Charger
      - Plug Bayonet
      - Musket Rest
      - Engraving of a Musketeer, Jacob de Gheyn, 1608
    - Wheellock Rifle, German, c1650
    - Snaphaunce Flintlock Mechanism
    - Ripoll Miquelet Lock Belt Pistol, c1720
    - Dutch Flintlock Pistol, Cornelius Coster, c1660
    - Queen Anne Flintlock Pistol, Richard Wilson, c1740

- Socket Bayonet, c1740, French and Indian War
- French Model 1763 Cavalry Flintlock Pistol, Documented Revolutionary War
- Revolutionary War Documents
  - Continental Paper Currency, $3 Note, 1775
  - Map, Siege of Boston, 1775-6
  - Connecticut Colonial Note, 1776
  - Receipt for Gun Locks, 1777
  - Connecticut Revolutionary War Bond, 1780
- French Model 1777 Flintlock Pistol, Revolutionary War
- Flintlock Pistol, Louisiana Militia Infantry, c1777-1800
- Eagle Head Sword, War of 1812, 1810-1820
- Bowie Knife, John Weiss
- Bowie Knife, Manson, Sheffield
  - Tintype of Civil War Confederate soldier holding a Bowie knife
- British Brown Bess Musket, Napoleonic Wars
- Springfield Model 1816 Musket, New Haven, 1827, Mexican-American War
  - Tintype of Civil War soldier holding a Model 1816 musket
- Powder Horn, 5th Massachusetts Militia Regiment
- U. S. Model 1836 Flintlock Pistol, Johnson, Middletown, Mexican-American War
- Kentucky Rifle
- Colt Model 1849 Pocket Revolver
- Smith & Wesson Model 1, Second Issue Revolver
- Colt Model 1860 Army Revolver, 1861, Civil War
  - Tintype of Civil War soldier holding a Colt Model 1860 Army Revolver
- Model 1861 Springfield Percussion Lock Rifle Musket, 1862, Civil War
  - Tintype of a well-equipped Union soldier holding a Springfield Model 1861 rifle with bayonet
- Powder Flask, 1848
- Gettysburg Battlefield Artifacts
  - Austrian Model 1851 Cavalry Carbine
  - Bullets
  - Artillery Shell Fragment
  - Map of Gettysburg
  - Union Army Uniform Coat Buttons
  - Tintype of the officers of Battery A, 2nd U. S. Artillery
- Civil War Pain Bullet
- Civil War Currency
  - Fractional Currency
  - Civil War Tokens
    - Indian Head Crossed Cannon Patriotic Token
    - Bridgeport CT Wallace's Civil War Store Card Token
  - Confederate Note
  - Confederate States of America Bond, 1864.
- Zentmayer U. S. Army Hospital Binocular Microscope, c1880
- “Indian” Trade Gun, 1868
  - Native American Powder Horn
- Model 1852 Naval Officers Sword
- Colt Model 1873 Single Action Army Revolver, 1876
- Winchester Model 1873 Repeating Rifle, 1881
- The Types of Ammunition Used in Firearms
  - Musket Ball

- Paper Cartridge
- Minié Ball
- Metallic Cartridge

Medicine

- Greco-Roman Surgical Instruments, 1stst-2nd century AD
- Islamic Cupping Glass, Greater Persia, c9th-12th Century AD
- Anatomical Wood Block Print by Andreas Vesalius, 1543
- Herbal Wood Block Print by Leonhart Fuchs, 1543
- Hippocrates, *Opera Omnia,* 1596
- Galen, *Several Works*, 1549
- Personal Dental Tool Outfit, Seventeenth Century
- Oil painting depicting an operation on a foot, after David Teniers, 17th century
- Syringe, Eighteenth Century
- Anatomical Model of a Pregnant Woman, c1680
- Grangeret Amputation Saw, 1770
- Trepanning Surgical Set, John Evans, London
- Dental Extractor Tooth Key, mid-nineteenth century.
- Fleam Bloodletting Device, Hargreaves & Co Sheffield, first half nineteenth century
- American Spring Fleam, c1875
- Blood Letting Lancet Set
- Leech Jar
- Leech Bowl
- Victorian Medicine Sample Case
- Ear Trumpet
- Phrenology Bust
- X-Ray of Human Skull (Victim of Black Death)
- Human Skeleton
- Medicine chest, English, 17th/18th century

Archaeoastronomy

Astronomy is probably the oldest science. The sky was very prominent and no doubt awe inspiring to early man who could see the sun, moon, planets, and stars and would have noticed their movements. Early astronomers mapped the stars and made tables to predict the future positions of celestial objects. Stone structures were built precisely aligned to the seasonal risings and settings of the sun, moon, planets, and some bright stars. This knowledge was important, for the sky served as a clock, a calendar, and a navigational aid. When people began to depend on agriculture, they needed to know the exact course of the seasons to help them decide when to plant and harvest. It was used by priests to set the time for religious observances and by astrologers to cast horoscopes.

Archaeoastronomy is the study of how ancient people understood the phenomena in the sky and how these were related to their cultures and religions. Early cultures identified celestial objects with gods and spirits and related them to natural phenomena such as rain, drought, tides, and seasons. The first true “astronomers” were probably priests and shamans. They were generally regarded as having positive contact with the deities of the religion. From their observation of the skies, they often interpreted the meaning of events and performed the rituals of their religion. Thus, astronomy had a long association with what is now called astrology. Ancient structures with possible astronomical alignments such as Stonehenge probably fulfilled both astronomical and religious functions. Many prehistoric and ancient objects bear symbols that appear to be based on astronomical observations. Archaeoastronomy attempts to decipher the meaning of these symbols.

Sun Disc, Tassili n'Ajjer, Algeria, 3,000-2,000 BC

In the Neolithic age, man began recording his perceptions of celestial phenomena through paintings and petroglyphs (incised images in rock). Among the most common petroglyphs are those typically interpreted as images of the sun. Most images consist of a central circle from which rays emanate outwards. Early agrarian societies made stone and clay discs symbolizing the sun. Sun discs are found in almost all near East civilizations, in ancient Egypt, and Europe. In all cases, the sun disc apparently served a religious or ritual purpose. One of the commonest motifs found in many ancient cultures is the eight-pointed star, which had different meanings in different cultures. It is probably of Sumerian origin, a symbol of the Goddess Inanna. One explanation for the eight rays is that they symbolize north, south, east, west, the two solstices, and the two equinoxes. The eight-pointed star was later imported into Babylonian, Christian, and Muslim symbolism.

This eight-pointed sun disc was found at Oued (Wadi) Djerat, Tassili n'Ajjer, Algeria. Tassili n'Ajjer is a mountain range in the Algerian section of the Sahara Desert. It contains one of the most famous North African sites of prehistoric rock painting spanning a period of 10,000 years. Its imagery documents a verdant Sahara teeming with life that stands in stark contrast to the arid desert the region has since become. The art depicts herds of cattle, large wild animals including the elephant, giraffe, rhinoceros, hippopotamus, and crocodile, and human activities such as hunting and dancing. It is now a National Park and UNESCO World Heritage Site (1982).

The disc is made of dark green chert and is roughly circular measuring 4 ¾ inches (12.3 cm) x 4 ¼ inches (11 cm). It is 9 mm thick and the center and 5 mm thick at the edges. Eight incised pointed rays extend from the central drilled and polished hole to the edge. The surface has been polished and there is evidence of fine pressure flaking at the edges. It is likely that the disc was mounted on a pole for ritual purposes. The disc is in good condition with some surface encrustation. It is from the Neolithic period and estimated to date from 3,000 to 2,000 BC. Ex Thomas R. Barnett Collection.

Sun Disc

Bronze Razor with Water Bird, Solar Bark, and Sun Disc Symbols, Urnfield Culture, Germany, c1300-750 BC

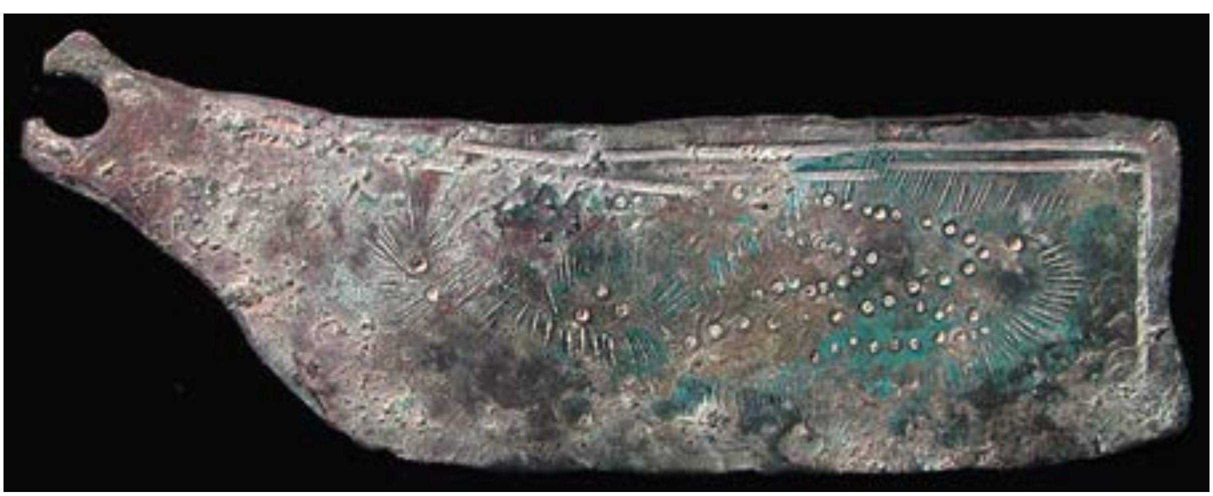
This is a rare and important bronze razor rich in symbolism. It is from the Urnfield Culture (c1300-750 BC), a late Bronze Age culture of central Europe. The name comes from the custom of cremating the dead and placing their ashes in urns that were then buried in fields. The razor displays a water bird and a solar bark (also solar boat, solar barque, solar barge, sun boat) with a sun disc. Although the precise significance of these features is obscure, they are considered to represent celestial powers. The solar bark with sun disc represents the sun's continual journey over the heavens at daytime and through the underworld during the night. The water bird may have been perceived as a suitable celestial emblem because it was able both to fly and to swim, thus bringing together the elements of sky and water, both of which belonged to the celestial powers. It was thus a mediator between earthly and celestial spheres. These symbols existed in the Neolithic period and may have originated in the Upper Paleolithic. The combined iconography of the sun and the water bird was prominent in the Urnfield culture and continued into the Hallstatt and Le Tène periods. The water bird-sun bark motif might represent an organized religion of the late Bronze Age in most parts of Prehistoric Europe. The solar bark persisted in the later myths of ancient Egypt with the sun god Ra.

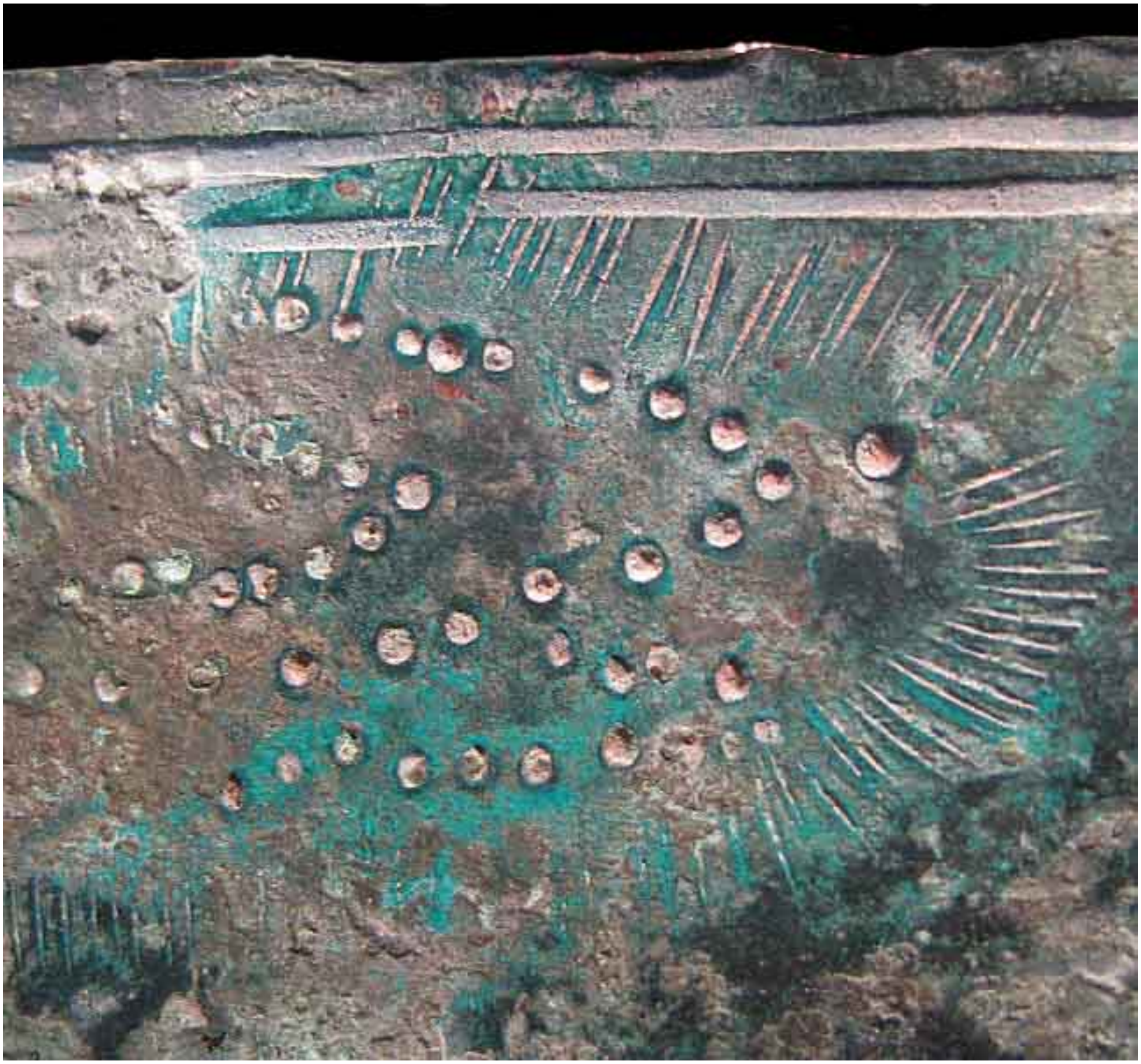
The razor is 8.0 cm long. The top of the blade, incised with parallel lines, forms the body of the water bird and continues on to the handle comprising the neck and head of the bird. The S-shaped form of the water bird probably represents a swan or similar bird. The bark holding the sun disc is crescent shaped with the ends curling up and over. The bark itself somewhat resembles a swimming bird. The sun disc is a circle with an indentation in the center and surrounded by punches representing the rays of the sun. The bark and disc represent the sun being carried across the sky. There are no designs on the other side of the blade. The razor is in uncleaned condition with patina and oxidation. Found: South Central Germany. Ex Dr. Friedrich Moog Collection.

Bronze Razor with Water Bird and Sun Bark

Bronze Razor with Possible Astronomical Markings, Urnfield Culture, Germany, c1200 BC

This is a Bronze Age razor with markings. It is made of bronze and is 10.2 cm long and 3 cm wide. One end narrows and has a notch for fastening to a handle. The piece is uncleaned and has a blue-green patina. One side of the razor is marked with symbols while the back is plain. The markings include a pair of parallel, incised lines along the top edge and a single line at the far end. Below the pair of lines are a series of dots the whole surrounded by a band closely spaced lines. Most of the dots are arranged in three Vs with their apices pointing toward the end of the razor. Toward the near end, there are two dots outside the band of lines. Lines forming rays extend from these two dots. The meaning of these markings is unknown, however, some artifacts of prehistoric societies appear to depict movements of celestial objects such as the sun, moon and stars. Sommerfeld (1994) has interpreted them as numerals associated with a lunar calendar. Found: South Central Germany. Ex Dr. Friedrich Moog Collection.





Bronze Razor with Markings, Urnfield Culture, Germany

Double Spiral Spectacle Ornament, Sun, Halstatt Culture, Europe, 800-650 BC

The double spiral originated in the Bronze Age as a symbol of the sun religion. It is sometime called a spectacle ornament because of its resemblance to a pince-nez. The most likely explanation of the symbol is that the spirals represent the path of the sun throughout the year. The counter-clockwise spiral represents the resurrection of the sun from the winter solstice to the summer solstice. The clockwise spiral represents the shrinking daylight after the summer solstice. The double spiral can also represent the equinoxes, when day and night are of equal length. A related interpretation is that the two spirals represent opposing cycles, e.g., birth and death, creation and destruction, male and female, light and dark. The two opposing spirals emerging from a single line signify that although the two activities have completely contradicting cycles, there is always a balance between them.

Double spirals are found on brooches, fibulae, pendants, and rings. This is an exceptionally large double spiral measuring 76 x 105 mm. It consists of a single brass wire forming two spirals with an intermediate loop. Because of its size, it was possibly worn as a large pendant below the neck. However, one end of the wire extends out 20 mm perpendicular to the spirals and tapers down to a point. Thus, this could have been a ceremonial object that was affixed by the spike to a building or staff. It was probably made by a Celtic Tribe of the Halstatt Culture, 800-650 BC. The object is in generally good condition but has verdigris. Parts of the wire are bent out of place.

Double Spiral Spectacle Ornament

Roman Terracotta Oil Lamp with Signs of the Zodiac, c200 AD

The word *zodiac* is derived from the Greek word *zodiakos*, which means "a circle of animals" or "little animals." In both historical astronomy and astrology, the zodiac is a circle of twelve 30° divisions of celestial longitude, or houses of the zodiac, that are centered upon the ecliptic; the apparent path of the sun across the celestial sphere over the course of the year. The belt of the zodiac extends about 8° north and south of the ecliptic, as measured in celestial latitude, and includes the paths of the sun, moon, and visible planets. Imaginary creatures were traced in the star groups bounded by these rectangles; and because most of them were animal or part animal in form, these constellations were given names that became the signs of the zodiac (Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricorn, Aquarius, and Pisces). In use, the zodiac is a celestial (or ecliptic) coordinate system, which takes the ecliptic as the origin of latitude, and the position of the sun at vernal equinox as the origin of longitude. The stars forming the signs of the zodiac can be used as a set of observational reference points for the positions of the sun, moon, and planets.

The zodiac was in use by the Roman era, based on concepts inherited by Hellenistic astronomy from Babylonian astronomy of the Chaldean period (mid-1st millennium BC), which, in turn, was derived from an earlier system of lists of stars along the ecliptic. The construction of the zodiac is described in Ptolemy's 2nd century AD work, the *Almagest*. Under the Greeks and Ptolemy, in particular, the planets, houses, and signs of the zodiac were rationalized and their function set down in a way that has changed little to the present day.

This is a Roman terracotta lamp dating to c200 AD and containing an early representation of the zodiac. On the top, the signs of the zodiac surround a central fertility goddess. A maker's mark, "M L C," is on the base. The lamp is 10.3 cm long and 7.3 cm wide. It is in excellent condition with blackening around the spout. Ex Glenn Woods collection, Dallas, Texas.

Roman Terracotta Oil Lamp with Signs of the Zodiac

Astronomical and Astrological Symbols in Antiquity

Many small objects of adornment and coins from antiquity contain designs that are astronomical and astrological symbols. There was little or no difference between the two because celestial objects and events were considered to have great influence over the lives of men. The interpretation of the meaning of the symbols from two or three thousand years ago is often difficult. Some studies exist (Faintich, 2008), but there are differences in interpretation. Most symbols originated much earlier in prehistory and their meanings changed with time or in different cultures. In some cases, the astronomical symbols can be traced to actual events such as a comet, eclipse, or a tight clustering of planets. Celestial symbols were often used as propaganda to demonstrate a divine right to authority. Sovereigns were often quick to capitalize on what the populace had seen in the sky. Other than the writings of Greek and Roman philosophers, objects such as these are the only physical records of perceptions of the universe in ancient times. Some of the interpretations given here are speculative, as are most other interpretations of abstract and symbolic designs. However, the present interpretations take into consideration the great attention and significance, much more so than today, paid by ancient populaces to celestial objects and their movements. There are 52 objects in the collection (see separate file for complete collection.) Sixteen objects are shown here. Detailed descriptions of the objects and their symbols follow the pictures.

Egyptian Scarab, Seven Hieroglyphic Sun Discs, 1650-1550 BC

Amlash, Gold Pendant with "Seven Planets," 1100-800 BC

Ionia, Miletus, AR Diobol, Equinoctial Cross, c500 BC

Attica, Athens, AR Tetradrachm, Moon of 480 BC, After 449 BC

Thrace, Istros Cast, Æ 10, Sun Cross (Solar Wheel), c400 BC

Greece, Gold Earring, Crescent Moon, c400 BC

Thrace, Cherronesos, AR Hemidrachm, Pentagram of Venus, c400-350 BC

Pontos, Mithridates VI, Æ12, Comet, 120-100 BC

Central Europe, Vindelici. AR Stater, Triskele and Sun Symbols, c60 BC

Roman Empire, Clodius, AR Denarius, Crescent Moon and 5 Planet Conjunction, 42 BC

Roman Empire, Augustus, AR Denarius, Caesar's Comet of 44 BC, c18 BC

Roman Provincial, Æ 18, "Star of Bethlehem," 56/57 AD

Roman Empire, Hadrian, AR Denarius, Crescent Moon and the Pleiades, 125-128 AD

Roman Empire, Hadrian, AR Denarius, Solar Eclipse, 134-138 AD

Roman Provincial, Emesa, Antonius Pius, Æ24, Stone of Emesa (Meteorite), 138-161 AD

Roman Empire, Julian II, Double Maiorina, Venus and Mars, 361 AD

Egyptian Scarab, Hyksos Period, Hieroglyphic Sun Discs, 1650-1550 BC

Astronomical and astrological symbols of the Sun are probably the most frequently encountered symbols. Virtually every culture, beginning in prehistory, had a god or deity represented by the sun. This is an Egyptian Hyksos scarab with hieroglyphic motifs, 1650-1550 BC. The scarab was an important religious symbol to the ancient Egyptians. It was modeled after the common Egyptian dung beetle, *Scarabaeus sacer*. The behavior of the beetle symbolized rebirth or resurrection to the ancient Egyptians. After laying an egg in a ball of dung, the scarab beetle rolls the ball before it and places it in an underground chamber. When the young beetle hatches it appears, apparently spontaneously, from the earth. Thus, to the Egyptians the scarab beetle was a symbol of rebirth and represented the god Khepri, who was thought to push the sun disc through the morning sky, just as a scarab beetle pushes its ball of dung along. The base of this scarab is inscribed with seven circumpuncts (circle with a dot in the center), the Egyptian hieroglyph for the sun (Gardiner sign N5). It is also one of the hieroglyphs that refers to the sun god Ra. This symbol for the sun remained in use in many cultures to the present time. The presence of seven symbols may be significant as there were seven known "planets," the celestial bodies that appear to move through the sky. The planets were the sun, moon, Saturn, Jupiter, Mars, Venus, and Mercury.

Pale green-cream steatite Egyptian scarab, Hyksos (Second Intermediate) period 1650-1550 BC. Base inscribed with seven hieroglyphs for the sun, longitudinal piercing for suspension. Size: 20 mm long, 3.4 gm. Condition: Very fine, complete and intact.

Gold Pendant with "Seven Planets," Western Asia, 1100-800 BC

This is a pendant fashioned of hammered sheet gold with repoussed details. Six triangular rays extend from a central raised boss. Six smaller nodes are situated between the rays. Small raised dots are located around the periphery. A suspension loop is formed from a rolled appendage at the top of the disc. It is from western Asia, possibly the Amlash culture, and dates from the eleventh to the eighth century BC. The seven raised elements in the pendant form a common motif in antiquity. They represent the seven non-fixed objects, the classical planets, visible in the sky: the sun, moon, Mercury, Venus, Mars, Jupiter, and Saturn. The word *planet* comes from the Greek word *planētēs*, meaning "wanderer," because ancient astronomers observed how certain lights moved across the sky relative to the fixed stars. They called these objects *asteres planetai*, which means wandering stars. In the pendant, the central boss and rays represents the sun and the six nodes the moon and the five known planets. The small dots around the periphery may represent stars. Ex Phoenicia Holyland Antiquities, 2016; Arte Primitivo Auction, December 5, 2013, lot #503; Taisei Gallery Collection, New York City, November 1992, lot #89.

Gold pendant with suspension loop, 1100-800 BC. Central boss surrounded by six nodes. Western Asia, possibly Amlash culture. Size: 25 mm, 0.6 gm. Condition: Extremely fine with some dents in the nodes.

Ionia, Miletus, AR Diobol, Equinoctial Cross, c500 BC

This tiny coin is one of the first true coins minted. The obverse has the head of a roaring lion, believed to be a symbol of the sun. The reverse has a cross with a pellet in the center and three leaves or buds in each quadrant of the cross. This design is usually interpreted as a star or floral star pattern. However, another interpretation is that this symbol is an equinoctial cross. The plane of the ecliptic, earth's orbit around the sun, intersects the celestial equator, the plane of the equator projected outward, at two points, the vernal and autumnal equinoxes. The cross represents one of these intersections that can be identified as the vernal equinox by virtue of the leaves between the arms of the cross. Thus, it is likely this coin represents spring and the time for planting of crops. Still another interpretation of the reverse design is that it is a sun image and represents Apollo, patron of Miletus and the nearby sanctuary of Didyma.

Ionia, Miletos, AR Diobol, ca. 500 BC. Obverse: Head of a lion roaring left. Reverse: Stellate pattern within incuse square. Size: 9 mm, 1.18 gm. Reference: SNG Kayhan 479. Condition: Very fine.

Attica, Athens, AR Tetradrachm, Moon of 480 BC, After 449 BC

Athens first minted the signature coin of ancient Greece, the thick and heavy silver Athenian "owl" tetradrachm, around 512 BC. They were produced for over four hundred years, and while the artistic style changed over time, the theme remained consistent, showing Athena, the goddess of wisdom and warfare, on the obverse and an owl, her patron animal, on the reverse. Athenian owls were the first widely used international coin. A few changes were made around 480 BC including the addition of a crescent moon on the reverse. Some regard the crescent moon as merely referring to owls' nocturnal activities. Others believe it refers to the Battle of Marathon, although this battle took place during a full moon. It more likely refers to Athens' famous nighttime naval victory over the Persian fleet at Salamis, which took place in September, 480 BC shortly before the addition of this feature to the coin.

Attica, Athens, AR Tetradrachm, after 449 BC. Obverse: Helmeted head of Athena right, in crested Attic helmet decorated with three olive leaves over visor and a spiral palmette on the bowl. Reverse: Owl standing right, head facing; olive sprig and crescent behind; legend ΑΘΕ ("ATHE"). Size: 23 mm, 16.6 gm. References: SNG Cop. 31, Sear 2526. Condition: Very fine.

Thrace, Istros Cast, Æ 10, Sun Cross, c400 BC

A sun cross (also solar wheel) is a symbol consisting of an equilateral cross inside a circle. The design is frequently found in the symbolism of prehistoric cultures, particularly during the Neolithic to Bronze Age periods of European prehistory. The symbol's ubiquity and apparent importance in prehistoric religion have given rise to its interpretation as a solar symbol. In the Bronze Age, the cross-in-a-circle was interpreted as a solar symbol derived from the interpretation of the disc of the Sun as the wheel of the chariot of the Sun god. The four quadrants are often considered to represent the four seasons or the four elements earth, water, air, and fire. The cross can also represent the cardinal points of north, east, south, and west. This cast coin with a sun cross is from Istros, a Greek colony near the mouths of the Danube on the Western coast of the Black Sea.

Thrace, Istros Cast, Æ 10, c400 BC. Obverse: Cross within a wheel. Reverse: ΙΣΤ. Size: 10 mm, 1.1 gm. Reference SNG BMC 221. Condition: Very Fine.

Greece, Gold Earring, Crescent Moon, c400 BC

The crescent is a symbol representing the moon. In Mesopotamian mythology it represented Nanna/Sin, a moon deity, and is seen on Akkadian cylinder seals as early as 2300 BC. The Egyptian logograph representing the moon (Gardiner N11) had a crescent shape. In the iconography of the Hellenistic period, the crescent became the symbol of Artemis-Diana, the virgin hunter goddess associated with the moon. Throughout antiquity, the crescent is seen on items of adornment and coins. This example is a gold earring, Greek, c400 BC.

Greek hollow gold earring, c400 BC. Crescent moon shape. Size: 14mm, 0.7gm. Condition: Excellent.

Thrace, Cherronesos, AR Hemidrachm, Pentagram of Venus, 400-350 BC

A pentagram is the shape of a five-pointed star drawn with five straight strokes. It is an ancient symbol found beginning in Neolithic times and appearing in many ancient cultures with different meanings. The presence of a pentagram next to a pellet representing a planet suggests that this is a pentagram of Venus. Venus orbits the sun thirteen times for every eight orbits by earth. As a result, Venus traces a pentagram across the ecliptic sky every eight years. The pathway of Venus would have been observed by Babylonian astronomers who recognized that astronomical phenomena are periodic and applied mathematics to their predictions.

Thrace, Cherronesos. AR Hemidrachm, ca. 400-350 BC. Obverse: Forepart of lion right, head reverted. Reverse: Quadripartite incuse square with alternating raised and sunken quadrants; one sunken quadrant with pellet and pentagram, the other with VE monogram. Size: 14 mm, 1.9 gm. Reference: cf. McClean 4072; BMC Thrace pg. 185, No. 43. Condition: Extra fine.

Pontos, Mithridates VI, Æ12, Comet, 120-100 BC

Mithridates VI or Mithradates VI, meaning "gift of [the god] Mithra," (135–63 BC), also known as Mithradates the Great and Eupator Dionysius, was king of Pontus and Armenia Minor in northern Anatolia (Turkey) from about 120 to 63 BC. Under his leadership, Pontus expanded to absorb several of its small neighbors and contested Rome’s hegemony in Asia Minor. This small coin bears a horse on the obverse and a comet on the reverse. The horse also represents a comet with the head being the head of the comet and the flowing mane the tail of the comet. The comet on the reverse is distinguished from a star because one of the “rays,” representing the tail of the comet, is longer, wider, and connects to the head of the comet in the center. The comet could be one that appeared in 134 BC around the time of Mithridates’ birth or one in 119 BC near the beginning of his reign. It should also be noted that Halley’s comet appeared in 87 BC, although this is later than the dates ascribed to the coin.

Pontos, under Mithradates VI, 120 to 63 BC. Æ12, uncertain mint, ca. 120-100 BC. Obverse: Horse head right with mane; below, star of eight points. Reverse: Comet moving left. Size: 11 mm, 1.5 gm. References: SNG BM Black Sea 984, Lindgren III, 154. Condition: Very fine.

Central Europe, Vindelici. AR Stater, Triskele and Sun Symbols, c60 BC

The triple spiral or triskele is a Celtic and ancient pre-Celtic symbol found at Irish Mesolithic and Neolithic sites. There are many interpretations as to its meaning. However, the positioning of the arms conveys a clear impression of movement, revolution, and progression. This has led to suggestions that it symbolizes life-death-rebirth, spirit-mind-body, mother-father-child, past-present-future, power-intellect-love, and creation-preservation-destruction to name but a few. The triskele on this celtic coin is closely associated with the sun. The center is a pellet within an annulet, the symbol for the sun. Each arm has a sun symbol at the end. Thus, this symbol appears to represent the motion of the sun through the sky. The reverse is a pyramid of sun symbols.

Central Europe, Vindelici, AR Stater, c60 BC. Obverse: Triskeles with a circumpunct at the center and pellets at the end of each arm, all within a wreath-like torc with a circumpunct at each open end. Reverse: Pyramid of eight annulets; five, on the bottom, each enclosing a pellet, and three, forming the top two rows, each enclosing a smaller annulet; all within a wavy torc. Size: 17 mm, 5.6 gm. References: Allen & Nash 160. De la Tour 9441. Kellner type IX B. Condition: Very fine.

Roman Republic, Clodius, AR Denarius, Crescent Moon and Five Planet Conjunction, 42 BC

In 42 BC, Clodius, a moneyer of the Roman Republic, issued a gold aureus and a silver denarius with the head of sol on the obverse and a crescent moon beneath five stars on the reverse. On November 28, 46 BC, a grouping of the five known planets occurred with a separation of 9°.38. A grouping of five planets with such a small degree of separation is extremely rare and would have attracted great attention. In the predawn southeastern sky on January 17, 44 BC, a thin crescent moon rose beneath another rare conjunction of all of the five known planets. It is possible that these events are recorded on this coin.

Roman Republic, P Clodius MF Turrinus, AR Denarius. Rome mint, 42 BC. Obverse: Radiate head of Sol right, quiver behind. Reverse: Crescent moon and five stars, P CLODVUS M F below. Bankers mark within the crescent. Size: 19 mm, 3.4 gm. References: Clodia 17, Syd. 1115, C494/21. Condition: About Very Fine.

Roman Empire, Augustus, AR Denarius, Caesar's Comet of 44 BC, c18 BC

Caesar's Comet (numerical designation C/-43 K1), also known as the Great Comet of 44 BC, was perhaps the most famous comet of antiquity. The seven-day visitation was interpreted by the Romans as a sign of the deification of the recently assassinated Julius Caesar (100–44 BC). This and other coins featuring comets and issued during the rule of Augustus, Caesar's great-nephew (and adoptive son), are delivering the message that Augustus now rules the world as the successor to Caesar.

Roman Empire, Augustus, 27 BC-14 AD. AR Denarius, Spanish mint, c18 BC. Obverse: CAESAR AVGVSTVS, head left in oak wreath. Reverse: DIVVS • IVLIVS across field, comet with eight rays and tail. Size: 21mm, 3.4 gm. Reference: RSC 97. Condition: near Very fine.

Roman Provincial, Syria, "Star of Bethlehem," 56/57 AD

According to Christian tradition as related in the nativity story in the Gospel of Matthew, the Star of Bethlehem, also called the Christmas Star, revealed the birth of Jesus to the biblical Magi, astrologers from the east, and later led them to Bethlehem. There have been many theories put forward regarding the identity of the star including a comet, a conjunction of planets, a supernova, or that it is a myth. The only physical evidence for a celestial event around the time of the birth of Christ is a coin minted in Antioch in 11/12 AD. The coin shows a ram with its head turned back and a star above. In later versions of the coin, a crescent moon is located next to the star. This has led Michael Molnar, an astronomer at Rutgers, to propose that the Bethlehem star can be explained by an occultation of Jupiter by the moon that occurred in the constellation of Aries just before dawn at its heliacal rising on April 17, 6 BC. In Greco-Roman astrology, Aries, the Zodiacal constellation of the Ram, rules over Judaea and was associated with the Jews. Jupiter coming together with the moon in an occultation (eclipse) of Jupiter was viewed as a symbol of majesty and sovereignty. Together, these symbols could have been interpreted as the birth of a king in Judaea. The crescent moon adjacent to the star appeared on coins in 55/56 AD. By this time, Antioch had become a seat of early Christianity. The traditional ram and star reverse was used periodically until at least 244 AD. Whether or not the symbols on the coin represent the Star of Bethlehem, they do indicate that a celestial event occurred sometime around the birth of Christ and that it had sufficiently great significance so as to be minted on a coin.

Roman Provincial, Syria, Autonomous Issue Under Nero, Gaius Ummidius Durmius Quadratus as Governor of Syria, Æ 18, Antioch mint, Caesarean Year 105 (56/57 AD), group 1. Obverse: ANTIOXEΩN, Veiled, turreted, draped bust of city goddess (Tyche) right. Reverse: ΕΠΙ ΚΟΥΑΔΡΑΤΟΥ, Ram running right, looking back, crescent and * above, ΕΤΕΡ below. Size: 18 mm, 5.5 gm. References: Butcher 121; SNG Copenhagen 101. Condition: Very fine.

Roman Empire, Hadrian, AR Denarius, Crescent Moon and the Pleiades, 125-128 AD

The reverse of this coin shows a cluster of seven stars above a crescent moon. A crescent and seven stars is most likely a lunar occultation of the Pleiades star cluster. A crescent moon was near the Pleiades on October 29, 125 and again on March 15, 126. The coin most likely depicts one or both of these occultations. In Greek mythology, the Pleiades were seven sisters: Maia, Electra, Alcyone, Taygete, Asterope, Celaeno and Merope. Their parents were Atlas, a Titan who held up the sky, and the oceanid Pleione, the protectress of sailing. Passage of the moon in front of the Pleiades is not rare, but it happens infrequently enough to be noteworthy.

Roman Empire, Hadrian, 117-138 AD. AR Denarius, Rome mint, 125-128 AD. Obverse: HADRIANVS AVGVSTVS, laureate head right. Reverse: COS III, seven stars above crescent moon. Size: 18 mm, 3.10 grams. References: RIC 202; RSC 465; Sear 3485. Condition: Very fine.

Roman Empire, Hadrian, AR Denarius, Solar Eclipse, 134-138 AD

This coin has the bust of Hadrian on the obverse and a seven-rayed star within a crescent on the reverse. Hadrian minted several coins during his reign with the crescent and star motif. This motif appeared in ancient Sumer and was continuously used throughout history until its present status as a symbol of Islam. It is often is attributed to a Venus–crescent moon conjunction. However, in this coin, the presence of the star within the crescent moon, an impossible location for a planet, indicates there is another explanation. It is possible that the coin is showing a solar eclipse and that the star represents the diamond-ring effect. The diamond-ring effect occurs at the beginning and end of totality during a total solar eclipse. As the last bits of sunlight pass through the valleys on the moon's limb, and the faint corona around the sun is just becoming visible, it looks like a ring with glittering diamonds on it. Thus, in the symbol, the crescent represents the sun, and the star the moon. During Hadrian's reign, a solar eclipse took place on September 3, 118 AD. Events such as this would have had great significance to the people and the emperor would have taken advantage of this to remind the people of his power to return events to normalcy.

Roman Empire, Hadrian, 117-138 AD. AR Denarius, Rome mint, 134-138 AD. Obverse: HADRIANVS AVGVSTVS, laureate head right. Reverse: COS III, star within crescent moon. Size: 19 x 11 mm, 2.8 g. References: RIC 355e, RSC 459. Condition: Very fine.

Roman Provincial, Emesa, Antonius Pius, Æ24, Stone of Emesa (Meteorite), 138-161 AD

Meteors and meteorite impacts were significant events to ancient peoples. Most cultures interpreted them as a message or visit from the gods. Meteorites were often used as a source of iron but many became sacred stones. The baetyl, an omphalos, was a sacred stone that was an object of worship in Greece, Phoenicia, and Rome. One of the most famous stones in antiquity was the black stone of Emesa in Syria. Emesa was the major cult center for the deity El-Gabal, who was worshipped there in the form of the baetyl. This coin shows an eagle with its wings spread protectively over the baetyl. The eagle is a universal symbol representing the sun, power, authority, victory, the sky gods, e. g., Zeus, and the royal head of a nation.

Syria, Seleucis and Pieria, Antoninus Pius AD 138-161. Æ24, Emesa. Obv: AVT KAI TI AIΛ ANTΩNEINOC CЄB ЄV, laureate head right. Reverse: ЄMICHNWN; eagle, holding wreath in beak, standing right, head left, on baetyl of El-Gabal; Γ in right field. Size: 24 mm, 10.2 gm. References: SNG Copenhagen 309 (Γ in right field of rev.), SGI 1496, BMC 1-7 (various letters on rev.) Condition: Very fine.

Roman Empire, Julian II, Double Maiorina, Venus and Mars, 361 AD

Two stars are found above a bull on the reverse of several bronze coins of the Roman Emperor Julian II (360-363 AD). One star is between the horns, and the other above the shoulder. In the spring of 360, Julian's troops rose in revolt against Constantius, and proclaimed Julian II as Augustus. On May 4, 360, Venus joined Mars to form a single star between the horns of Taurus, the Bull, as the constellation set in the western sky. Two weeks earlier, Mars was between the horns, and Venus rested on the shoulder of the bull. The coin records this planetary conjunction to commemorate the victory of Julian.

Roman Empire, Julian II, 361-363 AD. Æ Double Maiorina, 361-363 AD. Obverse: DN FL CL IVLI - ANVS PF AVG, Bearded, pearl diademed, draped, cuirassed and draped bust right. Reverse: SECVRITAS REIPVB/TCONST, bull standing right, above two stars, eagle on globe before holding wreath in beak, SCONST• in exergue. Size: 25.9 mm, 8.0 g. Reference: RIC VIII 320 Aries. Condition: Fine to Very fine.

Astronomy

The Babylonians were the first to apply mathematics to the prediction of periodic astronomical phenomena. Astronomy was developed to a highly sophisticated level by the ancient Greeks. Ptolemy of Alexandria (c90-c168 AD) presented a geocentric view of the universe with the earth at the center. The Arabs translated the Greek astronomy texts and greatly advanced knowledge in astronomy and other sciences during the Islamic Golden Age. The Ptolemaic system held until 1543 when Nicolaus Copernicus (1473-1543) published a heliocentric model of the universe that placed the sun, rather than the earth, at the center.

Aide-Memoire of Planetary Days and Hours, Germany, 1574

This is a plaque entitled in German “Table of the Rulers of the Planets for the Unequal Hours of the Day” and dated 1574. It is made of gilt brass and measures 3 7⁄8 x 2 1⁄8 inches (9.8 x 5.4 cm) including the diamond-shaped pendant extension. Both sides are boldly stamped and hand-engraved. The plaque shows the days of the week and the planetary symbol for each hour of the day. One side shows the daytime hours and the other side the nighttime hours. A legend at the bottom gives each of the known planet names with their symbols, thus for the sun, moon, Mars, Mercury, Jupiter, Venus, and Saturn. It is enhanced with a bit of floral engraving. Condition is very fine noting rubbing to the gilding.

The planetary hours are an ancient system in which one of the seven classical planets is given rulership over each day and the hours of the day. Developed in Hellenistic astrology, it has possible roots in older Babylonian astrology, and it is the origin of the seven-day week and the names of the days of the week as used in English and numerous other languages.

The classical planets are Saturn, Jupiter, Mars, the Sun, Venus, Mercury, and the Moon. The word *planet* comes from the Greek word *planētēs*, meaning "wanderer," because ancient astronomers observed how certain lights moved across the sky relative to the fixed stars. They called these objects *asteres planetai*, which means wandering stars. The planets take rulership over the hours in this sequence, known as the "Chaldean order" (listed from furthest to nearest in the planetary spheres model, or from the slowest to the fastest moving as they appear in the night sky). The Chaldeans lived in Chaldea c800 BC and ruled Babylonia 625–539 BC. They were renowned as astronomers and astrologers.

The 24-hour day contains three complete sequences of the seven planets plus three planets from the next sequence. Thus, the first hour of the next day is ruled by the planet three places down in the Chaldean order. For example, a day with its first hour ruled by the Sun (Sunday) is followed by a day with its first hour ruled by the Moon (Monday), followed by Mars (Tuesday), Mercury (Wednesday), Jupiter (Thursday), Venus (Friday) and Saturn (Saturday), again followed by Sunday, yielding the familiar order of the days of the week.

However, the planetary hours are not the same as the sixty-minute hours beginning at midnight that are used currently. The planetary days are divided into twenty-four planetary hours with the first hour of the day beginning at sunrise and the last hour of the day ending at sunrise of the next planetary day. The period that extends from sunrise to sunset (daylight) is divided into twelve hours and the period extending from sunset to sunrise of the next day (nighttime) is also divided into twelve hours giving the twenty-four hours of the planetary day. Thus, the hours vary in length throughout the year, except at the equinoxes.

Calculation of the planetary hours played a certain role in Renaissance astrology and magic. Each planet has specific characteristics so that it can be determined what is the most favorable hour in which to undertake certain actions. Astronomical tables published in the late 15th or during the 16th century often included a table of planetary hours with their significations. Even today, one can download an app to a smart phone with the planetary table.

Planetary Day Hours

Planetary Night Hours

Sanskrit Astrolabe, Northern India, Nineteenth Century

One of the earliest astronomical instruments is the astrolabe. An astrolabe shows the relative positions of the sun and stars on a flat surface. Throughout history, astrolabes have been used by astronomers and navigators to locate and anticipate the position of the celestial bodies such as the sun, moon, planets and stars. It has many uses including determining the time of day or night, location of celestial objects, time of sunrise and sunset, surveying, triangulation, and to cast horoscopes. The astrolabe was invented in ancient Greece around 200-100 BC. Ptolemy is believed to have made many of his observations using an astrolabe. Astrolabes were greatly refined and improved by the Medieval Islamic world.

Astrolabes vary depending on the era and maker, but the basic structure is described here. The mater (Latin for mother) is the main body of the astrolabe. The edge of the mater is called the limb on which the degree scale and scale of hours are engraved. The hollowed-out part of the mater is called the womb and contains the rete (Latin for net). Under the rete are brass plates or tympans or climates that are engraved with altitude and azimuth circles for different latitudes. The plates show the three-dimensional celestial sphere in two dimensions. The whole rotating assembly is fastened together by a pin through the center of the mater, rete, and plates and is secured by a wedge-shaped piece of metal called the horse, after its resemblance to a horse's head. The rete carries the star pointers and ecliptic ring and can be rotated over the latitude plates underneath. The star pointers mark the location of particular stars, which are often labeled on the rete. As the rete is turned, the star pointers mark out the position of these stars against the background of the celestial sphere on the plate. The ecliptic ring, the annual path of the sun through the sky, is scaled in ecliptic longitude and is divided into 30-degree intervals marking the 12 months of the zodiacal calendar. The rule or label seen on some astrolabes is a bar which rotates across the front of the astrolabe and is used to locate positions on the plate or rete, and to relate them to the scale of hours marked on the limb. On the back of the mater there is often engraved a number of scales that are used in the astrolabe's various applications. These vary from designer to designer, but might include curves for time conversions, a calendar for converting the day of the month to the sun's position on the ecliptic, trigonometric scales, and a graduation of 360 degrees around the back edge. The back may include a shadow square to determine distances and heights and zodiac symbols. The alidade is a rotating bar with sight vanes usually found on the back of an astrolabe but sometimes on the front. Altitude is measured by lining up an object, such as a star, in the two sighting holes, and then reading off the altitude in degrees on a scale around the edge. A throne at the top of the astrolabe makes it possible to hold the astrolabe vertically when pointing a star or the sun with the alidade. The throne is usually decorated and is equipped with a ring and a cord for suspension.

Sanskrit Astrolabe, Northern India

This fully functional authentic astrolabe falls within a group known from the city of Kuchaman, near Jaipur in Rajasthan, Northern India. Handmade of thin rigid sheet brass, this large astrolabe is 11 5/8 inches (29.5 cm) in diameter, with integral recurved throne. All notations and numerals are in the Sanskrit language in the highly cursive Devanagari script. The mater and plate are integral, hand-engraved with circumferential degree scale, in 60 numbered segments of 6° each, and bears a projection of the local celestial coordinate system for the single latitude of 27°. The rotatable rete has 22 named star pointers, a nearly complete equatorial circle, a counterchanged east-west bar, and an ecliptic circle divided into twelve named Zodiacal houses, each subdivided into five numbered segments, each of these further subdivided by sixths. The equatorial circle is joined to the tropic of Capricorn by two decorative supporters. The reverse has a semicircular degree scale but is otherwise plain. The astrolabe is complete with rotating alidade with sighting tube and decoratively shaped ends on the back of the instrument, all held together by a simple nut and bolt. Condition is fine noting some light stains to the brass.

Persian Astrolabes, 19th/20th Century

These are two brass Persian astrolabes from the late nineteenth or early twentieth centuries. It is likely these are imitation astrolabes meant as souvenirs for tourists. The first astrolabe is 4 ½ inches in diameter. The mater holds the rete and four plates each engraved on both sides. There is a rule on the front. A pin holds the rule, rete, and plates together and is fastened by an engraved horse. The triangular throne bears designs on both sides. The astrolabe is suspended by a ring attached to the throne. The rete bears an intricate open framework with star pointers for star location and the ecliptic ring. The limb of the mater bears letters. On the back of the mater, there is a grid with letters in the center. One quadrant has letters and another lines. The bottom half bears signs of the zodiac. All of these are surrounded by a ring of letters and a floral design on the outside. Signs of the zodiac also occur on the front side of the mater beneath the plates. The lettering on the astrolabe resembles Arabic. The astrolabe is in good condition but is worn in places and was polished sometime in the past.


Persian Astrolabe

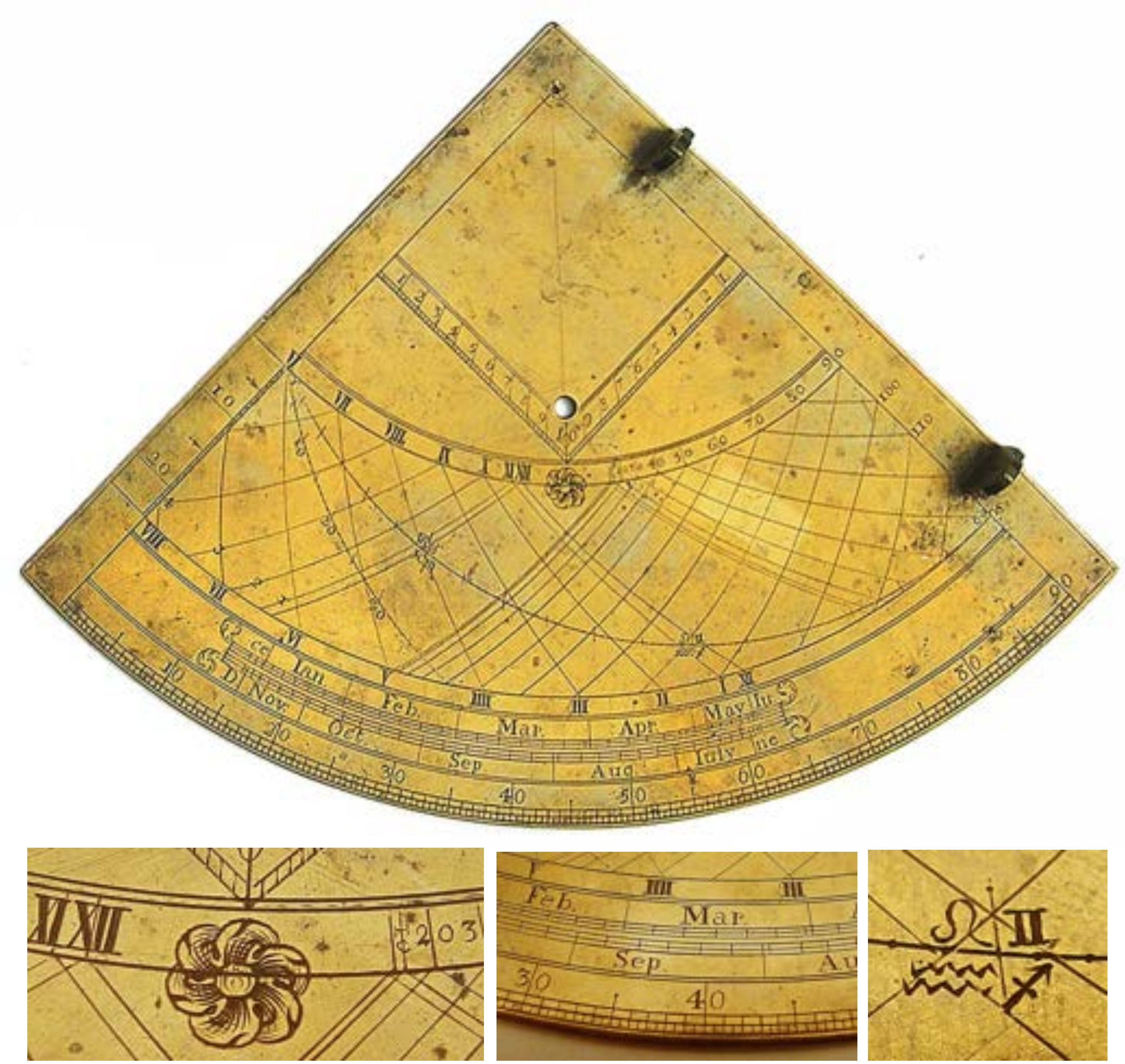
The second astrolabe 5 ¼ inches in diameter. The heavy mater holds the rete and four plates each engraved on both sides. The alidade is on the front of the instrument. A pin holds the alidade, rete, and plates together and is fastened by a horse. The throne bears an inscription-filled cartouche on both sides. The astrolabe is suspended by a ring attached to the throne. The rete bears the open framework for star location and the ecliptic ring but lacks star pointers. The limb of the mater bears letters and a degree scale. On the back of the mater, there is a grid with letters in the center. This is surrounded by finely detailed signs of the zodiac. These are surrounded by a ring of letters and a floral design on the outside. A similar pattern with signs of the zodiac occurs on the front side of the mater beneath the plates. The lettering on the astrolabe resembles Arabic. The astrolabe is in good condition but appears to have been polished sometime in the past. Ex Grogan's sale 137, lot 41, 2013, Elli Buk collection.

Persian Astrolabe

Gunter’s Quadrant, second half seventeenth century

The quadrant was first used by Ptolemy (c90-c168) to measure the sun’s position. Around 1460, the astronomical quadrant was converted for nautical use. It was used to determine the altitude of the Polestar or sun and, concurrently, the location of the ship in degrees of latitude. When in use, the navigator would sail north or south until the quadrant indicated he was at the destination's latitude, turn in the direction of the destination and sail to the destination maintaining a course of constant latitude. Along one edge, there were two sights forming an alidade. A plumb bob was suspended by a line from the center of the arc at the top. In order to measure the altitude of a star, the observer would view the star through the sights and hold the quadrant so that the plane of the instrument was vertical. The plumb bob was allowed to hang vertical and the line indicated the reading on the arc's graduations. It was not uncommon for a second person to take the reading while the first concentrated on observing and holding the instrument in proper position. The accuracy of the instrument was limited by its size and by the effect the wind or observer's motion would have on the plumb bob. For navigators on the deck of a moving ship, these limitations could be difficult to overcome.

Edmund Gunter (1581-1626), a mathematician and astronomer and Professor of Astronomy in Gresham College, London, described his quadrant, a simplified version of the Arabic astrolabe, in *De Sectore et Radio* in 1623. Like an astrolabe, it has a planispheric projection of the celestial sphere and local altazimuth coordinates, but these are "folded up" so as to be inscribed on a quadrant rather than a disk. The instrument was used for observations of the sun (altitude, azimuth, declination, right ascension, position of the sun in the zodiac) and stars, astronomical calculations, time of day, time of sunrise or sunset, and surveying.



Gunter’s Quadrant

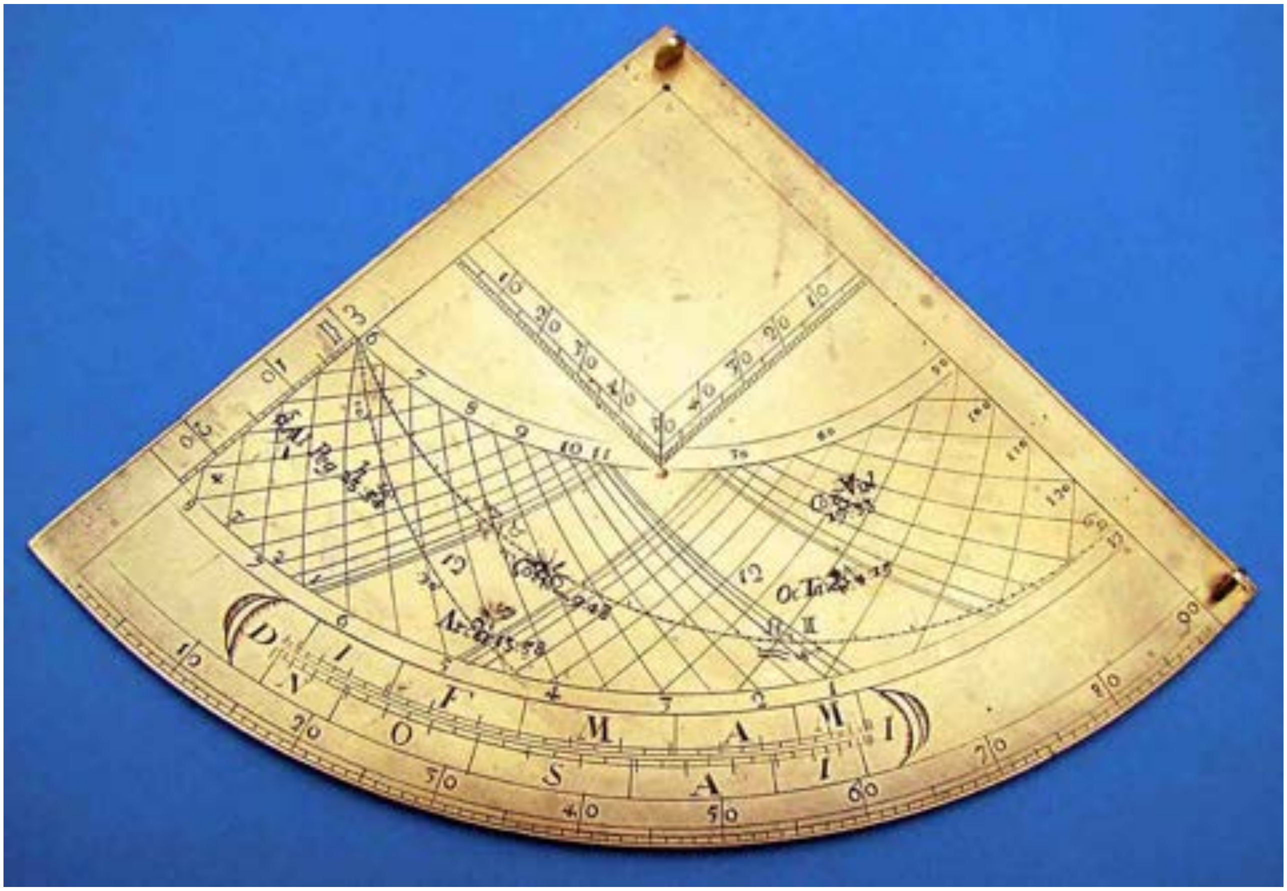
The substantial brass plate of this quadrant measures 5 5⁄8 inches (14 cm) on a side, and is set with twin shaped sight vanes, and pierced with a hole for the plumb line and a probably later hole for table stand mounting. The plate is hand engraved with Edmund Gunter's full layout, as described in 1623. It is laid out for a vernal equinox of 11 March, consistent with the Julian calendar still in effect in England, and for latitude just under 51 degrees consistent with Portsmouth, Southampton, and Hastings for example. Arranged as a quarter of an astrolabe, for a fixed latitude, the quadrant shows the sky projection between equator and tropics, crossed by the ecliptic (divided with a Zodiacal scale), horizon, azimuth lines, and hour lines. There is an edge scale of solar declination, a shadow square at the apex, a calendar scale, and a quadrantal scale for observing altitudes of sun and stars. The details follow exactly the figure published by Gunter, down to the labeling and frequency of subdivision of scales. The one exception is the maker's addition of a lovely central rose. The reverse is plain but for incised edge lines, typical of seventeenth century work. The quadrant is unsigned, but the lettering and some design features bear close resemblance to instruments by Henry Sutton and Walter Hayes. Condition is fine noting a little old pitting and staining.

Gunter's Day/Night Quadrant with Constellation Disk, English, c1690–1710

This is a brass quadrant, 4 7⁄8 inches (12 cm) in radius, set with twin pinhole sight vanes and pierced with a hole for plumb line. The front is hand engraved with Edmund Gunter's full layout, as described in 1623. It is laid out for a vernal equinox of 11 March, consistent with the Julian calendar still in effect in England, and for latitude of 51°, consistent with Salisbury and Winchester, for example, in southern England. Arranged as a quarter of an astrolabe, for a fixed latitude, the quadrant shows the sky projection between equator and tropics, crossed by the ecliptic (divided with a Zodiacal scale), horizon, azimuth lines, and hour lines. There is an edge scale of solar declination, a shadow square at the apex, a calendar scale, and a quadrantal scale for observing altitudes of sun and stars. The sky positions of five bright stars are plotted along with their names (Al Peg for the Wing of Pegasus, Oc Tau for the Bull's Eye, etc.) and right ascensions. The details follow very closely those published by Gunter, with the addition of crescent decorations, typical of around 1700, at the ends of the calendar scale.

The reverse carries a nocturnal, with fixed circular hour scale (twice-12 divided every 15 minutes), and central, moveable planispheric volvelle showing five constellations and their principal stars (45 in all). These are the traditional Ptolemaic circumpolar constellations of Ursa Major, Ursa Minor, Draco, Cepheus, and Cassiopeia, shown in geocentric view (i.e., on Earth looking outward), and surrounded by a calendar scale divided every five days. The constellation figures are depicted simply but quite distinctively. A survey of celestial maps (see in particular Warner, *The Sky Explored, Celestial Cartography 1500–1800*) shows enormous variety in design, the figures being adapted to the age and culture and technology, religious and political vogue, etc. The present imagery, however, is found only in Gunter's description of the nocturnal with volvelle ("rundle") located in his *Works* in the section on Use of the Sector.

In use, one can perform many observations and calculations with the instrument. Quite simply, one sights the sun through the pinholes and, using a plumb line and bead, determines the time of day. One can predict sunrise and set, length of daylight, etc., for any date. By sighting any of the five stars one finds the time at night. The nocturnal is even simpler to use; face North, hold the instrument vertical, rotate the volvelle until the orientation of the constellations matches that seen in the sky, and read the time against the current date. This use is described in more detail in an elusive work by William Leybourn, *The Description and Use of a Portable Infrument, Vulgarly known by the Name of Gunter's Quadrant* (2nd ed., 1721). Condition is fine noting areas of shallow scratches.



Gunter's Day/Night Quadrant with Constellation Disk

Nocturnal from Gunter's *Works*

Astronomical Quadrant, c1750

An astronomical quadrant is a graduated quarter of a circle designed to measure the angle of elevation between the horizon and celestial bodies like the sun, planets, moon, or stars. This is a brass astronomical quadrant, English, mid-18th century. It has a radius of 8 ¼ inches (21 cm) and is equipped with a weighted pointer on a swinging steel arm. The offset buttressed brass support arm is now mounted on a circular brass base. The quadrant scale is divided every ½º, and finely engraved every 10º from 0º to 90º and back again, with decorative divisions every 5º. Sighting is done along one of the straight edges. Condition is fine noting some pitting to the brass.

Astronomical Quadrant

Altazimuth Astronomical Quadrant, W. & S. Jones, c1800

Astronomical quadrants were used mainly for determining the altitude of a celestial body above the horizon. Meridian altitudes of the sun or a bright star could be employed for determining the geographical latitude of an observer; or, at a known latitude, the observer could obtain the time from an altitude. An altazimuth quadrant can be rotated to any bearing, measuring altitude and azimuth simultaneously.

The quadrant is constructed of boxwood throughout. It stands 9 inches (23 cm) tall overall. The 5 inch (13 cm) radius quadrant has edge scale divided every degree counter-clockwise from 0° to 90°, and is mounted with twin brass sight vanes and stowable plumb bob on cord. This is attached to a rotatable pillar with index arm reading against circular degree scale divided directly on the 5 ⅞ inch (15 cm) diameter baseplate with three leveling screws. It is signed "W. & S. Jones, 30 Holborn, London." Condition is fine noting some stains and cleaning residue. This is an example of the very rare astronomical quadrant of George Adams and subsequently by William and Samuel Jones. Its construction and use is described in *Lectures on Natural and Experimental Philosophy*, George Adams, 1794.

Astronomical Quadrant

Armillary Planetarium, Charles Dien, France, c1830

This instrument consists of a planetary system within armillary rings. It is unsigned but was made by Charles Dien (1809-1870), a Parisian astronomer and cosmographer who collaborated with globemaker Félix Delamarche and astronomer Nicolas Camille Flammarion. A brass sun, 3 cm in diameter, is in the center surrounded by 10 planets; Venus, Earth, Mars, Vesta, Juno, Ceres, Pallas, Jupiter, Saturn, and Uranus. The Earth is wooden with an ivory moon. A hand-turned geared mechanism turns the earth and moon. The other planets are ivory on separate brass arms that can be moved. The first four asteroids were discovered early in the nineteenth century and were considered planets until smaller asteroids were discovered in the 1850s. This instrument must date to between 1807 when Vesta was discovered and the discovery of Neptune in 1846. The pewter horizon ring shows the Zodiacal and Gregorian calendars. A brass meridian ring is stamped with stars and marked “Pole Arctique,” “Cercle des Solstice,” “Pole Antarctique,” and “Etoles Fixes.” The brass ecliptic ring is stamped with stars and marked “Cercle des Equinoxes” and “Etoles Fixes.” The whole is supported on a heavy ebonized column on a circular base. The instrument is 20 inches high with a diameter of 12 inches and is in fine condition.

Armillary Planetarium

Armillary Sphere

An armillary sphere is a model consisting of a number of rings representing the circles of the celestial sphere. A Ptolemaic armillary sphere has an earth globe at the center, surrounded by celestial circle and zodiac armillary rings, demonstrating the geocentric theory of the universe developed by Ptolemy (c90-c168) and others in ancient Greece and Rome. A Copernican armillary sphere has a sun ball at the center, with planetary and zodiac armillary rings, demonstrating the modern theory of the solar system, first popularized by Nicolaus Copernicus (1473-1543) during the Renaissance.

Armillary spheres were widely used in the late fifteenth century, at the time of the voyages of discovery. Demonstrational armillary spheres were commonly produced in France in the eighteenth and nineteenth centuries to show various basic principles of astronomy. The Delamarche family of cartographers was the most renowned and prolific producers of globes and armillary spheres in France in the nineteenth century. The firm was founded by Charles Francois Delamarche (1740-1817) in the late eighteenth century.

This is a large Copernican planetary armillary sphere with the sun at the center. The sphere is mounted on a turned wooden stand with three legs. The wooden rings are covered with printed paper with writing in French. The horizon or equatorial ring bears the zodiacal signs and months of the year. A meridian ring marked "colure of the equinoxes" and "fixed stars" is set into notches in the horizon ring. Inside the primary sphere, there is a planetary system consisting of five interlocking movable wooden rings and an ecliptic ring around a two inch gilt sphere for the sun. The planetary rings represent the orbits of the "Mercurii," "Veneris," "Martis," "Iovis," and "Saturni" and are marked with the time of revolution around the sun. Between the rings for Venus and Mars, the earth sphere is supported by an arm that can be rotated around the sun. The ¾ inch painted globe shows the continents. At the south pole of the earth, an arm with a disc for the moon is attached. The ecliptic ring, or path of the earth around the sun, bears the twelve signs of the zodiac and months of the year. The armillary sphere is 32 ½ inches high and 18 ½ inches wide. It is unsigned but the design and symbols are in the Maison Delamarche nineteenth century tradition. It is in excellent condition and probably dates to the late nineteenth century.


ETOILES • FIXES
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CANCER
LEO
VIRGO
LIBRA
SCORPIUS

Armillary Sphere

Bale & Woodward's Celestial Globe, c1850

This figural celestial globe, English c1850, is signed Bale & Woodward's New Celestial Globe." It is 6 ¾ inches (17 cm) in diameter, with a maximum height of 12 ½ inches (32 cm) on stand. The globe is constructed of 12 printed gores showing the Classical constellation figures (Orion, Aries, Taurus, Andromeda, Hydra, etc.) with later additions (Antlia Pneumatica, Fornax Chemica, etc.). Bright stars are named. The globe is light brown and there is green hand coloring to a number of constellations. It is mounted in a semicircular brass meridian ring divided every 10° of latitude supported on a turned mahogany stand in excellent condition. The globe has some old cracks, stains, and repairs partially obscuring some equatorial constellations in one hemisphere, but is otherwise in good condition.

Bale & Woodward's Celestial Globe

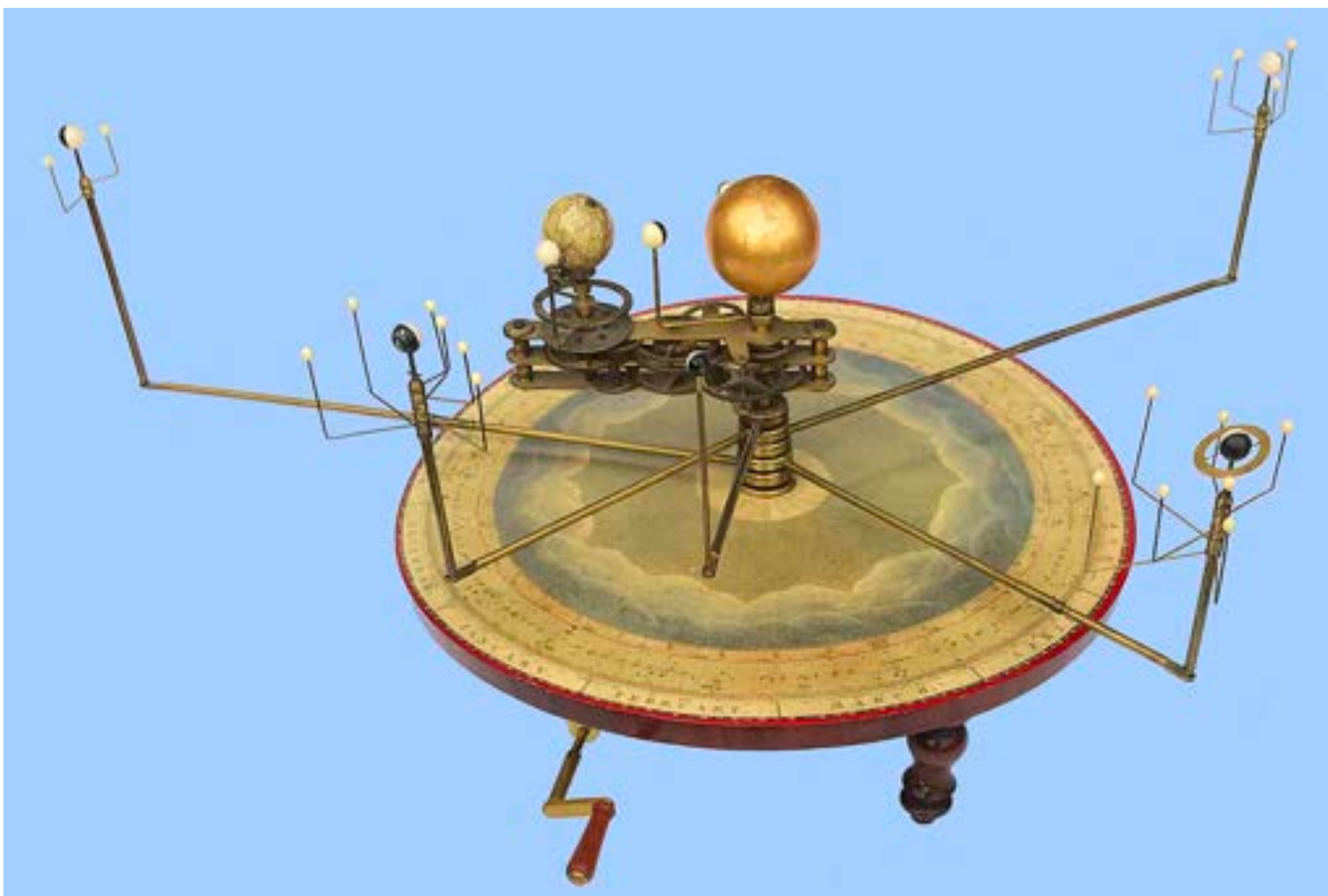
Orrery, Newton & Sons, c1830-50

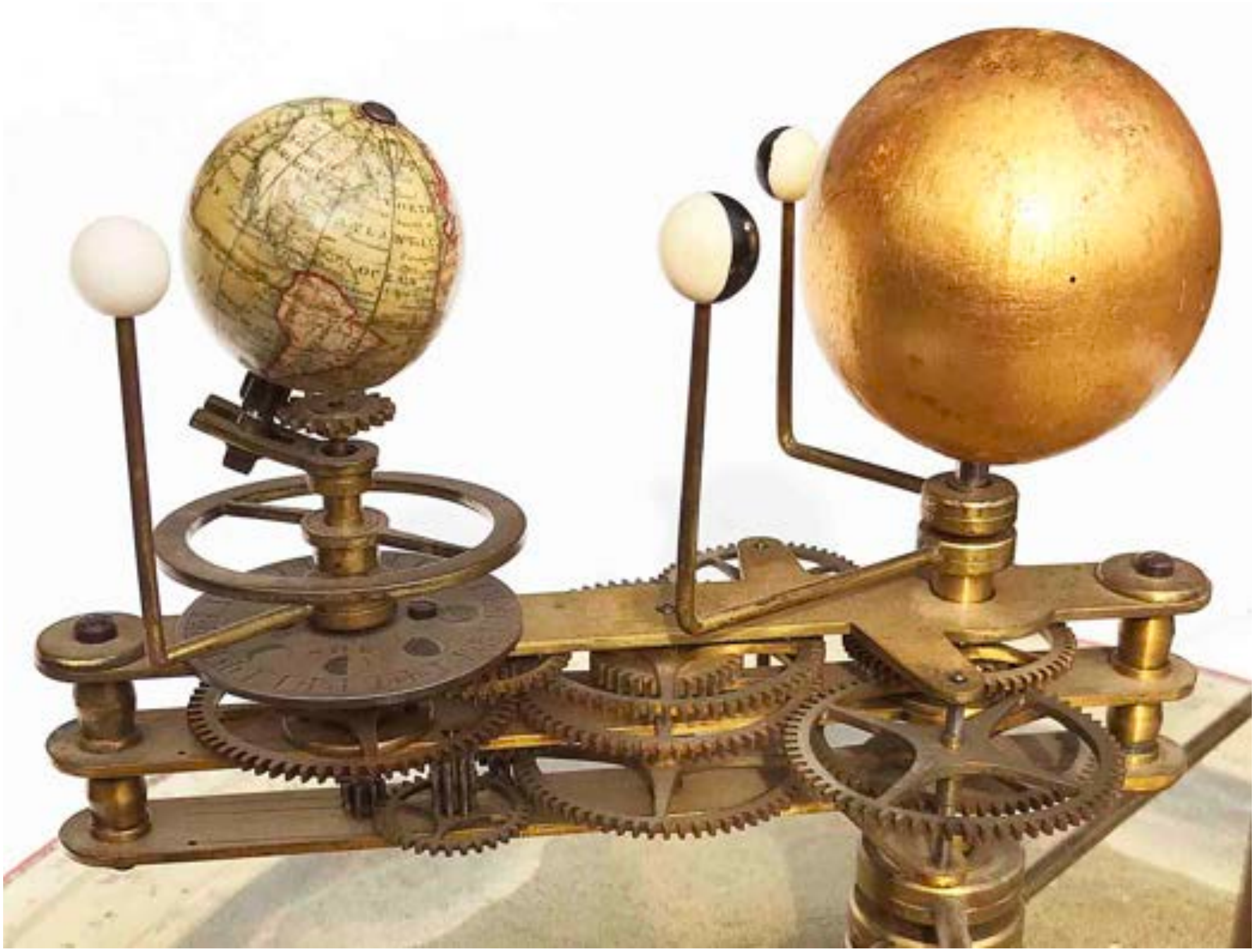
An orrery, previously referred to as a planetarium, is a mechanical model of the solar system that shows the relative positions and motions of the planets and moons according to the heliocentric (sun centered) model. They are typically driven by a clockwork mechanism with a globe representing the sun at the center, and with a planet at the end of each of the arms. The celebrated instrument maker John Rowley (1668-1728) of London made an orrery around 1712 for his patron Charles Boyle, 4th Earl of Orrery, from which the device took its name.

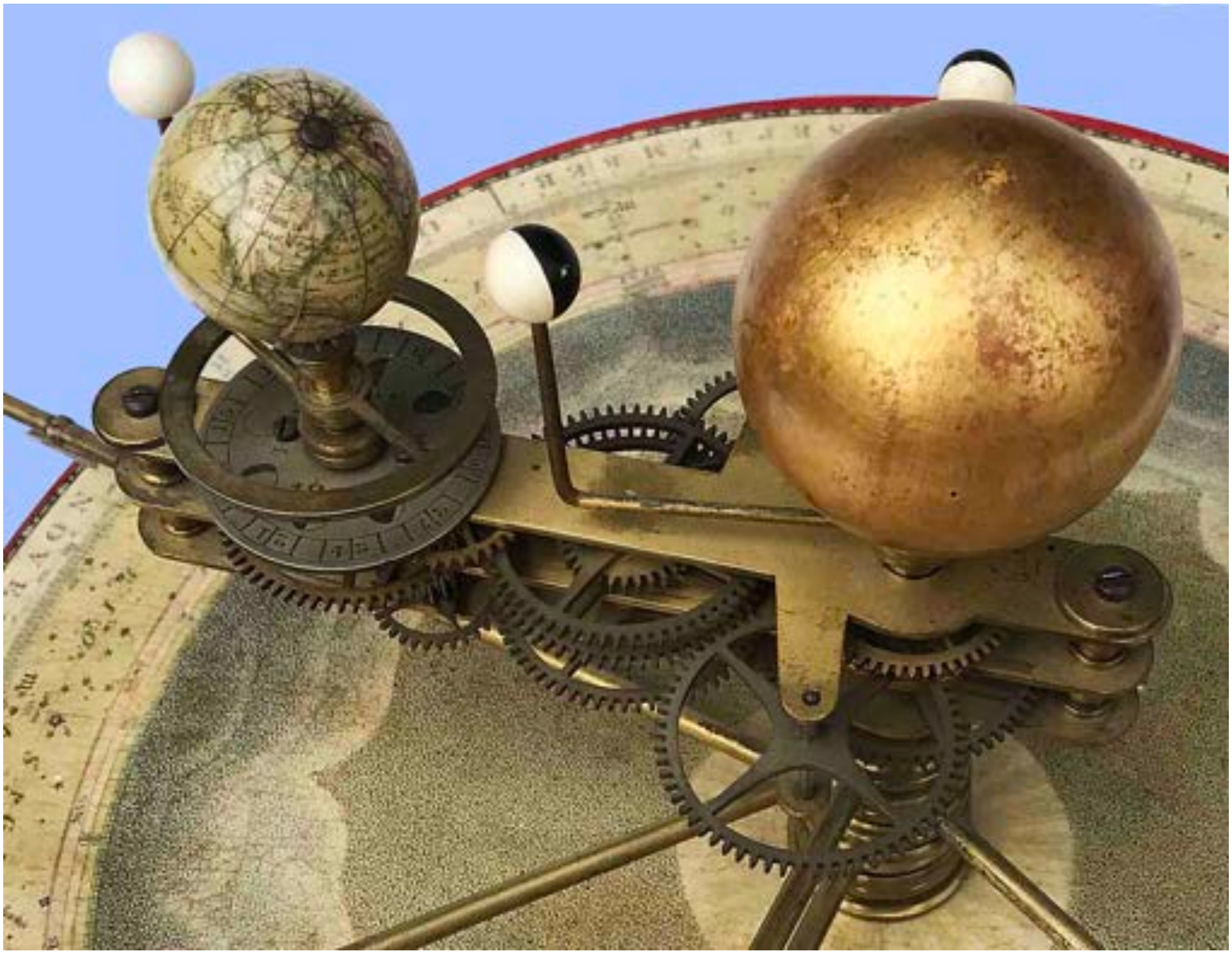
This instrument is on a wooden baseplate, 17 inches in diameter, with three short turned legs and a paper horizon scale, which was printed and pasted on the top and colored by hand. It stands 12 inches high. The paper scale is protected by a thin layer of varnish. The mechanism is made of brass, the earth is a detailed terrestrial globe 1 ½ inches in diameter, the sun is a 2 ¼ inch gilded wood ball, and the planets and moons are made of ivory. The paper on the wooden base is signed "Newton and Son 66 Chancery Lane, " and the globe is signed with "Newton & Son's New Terrestrial Globe." The Newton family of cartographers were the foremost English globe makers of the late 18th and early 19th century. The firm was founded in 1783 by John Newton (1759-1844). The paper has zodiac, compass, and calendar scales around its edge with artistic stippled clouds in the center. The instrument shows the planets Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. The earth and four outer planets have moons, a total of 20 moons. Saturn has a brass ring around it for the rings of the planet. The planets are mounted on brass arms that extend from a central shaft and are rotated independently by a geared wheelwork mechanism contained in the base. The mechanism is operated by turning a handle extending from one side of the base. The overall effect is to imitate the relative periods of rotation of the planets about the sun. The distances of the planets from the sun are not to scale. When Uranus and Neptune are opposite one another, the instrument is 31 inches across.

In addition to the planetarium, this instrument contains mechanisms above the base that demonstrate two other functions. One is a lunarium that shows the rotation of the moon around the earth. Below the earth is a disk with the phases of the moon and a scale from 1 to 29 ½ for the lunar month. The other is a tellurian (also spelled tellurion, tellurium) that that depicts how day, night, and the seasons are caused by the rotation of the earth and its orientation on its axis as it orbits around the Sun.

The mechanism of this instrument was restored in 2006 by the Boerhaave Museum in Leiden and the globe and paper restored by Sylvia Sumira in London. The planet Neptune was mathematically predicted based on irregularities in the orbit of Uranus before it was directly observed in 1846. It is likely the orrery was made shortly after Neptune was observed. However, it could have been made earlier and included by Newton based on the mathematical predictions. Neptune is shown with two moons indicating Newton was speculative to some extent since Neptune's second moon wasn't discovered until 1949. The orrery is in excellent condition and fully operational noting that the base plate is slightly warped. All gears are original and functioning properly.







Newton Orrery

Time Telling

The early time telling devices are also astronomical instruments because they depend on the observation of the sun or stars. The astrolabe and the quadrant can also determine time. *A* horary quadrant is used to find the time of day by measuring the Sun's altitude. The sundial is the oldest known device for the measurement of time and the most ancient of scientific instruments. It is based on the fact that the shadow of an object will move from one side of the object to the other as the sun “moves” from east to west during the day. The first device for indicating the time of day was probably the gnomon. It consisted of a vertical stick or pillar placed in the ground. The length of the shadow it cast gave an indication of the time of day. The earliest sundials known from the archaeological record are the obelisks (3500 BC) and shadow clocks (1500 BC) from ancient Egypt and Babylonia. The ancient Greeks developed many of the principles and forms of the sundial. The Greek dials were inherited and developed further by the Islamic Caliphate cultures, including the introduction of equal hours. The onset of the Renaissance saw an explosion of new designs in Europe. Even after the introduction of the mechanical clock in the fourteenth century, the sundial retained its importance. It was an essential tool to determine the correct time at which the clock should be set. Knowing the time of day was important for ecclesiastical time-keeping, travelers, and emerging commercial establishments. The sundial remained the most accurate device for determining time until the advent of the electrical telegraph in the mid-nineteenth century that was used to establish standardized time throughout the country.

The magnetic compass contains a magnetized needle that interacts with the earth's magnetic field pulling one end of the needle toward the Earth's North magnetic pole, and the other toward the South magnetic pole. The compass was invented during the Chinese Han Dynasty between the 2nd century BC and 1st century AD. The first compasses were made of lodestone, a naturally magnetized piece of the mineral magnetite. It was found that if a lodestone was suspended so it could turn freely, it would always point in the same direction, toward the magnetic poles. Early compasses were used for geomancy in the search for gems and the selection of sites for houses, but were later adapted for navigation during the Song Dynasty in the 11th century. Later compasses were made of iron needles, magnetized by striking them with a lodestone. The dry compass was invented in medieval Europe around 1300. The compass greatly improved the safety and efficiency of travel, especially ocean travel where it was used to calculate heading.

Horary Quadrant, France, 14th Century

This quadrant is made of a copper alloy (brass) and has a radius of 44mm. It is about 1 mm thick. At the apex is a swivel mount for the plumb bob, which may have been brass. The broken off base of the plumb bob is still attached. There are indentations on one side where the two sights, now missing, were attached. The instrument is engraved only on one side. The quadrant is engraved with curved lines for finding unequal hours. The top semicircular line indicates noon. The other curved lines with increasing radii show successive hours for both before and after noon. The outer lines are very faint but clearest near the apex. There is a shadow square with scales on two sides marked 4, 8, 12 and the corner meeting the 45^o point on the altitude scale. The 90^o altitude scale is divided into individual degrees and numbered 15, 30, 45, 60, and 75. The numbers are in Gothic style. There is a hole on the right side, possibly for suspension with a string when carrying. The quadrant shows some pitting and oxidation in places but all the engravings and lettering are visible. The front may have been partially cleaned. There is a slight ridge indicating it may have been bent at some point. The back has encrustations and is heavily oxidized and almost black. Unfortunately, little is known about its provenance. It was owned by a French collector and was reportedly found in Normandy, France in the second half of the 20th century. It is comparable to other small 14th century quadrants and, based on its simplicity, probably dates to the first half or middle of the 14th century. It closely resembles the Chatwode quadrant (Davis, 2015)

Horary Quadrant

Gothic Nocturnal Compendium, European, fifteenth century

The nocturnal is an instrument for telling the time at night. Its operation is based on the fact that the stars, because of the earth's rotation, appear to rotate about the Pole Star which lies along the Earth's axis of rotation. In use, holding the compendium upright, one would sight the Pole Star through the nocturnal's center, align the index arm with the circumpolar star beta Ursae minoris (Kochab), and then count the time interval from the index arm position to the current date. This value would be added or subtracted from midnight to determine the time. This was described by Ramon Llull (c1232-c1316) at the end of the thirteenth century in his book *Opera Omnia*. Only a few such medieval compendia survive. There is a similar instrument dated to the fifteenth century at the Museum of the History of Science at Oxford. The Oxford instrument has a hinged chapter ring but this example shows no evidence of having had one. This is a significant nocturnal and compass box from the Middle Ages and warrants further research.

The instrument is made of brass now darkened to a chocolate color, and measuring 1 ½ inches (39 mm) in diameter and just over ½ inch thick. It consists of a cylindrical compass box with engraved compass rose, and hinged lid with six-petal décor to the interior and nocturnal with rotating index arm to the exterior. The nocturnal dial is divided with a circular calendar scale of 12 months or 24 hours, each month denoted by a pointillated "engraving" of its initial letter, and subdivided into sixths (i.e., about every five days, or every 20 minutes of time). The index arm also serves as a closure latch. The compass rose has pointillated engraving of a central four-lobed rose, then a concentric band of cardinal directionals labeled "M" Meridional for south), "S" (septentrional for north), and possibly "OR" (oriental) and "OC" (occidental). Beyond this, another concentric band displays eight directionals, possibly an eastern cross, a western crescent, a southern arrow, and a northern asterism. The four intermediate ordinals are the numerals from 1 to 4, clockwise starting at southwest; the numerals are in clear Gothic shapes. Condition is reasonably good, noting the nocturnal's central hole plugged with a later rivet, and the base pushed in a bit. Lacking are a compass needle, pivot, and glass.

Gothic Nocturnal Compendium

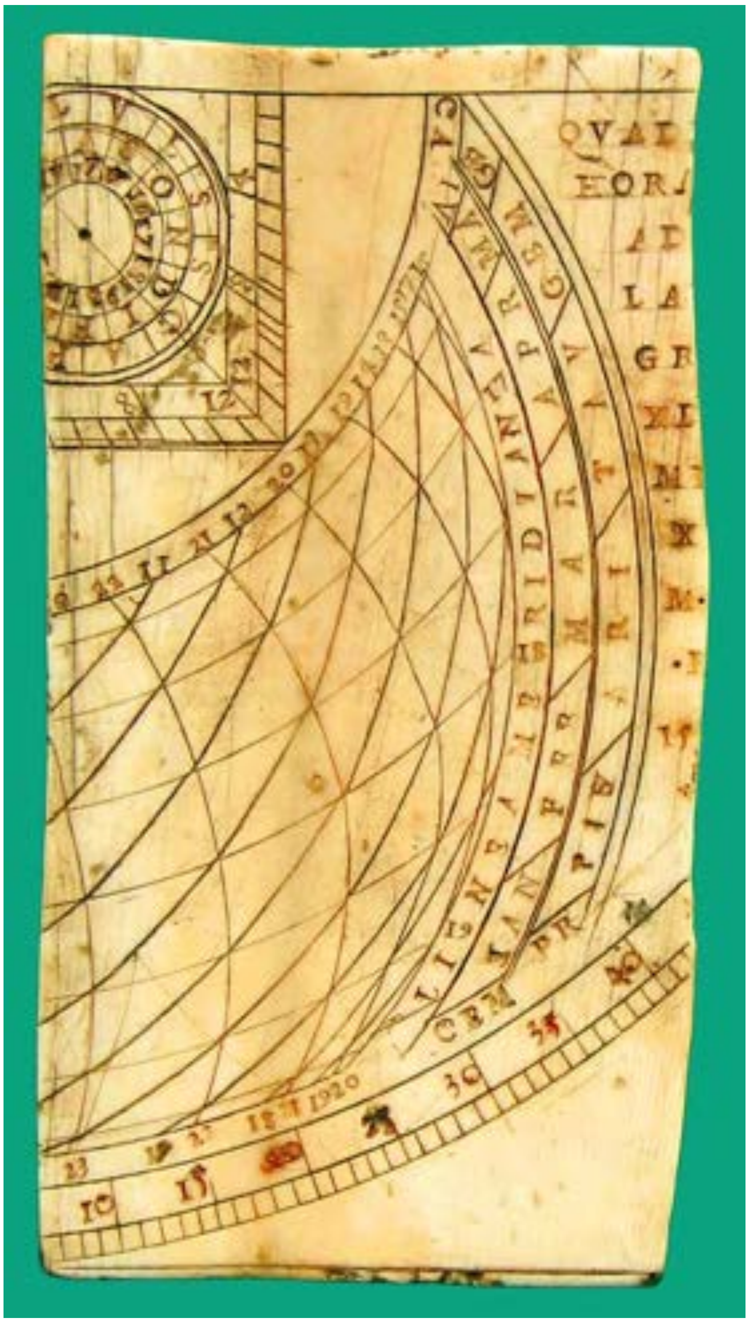
Portable Universal Equinoctial Sundial, c1600

Portable Universal Equinoctial Sundial

This is an early portable universal equinoctial sundial, which were developed as "watches" in the middle ages. This example is contained in a brass circular case with a lid and a pendant for suspension. The diameter of the case is 5.5 cm. The base is a round brass plate richly engraved with a vine pattern. A compass is inset in the base and viewed through a circular glazed aperture. The cardinal points are in Latin: SE (septentriones, North), OR (oriens, East), ME (meridies, South), OC (occidens, West). The equinoctial hour ring is hinged to the North side of the base plate and the latitude arc is hinged to the West side of the plate. The gnomon is a narrow pointed rod set at the center of a pivoted bar lying across the East-West diameter of the hour ring. The hours engraved in Roman numerals on the ring are from IV to XII and I to VIII. The latitude arc is marked 10 – 80 degrees. The dial is in excellent condition and fully functional. It was nearly black and cleaned at some point in the past. A very similar portable dial in the Science Museum is dated 1588.

Horary Quadrant, c1560

This is an Italian horary quadrant fragment in ivory, probably by Giusti, dated 15__. This ivory plate, measuring 4 ¼ x 2 ¼ x ⅛ inches (11 x 6 x 0.3 cm), is the finely crafted central and most important portion of a complex horary quadrant designed for measuring and calculating solar altitude, time of day, heights of structures, calendrical events, and other calculations. Near the bottom is a degree quadrant divided every degree and numbered counterclockwise "...10, 15, 20, 25, 30, 40..." The central area is crossed by "horizontal" arcs of dates emanating from calendrical edge scales and labeled "Linea Meridiana" giving the months "Cem (December), Ian, Feb, Mar, Apr, Ma, Iu," and the Zodiacal houses "Pr, Pis, Ari, Tau, Gem, Ge, Ca." These date arcs are crossed by two sets of "vertical" arcs of hours labeled "...11, 12, 13, 14, 15, 16, 17, 18, 19," and "...23, 22, 21, 20, 19, 18, 17." These represent Italian morning hours and afternoon hours, respectively. In the upper left is a shadow square centered by a circular table that gives the hour of noon in Italian hours, which divided the day into 24 equal hours starting at sunset, throughout the year, and which shows the correspondence with months and Zodiacal signs. On the right side is a partial inscription: QUAD[RANS] HOR[ARIUM] (horary quadrant), latitude in degrees AD LA[TITUDINEM] GR[ADUUM} XL[III]) and minutes MI[NUTORUM] X[L] (43º 40" and thus Florence), M[ERIDIES] (noon), and made in the sixteenth century F[ACIEBAT] 15__.



The maker in all probability was Giovanni Battista Giusti, a mathematical instrument maker working in Florence in the Medicean workshops in the second half of the sixteenth century. Quadrants made of ivory are extremely rare so that this instrument must of have been of considerable importance and in a prominent place. Gerard Turner did a major study of Giusti's extant products, and found four signed and an additional 22 attributable to him on the basis of detailed shapes of number and letter punches and other consistencies (Gerard L'E. Turner, "The Florentine Workshop of Giovan Battista Giusti, 1556-c.1575," Nuncius: *Annali di storia della scienza*, **10**: 131-172 (1995). The present instrument can be added to this inventory. It is very similar, with the same inscriptions, to a signed and dated (1565) brass quadrant (#9 in Anthony Turner's 2007 *Catalogue of Sundials, Nocturnals & Related Instruments*) in the Museo Galileo (Inv. 2524) in Florence. Ex Peter Brophy collection.

Universal Equinoctial Ring Dial, last quarter seventeenth century.

This is an early brass double ring dial, 3 ⅜ inches (87 mm) in diameter. The outer meridian ring has a sliding suspension reading against a 0° to 80° scale of North latitudes and on the reverse an auxiliary 0° to 90° scale centered on a pierced hole that is designed for inserting a straw or pin and measuring directly the solar altitude. The inner equatorial ring has a 3 AM to 9 PM scale of hours, divided every 30 minutes. The bridge, with its sliding pinhole, has scales of date by the Julian calendar on one side and of solar declination 0° ± 23.5° on the other. Condition is good, the brass showing a dark brown patina.

In use, the universal dial functions worldwide and can be used over a wide range of latitudes. To determine time, one sets the pinhole within the bridge to the date, the suspension ring to the latitude on the outer ring, holds the dial in sunlight, and reads the (apparent solar) time where light passing through the pinhole strikes the hour scale on the equatorial ring. The dial can also be used to determine latitude and the date.

Diptych Dial, 1648

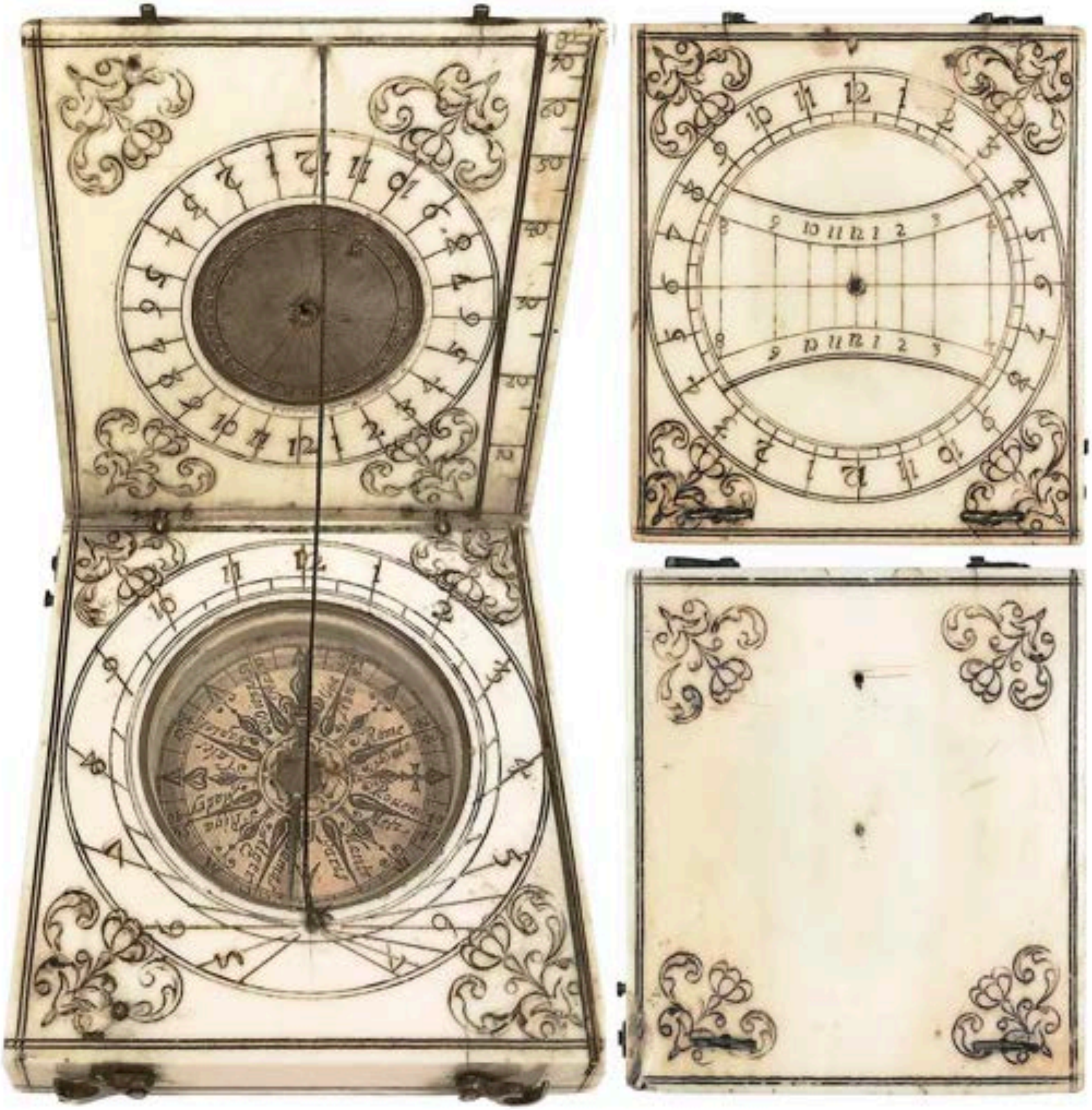
The diptych dial is a small, portable sundial that originated in the fifteenth century. It consists of two hinged plates, a string gnomon, and an hour scale and inset compass in the base plate. This simple brass and wood dial is beautifully engraved "Herman Nuttelman, Anno 1648," 2 ¼ " x 3 ½ " (6 x 9 cm) in size with hinged plain wood top latching upright to form the holder for the string gnomon and plumb line for leveling. An inset glazed compass has a well-shaped needle and simple card with north-south line. The wood has been painted (probably repainted) in gold and red. The fine brass dial plate has a 5 AM to 7 PM hour scale, signature and date, and delicate floral engraving in two corners. Condition is good. The dial was designed for use at approximately 52 degrees latitude (as indicated by the angle the string, representing the earth's polar axis, makes with the horizontal dial plate); this the latitude of central Germany, Poland, and the Low Countries. There is no offset line for magnetic declination on the compass face, but the declination was very near zero in the mid-seventeenth century in central Europe. An interesting dial by a seemingly unrecorded maker.

Diptych Dial, 1648

Diptych Sundial, Bloud, c1665

A diptych dial is a type of sundial that gains its name from the two hinged leaves, which open like a book. In its simplest form, when the dial is opened, a cord between the top and bottom leaves acts as the gnomon (the shadow-casting part of the dial). To use the dial to tell the time, it is placed outside on a horizontal surface, and oriented so that the gnomon is pointing towards true north. This is done with the help of a compass embedded in the horizontal leaf within the main dial. Once the dial has been arranged in the correct manner, the shadow of the gnomon, cast by the sun, falls onto the main horizontal dial indicating the local time. As the sun travels through the day, the shadow moves across the dial indicating the passing of time. Some dials, like this example, have additional functions. Diptych dials were used mainly by wealthy Europeans and royalty to tell the time. They were often carried along with pocket watches, which were generally inaccurate, to reset them.

This pocket sundial is a rectangular box (6 x 5.3 cm), made of two plates of ivory, by Charles Bloud, based on its design and poppy flower engravings. Charles Bloud made this type of sundial in Dieppe, France, from 1650 to 1686. The upper face of the lid has two dials, an equinoctial dial, for use in spring and summer months, and a polar dial. The circular hour scale of the equinoctial dial is numbered 1-12 twice. The polar dial has two hour scales numbered 8-12-4 and a central brass rivet with a hole for a pin-gnomon. Equinoctial (equatorial)) sundials consist of a flat surface aligned with the celestial equator, and a gnomon that is perpendicular to this celestial equator surface and directed towards the North or South Celestial Pole. A polar sundial is a sundial in which the dial plate is set along the East-West direction and inclines so that it is parallel with the polar axis. The polar pointing gnomon is also parallel to the dial plate. The polar sundial is universal and can be used at any latitude. The underside of the lid has a brass lunar volvelle graduated from 1 to 29 and an equinoctial dial with the hours 12-1 12-1. The lunar volvelle allows the user to calculate the time at night by converting the shadow of the gnomon cast by moonlight to the corresponding solar time. A latitude scale is along the right side from 0 to 80 degrees to set the correct angle for the dials of the upper face of the lid using an arm that folds into the base-plate. The upper face of the base-plate is a horizontal dial with a string gnomon and a single hour-scale for approximate latitude of 48°, numbered 5-12-7. The compass inside the hour-circle has the original blued needle with brass pivot and printed paper wind rose with 16 directions, central rosette, and 16 cities with their latitudes, and a glass over all. Four of the cities are unusual and three of these are outside of Europe: Algiers, Goa, Damascus, and Riga. This suggests the dial was made for a traveler or merchant who traveled to distant places. There is no correction for magnetic declination as in 1662 the declination in Paris was 0°. Finally, the underside of the base-plate is decorated in four spandrels of poppy flowers. The dial is in excellent original condition.



Diptych Dial

Japanese Traveling Compendium

This is a Japanese traveling pocket compendium that would have been worn by a traveler or naturalist and fastened to a kimono. It probably dates to the last part of the eighteenth century. It is made of brass and is 48 mm long, 21 mm wide, and 13 mm high. The gourd-shaped fob contains a compass, magnifier, schaphe, and pinhole lens. Each piece is cased in a coin-edge cylindrical ring that pivots into the housing. The top and bottom panels of the housing are decorated with an elaborate floral design. The scaphe is a sundial said to have been invented by Aristarchus, a Greek astronomer and mathemetician, in the third century BC. It consists of a hemispherical bowl which has a vertical gnomen placed inside it. Gradations inscribed in the bowl indicate the hour of the day. Looking through the pinhole "lens" produces a sharper image. The instrument is in excellent functional and cosmetic condition. An identical specimen, the only other known, is in the Museum of History of Science at Oxford.

Japanese Traveling Compendium

Hayes Magnetic Azimuth Sundial, 1664.

This glazed compass/sundial is set into a 5 3⁄8 inch (14 cm) square ¾ inch (2 cm) thick wood block that probably had a side mounting for a wooden plane table. Under the old glass is a finely crafted needle with arrowhead and crossbar shapes, and the complex printed card signed "Walter Hayes in Moore fields Londini * 1664 *." Reading outwards, concentric rings give scale of solar declination (0-23 ½°, four times full circle), scale of date (showing 10 March as vernal equinox, consistent with the Julian calendar in use in England until 1752), sundial hour scales for every two degrees of solar declination, degree scale (0°-360°), and degree scale (0°-90° four times). Condition is fine, the wood darkened and slightly warped, the putty probably replaced.

A similar dial face is shown on Henry Sutton's 1654 trade card (Science Museum). The trade card contains instructions for determining the time of day. It begins with "Place ye Sun on ye Card toward the Sun in ye Firmament ...", meaning to direct the south side of the compass card, marked with the smiling sun face, toward the sun. The time is read where the north end of the compass needle (in summer, south end in winter) crosses the hour lines along the proper parallel of solar declination as read from the central circular lookup table. The great mathematical instrument maker Henry Sutton (c1624-1665) was made free in the joiners guild in c1648 and after his death from the plague was succeeded by John Marke. Walter Hayes (c1618-c1696), freed in 1642, was probably the foremost instrument maker of his time and made high-quality scientific instruments, especially quadrants and sundials, from 1651 to 1692. He trained many apprentices and was succeeded by Edmund Culpeper. Cowham (2004) has shown that, on occasion, Hayes reused Sutton's printing plate by effacing and re-engraving the name and date. In this example, faint traces of earlier engraving can be seen, including a ten-year change in the date. This is a rare dialing compass with connections to the foremost instrument makers of the seventeenth century in London.

Hayes Magnetic Azimuth Sundial, 1664

Butterfield Equinoctial Sundial, c1690

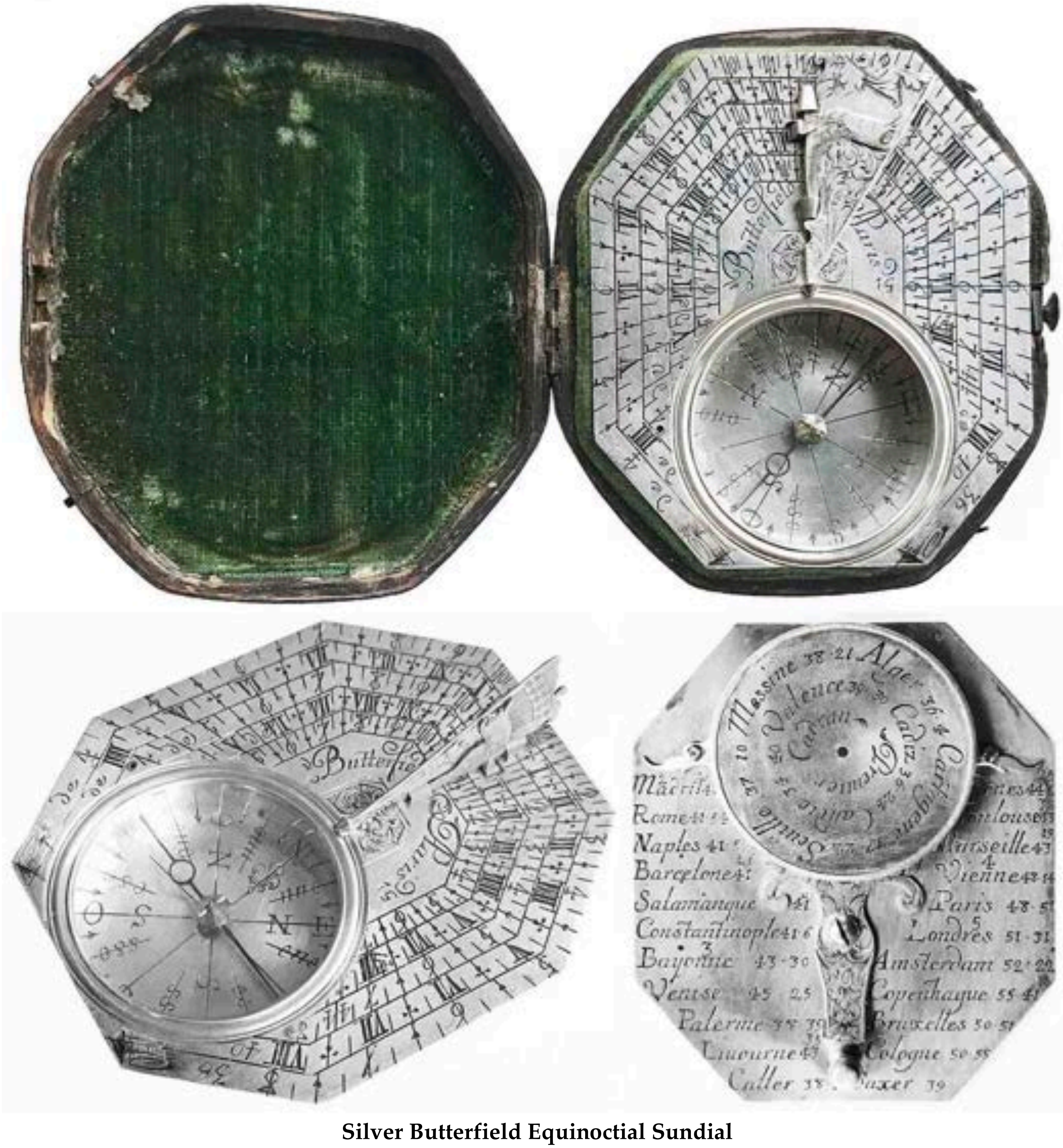
This is a Butterfield pocket or portable equinoctial (equatorial) sundial. This type of sundial was a fashionable traveler's accessory during the late 17th and 18th centuries. They were also used to set watches, which often were not accurate for long. Michael Butterfield (1635-1724) was a British clockmaker who moved to Paris in 1663 and established himself as a manufacturer of mathematical instruments and pocket sundials. He worked at the royal court of France and was appointed engineer to King Louis XIV. Butterfield developed a dial with a bird gnomen and this form was copied by many makers. This eight-sided dial is made of brass, 3 inches (7.5 cm) long and 2 ½ inches (6.3 cm) wide, with spring-loaded adjustable gnomen and inset compass. It is signed "Butterfield A Paris." There are four latitude rings for 43° 46°, 49°, and 52° with hour scales in alternating Roman and Arabic numbers. The bird gnomen has leaf-tip decoration on one side

Butterfield Dial

and is adjustable with the beak of the bird for latitudes 40° to 60° North. Leaf decorations are present in the dial center. The glazed compass has a blued steel needle, a fleur-de-lis at North, and other cardinal points in block lettering. The reverse is engraved with 14 European cities with their latitudes. The compass bowl is engraved "Calais, Lisle, Bruxelles, Londres, and Barcelone. " The dial has been used and would appear to be one of Butterfield's earlier versions. It is in very good condition noting only a crack at the side of the original compass glass.

Butterfield Equinoctial Sundial, Silver, c1690

This is a Butterfield pocket or portable equinoctial (equatorial) sundial. This type of sundial was a fashionable traveler's accessory during the late 17th and 18th centuries. They were also used to set watches, which often were not accurate for long. Michael Butterfield (1635-1724) was a British clockmaker who moved to Paris in 1663 and established himself as a manufacturer of mathematical instruments and pocket sundials. He worked at the royal court of France and was appointed engineer to King Louis XIV. Butterfield developed a dial with a bird gnomen and this form was copied by many makers for a hundred years. This eight-sided dial is made of silver, 3 inches (7.5 cm) long and 2 ½ inches (6.3 cm) wide, with spring-loaded adjustable gnomen and inset compass. It is signed "Butterfield A Paris." There are five latitude rings for 36° 40°, 44°, 47°, and 51° with hour scales in alternating Roman and Arabic numbers. The gnomen has the bird design on both sides and is adjustable with the beak of the bird for latitudes 35° to 55° North. The glazed compass has a blued steel needle, a fleur-de-lis at North, and other cardinal points in block lettering. The reverse is engraved with 22 European cities with their latitudes. The compass bowl is engraved "Seuille, Messine, Alger, Cartagene, Candie [Crete], Valence, Cadiz, Premier, and Cadran." Many are low-latitude cities mostly based in the Mediterranean Basin. Thus, this dial was probably made for a sea captain or a merchant who frequented these cities. It is in excellent condition with its original green velvet-lined case.



Silver Butterfield Equinoctial Sundial

Butterfield-Type Equinoctial Sundial, English, c1700

This is a rare English Butterfield-type pocket or portable equinoctial (equatorial) sundial. This type of sundial was a fashionable traveler's accessory during the late 17th and 18th centuries. They were also used to set watches, which often were not accurate for long. Michael Butterfield (1635-1724) developed a dial with a bird gnomen and this form was copied by many makers. This eight-sided dial is made of bright lacquered, possibly gilt, brass, 2 ½ inches (6.3 cm) long overall, with spring-loaded adjustable gnomen and inset compass. There are three latitude rings for 45°, 50°, and 53°. The bird gnomen has fine floral and running leaf-tip decoration on both sides, and is adjustable with the beak of the bird for latitudes 45° to 60° North. Floral swirls continue in the dial center and compass center. The latter has a ±20° scale of magnetic declination and is silvered. The base is engraved with 16 English country towns, most north of London, with their latitudes. The dial is not signed but is skillfully made. It is in very fine condition and is complete with the eight-sided case bound in black fishskin.

English Equinoctial Sundial

Sun & Moon Wandering Hour Watch, London, c1690

A wandering hour clock consists of a rotating disc with the hour numerals that are revealed in succession in a semicircular window in the dial. The Campani brothers are credited for creating the wandering hour concept in 1656 in a night clock for Pope Alexander XII. In England, these watches were often commissioned by the King, to be presented to visitors or in recognition of loyalty to the country. A rare variation of the wandering hour watch is the wandering sun/moon watch. Instead of hours on the rotating disc, there are images of the sun and moon. The hours 6-12-6 are marked on an arc on the upper part of the clock face above the window. As the disc rotates, the sun points to the hour on the arc during the day and the moon during the night. A minute hand is used in the normal circular fashion.

Description of watch: Pocket watch, sun & moon wandering hour dial, silver pair cases, 53 mm, London, c1690. Movement: Gilt verge movement, with finely pierced balance cock and plate, four wide gate type pillars pierced with trailing foliage, and silver regulator disk. The balance cock table is engraved with two birds. Signed John Ewer fecit. In very good condition, and running. Dial: A silver champleve wandering hour or retrograde dial, with central revolving disk, marking the day time hour with the sun, and the night time with the moon. Signed as the movement. There are a few very light scratches to the blue background of the disk, but generally all in fine condition. Excellent gilt minute hand, of the period, and probably original. Inner case: Silver, with rubbed makers mark. The hinge is fine and the bezel closes correctly. The high dome crystal is fine. The stem and bezel are slightly later replacements (mid 18th century). Outer case: Fine silver outer, with no makers marks. Nice large square hinge. The hinge and catch are fine (though the button is worn) and the bezel closes correctly. John Ewer is listed as making in London in and around 1690. A maker of this name was also apprenticed to Luke Bird in 1687.

Wandering Sun/Moon Watch

Verge and Fusee Single-Handed Pocket Watch, French, c1670

This type of movement, with a verge escapement and a fusee was used in watches from around 1600 to the early 1800s. The verge (or crown wheel) escapement is the mechanism in a mechanical clock that controls its rate by advancing the gear train at regular intervals or 'ticks'. All verge watches and spring driven clocks require fusees to equalize the force of the mainspring to achieve even minimal accuracy. The fusee is a tapered cone with a groove machined around its circumference, and into which a chain is wound. The chain is attached to the mainspring barrel. As the spring is unwound, the chain moves progressively onto a larger radius of the fusee cone and transmits increased torque to counteract the decreasing power of the mainspring.

Le Noir Oignon Watch

This is an early and large French "oignon" verge and fusee watch, with single-handed movement and enamel dial. Oignon is a style of watch made in France in the late seventeenth and early eighteenth centuries. Its fat, bulbous form suggests an onion. The first watches have a single hand, similar to sundials. This watch is held in a silver case, 56.5 mm in diameter. The case is in very good condition with just some light bruises around the sides of the back. The hinges and catch are in good condition and the bezel snaps shut correctly. The high dome bull's eye crystal is in good condition. The stem is original, the bow probably later. The enamel dial has black Roman numerals each painted on a raised cartouche and there are no minute markers. There is some damage on the edge at VI with hairlines running from the damage. The gilt brass verge movement has a large and beautifully engraved and pierced balance bridge, showing birds, animals, foliage, and scrolls. It is signed "Le Noir & Fils Rennes." There is a large silver regulator disk. The movement is wound through the dial. The single steel hand is driven directly from the fusee wheel of the movement train (no central wheel as with a two handed watch). The watch is in fine running condition. The watch is from the collection of Australian philanthropist and entrepreneur William Hughes (1922-2017).

English Silver Pair Case Verge and Fusee Pocket Watch, c1690

This is a fine early English two-hand verge and fusee silver pair case antique pocket watch signed by Francis Colman, Ipswich, c1690. The watch is 55.75 mm in diameter. It has a silver champlevé dial and blued steel beetle and poker hands. The dial plate is firmly attached to the movement by two dial feet, with one missing leaving an unused hole in the dial plate. It has a gilt verge movement with engraved and pierced balance cock and plate and Egyptian pillars. The inner case bears a maker's mark and a later stem and bow. The high dome bull's eye crystal is in good condition. The outer silver pair case has a few small bruises but is in very good condition. Francis Colman or Coleman of Ipswich was reputedly working by 1665, married in 1668, and died in 1709. The shape of the balance cock foot and the pillars, typical of Joseph Windmills, date this watch to the end of the 17th century, probably about 1690. The watch runs well and is in overall excellent condition.

English Silver Pair Case Verge and Fusee Pocket Watch

Verge Fusee Gold Pocket Watch, French, 1759-1760

This is a French 18k rose gold open faced, verge fusee pocket watch signed “Themeze a Versailles.” There is a floral arrangement design applied to the back cover. It has gold hands and a white porcelain dial with Roman numerals for hours and Arabic numerals for minutes. It has an ornately engraved and pierced balance cock and square Egyptian pillars. The inside of the case is hallmarked with the letter T with a crown, used between July 1759 and July 1760, and a duty mark used between October 1757 and September 1762. There is a pendant for suspension. The watch is 47 mm in diameter and 24 mm thick. It is functional and in near perfect condition.

French Verge Fusee Gold Pocket Watch

“Memento Mori” Pocket Watch, English, 1781

This is a London verge pocket watch with a gold and enamel “memento mori” case containing a locket of hair. The watch is held in a gold and enamel case 41.5 mm in diameter with a high dome crystal. The enamel dial has black Roman numerals and gilt brass hands. There are white enamel “pearls” on a green enamel background around the bezel and back. The back has an outer amethyst-colored guilloche enamel ring around an oval of larger enamel pearls. A central glazed panel contains further enamel borders in red and with a lock of hair and central gem set swags surrounding an enamel oval engraved with “AMITIE” (friendship). The inside of the case has gold hallmarks for London, 1781, maker IW, and case number 1330. It has a gilt verge movement, with engraved and pierced balance cock, diamond endstone, silver regulator disk, four round pillars and blued steel screws. It is signed “Wm Nodes London.” The watch is in excellent running condition, noting only a few missing pearls on the bezel. Locks of hair on jewelry have long served as sentimental and tangible reminders of deceased or far-away friends and close relations. Among family, friends, and romantic partners, exchanging a lock of hair was a sign of mutual esteem and deep affection. Upon the death of a loved one, locks of hair were often cut and kept as a way to mourn and remember the dead. Memento mori are images and symbols, which are intended to both memorialize the deceased and remind one of their own mortality.

Memento mori Pocket Watch

Open Face, Hour and Quarter Hour Repeater Pocket Watch, French, c1850

This is an open face pocket watch in a silver case, 50 mm in diameter. It is a quarter repeater that strikes the number of hours and then the number of quarter hours since the last hour when the pendant at the top of the watch is depressed. Repeaters originated before widespread artificial illumination, to allow the time to be determined in the dark, and were also used by the visually impaired. It uses a single tone to designate the hour and a pair of tones to signal the quarter hour. For example, 4:45 would sound ding, ding, ding, ding, ding-dong, ding-dong, ding-dong. The watch has key-wind and key set movement. The watch is wound by opening the back of the case and putting the key in the winding arbor to wind the mainspring. The time is set by opening the crystal and bezel and putting the key into the setting arbor, which is connected with the minute-wheel and turns the hands. The watch has a cylinder escapement. In this, the rotating 'dumb-bell' of the verge is replaced by a wheel, which has higher inertia and thus rotates more slowly and is more accurate. It was followed by the lever escapement. There are four ruby jewels. The enamel dial with Arabic numerals is signed Rodde à Lyon. Rodde worked on Rue de Clermont between 1838 and 1853. The dust cover is engraved "Rodde à Lyon, No 6617, Echappement À Cylindre En Pierre, Quatre trous en rubis." The case back bears a silver, winged cherub or angel and foliage design on a blue enamel background. The watch is in excellent cosmetic and functional condition.

Repeater Pocket Watch

Tiffany Patek Philippe Pocket Watch, c1884.

This is a pocket watch marketed by Tiffany & Co. with the movement made by Patek Philippe SA. Tiffany is renowned for its American luxury goods and Patek Philippe in Switzerland is considered to be one of the most prestigious watch manufacturers in the world. Tiffany was founded in 1837 as a small fancy goods store by Charles Louis Tiffany (1812-1902). Polish watchmaker Antoni Patek (1812-1877) and French watchmaker Adrien Philippe (1815-1894) formed a company, *Patek & Cie,* beginning in 1845, renamed *Patek, Philippe & Cie* in 1851. In 1851, Patek met with Tiffany in New York and the two formed a partnership that is still maintained between the firms today. Tiffany often collaborated with some of the most respected names in watchmaking to make the movements for their watches.

This is an 18K solid gold open face pocket watch with a mechanical (handwinding) movement. It has an enamel white dial with black Roman numerals, minute ring, blued steel hands, and large seconds subdial at 6 o'clock. The dial is signed "Tiffany & Co. New York." The dual hinge, snap bezel case is 43 mm in diameter and the watch weighs 73 grams. There is a monogram on the back of the case. The back of the interior dust cover is engraved “Ch. Wolff, Berlin, Königl Hof Uhrmacher [Royal Court Clockmaker], U. D. Linden 61, No 67165, Patek, Philippe & Co, Genève.” The same number and hallmarks are on the inside of the back of the case. The number and 18K are on the inside of the dust cover . The watch has a 17 jewel nickel movement with wolf's tooth winding and "moustache" counterpoised lever escapement. The watch is in excellent cosmetic and functional condition. It is housed in a Tiffany Blue box (not original).

Tiffany Patek Philippe Pocket Watch

Ladies Pocket Watch, Tiffany & Co., Edouard Koehn and Patek Philippe, 1886

This is a petite ladies 18K gold, pair case pocket watch, 27 mm in diameter. The face and movement are signed Tiffany & Co. The movement style and serial number indicate that, although not signed, the movement was made for Tiffany in 1886 by Edouard Koehn when he worked for Patek Philippe. Edouard Koehn (1839-1908) rose from watchmaker to partner in the firm Patek Philippe. He left the firm in 1891 to make watches under his own name and that of H. R. Ekegren. It is not known who made the elaborate case. The inside of the case is marked 18K, Tiffany & Co, and 7327. It is an unusual pair case in that on opening the glass front, the entire body of the watch can be lifted out separating the inner movement and face from the outer protective glass front and gold/diamond adorned back. The back has a cherub surrounded by 42 European cut diamonds and decorative green enamel. There are three additional diamonds around the case’s edge. The white enamel dial has Arabic minutes, Roman hours, and blued steel hands. The dial is "upside down" so that when worn on a chain and then brought up to eye level the pendant would be down but the watch dial would be in the conventional position. The watch has a nickel finished movement jeweled through the center, lever escapement, bi-metallic balance with flat spring, regulator, and wolf’s tooth winding. The movement, identical to some on signed Koehn watches, is stamped Tiffany & Co, No. 73277, New York, Swiss. The watch is in excellent running condition noting only a small loss of green enamel near the bottom edge.

Ladies Pocket Watch, Tiffany & Co.

Railroad Standard Watch, Waltham Clock Company, 1915

A railroad chronometer or railroad standard watch is a specialized timepiece that once was crucial for safe and correct operation of trains. In 1891, there was a collision with fatalities between Lake Shore and Michigan Southern Railway trains at Kipton, Ohio, which occurred because an engineer's watch was running four minutes late. The railroad officials commissioned Webb C. Ball (1848-1922) as their Chief Time Inspector, in order to establish precision standards and a reliable timepiece inspection system for railroad chronometers. The requirements in the early 20th century included that the watch be American made, have an open face dial, have a minimum of 17 jewels, be size 18 or 16, have maximum variation of 30 seconds (approximately 4 seconds daily) per weekly check, be adjusted to at least five positions, be adjusted to severe temperature variance, have the indication of time with bold legible Arabic numerals, outer minute division, second dial, and heavy hands, be lever set, and have micrometer adjustment regulator, and steel escape wheel. Most watches were set by pulling out and turning the knob. A lever-set mechanism requires the user to remove the bezel of the watch and engage a lever to place the watch in setting mode. This ensures that the time on the watch is never accidentally changed by catching the winding knob on a pocket or by some other accident. The numbers on the dial were large, black against a white enamel background, to make telling the time as clear and easy as possible.

This is a railroad watch that exhibits all of the required features. It was made by the Waltham Watch Company, which was founded in 1850 and produced watches and other precision instruments until 1957. Its innovation was to manufacture the movement parts of watches so precisely that they would become fully interchangeable. The Waltham Watch Company complied immediately with the requirements of Ball's guidelines and was later followed by most of the other American manufacturers. The watch is a Waltham Crescent St. grade, model 1908. The serial number 200067191 indicates it was made in 1915. 88,200 of these watches were made. It is size 16 (48 mm), open face, lever set, and has 21 jewels with gold-jeweled center wheel. The gold-filled case was made by the Illinois Watch Case Company in Elgin, Illinois. The bezel and back of the watch unscrew. A distinctive feature of this watch is the elaborate engraving on the back of the case. Most railroad watches have plain cases because the railroad staff (engineer, conductor, switch yard controllers, and others) were compelled to buy their own approved watches. An engraved watch such as this would have been much more expensive. The watch is in excellent condition and fully functional.

Waltham Railroad Watch

GUCCI Moon Phase, Pointer-Triple-Calendar Complication Wrist Watch

This is a Gucci quartz gold-plated, moon-phase wristwatch with month, week, and day dials. A quartz clock is a clock that uses an electronic oscillator that is regulated by a quartz crystal to keep time. This crystal oscillator creates a signal with very precise frequency, so that quartz clocks are at least an order of magnitude more accurate than mechanical clocks. The first commercial quartz watch was unveiled by Seiko in 1969 and quartz clocks and watches are now the world's most widely used timekeeping technology. Quartz watch movements are battery powered. Gucci is an Italian company founded in 1921 by Guccio Gucci. It is best known as a maker of luxury fashion and leather goods. Later, watches, jewelry, ties, and eyewear were added to the company's product lines. This watch was made between 1971 and 1983 and is an example of a modern complication clock. A complication is any function on a clock other than the display of the time. The case is stainless steel with 18K gold-plated trim and glass crystal. It is 30 mm wide without crown, 38 mm high with lugs, and 7 mm thick. The sides of the case are decorated with black acrylic/enamel filling. The enamel glass case back is marked with the Gucci double G logo in gold. The face is matte white enamel. It has hour and minute dot markers around the edge and stainless steel hands. The black GUCCI name and "SWISS MADE" are at 6 o'clock. The three calendar dials show the month, day, and date. The moonphase window is of the "bosom" type (so named for the shape of its aperture). The moon rotates through the window and when the last crescent sliver of the waning moon disappears from view as the new moon, it is soon followed by the first sliver of the waxing moon to emerge from the opposite side of the window. A 29 ½ lunar calendar is above the window. The crown sets the time and push-pins on the sides adjust the dials. The movement is a Swiss-made HARLEY one jewel quartz movement made for Gucci. It is battery powered. The watch has the original Gucci black leather band, box, watch pillow, and booklet.

Gucci Moonphase Watch

Apple First Generation (Series 0) Sport Watch, 2015

The first-generation Apple Watch, colloquially referred to as Series 0, uses the single-core S1 system-on-chip. It does not have a built-in GPS chip, instead relying on a paired iPhone for location services. It uses a linear actuator called the "Taptic Engine" to provide haptic feedback when an alert or a notification is received, and is used for other purposes by certain apps. The watch is equipped with a built-in heart rate sensor, which uses both infrared and visible-light LEDs and photodiodes. The first-generation Apple Watche has 8 GB of storage; the operating system allows the user to store up to 2 GB of music and 75 MB of photos. When the Apple Watch is paired with an iPhone, all music on the iPhone is also available to be controlled and accessed from the Apple Watch.

This is a first generation Apple Sport Watch, released on April 24, 2015. The watch is model A1554, serial number FHLRKW1DG9J6, manufacturer part number (MPN) MJ3T2LL/A, and universal product code (UPC) 0888462079983. The watch case is 42 mm, 7000 series aluminum, Ion-X glass, and space gray color with a black band. The watch comes with a watch band, Apple Watch magnetic charging cable, USB power adapter, instructions, and original box. It is Wi-Fi, Bluetooth, and near-field communication (NFC) capable. It cost $399 when new. The watch is in mint, unused condition.

Apple Watch

Spherical Polar Sundial, French, second half eighteenth century

This is a spherical polar sundial, French, c. second half 18th century. It is made of pewter with brass gnomon, standing 14 inches (35 cm) overall. The spherical sundial reproduces the geometry of the earth in space, with armillary rings defining the celestial projection of the earth's equator, axis of rotation, and local meridian plane. The polar axis of the dial is inclined approximately 43 degrees to the horizontal. The equatorial band is finely marked with Roman numerals in raised relief every hour from 5 AM to 7 PM, and subdivided to ⅛ hour (7.5 minutes). The Roman numerals include "...IX, X, XI, XII, I..." for "...9, 10, 11, 12, 1,..." as usual, but also "V, IV, IIV, IIIV,..." for "5, 6, 7, 8,...;" in a reversed manner, either in error or in some sense of trying to follow the course of the day with the numeral writing. A rotatable sheet brass gnomon is hand cut and pierced with a sort of handle, and with banner and scroll design, reminiscent of some Alsatian patterns and workmanship. Within the band and rings is a five inch (13 cm) diameter glazed compass, with 32-point rose, again in relief, the 16 principal directionals labeled in French (e.g., Sud, E.S.E., S.S.O., N.Ouest). The "N N Ouest" pointer (at 15 degrees west of North) is also labeled "S S E meridiene" (possibly representing the magnetic declination which in mid-eighteenth century France was 15-20 degrees west). The compass has a circumferential scale divided every degree, and is set with a blued steel needle with raised brass hub and faceted pink stone on glass pivot. The compass directionals are reflected in the design of the attractive pewter stand, with its octagonal baluster and knobs, and eight-lobed base. Condition is very fine throughout, noting one screw replaced.

In use the polar dial would be set up with its compass north point fleur-de-lys pointed toward the geographic north point on the horizon (thus taking into account the offset of the needle - the magnetic declination - toward magnetic north). The polar axis would then be parallel to the earth's axis of rotation (when the user is at the correct latitude for this dial - about 43 degrees North, corresponding to southernmost France, e.g., Perpignan or Marseilles). One rotates the brass gnomon until it is in line with the sun; the gnomon then casts a crisp shadow line on the equatorial hour band, giving immediately the apparent solar time. This is an elaborate openwork form of the relatively rare spherical dial with rotatable gnomon, usually constructed with a solid sphere of turned stone or wood with sheet metal gnomon. There is an eighteenth century French example in the Stewart Museum and a c1810 design by Thomas Jefferson at Monticello.

Spherical Polar Sundial

Universal Equinoctial Sundial, French, c1760

This is a brass hexagonal universal equinoctial sundial, 8.4 x 8.4 cm, signed “Bernier Au Niveau à Paris.” A drypoint compass with circumferential degree scale is embedded in the center of the plate. The hour dial, in the form of an open ring, is adjustable in inclination according to the latitude of the place of observation. The degree of latitude is given by an arc, foldable and graduated in degrees from 0° to 80°. The gnomon is a slim brass rod mounted on a pivot axis. Both sides of the dial are engraved with the names of 23 cities with their latitudes. Most cities are in France and a few in other European countries. “Edinbourg” (55°) is listed but there are no English cities. Of particular interest are listings for “Cartagenes” (10°), “Chandernagor” (22°), and “Jerusalem” (31°). Jerusalem is often classically placed on European sundials, but not Cartagenes and Chandernagor. Cartagenes at 10 degrees N latitude must refer to the Spanish city of Cartagena in Columbia. Chandernagor was a French colony located in West Bengal, India. It is uncertain as to why these two cities should be included on the dial. One possibility is that the dial was specially made for someone, perhaps a diplomat or a merchant, who had reason to travel to these cities. The dial is in very fine condition. “A Coslou,” possibly the name of an owner, is scratched on the base.

Bernier equinoctial sundial

Diptych Dial, Chinese

Boxwood dial, 2 x 2 ¼ inches, consisting of two leaves that fold together when not in use. On leaf Ia is a lunar volvelle, marked by Chinese characters. Six further Chinese characters in red paint read: “Moon plate” and “Combined Sun and Moon dials.” The volvelle is used with a brass screw pin, which is stored in a hole in the upper leaf. Leaf Ib features a vertical dial, within which four Chinese characters read: “The tiny shadow [i.e. time] is precious.” Leaf IIa displays the horizontal dial. In the centre of the dial is a grey metal compass with the cardinal points marked in black around it (red for South). The needle is reddened at its South end and the glass plate is held in place by a black ring. Down the sides of the dial are holes for setting the angle of the lunar dial. There is a black string gnomon that is attached between the two leaves. Leaf IIb carries instructions for the dial's use in Chinese characters. There are additional characters on the sides of the bottom leaf. This description is from a nearly identical dial at the National Maritime Museum, Greenwich. The dating of Chinese instruments is difficult, estimate for this instrument is 1780-1850. Additional details could be obtained by translation of leaf IIb and the sides.

Chinese Diptych Dial

Universal Equinoctial Sundial for South America, c1870

This is a brass hexagonal universal equinoctial sundial, 12 x 12 cm, for South America. It is labeled on the compass "Schwalb Hermanos Lima." A silvered compass box with circumferential degree scale is embedded in the center of the plate. The compass has a needle lift mechanism. The hour dial, in the form of an open ring, is adjustable in inclination according to the latitude of the place of observation. The degree of latitude is given by an arc, foldable and graduated in degrees from 0° to 75°. The gnomon is a slim brass rod mounted on a pivot axis. There is a bubble level and three leveling feet. The top of the plate is marked with the latitudes for Rio Janerio (22°), Bahia (13°), Lima (12°), Monte Video (34°), Buenos Ayres (34°), and Valparaiso (33°). The construction of this dial is very similar to those made in England and France at the time. It is possible this sundial was made in Europe for the South American market and Schwalb was a dealer.

Equinoctial sundial for South America

Sundial, Japan, 19th Century

This sundial is constructed of brass with a 3 5⁄8 inches (9 cm) diameter main plate rising on three cabriole legs and mounted with a hinged spring-loaded gnomon (for 35° latitude, as Kyoto or Tokyo), and with a fine doubly-gimbaled compass. The plate is engraved with thirteen evenly spaced concentric semicircles (labeled for the months), crossed by six non-circular hour lines (labeled for daytime hours and half hours) and orthogonal hour/direction lines (labeled for the principal compass headings). The glazed compass has a finely cut needle and a silvered rose with twin concentric scales, the outer with twelve direction zones each subdivided into ten parts, the inner with the twelve but all reversed east/west. The sundial is unique to the Japanese culture. Condition is very fine and all original throughout. Probably early 19th century. ex John Reed collection.

This elegant table dial gives time on the old temporal system whereby the interval from dawn to dusk was divided into six hours numbered sequentially 6, 5, 4, 9, 8, 7. The length of an hour was dependent on the season. With the present dial, the time is read on the hour line where the gnomon's shadow crosses the current month's semicircle. A similar system known as the Nagamata scale of variable hours was used on early Japanese clocks where the horizontal clock "hand" was read against a plate with thirteen vertical month lines crossed by arcuate hour lines.

Japanese Sundial

Equinoctial Sundial, China, 19th Century

Chinese Equinoctial Sundial

This is a Chinese folding string-gnomen sundial. It measures 16.7 cm long, 11.2 cm wide, and 4.8 cm high. The ornate plate is cast brass with floral decoration and three blue and one green glass jewels. These probably represent the cardinal points. The compass is inset in the center and surrounded by an enamel hour dial with Chinese and Arabic numerals. As with antique Chinese compasses, the needle points south. A folding bracket holds one end of the string gnomen and the plumb bob. There is a decorated bubble level and three leveling feet with red glass caps. The bottom brass leveling frame is in place. The sundial is in very fine working condition. The gnomen string, plumb bob, and three bottom screws are replacements.

Universal Equinoctial Sundial, French, c1840

The seven-sided brass body measures four inches across, set with three leveling screws, two spirit levels, hinged equatorial arc (divided every quarter hour from 4 AM to 8 PM and mounted with pin gnomon), and hinged latitude arc (divided every degree 0º–65º). In use, one sets the equatorial arc against the observer's latitude (thus placing the arc parallel to the plane of the earth's equator), sets the gnomon vertically north (in summer; south in winter) and thus parallel to the earth's polar axis, and reads the apparent solar time by the gnomon's shadow on the arc. There is an inset glazed compass for orienting the dial with silvered face and circumferential degree scale, and with a bold arrow for magnetic north. The needle has a red stone pivot and external needle lifter. The dial is housed in a decorative octagonal case. The dial is of the highest quality and is in excellent condition.

Universal Equinoctial Sundial

Lodestone, Early Eighteenth Century

A lodestone was essential equipment for navigation at sea, being required from time to time to remagnetize compass needles. Its power was considered magical, and its value great. This lodestone measures 1 ⅝" (4 cm) wide and ½" (12 mm) thick. It is constructed with a slab of naturally magnetic magnetite stone sandwiched between two iron pole pieces at the ends. The iron bands "arm" the lodestone increasing its attractive force by concentrating the lines of force of the magnetic field. The whole is bound in brass and with a brass suspension ring. Condition is fine noting some rust to the iron, and one mounting nut lacking. The stone retains slight attractive power. The small size of this lodestone indicates use for pocket compasses, small surveying compasses, and sundial compass needles.

Lodestone

American Pewter Window Sundial, c1762

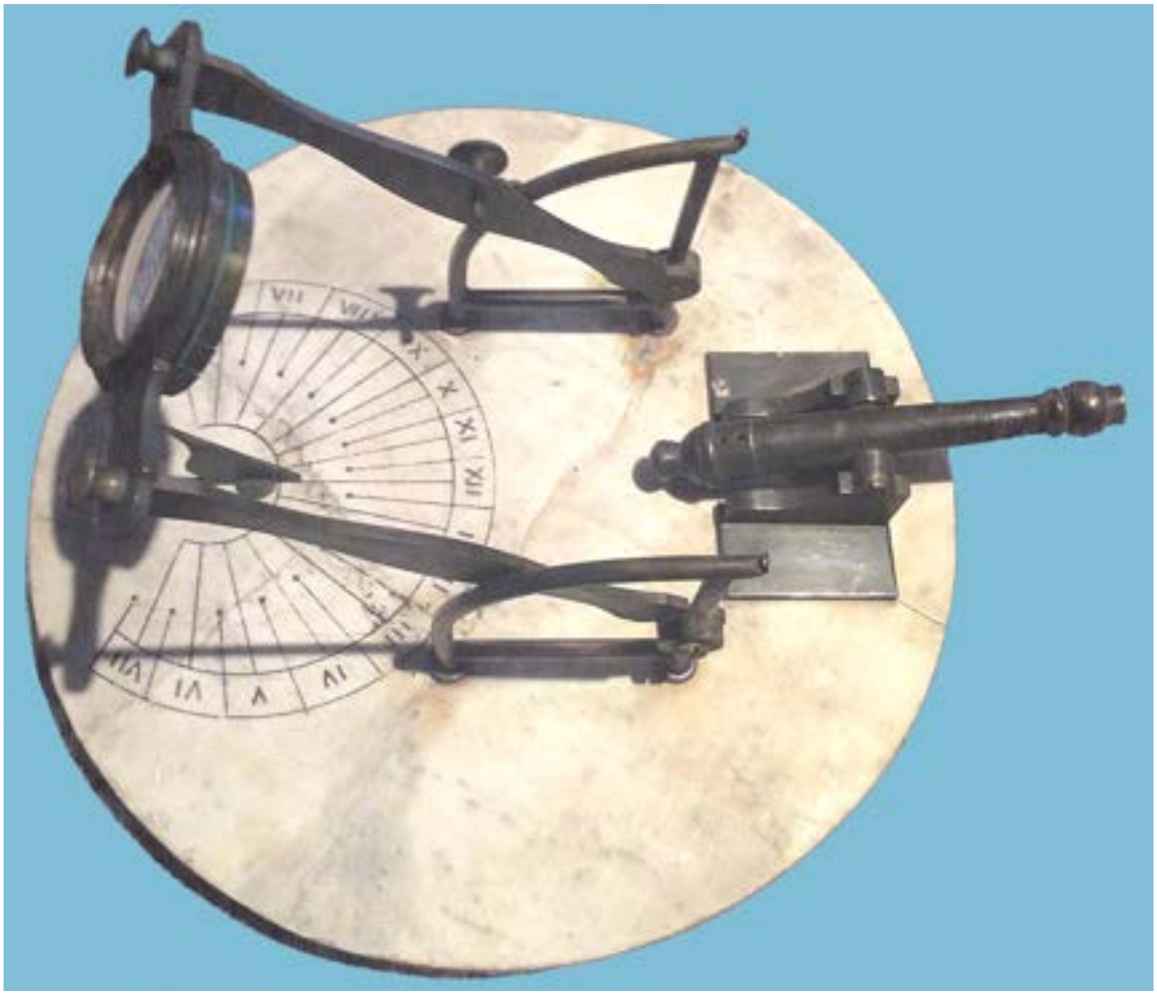
A sundial is a device that tells the time of day by the position of the sun. In common designs such as the horizontal sundial, the sun casts a shadow from its style onto a surface marked with lines indicating the hours of the day. The style is the time-telling edge of the gnomon, often a thin upright rod or a sharp, straight edge. As the sun moves across the sky, the shadow-edge aligns with different hour-lines. The earliest sundials known from the archaeological record are the Egyptian obelisks (3500 BC). Presumably, humans were telling time at an even earlier date from shadow-lengths of sticks set in the ground.

This is an American pewter window sundial. It is a traditional form of early American dial, often mounted in Colonial times on south-facing window sills. It is dated "1762" in the mold. The dial is 4 ½ inches (11.5 cm) in diameter and has a fixed gnomen for 42 degrees North latitude (that of Connecticut) and a chapter ring with raised divisions every 15 minutes from 5 AM to 7 PM. There are three mounting holes. Condition is fair with dark patina and some flaking.

American Pewter Window Sundial, c1762

Noonday Canon Sundial, French, c1820

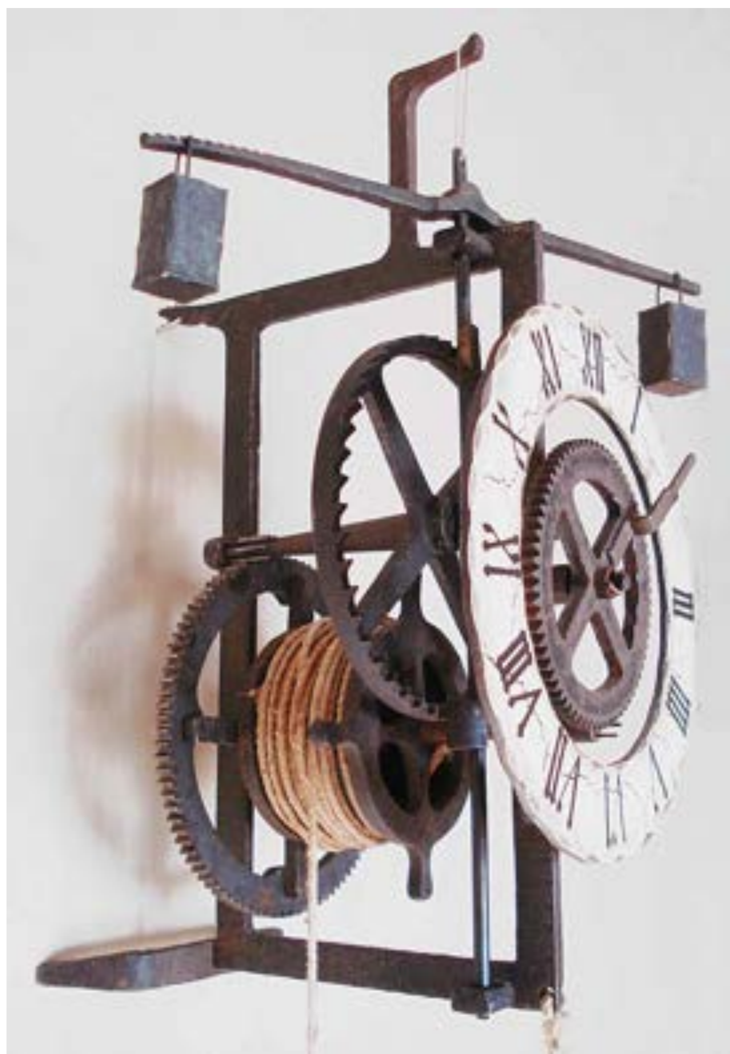
A noonday cannon sundial is a device consisting of a sundial incorporating a cannon. An overhanging lens concentrates the rays of the sun lighting a fuse causing the cannon to fire at noon, when the dial is properly oriented along a north-south axis. They were used by royalty, in estates to signal the time for the midday meal, and in European parks to signal noon. The sundial has a heavy 12-inch diameter, one inch thick circular white marble base holding the brass 5 ½ inch cannon on trunnions, sundial with gnomon, and quadrant arches supporting the magnifier. The plate is engraved with an hour scale in Roman numerals from V to VII. The sundial is probably French, c1820.



Noonday Canon

Gothic Style Verge and Foliot Mechanical Clock

Instruments to measure time originated in antiquity and included the obelisk, sundial, oil lamps with marked reservoirs, candles marked in increments, hourglass, water clock or clepsydra, and, in the Orient, small stone or metal mazes filled with incense that would burn at a certain pace. The first all-mechanical clocks were probably developed by monks in central Europe in the thirteenth century. They were made possible by the invention of the verge and foliot escapement mechanism that converted energy from a falling weight into periodic oscillations which are then used to measure the passage of time. The first clocks did not have dials or hands and only struck bells on the hour to tell the time for prayers or church attendance. These early clocks were very large and were made of heavy iron frames and gears forged by the local blacksmiths. Large mechanical clocks, with an hour hand only, began appearing in the towers and cathedrals of English and Italian cities as early as 1270. The early clocks were not accurate and could be off by plus or minus an hour a day. The first domestic clocks, in the early fifteenth century, are miniature versions of the cathedral clocks and show the time by means of a single hand on a 12-hour clock face. In subsequent years, the invention of the spring-driven mechanism and the pendulum greatly improved the accuracy of clocks. The development of accurate clocks was of as great importance as was the development of instruments in the advancement of sciences such as astronomy, physics, navigation, and chemistry where accurate time measurements are required.

Gothic Style Verge and Foliot Mechanical Clock

This is an old, possibly nineteenth century, replica of an early German mechanical clock (eisenuhr). It may be modeled after a clock in the Mainfrankisches Museum, Wurzberg which is dated to 1350. It is a weight driven iron gothic style wall clock with foliot controlled verge escapement and white painted dial. The escapement allows a toothed crown wheel to turn, one tooth at a time, by successive teeth catching against two pallets projecting from the upright rod or verge. The pallets are not parallel, but are oriented with an angle in between them so only one catches the teeth at a time. As the clock's gears turn the crown wheel, one of its teeth pushes on a pallet, rotating the verge in one direction, and rotating the second pallet into the path of the teeth on the opposite side of the wheel, until the tooth pushes past the first pallet. Then a tooth on the wheel's opposite side contacts the second pallet, rotating the verge back the other direction, and the cycle repeats. The result is to change the rotary motion of the wheel to an oscillating motion of the verge. The speed of its oscillation is regulated by a horizontal bar or balance beam known as a foliot attached to the top of the verge. The time taken in the foliot's swing can be regulated by moving weights in or out on each arm. Each swing of the foliot allows the wheel train of the clock to advance by a fixed amount, moving the single hand forward at a constant rate. Power is provided by a single lead weight with pulley unwinding a rope from the barrel and turning the crown wheel. The overall height is 10 inches, dial diameter 5 ¼ inches, and 6 inch projection from the wall. It weighs about eight pounds with weights. The clock is in very good condition noting only very slight rust in a few places. It works for a duration of less than 12 hours without rewinding. This clock is a useful device for demonstrating the operation of the verge and foliot escapement of the earliest mechanical clocks.

Hourglass

An hourglass or sand timer is a device used to measure the passage of time. It comprises two glass bulbs connected vertically by a narrow neck that allows a regulated flow of a substance, usually sand, from the upper bulb to the lower one. Typically the upper and lower bulbs are symmetric so that the hourglass will measure the same duration regardless of orientation. The specific duration of time a given hourglass measures is determined by factors including the quantity and coarseness of the particulate matter, the bulb size, and the neck width. The hourglass began to be seen commonly in the 14th century. They were very popular on board ships, as they were the most dependable measurement of time while at sea. Multiplying the ship's speed as measured by the chip log by the time the ship's course had been kept as measured by the hourglass, gave the distance traveled. This allowed the navigator to plot the ship's position on a map. Hourglasses were commonly used in churches, homes, and work places to measure sermons, cooking time, and time spent on breaks from labor. After 1600, hourglasses became less widely used due to the development of mechanical clocks and watches. The marine hourglass was replaced by the more accurate chronometer developed n 1761. The "egg timer," a three-minute sandglass, is still used in the kitchen for cooking eggs. This hourglass is held in a 12 inch high frame consisting of four turned and carved wood pillars holding the 5¾ inch square endplates. The plates are enclosed by vinyl leather bands. The hourglass times 30 minutes. It dates to the first part of the20th century.

Elgin Chronometer, c1918

A longitude describes the location of a place on Earth east or west of a north-south line called the Prime Meridian. Longitude is given as an angular measurement ranging from 0° at the Prime Meridian to +180° eastward and −180° westward. The purpose of a chronometer is to measure accurately the time of a known fixed location, for example Greenwich Mean Time (GMT). This is particularly important for navigation. Knowing GMT at local noon allows a navigator to use the time difference between the ship's position and the Greenwich Meridian to determine the ship's longitude. As the Earth rotates at a regular rate, the time difference between the chronometer and the ship's local time can be used to calculate the longitude of the ship relative to the Greenwich Meridian (defined as 0°) using spherical trigonometry.

In the seventeenth and eighteenth century, accurate navigation at sea out of sight of land became of critical importance in exploration, colonization, international trade, and warfare. Many ships and lives were lost due to errors in navigation. Accurate navigation at sea out of sight of land was an unsolved problem due to the difficulty in calculating longitude. Navigators could determine their latitude by measuring the sun's angle at noon or, in the Northern Hemisphere, to measure the angle of Polaris (the North Star) from the horizon. To find their longitude, however, they needed a time standard that would work aboard a ship. The difficulty, however, was in producing a clock that could maintain accurate time on a lengthy, rough sea voyage with widely varying conditions of temperature, pressure and humidity. The problem was considered so intractable that the British Parliament in 1714 offered a prize of £20,000 (comparable to £2.66 million in modern currency) for the solution.

John Harrison (1693–1776) set out to solve the problem by producing a reliable clock that could keep the time of the given place across a long sea journey. Harrison was a self-educated English carpenter and later a clockmaker. Between 1730 and 1761, Harrison produced four marine chronometers. The last, a "sea watch," underwent sea trials and proved highly accurate. Due to bickering between boards and Parliament, Harrison never received the official award, but over the years he did receive payments of £23,065 for his work on chronometers which made him an extremely wealthy man.

This is a fine and original Elgin chronometer or deck watch in a gimbaled mahogany case. Serial number is 21869036. The 21 Jewel Father Time movement is free-sprung stem wind, lever set and adjusted to five positions. It winds and sets smoothly and keeps accurate time. The screw-off bezel has the original beveled glass crystal. The weighted screw-off movement cover is marked U.S.S.B., Ship Watch No. 2191. The original enamel dial and hands are near flawless, noting one small dent at eleven o'clock. The dial has a sub-seconds at the six o'clock position and a 40 hour wind indicator dial at the 12 o'clock position. The mahogany case has "ELGIN" on the front and the ship number (matching) as well as the original key for the inner box (5 x 5 x 5 inches). The outer deck case (7 x 7 x 7 inches) has a large brass locking hook and leather strap.

The United States Shipping Board was established during WW I to build and operate merchant ships to support the war efforts. Towards the end of the war, contracts were placed for over 1000 wooden ships, tugs, and barges, but most of the contracts were cancelled and only 589 ships were completed. Most of these were scrapped in the 1920s. Ship #2191 was the Peshewah, a cargo ship hull, design #1001. It was built by the Coos Bay SB Co. in Marshfield, Oregon. The ship was launched but not completed. The Elgin National Watch Company was a major US watch maker from 1864 until its closure in 1968.

Elgin Chronometer

Ansonia Figural Clock "The Artist," 1904

The Ansonia Clock Company's roots lie in the Ansonia Brass Company, founded by Anson Greene Phelps in 1844. Phelps supplied brass to Connecticut clock manufacturers until 1851, when he joined forces with two powerful clockmakers, Theodore Terry and Franklin C. Andrews, to create a clockmaking company of his own. Terry and Andrews, who had a successful clockmaking business in Bristol, sold half of their business to Phelps in exchange for cheaper brass materials. Thus, the Ansonia Clock Company subsidiary was born. In the 1870s, the Ansonia Clock Company separated from the Ansonia Brass Company and moved part of its production to New York. In 1883, the Connecticut factory closed, and by the late 1880s, Ansonia had opened sales offices in New York, London, and Chicago. Ansonia produced an extensive line of clocks focusing on stylish clocks including statue clocks, swinging clocks, mantel clocks, china cased clocks, and other novelty clocks. Production peaked 1914, when Ansonia was turning out 440 different models of clocks, but by 1920, that number had dropped to less than 140, and by 1927, it was 47. In 1929, Ansonia went into receivership just months before the stock market crash of 1929 ushered in the Great Depression.

This is an Ansonia figural or statue clock, "The Artist." It was made in 1904. It is 11 inches high, 14 inches wide, and 6 ½ inch deep. The artist with book is seated on the left and the clock is on the right. The richly sculpted cast metal alloy case has a deep bronze finish. The clock face has beveled glass inside a cast brass bezel and a porcelain dial. It has an eight day time and strike brass movement. A gong counts the hour and sounds the half hour. It is signed "Ansonia Clock Co. New York" on the movement in the back. The clock has been professionally cleaned and oiled and is fully functional.

Ansonia Clock

Navigation

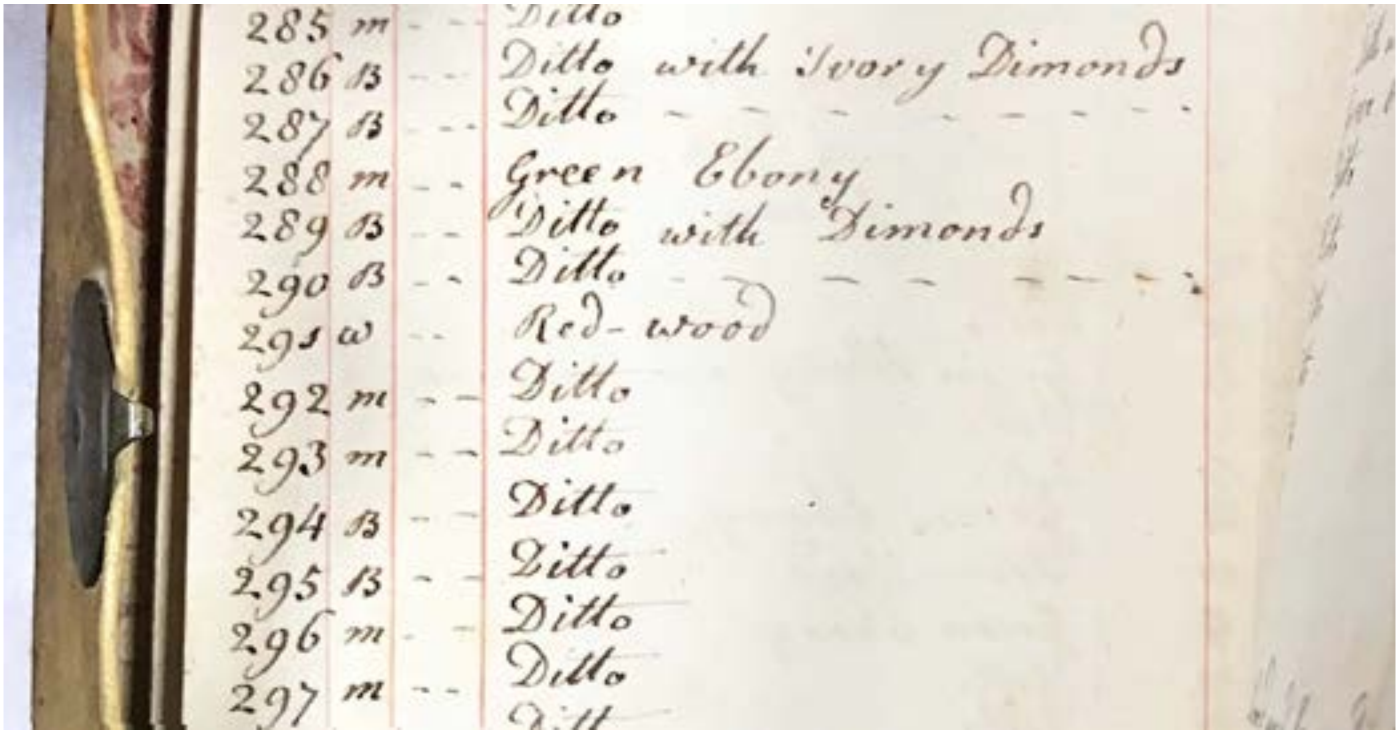
American Backstaff, Clark Elliott, New London, CT, 1761

The backstaff is a navigational instrument that was used to measure the altitude of a celestial body, in particular the sun or moon. It was invented by the English navigator John Davis who described it in his book *Seaman's Secrets* in 1594. In order to use the instrument, the navigator would place the shadow vane at a location anticipating the altitude of the sun. Holding the instrument in front of him, with the sun at his back (hence the name), he holds the instrument so that the shadow cast by the shadow vane falls on the horizon vane at the side of the slit. He then moves the sight vane so that he observes the horizon in a line from the sight vane through the horizon vane's slit while simultaneously maintaining the position of the shadow. This permits him to measure the angle between the horizon and the sun as the sum of the angle read from the two arcs. This angle was used to determine the latitude of the ship.

This is a rare American Davis quadrant backstaff by Clark Elliott (1732-1793), New London, Connecticut. The backstaff measures 24 ¼ inches in length. An inlaid ivory plate, partially effaced, on the long limb reads "M[ade by C El]liott New Londo[n] for Mr William Deming 1761." The frame is made of rosewood and the arcs of boxwood. The smaller arc is engraved from 0 to 60 degrees divided in degrees. The large arc has two scales, 65 to 90 degrees and 0 to 25 degrees, the latter scale divided every 10 arcminutes with transversal scale reading to one arcminute. The sight vane and horizon vane, made of walnut, are present and the shadow vane is absent (usually all vanes are missing). The brass rivets in the frame are capped by decorative ivory diamonds. The backstaff is decorated throughout with incised lines and punched stars. The end of the long limb and the horizon vane are numbered 295. The backstaff is in very fine condition noting only a few old chips and partial effacement of the ivory plate.

Backstaff, Clark Elliott, 1761

Clark Elliot apprenticed with Thomas Greenough (1710-1785), an American instrument maker in Boston. In New London, besides making instruments, Elliott published a *Connecticut Almanack* in 1768. His account book, which survives at the New London County Historical Society, lists the instruments he made. This backstaff is listed as being made of "Red-wood." William Deming was born about 1732 in Wethersfield, Connecticut, and died in 1811 in Wethersfield. He was called Captain, but his military record has not been ascertained.


285 m -- Ditto
286 B -- Ditto with Ivory Dimonds
287 B -- Ditto
288 m -- Green Ebony
289 B -- Ditto with Dimonds
290 B -- Ditto
291 W -- Red-wood
292 m -- Ditto
293 m -- Ditto
294 B -- Ditto
295 B -- Ditto
296 m -- Ditto
297 m -- Ditto

Elliott's Record Book listing #295

Octant, Eighteenth Century, American Provenance

An octant is a navigational instrument used chiefly at sea to measure the altitude of the sun or other celestial body in order to determine latitude. It is called an octant because its arc is one eighth of a circle (45°). It was independently developed around 1730 by John Hadley (1682–1744), an English mathematician, and Thomas Godfrey (1704–1749), a glazier in Philadelphia. Although an octant, it was called Hadley's quadrant to distinguish it from the earlier Davis quadrant or backstaff. It evolved into the sextant about 1757 but continued to be made as an octant with very few changes into the middle of the 19th century.

An octant consists of a frame having a graduated scale upon its arc, and an index arm, or alidade pivoted at its apex. Mirrors, called the index glass and the horizon glass, are fixed one upon the index arm and the other upon one side of the frame, respectively. When the instrument is held upright, the index arm may be swung so that the index glass will reflect an image of the sun upon the horizon glass, and when the reflected image of the sun coincides, to the observer's eye, with the horizon as seen directly through an opening at the side of the horizon glass, the index arm shows the sun's altitude upon the scale.

This is a 17-inch mahogany octant with ivory scale calibrated 0-90°, index arm with brass read-out, locking thumbscrew, and ivory vernier divided 10-15-5-10 and reading to 2 arc minutes. There is a double primary pinnula sight and another for back sighting and three interchangeable colored filters (2 solar/dark, 1 green). The cross arm holds an ivory pencil holder and has a blank ivory owners plate. The back has a small ivory plate for making notations. The octant is held in a stepped mahogany case. It is in fine, functional condition noting only some spidering of the primary index mirror.

The case bears a trade label "Robert King Mathematical Instrument Maker 212 Front Street New York." There is also a handwritten note reading "Volant sloop of Barnstable built at Barnstable in 1817." It lists the owners (10) and the Master, Isaac Bassett. It states "from original documents in New Bedford Custom House." Robert King (c.1789-1868) was an early American instrument maker from England who spent most of his career in New York City. He was at 212 Front Street from 1838 to 1843. The octant is considerably older than that so it is likely the case is a replacement. Boxes were often poorly-made and were often replaced by subsequent owners. The octant, which is unsigned, could have been made in the early 19th century for the Volant, but it closely resembles eighteenth century octants.

Octant

Weights and Measures

Methods for weighing and measuring were necessary for civilized communities that engaged in barter and trade in order to assess the amount or mass of the goods being exchanged. The first weighing machine was probably derived from the yoke when it was discovered that two equal masses would balance if they were suspended from a beam that was supported at its center. Balances were in use in Mesopotamia as early as 4000 years BC. They consisted of straight pieces of wood suspended by a cord passing through the center. Holes, pierced in the ends of the beam, carried cords suspending the scale pans. One pan was used for the goods to be weighed and the other held the weights. To prevent fraud, accuracy was necessary in the weighing of precious metals, coins, and drugs. The pound weight used by the Romans is derived from the Roman word *libra*, hence the abbreviation "lb" for pound.

Balance Scales, Roman, 1st - 2nd Century AD

This is a small pair of Roman balancing scales dating from the first or second century AD. Small Roman scales are often described as coin scales or medical scales. The scales are 2 ½ inches wide and made of bronze. Dual hooks that most likely held pans or baskets are suspended from the beam. The scales were suspended on a cord or hung on a hook. The scales may have been used to weigh gold or silver or small quantities of other high value goods. The scales are in good condition noting surface oxidation. Ex Museo Nazionale di Villa Giulia, Rome, de-acquisition, c1950's.

Jewelers Scale, Martinus de Backer, Amsterdam, c1690

Fine jewelers scale by Martinus de Backer (1661-1750) who came from a line of Amsterdam balance makers, which included his father Adolph Backer. Martinus worked under the sign of the Golden Balance in Oudebrughsteegh. The scale is housed in a rectangular wooden box (10.5 x 5.2 x 2.2 cm) with dark finish, beveled edges, and two cast brass hooks decorated with floral motifs. A coat of arms is carved on the outer lid with the initials DS. On the interior, a printed and hand colored master's label which reads "*Dese Gewichten maeckt Martinus de Backer inde Oude Brugh Steegh inde goude Munt Balans tot Amsterdam*." The label depicts death with an hourglass and justice with blindfold and scales. In the center is the coat of arms and lions of Amsterdam. The bottom of the box is lined with red silk. 6 brass weights are contained in fitting compartments. A compartment with a sliding lid holds a ~5 x 3 mm, 0.2 carat diamond. The steel scales are very finely made with round silvered bowls on green silk string and a small green silk tassel. The balance is file worked with decorative details. A small pearl adorns the end of the pointer. This balance most likely dates to the end of the 17th century, based on the decoration and early style of brass hook used. The balance is in excellent condition with the nearly complete label and all of its weights.


DESE GEWICHTEN
Maeckt
MARTINUS de BACKER
inde Oude Brugh Steegh
inde Goude Munt Balans
tot AMSTERDAM
10

Balance Scale

Clarke's Hydrometer, c1770

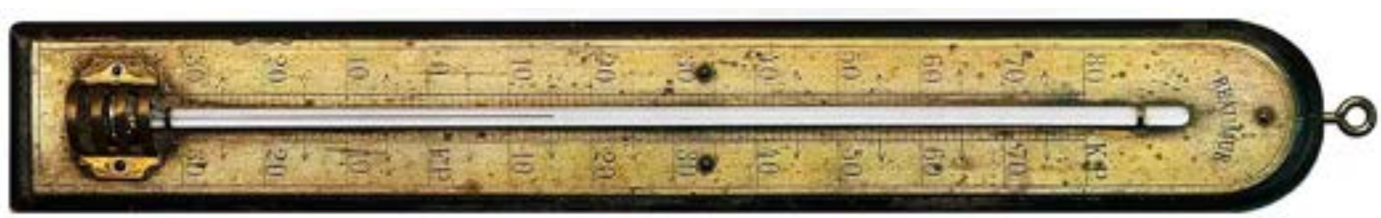
A hydrometer is an instrument used for measuring the relative density of liquids based on the concept of buoyancy. It makes use of Archimedes' principle; a solid suspended in a fluid is buoyed by a force equal to the weight of the fluid displaced by the submerged part of the suspended solid. The lower the density of the fluid, the deeper a hydrometer of a given weight sinks; the stem is calibrated to give a numerical reading. Clark's hydrometer was first introduced around 1725 by John Clarke, a "turner and engine worker," and described in the *Philosophical Transactions of the Royal Society* by J. T. Desaguliers in 1730. It was adopted by the English Excise Department in 1762 and was made the legal definition of proof for levying duty by an act of Parliament in 1787. This brass set consists of a spherical copper float 1 ⅜ inches in diameter attached to a flat rod with a counterpoise at the bottom to provide stability. There are 31 adjustment weights (only one missing) to adapt it to spirits of different specific gravities and all 11 "weather weights" to correct for variations in temperature. There is an ivory-backed mercury thermometer marked “J. LONG LONDON.” The rod is stamped with “CLARKE”, “IMPORT”, two 1 to 10 scales, and has the London Guildhall dagger mark and the number “5320.” The set is housed in a lined mahogany case 8 ¾ x 4 ¾ x 2 inches. The set is in excellent condition and remarkably complete with only one missing weight.

Clarke’s Hydrometer

Réaumur Thermometer

The Réaumur temperature scale, also known as the "octogesimal division,” was established in 1730 by the French naturalist René-Antoine Ferchault de Réaumur (1683–1757). It used alcohol in the tube and zero was set at the freezing point of water and 80 degrees was set at the boiling point of water at normal atmospheric pressure. The Réaumur scale was used widely in Europe, particularly in France, Germany, and Russia. By the 1790s, France had chosen the Celsius scale, rather than the Réaumur measurement, but it was used commonly in some parts of Europe until at least the mid-19th century. By the late 19th century it had been almost completely supplanted by the Fahrenheit and Celsius scales.

The thermometer consists of a glass tube and a brass scale mounted on a wood plaque with a hook for hanging. It is 12 inches long and 1⅝ inches wide. The plate is labeled Reaumur at the top. The scale is -30 to 80. The brass is tarnished. The thermometer is functional.



Réaumur Thermometer

DeGrave, Short & Co Diamond Balance, c1860

This a diamond balance by DeGrave, Short & Co, prominent makers of balances in London, in a fitted case. The balance consists of a steel handle and a balance beam, pointer attached to the beam, and two brass pans suspended from the arms by string. The cross beam is 4 ½ inches long and the pans are 1 ½ inches in diameter. There is a complete set of eight weights from one to 64 carats. The weights are held in individual recesses under a hinged wooden cover in the case. The wooden case is 5 ½ x 3 x 1 ¼ inches. Ornate brass tweezers for the handling of gems slide into a recess in the side of the case. A paper table of the monetary value against weight in carats and the maker's name and address is on the inside of the lid. The balance is in excellent condition with no corrosion and the case is very fine.

DeGrave, Short & Co Diamond Balance

Chinese "Opium' Scale

This is a dotchin, a type of steelyard scale consisting of a pan suspended from an arm with a sliding weight counterbalance. In use, a load is placed on the pan and the weight is moved along the arm until the scale balances. They were made in China between 1800 and 1920 and were used by merchants. Many were brought to America by Chinese immigrants following the discovery of gold in California. Although they became known as "opium scales" in the late 19th century, they were actually used to weigh many different kinds of small objects, such as coins, gems, and pharmaceutical drugs. The scale is held in a wooden violin-shaped case, 12 inches long. The case is made of two parts that pivot open at the rounded end. A plaited closer hold the halves together when closed. The inside has grooved spaces for the ivory beam with its marked scale, brass weight, and brass pan. The pan and the weight are both suspended by white thread. The threads from the pan are attached to a small ring that is attached to a larger ornate ring at end of the rod. The rings each have an inner pointer. The balance is level when the two pointers are aligned. There are two decorative tassels on strings attached to the rod. There are Chinese letters on the case and pan and a label inside on the recess for the pan. The scale is complete and in fine working condition. There is an example in the Smithsonian with an article on the dotchin scale by a curator.

Opium Scale

Fairbanks Postal Scale, 1859

Thaddeus Fairbanks (1796 –1886) was an American businessman, mechanic, and engineer. He invented furnaces, cooking stoves, cast iron steel plows, and other metal items related to farming. In 1815, he moved with his family to St. Johnsbury, Vermont, from the old Fairbanks' homestead in Dedham, Massachusetts. He then constructed an iron foundry with his brother Erastus, who later became Governor of Vermont. They established a new business partnership E. & T. Fairbanks to make furnaces for heating, cooking stoves, cast iron plows, and farm implements. Fairbanks' most famous invention was the platform scale for accurately weighing heavy objects The design was patented in 1831. Besides making platform scales for weighing up to 250-ton freight cars, he made scales for weighing milk containers at creameries, scales for fine weighing from a feather or a phonograph needle to 10 pounds as required by merchants, photographers, druggists, cloth sellers, and postal workers. Fairbanks platform scales are still made in Saint Johnsbury, Vermont.

Postal clerks used scales to weigh each letter and accurately calculate the postage. Until the early twentieth century most postal scales were small in both size and capacity because the Post Office Department had a package weight limit of four pounds. With the introduction of parcel post in 1913, post offices acquired larger scales that could accommodate packages up to seventy pounds. Until the 1990s most letter scales were mechanical, but today electronic scales are the most common.

This is an early Fairbanks postal scale. It consists of a 3 ½ x 4 ½ inch cast iron base pedestal. The 3 x 3 ¾ inch brass tray, balance arm, and sliding counterbalance are brass. The brass arm extends 6 ¼ inches out from the pivot. The arm is marked in ½ ounce increments up to 9 ½ ounces. The base is embossed with E & T Fairbanks VT.” One side of the end of the arm is marked “FAIRBANKS” and the other side “PATENTED NOV 8 1859.”

Fairbanks Postal Scale

Georgian Stick Barometer by Thomas Wright

This is a mahogany stick barometer with an integral thermometer. The instrument is 36 inches long. The mahogany case has an exposed mercury tube. The case consists of a compartment at the top and a long trunk to the cistern below with a mahogany hemispherical cover. The top compartment with a cornice and glass front holds the engraved brass register plate. It is signed Thomas Wright, Sarum. The barometer scale is calibrated from 28 to 31 inches with weather indications from “Stormy” to “Very Dry.” There is a sliding brass pointer next to the barometer scale. The thermometer scale is calibrated from -10º to 120º Fahrenheit and engraved with temperature indications from “Freezing” to “Fever Heat.” The plate is also engraved with the alchemist symbol for mercury. Most of the mercury has been removed for safety regulations but can be replaced. The age of this barometer is uncertain. The style is consistent with the second half of the eighteenth century but this is most likely a late nineteenth century reproduction. The barometer is in fine condition.

Georgian Stick Barometer

Wheel Barometer, c1840

One class of philosophical instruments demonstrated effects of heat and meteorology. For example, an apparatus showing the effects of heat was the thermoscope, devised by Galileo around 1592, which used a column of water in a spiral glass tube which rose as air in a bulb expanded with heat. The thermometer, derived from the thermoscope, is used to measure temperature. The hygrometer, devised by Robert Hooke in 1663, demonstrates the humidity of the air. The barometer, invented by Evangelista Toricelli of Florence Italy in 1643, is designed to measure the pressure or weight of the air. These instruments did not become widely available to the general public until 1800. In the nineteenth century, they were often combined in attractive mahogany cases.

This is a five dial wheel or banjo barometer measuring 39 inches high by 10 inches wide. It is in a banjo-shaped, mahogany-veneered case with boxwood stringing to the edge and a swan neck pediment and brass finial. The top dial is a hygrometer with silvered and engraved scales showing Damp/Dry. Next is the spirit thermometer on a silvered brass plate with various levels of temperature engraved on it. The third is a three-inch diameter mirror in a wood surround. The fourth is the barometer with a silvered and engraved eight-inch dial, showing the weather patterns and labeled Chanóe. Just beneath the dial is a turn key for the Rise/Fall indicator on the dial (knob missing). The last dial is the spirit level. The barometer mechanism is enclosed behind a door in the rear of the case. Wheel barometers are mercury column barometers operating with a "J" tube. A float in the mercury column rises and falls with changes in air pressure. The float is tied on a string that goes over the wheel and is held taught by a counterweight. As the wheel turns, the hand on the dial is moved giving the reading. There is a paper label pasted on the back explaining use of the barometer. The barometer is very attractive and in generally good condition. A defect is that the wooden scrolls on the pediment are missing and have been remodeled in clay and painted. The mercury tube and wheel mechanism in the case are intact.

Wheel Barometer

Sikes Hydrometer, c1880

This is a complete Sikes hydrometer set manufactured by Buss, 33 Hatton Garden, London, Maker to the Revenue, c1880. A hydrometer is an instrument used to determine the strength of spirits providing an accurate method of determining alcohol proof, strength, and percentages. Sikes's hydrometer was enshrined in legislation in 1816 with the Sikes Hydrometer Act and remained the legal standard until 1907. The set includes an ivory-backed mercury thermometer, brass float, nine brass weights graduated from 10 to 90, brass end block, and a boxwood slide rule. The slide rule was used for temperature correction of readings. The float and weights are individually marked with the serial number 20404 and all parts are labeled "Buss." The set is contained in a velvet and silk-lined inlaid mahogany case (9 ¾ x 4 ¼ x 2 inches). An ivory cartouche on the lid contains the Royal Coat of Arms and the maker's name and address. The silk lining is worn and the clasps on the case are missing. Otherwise, the set is in very good condition.

Sikes Hydrometer

Lionel CD V-700 6B Geiger Counter, 1962

This instrument is a relict of the cold war. The CD V-700 is a Geiger counter employing a probe equipped with a Geiger–Müller tube. It was manufactured by several companies under contract to US federal civil defense agencies in the 1950s and 1960s. This unit is quite sensitive and can be used to measure low levels of gamma radiation and detect beta radiation. According to the *Radiological Defense Planning & Operations Guide*, the CD V-700 can be used "(1) in long term cleanup and decontamination operations, (2) for personnel monitoring, and (3) for indicating the degree of radioactive contamination in food and water." Tens of thousands of these units were distributed to US state civil defense agencies and placed in fallout shelters. Even though large numbers have been sold off as surplus to civilian users, many remain in use with first responders and state emergency management agencies today. Operationally this instrument consists of a radiation detector, a regulated high voltage supply, electronic circuitry for pulse shaping and metering, and an indicating meter and headphone for audible detection of radiation. Ranges of this instrument are 0-0.5, 0-5, and 0-50 milliroentgens/hour. This example is a CD V-700 model 6B. It was made in 1962 by the Lionel Electronic Laboratories. It comes in its original box and has the original instruction manual, headphone, carrying strap, and the civil defense logo on the side. It uses two D batteries (not included). It is in very good condition except for some flaking off of paint in spots.

CD V-700 6B Geiger Counter

Calculation

Chinese Suanpan Abacus

The abacus, also called a counting frame, is a calculating tool that was in use centuries before the adoption of the written Hindu–Arabic numeral system. The exact origin of the abacus is unknown, but they were in use in ancient Mesopotamia, Egypt, China, Greece, and Rome. Originally they were beans or stones moved in grooves in sand or on tablets of wood, stone, or metal. Today, abacuses are usually constructed as a wooden frame with beads sliding on wires. They are still used by merchants, traders, and clerks in some parts of Eastern Europe, Russia, China, and Africa.

This is a Chinese abacus, known as the suanpan. The suanpan is first described in a 190 CE book of the Eastern Han Dynasty. This example consists of 13 wooden rods in a wooden frame. A separator beam separates two beads on each rod in the upper deck from five beads each in the bottom. The ones in the lower deck are sometimes called *earth beads* or *water beads*, and carry a value of 1 in their column. The ones in the upper deck are sometimes called *heaven beads* and carry a value of 5 in their column. The rightmost column represents the ones place and to the left of it are the tens, hundreds, thousands place, etc. Beads moved toward the beam are counted, while those moved away from it are not. The beads are rounded and made of a hardwood. Only one upper bead and four lower beads are needed for counting, addition, and subtraction. The other beads can be used for hexadecimal computation or more complicated mathematical calculations. Suanpan techniques have been developed to do multiplication, division, square root, and cube root operations at high speed.

The abacus has a 5 ¾ x 10 ½ inch red, wooden case with brass reinforcements and clasp. The top is covered with padded red leather decorated with a dragon and a phoenix. The inside is lined with paper bearing Chinese letters and scenes. The abacus is in excellent condition and probably dates to the middle of the twentieth century.

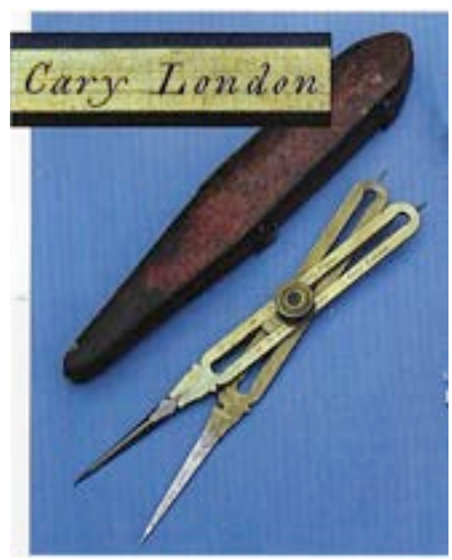
Abacus

Napier's Bones

This is a large set of Napier's bones, a manually-operated calculating device created by John Napier (1550-1617). Napier is best known as the inventor of logarithms. He also invented the so-called "Napier's bones" and made common the use of the decimal point in arithmetic and mathematics. In 1617, in the book *Rabdologie* he explained the use of his rods to guide one in the old Arabic lattice method of multiplication. In this set, there are 30 rods 6.4 cm long and made of wood bound in paper on all four sides. The papers are printed in ink with a multiplicand digit at the top and its products below. One rod bears the multiplier from 1 to 9. The rod 0 is needed for multipliers or multiplicands having a 0 in them. Several rods can be lined up to multiply a multi-digit number. The set is contained in a cardboard box. The rods are in excellent condition noting only slight discoloration to the paper in places. Nineteenth century.

Napier's Bones

Proportional Dividers



Proportional dividers by Cary, English, c late 18th century, signed "Cary, London," brass with inset steel points, 6 inches (15 cm) long, with proportional scales for solids, Plans, Lines, and Circles. They are elegantly designed, in excellent condition, and complete with original shaped Morocco leather bound case in worn condition. William Cary (c1759-1825), who announced himself as "apprentice to Ramsden," established a business in the Strand in 1789.

Protractor by Edmund Culpeper, c1700

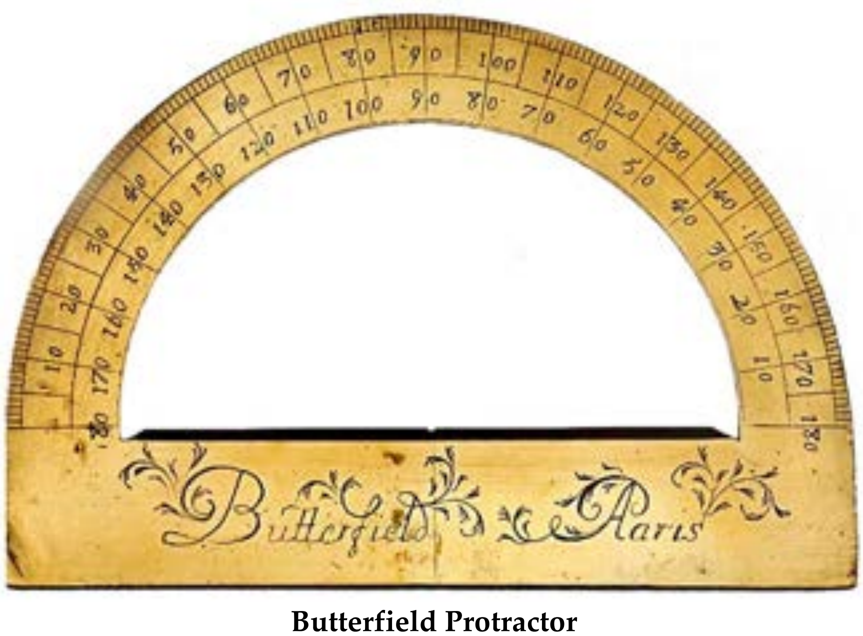
Culpeper protractor with transversal wings, English, c1700, signed "Culpeper Londini, and exquisitely engraved with an exuberant, subtly asymmetric, central foliate design. A protractor is an instrument used for measuring angles. The protractor is divided every degree from 0° to 180° and back, each 10° boldly numbered, and bears a double arc of polygonal angles from four-sided (square) ones to 12-sided (regular dodecagon) ones. Angled "wings" extend on both sides as transversals, each wing divided every five arcminutes from 0 to 60. This brass instrument measures 9 ¼ x 4" (23.5 x 10 cm) overall, and is in very fine condition throughout. Edmund

Culpeper (1660-1738) was a highly skilled English scientific instrument maker achieving fame principally in the optical and mathematical fields.

Culpeper Protractor

Protractor by Michael Butterfield, c1700

This is a brass protractor made by Michael Butterfield (1635-1724). He was a British clockmaker who moved to Paris in 1663 and established himself as a manufacturer of mathematical instruments and pocket sundials. He worked at the royal court and was appointed engineer to King Louis XIV. The protractor is four inches wide and 2 ¾ inches high with hand engraved inner and outer 180 degree scales. The straight edge is beveled. It is engraved “Butterfield AParis” in script with floral motifs.



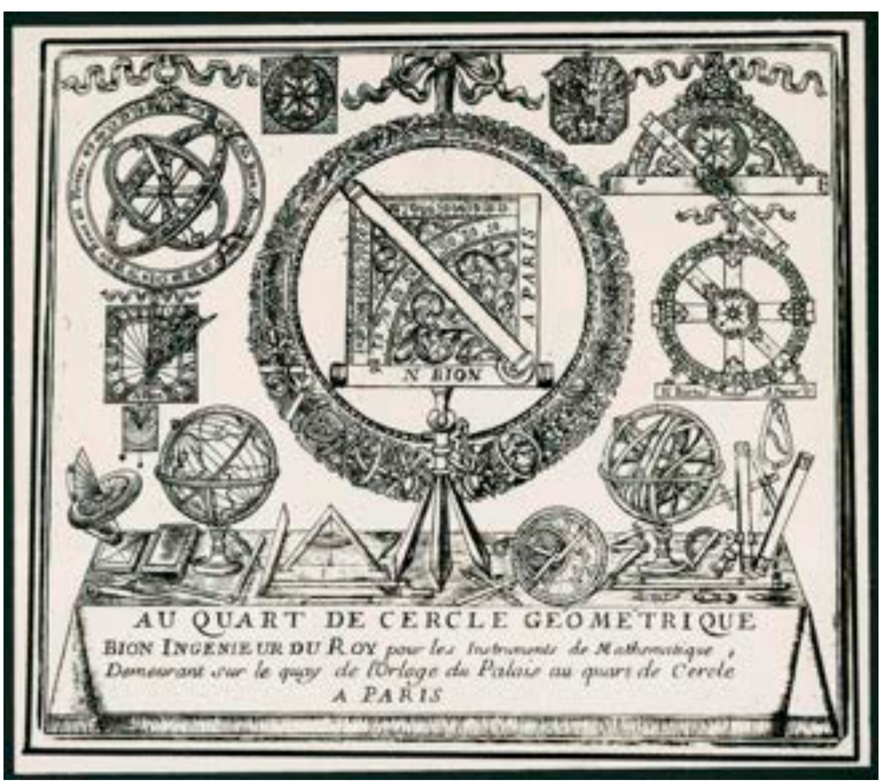
Butterfield Protractor

Bion Protractor, c1700

This is a brass protractor made by Nicolas Bion. The protractor is four inches wide and 2 ¾ inches high with hand engraved inner and outer 180 degree scales. The straight edge is beveled. It is engraved “Bion AParis” in script.

Bion Protractor

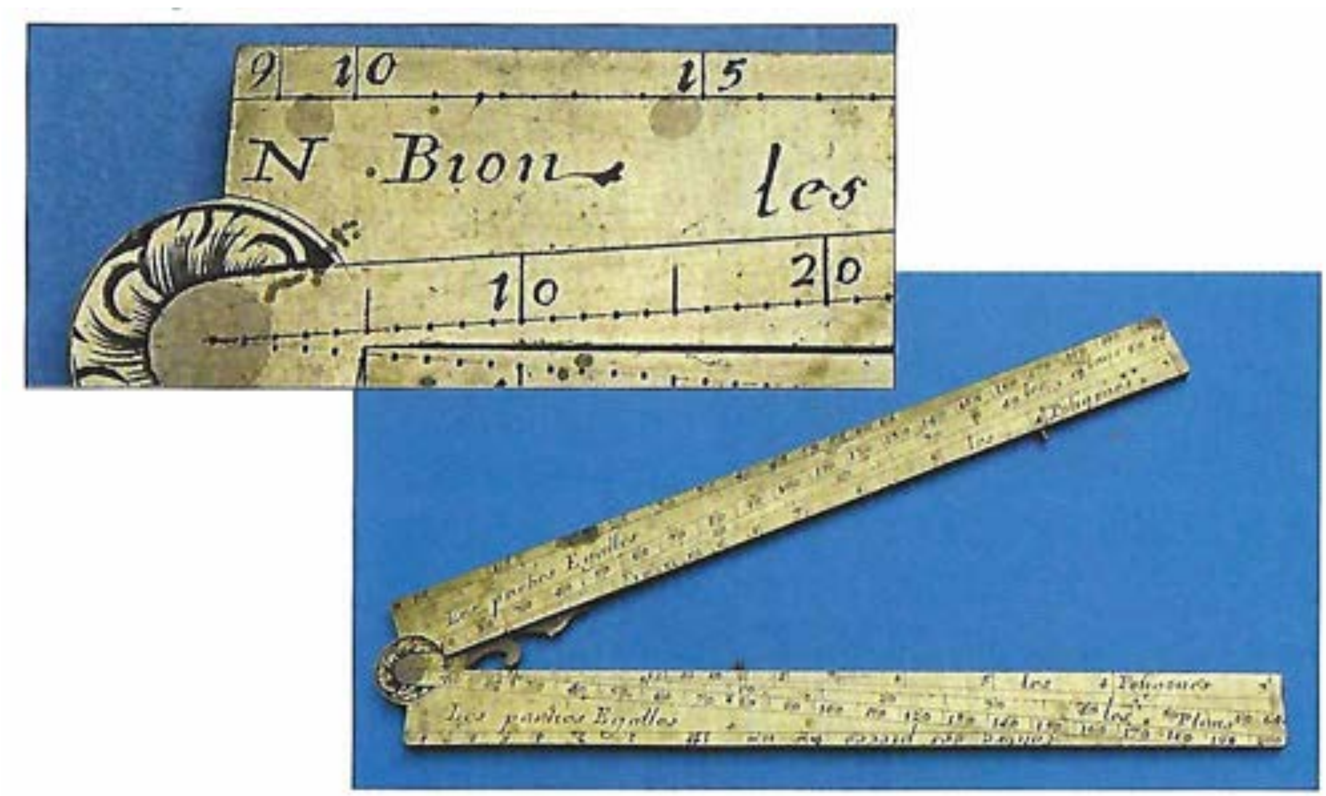
Nicolas Bion (1652-1733) was one of the most important makers of instruments in the late seventeenth and early eighteenth centuries. Bion made and sold mathematical instruments in Paris in his own shop and as royal maker for Louis XIV. His 1709 book *Traité de la construction et des principaux usages des instruments de mathématiques* has been described as "the most famous book devoted to instruments." A protactor and sector (see below) are present on the table in Bion’s tradecard.



Sector by Nicolas Bion, c1700

The sector, also known as a proportional compass or military compass, was a major calculating instrument in use from the end of the sixteenth century into the nineteenth century. It consists of two rulers joined by a hinge with a number of scales inscribed on the rules and is based on the principle of similar triangles. It was used with a caliper for solving problems in proportion, trigonometry, multiplication, and division, and for various calculations such as squares, cubes, reciprocals, and tangents of numbers. Its several scales permitted easy and direct solutions of problems in gunnery, surveying, and navigation.

Computing sector by Nicolas Bion (1652-1733), French, c1700, signed "N. Bion à Paris." This 6 ¾" (17 cm) long (closed) brass sector has the standard French system of mathematical scales as described by Bion in his 1709 *Traité de la construction et des principaux usages des instruments de mathématiques*. The quality of execution is fine, all hand engraved, and condition is fine. An excellent example by this great instrument maker.

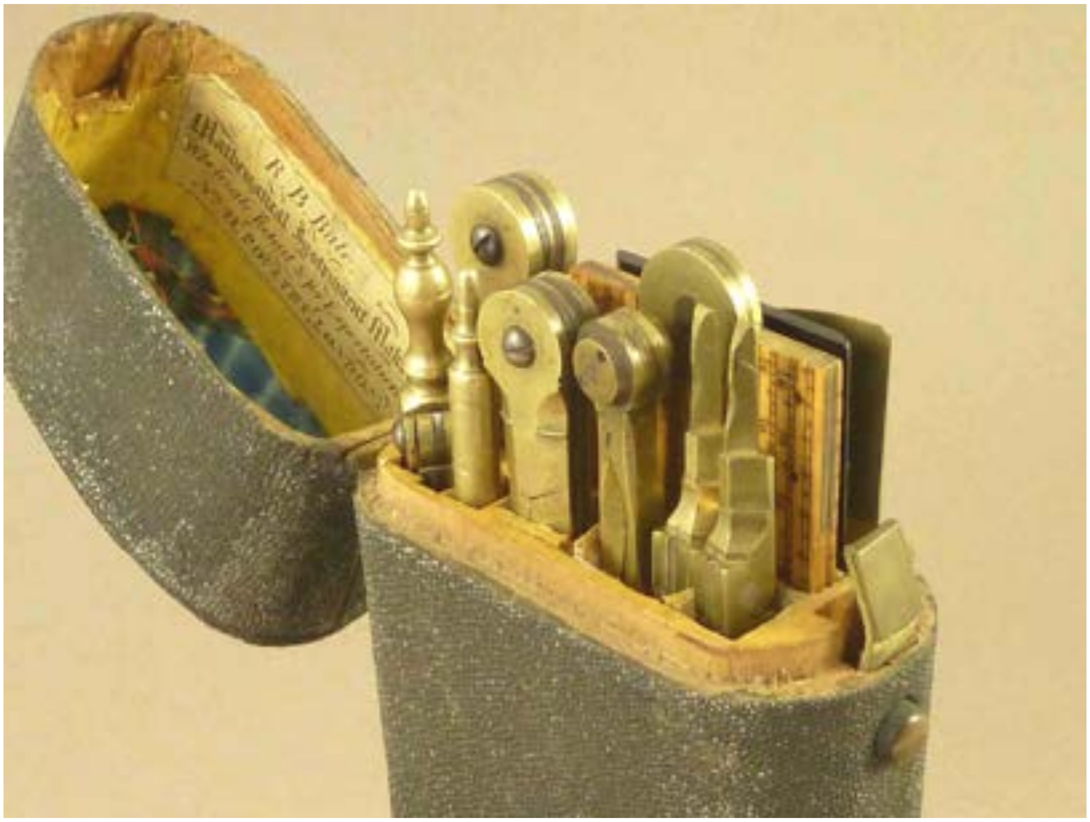


Bion Sector

Georgian Mathematical Drawing Instrument Set by R. B. Bate

This is a shagreen cased set of mathematical and drawing instruments. The instruments consist of three brass dividers of different sizes one with a fitting for pen and pencil holders, brass compass for pen, brass ruling pen, brass pencil and ink holders, boxwood sector, brass protractor, and ivory and brass parallel rule. The wooden case, covered in black rayskin, measures 6 ¾ inches (17 cm) in length, a tapered maximum width of 3 inches (7 ½ cm), and a maximum tapered depth of 1 ½ inches (3 ¾ cm). The case has a hinged lid, that when opened, reveals the instruments fitted into segmented compartments. A printed label inside the lid reads "R. B. Bate, Mathematical

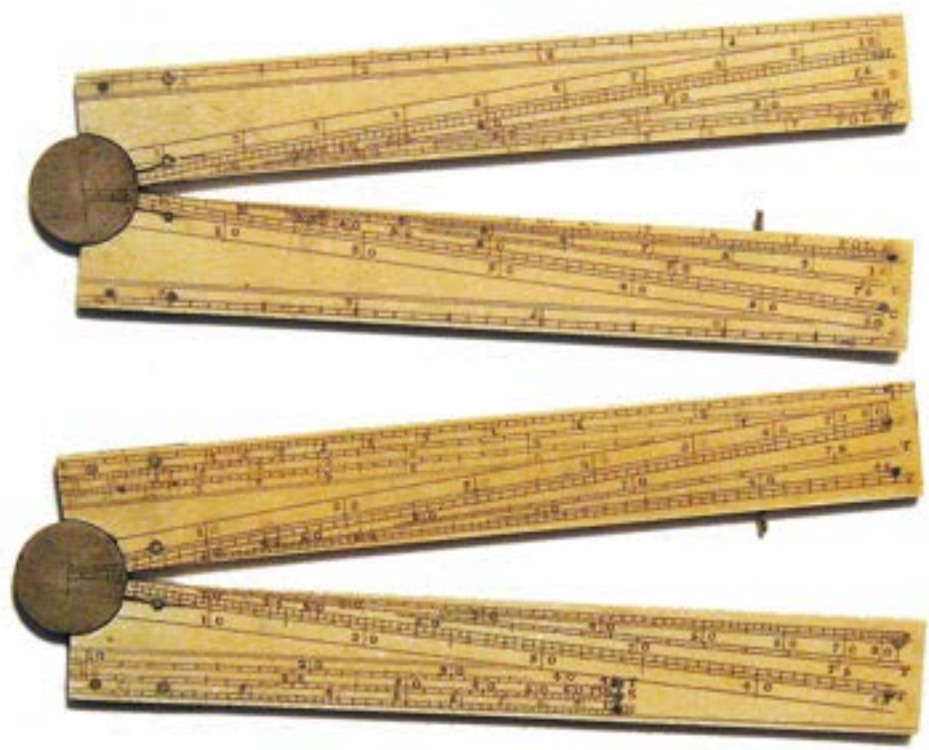
Instrument Maker, Wholesale Retail & for Exportation, No 21, Poultry London." The sector and protractor are signed. The set is in excellent condition.



Mathematical Drawing Instrument Set

English Ivory Sector, c1780

This is a small ivory sector nine inches long unfolded with a brass hinge and the two arms locking with a pin. Both sides have small inset brass pins at scale starts to protect the rule from the divider points at these frequently used places. There are three types of scales on an English sector: sectoral ones (radiating from the hinge center) that were used for calculation; plane scales (logarithms, sines, tangents) parallel to the edge; and rules (inches, tenths of feet). The scales permitted easy and direct solutions of problems in gunnery, surveying, and navigation. The sector is in excellent condition.

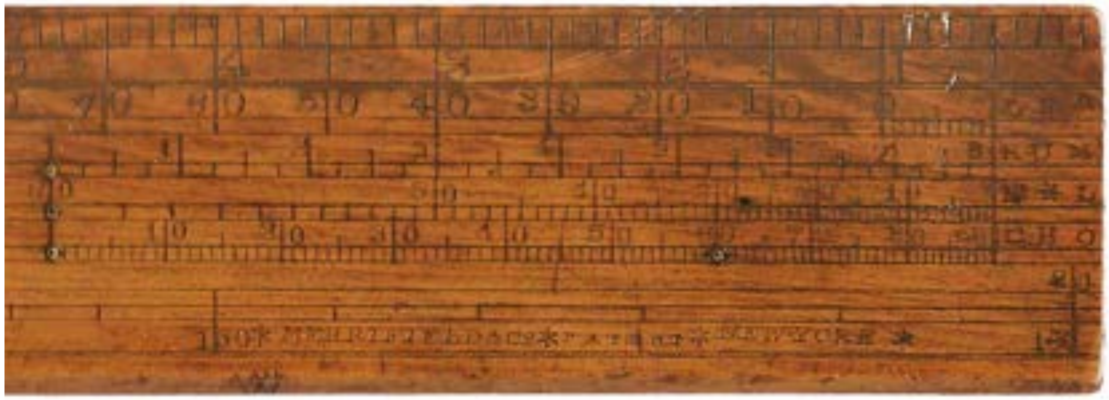


English Sector

Gunter's Rule (Scale) Signed Merrifield & Co.

In 1614 Scottish mathematician John Napier (1550-1617) announced his discovery of logarithms. Within eight years, Edmund Gunter (1581-1626), an English clergyman who was interested in mathematics, had devised a scale on which logarithms could be multiplied and divided, by measuring the distance between two logarithmic numbers with a pair of dividers. Shortly thereafter, instrument makers were manufacturing wooden rules with standard (or "natural") scales typically used in navigation on one side and Gunter's logarithmic (or "artificial") scales on the other side. This instrument, a precursor of the slide rule, became known as Gunter's rule or scale. Gunter's scale remained popular with ship's navigators until the end of the nineteenth century. Surveyors, mechanics, craftsmen, and retailers also used Gunter's scales to make logarithmic and trigonometric calculations.

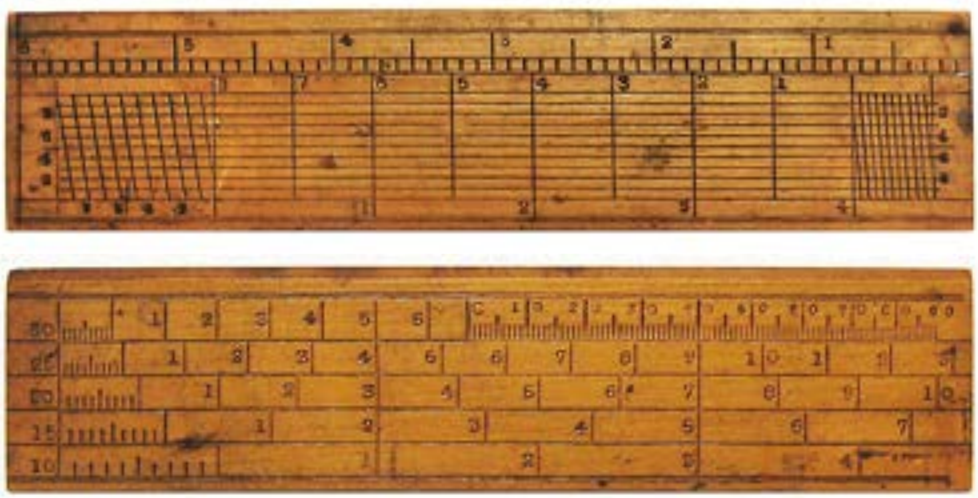
This boxwood Gunter's rule is two feet long. The top of one side has a scale of inches, divided to tenths of an inch and numbered by ones from 23 to 1. On the left are 10 inch and 9 inch (divided to ½ inch) plotting scales with diagonal scales at each end. In the middle are scales for rhumbs, chords, sines, tangents, and semitangents. On the right are scales for leagues, rhumbs, miles of longitude, and chords. Brass inset pins at the zero and 60° marks and elsewhere reduce wear from the points of dividers, which were used to transfer measurements between the scale and the user's drawing. The other side has logarithmic scales: sines of rhumbs, tangents of rhumbs, line of numbers, sines of degrees, versines of degrees, and tangent of degrees. At the bottom edge are a meridional line and a scale of equal parts that divides 23 inches into 17 sections. The sections are numbered by tens from 60 to 10 and from 100 to 0. On the side with the scale of inches, the rule is marked in the lower right corner: *MERRIFIELD & C° * PATENT * NEW YORK*. Merrifield & Co. sold Gunter's scales in Boston and New York in the early 19th century. The rule is in very fine condition.



Gunter's Rule

English Six Inch Boxwood Rule

This is an English six-inch boxwood rule with a diagonal scale on one side and a plane scale on the other. First quarter nineteenth century.



English Boxwood Rule

Abacus-form Financial Calculator, English, 1856

In the 1850s, James R. C. Appleby (1807-1891), a linsey maker and hosier from Shaftesbury, Dorset, England, devised a stylus-managed, financial calculating device based on the abacus. The beautiful thick-grained mahogany body of the device measures 14 ¾ x 4 x 1 ¾ inches (38 X 10 x 4.5 cm) closed. Mounted within are eight thick boxwood strips bearing 20 columns of manuscript numbers, giving various pounds, shillings, pence, and farthings. In between are four columns of copper (?) wires carrying sliding beads and boxwood markers, each column with 50-55 beads of two colors and five markers. It appears to permit monetary tallying and conversions. It is signed "Accountant Machine by J.R.C. Appleby, Saint James, Shaftesbury, Dorset, 1856." Condition is fine, noting oxidation of the wires, thus some beads tight, and a few beads possibly lacking. It is complete with the original stylus. A second, almost identical example is known, shown on the comprehensive History of Computers web site.

Abacus-form Financial Calculator

Texas Instruments SR-10 Handheld Pocket Calculator, 1973

The handheld pocket calculator was invented at Texas Instruments in 1966 by a development team that included Jerry D. Merryman, James H. Van Tassel, and Jack St. Clair Kilby. In 1974, a basic patent for miniature electronic calculators was issued to Texas Instruments. The patent is for personal-sized, battery-operated calculators that have their main electronic circuitry in a single integrated semiconductor circuit array. In 1972, Texas Instruments introduced it first scientific calculator, the SR-10. The SR-10 was described as an "electronic slide rule calculator," hence the "SR" in the name. It has semi-scientific functions, comparable to the capabilities of a mechanical slide rule, though initially at about ten times the cost.

This is an example of the first model of a scientific calculator, second version, issued by Texas Instruments in 1973 at a cost of $89.99. It is 6.3 x 3.1 x 1.5 inches in size and weighs 10 ounces. The calculator has a black and grey-colored plastic case with an array of twenty-three plastic keys. Twenty-one of these are square in shape, the 0 and the total keys are rectangular. In addition to ten digit keys, a decimal point key, a total key, and four arithmetic function keys, the calculator has a reciprocal key, a square key, a square root key, a clear key, a clear display key, a change sign key, and an enter exponent key. Text above the keyboard, just below the display and to the left, reads SR-10. Behind the keyboard is a 12-digit LED display. Numbers larger than eight digits are displayed in scientific notation. A mark behind the display reads TEXAS INSTRUMENTS with a state of Texas symbol above. An on/off switch is to the right behind the display.

The back edge of the calculator has a jack for a recharger/adapter. A sticker on the back gives extensive instructions. It also gives the serial number SR10 429033. Unscrewing screws near the top and bottom of the back reveals the workings of the calculator. It has a total of five chips. The main integrated circuit is the Texas Instruments TMS0120NC calculator chip, manufactured in mid-1973. It is surrounded by four smaller integrated circuits, two SN75493 and two SN75494, which interface the low-current capability of the MOS calculator IC to the high-current requirements of the LED display. Also in the case is space for three AA nickel-cadmium rechargeable batteries. The leather zippered case has both a loop and a hook for attaching the calculator to a belt. There is an instruction pamphlet entitled *Texas Instruments electronic slide rule calculator SR-10*, copyrighted 1973. The calculator is in excellent working condition and has the original box and all accessories. The batteries are new but should not be stored in the calculator.

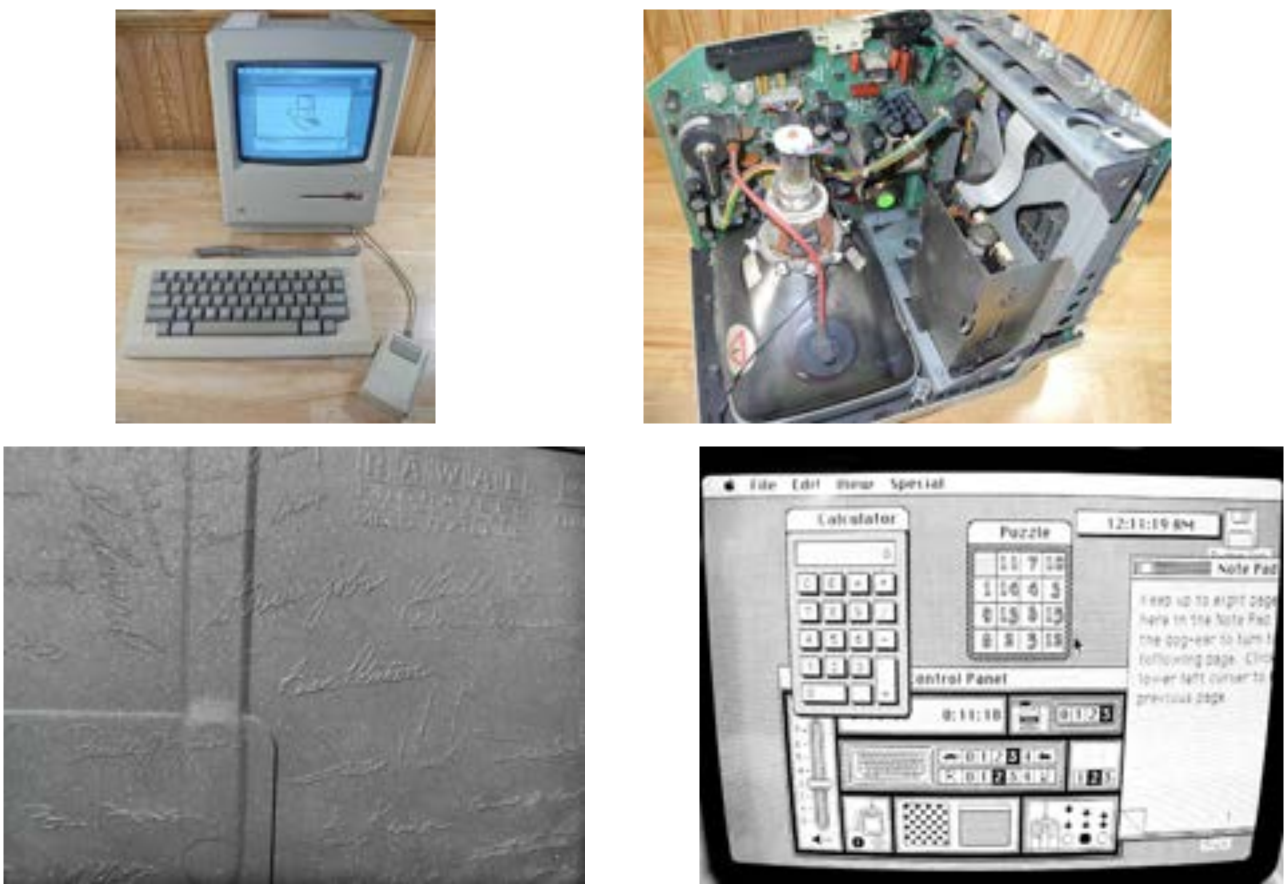
Texas Instruments SR-10 Handheld Pocket Calculator

Apple Macintosh 512K Model M0001W Computer, 1985

A computer is a device that computes or calculates. Although rudimentary calculating devices first appeared in antiquity and mechanical calculating aids were invented in the seventeenth century, the first 'computers' were conceived of in the nineteenth century, and only emerged in their modern form in the 1940s. Early devices included the tally stick, abacus, astrolabe, and Napier's bones. Historically, computers as known today evolved from mechanical computers and then from vacuum tubes to transistors. Charles Babbage, an English mechanical engineer and polymath, originated the concept of a programmable computer. Considered the "father of the computer," he conceptualized and invented the first mechanical computer in the early nineteenth century. The principle of the modern computer was first described by computer scientist Alan Turing, who published the idea in his seminal 1936 paper, *On Computable Numbers*. Conventionally, a computer consists of at least one processing element for arithmetic and logic operations, typically a central processing unit (CPU), and some form of memory.

The Macintosh 512K is an example of a computer manufactured by Apple, Inc. Apple was founded by Steve Jobs, Steve Wozniak, and Ronald Wayne on April 1, 1976 to develop and sell personal computers that could be used by individuals. The Macintosh 128K was introduced by the now-famous $1.5 million Ridley Scott television commercial, "1984.” It most notably aired during the third quarter of Super Bowl XVIII on January 22, 1984, and is now considered a watershed event and a masterpiece in advertising. Steve Jobs introduced the Macintosh 128K two days later on January 24, 1984 in the first of his famous Mac keynote speeches. This was the first mass-market personal computer featuring a graphical user interface and mouse. The applications MacPaint and MacWrite were bundled with the Mac. The Macintosh 512K was released on September 10, 1984 at a price of $3,195 and was the first update to the original Macintosh 128K. It was virtually identical to the previous Mac, differing primarily in the amount of built-in memory (RAM). Because of the increased memory, it was known as the “Fat Mac.” Like the 128K Macintosh before it, the 512K contained a Motorola 68000 microprocessor connected to a 512 kB DRAM by a 16-bit data bus. The Mac was particularly powerful in the desktop publishing market due to its advanced graphics capabilities.

This is an Apple Macintosh 512K Model M0001W computer first brought out in 1984. The serial number of F52528SM0001W indicates it was made in Freemont California (F), in 1985 (5), in week 25 (25). The computer has the original 512K RAM motherboard, an available upgrade of a 800K Sony double-sided internal disk drive, Mac short keyboard, and one button mouse. There is a standard non-original power cord, new plain label copies of Mac System software and MacPaint and MacWrite programs on disk. The built-in monitor is monochrome. The exterior case (11 x 9 5/8 x 13 5/8 inches) is the original beige color in fine cosmetic condition. The inside case has the molded signatures of Steve Jobs, Bill Atkinson, and the original Macintosh design team. The computer has been serviced and tested and is fully functional. It is a very fine example of the early development of the personal computer that has revolutionized the processing of information by individuals. Includes original user manuals for Mac computer, MacPaint, and MacWrite.



Apple Macintosh 512K Computer

iPad, First Generation, 2010

The iPad is a tablet computer designed and marketed by Apple Inc. The device was announced on January 27, 2010, by Steve Jobs at an Apple press conference at the Yerba Buena Center for the Arts in San Francisco. Jobs later said that Apple began developing the iPad before the iPhone, but temporarily shelved the effort upon realizing that its ideas would work just as well in a mobile phone. On April 3, 2010, the Wi-Fi variant of the device was released in the United States, followed by the release of the Wi-Fi + Cellular variant on April 30. Apple sold more than 15 million first-generation iPads prior to the launch of the iPad 2.

This is an original Wi-Fi only Apple iPad (1st Gen/A1219, iPad 1). The model is MB293LL and the serial number GB031WD1Z39. The device is powered by a 1 GHz Apple A4 processor, has 32 GB of flash memory, Wi-Fi support, and a 9.7 inch touchscreen display. The 32 GB version cost $599. It is 9.56 inches tall x 7.47 inches wide x 05 inches thick and weighs 1.5 pounds. The operating system has been upgraded to iOS 5.1.1. It has several applications including Safari, Mail, Photos, Music, Messages, Calendar, Notes, Reminders, Maps, YouTube, Videos, Contacts, Game Center, iTunes, App Store, Newsstand, and Settings. It has all of its original accessories including the charger, USB cord, booklets, stickers, and box. It also includes Apple's original carrying case. The iPad is in excellent cosmetic and functional condition.

First Generation iPad

Underwood Adding Machine

This is an electric adding machine made by Underwood around 1960. It is a retro-style "Add-Mate" adding machine, model 782A with case. The Underwood Computing Machine Company was founded in New York City in 1909 by John T. Underwood, then president of the Underwood Typewriter Company. The company manufactured calculators and accounting and billing machines for commercial use. A large factory was built in 1917 on Arbor Street in Hartford, Connecticut. The factory closed in 1969 but has since been repurposed and is on the National Register of Historic Places. Adding machines were ubiquitous office equipment until they were phased out in favor of calculators in the 1970s and by personal computers beginning in about 1985.

Underwood Adding Machine

Sewing and Textiles

Flax Wheel, 1854

A flax wheel is used to spin the fibers of the flax plant into linen thread, although they can be used for other spinning materials including wool. It consists of a slanted platform or table supported by three turned legs, a treadle or foot pedal, a drive wheel, and a piece called a "mother of all." The mother of all has two uprights called "maidens" that hold the spindle, a bobbin that is fitted over the spindle, and a U-shaped arm called a flyer that twists and then wraps spun yarn around the bobbin. A distaff post holds unspun fibers. The flax wheel is powered by the treadle that is attached to the axle of the wheel by a straight rod or footman. The spindle is powered by the wheel using two string drive bands. One powers the flyer that has hooks in the two arms. The other belt powers the bobbin internal to the flyer. Because the diameter of the flyer pulley and bobbin are different, the flyer and bobbin spin at two slightly different rates. The knob on the rear of the flax wheel allows tension of the drive bands to be adjusted by moving the spindle assembly backwards or forward. The flax is twisted by routing the fibers through one end of the spindle axle, over an arm of the flyer, through one of the loops on the arm and then onto the bobbin. As the spindle turns, the fibers are twisted and then collected on the bobbin. The drive wheel is 20 inches in diameter and the bench 17 inches long. The date 1854 is incised on the bottom of the platform. This flax wheel is complete and in very good condition. Almost every household had a flax wheel or larger walking or wool wheel up to the middle of the 19th century. The Industrial Revolution brought mechanization to the textile industry, and eventually spinning was done on large machines in textile mills.

Flax Wheel

Great Wheel, Walking Wheel, or Wool Wheel

The great wheel, also called a walking or great wheel, is a large wheel mounted on a bench. It is used primarily to spin wool and cotton. A spindle post at the back holds a Minor's head or accelerating head. The Minor's head has an additional pulley that increases the speed at which the spindle turns. A driving cord is passed from the drive wheel around the rim of a small pulley on the accelerating head. A second cord goes from a larger pulley on the head around a smaller pulley on the spindle. A tensioning device allows the user to move the head post closer to or further away from the great wheel to allow enough tension for the drive band to drive the pulley and thus the spindle. Spinning on the great wheel is done by turning the wheel with one hand and drawing the wool away from the spindle with the other hand. When the thread is pulled out as far as the spinner can reach, the wheel must be stopped, reversed, and the newly spun yarn wound onto the spindle. A variation on this, is to walk away from the wheel for as long as it continues vigorously spinning, then wind the yarn onto the spindle as you walk back towards the wheel. Either way, the spinner is obliged to stop and wind the yarn. The drive wheel is 46 inches in diameter and the bench 43 inches long. It is complete and in very good condition. Almost every household had a walking or wool wheel up to the middle of the 19th century. The Industrial Revolution brought mechanization to the textile industry, and eventually spinning was done on large machines in textile mills.

Wool Wheel

Yarn Winder

This tool is known as a yarn winder, wool winder, skein winder, or clock wheel. It was used to measure loose yarn into skeins by winding yarn around the wheel. It consists of a floor stand with four legs, an upright shaft leading to a box containing hand-fashioned wooden worm gears with clock counter, and a four-spoked wheel with spool ends. Yarn is wrapped around the arms by turning the wheel. As the yarn is wrapped, the screw on the shaft moves a gear that turns another gear. The amount of yarn wound can be determined by how much the latter gear has turned. The lower gear has a short extension that, as the gear turns, engages a wooden piece on the front of the upright. The extension bends the wooden piece and then releases it causing a "pop" sound indicating a skein has been wound. This winder is made of oak and the stand is 26 inches high and the wheel is 26 inches in diameter. It is complete and in very good condition with a functional counter. Like the wool wheel and flax wheel, mechanized textile mills made the yarn winder obsolete.

Yarn Winder

Flax Wheel Mother of All

Wool Wheel Minor's Head

Needlework Sampler, 1817, Old Lyme, CT

A needlework sampler is a piece of embroidery or cross-stitching produced as an example of achievement and demonstration of skill in needlework. It often includes the alphabet, figures, motifs, decorative borders and sometimes the name of the person who embroidered it and the date. The word *sampler* is derived from the Latin *exemplum*, which means "example." The earliest known American sampler was made by Loara Standish of the Plymouth Colony about 1645. By the 1700s, samplers depicting alphabets and numerals were worked by young women to learn the basic needlework skills needed to operate the family household. By the late 1700s and early 1800s, schools or academies for well-to-do young women flourished, and more elaborate pieces with decorative motifs such as verses, poems, flowers, houses, religious, pastoral, and/or mourning scenes were being stitched. The parents of these young women proudly displayed their embroideries as showpieces of their work, talent, and status.

In recent years, samplers have become important in museum collections as representations of early American female education. Many are signed, and some are inscribed with locations and the names of teachers and schools. The emergence of large numbers of these samplers has resulted in much research in diaries, account books, letters, newspaper ads, local histories, and published commentary that is helping to illuminate the lives of women in early America.

Sampler

This is a cross-stitched, silk on linen sampler bearing the name Lucy Rogers and the date December 11, 1817. There are several alphabets in upper and lower case and in block and script letters. The borders on the sides contain vines, trees, flowers, and a large number of what appear to be acorns. There are 21 standing birds throughout the sampler. Near the bottom is a scene with a house and a lawn with trees, birds, two sheep, and two standing people, perhaps Lucy's parents. At the bottom of the sampler is a verse: "This work in hand my friends may have This I have done to let you re When I am dead in my grave What care my parents took of me."

This sampler is said to be from the Roger's Lake District in Old Lyme, Connecticut. There was a sampler school in Norwich, CT where the sampler could have been made. The framed sampler measures 21 ½ x 17 inches and is in reasonably good condition. The linen has faded to a brown color. It has one small hole and fraying at the edges. The lettering is clear with two or three missing letters. The frame is original.

Milliner's Paper Mache Doll, c1840

This is a paper mache doll known as a Milliner's doll, although the name is a misnomer that stuck. These dolls were for children. They were first created in the mountain hamlets of Germany's Thuringian Forest in the late 1700s and early 1800s and became popular throughout Europe and America. They were made in America by various makers, most notably Ludwig Greiner in the mid 19th century. The dolls are characterized by paper mache busts, kid leather bodies stuffed with sawdust, and carved wooden limbs. Their clothing mirrors the fashions of their contemporary era. The earliest paper mache dolls were individually handmade. By the mid 1800s pressure mold processes made it possible for dolls to be mass produced. By the mid 19th century, the paper mache dolls reached the height of their popularity but began to be replaced by bisque and porcelain dolls.

This is a 19th century Milliner's paper mache doll. It measures 10 inches tall. The doll has a paper mache head and shoulders. The head has black painted hair with sausage curls in the back, blue eyes, eyebrows and red lips. The body and upper arms and legs are leather. The lower arms and legs are carved wood. Her hands are carved with her thumbs free and the rest of her fingers are together. She wears a red floral print blouse with an extra tuck in the sleeves. The skirt is red and white stripes. There is an apron of blue stripes and dots tied at the waist. The pocket of the apron has two compartments. The first petticoat is a blue and white stripe. The second petticoat is an orange and white stripe. Beneath that is a muslin half-slip. She has woolen knit socks on her feet. The doll is in very good condition noting only a small forehead dent and crack and a chip on the top of her head. The clothes are faded and have a few spots.

Rag Dolls

A rag doll is a children's toy and is one of the oldest children's toys in existence, probably appearing at the same time cloth was invented. It is a cloth figure traditionally made and stuffed in the home from spare rags and scraps of material found around the house. They also could be created from high-quality cotton, silk, velvet, or felt. In America, from the colonial era up to the early 20th century, children of various statuses would play with rag dolls. The popularity of rag dolls increased around 1830, when fabric color printing was first developed. Rag dolls have been used as comfort objects and to teach young children nurturing skills. They were often used to teach children how to sew, as the children could practice sewing clothes for the doll and make some simple dolls themselves. Today, many rag dolls are commercially produced to simulate the features of the original home-made dolls, such as simple features, soft cloth bodies, and patchwork clothing. One prominent example of a commercially produced rag doll is the Raggedy Ann doll.

Black Rag Doll

Black Rag Doll

This is an exceptionally fine black cloth doll standing 18 inches tall. The face is embroidered with a red mouth, two small circles for the nose, and golden brown eyebrows and outlines of the eyes. The eyes are white with amber-color bead pupils. She wears a red shirt with white lace fringes and a calico dress, has black yarn hair, and stitched defined fingers and thumbs. Her arms and legs are fully jointed and move freely. She has sewn on satin shoes that are the same golden brown as used on her face. Black dolls were made by both African American and white mothers. In the Jim Crow era, it became common in the north for mothers to teach their children about the plight of African Americans by making a black doll for them. The doll dates to around 1890-1900 and is in excellent condition. Purchased from Pat Hatch, Harvard, MA.

Christening Doll

This is a 15 inch tall rag doll with a body made of oilcloth. She has a painted face and black yarn hair. She wears a cotton bonnet fringed with lawn cloth, ivory lawn cloth dress, a petticoat edged with lace, and pantalets. The petticoat lace appears just below the dress. There is a lace bodice piece and pink silk sash, ribbons, bows, and trim. The decorative features of this doll indicate it could be a Christening doll, a doll given out to commemorate a baptism. The date of this doll is unknown, but it appears early, c1880-1920.

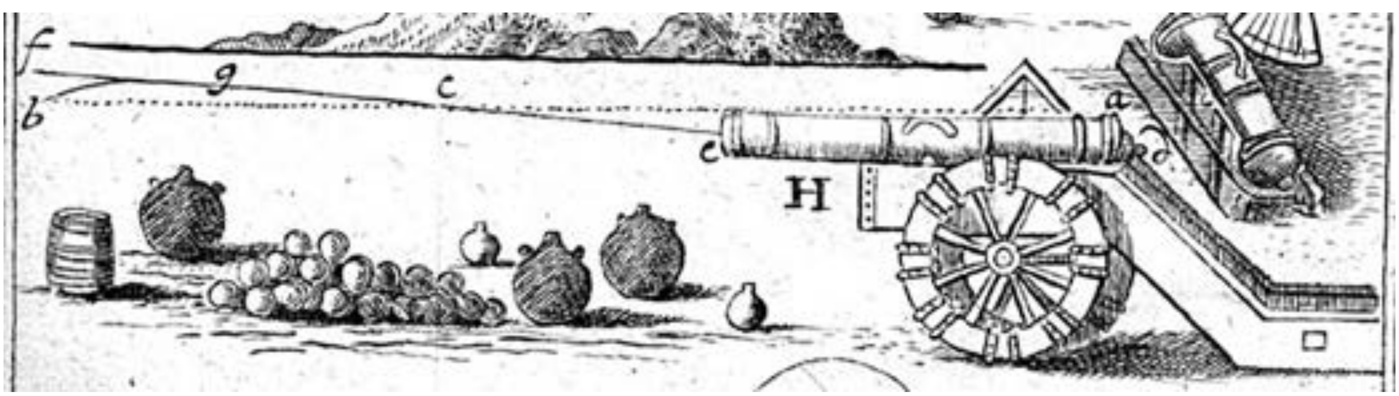
Christening Doll

Surveying

Gunnery Level, 1588

Sixteenth century gunnery level, Continental, signed "A. Pourtales, 1588." No record could be found for the name Pourtales as an instrument maker. The level is made of sturdy brass, 7 5⁄8 inches (19.5 cm) wide from foot to foot, and over ¼ inch (7 mm) thick. An integral 90-degree arc is divided every degree 0 ± 45 and labeled every 5. There are distinctive early numeral shapes, in particular the Z-shaped "2" and the slanted topless "5." The Z-shaped "2" strongly suggests origin in Germanic countries. The vertex is pierced for use with string and plumb bob. The arms are decorated with sinuous floral designs, engraved and punched. Surfaces have linear outlines throughout, and there seem to be small traces of gilding. The reverse is otherwise plain but for a preliminary scale division on the arc. Condition is good, the brass with a fine dark patina, noting nicks and a stress crack in the arc.

As with other artillery instruments, sights and levels were introduced in the 16th century. They were intended to accompany the new form of cast bronze guns, which came into increasing use from the late 15th century. English fighting ships relied increasingly on gunnery rather than boarding to defeat an enemy. This new style of artillery could be set at variable elevation by pivoting on its trunnions. To place the gun at an angle determined by the master gunner, a level is placed against the breech of a cannon. A plumb line is attached at the hinge of the level and reads against a scale on the cross-piece. Nicholas Bion shows a similar level on the breech of a cannon (*The Construction and Principal Uses of Mathematical Instruments*, 1709). Tables showed the desired setting for the cannon type, projectile type, and estimated range. On ships, in order to achieve the desired elevation, the gunner would have a crew member raise and lower the gun using a handspike, then hold it in position with a wedge known as a quoin (coyne or coin). In civil use, a level such as this is used to measure the inclinations of planes.



Gunner's level, Bion, 1709

Although there is no direct evidence this level was used in the Armada campaign, much circumstantial evidence indicates that it could have been. Because the level appears to be Continental, one explanation is that it was used by the Dutch. In 1588, Spain had an army in the Spanish Netherlands that was to be ferried across the English Channel for the invasion of England. However, the Dutch blockaded the shallow waters off Flanders with a fleet of 30 ships preventing the Spanish army from being supplied and joining the Armada. These ships could have been equipped with gunnery levels. Other possibilities are that the level was imported by England from its place of manufacture or that Pourtalis was an immigrant or refugee from the continent. Because the English were using long-range cannons instead of boarding in naval warfare, there was a great need for instruments of this type in preparation for the Armada. The date on the level seems more than coincidental. Even if not used against the Armada, the level remains a significant early dated instrument that deserves more research.

Gunnery Level

Graphometer, Henry Macquart, c1680

A graphometer is a surveying instrument used for the measurement of angles. It consists of a graduated semicircle with a pair of sight vanes at either end, and a movable alidade with another pair of sights at either end. The form was introduced by Philippe Danfrie in *Déclaration de l'usage du graphomètre* (Paris, 1597). It was widely used beginning in the 17th century especially by rulers who wanted their dominions surveyed and mineral resources and woodlands recorded. To use the graphometer, the fixed sights on the straight line of the semicircle were used to aim at a landmark and the movable sighting rule was used to aim at the second point. The angle between the two points could then be read off the scale.

This is an early decorative example of a French brass graphometer signed "Macquart A Paris." Henry Macquart was the successor of Pierre Sevin and was active from 1660 to 1720. The graphometer measures 20.8 cm in diameter. There is a scroll and leaf decoration at the top. The semicircle is graduated with a double scale of 0 to 180 degrees and 180 to 0 degrees. There is a central compass with a silver compass card with eight points labeled in French. The main plate has engraved dolphins on either side of the compass. The dolphin motif was popular in France because of the *Dauphin de Viennois,* the title given to the heir apparent of the throne of France from 1350-1791.There are sights are each end of the semicircle and at each end of the moveable alidade. The sights have a slit and a vertical thread in a rectangular frame. There is a staff mount below with a ball joint permitting both horizontal and verticle use. The instrument is in excellent condition.

Graphometer

Compass by George Adams, Sr., c1745

George Adams Sr. (1709-1773) founded his workshop in 1734 and was one of the most prominent makers of instruments in the eighteenth century. He became Instrument Maker to King George III in 1760. The compass is 5 ¼ inches in diameter. The paper sunburst dial shows 32 cardinal and intercardinal points with a *fleur de lis* symbol at north, a 360 degree circle at the edge, and the maker's name in the center. It is signed "Made by G: Adams in Fleet Street London." The blued steel needle is marked for N and S. A 360 degree brass circle surrounds the dial. The original clear glass is secured with a molded sprung brass bezel. The square mahogany case with hinged lid measures 5 ¾, x 5 ½ x 1 ⅛ inches. The compass is in very fine condition.

Adams Compass, c1745

Waywiser, English, Eighteenth Century

The waywiser, also known as a surveyor's wheel, perambulator, or odometer, originated in Greco-Roman times and was reintroduced in the seventeenth century to measure distances used in surveying and map making. A single wheel is attached to a handle and the device can be pushed along by a person walking. Early devices were made of wood and may have had an iron rim made by a blacksmith to provide strength. The wheels themselves would be made in the same manner as wagon wheels and often by the same makers. The measuring devices would be made by makers of scientific instruments and the device and handles would be attached to the wheel by them. The device to read the distance travelled would be mounted either near the hub of the wheel or at the top of the handle.

This is an eighteenth century waywiser. It is 54 inches in length and 27 inches high. The two handles and legs are made of ebonized wood supported by a decorative wrought iron frame. The wheel, 23 inches in diameter, has an iron rim and turned wooden spokes. The box containing the mechanism is located behind the wheel. Two iron rods connected to the axle turn a screw in the box that turns three wooden gears engineered to accurately measure miles, furlongs, and yards. The measurements are shown on a handwritten paper dial and three decorative iron pointers. The instrument is in excellent working condition.

Waywiser

Alidade, Italian, 1789

An alidade is a surveying instrument of ancient origin that employs line-of-sight to determine the positional characteristics of a remote object in relation to the observer. The earliest alidades consisted of a bar, rod or similar component with a vane on each end. Each vane has a hole, slot or other indicator through which one can view a distant object. In use, the alidade would be placed on a surveyor's plane table, then sights taken and the directions ruled directly on a paper by running a pencil along the edge of the rule. The sighting arms of other instruments such as astrolabes, sextants, and theodolites are alidades. Telescopes were added to the alidade in the eighteenth century.

This plane table alidade/rule is constructed of brass inset into an ebony base and is 22 inches long overall. The sight vanes are 7 ¼ inches high. The rule is divided linearly from 0 to 24 and labeled "Due palmi Napolitani" (for two Naples hands), and mounted with hinged clampable sight vanes with elegantly shaped bases and clamp mechanisms. It is signed "Joseph Cirillo fecit A.D. 1789." Condition is good noting edge losses to the ebony, an old repair on one sight vane, and lacking one lug to one thumbscrew. It is a rare example of a local Italian instrument, designed for surveying in Southern Italy, by an unrecorded maker.

Alidade, Italian. The picture is from the famous 1748 work by Giovanni Battista Nolli, the *Nuova Pianta di Roma* and shows a *putto* using such an alidade on a plane table.

Miners Dial, English, 3rd quarter 19th century

The miners dial is an example of a surveying instrument using an alidade for sighting. The miner's dial was used by a surveyor to establish the direction in which the mine's underground roadways and tunnels went. When using a dial, a fixed reference point was created (often using a plumb line fixed in the mineshaft). From this starting point a line is drawn to a second point along the tunnel being surveyed. The axis of the dial was laid parallel to this line and the compass bearing noted. The distance between the two points was also measured. The line would then be extended from the second point to a third, further along the tunnel, and the dial again used to measure the bearing. In this way the direction and length of the tunnel was measured.

This dial is signed in script on the silvered compass face "A. Reid, Edinburgh," and was undoubtedly made for use in the Scottish coalmines. Made of heavy polished lacquered brass, this miners surveyor's dial has a silvered compass face, circular bubble level, and 5″ long edge bar needle in the 6 ⅛" diameter lacquered brass compass housing. The brass base plate frame is 10" long, with twin 9" tall folding sight vanes and a fixed staff mounting underneath. This attractive mining dial is in very good overall condition noting some spots of wear to the lacquer. It is held in its original 11 ¼" x 7 ½" x 4 ¼" fitted mahogany case with leather carrying strap. It includes the original breakdown mahogany tripod for the dial. The tripod can be used at full height or at half height if necessary in the mine.

Miners Dial

Compass, Denison Olmsted, Yale, 1858

This is a small compass in a 2 ¼ x 2 ½ inch gutta-percha case. The 32-point rose has 360 graduations around the edge. The case and the compass are in poor condition. The compass is missing the needle and cover glass. The significance of the piece is the writing on paper affixed to the underside of the case lid. The writing reads "Variation of Needle at Yale College for 1858 7° 20′ West. D. Olmsted." This inscription refers to the difference between true and magnetic north. Denison Olmsted (1791-1859) was Professor of Mathematics and Natural Philosophy at Yale College from 1825 to 1835 and Professor of Natural History and Astronomy from 1835 to 1859. He made contributions to many scientific fields, most notably astronomy. He is also noted for his effective teaching and dissemination of scientific knowledge through numerous textbooks.

Olmsted Compass

Chinese Geomancer Compass

In ancient China, the magnetic compass was an essential tool used in geomancy, which predated its use in navigation by centuries. Geomancers used the compass to determine the orientation of tombs, temples and secular buildings, and the alignment of city walls and streets, in order to be in harmony along lines of the magnetic field of the local landscape. The location for a building was carefully chosen so that the forces of Yin and Yang were balanced correctly, thus reducing the chance of illness. It was also used to select the best times and locations for important events. This is a large geomancer's compass, 11 ¼ inches in diameter and ¾ inch thick. The instrument is made of a circular piece of lacquered wood and has a compass inset at the center, and concentric rings expanding out from the center. The rings contain the major Chinese symbols relating to astrology, time of day, the elements, directions, and forms of landscape. The data on the rings enable the practitioner to co-ordinate movements between the Earth and the heavens for determining auspicious moments for orientation and events. The outer ring contains 384 hexagram lines of yin and yang. Each line has an auspicious or an inauspicious meaning. An expert knowledgeable about these compasses should be consulted regarding the meanings and purposes of the other rings. The dating of Chinese instruments is difficult, estimate for this instrument is 1780 to 1820. There are very similar geomancer compasses in the Science Museum, London, and the National Maritime Museum, Greenwich.

Geomancer's Compass

American Surveying Waywiser

A waywiser consists of a wheel at the end of a handle, with a counter to measure the number of turns the wheel makes. Waywisers became popular in England in the eighteeth century, and were still in use in the United States in the early twentieth century. They were also known as perambulators. This example consists of an iron wheel with residual green paint, wooden handle, and metal counter. The wheel is 24 inches in diameter and the whole unit is 44 inches long. The counter has three wheels for tallying numbers up to 999. It is stamped "Carmean Anthony, KS." An identical counter is in the Smithsonian Museum of Natural History where it is noted that W. H. Carmean is listed in the 1910 U. S. Census as a 24-year old resident of Anthony, Kansas. According to the donor, an employee of the U. S. Department of Agriculture, the counter and wheel were used in the early days of the Agricultural Adjustment Administration. The instrument is in very good condition and fully functional.

Waywiser

Gunter's Surveying Chain

Surveying land boundaries dates back to ancient Egypt, Babylonia, Greece, and Rome. Many devises were used for measuring distances including rope, wooden poles, grape vines, and pacing. In England, in 1616, Aaron Rathborne mentioned "the making and use of the Decimal Chayne, used only by myself." This chain had ten links and measured 1 pole (a rod, 16.5 feet) overall. In 1620, Edmund Gunter, English clergyman and mathematician, introduced a chain with 100 links that measured 66 feet (4 poles) overall. Eighty chains equal a mile and ten square chains equal an acre. Gunter's chain became the primary tool of surveyors to measure distance in North America from the 1600's to the end of the 1800's. This is an example of a two pole (33 feet) or half chain Gunter's chain. The chain consists of 50 7.92-inch links. There are two oblong rings between links and a brass tally every ten links. Two of the tallies are notched and one is stamped "J C Chesterman Sheffield Engd." The James Chesterman Company was founded in 1829. A brass handle with swivel joint is at each end of the chain. The handles are marked "2P" for two pole. The steel chain is in excellent condition with virtually no rust.

Gunter's Chain

Plumb Bob Level, American, c1800

The plumb bob is an ancient tool that has remained virtually unchanged for thousands of years and is still in use today. It is made of the simplest possible parts; namely a string and a heavy weight. The weight, usually with a pointed tip at the bottom, is suspended by a string and gravity causes the attached string to establish a perfectly vertical line. It probably originated when early man first started building permanent settlements in order to determine that the stone walls of buildings were built truly vertical. The Egyptians used plumb bobs in wooden frames in their construction of pyramids, buildings, and canals. The plumb bob is a versatile tool and came to be used in astronomical, navigational, and surveying instruments. With a plumb bob level, the frame is placed parallel to the surface being measured allowing the worker to make a more precise visual judgment as to the trueness of plumb or horizontal level. Plumb bob weights being made of stone or metals often survived. Wooden frames or levels that may have been used with a plumb bob, however, are very rare.

This is an early and primitive standing level with line and plumb bob. It consists of a wooden board, possibly pine, that is 55 inches tall, 3 ½ inches wide and ¾ inch thick. The board has traces of red paint. The top has three indentations to hang the twine line. The body has a vertical line running its length. It still has an aged piece of twine or hemp cord. The plum bob is lead, 2 inches long, and egg-shaped. There is a cutout in the level so the plumb bob can hang free and not rub against the board. This piece is in very good aged condition with an uneven base from wear.

Geography

Pocket Globe, Nicolas Lane, London, c1790

A pocket globe is a small, terrestrial globe held within a spherical case, the inner surface of which is a celestial globe. First made in the late 17th century, a pocket globe in its case represents the Earth surrounded by the stars. The pocket globe was mainly used for teaching geography and astronomy to children, but it was probably also a status symbol carried by the middle and upper classes along with a pocket watch. Pocket globes enjoyed a period of high production at the time of the voyages of discovery. The small globes may have served as references and conversation pieces in both social and geographic circles as each new map edition charted a new track of Cook's, for example, or a recently defined far-off coastline.

This is a 3-inch diameter Nicolas Lane terrestrial pocket globe having a round cartouche reading "Lane's Improved Globe London." The Lane firm, founded by Nicolas Lane (fl. 1775-1783), was a major producer of pocket globes. Various updated pocket globes were produced under the Lane name by his successors into the first part of the 19th century. Of typical form, the terrestrial globe has engraved hand-colored gores and steel axis pins at the poles. It is contained within a spherical conforming case opening into two concave hemispheres — one with an applied engraved celestial chart of the Northern Sky, the other with a Southern Sky celestial chart. The outside of the case is covered with black-pebbled fish skin. The two halves are joined with a brass hinge and close with three brass hook-and-eyelet closures.

This globe probably dates between 1783 and 1803 based on the references to "United States" and "New France" on the globe. Britain acknowledged the "United States" in the Treaty of Paris in 1783. The United States purchased the remaining French lands in America, once part of New France, in the Louisiana Purchase in 1803.

The globe is made of 12 hand-colored engraved gores, colored in tones of pink, green, red, blue, and yellow, with thick outlines. Oceans are colored blue-green and are labeled with the Pacific as "Pacific Ocean" and "Great South Sea," the Atlantic as "The Western Atlantic Ocean" and "The Ethiopic Ocean," and the Indian Ocean as "The Eastern Ocean." They show the routes of George Anson's voyage around the world in 1744 and James Cook's third voyage, marked "Going Out 1776" and "Cn. King's Return 1780" after the murder of Cook in the Sandwich Islands. Nothing is shown in the Arctic and Antarctic regions. The small globe shows considerable details of geography and place names. For example, in North America, "United States" is marked on the east, "New Britain" is shown north of the St. Lawrence River, "Canada" to the west, and "New France" below that. California is shown as a peninsula. Australia is "New Holland," the Great Wall of China is shown as "Chinese Wall," Central Asia is "Independent Tartary," and South Africa is "Country of the Hotentots." The equator, graduated in degrees, is marked "The Equator or Equinoctial Line" and the ecliptic, graduated in days and showing the symbols of the houses of the zodiac, as "The Ecliptic Line." The Arctic, Tropic of Cancer, Tropic of Capricorn, and Antarctic circles are shown. A prime meridian between north and south poles and passing through the Pacific Ocean is marked with latitudes. The concave celestial hemispheres inside the case illustrate the constellations as figures of classical mythology and as scientific instruments. Stars are shown and the ecliptic has the houses of the zodiac.

Condition: The colors and lettering on the globe are very sharp and clear. There is an old fracture to the globe that was repaired and does not affect the lettering and integrity of the globe, but could probably be improved with additional professional restoration. There are a few small spots of rubbing on the varnish. The case has a one-inch crack not affecting its integrity. Case closes well with globe securely inside.

Pocket Globe

Newton's Terrestrial Globe, English, 1823

Terrestrial globes were first made in Europe probably toward the end of the fifteenth century. The earliest globes were constructed for the use of scholars or explorers, to demonstrate particular theories or to show where a voyage had gone. The geographical discoveries at the end of the century helped popularize globes and they were used to publicize new discoveries and to teach the new geography.

This twelve-inch terrestrial desk globe is made of two hemispheres of papier-mâché, joined at the equator. It is covered with plaster and twelve full gores that are copper-engraved and hand-colored. The globe is mounted on a turned four-legged mahogany stand with stretchers. Overall the globe stands 18 inches tall. It is surmounted by a brass hour disc at the North Pole with a full brass meridian. The horizon band features a colored paper ring showing degrees of amplitude and azimuth, compass directions, days and months of the year, and the names of the signs of the zodiac. The large analemma is "An Improved Analemma shewing the SUN'S declination and place in the Zodiac for every day of the Year." The globe shows new information from the Lewis and Clark expedition. The tracks of major voyages of discovery including Capt. Cook's three voyages are shown and labeled. The Antarctic is blank with the notation "Jan 1773 Many Islands firm Fields of Ice" below the Antarctic Circle. The rectangular cartouche reads: "NEWTON'S New & Improved TERRESTRIAL GLOBE, Embracing every recent Discovery to the Present Time, MANUFACTURED by J. & W. NEWTON 66 Chancery Lane" and below the cartouche "London Published July 1, 1823." The Newton family of cartographers were among the leading English globe makers of the early nineteenth century. The globe has several defects. The varnish has turned brown, there are abrasions to the varnish not affecting lettering, hairline fractures in the plaster, and a slice missing from the edge of the paper on the horizon band. Nonetheless, this is an intact, restorable example of an important globe.

Newton's Terrestrial Globe

Miniature Terrestrial Globe, c1830

This is a 19th century two-inch globe in a fruitwood stand. The sphere is mounted in a graduated brass meridian ring that slots into a horizon ring. The ring is supported by four turned legs. A platform holds a central pillar that supports the meridian ring. A paper on the horizon ring has eight compass points, the months of the year, and the houses of the zodiac. The globe has 12 engraved hand colored gores with original varnish and metal pins at each pole that enable the globe to spin. Geographic entities are boldly outlined in green. The equinoctial line is graduated in degrees, the ecliptic is graduated in days and shows the symbols of the houses of the zodiac, and the meridian is labeled "Meridian of London." The routes of Captain Cook's third voyage, and the route taken by "Clarke & Gore" who completed the voyage in 1779 after Cook was killed in Hawaii, are indicated. California is shown as a peninsula. The Sahara is called "Great Desert" and indicated with a dot pattern. Asia is "Tartary" and South Africa "Hottentot." Australia is named New Holland. The Antarctic region is shown without cartography. The globe is labeled "New Terrestrial Globe." There is no maker's name but the globe closely resembles those by Newton & Son. It is in good condition but browned and with a few spots of rubbing on the varnish.

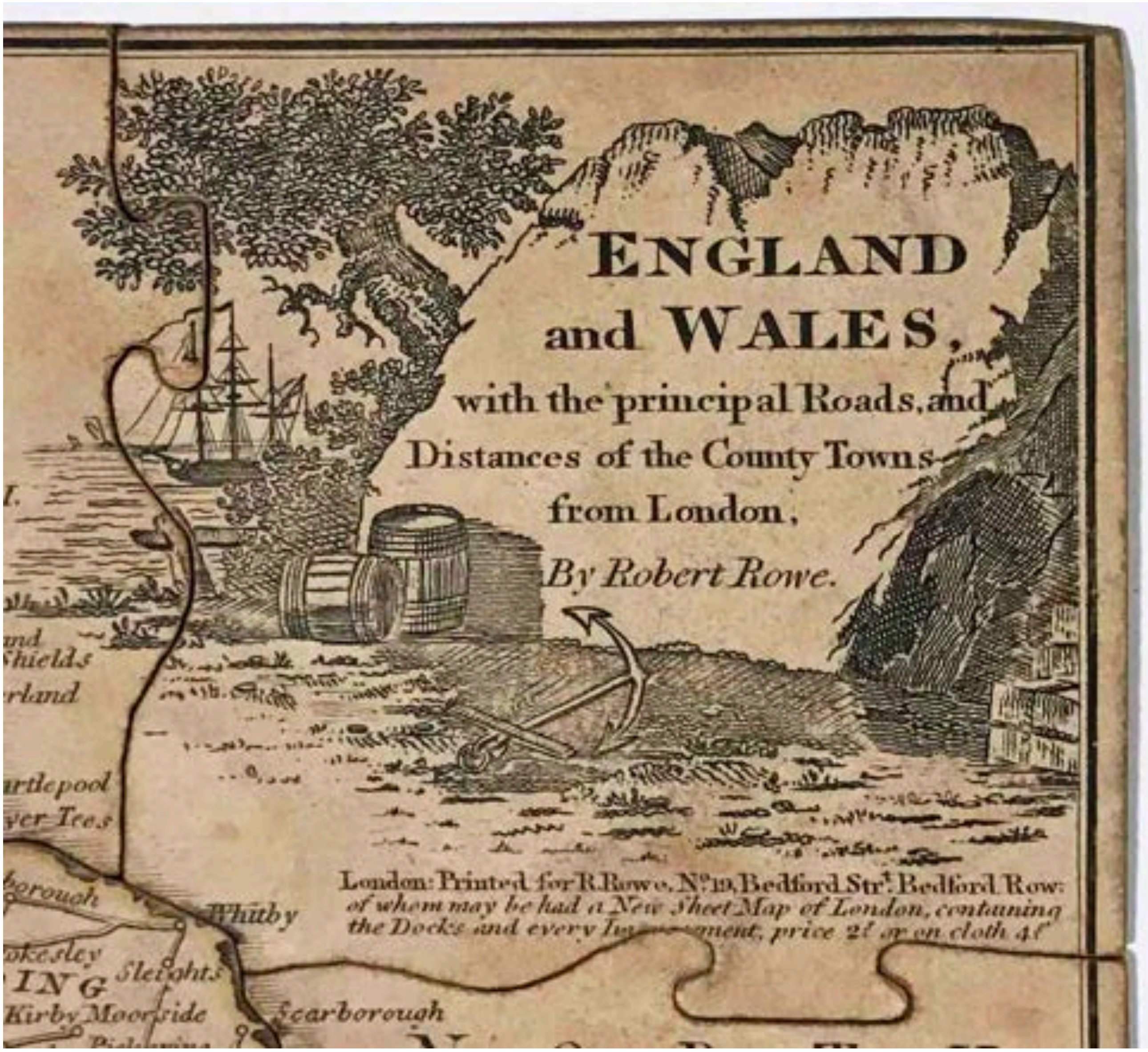
Miniature Terrestrial Globe

Dissected Map (Puzzle), England and Wales, c1810

A jigsaw puzzle is a set of varied, irregularly shaped pieces that, when properly assembled, form a picture or map. The first jigsaw puzzle was created by a British cartographer and engraver, John Spilsbury (1739-1769), in 1766. He mounted a map onto wood and then cut around the countries. He gave it to children in the local school to help them with their geography education. These puzzles were known as dissected maps. It was an instant hit and the concept was soon copied by others and expanded into other educational images other than just maps, covering such subjects as history, alphabets, botany, and zoology. At this time, all jigsaw puzzles were created from wood. The term jigsaw comes from the special saw called a jigsaw that was used to cut the puzzles, but not until the saw was invented in the 1880's. The use of popular pictures began in the 1860s and '70s. By 1900, the wooden jigsaw puzzle evolved from children's games into a form of entertainment for adults, although they were expensive. In the 1930s, die-cut cardboard jigsaw puzzles became available. These mass produced cardboard puzzles sold for ten to 25 cents and could be afforded by families struggling through the Great Depression, thereby greatly expanding the puzzle market. Another revival began after World War II, and jigsaw puzzles have remained a popular entertainment since then.

This is a dissected map of "England and Wales, with the principal Roads, and Distances of the County Towns from London, By Robert Rowe." "London: Printed for R. Rowe, No. 19, Bedford Strt. Bedford Row. Robert Rowe (1775-1843) was an English engraver and publisher of maps and atlases. The puzzle consists of 73 hand sawn pieces. It measures 9 ½ x 11 ¼ inches and is held in its original, labeled mahogany box with sliding lid. It shows in great detail the shires, towns, and roads. It is in good condition for a puzzle this old but has 5 replacement pieces, plain wood with the Shire name written on it, and a missing retaining strip on one side of the box. Another example of this puzzle is in the United States Library of Congress.

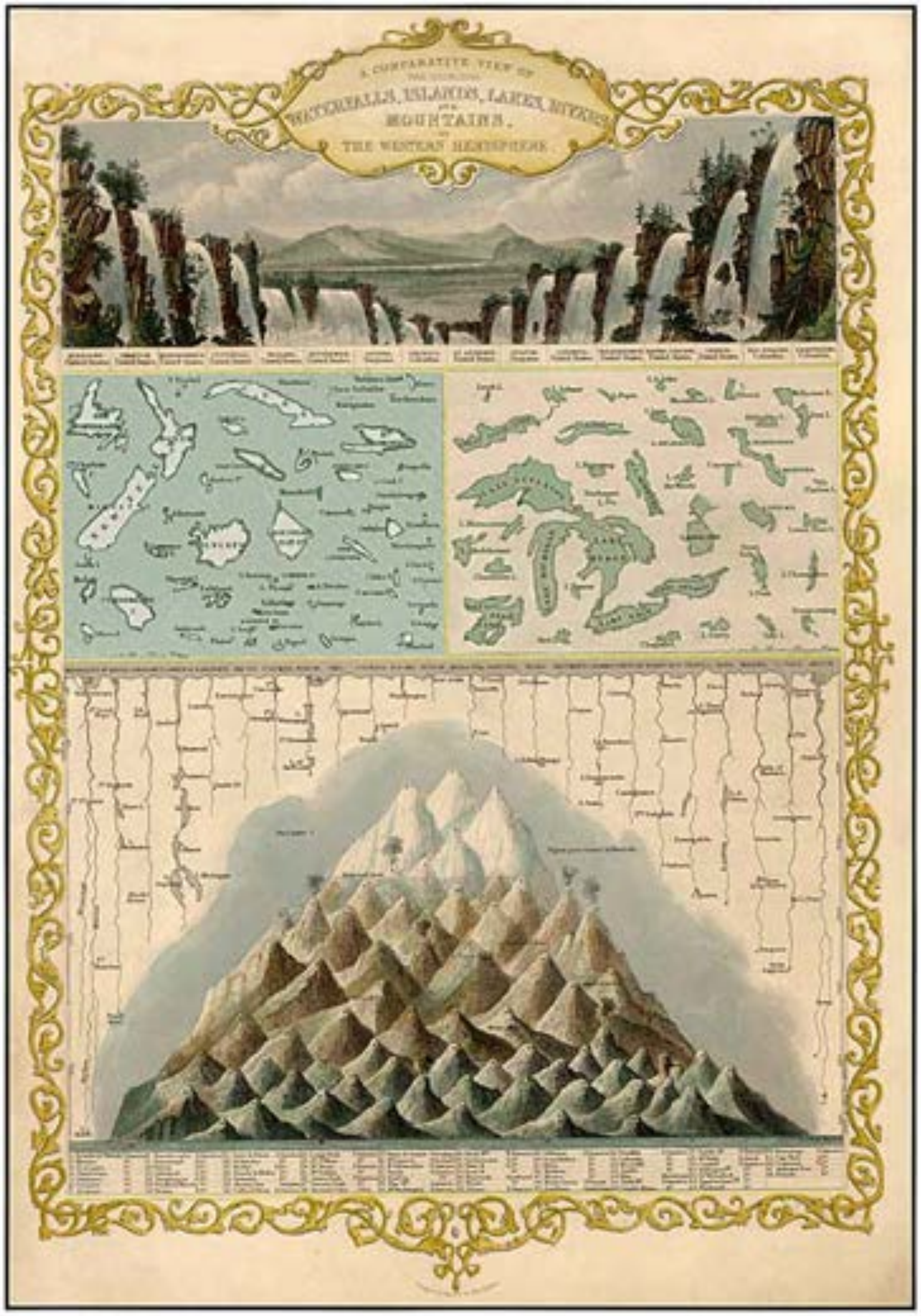

ENGLAND
and WALES,
with the principal Roads and
Distances of the County Towns
from London.
By Robert Rowe.
SCOTLAND
NORTHUMBERLAND
CUMBERLAND
DURHAM
WESTMORELAND
YORK SHIRE
LANCASHIRE
CHESHIRE
DERBY SHIRE
LINCOLN SHIRE
NORFOLK
SUFFOLK
ESSEX
WARWICK SHIRE
WILTSHIRE
SURREY
KENT
SUSSEX
HAMPSHIRE
SOMERSET SH.
DORSET SHIRE
DEVON SHIRE
CORNWALL
BERKSHIRE
GLAMORGAN SH.
CARMARTHEN SH.
MERIONETH SHIRE
ANGLESEA
IRISH SEA
NORTH SEA
ST. GEORGE'S CHANNEL
NORTH CHANNEL
CARDIGAN BAY
BRISTOL CHANNEL
ENGLISH CHANNEL
IRELAND
FRANCE



Dissected Map

Comparative Chart of Waterfalls, Islands, Lakes, Rivers and Mountains, 1850

The comparative mountains and rivers chart is one of the most interesting cartographic conventions to be developed. It appeared in Europe towards the end of the eighteenth century and reached its fullest expression in the nineteenth century. Its roots were in the coastal profiles drafted on many eighteenth century nautical charts. This type of map or chart was generally constructed as a scientific and reference tool, comparing various mountains and rivers within the same plane and on the same scale, thus showing their relative magnitudes. The first maps compared mountains. Later, rivers were added to the maps followed by waterfalls, islands, and lakes. These maps appeared in atlases, as wall maps, and as pocket maps.

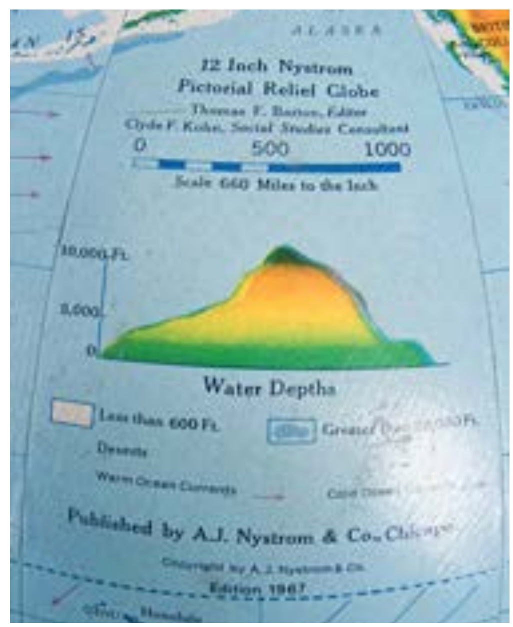


Comparative Chart

This is a chart entitled *A Comparative View of the Principal Waterfalls, Islands, Lakes, Rivers and Mountains, in the Western Hemisphere*. The most significant advancement of this chart was to place all of the common comparative values of a hemisphere into a single plate. It shows, for example, Niagara Falls, the islands of New Zealand, Cuba, and Iceland, the Great Lakes, the rivers Mississippi, St. Lawrence, and Amazon with the principal cities along them, and the mountains with the highest given as Nevada de Sorata S. America. This chart was designed and engraved by John Rapkin and published by the John Tallis & Company, London & New York, in 1850. It is 14 ½ x 10 inches, hand colored with a decorative border, and in fine condition.

Satellite Orbiter Globe, 1967

This is a mechanical satellite orbit demonstrator globe from the beginning of the space age era. It demonstrates the rotation of a satellite in orbit around the earth. The cartouche on the globe reads "12 Inch Nystrom Pictorial Relief Globe," "Edition 1967." The globe is mounted and rotates on a Synchron motor. A second motor on top of the half meridian rotates the satellite. The power switch allows you to choose rotation of the earth, the satellite, or both in motion at the same time. The satellite motor can be moved along the half meridian to change the orbit of the satellite. The globe itself is a physical political relief model, showing only outlines of political borders but physical characteristics of areas. The base, meridian, and satellite are made of gold metal; the globe is made of pasteboard. The diameter of the globe is 12 inches with a total height of about 22 ½ inches. The model is in excellent condition with minimal wear to the frame and base. The sphere is exceptionally well preserved. The electric motors and gear mechanisms are in perfect working order.



Satellite Orbiter Globe

Communication and Writing

Illuminated Manuscript Book of Hours Leaf in Latin, Paris, c1420

The distinction between prehistory and history is defined by the advent of writing. Writing is the use of a set of letters or other marks that represent the sounds or words of a language and are written or imprinted on a surface. Writing most likely began as a consequence of political expansion in ancient cultures. Reliable means were needed for transmitting information, maintaining financial accounts, keeping historical records, and similar activities.

Latin developed sometime before 600 BC and was originally spoken in Latium and Ancient Rome. The Romance languages developed from Latin in the sixth to ninth centuries. Medieval Latin was used as the language of international communication, religion, scholarship, and science until well into the eighteenth century. Latin is still used in the creation of new words in modern languages, in biological taxonomy, and as the liturgical language of the Roman Catholic Church. The Latin or Roman alphabet is the most widely used alphabetic writing system in the world. It is the standard script of the English language and the languages of most of Europe and those areas settled by Europeans.

Illuminated Manuscript Book of Hours Leaf in Latin

This is an original leaf from a medieval illuminated manuscript *Book of Hours*, with illuminations by a Master of the Boucicaut School. A book of hours is a Christian devotional book that was popular among the Christians of Northern Europe during the Middle Ages. The books are works of art and cultural documents of their time. There are fifteen lines of red-ruled, Latin text, written with dark brown ink in gothic book-hand script on animal vellum. There is one two-line illuminated initial in burnished gold on blue and pink ground extending into the margin with a delicate rinceaux design in burnished gold, red, and blue. There are also eight one-line illuminated initials alternating in blue with delicate red penwork and burnished gold with delicate blue penwork. The text in Latin is Psalm 87 (King James 88) and an 11th century hymn. The one-line illuminated "U" continues an 11th century hymn, *The Lord's Atoning Grief*: "Ut placas..." (May these all our spirits sate, And with love inebriate; In our souls plant virtue's root, And mature its glorious fruit. Crucified! we Thee adore, Thee with all our hearts implore; Us with saintly hands unite In the realms of heavenly light. Christ, by coward hands betrayed, Christ, for us a Captive made, Christ, upon the bitter tree Slain for man, be praise to Thee). The two-line illuminated "D" on the other side begins Psalm 87: "Domine..." (O Lord, the God of my salvation: I have cried in the day, and in the night before thee. Let my prayer come in before thee: incline thy ear to my petition...). This leaf measures 127 x 92 mm (5 x 3 11/16 inches) and is in excellent condition. Provenance: Sotheby's ex G. Barilla of Geneva, and formerly Frederick Fowler collection (England c1820's).

Telegraph Key and Sounder, c1920

The telegraph is a system for transmitting messages from a distance along a wire, especially one creating signals by making and breaking an electrical connection. The Morse system of telegraphy was invented by Samuel Finley Breese Morse (1791 – 1872) in the 1840s in the United States. "Morse Code" is essentially a simple way to represent the letters of the alphabet using combinations of long and short pulses. A unique pattern is assigned to each character of the alphabet, as well as to the ten numerals and punctuation. These long and short pulses are translated into electrical signals by an operator using a telegraph key. An operator at the receiving instrument or sounder "copies" these electrical signals as letters, numbers, or punctuation.

The “key on board” or KOB consists of a telegraph key and a telegraph sounder mounted on a wooden board. KOBs have been produced since telegraphy began in the 1850s. They were originally used for operator training and practice. The key is a simple bar with a knob on top and a contact underneath. When the bar is depressed against spring tension, it forms a circuit and allows electricity to flow to the sounder. The sounder consists of an electromagnet and an armature. When current flows through the electromagnet, a magnetic field pulls the armature down to strike the frame resulting in a “click.” When the circuit is broken by releasing the key, the armature returns to its original position striking the frame resulting in a “clack.” These sounds are used in the form of Morse code to construct a message.

This is a KOB with a telegraph key (right) and a telegraph sounder (left) mounted on a single wooden board. It is marked on the sounder arm “SIGNAL” for the Signal Electric Manufacturing Company, which was located in Menominee, Michigan. It dates to around 1920. The board measures 4 ½ x 7 inches and is marked 4 ohms. The holes in the board between the key and the sounder were used for affixing the KOB to a desk or table. The instrument is in good condition with some rusting to the metal.

Telegraph sounder (left) and key (right)

Edison Cylinder Phonograph, c1907

Thomas Edison invented the phonograph in 1877. However, he did not pursue it choosing instead to work on the incandescent light bulb. In the meantime, Alexander Graham Bell and

Charles Sumner Tainter made improvements to Edison's machine and patented it in 1886. Their machine was exhibited to the public as the graphophone. Edison returned to the phonograph and formed the Edison Phonograph Company in 1886. The company underwent several changes in ownership and name but Edison regained control and started the National Phonograph Company in 1896. The Edison Standard Phonograph was introduced in 1898 with a price of $20. The machine used wax cylinders that featured marches, sentimental ballads, popular songs, hymns, humorous monologues, vaudeville, and speeches. Standard cylinders are about 4 inches (10 cm) long and 2 ¼ inches (5.7 cm) in diameter. The Standard Phonograph was produced in various models until 1913.

This is an Edison Standard Phonograph, Model B. The Standard Phonograph was introduced in 1898 and the Model B produced from 1905 to 1908. The serial number is S383640. The instrument is housed in an oak case with removable domed lid, 13 x 9 ½ inch base, 12 ½ inches high. There is molding around the case. The case bears an "Edison" decal. The phonograph is made of iron, steel, and brass with nickel-plated mandrel. A metal plate on the top of the box holds the playing assembly on top and the motor below. It is hinged so that it can be raised to expose the motor. It has a 14-inch black and brass witch hat horn. The Model C reproducer is the assembly that contains the stylus with a sapphire needle and the diaphragm. The phonograph is powered by a spring motor. To operate, the mainspring is wound by a crank on the side. A cylinder is placed on the mandrel and the stylus lowered onto the cylinder. The phonograph is turned on and a belt from the motor turns the mandrel. The cylinders run at 160 rpm and play for 2 minutes. This phonograph has been serviced and reconditioned and is fully functional. It includes five cylinder discs that can be played. Wax cylinders became obsolete when they were replaced by flat discs and the phonograph evolved into the record player.

Edison Standard Phonograph

Blickensderfer Model No. 5 Typewriter, 1893

The Blickensderfer typewriter was designed by George Canfield Blickensderfer (1850–1917) in 1892. The typewriter was far ahead of its time in that it was portable and used a type wheel. George Blickensderfer spent much time traveling by train while pursuing his conveyor business. He realized the need for a lightweight portable typewriter so that businessmen could type letters and invoices while traveling on the train or while in their hotel. Instead of the common mechanism with letters on the end of individual bars connected to the keys, the Blickensderfer uses a cylindrical wheel with letters embossed on it. Pressing a key causes the type wheel to turn positioning the correct letter, sending it in an arc down toward the platen, and brushing past an ink roller before striking the paper. The mechanism is very similar to the IBM Selectric design introduced decades later. Like the Selectric, one could easily change the typeface on a Blickensderfer simply by changing the type cylinder. Early Blickensderfers were also notable for their keyboard layout. The bottom row of keys contained the most commonly used letters, DHIATENSOR, to increase efficiency. This keyboard was called the "scientific" keyboard. The Blickensderfer system dramatically reduced the complexity of typewriter design. A typical example contained many fewer parts than a standard typewriter. It was much smaller, lighter, and cheaper than other typewriters. It could be considered the laptop of its time. The first successful production model was the Blickensderfer 5, introduced at the 1893 World's Columbian Exposition. Models 1-4 may have been prototypes and no examples are known.

This is a Blickensderfer No. 5 portable typewriter in its original case. The metal label reads "No. 5, BLICKENSDERFER, STAMFORD, CONN., U.S.A." The typewriter has the DHIATENSOR keyboard and three rows of keys. There is a key for capital letters and one for numerals. The keys, carriage, slider, and all other parts of the typewriter are functional. There are three type wheels and two cases for the wheels built into the case. The last patent date is 1892 and the serial number is 88419. The oak case is 12 ¾ inches wide, 9 ¼ inches deep, and 6 ¾ inches high. The typewriter is in excellent condition with only slight rusting on a few metal parts in the back. The case was refinished at some point and the leather handle is broken.

Blickensderfer No. 5 Typewriter

1897 Advertisement for Blickensderfer Typewriters

Western Electric Candlestick Telephone, 1918

A telephone is a communications device that permits two users to conduct a conversation when they are separated by a great distance and cannot be heard directly. A telephone converts sound, typically the human voice, into electronic signals suitable for transmission via cables or other transmission media over long distances, and replays such signals simultaneously in audible form to the user. As with other major inventions of the nineteenth and twentieth centuries such as the radio, television, light bulb, and computer, there were several inventors who did pioneering experimental work that led to a workable model. Several people did pioneering work on voice transmission over a wire and improved on each other's ideas, but Alexander Graham Bell was the first to be awarded a United States patent for an electric telephone in March 1876.

The candlestick telephone was made by the Western Electric Company. Western Electric was an American electrical engineering and manufacturing company and the supplier to AT&T from 1881 to 1995. The candlestick telephone is a style of telephone that was common from the late 1890s to the 1930s. Candlestick telephones featured a mouth piece (carbon granule transmitter) mounted at the top of the stand, and an ear piece (electromagnetic receiver) that was held by the user to the ear during a call. When the telephone was not in use, the receiver rested in the fork of the switch hook protruding to the side of the stand, thereby disconnecting the audio circuit from the telephone network. Candlestick telephones required the nearby installation of a subscriber set or ringer box which housed the ringer to announce incoming calls and the electric circuitry (capacitor, induction coil, signaling generator, connection terminals) to connect the set to the telephone network. In the early days, businesses, banks, depots, and installations requiring multiple telephones and lines were equipped with various ringers such as round bells, cow bells and liberty bells producing distinctive sounds so users could tell which phone to answer. When automatic telephone exchanges were introduced, the base of a candlestick also featured a rotary dial, used for signaling the telephone number of an intended call recipient.

Western Electric Candlestick Telephone

This is a Western Electric solid brass dial candlestick telephone. The last patent date on the side of the base is 1918. The phone is 11 ½ inches high. The upright, base, and mouthpiece are polished brass. The dial is a Western Electric #4 that clicks when rotated. The finger wheel is polished solid brass. The ringer box is oak and bears sleigh bell ringers, the rarest type of ringer. The phone was restored by Richard R. Marsh. All of the cords have been replaced with cloth cords. The phone has been supplied with a modern modular line cord that can be plugged into a modular jack to make the phone functional.

Atwater Kent Model 40 Radio, 1928

Radio is the wireless transmission of signals from a transmitter through space by electromagnetic radiation. The electromagnetic wave (radio wave) is intercepted by a receiving antenna. A radio receiver receives the radio waves and converts the information carried by them into sound. The development of the radio was an incremental process based on many discoveries and inventions in the nineteenth century. There are several claimants for the first workable wireless radio, although credit is usually given to Guglielmo Marconi (1874–1937).

Arthur Atwater Kent, Sr. (1873–1949) was an American inventor and prominent radio manufacturer based in Philadelphia. His business was called the Kent Electric Manufacturing Company, which he began in the back room of his father's machine shop, and from which he sold small electric motors, generators, fans, and later automobile ignition systems. In 1921, Kent produced his first radio components, selling the do-it-yourself kits consisting of "breadboards" that could be assembled by early radio enthusiasts. In 1923, the Atwater Kent Manufacturing Company started producing complete radio sets and by 1925, it became the largest maker of radios in the United States. Atwater Kent radios were of high quality and the onset of the Great Depression greatly hampered sales of Atwater's premium radio sets. Kent dissolved his design engineering facility in 1931 and shut down his radio factory in 1936.

Atwater Kent Model 40 Radio and E3 Speaker

This is an Atwater Kent Model 40 AM tabletop radio, serial number 2775504, made in 1928. It uses a tuned radio frequency (TRF) amplification type receiver with a tuning knob and volume knob. Power is AC, one of the first to use AC, and voltage is 110 volts. It has seven tubes: 26 (4), 27, 71A, and 80 and there is an extra set of tubes. The receiver is in a metal cabinet 17 x 10 x 7 inches in size. The speaker is an Atwater Kent E3 serial number 442106 and is 11 inches in diameter. The radio is in excellent condition. The cords for the radio and speaker are original and worn and the connection to the speaker is loose. There is a small tear in the cloth at the back of the speaker. With a long copper wire antenna, reception is excellent.

Hallicrafters Television Set Model T-54, 1948

Experiments on transmitting images began in the 19th century. Rudimentary television sets existed in the 1930s but they were extremely expensive and there were very few broadcasters and programs. World War II delayed the commercial development of the television, although research done on communications translated directly to the television and led to improved television design.

William J. Halligan founded his own radio manufacturing company in Chicago in 1932. The company name Hallicrafters was a combination of Halli(gan) and (hand)crafters. By 1938, Hallicrafters was doing business in eighty-nine countries and manufactured the most popular radio sets in the USA. That year, the company began to produce radio transmitters. With the outbreak of World War II, the company prepared for wartime production, and was responsible for new communication designs and innovations for use by U.S. troops. During the Cold war era, the company took active participation in the Atlas missile projects and helped develop capability for many areas of electronic warfare and in missile technology. In 1966, Halligan sold the company to the Northrop Corporation. Northrop ran the company until the early 1970s, but by this time, fierce Japanese competition was putting pressure on the US domestic electronics market. Northrop sold the company name (but kept the factory, by then located in Rolling Meadows, a Chicago suburb) in 1975, bringing non-military electronics production to an end. The Hallicrafters plant became Northrop Corporation's Defense Systems Division.

By 1946, the nation had adopted a single TV broadcasting standard. TV networks were springing into existence, and the refinement of all-glass miniature tubes made it possible to build more affordable TVs. By 1947, the number of TVs in the US had mushroomed from a few hundred to as many as 44,000. This encouraged radio manufacturers, including Hallicrafters, to enter the TV market. Their first was model T-54, introduced in 1947. The T-54 came in the same grey metal cabinet as the popular Hallicrafters SX-42 communications radio. Raymond Loewy, the famous Machine Age designer, is credited with designing both of these sets.

The heavy tabletop television measures 20 x 10.5 x 16 inches. It has a 7-inch diameter 7JP4 picture tube that uses electrostatic deflection and 22 tubes. The leftmost control combines the power switch and contrast control, while the next knob to the right controls brightness. The three large knobs on the top adjust the volume, horizontal hold, and vertical hold, respectively. Below these is a row of fourteen pushbuttons, for selecting VHF channels 1 through 13. Channel 1 was decommissioned from television use in 1948 by the FRC/FCC. The rightmost "button" is a rotary fine-tuning control. The back panel of the TV provides five additional picture controls, to adjust focus, vertical and horizontal position, width, and height. Included is a “Photofact Folder” with specifications for this model, 8/48. The television powers on and should work when connected to an Apex Digital TV Converter Box (included), which converts the digital signal into an analog signal. The case is in good condition noting some spots where the paint has been chipped off. Televisions are not obsolete but those using tubes and the analog signal are.

Hallicrafters Television

Crosley AM Tube Radio, 1949

This is a Crosley AM radio model number 9-120W made in 1949. Powel Crosley Jr. (1886-1961) began making low cost radios in 1921 and by 1925 the Crosley Radio Corporation became the largest radio manufacturer in the world. Crosley sold the company to the Aviation Corporation (AVCO) in 1946, and it became the Crosley Division of AVCO. This table model radio measures 8.5 x 5.25 x 4.87 inches. It is a five tube set and the controls are volume and tuning. It has a red and white plastic case, grill cloth behind bars, and round dial window. The radio is in excellent functional condition. Radios did not become obsolete, but those using vacuum tubes did.

Crosley Radio

RCA 45 RPM Record Player, 1950

RCA introduced the new seven-inch 45 RPM format records and record players in 1949. The 45s became very popular in spite of their ability to hold only one song per side. This was mostly due to their smaller size and lower cost. The introduction of this record player came shortly before the rise of rock music in the 1950s. Teenagers in the 50s and 60s listened to radio shows playing hit songs and purchased large numbers of the inexpensive 45 records with these songs. Most used this iconic RCA player.

This 1950 RCA Victor 45-EY-2 Phonograph was introduced in 1950 and was designed to stack and play up to twelve 45 RPM records at a time. It is an AC operated three tube automatic phonograph with mono amplifier and speaker. The cabinet is maroon plastic and measures 10.625 x 8.375 x 8.625 inches. It has its original leather carrying case. The record player has been completely restored and is fully functional.

The new smaller vinyl records released by RCA were color-coded at first. Children's records were yellow, County and Western green, Classical red or dark blue, Rhythm & Blues orange, and Popular songs were pressed on black vinyl. The collection has the following early 45 RPM records:

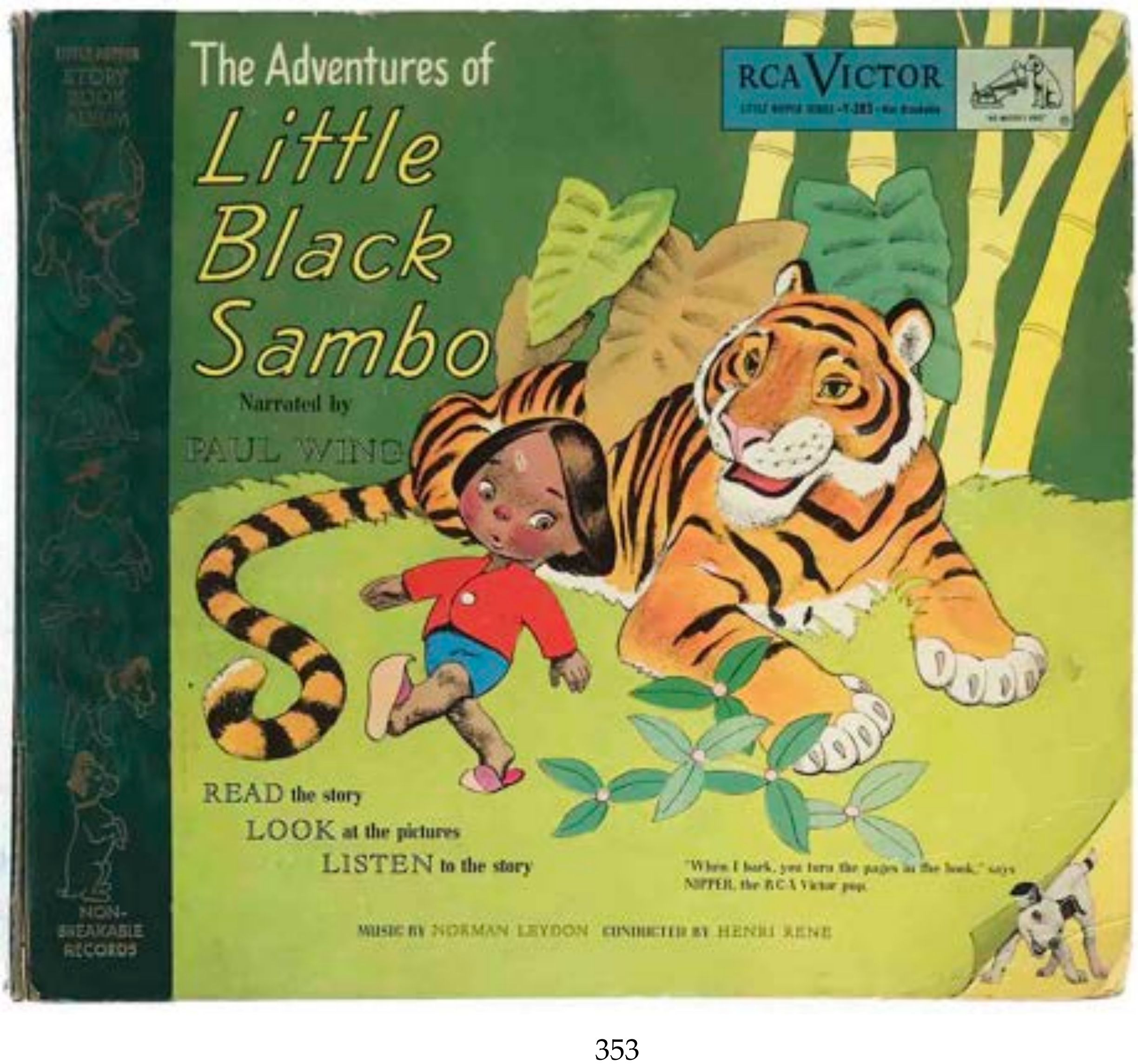
"Walt Disney's Cinderella," two yellow vinyl records in a storybook album, 1949. This is one of the "Little Nipper" series of records for children. With the album, children read the story and looked the pictures and listen to the story. When Little Nipper, the RCA Victor Pup barked, you turned the page in the book.

"The Adventures of Little Black Sambo," two 45 RPM yellow vinyl records and two 78 RPM records in a storybook album, 1949. This is another album in the Little Nipper series. The Story of Little Black Sambo is a children's book written and illustrated by Scottish author Helen Bannerman and published in 1899. Sambo is a South Indian boy who lives with his father and mother, named Black Jumbo and Black Mumbo, respectively. While out walking, Sambo encounters four hungry tigers, and surrenders his colorful new clothes, shoes, and umbrella so they will not eat him. The tigers are vain and each thinks that he is better dressed than the others. They have a massive argument and chase each other around a tree until they are reduced to a pool of ghee (clarified butter). Sambo then recovers his clothes and his father collects the ghee, which his mother uses to make pancakes.

At the time, critics observed that Bannerman presents one of the first Black heroes in children's literature and regarded the book as positively portraying Black characters in both the text and pictures. In that era, most books negatively depicted Blacks as simple, lazy, and uncivilized. However, it became an object of allegations of racism in the mid-20th century, due to the names of the characters being racial slurs for dark-skinned people, and the fact the illustrations were in the pickaninny style. For many African Americans, *Little Black Sambo* was an entertaining story ruined by racist pictures and racist names. This edition of the story contains these objectionable features. Both text and illustrations have undergone considerable revisions since.

"Eddy Arnold Sings," three green vinyl 45 RPM records in a boxed set, 1950.
"Mario Lanza The Great Caruso," four red vinyl 45 RPM records in a boxed set, 1951.
"Year 'Round Favorites with sammy kaye and his orchestra," three black vinyl 45 RPM records, 1949.

In addition, there are 45 RPM records from the 1950s and 60s with songs by Paul Anka, The Beach Boys, The Beatles, Patsy Cline, Neil Diamond, Fats Domino, Bob Dylan, The Everly Brothers, Buddy Holly, Elton John, Jerry Lee Lewis, The Monkees, Dolly Parton/Kenny Rogers, Elvis Presley, Simon and Garfunkel, Bruce Springsteen, Rod Stewart, The Supremes, and Stevie Wonder/Paul McCartney.


The Adventures of
Little
Black
Sambo
Narrated by
PAUL WING
RCA VICTOR
READ the story
LOOK at the pictures
LISTEN to the story
"When I bark, you turn the pages in the book," says NIPPER, the RCA Victor pup.
MUSIC BY NORMAN LEYDON CONDUCTED BY HENRI RENE
NON-BREAKABLE RECORDS

Royal Typewriter, 1957

A typewriter is a mechanical machine for writing characters similar to those produced by a printer's movable type. Typically, a typewriter has an array of keys, and each one causes a different single character to be produced on the paper, by means of a ribbon with dried ink struck against the paper by a type element. The typewriter became common in offices after the mid 1880s and quickly became an indispensable tool for practically all writing other than personal handwritten correspondence. This is a Royal Quiet Deluxe, a portable typewriter, made by the Royal Typewriter Company from 1939 until 1959. The Royal Typewriter Company was a manufacturer of typewriters headquartered in New York City with its factory in Hartford, Connecticut. This typewriter in crinkle green, serial number AG3705467, was made in 1957. Beginning in the 1980s, the typewriter was largely supplanted by computers.

Royal Typewriter

RCA Videocassette Recorder, 1978

A videocassette recorder (VCR) or video recorder is an electromechanical device that records analog audio and analog video from broadcast television or other source on a removable, magnetic tape videocassette, and can play back the recording. Ampex Corporation released the world's first magnetic tape video recorder, the VRX-1000, in April 1956. It caused a sensation. But with a price tag of $50,000, it was far from a consumer item. The orders from the television networks, however, came pouring in. Other companies abandoned their research and followed Ampex's lead. Prototypes of videocassette recorders were developed in the l960s, but the first relatively convenient and low-cost VCR was introduced by the Sony Corporation in 1969. With the subsequent development of the Betamax format by Sony and the VHS format by the Matsushita Corporation in the 1970s, videocassette recorders became sufficiently inexpensive to be purchased by millions of families for use in the home.

The RCA SelectaVision was the first VHS video cassette recorder marketed in the United States. It was announced on August 23, 1977 and went on sale in October at a cost of $1,000. This is an early RCA SelectaVision VCR, Model VCT 201. It was made by Panasonic for RCA on June 28, 1978. It features a clock, timer, two speeds recording up to four hours, analog timer with reset, and memory on/off. From about 2000, the DVD became the first universally successful optical medium for playback of pre-recorded video, as it gradually overtook VHS to become the most popular consumer format. DVD recorders and other digital video recorders dropped rapidly in price, making the VCR obsolete. The following VHS taps are included: Winnie The Pooh, Gone With The Wind, The Wizard Of Oz, Thomas The Tank Engine, Spencer Tracy and Katherine Hepburn Desk Set, and The War Of The Worlds.

RCAVideocassette Recorder

Motorola DynaTAC 8000 Series Handheld Brick Cellular Phone, 1986

Prior to 1973, mobile telephony was limited to large phones installed in cars and other vehicles. Motorola was the first company to produce a commercial handheld mobile phone. On April 3, 1973, Martin Cooper (1928-), a Motorola researcher and executive, made the first mobile telephone call from handheld subscriber equipment, placing a call to his rival Dr. Joel S. Engel of Bell Labs. After more than a decade of work in cellular research and technology, Motorola produced the DynaTAC cell phone in 1984. The Motorola DynaTAC 8000X was the first commercially available portable handheld cell phone. DynaTAC was an abbreviation of "Dynamic Adaptive Total Area Coverage." The phone was nine inches tall, weighed 28 ounces, had 30 minutes of battery life, took ten hours to recharge, and sold for $3,995. It had an LED display and thirty circuit boards for recall of 30 phone numbers. The phone's bulky form and weight earned it the nickname "the brick." Despite its size, it was considered revolutionary because previous mobile telephones were bulky affairs installed in vehicles or in heavy briefcases. Several models followed, starting in 1985 with the 8000s, and continuing with periodic updates until 1993. The DynaTAC series was succeeded by the MicroTAC series in 1989.

This is a DynaTAC cellular phone model F09LFD8437AG. The serial number 472GUL 1186 indicates it was made in November, 1986. It is 7 ¾ inches tall, 1 ¾ inches wide, and 2 ½ to 3 inches thick. The phone has the typical 12-key telephone numerical keypad and a 9-key control keypad: Rcl (recall), Clr, (clear), Snd (send), Sto (store), Fcn (function), End, Pwr (power), Lock, and Vol (volume). Instructions for use are given on the back. It is complete in the original box with a user manual, antenna, car charger with cord, desktop overnight charger and ac adapter, and 7.5V nickel-cadmium battery. The phone bears an "Ameritech" label. Ameritech Mobile Communications was the first company in the United States to provide cellular mobile phone service to the general public. It originally charged subscribers $50 a month plus 40¢ a minute peak, 24¢ off-peak. The phone is in excellent condition and appears unused. The battery charges and the phone powers up but with the discontinuance of analog cellular service, it cannot make calls.

Motorola DynaTAC Cellular Phone

Sony Walkman, 1988

Walkman is a brand of portable media players manufactured by Sony. The compact cassette was developed in 1963 at the Dutch company Royal Philips in Hasselt, Belgium by Lodewijk (Lou) Frederik Ottens (1926-2021) and his team. The original Walkman, released in 1979, was a portable cassette player. A major reason for its popularity was that people could choose the music they listened to while on the move. By 2010, Sony had built about 200 million cassette-based Walkmans. Portable compact disc players and the iPod led to the decline of the cassette Walkman, which was discontinued in Japan in 2010.

This is Sony Walkman model WM AF-23 made in 1988. It consists of a cassette player, AM/FM radio, belt clip, and headphones. It operates on two AA batteries and is compatible with a Sony rechargeable battery. The Walkman is in its original unopened package. A set of cassette tapes, by various artists and dating to the 1980s, is included with the Walkman.

Sony Walkman

PalmPilot 5000 Personal Digital Assistant, 1996

Palm, Inc. was a technology company that developed and designed Personal Digital Assistants (PDAs), mobile phones, and software. Palm Computing was founded in 1992 by Jeff Hawkins and acquired by U.S. Robotics in 1995 for $44 million. The company released their first devices, the PalmPilot 1000 and 5000, in 1996. These were the first handheld computers and ushered in the smartphone era. The first Palms had no infrared port, backlight, or flash memory, but did have a serial communications port. Their RAM size was 128 kB and 512 kB respectively, and they used version 1 of Palm OS. The company continued to make Palm branded PDAs and smartphones until 2010. In April 2010, it was announced that Hewlett-Packard would acquire Palm for around $1.2 billion. Although HP kept the Palm brand initially, all PDAs released after 2011 were branded as HP devices, not Palm.

This is a PalmPilot 5000, the first generation PDA. It has a plastic case and its dimensions are 120x80x18 mm and weight is 160 grams. With a purchase price of $369, the Pilot 5000 had a Motorola processor that operated at 16 megahertz and 512 kilobytes of memory. It uses version 1 of Palm OS. The Pilot has a 160x160 pixel monochrome LCD tactile panel, with a "Graffiti input zone, " presented in the bottom third of the screen. The Pilot’s system of “graffiti” shorthand provided users with an effective text input system. Underneath the screen sits a green on/off button, four applications buttons (Date Book, Address Book, To Do List, and Memo Pad) and two scroll buttons. At left, contrast control. At right top, stylus slot. On the back of the device there is a Memory Slot door, Reset button, battery compartment (holds two AAA batteries) and Serial Port for use with the PalmPilot Cradle for synchronization with a personal computer (PC). After a calibration test presented during the initial power up, the Pilot would boot and be ready for use and synchronization. Connecting and synchronizing the PDA was initially done through a utility called Pilot Desktop. This PDA is accompanied by Puma Technology “IntelliSync” with a disc for synchronizing the Pilot 5000 with a PC using Windows 95 and Windows NT. The Pilot is in excellent working condition with cradle, stylus, case, synchronization cable, manual, and original box.

PalmPilot 5000

BlackBerry Wireless Handheld 7510, 2004

BlackBerry is a line of smartphones, tablets, and services originally designed and marketed by Canadian company BlackBerry Limited (formerly known as Research In Motion, or RIM). BlackBerry was one of the most prominent smartphone vendors in the world, specializing in secure communications and mobile productivity, and well known for the keyboards on most of its devices. At its peak in September 2013, there were 85 million BlackBerry subscribers worldwide.

However, BlackBerry lost its dominant position in the market due to the success of the Android and iOS platforms. The latter devices also used touchscreens instead of a physical keyboard. Its numbers had fallen to 23 million in March 2016. In 2016, BlackBerry announced that it would no longer be making devices of its own, with the Chinese company TCL Communication picking up the license. In 2020, TCL has reported that it no longer has the license and will not sell any more BlackBerry devices after 31 August 2020. However, the BlackBerry may not be completely dead. A recent report says that a company named OnwardMobility will produce a BlackBerry handset with a physical keyboard in 2021.

The BlackBerry 7510 wireless handheld was introduced in 2004. It was first BlackBerry equipped with a speakerphone and the first color-display BlackBerry for iDEN networks. It features a built-in cell phone, personal organizer and Web browser, supports Nextel Online Wireless Web and offers Nationwide Direct Connect. Other key features include advanced e-mail, push-to-talk voice, Java applications, wireless internet, and PIM (organizer) features. It has a QWERTY keyboard, trackwheel, 240 x 160 LCD display, 900 mAh lithium ion battery, 16 MB internal storage, and BlackBerry OS. This BlackBerry is complete with all of its accessories including battery, travel charger, earpiece, belt holder, desktop cradle, USB cable, desktop software, manuals, and original box. The phone charges up and turns on.

BlackBerry Phone

Apple iPhone, First Generation, 2007

Development of what was to become the iPhone began in 2004, when Apple started to gather a team of 1,000 employees to work on the highly confidential "Project Purple." Apple CEO Steve Jobs steered the original focus away from a tablet (which Apple eventually revisited in the form of the iPad) towards a phone. Apple created the device during a secretive collaboration with Cingular Wireless (which became AT&T Mobility) at the time—at an estimated development cost of 150 million dollars over thirty months. Jobs unveiled the iPhone to the public on January 9, 2007, at the Macworld 2007 convention at the Moscone Center in San Francisco. The original iPhone was described as "revolutionary" and a "game-changer" for the mobile phone industry.

All generations of the iPhone use Apple's iOS mobile operating system software. The user interface is built around the device's multi-touch screen, including a virtual keyboard. The iPhone has Wi-Fi and can connect to cellular networks. An iPhone can shoot video (though this was not a standard feature until the iPhone 3GS), take photos, play music, send and receive email, browse the web, send and receive text messages, follow GPS navigation, record notes, perform mathematical calculations, and receive visual voicemail. Other functionality, such as video games, reference works, and social networking, can be enabled by downloading mobile apps.

This is a first generation iPhone (colloquially known as the iPhone 2G and iPhone 1 after 2008 to differentiate it from later models), the first smartphone designed and marketed by Apple Inc. It is a handheld device combining mobile phone, iPod, and Internet communications functionality. It pioneered the multitouch finger-sensitive touchscreen interface of Apple's iOS mobile operating system. The phone has the model number A1203 and MPN MA712LL/A. The serial number 88801D4UWH8 shows that it was made the week of December 31, 2007. It is a Quad-band GSM capable phone and features a 3.5 inch display with 320x480 resolution at 163 ppi, 8 GB of flash memory, built-in support for Wi-Fi, EDGE, and Bluetooth 2.0, as well as an integrated 2.0 megapixel and camera all packed in a case 0.46 of an inch thick that weighs 4.8 ounces. It has the original iOS 1.1.1 firmware with 13 icons. It is complete with a box and accessories including a wall charger, USB sync cable, docking station, earplugs, and booklet. The phone is in perfect cosmetic condition. It lights up when plugged in but the battery does not charge and is dead. It will work with a replacement battery.

A second iPhone is an identical phone with the same specifications that has the serial number 83749CW6WH8 showing that it was made the week of December 3, 2007. It is unlocked, the battery can be charged, and all features are functional. The phone is in very good cosmetic condition noting that the back aluminum cover has a few minor scratches.

First Generation iPhone

Apple iPhone 3GS, 2009

The iPhone 3GS, Model No. A1303, is the third generation iPhone. It was released on June 19, 2009. It is an upgrade to the 3G that was introduced in July, 2008. The "S" refers to its enhanced speed (600 MHz). It has 16GB storage capacity, a 3.0 megapixel camera, and runs on iOS 3.0. The LCD display on the device was designed by Apple and made by LG Corporation. It features a capacitive touchscreen with a pixel density of 163 pixels per inch (ppi) on a 3.5 in (8.9 cm) 480-by-320 display. The iPhone 3GS uses the Samsung APL0298C05 chip, which was designed and manufactured by Samsung and is powered by an internal 3.7 V 1220 mAh rechargeable lithium-ion polymer battery. The phone is not connected to a carrier but is in excellent working condition. It comes with the original box, manual, charger and cable, and headphones. When it came out, it cost $299 with a 2-year AT&T contract.

Apple iPhone 3GS

Electricity

Nairne-Type Electrostatic Generator, c1790

An electrostatic generator, or electrostatic machine, is a mechanical device that produces static electricity, or electricity at high voltage and low continuous current. Development of electrostatic machines began in earnest in the eighteenth century, when they became fundamental instruments for studies in the new science of electricity. Electrostatic generators operate by transforming mechanical work into electric energy. The charge is generated by one of two methods; either the triboelectric effect (friction) or electrostatic induction.

Edward Nairne (1726-1806) was an optician and scientific instrument maker. He did his apprenticeship with Matthew Loft. He worked on his own from 1749 until 1774 when he entered into partnership with Thomas Blunt. Nairne patented several electrical machines, including in 1782 a “Nairne Patent Medical Electrical Machine.” The device consisted of a glass cylinder mounted on glass insulators and could supply either positive or negative electricity and was intended for medicinal use. In the eighth edition of the instruction manual for this device he claimed that "electricity is almost a specific in some disorders, and deserves to be held in the highest estimation for its efficacy in many others." He recommended its use for nervous disorders, bruises, burns, scales, bloodshot eyes, toothache, sciatica, epilepsy, hysteria, agues, and other ailments.

Nairne-Type Electrostatic Generator

This is a Nairne-type electrostatic friction generator of the cylinder type. The machine is 16 ½ inches long, 8 ½ inches wide, and 11 inches high. It consists of a base with two uprights at the ends supporting a 10 x 7 inch blown glass cylinder with extensions on each end fitted into turned wood sheathed caps. Two uprights on a long side hold a wooden bar with attached leather friction pad against the cylinder. A hand crank turns the cylinder against the friction pad. A tray rests on the base beneath the cylinder. All of the wood parts are made of mahogany or other hardwoods. A glass pillar, possibly broken off, holds a brass conductor. There are several accessories including brass pieces with wooden handles to apply charge to a patient's skin. A T-shaped brass conductor is mounted on a turned wood stand. A small cardboard container contains mercury used to smear with lard on the surface of the leather pad. A silk apron was placed over the cylinder to prevent escape of electrification from the glass. A brass clamping screw that attaches to the base and with a string permits adjustment of the frictional pressure offered by the cushion against the glass cylinder. The machine has its original wooden case with iron handles at each end and painted in a mustard color. The machine is intact and in good condition in view if its age. There are some cracks and splits in the wood fixtures. Plaster is missing on one crank handle collar. This machine came out of the earliest house in Holyoke, Massachusetts.

Davis & Kidder's Patent Magneto-Electric Machine

Ari Davis (ca. 1811-1855) was a skilled American craftsman who received two patents in 1854. One described a machine for producing wooden boxes with metal-reinforced dovetail corners. The other described a magneto-electric machine. While this second patent was still in process, Davis sold the rights to both patents to Walter Kidder, a physician in Lowell, Massachusetts, allegedly for $4000. Kidder manufactured and advertised electric machines. When electricity was new, people had high hopes that it had curative powers. Unlike other "magical" cures, electricity could be felt. Electropathy, very popular from 1850-1900, promised to cure most diseases and conditions including cancer, tuberculosis, diabetes, heart disease, and mental illness.

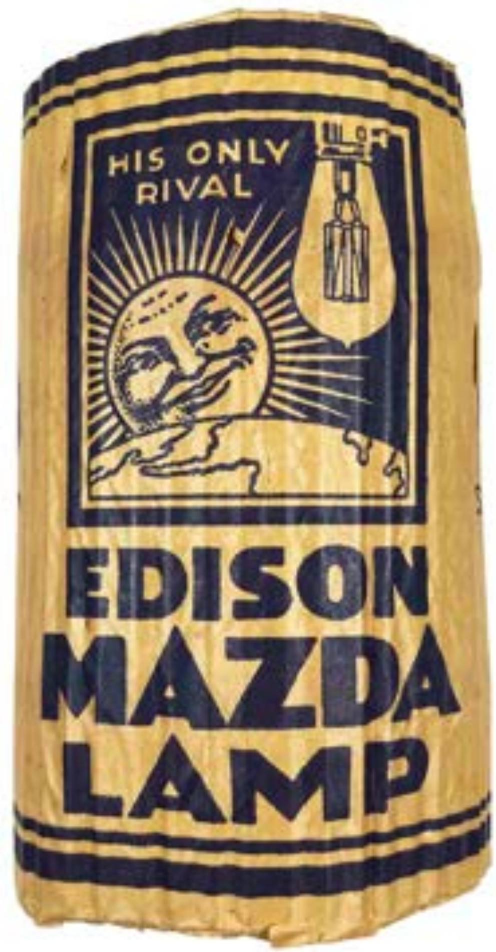
This example of an electric machine has a mahogany box with brass corners (per the earlier patent) and ivory handle. The paper label inside the lid is marked "DAVIS & KIDDER'S PATENT MAGNETO-ELECTRIC MACHINE FOR NERVOUS DISEASES." The label also bears directions and testimonials from Prof. Benjamin Silliman at Yale College and Charles G. Paige in Washington, D.C. With the machine, the "patient" held a metal cylinder, a hand electrode, while the healer applied a second electrode to the ailing body part. Alternatively, the patient held a metal cylinder in each hand while someone else wound the crank. Turning the crank causes two velvet-covered armatures attached to a U-shaped magnet to spin generating an electric current. The current passes over cloth-insulated wires to the electrodes and into the patient's body. This machine is complete and in excellent condition and probably still works. The electric machines were quack medicine and eventually fell into disuse.

Magneto Electric Machine

Edison Mazda Incandescent Light Bulb, c1919

An incandescent light bulb is an electric light with a wire filament heated until it glows. The filament is enclosed in a bulb to protect the filament from oxidation. Current is supplied to the filament by terminals or wires embedded in the glass. A bulb socket provides mechanical support and electrical connections. Thomas Edison did not invent the first light bulb; however, he did improve the design and performance of the earliest incandescent lamps to create the first commercially viable light bulb. In 1880, Edison's team improved the light bulb with a bamboo filament that burned for 1,200 hours. The carbonized bamboo filament became the standard filament for the next twenty years. The General Electric Company developed tungsten filaments that lasted longer and burned brighter than carbon filaments. Mazda was the trademarked name registered by General Electric (GE) in 1909 for the tungsten filament light bulb.

Shown here is a 1919 advertisement for the Mazda light bulb and a bulb the same as in the advertisement. The bulb is a large, tapered, oval-shaped, clear glass bulb with a point on the top; has a brass bottom with threads on the end; attached to the inside of the bottom is a long glass tube with two terminals on either side and a long glass rod and platform attached to the top; both terminals extend up vertically; there are small wires attached to the top and bottom of the rod forming a circular pattern; a thin wire is attached to the terminals and is stretched vertically, hooking on to each of the small wires; the name of the manufacturer is printed on the side. The tip at the top marks the point at which a thin glass tube connected the bulb to a vacuum pump. Once all the air was removed, a torch melted the tube and sealed the lamp, leaving the tip. This bulb is intact and lights up when screwed into a live socket. There is also a very rare, intact sleeve for the bulb. The sleeve has patent dates from 1912 to 1922. Incandescent bulbs are not efficient, converting less than 5% of the energy they use into visible light. As a result, legislation in many countries, including the US, has mandated phasing them out for more energy-efficient options such as compact fluorescent lamps (CFL) and light emitting diode (LED) lamps.



Mazda Light Bulb

Edison Incandescent Light Bulb, 1929

An incandescent light bulb is an electric light with a filament that is heated to a high temperature by passing an electric current through it until it glows with visible light (incandescence). Thomas Alva Edison (1847-1931) created the first commercially practical incandescent light in 1879.Beginning in 1802, over 20 versions of incandescent lamps were produced by different inventors with limited success. Edison's version was successful because it used a carbon-based filament that was durable and had a high resistance requiring lower voltage. In addition, he utilized a more effective vacuum to remove oxygen from the bulb to prevent oxidation of the filament. This is a reproduction of Edison's 1879 light bulb made in 1929 for the 50th anniversary commemoration of Edison's invention. It is 7 inches high, has a wax filled insulated wooden base, Bakelite thumb screws on the contacts, triple loop element, and bulbous exhaust tip on the top of the bulb. The bulb lights but should be used with a rheostat at low voltage to conserve the filament.

Edison Light Bulb

Bradley & Hubbard Slag Glass Lamp, 1908

With the advent of electricity, lamps were made in new shapes and materials to replace kerosene and gas lamps. Around the turn of the century, leaded stained glass lamps like those made by Louis Comfort Tiffany were popular, but expensive to make and costly to purchase. Prices for Tiffany table lamps ran into the hundreds of dollars. Slag glass panel lamps, as they're called today, with a few large pieces of glass fitted into a cast metal frame evolved as a way to create some of the effects of the leaded lamps without the high cost of labor and materials. That made them affordable for many more people.

Slag glass, also known as marble glass or malachite glass, is a type of opaque, streaked pressed glass. Production of slag glass originated in late-19th-century England, where glass manufacturers are thought to have added slag from iron-smelting works to molten glass to create a range of effects and colors. One of the most popular applications for pressed opaque glass was in lampshades. Wide bands of creamy colors allowed the light source in a lamp to fill a room with a soft ivory glow, while the purples and greens and reds pieced together in detailed leaded shades resulted in multi-colored illumination.

Many manufacturers made this type of lamp. One of the best-known makers was the Bradley & Hubbard Manufacturing Co. located in Meriden, Connecticut. The company was already well-established in the lighting arena as a manufacturer of kerosene lamps when electricity came along. It had its beginnings in the 1850s as a clock manufacturer. Bradley & Hubbard also made other metal goods like bookends, inkwells and spittoons. The Wall Street crash of 1929 gave birth to the Great Depression and people became more concerned with economic survival than buying pretty things. The market for dramatic, heavy lamps with glass shades faded and manufacturers responded with cheaper, lightweight lamps with paper or fabric shades.

This is a Bradley & Hubbard slag glass lamp. The lamp is 19 inches tall and the shade 15 inches in diameter. There are six large green glass panels and six small red panels at the top. There are two lamps with pull chains. It has a six sided bass base. The inside of the base is cast "189" and " B & H." The inside of the frame is stamped "PAT'D. OCT : 20 . 08."

Slag Glass Lamp

Machines

A machine is a tool that consists of one or more parts and converts energy into mechanical motion to perform a particular function. Archimedes (c287-c212 BC), a Greek mathematician, physicist, engineer, inventor, and astronomer, described simple machines such as the lever, pulley, and screw. A simple machine (lever, wheel and axel, pulley, inclined plane, wedge, and screw) is a non-powered mechanical device that changes the direction or magnitude of a force. Renaissance scientists regarded the simple machines as the elementary "building blocks" of which all more complicated machines are composed. Machines, which include engines and motors, became more complicated and composed of multiple parts. They are usually powered by mechanical, chemical, thermal, or electrical means. Heat engines, including internal combustion engines, such as gasoline engines, and external combustion engines, such as steam engines, burn a fuel to create heat, which then creates motion. Electric motors convert electrical energy into mechanical motion.

Medieval Iron Bearded Axe Head, 1000-1300 AD

The axe is an example of a simple machine, as it is a type of wedge. The wedge functions by converting a force applied to its blunt end into forces perpendicular (normal) to its inclined surfaces. It can be used to separate two objects or portions of an object, lift up an object, or hold an object in place. The first example of the wedge is the Acheulean hand axe. When used for cutting or splitting wood, the handle of the axe also acts as a lever allowing the user to increase the force at the cutting edge.

Medieval Bearded Axe Head

This in an iron axe head from the European medieval period, 1000-1300 AD. This type of axe is referred to as a bearded axe because the cutting edge extends below the width of the butt to provide a wide cutting surface while keeping the overall weight of the axe relatively low. The top is relatively straight from the butt to the toe of the blade. The 4 ½ inch blade curves downward slightly to the rear. The beard of the axe from the heel of the blade is straight inclining upwards before curving upwards sharply to the narrow eye. The length of the axe is 7 ½ inches. There appears to be a maker’s or armourer’s mark resembling a “W.” Many axes doubled as tools and weapons. This type of axe is most closely associated with the Vikings. It is in generally very good condition with slight pitting and rusting.

Cooper’s Broad Axe Head, c1700

This is the type of broad axe, named for the broad blade, with one side flat and the other side beveled. The eye for the handle is offset to the right side. It is also a bearded axe of the medieval “Viking” design because the cutting edge extends below the width of the butt to provide a wide cutting surface. Also known as a Cooper's side axe, it is a short one-handed axe that has a long cutting edge intended for the initial dressing of staves and heading pieces that make up a wooden cask. Similar axes were used by wheelwrights in making wagon wheels. It is 5 ¾ inches wide and 6 inches long and flat on one side. The axe has a cut out keyhole in the center and two unusual cartouche oval markings. The markings show crossed scythe blades with the letters H A G inside a dot border with a star at the bottom. Nothing is known bout the origin of this axe but the style suggests an early date of c1700 or earlier. The axe is in very fine condition with little pitting and rust.

Cooper's Broad Axe Head

Broad Axe Head, Isaiah Blood, c1860

A broad axe is an axe with a broad blade used for final squaring of round logs by hewing. There are two categories of the cutting edge on broadaxes. On one type, one side is flat and the other side beveled, a basilled edge, also called a side axe, single bevel, or chisel-edged axe. On the other type, both sides are beveled, sometimes called a double bevel axe, which produces a scalloped cut. On this axe, both sides are beveled. The heavy axe is 11 ½ inches long with a 6 ¼ inch wide blade. The axe is stamped by the maker "I. BLOOD, BALLSTON. N.Y." It is also stamped in several places "T L Priest" who may have been the distributor or owner. Isaiah Blood (1810-1870) took over his father's scythe shop on the Kayaderosseras Creek in Ballston, Saratoga County, New York in 1831. He built an axe factory downstream in 1851. His scythes and axes were of high quality and his business expanded greatly. His tools became well known throughout the Western Hemisphere, and lumbermen were proud to have the name "I. Blood" stamped on their axes. He was active in politics serving in the New York State Assembly and New York State Senate. The axe is in very good condition with little rust or pitting.

Broad Axe Head, Isaiah Blood

Ten-Inch Broad Axe

The blade on this large broad axe head is ten inches wide. Axes such as these were used in hewing the beams of Colonial houses in America.

Broad Axe

Collins & Co. "Legitimus" Carpenter's Hatchet Head, c1880

The Collins Company was founded by Samuel W. Collins, David C. Collins, and William Wells in 1826 and eventually became one of the largest axe and edge tool manufacturers in the world. They were located in the village of Collinsville in town of Canton, Connecticut along the Farmington River. The company used high quality iron from Watkinson & Co. As a result, the company gained a reputation for quality tools and underwent considerable expansion. That expansion ultimately resulted in serious complications for The Collins Co. as competitors started to use labels strikingly similar to those used by Collins. One means by which Collins & Co. indicated they were the manufacturer was by stamping the company name on their axes. The most recognizable marking is the LEGITIMUS brand, first used around 1876. It was often accompanied by a crown, from which rises an arm holding a hammer.

This is a Collins & Co. carpenter's hatchet or hammer axe head. It has a blade for cutting and splitting wood, a hammer head on the other side, and a notch for pulling nails on the heel. It is 5 ¾ inches long with a 3 ⅜ inch blade and weighs 1 lb 1 oz. This tool is marked "COLLINS&CO, HARTFORD, LEGITIMUS" and the crown, arm, and hammer symbol. The word Hartford is included because it was the original location of the office maintained by Samuel Collins. It is in very good condition with no rust, little pitting, and clear markings.

Collins Carpenter's Hatchet

Hatchet, Estwing Manufacturing Company, 2014

This is an Estwing E24A sportsman's hatchet. It marks the final stage in the progression of axe materials from stone to copper, bronze, iron, and finally steel. Estwing Manufacturing Company was founded in Rockford, Illinois, in 1923 by Ernest O. Estwing, an immigrant from Sweden. The company is known for its tools constructed of one solid piece of hardened tool steel for impact resistance and strength. This hatchet is made of 1055 carbon steel with the head and handle forged in one piece. It has a leather grip and sheath. It is 13 inches long with a 3 ¼ inch cutting edge.

Estwing Steel Hatchet

Hand Crank Centrifuge, c1910

A centrifuge is an apparatus in which compartments, called a rotor, are placed in rotation around a fixed axis. The rotors were first driven by a hand crank and later by an electric motor. The centrifuge is used to separate substances of different densities. The centripetal acceleration causes denser substances to separate out along the radial direction perpendicular to the axis toward the bottom of a tube while lighter objects will move to the top. The first centrifuge was invented in 1864 by Antonin Prandtl and used to separate cream from milk. Small hand-cranked tube centrifuges were commonly used in the late nineteenth and early twentieth centuries by dairy farmers who wanted to compare the butterfat content of milk from each of their cows. The centrifuge became an indispensible piece of equipment in medicine, chemistry, biology, and physics. Theodore Svedberg developed the ultracentrifuge that produced forces up to 900,000 times gravity. He used it to determine accurately the molecular weights of substances including proteins and viruses and received a Nobel Prize in 1926. Albert Claude used the ultracentrifuge to separate organelles from homogenates of cells and received a Nobel Prize in 1974.

This is a hand crank centrifuge of a type commonly used on dairy farms for separating cream from milk. It is marked Popper & Klein Germany and is made of cast iron. It clamps onto a table top and measures 11 inches high not including the handle and crank. The rotor consists of two buckets that hold glass tubes. It has its original wood case with compartments for the parts. It is in excellent working condition with only minor chipping to the black paint.

Hand Crank Centrifuge

Steam Engine Cutaway Model, c1920

A steam engine is a heat engine that performs mechanical work using steam as its working fluid. In the cycle, water is heated into steam in a boiler until it reaches a high pressure. When expanded through pistons or turbines, mechanical work is done. The reduced-pressure steam is then condensed and pumped back into the boiler. Since the late 1700s steam engines have become a major source of mechanical power. Steam engines can be said to have been the moving force behind the Industrial Revolution and saw widespread commercial use driving machinery in factories, mills and mines; powering pumping stations; and propelling transport appliances such as railway locomotives, ships and road vehicles. Their use in agriculture led to an increase in the land available for cultivation.

This is a cutaway cast iron model of a reciprocating steam engine as used on a locomotive. It is 15 inches long, 8 ½ inches high, and 1-2 inches deep. It was made by the Chicago Apparatus Company, a maker of laboratory apparatus, and used as a scientific teaching aid. Steam enters the steam chest located above the cylinder. Inside the steam chest is a sliding valve that opens and closes two steam ports. As the valve slides, steam is alternately admitted to the cylinder space on each side of the piston. The first stroke is to the front of the piston and the second stroke to the rear of the piston; hence two working strokes. The piston transmits power directly through a connecting or main rod connected to a crankpin or wristpin on the drive wheel. The two piston strokes result in one full turn of the wheel. There is a reversing lever and linkages that cause the drive wheel to turn in the opposite direction. The two small wheels are unpowered carrying wheels. The model is in very good condition with the manufacturers label and most of the original paint. All of the mechanics operate freely. There is slight surface rusting to the metal levers.

Steam Engine Cutaway Model

Electric Motor, General Electric Fan, 1923

An electric motor is a machine that converts electrical energy into mechanical energy. The application of electric motors in the nineteenth century revolutionized industry, farming, and the household. The first fans powered by electric motors were made from around the late 1890s. This is an oscillating three speed electric fan made by General Electric. The plate beneath the switch reads " TYPE AOU, FORM AC 1, HIGH MEDIUM LOW, NO D118459, CAT 75425, SPEC 272070-1, GEN ELEC CO U.S.A., VOLTS 110, CYCLES 60." The main body of the fan is constructed of cast iron. The round base is five inches in diameter. The motor is located in a hub behind the blades. The hub has a loop handle. The steel cage is 17 5⁄8 inches in diameter and 3 ¾ deep in the middle. A GE badge is located in the center of the cage. There are four brass fan blades. The fan has the original dark green color. The cord is original and taped from the motor to the base. Otherwise, the fan is in excellent condition and fully functional.

General Electric Fan

Singer Model 12 Sewing Machine, 1885

A machine is a tool containing one or more parts that uses energy to perform an intended action. A sewing machine is a machine used to stitch fabric and other materials together with thread. In 1790, the first workable sewing machine was invented and patented by the British inventor Thomas Saint. Saint's machine, however, never progressed beyond the patent model stage. In 1830 a French tailor, Barthelemy Thimonnier (1793-1857), patented the first practical sewing machine. By 1841, eighty of his machines were being used to sew uniforms for the French army. However, his factory was destroyed by a mob of tailors, who saw the new machines as a threat to their livelihood. Elias Howe (1819-1867) of Massachusetts originated significant refinements to the design concepts of his predecessors, and on September 10, 1846, he was awarded the first United States patent for a sewing machine using a lockstitch design. Howe could not find investors for his machine in America and England. Other entrepreneurs began manufacturing sewing machines, all infringing on some part of his 1846 patent. In 1851, Issac M. Singer (1811-75) patented the first rigid-arm sewing machine. Parts of Singer's new machine were based on Howe's work. Singer was sued by Howe for infringement of the latter's patent rights, but a compromise was reached where Singer paid Howe a royalty. Both men became extremely wealthy. Singer’s company became the world's largest manufacturer of sewing machines by 1860. He was awarded 20 additional patents, spent millions of dollars advertising his machine, and initiated a system of providing service with sales. By the 1850s, Singer sewing machines were being sold in opulent showrooms. Because the $75 price was high for the time, Singer introduced the installment plan to America and sold thousands of his machines in this way.

The sewing machine gained popularity amid the industrial boom in America. It sped up the production of everything with stitching—from umbrellas to tents—and most especially clothing. Ready-made clothing replaced the idea of owning only a few items of clothing. Increased efficiency meant cheaper costs of production and, along with a rise in fashion, people began to own more mechanically-stitched clothes. As evidenced by the dramatic increase in production and decrease in time it took to make articles of clothing, the sewing machine revolutionized the modern world. The sewing machine also produced a revolution in household labor by offering women a relief from the countless hours and tedium of hand sewing.

This is a Singer Model 12 sewing machine. The serial number is 6732654 showing it was made in 1885 in the Singer factory in Elizabeth, New Jersey. The Singer New Family Sewing Machine or Model 12 came onto the main market towards the end of the American Civil War in 1865 and lasted until 1902. It was one of the first reliable and easy to use lockstitch sewing machines. It would become the best selling machine of the age and was imitated by most other manufacturers. This example was portable and fits into a walnut case. It is made of cast iron painted in Japan black lacquer. These machines are known as fiddlebacks because of the shape of the base. It is operated by a hand crank. Singer applied decorative decals to his machines but did not name them. Collectors later assigned names to the patterns and this is known as “Acanthus Leaves.” Almost all of the decals are intact with only wearing in one corner where cloth was pushed in for sewing. The machine is complete with shuttle, needle, and bobbin. It is in excellent condition and functional and can sew. The case is 17 x 10 x 11 inches.

Singer Model 12 Sewing Machine

Gasoline Engine, Maytag Hit-and-Miss Model 92, 1930

A hit-and-miss or flywheel engine is an internal combustion engine that uses a flywheel or set of flywheels attached to the crankshaft for the purpose of maintaining engine speed by storing energy. The sound made when the engine is running is a distinctive, "pop whoosh whoosh whoosh whoosh pop" as the engine fires and then coasts, by means of the flywheel, until the speed decreases and the engine fires again to maintain its average speed. Power is taken from the engine via a pulley with a belt attached to a pulley on the equipment being driven. The hit-and-miss engine was one of the first gasoline engines and was conceived in the late nineteenth century. It was produced by a multitude of engine manufacturers from the 1890s through the 1940s. It performed a large variety of functions especially on farms in rural areas that lacked electricity.

This is a Maytag Model 92 hit-and-miss engine. The serial number of 454631 dates it to July 1 to September 30, 1930. The company founded by Frederick Maytag (1857-1937) produced its first washing machine in 1907. Maytag Introduced the model 92 single cylinder, kick start washing machine in 1927. It was manufactured through 1942. The model 92 was powered by an air-cooled, two-stroke hit-and-miss gasoline engine. A label reads “The Maytag Multi-Motor, Maufactured by the Maytag Company, Newton, Iowa U.S.A., Patent No. 1,565,110 Dec. 8th, 1925, Other Patents Applied For.” It is made of cast iron, has one cylinder, and one flywheel. It was rated ¾ h.p. and is a two cycle engine with a 2 ½ inch bore and two inch stroke. The Bosch FY-ED4 magneto was standard on the model 92. It has an Autolite spark plug and runs on a 16 to 1 gas/oil mix. The model 92 was the first Maytag washer motor to have as part of the engine a kick pedal for starting. It is painted in the characteristic Maytag green. The engine has been restored and is in excellent running condition.

Maytag Hit-and-Miss Gasoline Engine

Weaponry and Firearms

In prehistoric times, tools such as the axe, spear and knife had beneficial uses including obtaining and processing food, clearing land for farming, and building houses. They were also used as weapons for baser purposes such as acquiring territory and treasure. Weapons, like all other instruments, underwent technological improvements beginning with stone implements and eventually leading to nuclear weapons. This collection illustrates the history of weapons to 1900. It includes the major types of firearms used during this time. It also includes spears, bows, knives, swords, firearm accessories, and artifacts and documents related to weaponry. For firearms, it shows the technological advances that led from the simple hand cannon, to matchlock, wheellock, flintlock, percussion cap to modern guns. It also includes weapons of the types that were used in various wars including the French and Indian War, Revolutionary War, Napoleonic Wars, War of 1812, Mexican War, Civil War, Indian Wars, and Spanish American War.

Axe

An axe is an implement that has been used for millennia to shape, split and cut wood, to harvest timber, as a weapon, and as a ceremonial or heraldic symbol. The axe has many forms and specialized uses but generally consists of an axe head with a handle, or *helve*. The bifacial hand axe of the Acheulean industry began 1.76 million years ago and remained in use for over a million years. The first hafted stone axes appeared about 8000 BCE during the Mesolithic period. Technological development continued in the Neolithic period with the much wider usage of hard stones in addition to flint and chert and the widespread use of polishing to improve axe properties. Axes made of copper, bronze, iron and steel appeared as these technologies developed. Axes used as tools often doubled as battle axes. Others were specifically designed for combat. They were popular weapons because they were easy to make, effective and required little training. Battle axes were very common in Europe in the Roman period and throughout the Middle Ages including the Viking Age and the Crusades. Battle axes were eventually phased out at the end of the 16th century as military tactics began to revolve increasingly around the use of gunpowder.

Bearded Axe, c16th Century

A bearded axe, or Skeggøx (from Old Norse *Skegg*, "beard", and *øx*, "axe") refers to various axes, used as a tool and weapon, as early as the 6th century AD. It is most commonly associated with Viking Age Scandinavians. This type of axe is referred to as a bearded axe because the cutting edge extends below the width of the butt, like a beard, to provide a wide cutting surface while keeping the overall weight of the axe relatively low. The axe could be used for chopping wood. Also, a user could grip the haft in the space behind the "beard" and use the axe for planing or shaving wood. As a battle axe, the trailing lower blade edge increased cleaving power and could be used to catch the edge of an opponent's shield and pull it down, leaving the shield-bearer vulnerable to a follow-up blow.

This is a large, iron or steel hand-forged 15-17th century bearded axe with D-section socket and broad centered blade. It has an old wooden handle and measures 15.4 inches long. The top of the axe head is relatively straight from the butt to the toe of the blade and measures 7.6 inches. The 8.2 inch blade is slightly convex. The beard of the axe from the heel of the blade is straight inclining upwards before curving upwards sharply to the narrow eye.

The axe head has a number of punched marks to the blade. One cluster consists of a cross with three seven pointed stars above it. The second cluster has two serrated demilunes and six stars. Although these could be a maker's or armourer's marks, their extent and nature are more suggestive of a symbolic meaning. The Christian cross is found on some medieval axes, especially those used in the Crusades. Although uncommon, it persisted in post-medieval times as a religious, heraldic, or chivalric symbol. The demilunes and stars are suggestive of astronomical symbols. An expert on axe markings should be able to provide more information on these markings.

Bearded Axe

British Native American Trade Axe Head, c1700-1750

Before the arrival of the Europeans, the Native Americans lived in the Stone Age and had never seen iron objects. Their axes were made of stone. When America was discovered, the 'trade axes' played a major role in trade with the natives. The axes were made by the Europeans, but were soon so frequently used by the Native Americans that they came to be one of their leading symbols under the name "Tomahawk." The axes served as currency, with the Europeans trading a given number of axes for guides, bearers, leather and fur, crafts and other valuables. They were produced in Europe and shipped to America in barrels comprising part of the ballast for sailing ships.

This is an example of the classic style English iron Native American trade axe head. The top of the blade is flat and at a 90 degree angle to the eye. The bottom of the blade is at a 130 degree angle from the eye. The axe is eight inches long with a four inch blade. It dates to c1700-1750. The axe is heavily pitted but is intact and has been conserved.

Trade Axe

Spear

A spear is a pole weapon consisting of a shaft, usually of wood, with a pointed head. The head may be simply the sharpened end of the shaft itself, as is the case with fire hardened spears, or it may be made of a more durable material fastened to the shaft, such as bone, flint, obsidian, bronze, iron, or steel. Stone spear tips were first used in the early Chibanian (Middle Pleistocene), possibly 500,000 years ago, a period associated with *Homo heidelbergensis*, the last common ancestor of Neanderthals and modern humans. The most common design for hunting or combat spears since ancient times has incorporated a metal spearhead shaped like a triangle, lozenge, or leaf. The spear has been used throughout human history both as a hunting and fishing tool and as a weapon. It was used in virtually every conflict up until the modern era, where even then it continues on in the form of the fixed bayonet on a long gun, and is probably the most commonly used weapon in history. A pike, or pole arm, is a very long thrusting spear formerly used extensively by infantry. The standard infantry pike was often between sixteen and eighteen feet long. Some pike-heads included a cross-bar or “toggle,” which could be used to entrap the adversary’s weapon or entangle the bridle of a horse. Pikes were used regularly in European warfare from the Late Middle Ages to the early 18th century, and were wielded by foot soldiers deployed in close quarters, until it was replaced by rifles, which had a longer range, and to which a bayonet could be attached. Naval boarding pikes were used to repel boarders of ships. Boarding pikes were smaller than infantry pikes, about eight feet long and stored in beckets around the masts. From American Colonial through Civil War eras the American sailor regularly practiced repelling boarders with the boarding pike.

Pike Head, French and Indian War, Fort Carillon (Ticonderoga)

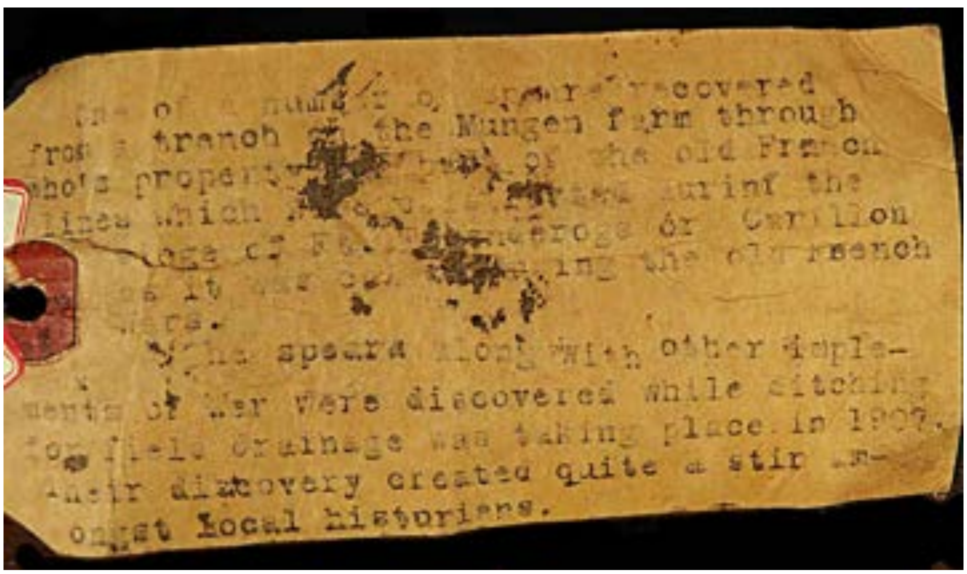
This large iron pike head is 18 ¼ inches long. The blade is 9 ¼ inches long and leaf-shaped with a constriction in the middle. Below the blade are two polyhedral knobs separated by a 1 inch long square shaft. The shaft has a hole through it that held a cross bar. The tubular socket is 7 ½ inches long and 1 ¼ inches in diameter at the base and narrows toward the blade. There is a split along its length. The pike head is in overall very good condition for a found object. The blade is slightly bent and there is pitting but no active rust.

Pike Head

The head had a tag attached that reads:

"One of a number of spears recovered from a trench on the Mungen farm through who's property was part of the old French lines which were constructed durinf[g] the siege of Fort Ticonderoga or Carillon as it was called during the old French Wars.

The spear along with other implements of War were discovered while ditching for field drainage was taking place in 1907. Their discovery created quite a stir amongst local historians."



The reference to "French lines" and Fort Carillon show that this object was used in the French and Indian War. The battle at Ticonderoga in the Revolution was between the British and Americans and Carillon was the French name for the fort before the English captured it. The British changed the name to Ticonderoga.

Fort Ticonderoga, formerly Fort Carillon, is a large 18th-century star fort built by the French between October 1755 and 1757 at a narrows near the south end of Lake Champlain. It was thus strategically placed between the British-controlled Hudson River Valley and the French-controlled Saint Lawrence River Valley. The fort was of strategic importance during the 18th-century colonial conflicts between Great Britain and France, and again played an important role during the Revolutionary War.

It is probable this pike was used by the French in the Battle of Carillon in 1758*. The French general Louis-Joseph de Montcalm, engaged his troops in a flurry of work to improve the fort's outer defenses. They built, over two days, entrenchments around a rise between the fort and Mount Hope, about three-quarters of a mile northwest of the fort. In this battle, 4,000 French defenders were able to repel an attack by 16,000 British troops who mounted a direct frontal assault on the thoroughly entrenched French, without the benefit of artillery. This pike head was for a long infantry pike of the type that would be utilized by entrenched troops.

*This could be verified if the location of the Mungen farm was known. I contacted the Ticonderoga Historical Society but they had no information. Further research could be done. Land records of the area should show the location of the Mungen farm and allow determination whether this was the location of the French lines in the Battle of Carillon. The French lines are shown on an old map of the battle.

Atlatl, Spear Thrower

An atlatl or spear thrower consists of a shaft with a cup or a spur at the end that supports and propels the butt of the dart. The dart is a wooden rod with a stone point at one end and feather fletchings at the other. It is held in one hand, gripped near the end farthest from the spur. The dart is thrown by the forward action of the upper arm and wrist. The throwing arm together with the atlatl acts as a lever. The atlatl is a low-mass, fast-moving extension of the throwing arm, increasing the length of the lever. This extra length allows the thrower to impart force to the dart over a longer distance, thus imparting more energy and ultimately higher speeds.

The atlatl is believed to have been in use by *Homo sapiens* since the Upper Paleolithic (around 30,000 years ago). The atlatl greatly improved the efficiency and safety of hunting large animals such as mammoths that previously were hunted with spears thrown by hand at close range. In Europe, it was supplemented by the bow and arrow in the Mesolithic between 20,000 and 10,000 years BP. The spear-thrower was used for hunting by early Americans as well. It may have been introduced to America during the immigration across the Bering Land Bridge. In America, it also was largely replaced by the bow and arrow.

The atlatl does not seem to have been used much in warfare, except by the Maya and Aztecs in America. They used it mostly in conflicts with other tribes, but it was noted that the atlatl dart could pierce Spanish leather and chainmail breastplates. The ancient Greeks and Romans used a leather thong or loop, known as an *amentum*, as a spear-throwing device. The amentum was tied to the shaft of a javelin or spear and fingers passed trough a loop for the throw. It increased the effective length of the throwing arm, as does a spear-thrower, and so enhanced speed of the projectile.

This is a Native American atlatl and dart. The shaft or thrower is 20 inches long with a guide for the dart at one end and a bone spur for the butt of the dart at the other. There are two leather loops for grasping the thrower with the fingers. The spur and grips are held on by sinew. The wooden spear is 45 inches long, has a flint point, and is covered with buckskin. The 4 inch basal notched flint point closely resembles a Calf Creek point. The edges of the buckskin are held together by very fine stitching with sinew cord. Another cord is wrapped around half of the shaft. It has large hawk feather fletchings. The point and feathers are tied on with sinew. It is hollowed out at one end to fit into the spur. The throwing shaft is more crudely made the than the dart. However, both have the same sinew wrappings indicating they belonged together.

The atlatl was originally obtained at a Comanche Nation Homecoming Pow-Wow in Oklahoma around 1960. It is from the collection of Leonard Kubiac, Fort Tumbleweed, Texas. Ancient atlatls or fragments are extremely rare as they are perishable, except for the stone points, and were replaced by the bow and arrow hundreds or thousands of years ago. Because of the elaborate wrappings around the dart of this specimen, it does not seem likely it was used for hunting. One explanation for this atlatl is that it is a late 19th or early 20th century object made by Native Americans, possibly the Comanches, for ceremonial purposes. Further research should be performed, but any example of an atlatl that is not a modern model manufactured for today's sport enthusiasts is in itself very rare.

Atlatl Bannerstone

An important improvement to the atlatl's design was the introduction of a small weight (between 60 and 80 grams), called a bannerstone, strapped to its midsection. Some atlatlists maintain that stone weights add mass to the shaft of the device, causing resistance to acceleration when swung and resulting in a more forceful and accurate launch of the dart. Others believe they also had ceremonial and spiritual importance and that they protected hunters during the hunt. This is supported by the fact that considerable skill and effort was required to produce them. They may have also conferred prestige and status on the hunter. It has also been suggested they had nothing to do with the atlatl but were tools for drilling, cordage making, or fire making.

This is a double-notched butterfly bannerstone. It was found in Missouri and is made of quartzite. It has a centered hole slightly less than ½ inch in diameter, 4 ½ inch wingspan, and 3 1/8 inches deep. It dates to the middle archaic period, c4600 BC. It has a certificate of authenticity.

Bannerstone

Eagle Head Sword, War of 1812, 1810-1820

A sword is a bladed weapon used primarily for cutting or thrusting. In its most basic form, it consists of a blade with two edges and a hilt or handle. It is one of the oldest technologies with its development related to breakthroughs in metallurgy. The sword developed from the dagger in the bronze age when construction of longer blades, first of copper and then of bronze, became possible. The first swords were relatively short because copper is soft and malleable and bronze, although harder, has a low tensile strength. The first short swords appeared around 3000 BC and longer "true swords" of bronze around 1600 BC. The latter were replaced with the introduction of iron and steel. The sword made advances in design in the middle ages and were used as effective weapons, but in the modern age fell from use when the sidearm became available. It became and remains a ceremonial emblem in the military services.

This is a very fine 1810 to 1820 American Eagle pommel sword. It was most likely an officer's saber. The curved blade with a raised ridge measures 33 ½ inches long showing a 14 inch niter blue panel with gold accented engraving. The overall length is 39 inches. The bone grip is carved in a spiral. The knuckle bow is a brass stirrup pattern and is crowned with a detailed eagle head pommel. A backstrap extends the pommel to a ferrule behind the cross guard and forms the back of the grip. The languets bear a rose motif. The engravings on the blade include an American eagle, a stand of arms, and foliate and scroll designs. The bald eagle was adopted as the National symbol in 1782. The eagle is clasping arrows and olive branches and holds a ribbon with "E Pluribus Unum." The eagle bears a breast shield with 15 stars. In 1795, the number of stars was increased from 13 to 15 to reflect the entrance of Vermont and Kentucky into the Union. Fifteen stars were used until 1818. The word "Warranted" is engraved in script below the right ricasso. This indicates the sword was made in England. Due to the scarcity of skilled swordsmiths in the young republic, weapons of more refinement in design and manufacture were imported from France, Germany, England, and Spain. The sword is accompanied by its original leather scabbard which is complete with brass throat and tip.

The condition of the sword is very good to excellent. The blade shows some light spotting and has much of the original blue. The gold accented engravings are exceptionally crisp and clear. The brass elements have minor dents and much of the gilt finish remaining. The bone handle has cracks and a small chip missing. The hilt is somewhat loose and has a little play in it. The sheath is very good with the leather showing a few scuffs and wrinkles.

Eagle Head Sword, War of 1812

Crossbow with Scrimshaw, American, 1794

A crossbow consists of a short bow or prod fixed transversely on a stock or tiller having a trigger mechanism to release the bowstring, and often accompanied by a mechanism for drawing the bowstring bending the bow. The crossbow shoots projectiles, called bolts or quarrels. The crossbow originated in China around the fifth century BC. Types of crossbows were known to the ancient Greeks and Romans, and by medieval times in Europe, the crossbow had evolved into a powerful weapon capable of penetrating armor. The role of the crossbow became very important in warfare as it was one of the first hand-held distance weapons that, unlike the longbow, could be used by an untrained soldier.

This is a rare eighteenth century American crossbow with scrimshawed bone inlays. This type of crossbow was used on ships to transfer lines to other vessels for supply or mail transfers or for sending a line high up in the rigging. The hardwood tiller is 26 inches long and the bow 31 ½ inches long. There is a groove on the top of the tiller for the projectile, a pawl or nut to hold the bowstring, and a working trigger mechanism to release the bowstring. There is a ring at the end of the tiller that could have been used to hold a lever for drawing the bowstring back. There are a number of bone inlays, two inscribed, on all sides the tiller. One reads "The GOOD SHIP CHATHAM" and another "JRM 1794." Others include a cross, a gun, and stars. There is also an inlay in the shape of the arrow or dart used. The ship Chatham was built in 1794 in the Middle Haddam part of East Hampton, then a part of Chatham, Connecticut on the Connecticut River. The Chatham was a brig with a length of 70 feet and beam of 21 feet four inches and tonnage of 142 71/95. It was a coastal trader with its homeport in New York, N. Y. JRM was probably Joseph Mudge who was a master of the ship. In 1813, he made a deposition to a committee of the House of Representatives of Massachusetts on the subject of impressed seamen. He describes the taking of seamen taken from him including Manuel, a Portuguese, taken from the brig Chatham by the Hawk sloop of war in the West Indies in 1802. The cross bow is in generally good condition with some age cracks to the wood body. Two inlays are missing. Besides being a good example of a crossbow, it is a rare piece of early Americana.

Crossbow

Crossbow Bolt Head, German, c1550

The arrow-like projectiles of a crossbow are called bolts. These are much shorter than arrows, but can be several times heavier. Crossbow bolts can be fitted with a variety of heads, but the most common is a four-sided point called a quarrel. The name "quarrel" is derived from the French *carré*, "square", referring to the fact that they typically have square heads. These heads had the ability to pierce armor.

This is a classic mid-sixteenth century German military form iron crossbow bolt head or quarrel. It is 88 mm long and a maximum width of 18 mm. The head is diamond-shaped in section and tapers to a point. The rest of the bolt head is circular and socketed with an overlapping seam. The bolt has hand-wrought forged surfaces. It is in very good excavated condition with expected pitting and signs of age and use. It has been professionally cleaned and preserved.

Crossbow Bolt Head

Algonquin Longbow

This is a long self bow attributed to the Algonquin tribe, late 18th century to early 19th century. A self bow is a bow made from a single piece of wood. The natives of the eastern woodlands typically used long bows about five feet long. This size proved to be best for use in the forest, being long enough to handle well and not too long to be a handicap while moving through the timber and underbrush. The bows were made of local materials and some popular woods were oak, ash, hickory, mulberry, cedar, walnut, maple, birch, sassafras, witch hazel and others. Algonquians were credited with using the same woods, especially oak, ash, and hickory for their bows. Most Native American bowstrings were made from sinew. Even after firearms became available, some tribes, particularly in the East, preferred the bow and arrow for hunting. This bow is 55 inches long and made of a light, fine-grained wood, possibly white oak. It is D-shaped in cross section and one inch wide at the center tapering to ⅝ inch at the nocks. The nocks are three inches from the tips. The bowstring is sinew. The bow has a fine patina and is in excellent condition. Ex collection of John J. Hayes, Historical Collectibles, Gettysburg, PA.

Long Bow

Bowie Knife, Manson, Sheffield

A Bowie knife is a pattern of fixed-blade fighting knife created by James Black in the early 19th century for legendary frontiersman James Bowie, who had become famous for his use of a large knife at a duel known as the Sandbar Fight in 1827. As a result of this much-publicized duel, the popularity of Bowie knives in America grew dramatically. While the Bowie is often considered a uniquely American knife, most blades were produced in Sheffield England beginning in the 1830s. The great Sheffield makers like Joseph Rodgers and George Wostenholm stepped in with highly-crafted knives to satisfy the demand. The term Bowie knife has been used to refer to any large knife held in a sheath. The earliest resembled a butcher knife and included spear point knives. Since then, in common usage, the term refers to any large sheath knife with a crossguard and a clip point. Bowie knives had a role in the American conflicts of the 19th century. They are historically mentioned in the Texas Independence, the Mexican War, the California gold rush, the civil strife in Kansas, the Civil War, and later conflicts with American Indians.

The overall length of the knife is 11 ¾ inches. The blade is 6 ½ inches long with a clip point, unsharpened false edge, and "MANSON/ SHEFFIELD" on the left ricasso. It has a stag antler grip with German silver, scrolled pommel and ferrule. The guard is nickel silver and is 2 ⅛ inches long. The knife is in very good condition noting very slight pitting on the tip and base of the blade. This ornate Bowie knife was probably expensive and may have belonged to an officer. Little is known about Manson. The *Official Price Guide to Collector Knives* says "It has been speculated that Manson was a yet-unidentified importer here in the U. S. Knives bearing his mark are relatively common and are generally considered to be of Civil War vintage."

Manson Sheffield Bowie Knife

Firearms

Hand Cannon (Handgonne), Ming Dynasty, China, 1368-1398

The ancestor of the modern firearm is the cannon. The cannon, first developed in China around the tenth century, is any piece of artillery that uses gunpowder to launch a projectile. A large thick metal tube with one closed end (the breech) and an open end (the muzzle) was loaded first with gunpowder and then with a projectile. The powder was ignited with a torch or smoldering ember through a small hole in the rear (the touchhole). The rapidly expanding gases from the exploding gunpowder would throw the projectile from the barrel. Gunpowder, a mixture of sulfur, charcoal, and potassium nitrate (saltpeter), was also invented in China in the ninth century. The earliest Western accounts of gunpowder appear in texts written by the English philosopher Roger Bacon in the thirteenth century. The first portable firearm was a hand cannon or handgonne. It is believed the hand cannon originated in the thirteenth century in China. The hand cannon then spread from there to the rest of the world and was used until the first half of the sixteenth century in Europe. It was a simple weapon consisting of a barrel into which gunpowder and a projectile were rammed. It was then manually ignited through the touchhole. The barrels were typically short compared to later firearms and made from wrought iron or cast in bronze. For ease of handling, the barrels were often attached to a wooden stock. The hand cannon could be propped up against something and set off by the gunner himself, although it would be difficult to sight and ignite the cannon at the same time. More likely, it was held in two hands while an assistant applied ignition, such as hot coals, wire, or burning tinder, to the touchhole. Projectiles included metal tipped arrows, stones, and lead balls.

Hand Cannon, Ming Dynasty

This hand cannon is from the reign of the Hongwu Emperor (Zhu Yuanzhang, Guorui, 1328-1398) who was the first emperor of the Ming dynasty in China and ruled from 1368 to 1398. It is made of cast bronze and consists of a straight barrel 17 ⅝ inches in length with molded banding. A potbelly held the gunpowder and has the touchhole on top. The tube is hollow to accept a straight, wooden pole stock at the proximal end. It has a bore diameter of 1 3⁄16 inches. It also has a semicircular handle attached to the barrel. There is lettering near one end that identifies the emperor, dynasty, and possibly the date. In use, it was most likely held by one person by the handle and stock while a second person ignited the touchhole. The cannon is heavily encrusted and oxidized and there is slight loss at one edge of the muzzle.

Engraving of a Musketeer, Jacob de Gheyn, 1608

Engraving of a Musketeer

This is an engraving, No. 12, from *Wappenhandelinghe van Roers, Musquetten ende Spiessen* (The Exercise of Arms, for Calivres, Muskets and Pikes) by Jacob (Jacques) de Gheyn (1565-1629) and published in 1608. The plate shows a musketeer firing a matchlock musket with a smoking match lit at both ends. He wears a bandolier holding powder chargers known as the "12 Apostles" based on the number usually carried. The musket is supported by a musket rest. The musketeer carries a sword, and a bullet pouch and powder flask hang from his waist. The plate is hand colored with some silver and gold highlighting. The plate is 13 x 10 inches and is in fine condition with light margin soiling. Items in the engraving that are part of this collection are a matchlock musket, musket rest, powder flask, and powder charger, all of the same period.

Matchlock Musket/Arquebus, Germany, c1590

The matchlock, which appeared in Europe in the mid-fifteenth century was the first mechanism, or "lock" invented to facilitate the firing of a hand-held firearm. The classic European matchlock gun held a burning slow match in a clamp known as the serpentine. Upon the pulling of a lever (or in later models a trigger) protruding from the bottom of the gun and connected to the serpentine, the clamp dropped down, lowering the smoldering match into the flash pan and igniting the priming powder. The flash from the primer travelled through the touchhole igniting the main charge of propellant in the gun barrel. On release of the lever or trigger, the spring-loaded serpentine would move in reverse to clear the pan. The low cost of production, simplicity, and high availability of the matchlock kept it in use in European armies until about 1720. It was followed by the wheel lock and later completely replaced by the flintlock as the foot soldier's main armament.

This is a fine restocked sixteenth century German lever-trigger matchlock musket/arquebus. The heavy, hand-forged iron barrel is 46 inches long with sights, smoothbore, 80+ caliber, octagonal to round with a wedding band transition, pin fastened, and ending in a flared cannon-tuned muzzle. There is a deeply struck "Z" makers mark on the left side of the breech. The musket has an integrally-forged, rectangular iron powder pan with its screw-retained fence and manually rotated pan cover. The flat, rectangular lock has a large, forged serpentine with a dragon-head profile and a heart-shaped finial tensioning screw. The lockplate is secured by two sidebolts and the tail struck with an "S" maker's mark. The lever type trigger has a decoratively twisted shaft and flared finial. The hardwood fullstock is a Victorian replacement. It is molded and carved in the classic late sixteenth century style with a deeply fluted, triangular butt stock and a long robust forestock with an integrally carved, ramrod channel. The stock bears simple sheet-iron mounts: a pin-fastened buttplate, a matching trigger-hole-plate and two, friction-fitted, reinforcing-bands/ramrod-guides along the forestock. There is a wooden ramrod with flared tip. The overall length is 62 inches. The musket is in fine condition and in mechanically functional order. The metal surfaces have a generally smooth, steel-gray patina with some light surface stains, pitting, and signs of use. The stock is very fine with sharp contours, finish, and some minor handling marks and abrasions. Because of the size and weight of this military musket, it can be called an arquebus and would have required a musket rest for firing. It was restocked in the Victorian period as part of the Victorian Medieval Revival that took place as a mode of dissent from the modern social and industrial developments in the Victorian era.

Matchlock Musket/Arquebus

Matchlock Powder Flask, German/Dutch, c1590

This is a rare German/Dutch military matchlock/wheellock musketeer's powder flask, c1590-1610. These distinct powder flasks were carried by infantry troops during the late 16th century to the end of the 30 Year War. The body is of classic Germanic form with a tapered, slightly curved, trapezoidal-form, flat-side wooden body with blackened finish in sheet-steel mounts. There is a cone-shaped powder dispenser with its original spring cutoff. There are four suspension loops and a screw-fastened belt hook on one side. One face bears a pierced and decorative central medallion. The overall length of the flask is 12 inches. The flask is in very fine untouched condition. The mounts show a smooth, untouched, gunmetal age patina and some light surface discoloration and minor imperfections.

Matchlock Powder Flask

Powder Charger for Matchlock Musket, German, c1600

This is a rare German/Dutch Matchlock Musketeer's powder charger from a "12 Apostles" bandolier, c1600. A charger is a container holding sufficient gunpowder for a single charge of a matchlock musket. It consists of a turned wooden body with integrally pierced side-arms for the braided hemp suspension cord. It has a turned wooden cap. The overall length is four inches. It is missing an arm on one side but is otherwise in very good condition. The wooden surfaces are smooth and light colored with dark areas of staining.

Powder Charger for Matchlock Musket

Plug Bayonet for Matchlock Musket, German, c1600

The early muskets were fired at a slow rate and could be inaccurate and unreliable. Bayonets provided a useful addition to the musket for holding off infantry or cavalry charges. The first bayonets were of the "plug" type that had a round handle that slid directly into the barrel of the musket. They could also be used as a dagger or fighting knife. The obvious disadvantage of the plug bayonet is that once fixed, the gun could not be fired until the bayonet was removed. It was replaced by the socket bayonet that fitted over the muzzle using a circular band of metal, allowing the musket to be loaded and fired.

This is an early seventeenth century, German/Central European plug bayonet that would have been used with a matchlock musket. It has a 10 ½ inch double edge blade with a central ridge and tapering to a point. There is a turned dark hardwood grip, brass cross guard, and faceted brass cap pommel. The total length is 16 inches. The bayonet is in overall vary good+/fine condition. The blade has smooth, mottled steel surfaces, sharp edges with nicks from use, and a chip at the tip. The grip has some nicks and the brass minor verdigris.

Plug Bayonet for Matchlock Musket

Matchlock Musket Rest, German, c1600

The length and weight of some matchlock muskets required a support for aiming and firing. This is a fine example of a rare German military matchlock musketeer's musket rest or fork. It is 52 inches long and consists of a steel rest, cylindrical hardwood (oak) haft, and a spike-like "grounding iron." The steel fork has an open type plain socket with a slotted piercing for the retaining screw and upward curved arms having finely curved finials. The rest is in very good+ to fine condition. The steel fork has generally smooth untouched surfaces with light discoloration. The haft has scattered abrasions, minor wormholes, tool marks, and dark surfaces preserved with beeswax. The spike has pitted surfaces and wear at the tip.

Matchlock Musket Rest

Wheellock Rifle, c1650

A wheellock or wheel lock, developed in Europe around 1500, is a friction-wheel mechanism to cause a spark for firing a firearm. It was the next major development in firearms technology after the matchlock and the first self-igniting firearm. Its name is from its rotating steel wheel to provide ignition. The wheellock works by spinning a spring-loaded steel wheel against a piece of pyrite to generate intense sparks, which ignite gunpowder in a pan, which flashes through a small touchhole to ignite the main charge in the firearm's barrel. The pyrite is clamped in vise jaws on a spring-loaded arm (or 'dog'), which rests on the pan cover. When the trigger is pulled, the pan cover is opened, and the wheel is rotated, with the pyrite pressed into contact. A wheellock firearm had the advantage that it can be instantly readied and fired even with one hand, in contrast to the then-common matchlock firearms, which must have a burning cord of slow match ready if the gun might be needed and demanded the operator's full attention and two hands to operate. On the other hand, wheellock mechanisms were complex to make, making them relatively costly. A highly skilled gunsmith was required to build the mechanism, and the variety of parts and complex design made it liable to malfunction. John Alden brought a wheellock ashore with the pilgrims in 1620. Around 1650, the flintlock mechanisms began to replace the wheellock as it was cheaper and easier to use than the wheellock.

Wheellocks were very expensive to produce because of their complexity. As a result, wheellocks could only be afforded by nobility, officers, and rich merchants, though some military units with noble sponsors could afford to equip their troops with them. Wheellock pistols were used by calvary during the Thirty Years War (1618-1648). Some, such as this example, were decorated with fine bone and horn inlays drawing on the skills of furniture makers and engravers. The nobility sometimes collected these as fine technical devices and works of art as much as military tools. This rifle was made in Germany in the second half of the 17th century. It was most likely used as a hunting or sporting rifle.

This ornate rifle is 43 ¾ inches long and weighs 9 pounds 14 ounces. The heavy blued rifled octagonal barrel is of approximately 9mm bore, expanding toward the muzzle, with adjustable dovetailed brass front sight and notched rear sight, the base of which is decorated with a Landsknecht warrior with shield. The flat lock plate with internal wheel, is finely etched with acanthus and a mounted hunter firing at running deer; sliding pan cover with decorative finial. The cock is engraved as a monster head. The full stock is fruitwood with a patchbox, the sliding cover inlaid with bone finely engraved with a stag and classical designs. The butt plate is horn and pinned to the stock with bone pins and framed with carved dentil molding on the stock. There are numerous bone inlays engraved with hunting dogs, game, and classical decorations. The ramrod is wood with engraved bone tip fitting inside bone ramrod thimbles engraved with acanthus. The trigger guard is iron and the trigger is fitted inside a bone plate. The rifle is complete and in very good condition overall with all inlays intact.

Wheellock

Dutch Flintlock Pistol, Cornelius Coster, c1660

This is a 17th century Dutch "true" flintlock pistol. It was made and signed by Cornelius Coster of Utrecht, c1660. The gun is 18 ½ inches long with an 11 ⅝ inch tapered round barrel of approximately .60 caliber with ribbed breech. The stock is beautifully grained walnut. The lock plate and cock are engraved with acanthus designs and marked "COSTER VTRECHT" in front of the cock. The brass furniture consists of the trigger guard with finials, ramrod thimbles, pierced side plate with a floral design and seated figure, and long-eared, pierced butt cap with two cameo heads. It has the original iron-tipped wood ramrod. The pistol shows fine quality workmanship made at the height of the Dutch gun making art, in very good original condition overall with even pitting on the barrel. Other examples of Coster's pistols are in the Rijksmuseum, Amsterdam, The Netherlands. In the New World, the Dutch in the first half of the 17th century supplied the Iroquois with flintlocks to secure the beaver fur trade for New Netherland.

Dutch Flintlock Pistol

French Model 1763 Cavalry Flintlock Pistol, Documented Revolutionary War

The flintlock was in common use for over two centuries until it was replaced by the percussion lock around 1840. To use a flintlock, a measure of gunpowder is poured down the barrel. A lead ball wrapped in a small piece of cloth or paper is rammed down the barrel with a ramrod on top of the gunpowder. The frizzen, a steel plate, is snapped into place over the pan. The hammer, holding a piece of flint, is cocked and the trigger pulled. The flint strikes the frizzen and this friction causes sparks to shoot into the priming pan of the musket barrel. The sparks ignite the black powder primer through a small hole in the side of the barrel, which in turn ignites the main propellant in the barrel and fires the musket.

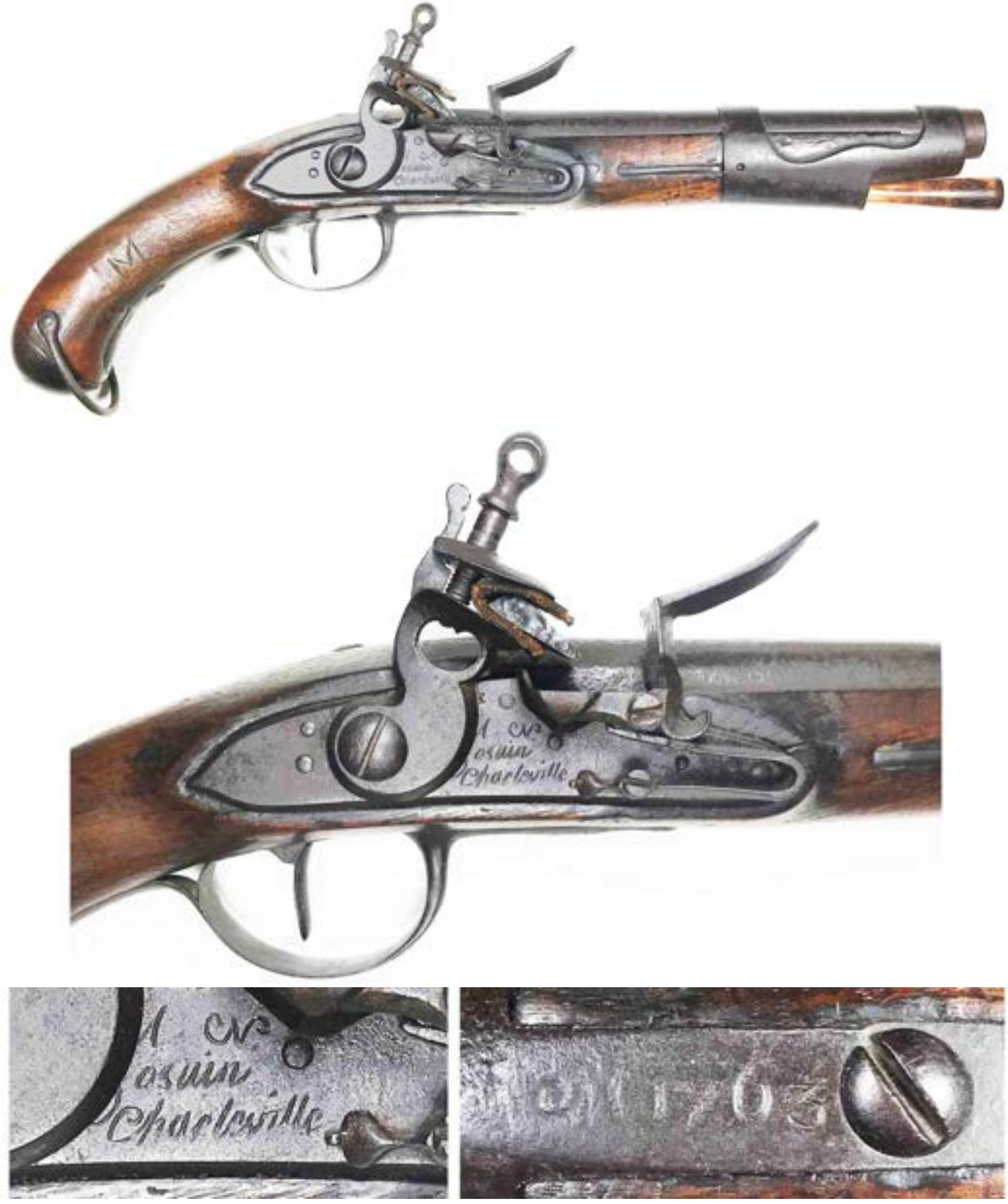
This was the most common type of handgun supplied by France to aid the Colonists during the American War of Independence. This pistol is 15 ¾ inches long overall with a round, smoothbore, iron, .69 caliber, 9 inch barrel. The barrel is marked with an "N" French Arsenal inspector's mark. The lock is of Regulation Model 1763 design with a flat lockplate, a bridled faceted iron powder-pan and its original reinforced hammer, teardrop finial frizzen-spring and rounded frizzen with a tail. The face of the lock is clearly marked with a “Charleville” French Arsenal marking and a matching "N" Arsenal-inspector’s mark. The barrel tang is marked “M 1763.” It has full iron furniture: a raised "S" shaped sideplate, a double-loop barrel band, the trigger-guard with long teardrop finials and the screw-fastened rounded butt-cap with a short rear finial. The fullstock is walnut with a belt loop at the butt. The right grip has an M carved into it (possibly representing Massachusetts). There is a wooden ramrod. The gun is in very good condition and retains untouched, smooth, dark-steel-gray surfaces with a nicely toned age-patina.

Although this is a fine example of a Revolutionary War period flintlock pistol, its significance lies in its provenance. Many firearms, such as this, are of the period of wars, but there are very few that have documentation that establishes when and where they were actually used and by whom. In the case of this gun, there is substantial evidence to show that it was used in the Revolutionary War by Elijah Alford. It was passed down through his descendants; Elijah to Levi Alford (1789-1869) to Darius Manley Alford (1832-1907) and to William Valorus Alford (1858-1935). William's wife, Georgia Lee (1881-1968) sold the gun in 1950 with a note that it was from the Alford family and was used in the French and Indian War*, Revolutionary War, War of 1812, and Civil War. Thomas Lentz purchased the gun in 2020 from John J. Hayes, Historical Collectibles, Gettysburg, PA, who had purchased it at auction. There are numerous documents in various Revolutionary War rosters and rolls pertaining to Elijah's service in the War. Other documents describe his activities in Becket, move to Ohio and establishment of the church there, and the Alford genealogy.

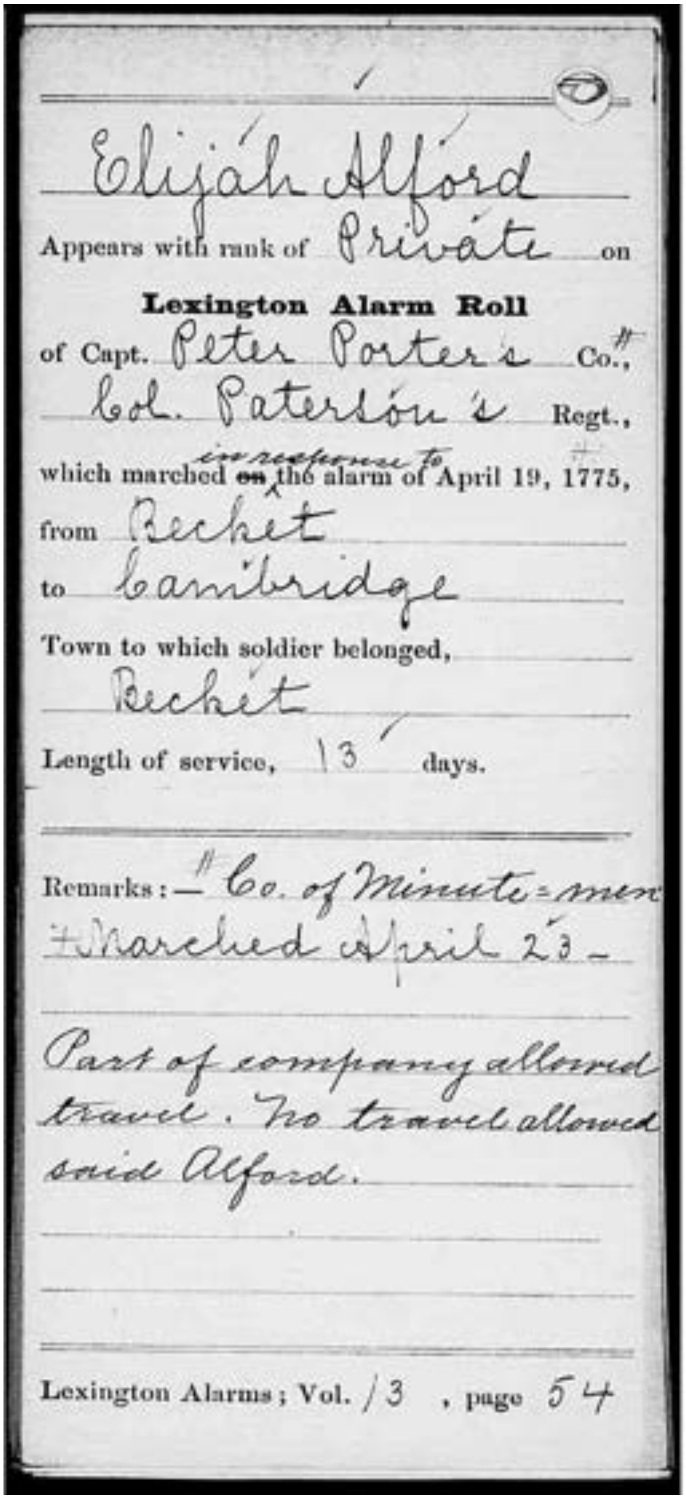
Elijah Alford (1757-1832) was a descendant of Benedictus Alford (Alvord) (1619-1689). Benedictus was in Windsor, Connecticut in 1637. He was one of 30 men from Windsor who fought under Capt. John Mason in the Pequot War in May, 1637. He received a home lot and married Jane Newton in 1640. Elijah Alford Sr. (1731-1771) moved from Simsbury, Connecticut to Becket, Berkshire County, Massachusetts where Elijah was born in 1757. Elijah Sr. served from Connecticut in the French and Indian War in 1755 and 1757.

Elijah enlisted as a minuteman in 1771 at age 14. Minutemen were militia companies, mostly composed of young men, that were highly mobile and could be deployed rapidly. In 1775, he was a private in Capt. Peter Porter's Company, Col. John Paterson's** Regiment, which marched on April 23, 1775 in response to the Lexington Alarm of April 19, 1775, to Cambridge. On June 15, 1775, Colonel Paterson's regiment was transferred from Minuteman (militia) status to the Continental Army for an eight-month enlistment. In November 1775, Elijah was granted a coat that was a bounty authorized by the Massachusetts Provincial Congress to provincial soldiers enlisting for a military expedition. At that time, he was in Camp No. 3 at Charlestown during the Siege of Boston. He later became a Corporal in Capt. Enoch Noble's Company, Col. Ezra Wood's Regiment. He served in the Revolution until at least 1779 and saw service at Ticonderoga, Montreal, Long Island, White Plains, Monmouth, and Peekskill. There are also references to his being captured by Indians and released, and as a deserter, although it was common for soldiers to leave their units for a time to tend to their homes and families and then return.

*Seems unlikely. The French & Indian War ended in 1763, the same year the Model 1763 was made. If it was used in the war, it would been by Elijah Alford, Sr.
** John Paterson (1744-1808) graduated from Yale College in 1762. He served throughout the war and attained the rank of Major General.



Model 1763 Flintlock Pistol



1

Elijah Alford

Appears with rank of Private on

Lexington Alarm Roll

of Capt. Peter Porter's Co.#

Col. Paterson's Regt.,

which marched ~~on~~ in response to the alarm of April 19, 1775,

from Becket

to Cambridge

Town to which soldier belonged,

Becket

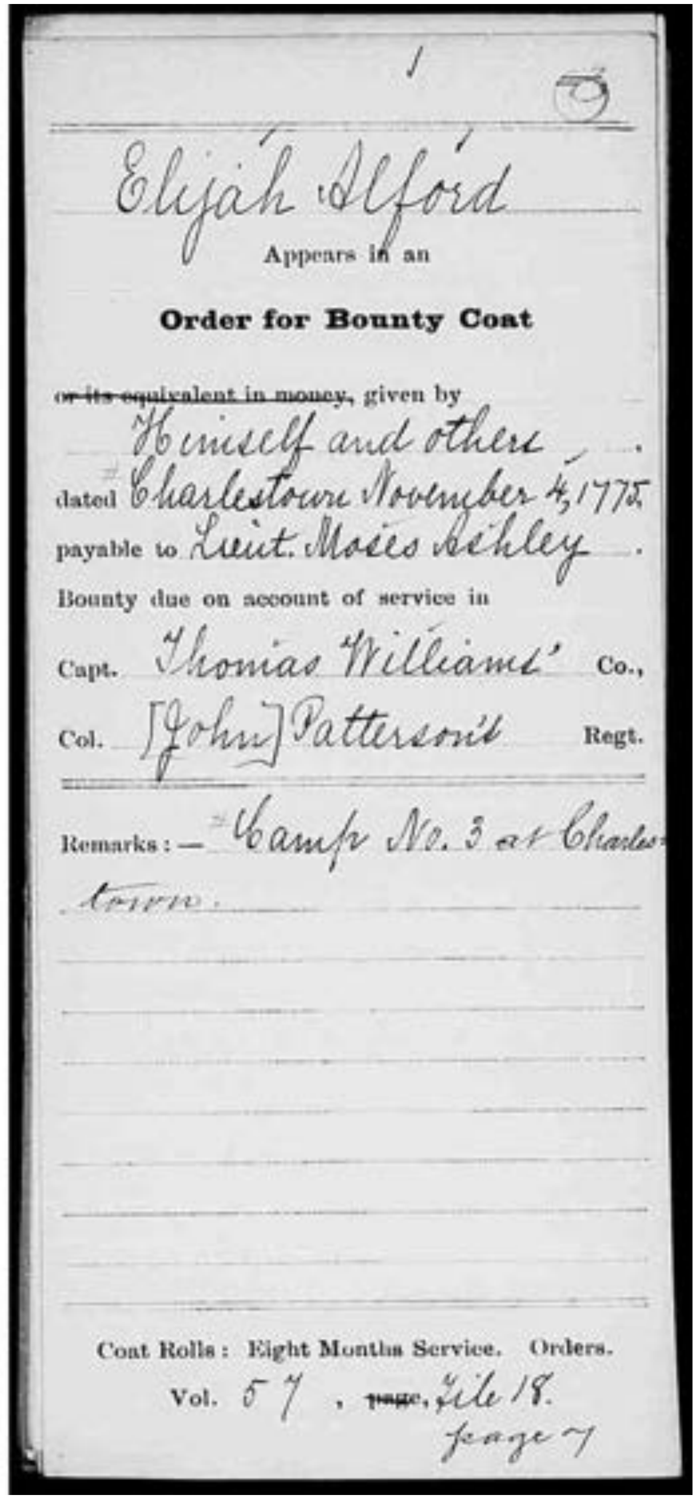
Length of service, 13 days.

Remarks: — #Co. of Minute-men

† Marched April 23 –

Part of company allowed travel. No travel allowed said Alford.

Lexington Alarms; Vol. 13, page 54



1

Elijah Alford

Appears in an

Order for Bounty Coat

~~or its equivalent in money,~~ given by

Himself and others.

dated Charlestown November 4, 1775.

payable to Lieut. Moses Ashley.

Bounty due on account of service in

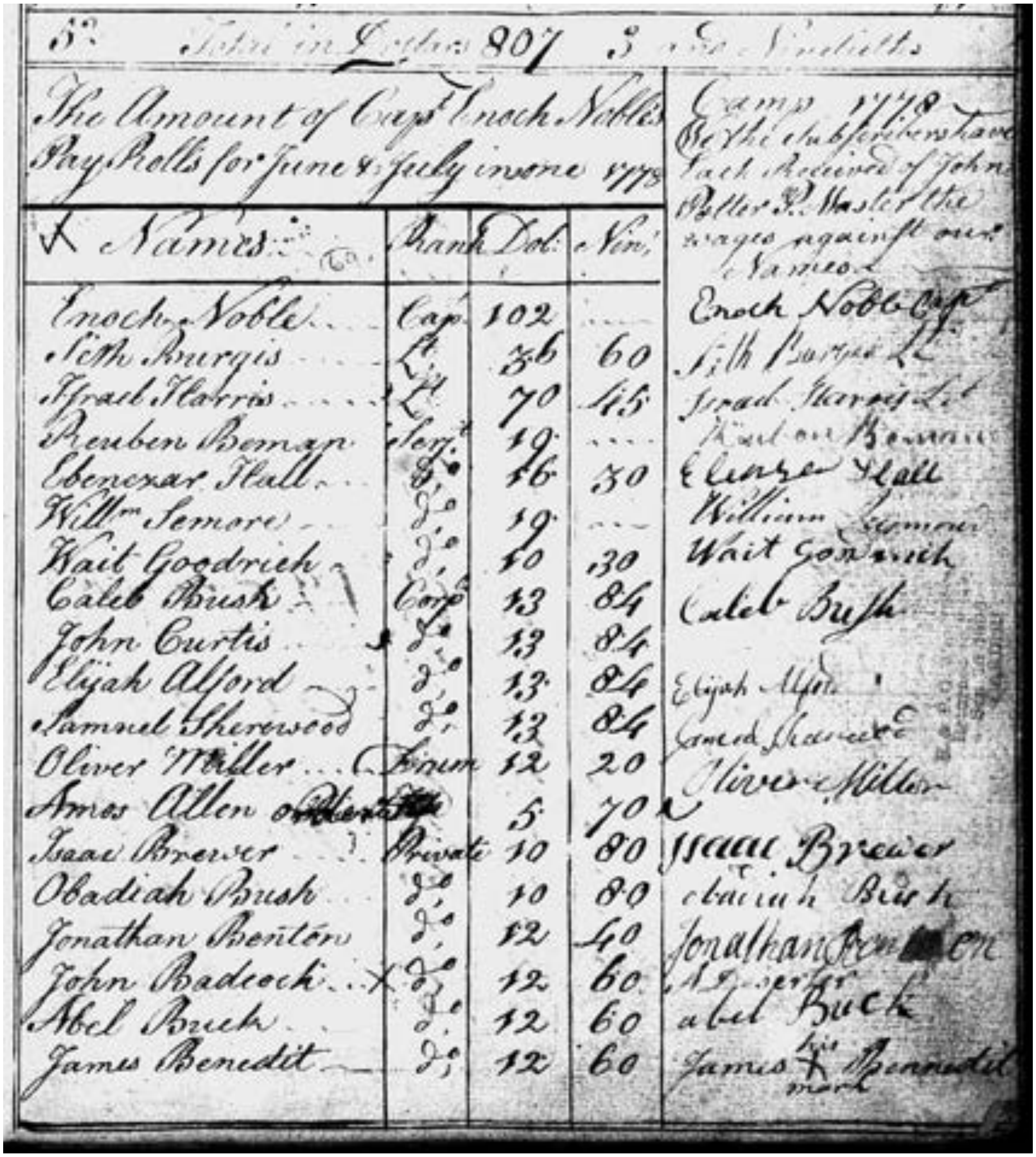
Capt. Thomas Williams' Co.,

Col. [John] Patterson's Regt.

Remarks: — #Camp No. 3 at Charlestown.

Coat Rolls: Eight Months Service. Orders.

Vol. 57, ~~page~~, file 18. page 7



[illegible] 807 3 [illegible]

The Amount of Capt Enoch Noble's Pay Rolls for June & July in one 1778

Camp 1778 We the subscribers have each Received of John Potter P. Master the wages against our Names

Names	Rank	Dol.	Nin.	Names
Enoch Noble	Capt	102	...	Enoch Noble Capt
Seth Burgis	Lt	36	60	Seth Burges Lt
Israel Harris	Lt	70	45	Israel Harris Lt
Reuben Beman	Serjt	19	...	Reuben Beman
Ebenezar Hall	do	16	30	Ebenezer Hall
Willm Semore	do	19	...	William Seymour
Wait Goodrich	do	10	30	Wait Goodrich
Caleb Brush	Corpl	13	84	Caleb Bush
John Curtis	do	13	84	
Elijah Alford	do	13	84	Elijah Alford
Samuel Sherewood	do	13	84	Samuel Sherwood
Oliver Miller	Drum	12	20	Oliver Miller
Amos Allen		5	70	
Isaac Brewer	Private	10	80	Isaac Brewer
Obadiah Brush	do	10	80	Obadiah Brush
Jonathan Benton	do	12	40	Jonathan Benton
John Badcock	do	12	60	A Deserter
Abel Buck	do	12	60	abel Buck
James Benedict	do	12	60	James his X mark Benedict

Elijah Alford Revolutionary War Documents

British Brown Bess Musket, Napoleonic Wars

"Brown Bess" is a nickname of uncertain origin for the British Army's muzzle-loading .75 caliber, smoothbore flintlock Land Pattern Musket and its derivatives. These muskets were the standard long guns of the British Empire's land forces from 1722 until 1838. The second model was widely used by both sides in the American Revolution. When it was introduced, the flintlock represented a technological advance over the earlier matchlock and wheellock muskets. The Brown Bess was sturdier than its predecessors, had a "half-cock" feature for safety, accepted a socket bayonet, and better withstood soldierly abuse. The Brown Bess was also heavy, took considerable time to load, was inaccurate, and was quickly fouled. Despite of the musket's flaws, it was effective in mass fighting formations, soldiers considered it reliable, and it gained a huge symbolic significance in Britain as the musket that made the empire.

This is a third model East India pattern Brown Bess musket. The Brown Bess was modified by the East India Company in 1771 for its own armies to have a lighter weight and shorter barrel. The East India pattern began to be used by the British army in 1793 and, in 1797, it was officially adopted by the British Board of Ordnance as the standard infantry musket. It was the most widely used British firearm in the Napoleonic Wars and more than three million were manufactured.

The musket is regulation pattern with a walnut fullstock with a raised-carved beavertail apron behind the barrel tang, a deeply fluted comb on the buttstock, and a pronounced lobe on the handrail. It is 55 inches long with a 39 inch, .75 caliber, pin-fastened, round, smoothbore barrel with its original top mounted bayonet-lug/sight. It has full brass hardware: the trigger guard with a flat hazelnut forward finial, a raised "S" shaped sideplate, a screw-fastened buttplate with a three-stepped finial, a pin-fastened fore-end-cap and three baluster-type ramrod pipes. The lockplate is marked with a clear Crown over "GR" Royal cypher and a crown/broad arrow acceptance mark beneath the bridled powder-pan. The tail of the lock is marked "Tower." GR stands for Georgius Rex to show the gun was manufactured under the authority of King George III. "Tower" refers to the Tower of London, which was responsible for manufacturing, testing, and storing weapons for the British king. The metal is a smooth mixture of bright and dark patina. Stock is good with small dents and dings and multiple small worm holes. "BGS" is faintly stamped on the left flat above the rear trigger guard bow. The cleaning rod is a replacement and three stock pins and the rear swivel are absent. The markings on the lock are exceptionally clear. The action functions correctly.

Brown Bass Musket

Springfield Model 1816 Musket, New Haven, 1827, Mexican American War

The War of 1812 revealed many weaknesses in American muskets. In an attempt to improve both the design and manufacture of the musket, the Model 1812 musket was created. The Model 1816 made further improvements and replaced the Model 1812. The M1816 was a smoothbore, muzzle loading weapon that used a .69 caliber musket ball. It was in production at the Springfield Armory (325,000) and the Harpers Ferry Armory (350,000) between 1816 to 1844 with around 675,000 muskets produced during this run. Additionally, more than a dozen contractors also made the Model 1816 muskets during its production years, adding more than 146,000 muskets for a grand total of 821,421 M1816 muskets produced. This musket was made at the Eli Whitney (1765-1825, Yale, 1792) armory, founded in 1798, in New Haven. It was made by Phineas and Eli Whitney Blake, nephews of Eli Whitney who held the Whitney estate in trust for Whitney's son, Eli Whitney, Jr. until he came of age in 1841.

This "Type 2" musket has an overall length of 57.75 inches and a 42 inch long .69-caliber smoothbore barrel. It has a browned barrel, three barrel bands, trigger guard, side plate and buttplate with case hardened lock and hammer. The lock features a removable brass pan. Two sling swivels with the lower swivel located on the trigger guard bow. Metal ramrod with button shaped head, bayonet lug on top of barrel at muzzle, brass blade front site located on front barrel band. The, oil-finished, black walnut stock has the characteristic low comb found on Model 1816 muskets. The lock plate is marked: "U.S, P.&E.W. BLAKE" and stamped vertically behind the hammer "NEW HAVEN, 1827". The barrel tang is dated "1827". The breech end of the barrel is stamped with "US", "JC" for James Carrington the government inspector, and "P" proofmark. The musket is in very good condition with working action.

It saw service during the Mexican-American War and was even pressed into service during the early days of the Civil War especially by the Confederacy in both the updated percussion and the original flintlock format, due to the shortage of guns. This musket is symbolic for the westward expansion of the country throughout the first half of the 19th century. The Model 1816 saw service in the Texan Revolution, including the Battle of the Alamo and the Battle of San Jacinto. After the independence of Texas, the 1816 musket was chosen as the first standard musket of the Texan army in 1839. It was last produced as a flintlock in 1840. Until the production of the U.S. Rifle Model 1903, the Model 1816 Musket enjoyed the longest period of production and possibly longer usage than any other shoulder arm in United States history.

Flintlock Musket, Model 1816

Sixth plate tintype of a young Civil War Confederate soldier holding a Springfield Model 1816 flintlock musket.

U. S. Model 1836 Flintlock Pistol, Johnson, Middletown, Mexican-American War

This heavy .54 caliber smoothbore, single-shot flintlock Model 1836 pistol was made by Robert Johnson of Middletown, Connecticut in 1838. It was the primary handgun issued by the U.S. Army during the Mexican War and many were converted to percussion and used during the Civil War. Johnson manufactured an estimated 18,000 Model 1836 Pistols under government contracts between 1836 and 1844. The 8 ½ inch barrel has a brass, half-moon front sight; an oval rear sight is located on the tang. The pistol has a distinctive swivel ramrod with button-shaped head, barrel band with strap extension that joins the side plate, and integral back strap and buttcap. The lock has a detachable, fenced brass flash pan. The legend "U.S./R. JOHNSON/MIDDN CONN/1838" is stamped in four lines on the lock plate between the hammer and frizzen spring. The inspector's mark "U.S/JH/P" is stamped on the top of the barrel at the breech. The left stock flat is stamped with the script initials of the Ordnance sub-inspector, "L F." The barrel and iron furniture are finished bright and the lock plate, hammer, frizzen and barrel tang are casehardened. The stock is walnut. The Model 1836 pistol was the last U.S. flintlock pistol. It is considered by many experts to be the best made, most attractive and best designed of all U.S. military flintlock handguns. This example is in excellent condition.

Besides being a very fine example of this important model flintlock, its significance is greatly enhanced by its provenance. A very old, tan parchment with a presentation is affixed to the stock in front of the trigger guard. It reads "Trophy from the Battle of New [ ] for Sidney H. Gay from H. S. Olcott."

Henry Steel Olcott (1832–1907) was an American military officer, journalist, lawyer and the co-founder and first President of the Theosophical Society. He served in the US Army during the Civil War and afterward was admitted as the Special Commissioner of the War Department in New York. He was later promoted to the rank of colonel and transferred to the Department of the Navy in Washington, DC. He was well respected, and in 1865, following the assassination of Abraham Lincoln, assisted in the investigation of the assassination. Olcott was the first well-known American of European ancestry to make a formal conversion to Buddhism. His subsequent actions as president of the Theosophical Society helped create a renaissance in the study of Buddhism.

Sydney Howard Gay (1814–1888) was an American attorney, journalist and abolitionist who was active in New York City. Beginning in 1843, he was editor of the *National Anti-Slavery Standard* for 14 years. His offices became a stop of the Underground Railroad. He worked closely with Louis Napoleon (1800-1881), a free black man. Napoleon was reported to be "the key guy on the streets in New York bringing in fugitives, scouring the docks, looking for people at the train station." Gay and Napoleon may have aided an estimated 3,000 fugitive slaves, helping many get to upstate New York and Canada. These included three of history's most famous fugitives: Henry "Box" Brown, Jane Johnson, and Harriet Tubman. During the civil War, Gay was the managing editor for Horace Greeley's *New-York Tribune*. It is interesting to note that Gay defied Greeley's command against arming staff at the *Tribune* building during the 1863 Draft Riots, and they were able to prevent a mob from burning it to the ground. This implies that Gay was armed, perhaps with this pistol.

Model 1836 Flintlock Pistol

Kentucky Rifle

This “Kentucky” long rifle is a percussion gun. Flintlock firearms were gradually replaced by caplock or percussion guns that used a percussion cap, introduced in the early 1820s. A percussion gun, like the flintlock, is a muzzle loader in which the powder and bullet are rammed down the barrel. In the percussion gun, the powder is ignited by the hammer of the gun striking a percussion cap containing explosive material. Flames from this explosion travel through a hollow nipple to ignite the main powder charge and expel the bullet. The advantage of the percussion gun is that it can be fired reliably under any weather conditions. The percussion lock was the predominant firing mechanism into the early 1870s.

The Kentucky rifle, also known as Pennsylvania rifle and long rifle, is a distinctive American rifle. It was first created in Lancaster, Pennsylvania around 1740, by skillful immigrant craftsmen from Germany and Switzerland who brought with them the knowledge of German rifled guns. The guns they made had unusually long barrels, were rifled (spiral grooves in the bore), and the bores were reduced to 0.45 to .50 caliber. This compared to the shorter barrel, larger caliber, smoothbore muskets commonly in use. As a result, the new rifles were lighter and more accurate, making them an ideal tool for hunting wildlife for food in the forests of colonial America. This rifle became the primary weapon of the frontiersmen, especially in the isolated and hazardous wilds of Tennessee and Kentucky. The extensive use in Kentucky led to the adoption of the name "Kentucky" for this rifle. Daniel Boone carried a Kentucky Rifle through the Cumberland Gap. The rifles also saw service in all the wars from the French & Indian War through the Civil War. Because of its accuracy at long range, it was greatly feared by opposing troops and was known as “the widow maker” by the British. Strong pockets of long rifle use and manufacture continued in the Appalachian Mountains of Virginia, Tennessee, Kentucky, Ohio and North Carolina well into the 20th century as a practical and efficient firearm for those rural segments of the nation. Artistically, the long rifle is known for its graceful stock, often made of curly maple, and its ornate decoration, decorative inlays, and an integral, patch box that was built into the stock. Originally rather plain, by the 1770s every surface of the rifle could have applied artwork. An accomplished gunsmith had to be a skilled blacksmith, whitesmith, wood carver, brass and silver founder, engraver, and wood finisher. The first rifles were flintlocks, but continued to be made as percussion locks well into the 19th century.

This is a fine percussion “Kentucky” long rifle with numerous inlays and carvings, c1840. It is signed S. H. St. Clair in script on the barrel top flat. Samuel H. St. Clair (1793-1849) is listed in the tax records as a gunsmith residing along Penns Creek in Union Township (now Jackson Township) in Union County (now Snyder County), Pennsylvania. Snyder County was settled in the 1740s by Pennsylvania Germans from Berks and Lancaster counties. St. Clair later moved to Kratzerville, in Snyder County. He was known for his high quality carved and inlayed rifles. The gun has an overall length of 52 inches with a 37 ½ inch octagonal barrel with a rifled .50 caliber bore. The tiger stripe maple full stock is adorned with numerous brass teardrop and lunette inlays and carvings. The brass patchbox is of the pierced whaletail design. The cheekpiece is an inlayed brass eagle with a brass plate spelling “LIBERTY” beneath it. There is a carved design on the left butt. An ornate side plate, trigger guard, butt plate, toe plate, ramrod pipes, and end cap are brass. The iron lock and hammer are stamped with a floral design. It has double set triggers, iron open rear sight, and brass front blade sight. The rifle is in excellent condition.

Kentucky Rifle
Model 1861 Springfield Percussion Lock Rifle Musket, 1862, Civil War

The Model 1861 percussion rifle musket was the standard issue infantry arm used by the United States Army and Marine Corps during the Civil War. It was a single-shot, muzzle-loading gun detonated with a percussion cap. Originally made by the Springfield Armory, the U.S. government also contracted with twenty private firms to meet the wartime demand for rifles. From 1861 to 1865, the Springfield Armory produced 793,434 and private contractors produced 882,561 of these arms.

This is a Model 1861 percussion rifle made at the Springfield Armory in 1862. It is 56 inches long, with a 40 inch barrel with rifling, firing a .58 caliber Minié ball, and weighing about nine pounds. The lock is marked with a Federal eagle and US over Springfield (worn). There is an 1862 date behind the percussion hammer. It has a one-piece, polished iron barrel, three barrel bands, buttplate, and trigger guard and trigger, and a swelled ramrod. It has regulation Springfield American black walnut fullstock. It has two flip-up leaf sights, one for 300 yards and the other for 500 yards, and with both leaves down, the sight was set for a range of one hundred yards (91 m). It has both its sling-swivels and the very rare original leather sling. The rifle is in good condition with some wear, spotting, and pitting.

Model 1861 Springfield Rifle

Sixth plate tintype of a well-equipped Union soldier holding a Springfield Model 1861 rifle with bayonet.

"Indian" Trade Gun, 1868

The trade gun, also known as the Indian Trade Gun or Northwest Trade Gun is one of the most important guns in America. No other single firearm was carried over 200 hundred years through as much of American history, from the primeval forests of the east to the shores of the western coast and from Canada to Mexico, as was the trade gun. Since the late 17th century, English makers supplied Indians in the New World with guns to secure alliances with tribes and for use in the fur trade. A major trader in guns was the Hudson's Bay Company, founded in 1670. By 1742, beaver pelts were valued at one pelt for one pound of shot or three flints; four pelts for one pound of powder; ten pelts for a pistol; and twenty pelts for a trade gun. By the 18th century, these weapons became standardized and were known as trade guns. A light and dependable flintlock weapon for hunting and war, it featured a large iron guard, a brass serpent or snake-shaped side plate, and a thin, smooth-bored barrel that could be loaded with either shot or round ball. This same pattern with minor variations was manufactured for the fur trade until 1900. Native Americans used these guns for hunting game for food. They were at times used in war against colonists and soldiers. Sitting Bull, a Hunkpapa Lakota holy man and leader, who led resistance against the US government policies toward Indians, carried a Parker Field & Co. 1870 dated Hudson's Bay Trade Gun. They were also used by European fur traders, settlers, and mountain men. Although a flintlock, the Indians preferred it to percussion guns because it was dependable and powder and musket balls could be more easily obtained at remote trading posts than supplies for percussion guns. The gun proved so durable that it was used, without any great changes in design, for more than 200 years and was still in use among some Northern tribes well into the 20th century.

This well-marked, flintlock Indian trade gun is dated "1868" at the tail of the lock below "PARKER FIELD & Co," an important English gunmaker. The center of the lock has the classic tombstone sitting fox looking left emblem over "EB." EB is for Edward Bond who inspected arms for the Hudson's Bay Company. The upper left barrel flat has "J E B" (John Edward Barnett) beneath a crown, a flag proof, and the number "24" which is flanked by British crown/letter proofs, crown and "P" and crown and "V." Barnett supplied firearms to both the Northwest Company and Hudson's Bay Company. It also has the "Fox in the Circle" Hudson Bay acceptance cartouche on the right buttstock. The flintlock gun is 56 ½ inches long with a 40 ½ inch, .60 caliber, smooth bore, octagon to round barrel. The full length stock is walnut. The lock, hammer, and frizzen, the typically oversized trigger guard and two finger trigger are iron. The latter were large so they could be used with gloves. The flat buttplate, ramrod pipes, and ramrod tip are brass. The three screw side plate is brass and shaped like a mythical serpent/dragon known as the Hudson's Bay Fuke, a common ornament of 19th century trade muskets. Some tribes would not trade for a gun that lacked this ornament. The front sight is a flat iron semicircle and there is no rear sight. Condition is very good with dark brown and gray patina, aged patina on the brass, scattered dings and marks, and clear markings.

A letter accompanying this gun states that it was originally purchased from a person who lived on the Indian reserve in Manawaki, Quebec. Maniwaki is a town located north of Gatineau and northwest of Montreal, in the province of Quebec, Canada. In the first half of the 19th century, Algonquins of the mission at Lake of Two Mountains, under the leadership of Chief Pakinawatik, came to the area of the Désert River. Shortly after, in 1832, the Hudson's Bay Company followed them and installed a trading post at the mouth of this river (now within the municipal boundaries of Maniwaki). It is likely this gun was traded at this post. A reserve called Manawaki was legally established in 1851 and demarcated in 1853. The name of the reserve was changed to "Kitigan Zibi" (also known as River Desert) in 1994. Kitigan Zibi is a First Nations reserve of the Kitigan Zibi Anishinabeg First Nation, an Algonquin band.

Indian Trade Gun

Medicine

Greco-Roman Surgical Instruments, 1st - 2nd century AD

The Greeks and Romans performed a number of surgical procedures and invented numerous surgical instruments. These were described in detail by Hippocrates, Galen, Celsus, Paulus Aegineta, and others. This is a collection of Greco-Roman surgical instruments of the type from the Syro-Palestine region. The instruments are made of cast bronze and have a green patina and encrustation. They are six to seven inches in length. These Greco-Roman instruments set the pattern for modern surgical instruments. The shears and saw are reproductions and the others may also be reproductions but are useful for demonstrating the types of instruments available at the time.

The scalpel or *scalpellum* was made in a variety of forms. The first pictured is similar to what is considered a scalpel today with a broad blade cutting on one edge, sharp-pointed, and with the back slanting slightly upwards. The second scalpel is a phlebotome or *phlebotomum*, a straight, double-edged, sharp-pointed instrument. It was used for phlebotomies (cutting veins) but also for the opening of abscesses, the puncture of cavities containing fluid, and for fine dissecting work. The third scalpel with a shorter protruding blade, referred to as a "bellied scalpel," allowed delicate and precise cuts to be made. The hook or *hamus* came in two basic varieties: sharp and blunt. The blunt hook with a slanted tip was primarily used as a probe for dissection and for raising blood vessels. The sharp hook with a curved end was used to hold and lift small pieces of tissue so that they could be extracted and to retract the edges of wounds.

Greco-Roman bronze surgical instruments: scalpel, phlebotome, bellied scalpel, slanted hook, curved hook, flat probe, pointed probe, spathomele, forceps, bone drill, chisel, ligula, ligula, shears, saw

There were several different types of probes, or *specilla*. Probes were used for exploring a fistula, examining wounds, or locating foreign objects. The first probe has a flat blade and pointed end. The pointed probe or stylus was used as an ear probe and was specially adapted for wrapping round with wool to apply medicaments, or wipe away discharge. The *spathomele* is a combination of spatula and probe that was in common use for pharmaceutical purposes. It could also be used as a tongue depressor for examining the oral cavity and depressing the tongue for tonsillectomies.

The forceps is a tumor *vusellum* (*myzon*) which has finely toothed jaws. It was used whenever it was necessary to grasp an object firmly, for example holding a tumor so it could be excised. The bone drill or *terebra* was generally driven in a rotary motion by means of a thong. Greek and Roman physicians used bone drills in order to excise diseased bone tissue from the skull and to remove foreign objects from a bone. The chisel or *scalper* was used mainly in bone surgery, especially in injuries to the skull. The *ligula* is a spoon and was used by physicians for extracting ointment, balsams, and powders from tubes and boxes and applying the medicament to affected areas on the body. It was also a domestic article used for cosmetic purposes. Shears or *forfex* were used for the cutting of hair that was considered a therapeutic measure for some conditions. They were also used to remove certain pathological protuberances from the body. The surgical saw or *surrula* was used to cut through bones in amputations and surgeries. A common type was the broad-bladed tenon saw.

Islamic Cupping Glass, Greater Persia, 9th-12th Century AD

Bloodletting is one of the oldest medical techniques and was the most common medical practice performed by physicians from antiquity until the late 19th century, a span of almost 2,000 years. It was practiced among ancient peoples including the Mesopotamians, Egyptians, Chinese, and Greeks. In Greece, bloodletting was in use in the fifth century BC during the lifetime of Hippocrates. Bloodletting was based on an ancient system of medicine in which blood and other bodily fluids were regarded as "humors" that had to remain in proper balance to maintain health. The four humors were blood, phlegm, black bile, and yellow bile, relating to the four Greek classical elements of air, water, earth, and fire respectively. Galen believed that blood was the dominant humor and the one in most need of control. In order to balance the humors, a physician would either remove "excess" blood from the patient or give them an emetic to induce vomiting, or a diuretic to induce urination. In Roman times, bronze bleeding cups were used for both “dry” and “wet” cupping. The physician Celsus described the use of such vessels in the first century AD. A burning lint was placed inside the cup which was then inverted over the patient's skin. As the cup cooled, a vacuum was created. In wet cupping, cuts were made and blood flowed into the cup restoring a balance in the humors. In dry cupping, cuts were not made and the cup was believed to draw out excessive pneuma. In the early Islam Era, The prophet Muhammad and medical authors recommended bloodletting. Even after the humoral system fell into disuse, the practice was continued by surgeons and barber-surgeons. The red and white striped pole of the barbershop originated as "advertising" their bloodletting services, the red symbolizing blood and the white symbolizing bandages. It is still used today in China and Muslim countries. Bloodletting was used to "treat" a wide range of diseases, becoming a standard treatment for almost every ailment, and was practiced prophylactically as well as therapeutically. In the overwhelming majority of cases, the historical use of bloodletting was harmful to patients.

This is a very rare Persian blown clear green-aquamarine glass vessel with a pipette extension, used in the medical procedure of bloodletting. There is loss on the extremity of pipe. The bowl is 52 mm high and 53 mm in diameter at the rim and the pipe is 33 mm long. There is a pontil mark on the bottom and a number painted on. The glass contains bubbles. There is extensive encrustation where the pipette is joined to the body and inside the pipette. The bowl appears to have been cleaned. In use, the cup was placed on the skin and by sucking on the tube the physician would create a vacuum that would draw the blood to the surface. The cup would then be removed and a small incision made to allow the blood to flow. For similar examples see "Glass from Islamic Lands: the Al-Sabah Collection," Kuwait National Museum, p145 and "Ventouse médicale" at the Louvre, Paris.

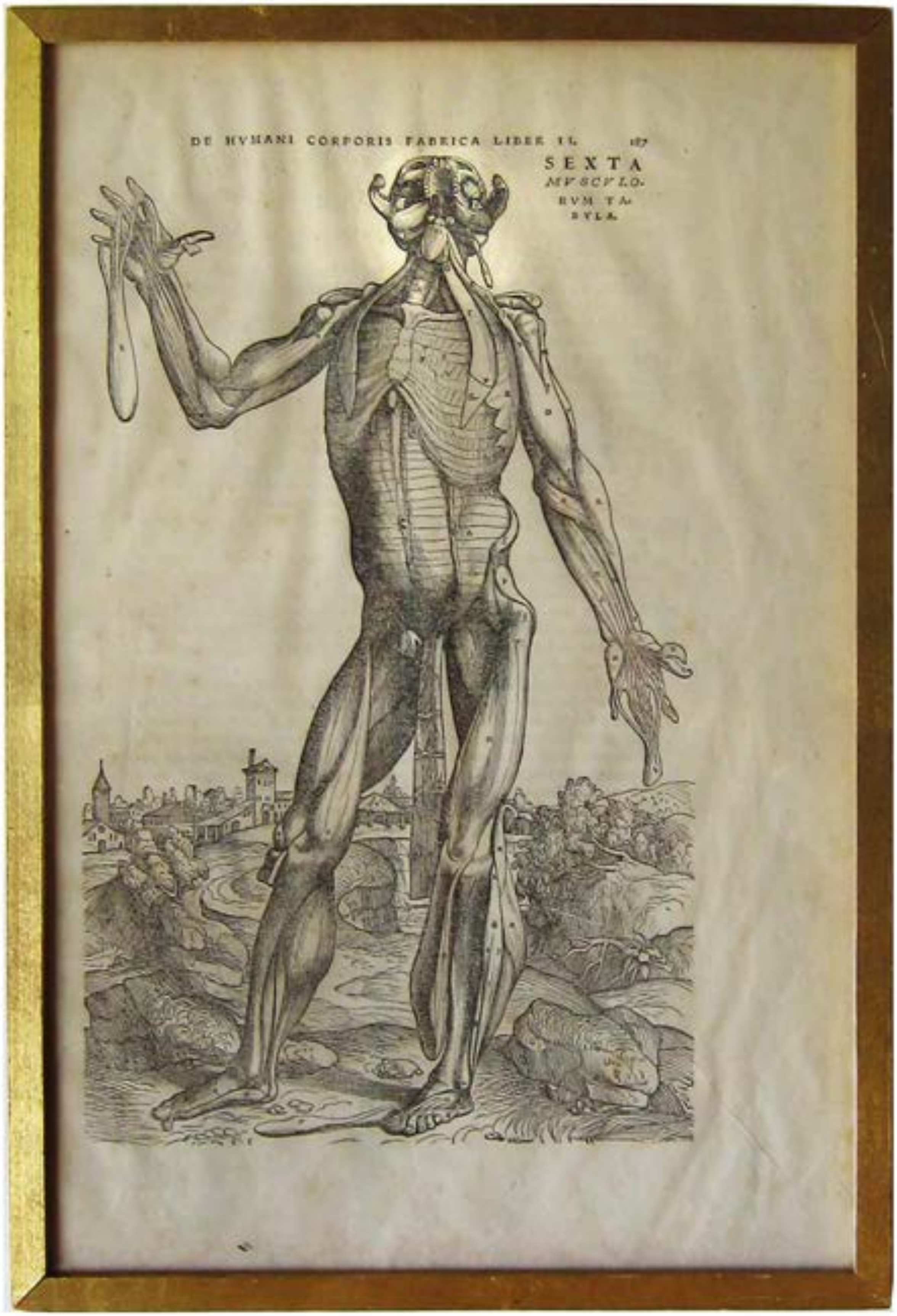
Islamic Cupping Glass

Anatomical Wood Block Print by Andreas Vesalius, 1543

Andreas Vesalius (1514-1564), a native of Brussels, was an anatomist, physician, and author of one of the most influential books in the history of medicine. He was professor at the University of Padua and later became Imperial physician at the court of Emperor Charles V. In 1543, he published *De humani corporis fabrica libri septem* (On the fabric of the human body in seven books), a textbook of human anatomy. The book is based on his Paduan lectures, during which he deviated from common practice by dissecting a corpse himself to illustrate what he was discussing. It presents a careful description of the complete structure of the human body in unprecedented anatomical drawings that set a new standard for future medical books. It corrected many errors of the Galenic tradition which had dominated medicine for 1400 years. The illustrations are of great artistic merit and are generally attributed by modern scholars to the "studio of Titian." It was published by one of the foremost printers of the time, Joannis Oporini in Basel. The greatest significance of the work, though, was the manner in which it was produced. By breaking with the Galenic tradition and relying on his own observations, Vesalius created a new scientific method that would be applied to all branches of medicine.

This is an original wood block print from the 1543 first edition of *De humani corporis fabrica* by Andreas Vesalius. The print is the sixth plate of the muscles in book 2. A description of the muscles is on the reverse. These prints of the muscles were known as the "muscle men" and provided accurate information on the structure and function of the muscles of the body. The print is 28.5 cm wide by 42.7 cm high and held in a frame. It is in excellent condition. Ex Marvin S. Sadik collection.

On the backing is a presentation that reads "E & L Baskin, Marvin, with the warm & affectionate regard of Esther & Leonard, fort hill, VT, June, 1964." Marvin is Marvin S. Sadik (1932-2013), a former Director of the National Portrait Gallery, a Smithsonian Institution. Leonard Baskin (1922 -2000) was an American sculptor, book-illustrator, wood-engraver, printmaker, graphic artist, writer, and teacher. He founded the Gehenna Press, one of the premier twentieth century fine presses in America, in 1942 while studying art at Yale. Baskin produced works such as *Ars Anatomica A Medical Fantasia* that were inspired by the classical anatomical works of the Renaissance such as the *Fabrica*.



Vesalius Wood Block Print

Herbal Wood Block Print by Leonhart Fuchs, 1543

Nightshade

Leonhart Fuchs (1501-1566) was a German physician and botanist and is considered one of the founders of modern botany. He was professor of medicine at the University of Tübingen and created its first medicinal garden in 1535. He stocked the garden attached to his house with rare specimens solicited from friends around Europe. His chief notability is as the author of a large book about plants and their uses as medicines. *De historia stirpium commentarii insignes* ("Notable commentaries on the history of plants"), his great herbal, was first published in 1542 in Latin. It was followed by "New Kreüterbuch" in a German translation in 1543. It has about 500 accurate and detailed drawings of wild and domesticated plants that were printed from woodcuts. Fuchs employed the best artists then available in Basel: Albrecht Meyer did the drawings; Heinrich Füllmaurer transferred them to the woodblocks; and they were cut by Veit Rudolph Speckle. All three are depicted in the book, the first time that book illustrators are themselves portrayed and named. It was printed at the famous shop of Michael Isengrin in Basel. The drawings are the book's most notable advance on its predecessors. These illustrations set a new standard for botanical depiction and were some of the most influential in botanical history, being copied for innumerable works well into the 18th century. Some 40 species are illustrated for the first time, including several American plants, such as maize and the pumpkin. He tried to find the medicinal plants recommended by the ancient Greeks, mainly Dioscorides, among the local flora and thereby developed the principles of modern botany as a science of detailed comparisons of plants in different locations. Fuch’s work and its beautiful illustrations effected a revolution in the natural sciences, comparable to that of Copernicus in astronomy and Vesalius in anatomy

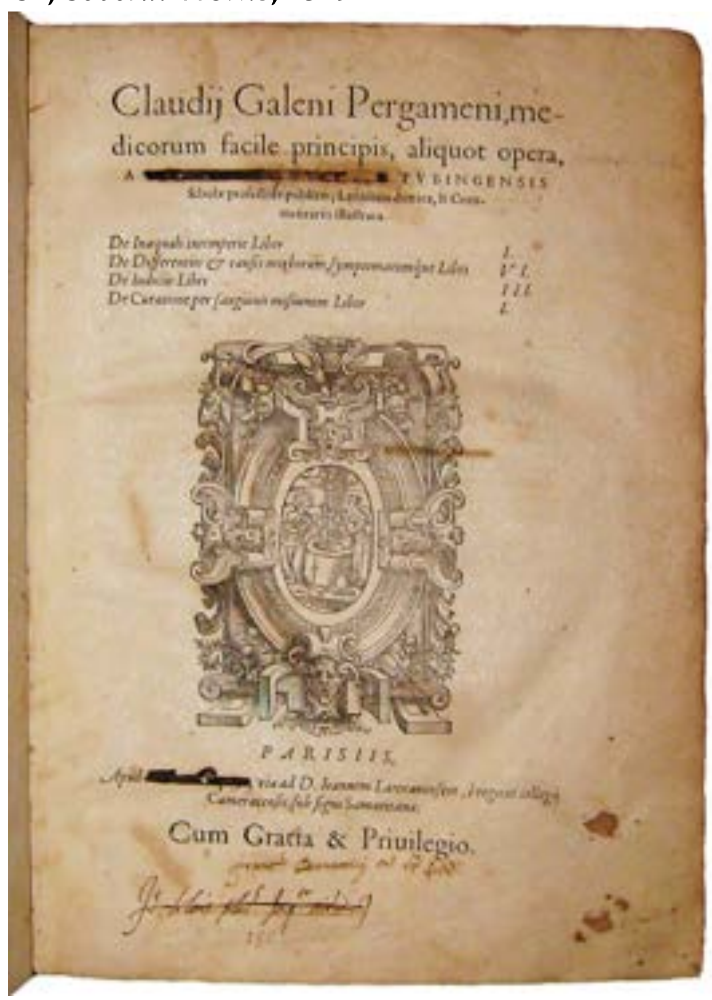
This is an original leaf from the “New Kräuterbuch,” the German folio edition of 1543. Nightshade is on one side of the page and balloon vine on the other. The drawings are hand colored and the sheet is 36 x 23 cm. The nightshade plant is *Atropa belladonna* or deadly nightshade. The psychotropic and medicinal effects of this plant were known in antiquity. The foliage and berries contain psychoactive alkaloids including atropine, scopolamine, and hyoscyamine which can be extremely toxic. In proper dosage, however, some agents from this plant are used medicinally today. Atropine, for example, an anticholinergic agent, is used to dilate the eye for ophthalmoscopic examinations.

Hippocrates, *Opera Omnia,* 1596

The ancient Greeks developed a system of humorism or humoralism in which disease resulted from an excess or deficit of one of the four humors. The four humors were black bile, yellow bile, phlegm, and blood. This theory was closely related to the theory of the four elements: earth, fire, water and air; earth predominantly present in the black bile, fire in the yellow bile, water in the phlegm, and all four elements present in the blood. Treatment sought to restore the balance of humors within the body. Hippocrates of Kos (c460 – c370 BC) and his followers described many diseases and medical conditions and is considered the father of modern medicine. He was the first to perform chest surgery and other procedures. He is best known for his oath historically taken by physicians and other healthcare professionals swearing to practice medicine ethically and honestly.

Hippocrates. Magni Hippocratis medicorvm omnivm facile principis, opera omnia quae extant. Anvtio Foesio. Francofvrti, Apudher, And. Wecheli, Claud. Marne. & Io Aubr., 1596, 17 1/2 cm, [24], 1188 [76] pp. Original vellum, a few worm holes, ex-lib, near fine. This book, *Great Hippocrates Easily Prince of all Physicians, All Works which Exist* is one of the fundamental texts of Western medicine and first appeared in a printed Latin edition in 1525.

Galen, *Several Works*, 1549


Claudij Galeni Pergameni, medicorum facile principis, aliquot opera,
A [redacted] TVBINGENSIS
PARISIIS,
Apud [redacted]
Cum Gratia & Priuilegio.

Galen (131–201 AD), a Roman of Greek ethnicity, contributed greatly to the understanding of numerous medical disciplines, including anatomy, physiology, pathology, pharmacology, surgery and neurology, as well as philosophy and logic. Galen was principally influenced by the then-current theory of humorism but used observation and reasoning in his studies. The writings of Galen and Hippocrates so dominated Western medicine that few advances were made until the nineteenth century. Humorism was not completely displaced until 1858 by the publication of Rudolf Virchow's theories of cellular pathology.

Galen. Claudij Galeni Pergameni, medicorum facile principis, aliquot opera. A Tvbingensis scholae professore publico, Latinitate donata, & Commentariis illustrata. De inaequali intemperie Liber I, De Differentiis & causis morborum, symptomatum'que Libri VI, De Iudiciis Libri III, De Curatione per sanguinis missionem Liber I. Parisiius, Fuchs, 1549, 30.5 cm, 26 pl, 293 leaves (three misnumbered), contemp vellum, holes for fasteners, a few cracks in spine, paper label. The name of Fuchs has been crossed out with ink wherever it appears, ex-lib, vg+.

This book, *Claudius Galenus of Pergamon, Prince of Physicians, Several Works*, contains several books on uneven weather, different causes and symptoms of disease, judgments, and treatment by blood discharge. Blood letting was practiced from antiquity into the late nineteenth century. It was based on the ancient humoral system of medicine and was intended to restore the balance of humors in the body. Leonhart Fuchs (1501-1556) (see above) was a German physician and professor of medicine at the University of Tübingen. He created its first medicinal garden in 1535 and is considered one of the three founders of botany.

Personal Dental Tool Outfit, Seventeenth Century

Beginning in the seventeenth century, people began carrying personal dental tool sets for oral hygiene and removing tartar from teeth. This is a rare early set, seventeenth century, probably Continental. It consists of three 2 ¾ inch double ended cut steel tools incorporating various scrapers, knife, file, and scoop. The tools have decoratively turned central finger grips and are contained in a turned bone holder. The set is in excellent condition noting only two age checks in the holder.

Dental Hygiene Set

Oil painting depicting an operation on a foot, after David Teniers, 17th century

An oil painting on copper, unsigned but after David Teniers, depicting a minor operation on a foot. The theme of physicians and alchemists was popular in 17th century Flemish and Dutch genre painting. David Teniers the Younger (1610–1690) was the principal contributor to this genre and its iconography in Flanders. Teniers was a Flemish painter, printmaker, draughtsman, miniaturist painter, staffage painter, copyist and art curator. He was an extremely versatile artist known for his prolific output. He was an innovator in a wide range of genres such as history, landscape, portrait, and still life. Teniers is particularly known for developing the peasant genre, the tavern scene, pictures of collections, and scenes with alchemists and physicians. These were often small paintings on copper designed for the budding and prosperous bourgeois class that wished to decorate their houses with scenes of everyday life. They were often characterized by a slight satirical touch not exempt of a certain burlesque and caricatured tone.

The painting depicts a barber-surgeon performing an operation on a patient's foot. The surgery being performed by the surgeon is on what appears to be an infected wound. At that time, the most frequent operations were performed on the skin. Generally, abscesses, carbuncles, small tumors, and necrosis due to wound infection constituted the most frequent pathologies. The remedy against these types of diseases was incisions or extirpations, with tools such as scalpels, blades, and lancets. Next to the surgeon, an attendant holds a cloth to clean the wound. Three men in the back observe the operation. On the floor, are a human skull and a flask.

The painting is 11 x 8 inches in size on copper. Beginning in the early 16th century, European artists painted on small sheets of copper as part of a broader experimentation with painting on smooth surfaces. The frame is new but in the style of the period.

Painting of operation on foot in manner of David Teniers the Younger

Syringe, Eighteenth Century

This is an early English syringe (archaic clyster or glyster). Simple piston syringe clysters were developed in the early seventeenth century. They are usually made of pewter or silver and are heavy and cumbersome. They had multiple uses including giving enemas, irrigating wounds, and applying mercury for treatment of syphilis. This syringe consists of a hollow cylinder holding a plunger and with a nozzle at the end. The cylinder and nozzle are made of pewter and the plunger of wood with a turned handle. The end of the plunger has two metal discs with string wound tightly between them for tight fit and suction. A threaded collar unscrews for filling and cleaning the inside of the cylinder. The heavy syringe is 24 inches long with a diameter of three inches. It is in very good condition noting an old repair to the cylinder and wormholes in the handle.

Syringe

Anatomical Model of a Pregnant Woman, c1680

This is a carved ivory anatomical model of a pregnant woman attributed to Stephan Zick or his workshop. In 1543, Andreas Vesalius (1514-1564) published *De Humani Corporis Fabrica*, a book of anatomical drawings that revolutionized the study of the human body and the practice of medicine. During the 16th and 17th centuries, interest in human anatomy grew with many books, prints, and art illustrating the body dissected to reveal the internal organs, skeleton, muscles, nerves and blood vessels. Because of the lack of cadavers and the means to preserve them, wax and ivory models appeared. Among the latter were small ivory models produced in Germany, Italy, and France. The majority of the models were women, almost all in an advanced stage of pregnancy. There are some of men. None of the known figures are signed or dated, although they can be placed on stylistic grounds into groups, each of which probably originated in a particular workshop. German workshops are well documented and one of the most prominent and prolific was that of Stephan Zick.

Stephan Zick (1639-1715) was one of the greatest ivory sculptors of the 17th century. He is most recognized for making anatomical models of eyes and pregnant woman. Zick came from a family of Ivory turners in Germany, from whom he learned the trade. Not only did Zick follow his family trade, but became recognized across Europe for his incredible skill and ingenuity in the field. Zick led the Nuremberg Workshop, which trained a number of artists to be masterful carvers.

Three possibilities have been suggested as to the purpose of these small models of pregnant women.

1. They were used by physicians or midwives to instruct lay people about basic anatomy, particularly that related to pregnancy.

2. Medical students used the models to study the anatomical structure of a pregnant woman because cadavers were rare. Some doubt that the models were used in teaching because they are not sufficiently detailed or are not anatomically correct.

3. The models are *memento mori*, symbolic reminders of the inevitability of death. In some models, the body is presented in a deathly repose upon a velvet and gold braid covered wood funeral bier or in a coffin-like case. However, if a *memento mori*, why show the internal organs?

It is possible that the models were used for all of these purposes, depending on the situation.

This is a carved ivory model of a pregnant woman in a deathly repose measuring 1 inch high, 5 ½ inches long, and 1 ½ inches wide. The front of the torso can be removed to reveal the trachea, lungs, stomach, liver, and a fetus within the uterus. The inside of the front has the heart and intestines. The arms are articulated and can be moved. The figure is held in a wood case shaped like a coffin. The outside of the case is covered with patterned leather and the inside lined by maroon velvet. The original brass clasps are present. The model is in excellent condition with no missing parts noting only small hairline fracture common in ivory of this age.

Grangeret Amputation Saw, 1770

It is believed that amputations were performed in the Neolithic times, from evidence of saws of stone and bone and what appears to be amputated bone stumps in skeletons of the period. Amputations were performed in ancient Greece and Rome usually in cases of gangrene to prevent spread of the infection. Surgeons dealt with the problem of hemorrhaging by introducing the technique of tying off, or ligating, blood vessels during surgery. The procedure for amputation was described in detail by Celsus in the first century. Amputation came to be used for other conditions such as ulcer, tumor, injuries, animal bites, frost bite, and deformity. Over the ensuing centuries, through the Dark Ages, there was little change in operative technique other than the use of cautery with hot irons and hot oil to prevent hemorrhage. A major step in the development of the operative technique was the introduction of an artery forceps by French military surgeon Ambroise Paré during the sixteenth century. He also reintroduced the technique of ligating blood vessels in 1529. Nevertheless, due to a lack of analgesics and narcotics, the operation had to take only a few minutes.

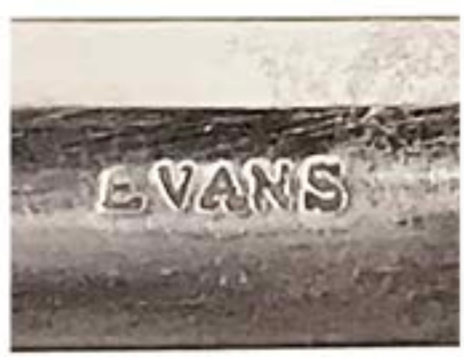
This amputation saw is 19 ¼ inches long. The stylized steel frame is typical of the eighteenth century as described by Jean-Jacques Perret in *L'Art du Coutelier* in 1771. The saw is set with a blade and a butterfly blade-tightening nut. The handle is an eight-sided pistol grip of ebony. The handle was cracked at some point and repaired with a wrapping of copper wire. This very old repair is of interest because it indicates the saw was considered valuable enough to repair instead of simply replacing it with a new one. The saw is signed GRANGERET in one place and GRANGERET PARIS in another. Pierre Grangeret (c1731-1802) was a master cutler and cutler to Louis XVI. The saw is in fine condition with only some mottling and noting the repair to the handle and that the blade is not original.

Grangeret Amputation Saw

Trepanning Surgical Set, John Evans, London

Trepanning, also known as trepanation, is a surgical intervention in which a hole is drilled or scraped into the human skull. Trepanation is perhaps the oldest surgical procedure for which there is archaeological evidence. It was widespread occurring in Neolithic Europe, pre-Columbian Mesoamerica, and ancient China, Greece, and Rome. Trepanation could have beneficial effects as emergency surgery after head wounds to remove shattered bits of bone from a fractured skull and to clean out the blood that often pools and creates pressure under the skull after a blow to the head. It may also have been performed on persons who were behaving in what was considered an abnormal way to release what people believed were evil spirits. Many prehistoric and premodern skulls have signs of bone remodeling and healing around the edge of the hole, suggesting that many of those subjected to the surgery survived. Trepanation was routinely performed in the Renaissance period and surgical kits were developed for performing the procedure. It was probably done for a variety of ailments including physical injuries, concussions, headaches, epilepsy, and perceived mental illness. It was probably performed more than necessary and often did more harm than good. Nonetheless, it was accepted because, like blood letting, was one the few tools available to physicians.

This is an early 19th century trepanning set made by John Evans in London. Evans & Co. was one of the more established maker's of surgical instruments in England. The Evans family was active from 1676 until at least 1889. John Evans & Co. was located at 10 Old Change, London in 1811. The complete set contains a scalpel, a lenticular, two trephines, a brush, forceps, Hey's saw, and elevator. The instruments have ebony handles and some are stamped "EVANS." They are held in a fitted velvet-lined mahogany case 9 ¼ inches wide. The scalpel was used to open the scalp for trepanning or locating fractures. A lenticular was used to scrape away adherent scalp from the bone of the cranium and to smooth the edges of an opening in the bone of the skull. A trephine is a T-shaped, hand-operated saw with a circular serrated blade. It was used to bore holes in the skull, allowing for the removal of a round piece of bone. The small brush was used to sweep away the bone dust and small slivers of bone created during the trepanning process. Forceps were used to remove slivers or pieces of bone after skull fractures. They were also used to remove the round piece of bone created by trepanning. Hey's saw consists of an ebony handle attached to a metal shaft holding the blade. The blade is flat and has one side that is convex and serrated and the other side is straight and serrated. The saw allows for variously angled cuts. It was designed by the surgeon William Hey (1736-1819). The elevator was used to elevate parts of a depressed skull after fractures. The set is complete and all parts are in excellent condition.



Trepanning Surgical Set

Dental Extractor Tooth Key

The dental key is an instrument that was used in dentistry to extract diseased teeth. The dental key was used by first inserting the instrument horizontally into the mouth, then its "claw" would be tightened over a tooth. The instrument was rotated to loosen the tooth which would then be extracted. This is a dental extractor tooth key with a claw. It has a hardwood handle, unplated steel shaft, and is six inches long. It has its original leather case. Mid-nineteenth century.

Dental Key

Fleam Bloodletting Device

The fleam with its triangular-shaped blades was designed to be placed over a vein, most commonly the jugular or saphenous, and struck with a fleam stick. This would ideally result in a rapid penetration of the vein with minimal dissection of the subcutaneous tissues. Once the desired blood was drained from the patient, the operator would place a pin through the edges of the incision. A figure eight of tail hair or thread would then be placed over the pin to retain closure. This is a fleam bloodletting device. It consists of a brass and horn case and two folding blades. It is signed Hargreaves & Co Sheffield. This type of fleam was used primarily for veterinary purposes. It has its original leather case. First half nineteenth century.

Fleam

Spring Fleam

American Spring Fleam, c1875

The fleam has a brightly plated brass body with sliding cover, spring-loaded trigger, spring-steel cocking, and steel blade. It has a leather-covered wood case lined with dark blue velvet. A label in the case reads "Charles Lentz, Maker of Surgical Instruments, 27 S. Tenth St. Phila." The spring fleam permitted rapid, "painless" incisions to bleed the patient "curatively." The Charles Lentz firm was founded in 1863. It became Charles Lentz & Sons and operated into the 1940s. The firm sold surgical instruments, orthopaedical apparatus, physician and hospital supplies, and microscopes made by Bausch & Lomb. The fleam is in very fine condition and functional. The outside of the case is badly worn with broken hinge.

Blood Letting Lancet Set

Bloodletting had its origins in humorism, a system of medicine adopted by ancient Greek and Roman philosophers. According to this theory, there were four main bodily humors: blood, phlegm, black bile, and yellow bile. Diseases were the result of an imbalance in these humors. Bloodletting was performed in order to remove an excess of a humor that was causing the problem. Virtually every known medical condition at one time or another was treated by bloodletting. George Washington is believed to have died as a result of excessive loss of blood from bloodletting for a throat ailment. It is difficult to understand how a practice that originated in antiquity and had no benefits was practiced well into the 19th century. The main reason that bloodletting persisted is that, despite increasing knowledge about diseases, there were no effective treatments for almost all of them. Thus, bloodletting remained a treatment physicians could offer, and patients accepted, even though it did not improve and usually worsened the patient's condition.

This is a set of four bloodletting lancets held in a silver case. The case is 6.5 cm long and has a push button release. It is engraved "Dr. W. Case. 26. Westbourne Rd. W." There are four instruments all with tortoise shell handles. They have blades of different sizes. One has a "thumb" lancet at one end and a scarificator at the other end. The blades are signed "Mayer Meltzer." Mayer & Meltzer" were surgeon's instrument makers in London from about 1869 to 1886.

Lancet Set

Leech Jar

In addition to various types of lancets, leeches were also used for bloodletting since ancient times. Medicinal leeches are bloodsucking aquatic worms with unusual mouth structures and special saliva that serves as both an anesthetic and anticoagulant. At each feeding, a leech can ingest about 5 to 10 ml of blood, almost 10 times its own weight. Multiple leeches were used; early records show that over 100 leeches were sometimes applied to a single patient over a few days. The use of leeches became very popular in the nineteenth century and leeches were employed by physicians on a massive scale. The cultivation of leeches by leech farmers or medical facilities became a thriving industry. In apothecary shops, leeches were kept in large, highly ornate earthenware jars such as this example. The jar's elaborate presentation indicates the high value leeches held as a commodity during this period, as they were sold in great numbers to members of both the medical profession and the public. The jar is 15 ½ inches high with "LEECHES" prominently displayed on the bowl. It has seen considerable use with several chips and repaired breaks. Nonetheless, it is a fine example of an elaborate nineteenth century leech jar.

Leech Jar

Leech Bowl

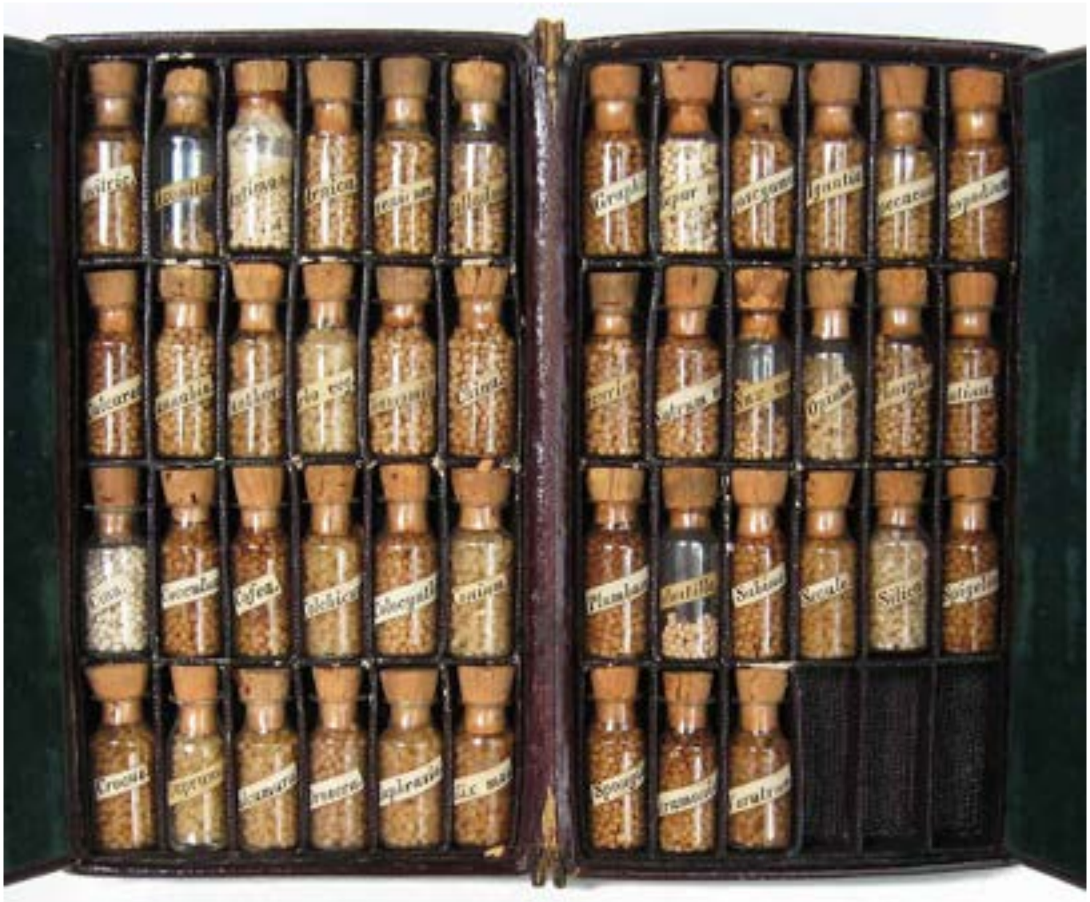
Leech Bowl, c1800

This hand-blown, lead glass leech bowl measures 7 inches high with a 6 inch opening. It has a round stemmed base with pontil mark underneath, globoid body, and everted lip. The top would be covered by a piece of muslin to let air in for respiration and secured in place by tying string around the everted lip. In apothecary shops, leeches were kept in large, highly ornate earthenware jars. Leeches were purchased and transferred to smaller bowls or jars like this for home use. Leeches could be kept in these jars for months until needed. The jar dates to around 1800.

Victorian Medicine Sample Case

This is a sample case of Victorian medicines. The case is in the form of a leather-hinged book and is made of embossed burgundy leather. It holds 45 labeled glass vials holding samples and stoppered with corks. The vial case fits into an embossed card slip case, which measures 6 ¼ x 3 ⅝ x 1 ⅝ inches (15.7 x 9.2 x 4.3 cm). The case is in very fine condition with slight surface wear. All labels are present. The slip case shows edge wear.

These samples illustrate the pharmacopoeia available in Victorian times. Some of the agents are beneficial, some are addictive, and some are harmful. The vials are labeled as follows: Ac. Nitric, Aconitum, Antimon, Arnica, Arsenicum, Belladonna, Calcarea, Cannabis, Canthatides, Carbo veg, Chamomilla, China, Cina, Cocculus, Cofea, Colchicum, Colocynthis, Conium, Crocus, Cuprum, Dulcamara, Drosera, Euphrasia, Filix mas, Graphiles, Hepar sulph, Hyoscyamus, Ignatia, Ipacacuanha, Lycopodium, Mercurius, Natrum mur, Nux vom, Opium, Phosphor, Platina, Plumbum, Pulsatilla, Sabina, Secale, Silica, Spigelia, Spongia, Stramonium, and Veratrum.



Victorian Medicine Sample Case

Ear Trumpet

Ear trumpets are tubular or funnel-shaped devices that collect sound waves and lead them into the ear. They were used as hearing aids, resulting in a strengthening of the sound energy impact to the eardrum and thus improved hearing for a hard-of-hearing individual. Ear trumpets were made of sheet metal, tin, silver, wood, snail shells, or animal horns. The use of ear trumpets for the partially deaf dates back to the 17th century. By the late 18th century, their use was becoming increasingly common. The first firm to begin commercial production of the ear trumpet was established by Frederick C. Rein in London in 1800. F. C. Rein remained in business until 1963. Ear trumpets have largely been replaced by modern hearing aid technology that is much smaller and less obtrusive, albeit more expensive.

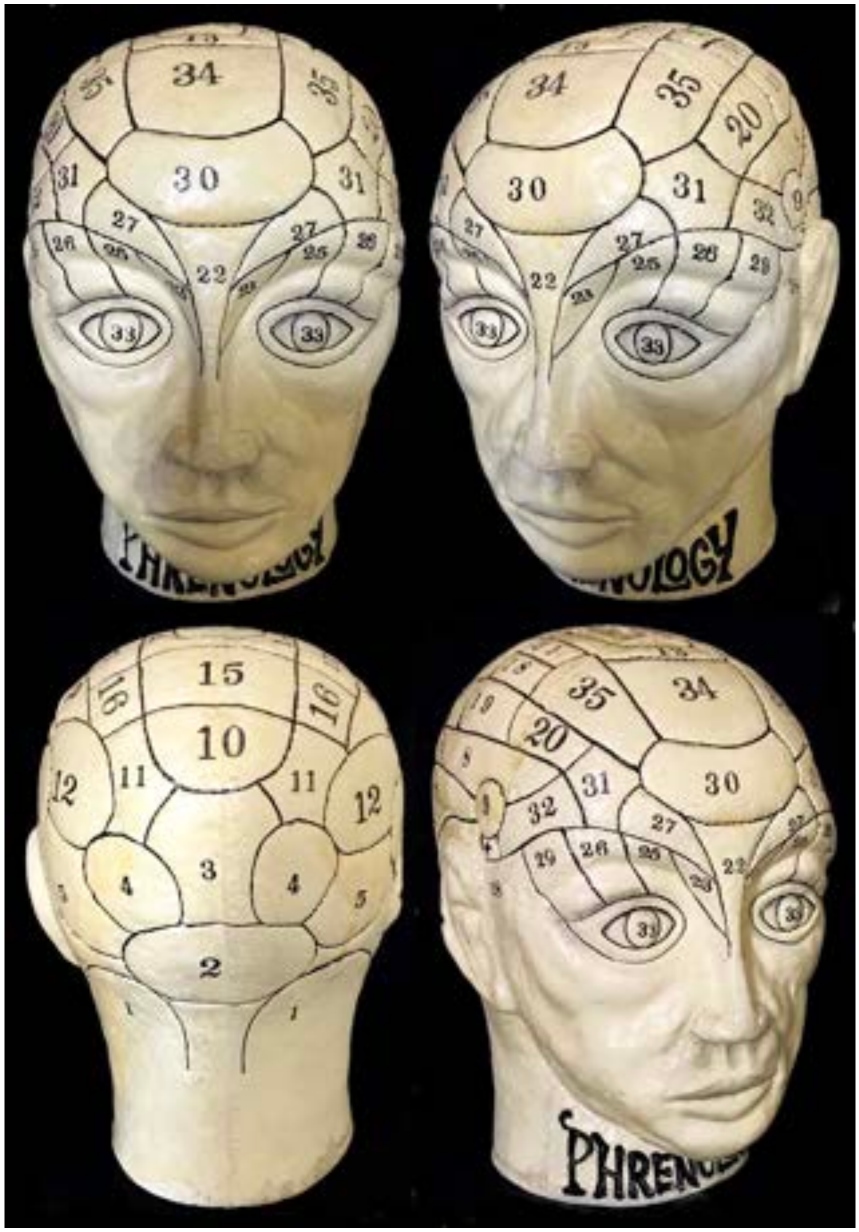
This is a silver-plated ear trumpet by F. C. Rein and Son dating to around 1880. It is 6 3⁄8 inches long and 3 1⁄8 inches wide and known as the Grand Opera Dome, a type of London Dome ear trumpet. This style of trumpet was named because of its similarity in shape to the dome on St. Paul's Cathedral in London. The design is a parabolic reflector that directs the sound into the ear tube. It is signed around the bell "F C Rein and Son Patentees sole inventors & only makers 108 Strand London." It features a decorative grill and is entirely covered with elaborate leafy engraving. The piece is in very good condition with no dents. It should be noted that these trumpets are effective.

Ear Trumpet

Phrenology Bust

Phrenology is the study of the conformation of the skull as indicative of mental faculties and traits of character. It was developed by German physician Franz Joseph Gall (1758–1828) in 1796. Gall believed that the brain was made up of 27 individual organs that determined character, thoughts, emotions, and personality. An enlarged, and therefore active “organ” in the brain was reflected on the surface of the skull. These regions were mapped on the skull and phrenologists would run their fingertips and palms over the skulls of their patients to feel for enlargements or indentations in these regions. Busts were manufactured that showed the regions and the personality traits associated with them. Examples of traits are tenacity, courage, benevolence, hope, and individuality. Phrenology enjoyed great popular appeal well into the 20th century but has been wholly discredited by scientific research. The only positive aspect of phrenology is that it was among one of the earlier disciplines to postulate that different parts of the brain have different functions.

This is a phrenology bust with the locations of personality traits outlined and numbered on the surface. It probably dates to the first part of the twentieth century. It is made of paper-mache and is slightly larger than life-size. It is also a “piggy” bank with a slot on top for depositing coins. It was most likely a bank’s gift to those opening new accounts. A paper on the bottom lists the traits associated with each numbered region. There is also an opening at the bottom, missing its stopper, for retrieving coins. The bust is in excellent condition. It is indicative of how long phrenology had popular appeal.



Phrenology Bust

X-Ray of Human Skull (Victim of Black Death)

The first technology that allowed visualization of the interior of the living human body was the X-ray. The German physicist Wilhelm Röntgen (1845-1923) is credited as the discoverer of X-rays in 1895. While investigating cathode rays with a Crookes tube he noticed a faint green glow from a nearby fluorescent screen. He realized this was due to an unknown type of radiation that he referred to as "X." He discovered the medical use of X-rays when he used them to take a photograph of his wife's hand. It showed the bones in her hand and her ring. Shortly thereafter, X-rays were put to diagnostic use. For his discovery, Röntgen received the first Nobel Prize in Physics in 1901.

This is an X-ray or lateral radiograph of a human skull clearly revealing the bone structure. It measures 11 ¾ by 9 ½ inches. The vertical density is due to the Perspex locating and immobilizing device in the X-ray machine. The skull is that of a victim of the Black Death, which swept through England in 1348 and 1349. It is from a "plague pit" burial in London found on the site of the old Royal Mint close to the Tower of London. The X-ray was taken as part of a study by the University and Museum of London in the 1980s. Based on the good condition of the teeth, this appears to be a young adult.

The Black Death was a bubonic plague pandemic that reached England on June 24, 1348. The plague is caused by the *Yersinia pestis* bacterium and is spread by infected fleas on rats and mice. Originating in Mongolia, it spread west along the trade routes across Europe and arrived on the British Isles from the English province of Gascony. Over the next 500 days, the plague traversed the entire country and killed approximately half of the population.

X-Ray of Human Skull

Human Skeleton

Physicians studied the human skeleton from antiquity through the Renaissance. They were primarily impressed with the hardness of the bone and saw its necessity for the structural integrity of the body. Galen observed: "To protect the system completely, it was better for it to consist of many bones, and further, of bones just as hard as they are ... Nature consequently did not merely entrust its defense to the skin, as she did for the parts in the abdomen, but first, before the skin was put on, she invested it with bone like a helmet." At the end of the fifteenth century, renewed interest in dissection led to closer inspection of skeletons. Leonardo de Vinci produced beautiful, highly geometrized drawings of the skeleton in 1510-1511. In *On the Fabric of the Human Body* (1543), Andreas Vesalius corrected many of Galen's errors. By the late sixteenth century, anatomy theaters contained articulated skeletons. The idea of arraying biological specimens in a museum exhibit in order to instruct medical students and foster research first arose during the Enlightenment period in Europe. One of the pioneer innovators in this area was John Hunter (1728-1793), a Scottish-born anatomist who amassed a collection now known by his name. Today, skeletons, usually plastic models, are used in human anatomy courses for teaching students in the health professions. The source of most human skeletons in the United States was India and China, both of which have now banned the export of skeletons.

This is an actual human skeleton composed of 206 bones. The skeleton is articulated and has the insertions and origins of muscles painted on the limbs, pelvis, shoulders, and skull. It is 57 inches tall. It was obtained in 1956 from the Carolina Biological Supply Company for $125 by Thomas L. Lentz who painted the insertions and origins of muscles. The skeleton is most likely from India.

Medicine chest, English, 17th/18th century

This is an oak fall-front chest measuring 15 ½ x 13 x 6 inches (39 x 33 x 15 cm). It has two shelves, the upper one buttressed supporting two drawers. The brass escutcheon for the key hole is in the William and Mary style. There is a working key. The notable feature of this chest is the carving on the front and two sides. It consists of raised leaves, geometric banners, and symbolic crosses interwoven with raised lettering. It reads on the front "He giveth medicine to heal their sickness. Acknowledge Him and He shall direct thy paths" and on one side "And now Lord what is our hope truly our hope is even in Thee." The chest illustrates marriage of the curative powers of science and of religion, a combination often evoked today. Overall condition is fine, noting a few age cracks.

Microscopy Accessories

Miscellaneous
- Slide-Making Outfit and Zentmayer Student Microscope, American, 1879
- Folding Portable Microscope and Slide-Making Outfit, W. F. Stanley, c1890
- Microscope Table, The Adjustable Table Co., Grand Rapids, Michigan, c1905

Microtomes
- Valentin Knife
- Hand microtome, c1880
- Bench microtome, c1880
- Table microtome, c1880
- Microscopic Section Cutter, c1880
- Microtome Knife, c1900, Arthur H. Thomas Co., Philada, U.S.A. Blade with handle.
- Cambridge Rocking Microtome, c1900. The Cambridge Scientific Instrument Co Ltd, Cambridge, England
- Cambridge Rocking Microtome, Knife, Cambridge Instrument Co., Ltd., Cambridge, Wilkinson Sword Co Ltd, Made in England
- Bausch & Lomb Minot Microtome, Arthur H. Thomas Co., 1904
- Minot-pattern Rotary Microtome, Spencer Lens Co., Buffalo, 1929
- Wiebach & Pietzsch Lever Microtome, Philadelphia, c1895
- Bausch and Lomb/Arthur H. Thomas Sliding Microtome, 1905
- Spencer Sliding Microtome, Model 860
- Ivan Sorvall Servall Microtome, 1953
- Porter-Blum MT-1 Microtome

Projection Instruments
- Solar Microscope, c1772
- Cary Camera Lucida, c1810
- McAllister Magic Lantern, 1886
- Baird Magic Lantern, c1890
- Ernst Plank Magic Lantern
- Lantern Slide Projector, Bausch & Lomb Model C Balopticon, Rochester, c1905
- Projection Microscope, Williams, Brown, & Earle, Philadelphia, c1900
- Projection Microscope, Bausch & Lomb, 1st quarter 20th century

Lighting Devices
- Replica Hooke-type Microscope Illuminating Device
- Candle Lamp
- Bockett Kerosene Microscope Lamp, Collins London, c1875
- Kerosene Microscope Lamp, c1880
- Brass Electric Lamp, 1909
- Candle Holder and Shade, c1820
- Mechanical Arc Lamp, Bausch & Lomb, c1925

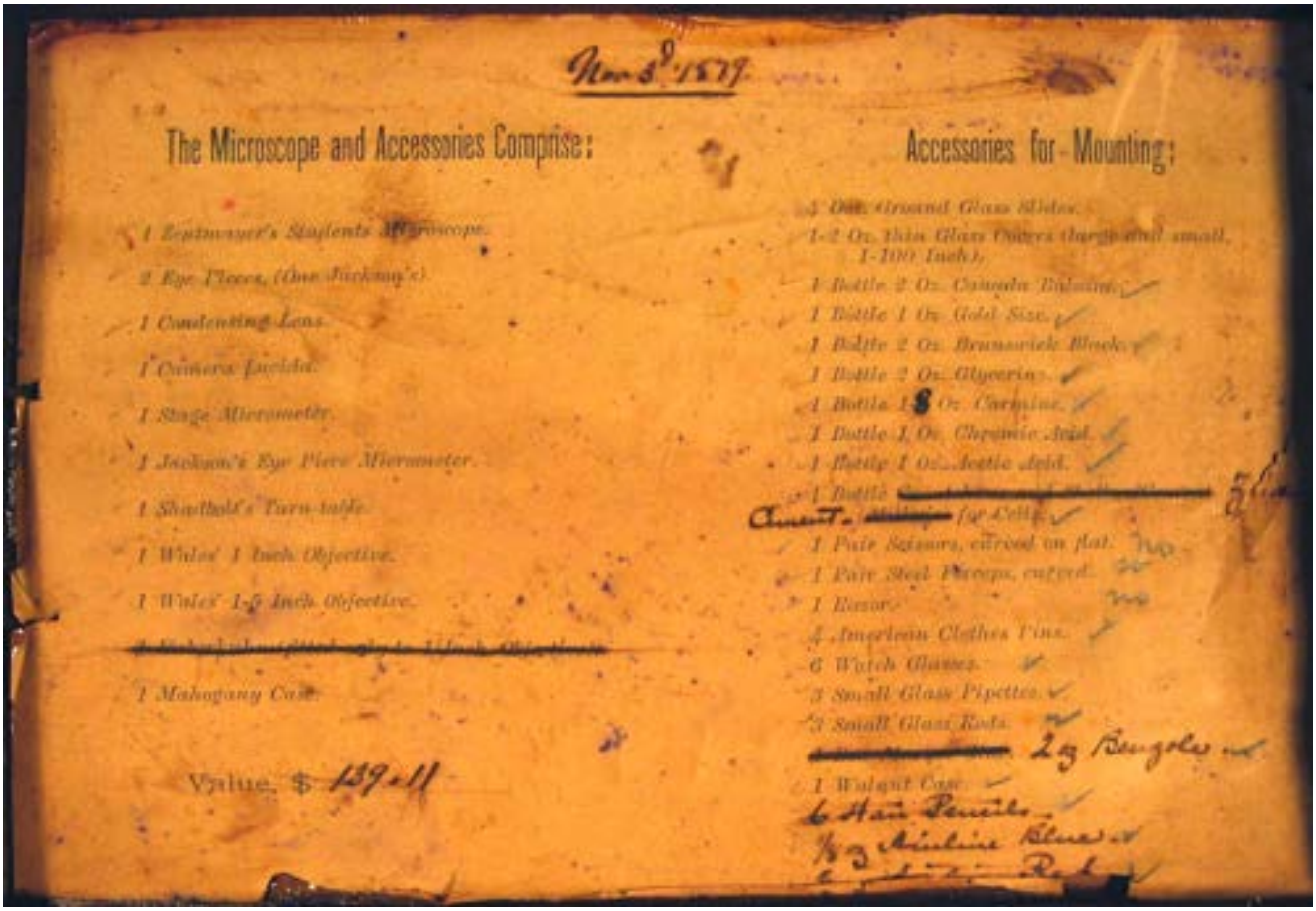
Other Accessories
- Slider Holder
- Slide Ringing Table
- Stage Forceps
- Aquatic Box
- Fish Plate
- Compressorium
- Livebox
- Microscope Filters
- Shillaber’s Immersion Oil

Nineteenth Century Microscope Setups

The microscope was not appreciated as a useful scientific instrument until the middle of the nineteenth century. Some notable discoveries had been made with the microscope, especially Hooke's observation of capillaries connecting arteries and veins in 1665. This confirmed Malpighi's hypothesis of the continuous circulation of blood. Leeuwenhoek observed spermatozoa with his simple microscopes. However, there were no descriptions of tissues and their cells. This was largely blamed on the aberrations and low resolution of the early microscopes. Early observers did observe and publish pictures that showed considerable details of whole objects such as fleas and other insects. The fact that there was no information on tissues was not due as much to defects in the optics of the microscope, but to the lack of methods for adequate fixation and sectioning of tissues. With a modern slide, the basic structure of a tissue is easily observed with the early microscopes. Hooke made his observations on the thin tail fin of a fish. Fish plates for the observation of the circulation in the tail of the fish were supplied with microscopes from around 1700 until the end of the 19th century. Similarly, the first electron micrographs of cells by Keith Porter were made on intact thin tissue culture cells. It was not until the middle of the 19th century when effective techniques for thin sectioning of tissues became available that it became possible to accurately describe the detailed structure of tissues and cells. Similarly, the subcellular structure of cells was not clearly discerned with the electron microscope until the development of adequate fixation, embedding, and sectioning by the ultramicrotome.

American slide making kit and Zentmayer Students microscope, 1879

This is a slide-making kit and Zentmayer Students Microscope that were sold as a set. The label glued within the lid of the chest has a hand-written date of November 3, 1879, and the same hand records the sum of $139.11 following the printed word "value." The label lists the contents of the cabinet and accessories for the microscope. Not all of these are present and there are additions and replacements. Labeled bottles are Oil of Cedar Wood, Gold Size, Canada Balsam, and Alcohol. Stains made by Dr. G. Grubler & Co., Leipzig are Hämatoxylin pur cryst, Scharlach R. (Michaelis), Crystallviolett, Malachitgrün, Fuchsin S, and Hämatein purise. This set is important because it illustrates the types of materials used for slide making at that time in America. The Students Microscope was reported in the American Naturalist in 1877. This microscope is in exceptionally fine condition and has its own case.



Nov 3d 1879

The Microscope and Accessories Comprise:

1 Zentmayer's Students Microscope.

2 Eye Pieces, (One Jackson's).

1 Condensing Lens.

1 Camera Lucida.

1 Stage Micrometer.

1 Jackson's Eye Piece Micrometer.

1 Shadbolt's Turn-table.

1 Wales' 1 Inch Objective.

1 Wales' 1-5 Inch Objective.

[illegible]

1 Mahogany Case.

Value, $ 139.11

Accessories for Mounting:

3 Doz. Ground Glass Slides.

1-2 Oz. thin Glass Covers (large and small, 1-100 Inch).

1 Bottle 2 Oz. Canada Balsam.

1 Bottle 1 Oz. Gold Size.

1 Bottle 2 Oz. Brunswick Black.

1 Bottle 2 Oz. Glycerin.

1 Bottle 1 Oz. Carmine.

1 Bottle 1 Oz. Chromic Acid.

1 Bottle 1 Oz. Acetic Acid.

1 Bottle [illegible]

Cement [illegible] for Cells.

1 Pair Scissors, curved on flat.

1 Pair Steel Forceps, curved.

1 Razor.

4 American Clothes Pins.

6 Watch Glasses.

3 Small Glass Pipettes.

3 Small Glass Rods.

[illegible] 2 oz Benzole

1 Walnut Case.

6 Hair Pencils

1/2 oz Aniline Blue

[illegible] Red

Stanley Folding Portable Microscope and Slide-Making Outfit

Stamped in the lid "W.F. STANLEY, OPTICIAN." The mahogany case has a hinged drop-front and ten drawers (1 for tools and 9 for completed slides). The case contains many separate items, including a bull's eye condensing lens on a table stand, three objectives for the microscope, folding brass slide warming table, 5 empty chemical bottles, some small tools and supplies, and 54 finished slides filling the 9 slide trays. The accompanying folding portable microscope is made of black oxidized brass, with polished lacquered brass fittings, and stands 9 ¼" tall on its folding tripod base. The microscope is in very good overall condition in its original fitted mahogany case.

The W.F. Stanley Company was started in 1853. They were the largest and best engineering instruments dealer (drafting, surveying, etc) in England, but they also sold meteorological instruments, telescopes & other optical instruments, and some microscopes.

Microscope Table, The Adjustable Table Co., Grand Rapids, Michigan, c1890

This is a table designed for use with Victorian microscopes and library telescopes. The table has a very heavy cast iron base with three cabriole style legs with wheels. The height is adjustable by faucet handles. The table is 27 inches high (adjustable), 23 ½ inches long, and 15 inches wide. The rotatable top is walnut framed milk glass for easy cleaning.

Microtomes

A microtome (from the Greek *mikros*, meaning "small", and *temnein*, meaning "to cut") is a sectioning instrument that allows for the cutting of extremely thin slices of objects to be examined under the microscope. The ability to make sections of tissues was equally important to the advancement of histology as improvement in the optical qualities of microscopes. Prior to the development of the microtome, objects to be examined with the microscope were sliced with a knife or razor, teased apart, or compressed. The first book substantially devoted to microscopy was Robert Hooke's *Micrographia* published in London in 1665. With a finely sharpened knife, Hooke cut very thin slices of cork and observed its porous structure calling the holes "cells." About a century after Hooke published his researches, the first microtomes for systematically cutting specimens for the microscope were developed. The first microtome was constructed for John Hill to make specimens described in his book on the structure of timbers (1770). The instrument resembles a pepper mill with a cam-shaped blade at the top for cutting sections of wood. Hill also introduced methods for fixation, clearing, and staining. Unfortunately, these methods were ignored until they were rediscovered separately decades later. In the first half of the nineteenth century, the Valentin knife and simple hand, table, and bench microtomes became available for sectioning. Other designs of microtomes were developed but their use remained very rare until the second half of the nineteenth century. The expansion of universities and the development of research laboratories, together with improvements in the optical qualities of microscopes, created an expanding market for microscopes in the nineteenth century. The scale of manufacture increased enormously in the closing decades of the century and microtomes likewise were being designed and manufactured for biological and medical work. Numerous different designs of microtomes were produced. Many are very fine mechanisms and still functional today.

The three main types of microtomes are the rocking, the rotary, and the sliding microtome. Each type of microtome has a special sharp steel knife to cut the specimen, which is usually embedded in a paraffin or celloidin block. In a rocking microtome, the knife is in a fixed horizontal position. The block is attached to the end of an arm pivoted near the knife and is moved or rocked in an arc past the knife edge. On a rotary microtome, the specimen moves up and down in a vertical plane. A large hand wheel in which one rotation produces a complete cutting cycle advances the specimen. A sliding microtome has a fixed specimen holder and the knife slides back and forth on a slide way. All three types of microtomes are still manufactured today.

Valentin Knife

The Valentin knife was invented in 1838 and for 20 years was virtually the sole instrument for sectioning animal tissues. It is a double-bladed knife and the distance between the two blades, and hence the thickness of the section, could be adjusted by two thumb screws. The section was made by a smooth pass of the knife through the specimen embedded in cork or carrot. The knife remained in use up to the twentieth century. This knife is 7 ¾ inches long with an ivory handle. It is signed Weedom London and has its own case.

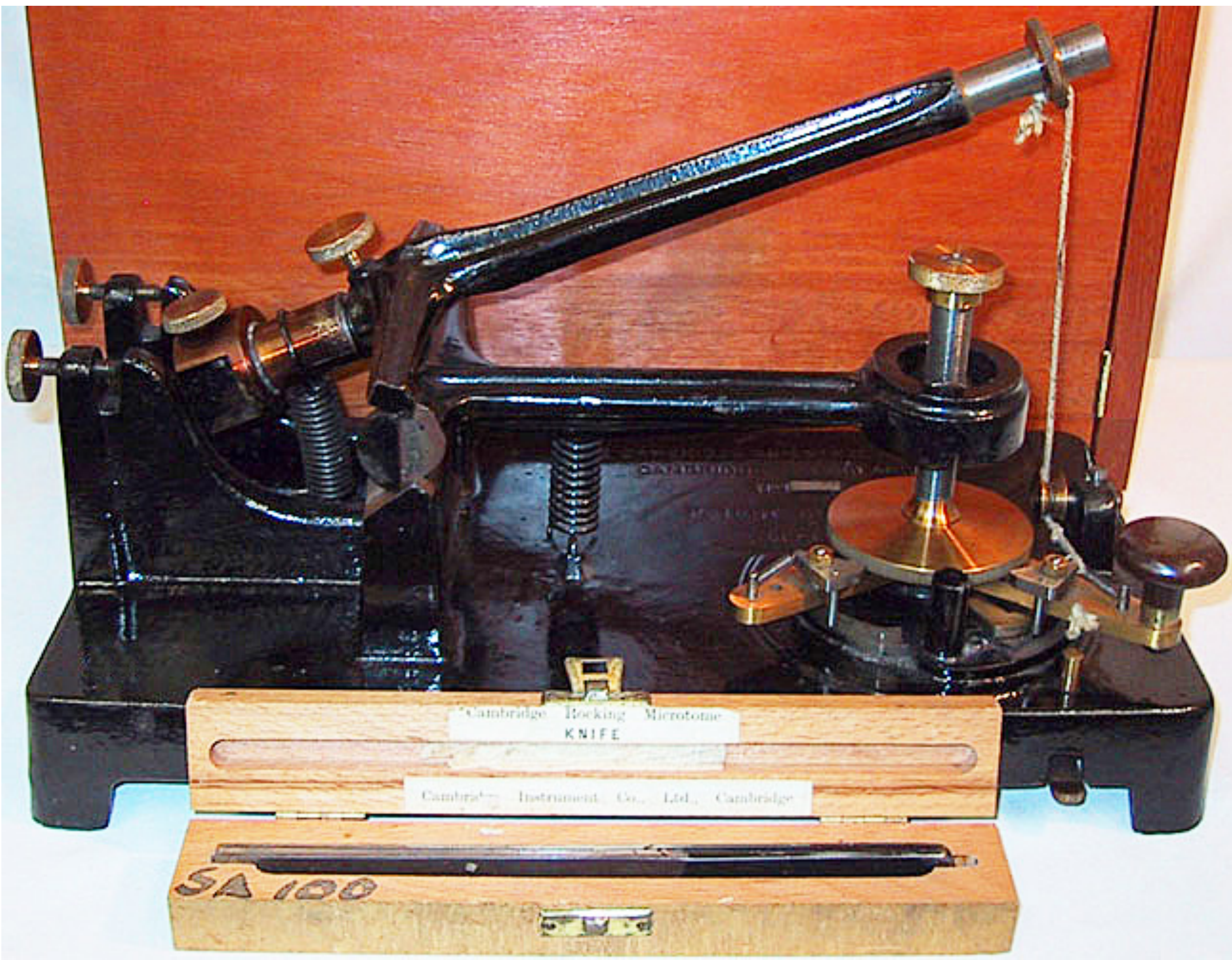
Hand microtome **Bench microtome** **Table microtome**

The hand microtome was one of the first microtomes introduced in the mid-nineteenth century. The bench microtome was clamped onto a laboratory bench. The table microtome consists of a heavy base and a round platform supported by pillars. These microtomes operated in the same manner. In the center, there is a tube containing a piston raised by turning a screw at the bottom. A piece of cork, carrot, or pith containing the specimen sat on top of the piston. As the specimen was raised, a knife was passed by hand across the platform and through the specimen to make a section. Some histologists became very adept with the use of these and continued to use them even after more sophisticated microtomes became available.

Microscopic Section Cutter, c1880.

Special knives were made for use with these hand microtomes. The "Microscopic Section Cutter" is a folding knife with a curved blade for collecting the specimen. Another example (not shown) of a blade with a handle is by the Arthur H. Thomas Co., Philadelphia, c1905.

Cambridge Rocking Microtome and Knife, 1899



The Cambridge Rocking Microtome, or Cambridge Rocker, is one of the most famous of all microtomes. First designed in the 1880s, it and the Minot microtome were based on the new principle that the object moves to and fro rather than the knife. It was designed by Horace Darwin, younger son of the famous Charles. The rectangular main frame stands on four short legs. There are two levers, a specimen holder, and a knife holder. The instrument is operated by a hand lever which drives the ratchet and pulls the tail of the upper lever down, ultimately advancing the specimen holder toward the knife. Construction is of cast iron with small parts made of brass. It was very popular because of a high degree of accuracy and reliability and relatively low cost. It could cut serial sections and sections as thin as 2 μm. It comes with Cambridge Rocking Microtome, Knife, Cambridge Instrument Co., Ltd., Cambridge, Wilkinson Sword Co Ltd, Made in England.

Bausch and Lomb/Arthur H. Thomas Minot Rotary Microtome, 1904

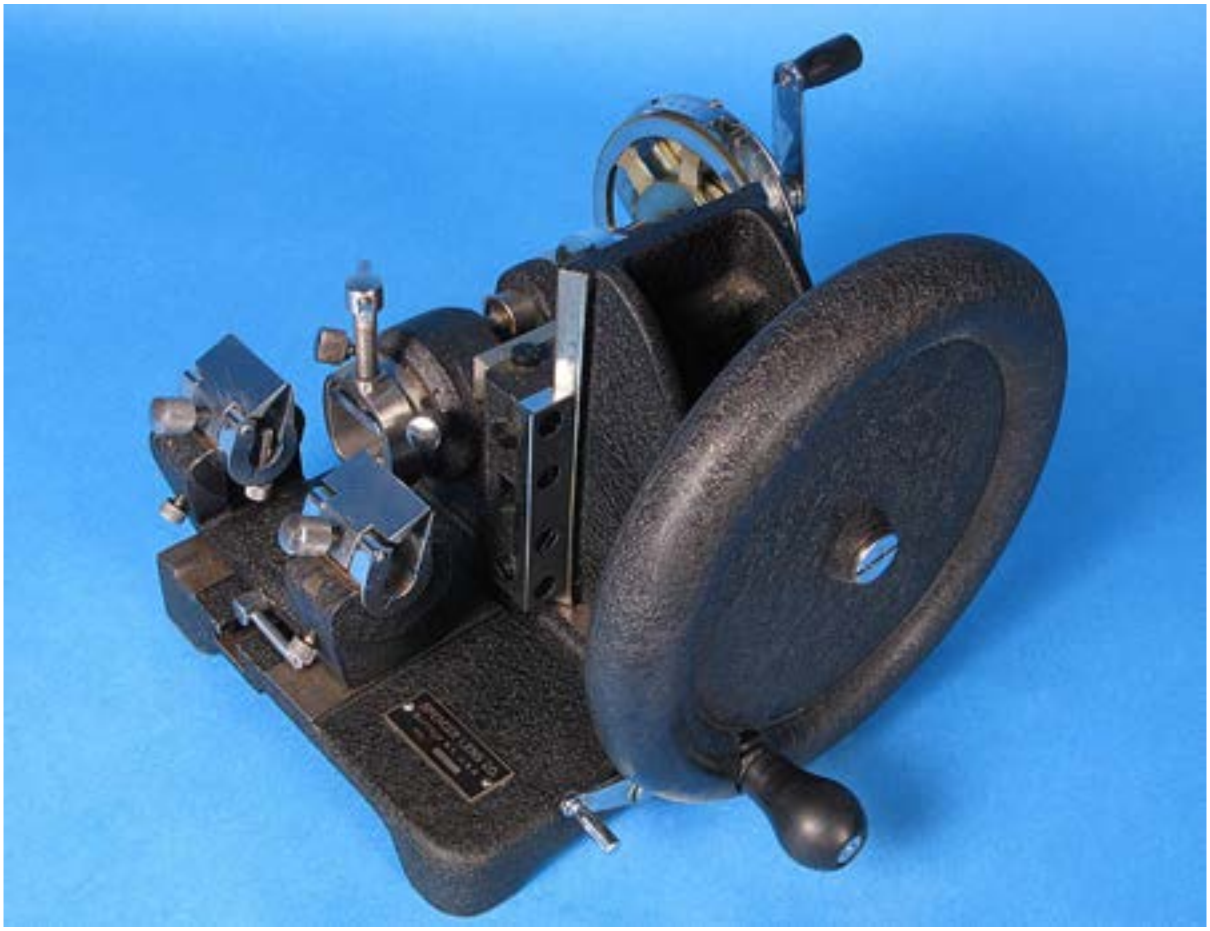
The Minot microtome is constructed on the basis of a stationary knife and a block with the specimen moving up and down and advancing at the top of each stroke produced by turning a wheel. Charles Sedgwick Minot (1852-1914) was the James Stillman Professor of Comparative Anatomy at the Harvard Medical School and was best known for his research and textbooks of embryology. He designed an automatic rotary microtome in 1886. It became the model for most subsequent microtomes. This microtome differs little from the original and was manufactured unchanged for many years.

In 1892, Arthur H. Thomas joined the microscope department of the James W. Queen Company, a leading supplier of optical and scientific equipment in the second half of the nineteenth century. It is there that he met Mr. J. Edward Patterson, who had joined the company in 1890. After the death of Mr. Queen, the business began to decline, causing many employees to leave for other businesses or to start their own. In 1899, Mr. Thomas left to start his own company and Mr. Patterson joined Charles Lentz & Sons, who were agents for the Bausch & Lomb Optical Company.

Mr. Patterson would often visit Mr. Thomas and cooperation between the companies continued. This eventually led to a landmark meeting on December 7, 1900 at the Hotel Walton in Philadelphia. In attendance were Mr. Thomas, Mr. Patterson, William and Charles Lentz, along with William Drescher and Henry Bausch of the Bausch & Lomb Company. A new company and partnership was organized and incorporated as the Arthur H. Thomas Company. William Howell, who had also been at the Queen Company, joined the group as head bookkeeper and the company opened its place of business in the Freeman building at 12th & Walnut Streets in Philadelphia. The first customer was Frank J. Keeley (see Keeley slide collection under slides.)

The instrument is constructed of blackened cast iron with nickel plated fittings. It has a square base, a hand wheel, an automatic feeding mechanism comprising a micrometer screw driven by a ratchet wheel and steel pawl, a specimen holder block, and a knife holder with two clamps for gripping the knife blade. The drive wheel has a wooden handle. This microtome is labeled "BAUSCH AND LOMB OPTICAL CO., ROCHESTER, N.Y., MADE FOR ARTHUR H. THOMAS CO., PHILADELPHIA, PA., No. 6325." A wheel is stamped "Pat. July 26. 04."

Spencer Minot-Pattern Rotary Microtome, Model 815



The Spencer Lens Company was founded by Herbert R. Spencer (1849-1900) in 1895. The company was the continuation of the firm established in the 1840s by his father, Charles A. Spencer (1813-1881), who was one of the first American microscope makers. In 1935, it was bought by the American Optical Company. The microtomes made by the Spencer Lens Company and American Optical were probably the most popular and successful microtomes. Every histologist of the twentieth century was familiar with the black Spencer rotary microtomes. This model differs little from the original Minot microtome.

This microtome is another example of the Minot rotary automatic microtome. This is model 815. The instrument is constructed of blackened cast iron finished in black enamel with nickel-plated knobs and levers. It has a square base, a hand wheel, an automatic feed mechanism comprising a micrometer screw driven by a ratchet wheel and steel pawl, a specimen holder block, and a knife holder. Any thickness may be cut in multiples of two microns up to 40 microns. The object holder moves on a vertical slide actuated by a crank on the drive wheel. It bears a metal tag with Spencer Lens Co., Buffalo, N. Y., USA. It cost $175.

Interestingly, all of the types of microtomes in this collection, the hand microtome, bench microtome, table microtome, rocking microtome, sliding microtome, and rotary microtome, are still manufactured today. This attests to their good design and functionality.

Wiebach & Pietzsch Lever Microtome, c1895

This is an automatic lever microtome for paraffin sectioning. It was sold by Edward Pennock who ran a scientific instrument company and previously worked for Queen & Company. The microtome is a modification of a microtome designed by John Adams Ryder in 1887. Ryder was a professor of Histology and Embryology in the School of Biology of the University of Pennsylvania. He designed a relatively simple and inexpensive microtome meant primarily for the use of students. The main casting is formed of cast iron with black lacquer finish. The rest of the instrument is nickel-plated brass. The central lever can be lifted by the ring at the end near the specimen holder to drive the ratchet and ratchet wheel. The instrument is stored inside an oak case with a handle and a celluloid label for Edward Pennock, Philadelphia. The case is 6 1⁄4 x 10 x 8 1⁄16 inches.

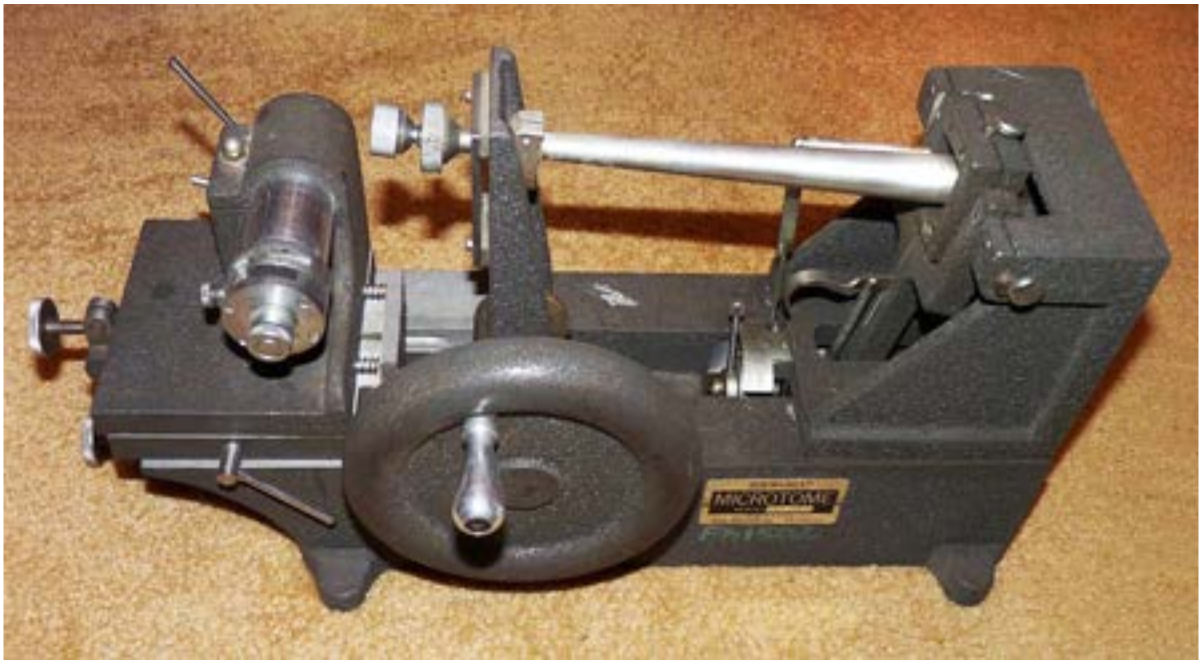
Bausch and Lomb/Arthur H. Thomas Sliding Microtome, 1905

This sliding microtome is labeled Bausch & Lomb Optical Co. and Arthur H. Thomas Co., No. 4411. A label on the case says "From Edward Pennock, Optical and Other Scientific Instruments, Philadelphia." This type of microtome was brought out by Bausch & Lomb around 1885 and this example was made circa 1905. It is called a student microtome by B & L. The microtome has a screw rise for the object and a knife attached to a sled or sledge which slides in a V-shaped groove to pass the knife through the object which is held in a clamp. The microtome could be used for making frozen sections and there is a copper pan for catching any drops of water. A related microtome is the sledge microtome in which the object is attached to the sled and the knife is fixed. The microtome is accompanied by a booklet *Use and Care of Bausch & Lomb Microtomes*. The booklet has instruction for use of the sliding microtome and the Bausch &Lomb Minot rotary microtome.

Spencer Sliding Microtome, Model 860

This is a Spencer, heavy-duty precision sliding microtome, model 860, manufactured for use in hospitals and research laboratories. It is designed to cut sections of bone, wood, frozen celloidin, and paraffin preparations. The knife block slides on a horizontal surface on top of the main casting. There is a knife holder, an object clamp, and a circular feed mechanism. The thickness of specimen sections can be adjusted from 1 to 40 microns using the automatic advance mechanism. The entire apparatus sits on a rectangular hardwood base. It is signed on a metal label on the base "SPENCER LENS CO., BUFFALO N.Y., U.S.A." The serial number is 10328. There are two microtome knives in wooden cases. The microtome weighs 60 pounds. Dimensions (H x W x D): 33.5 x 54 x 29 cm (13 3/16 x 21 1/4 x 11 7/16 in.) The instrument is in very fine condition and dates to before 1945. Donated by James B. McCormick.

Ivan Sorvall Servall Microtome, 1953



Ivan Sorvall Servall Microtome, 1953, the First Ultramicrotome

Several advancements made the observation of cells at the subcellular level with the electron microscope possible. These included the development of methacrylate as an embedding medium, the use of glass knives for sectioning, buffered osmium tetroxide for fixation, and the development of a microtome capable of producing extremely thin sections. This microtome is an early example of one of the most important scientific instruments of the twentieth century. It allowed the making of ultrathin sections of tissues that could be examined with the electron microscope thereby revealing the subcellular structure of cells. Development of a suitable ultramicrotome was achieved in 1953 by Keith Porter and Josef Blum, the head instrument designer at the Rockefeller Institute. The experimental or prototype model incorporated a horizontal steel bar, which was suspended in a gimbel at one end and held the specimen in a chuck at the other. The specimen was advanced toward the knife by thermal expansion of the horizontal rod. The heat was supplied by a 60 watt bulb in a goose-neck reading lamp. This was followed shortly by a derived and improved model that was similar but used a mechanical advance that could move the specimen at increments of 0.025μ. This microtome is an early example of the improved model and was the first commercially available ultramicrotome. It was manufactured by Ivan Sorvall as the Servall microtome. It bears the label Servall Microtome, Serial 140, Ivan Sorvall, inc., New York, U.S.A. This model was later provided with a cover and was known as the Porter-Blum MT-1 microtome.

Porter-Blum MT-1 Ultramicrotome

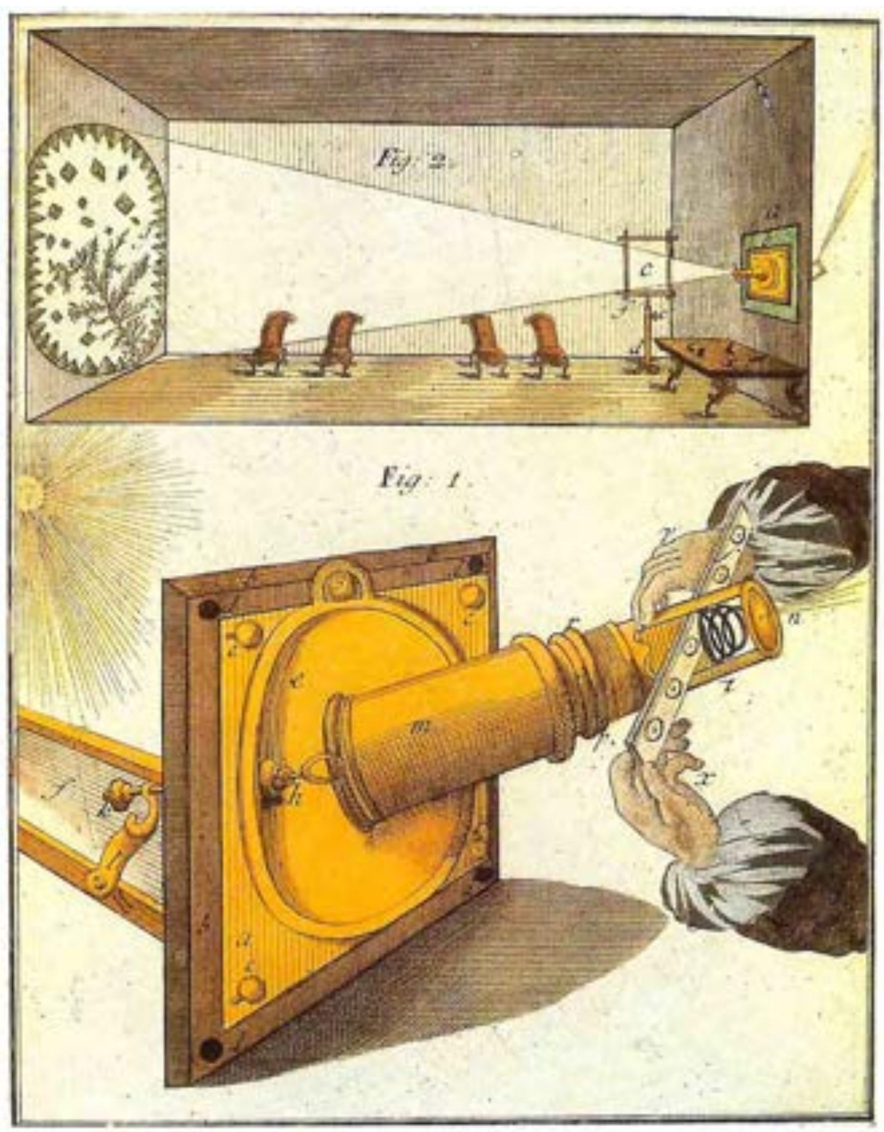
Improvements were made to the Sorvall Servall microtome which became known as the Porter-Blum MT-1 microtome. This is a fine example of the Porter-Blum MT-1 microtome. It was manufactured by Ivan Sorvall Inc., Norwalk Conn. The microtome is completely encased and has a fluorescent lamp. It has a mechanical advance and the typical thickness of sections is between 40 and 100 nm for transmission electron microscopy. This microtome includes the accessory stand for a Bausch and Lomb binocular stereomicroscope. The accessory stand has a base to hold the microtome, a pillar holding an arm which holds the stereomicroscope for viewing the sectioning. Most electron microscopists of the twentieth century used this microtome because of its simplicity and reliability.

Projection Instruments

The desire to project images is universal and ancient. It probably began in prehistoric times with the casting of shadow finger images on the walls of caves using fire as the source of light. The precursor of instruments used to project images is the camera obscura. The first instrument used to project microscopic images was the solar microscope.

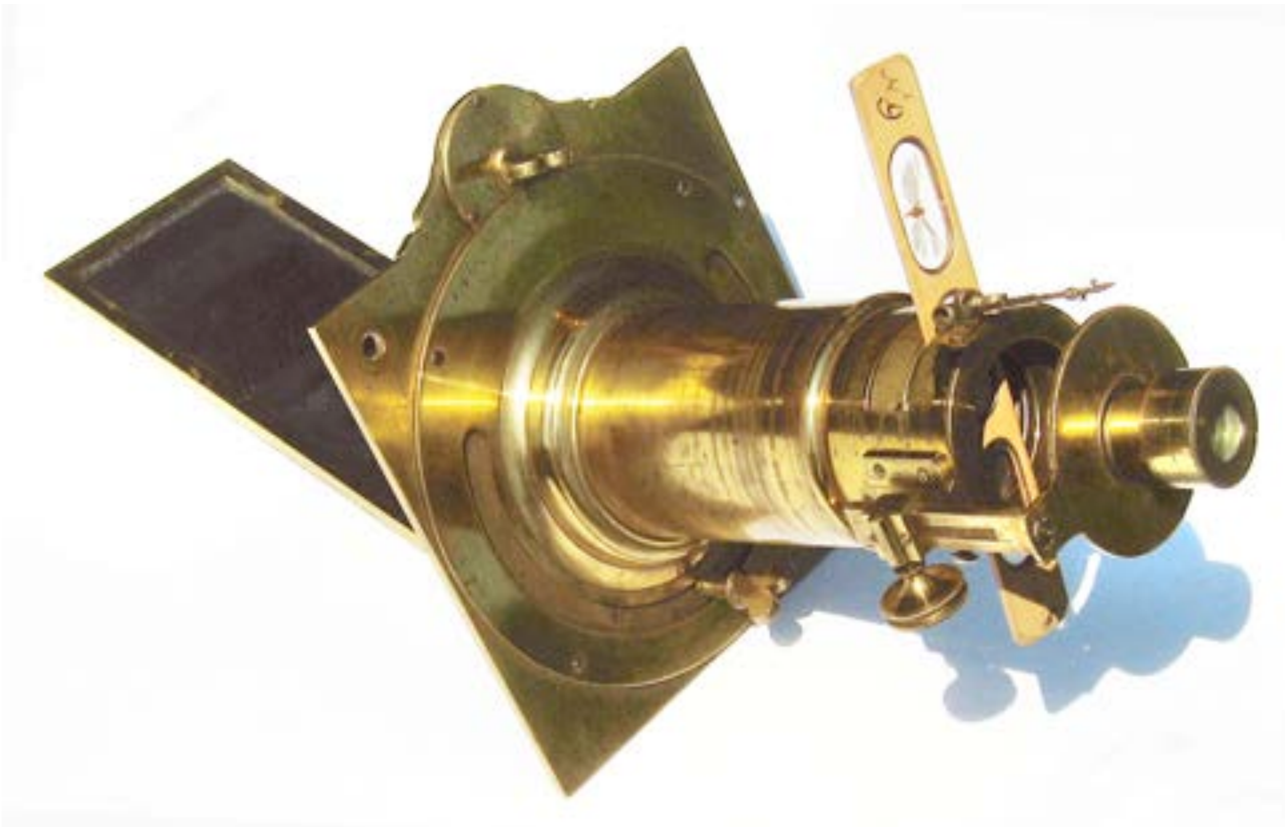
Solar Microscope, c1772

The solar microscope is a projection microscope. It differs little from the projection microscopes of the early twentieth century except that the source of illumination is the sun instead of a carbon-arc magic lantern or lamp. The forerunners of the solar microscope are the camera obscura, scioptic ball, and the magic lantern. A simple screw-barrel microscope could be attached to a scioptic ball fitted into a window shutter. By adding a mirror to the scioptic ball to collect sunlight, the solar microscope was formed. The definitive solar microscope was made by John Cuff around 1740 but was copied by other London instrument makers in the eighteenth century. In Cuff's microscope, the microscope tube was fixed and the mirror was moveable so as to be able to follow the sun.



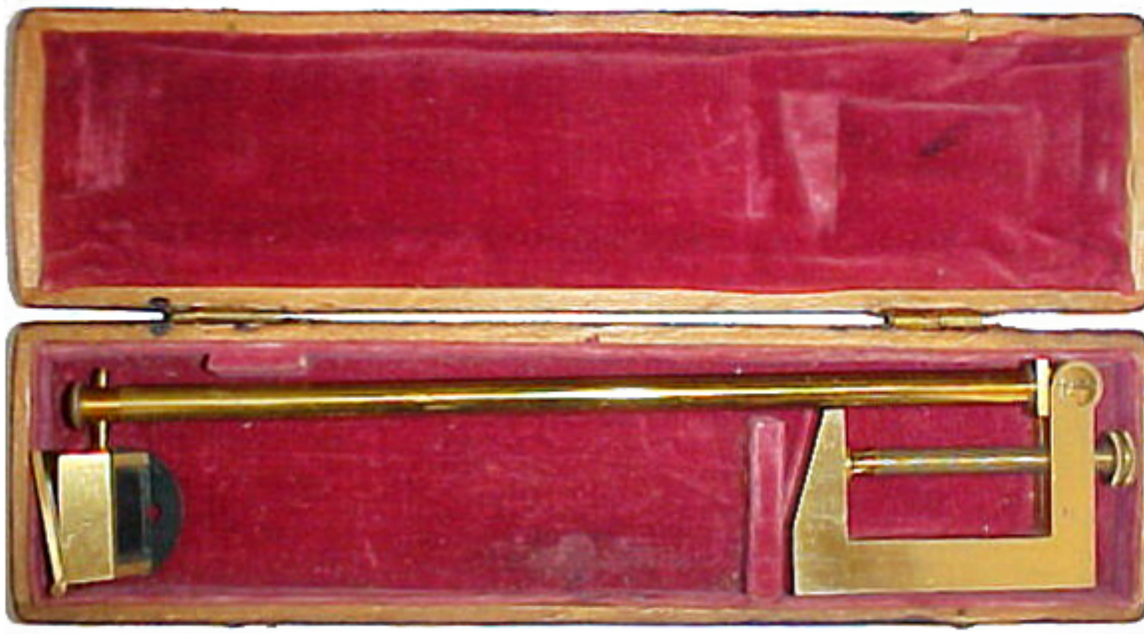
A plate from M. F. Ledermüller *Nachleese seiner Mikroskopischen Gemüthe- und Augen-Ergötzung* (Nürnberg, 1762) shows how the solar microscope was used. The microscope was attached by a plate to a window shutter with the mirror outside to reflect sunlight into the microscope. The light passes through an object in a slider and the image is magnified by a screw-barrel microscope and projected onto the opposite side of the room. A drawing of the image could be made by placing a paper on the screen standing in the corner. The solar microscope seems to have been used mainly in exhibitions for the amusement of the public, and less for educational or scientific purposes.

This solar microscope is unsigned. It has its original mahogany fitted case. It is a substantial instrument. The mirror framed in brass is 3 5⁄8"wide x 9 ¾" long. The heavy brass plate is 6 ¾" square. The mirror is inclined by an "endless screw" and rotated by a Cuff-type rack and pinion. A condenser tube, 2 ¾ " in diameter and 4 ½ " long, screws into the plate. A 3" long Bonani-type spring stage with rack and pinion screws into the tube. There are six eye lenses that screw into the end of the spring stage. The microscope is in excellent condition with much of its original lacquer finish remaining. A handwritten list of the contents of the box is dated 1 March 72.

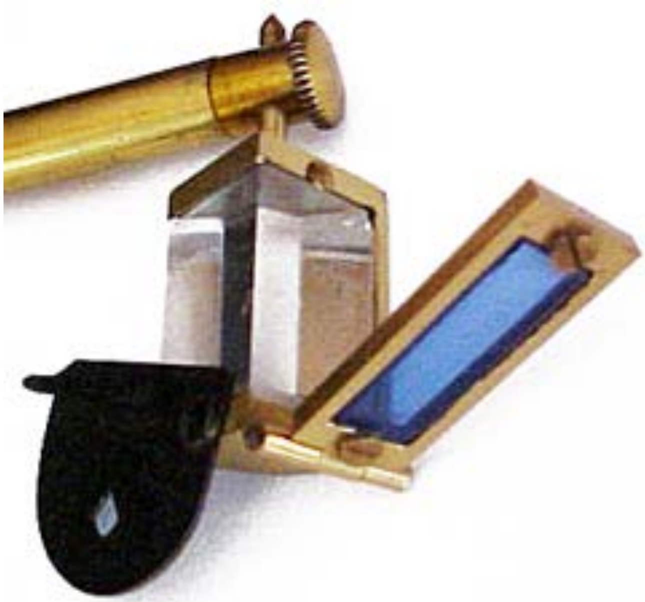


The case has a fitted drawer with a very fine collection of 16 ebony, 15 boxwood, and 11 glass sliders. These sliders are much larger than those used with the conventional microscope. The glass sliders are ½″ x 5″ (only one with specimen). The ebony sliders are ¾″ x 6″ (some specimens missing). The boxwood sliders are 7⁄8″ x 7″ (all specimens present). Most of the specimens are minerals, plants, insects, and wings of insects.

Cary Camera Lucida, c1810.

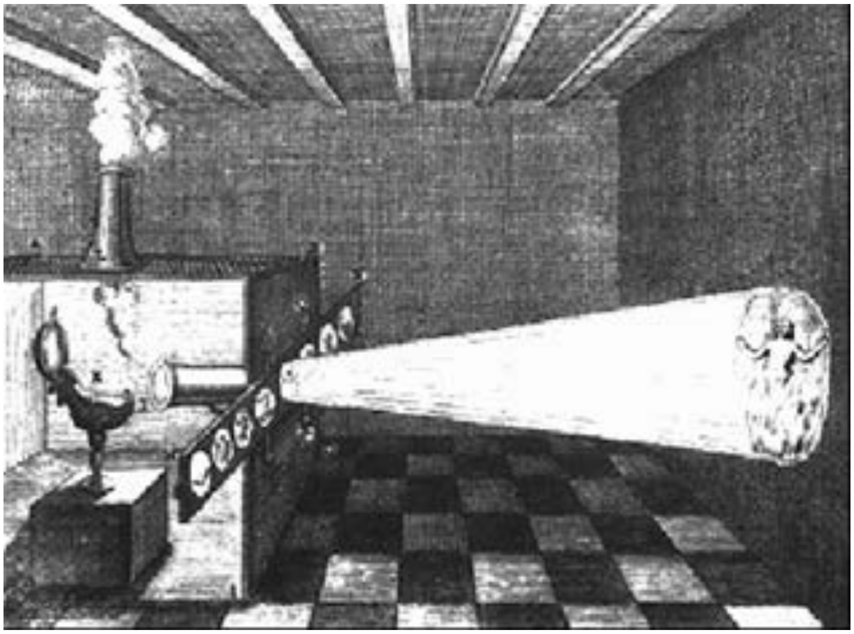


The camera lucida is an optical device that by means of a prism allows an artist or scientist to see both the subject and a transparent image of the subject reflected onto a paper or canvas, so that the image can be traced; thus, making an accurate drawing of the subject. A camera lucida can also be used with a microscope. In the nineteenth century, before photomicroscopy, most illustrations of cells and tissues were drawings made with a camera lucida. The concept of the camera lucida was first recorded by the German Scientist Johannes Kepler in his *Dioptrice* (1611). Kepler's description apparently fell into oblivion and the camera lucida was rediscovered and patented by William Hyde Wollaston (1766 -1828) in 1807. Wollaston called the device a camera lucida, light room in Latin, as opposed to camera obscura or dark room. Wollaston was an English chemist and physicist who is famous for discovering palladium and rhodium and for developing a method to process platinum ore among many other important scientific discoveries.



This is a brass camera lucida signed Cary London. It consists of a telescoping column with a clamp at one end and at the other a unit with the prism, blue folding filter, and light reducing black metal shade. The sharkskin case lined by red velvet measures 8 ¾ x 2 ⅜ x ¾ inches. The instrument is in exceptional condition and seems to have received little, if any, use. The construction is very early and probably shortly after the Wollaston patent of 1807.

Magic Lantern



The magic lantern is the precursor of the modern slide projector. The first projection lantern is shown in 1420 in *Bellicorum Instrumentorum Liber* by a Venetian engineer, Giovanni de Fontana. The illustration in the book shows a man holding a lamp or lantern with a transparent image of the devil on its side, and on the wall is a large projected picture of the devil. In later years, several individuals, including Italian scholar, polymath and playwright Giovanni Baptista della Porta (1589), polymath Jesuit scholar Athnasius Kircher (1646), Dutch Physicist Christiaan Huygens (1659), and the Danish mathematician Thomas Rasmussen Walgensten (1660), and others, improved the magic lantern. Walgensten was the first person to use the term "Laterna Magica" and to travel in Europe giving shows.

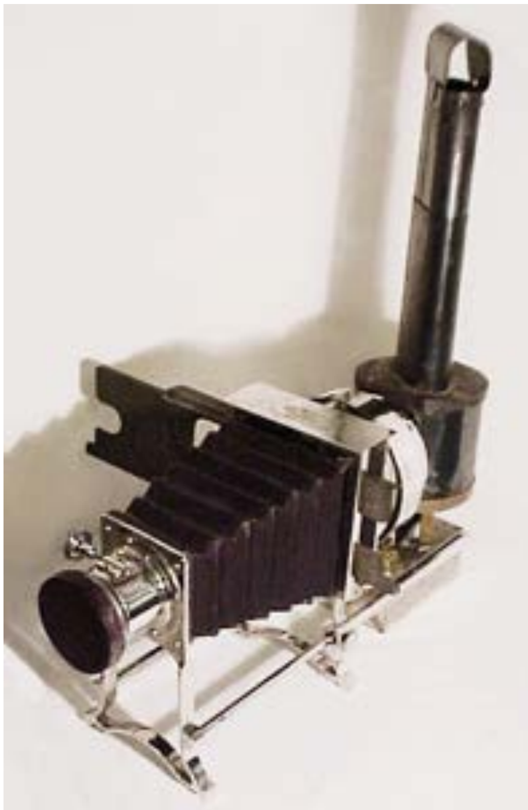
Kircher published *Ars Magna Lucis et Umbrae* (The Great Art of Light and Shadow) in 1646, in which he described arrangements to project using candle light or sunlight from a mirror and using a convex lens as an objective to focus the images. In the 1671 edition, he illustrated a magic lantern that has no projection lens. The illustration above shows a smoking oil lamp and projected images from handpainted glass slides onto a screen.

In its early development, the magic lantern was mostly used by magicians and conjurers to project images, making them appear or disappear, transform from one scene into a different scene, animate normally inanimate objects, or even create the belief of bringing the dead back to life. In the late eighteenth century several showmen used the lantern to produce horror shows. These were known as "Phantasmagoria" shows. A variety of horrific images were projected to frighten the audience, examples being ghosts projected on smoke to give a frightening appearance and images that would move around the walls.

The original sources of light were candles and oil lamps which were quite inefficient. The invention of the Argand lamp in 1780 helped to make the projected images brighter. Further improvements in light sources in the nineteenth century brought changes in the style of shows. Limelight, produced by burning oxygen and hydrogen on a pellet of lime, provided much better illumination and began to be used around 1830. It was followed in the 1880s by the carbon arc lamp. The improvements in illumination made it possible for the projectionist to create huge images and elaborate effects using multiple lanterns and double and triple lens projectors in front of large audiences. Simpler types of lantern were also improved with the introduction of the kerosene lamp. This allowed people to present shows in small halls and churches and in the home.

McAllister Magic Lantern, 1886

The magic lantern was not used extensively for educational purposes until the second half of the nineteenth century. In the middle of the century, the photographic positive on a glass plate was developed. These plates could be projected onto a screen or wall from a magic lantern which later became known as a lantern slide projector.



This magic lantern bears the labels "T. H. McALLISTER, M'F'G OPTICIAN, NEW YORK" and "PATD APRIL 6TH 1886." Thomas H. McAllister (1824-1898) established a scientific supply house in New York around 1866. He manufactured and supplied microscopes, magic lanterns, lantern slides, microscope slides, and other optical and scientific equipment. The firm went out of business in the 1890s. The metal of the projector is nickel-plated. The burner for this projector is an oil lamp and is built into the projector. There are two wicks each two inches wide and the back of the lamp housing is polished metal. The lantern is 20 inches long with the bellows extended and the chimney is 21 inches high. The slide holder takes 3¼ x 3¼ inch slides. The lantern fits compactly into a tin case with a handle. It is in exceptional condition and seems to have received little use. Although the light source is a lamp, such a projector with dual wicks, a reflector, and large condenser lens is quite effective in a dark room. The projector represents the culmination of 250 years of development of oil lamp-illuminated magic lanterns. It was replaced by the carbon arc and electric light lantern slide projectors.

McAllister Magic Lantern

Baird Magic Lantern, c1890

This is a large wooden magic lantern that would have been used to project images in theaters and classrooms in the latter part of the nineteenth century and early twentieth century. The lamp housing and base are made of mahogany. The base is 12 x 22 inches with a pull out extending the length another 15 inches. The lamp housing is 12 x 12 inches and 20 inches high to the top of the chimney. The wooden lamp housing contains a metal box with a space between the metal and wood sides. The metal box dissipates the heat of the lamp and allows the lantern to have a wooden body and not catch on fire. The light source is a carbon arc lamp that fits into a slot in the base of the inner metal lamp housing. The lamp unit is made by Ross, London and is marked "B Eclipse Patent Arc Lamp No 497". It is unusual for lanterns of this period to have the original arc lamp as most arc lamps were replaced with incandescent lighting when it became available. There is a pair of condenser lenses, holder for 3 ¼ x 3 ¼ inch lantern slides, and a brass lens assembly. The lens assembly has two slots, one for a filter and one for a slide. There is a velvet curtain at the back of the lamp housing that the projectionist would have thrown over his head while adjusting the carbons. During a slide show, the carbon rods burned and had to be brought into proximity periodically.

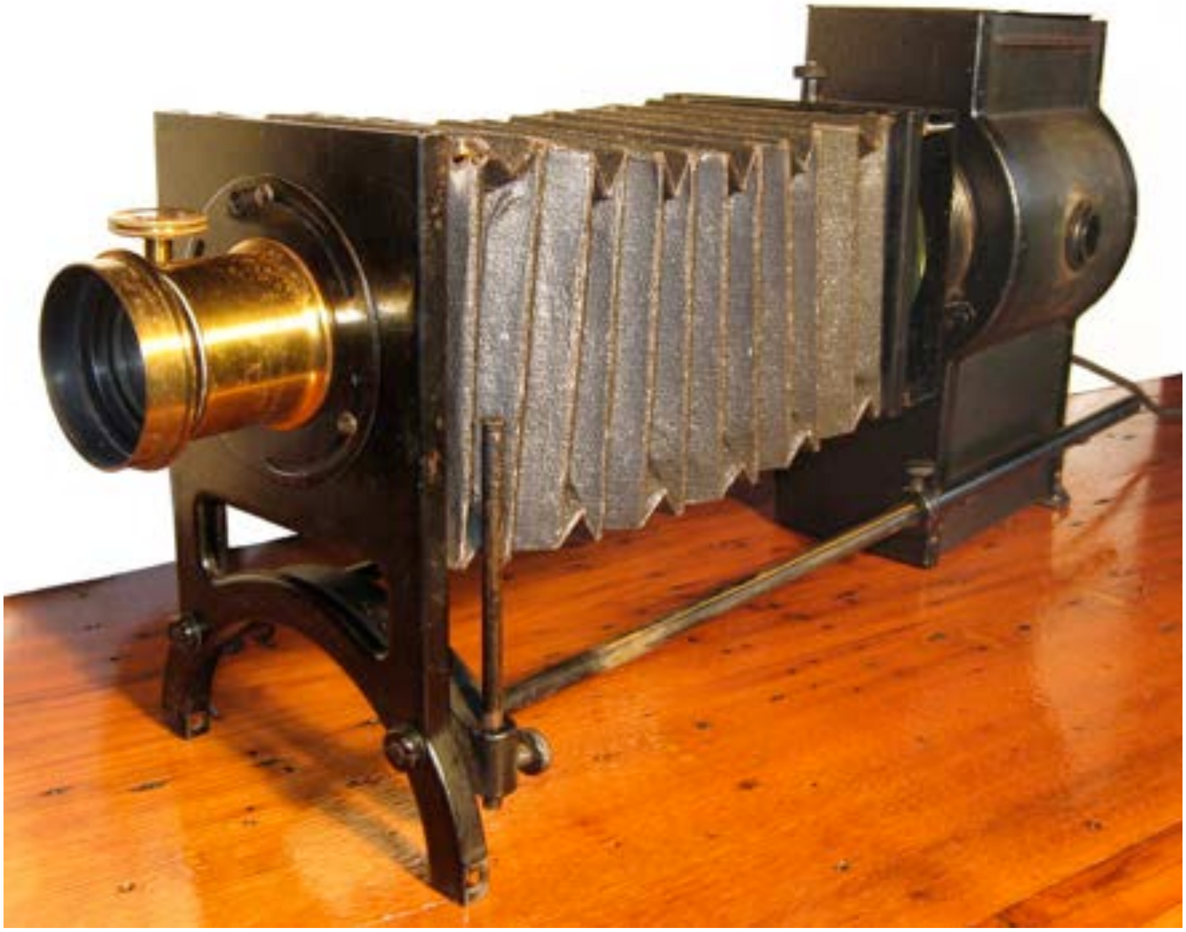
The lantern is labeled "A. H. Baird Scientific Instrument Maker Edinburgh." Andrew H. Baird was a major manufacturer of high quality magic lanterns and all types of photographic equipment including cameras from c1890 to 1937.

Ernst Plank Magic Lantern

Magic lanterns (Laterna Magica) are used to project transparent images onto a wall or screen. The practice of projecting images from glass plates began centuries before the invention of photography. As early as the seventeenth century, the magic lantern was used to project painted images on glass for children's picture shows, religious displays, and for phantasmagoria shows. In the nineteenth century, lantern slides were increasingly used for educational purposes. The first projectors used oil lamps for light. By the mid nineteenth century, limelight, produced by burning oxygen and hydrogen on a pellet of lime, offered a better, although more dangerous, form of illumination. In the 1880s, the invention of the carbon arc lamp, followed by electric light, provided a safe method for displaying the lantern slide image. In the nineteenth century, the kerosene lamp allowed people to present shows in small halls and churches and in the home. Slide projectors replaced magic lanterns in the 20th century.

This is a small magic lantern that was used in the home primarily for the amusement of children. It measures 6 ½ x 3 x 8 inches. These were very popular in the second half of the 19th century and first part of the 20th. The lantern is marked "EP" for Ernst Plank. Ernst Plank was a German manufacturing company founded in 1866. The company initially built toy steam engines and magic lanterns at Hochfederstrasse 40 in Nuremberg. This model is known as the "Climax" or "Brilliant M.L." and was made in 1898. It has a red lacquered spherical tinplate body and uses a kerosene lamp for the light source. The lantern has its original box that has a picture of a magic lantern being used on the top. Instructions in German, French, and English are pasted on the inside of one side of the box. There are 12 lantern slide strips. The 1 ⅛ x 4 ⅛ inch slides have a variety of subjects for children. Each slide has five scenes that can be shown successively.

Plank Magic Lantern
Bausch & Lomb Model C Balopticon Lantern Slide Projector c1910



The Bausch and Lomb Balopticon was the utilitarian standard for lantern slide projectors in the first part of the twentieth century. The projector consists of a base with feet and horizontal sliding rods, slide carrier, lamp housing, and bellows. The light source in this early model was originally a carbon arc. The brass lens with rack and pinion focusing is marked Bausch & Lomb Optical Co., Rochester, N. Y. The round windows on the sides of the light housing were for viewing the position of the carbons. The arc was replaced with incandescent lighting at an early date.

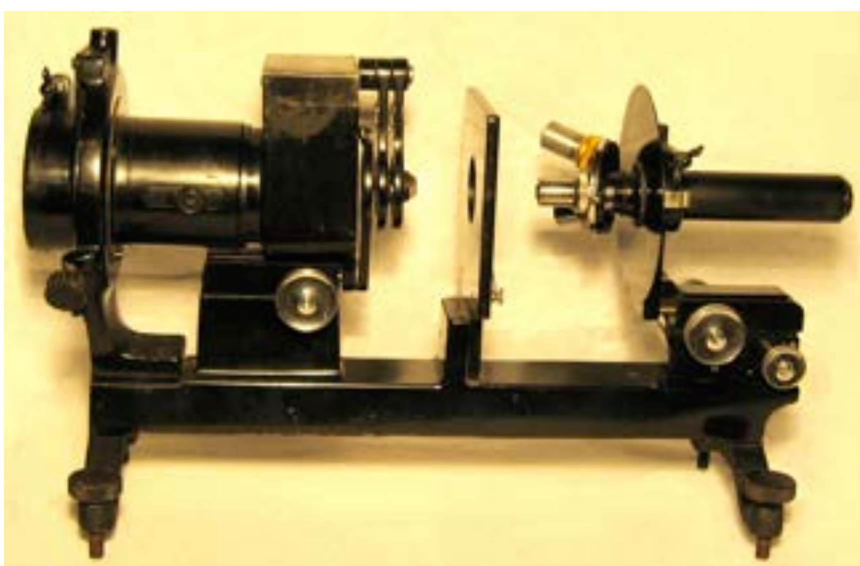
Projection Microscope, Williams, Brown & Earle, c1900

The projection microscope projects the image of a slide onto a screen. This well-engineered instrument is signed Williams, Brown and Earle, Philadelphia on the barrel. This firm was established in 1885. H. S. Williams and N. H. Brown previously worked for James W. Queen & Company. The microscope is in exceptional condition and housed in a very fine case. Front and rear footed standards hold two horizontal rods along which the microscope can slide. The brass body tube focuses by rack and pinion. There are two objectives, one marked 32 & 14 MM and the other marked Williams Brown & Earle, Phila. Pa. U.S.A., 1-12 Homog. Imm. 1.35 N.A. in a matching brass canister. There are two stages. One has a circle of stops, a mechanical stage, and a condenser. The other has a circle of stops and attaches to a ring that fits around the lens piece of a magic lantern. The projection microscope can be attached to the Balopticon lantern slide projector in this collection and is fully functional.

Williams, Brown & Earle Projection Microscope

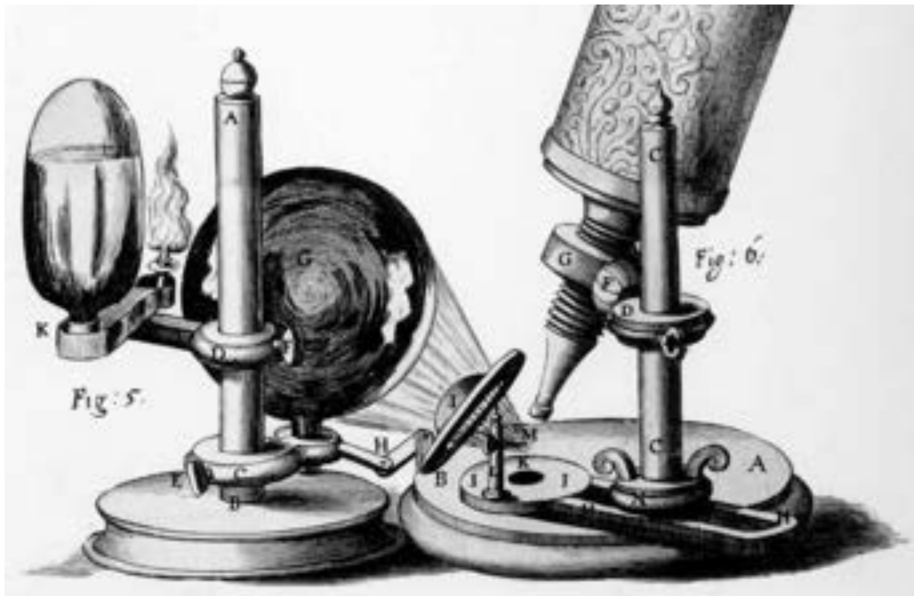
Projection Microscope, Bausch & Lomb

The projector consists of a heavy base carrying an illuminating unit support, stage, and microscope moveable by rack and pinion. A magic lantern or carbon arc lamp served as the source of illumination. A rectangular box behind the condensers held a glass container (missing) that was filled with water to cool the beam of light before it struck the specimen. Three swinging condenser lenses are behind the stage. The microscope has three objectives and an eyepiece.



Lighting Devices

A limitation in the use of early microscopes was the lack of a suitable light source. The early tripod microscopes were simply held up to the sun. One of the earliest illumination devices was designed by Robert Hooke and illustrated in his *Micrographia* in 1665. This consisted of an oil lamp, a glass sphere filled with water, and a bulls eye condensing lens. The sphere and condenser served to focus the light from the lamp onto the specimen. The device must have been effective, judging from the fine detail seen in Hooke's drawings.



Hooke's Illuminating Device, from *Micrographia*, 1665

Hooke-type Illuminating Lamp and Martin Universal Microscope

This is a replica of an illuminating device similar to that of Hooke's. It is made of brass and is 11 ¼ inches tall. It consists of an upright post supported by a base with three legs and having a horizontal arm. Another upright with a candle holder screws into one end of the arm. The candle holder can be slid up or down on this upright. The other side of the arm has a recess to hold the globe and at the end an articulating arm holding a bulls eye condenser on a gimbal. The glass globe is 3 ½ inches in diameter and has an opening for filling with water. The words "1985, Director's Club, Ron Visintine, Litchfield, IL" are etched on the side of the globe. There is a small metal tag with "Made in Italy." It is in excellent condition. Although a replica, it is a fine educational device.

Microscope Lamps

Candle lamp

Bockett kerosene microscope lamp

Kerosene microscope lamp

Candles were used early on and were made into lamps by placing a condenser or prism in front of the flame. The brass candle lamp is nine inches high and stamped R&MB Sweden. By the nineteenth century, oil and kerosene lamps were developed that provided adequate illumination. The Bockett microscope lamp has a brass base and an upright rod to hold the lamp and a condenser lens that focused the light from the lamp onto the mirror of the microscope. A chimney fits on top of the lamp. Collins of London manufactured these lamps between 1866 and 1900. Another kerosene lamp is 10 ½ inches tall minimum, with separately adjustable height of the assembly and of the porcelain shade. Electric lamps replaced kerosene lamps in the early twentieth century.

Brass Lamp, No 237, 1909

Candle Holder and Shade, c1820

Candle holder and shade

This is an early nineteenth century brass candle holder and shade. It consists of a folding base, telescoping stand, candle holder, and fan. Light from the candle is focused onto the specimen by a condenser on the microscope stage or on a stand. The cloth shade is positioned to protect the user from the glare of the flame. Assembled, the unit is 20 inches high. It folds into a red Moroccan leather case. Cosmetically the set is in good condition with some wear to the lacquer. The fan has a few small splits and the cord used to keep the center tight is loose. The case is good with some minor scuffing.

Bausch & Lomb Mechanical Arc Lamp

The carbon arc was used at the end of the nineteenth century and beginning of the twentieth as a light source for magic lanterns and lamps for projection microscopes. Even after incandescent light bulbs became available, carbon arcs continued to be used because they were brighter. This lamp was manufactured by Bausch & Lomb. The box on the side contains a clock mechanism that automatically ad-vances the two carbons as they burn. The clock is wound by the key on the side. A patent for this mechanism was applied for by Allan F. Martin in 1925 and granted in 1931. A copy of the patent appli-cation is included. The round windows on the sides are for viewing the carbons and admitting air.

Carbon arc lamp

Other Accessories

Slider Holder

This slider holder is a rare and unusual microscope accessory. It is a brass channel just over six inches long and ¾ inch wide and equipped with a long spring. The inside of the channel has been painted matt black and inscribed "To hold the Ebony Sliders with Opake Objects." Condition is very good with virtually all the external lacquering present.

Slide Ringing Table

The slide ringing table was used for various tasks in the construction and finishing of microscope slides, but primarily for placing ringing cements around the circular cover slips to seal and finish them. A slide is held on the round brass stage by the slide clips. Circles engraved in the center of the brass plate help center the slide. The stage is spun and while it is turning a paint/asphalt ring is applied on the edge of the coverslip with a brush. The wooden base functions as a hand and brush support. Ringing was widely used in the second half of the nineteenth century but began to go out of favor in the twentieth century even though ringed slides seem to stand the test of time better than those without rings.

Stage Forceps

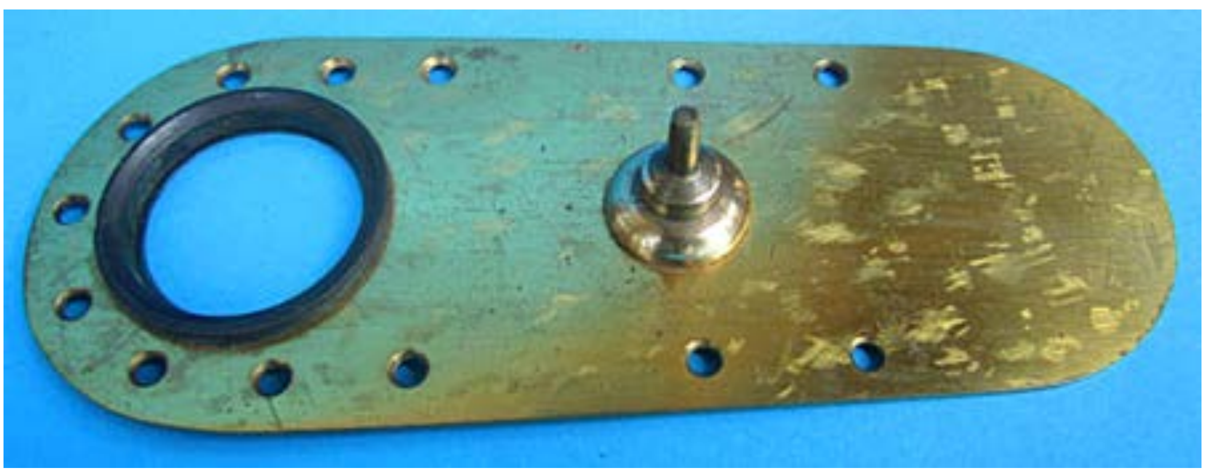
The stage forceps was used for holding small objects for observation under the microscope. The stem is held by a ball joint with a pin that fits into a hole on the edge of the stage. One end of the stem has two blades which can be tightened by a screw for holding an object such as a fly wing or flower petal. The stem can be turned, rotated, or moved forward or backward for precise positioning of the object under the objective. The other end of the stem has a small cylinder holding cork and perforated with holes on its side. Pins holding objects such as insects can be attached to the cork.

Aquatic Box

The aquatic box or animalcule cage was used for examining small organisms in pond water. It consists of a brass cylinder with glass at one end mounted over an opening in a brass plate. A second cylinder with glass at one end fits over the first cylinder. A drop of water is placed on the glass of the inner cylinder and the outer cylinder is pressed down over the water causing it to spread out. The box is placed under the objective for observation.

Fish Plate

A fish plate is a device for strapping down a small fish so that the blood circulation in the tail fin can be observed, thus repeating Marcello Malpighi's microscopical discovery of capillaries in 1661. A ribbon is passed through the holes around the edge and used to tie down the fish. The tail is placed over the glass circle. There is a pin on the bottom allowing the plate to be inserted onto the microscope stage. The fish plate is brass and four inches long and two inches wide. John Marshall introduced the fish plate on his Great Double Microscope at the end of the seventeenth century. It became a standard microscope accessory for nearly 200 years. c1850.



Compressorium

A compressorium is an instrument by which objects under observation can be gradually compressed between two parallel plates of glass to immobilize them or make them thin enough for light to pass through. It is 1 x 3 inches in size. A screw lowers the upper plate onto the base. c1875.

Livebox

A livebox, very similar to the aquatic box, is a compartment for holding a living organism such as an insect for viewing with a microscope. This brass livebox is 30 x 55 mm. The top can be pushed down to restrict the specimen's movement.

Compressorium

Livebox

Microscope filters are used in a variety of microscopy applications for increasing contrast, blocking ambient light, removing harmful ultraviolet or infrared light, or for selectively transmitting only wanted wavelengths. They are typically placed in the light path, either over the illuminator or in a filter slot that lies in the light path.

Microscope filters

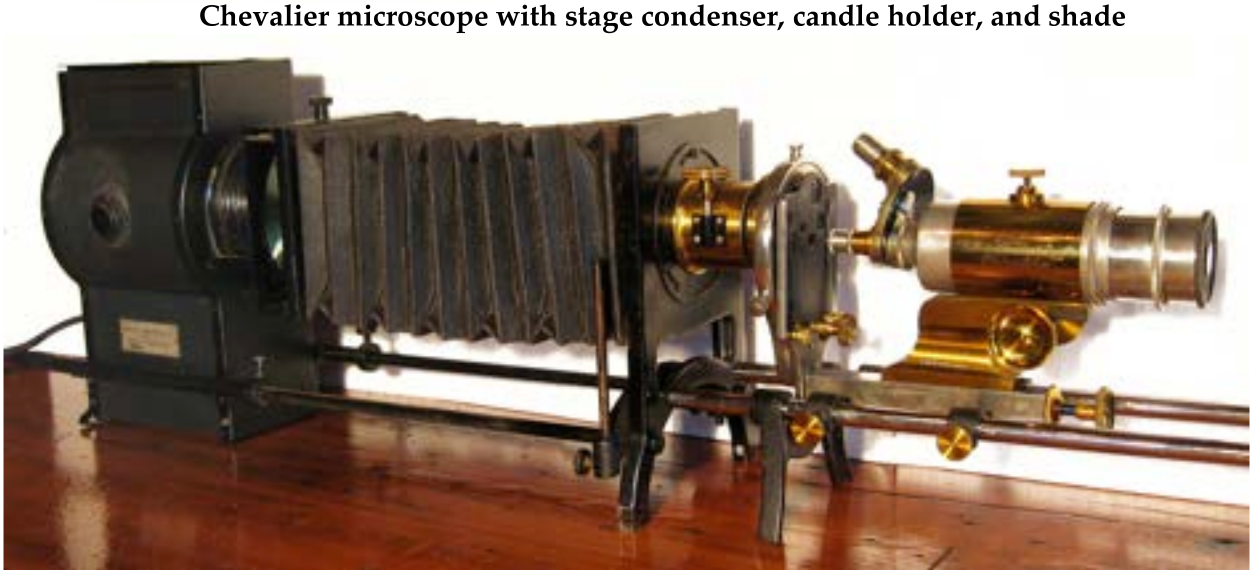
Shillaber's Immersion Oil

Shillaber's Immersion Oil, $n_D = 1.5150$, Made for Bausch & Lomb Optical Co. Immersion oil with a refractive index close to that of glass, placed between the glass slide and objective lens, allows light rays to pass through the glass-oil interface without deviation due to refraction. c1920.

Nineteenth Century Microscope Setups

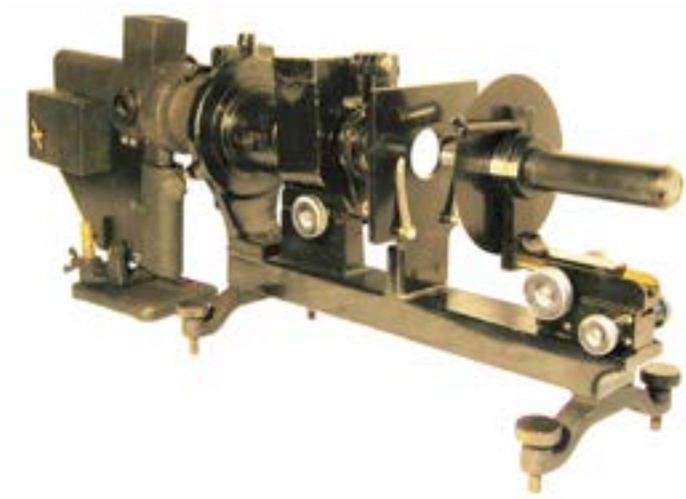
This is an early nineteenth century brass candle holder and shade. It consists of a folding base, telescoping stand, candle holder, and fan. Light from the candle is focused onto the specimen by the condenser on the stage of the microscope. The cloth shade would be positioned to protect the user from the glare of the flame.

Chevalier microscope with stage condenser, candle holder, and shade



Balopticon lantern slide projector and Williams, Brown & Earle projection microscope

The projection microscope projects the image of a slide onto a screen. This well-engineered instrument is signed Williams, Brown and Earle, Philadelphia on the barrel. This firm was established in 1885. The Balopticon lantern slide projector serves as the light source.



Bausch & Lomb carbon arc lamp and projection microscope

Microscope Oil Lamp, B & L Universal Microscope, Microscope Table

A Bausch & Lomb Universal microscope stands on a microscope table. Microscope tables are low, have a heavy iron base for support, and an easily cleaned hard surface. The Bockett microscope lamp, Collins London, c1875, burns kerosene and has a condenser to focus light onto the mirror. It is nearly as effective as an electric lamp.

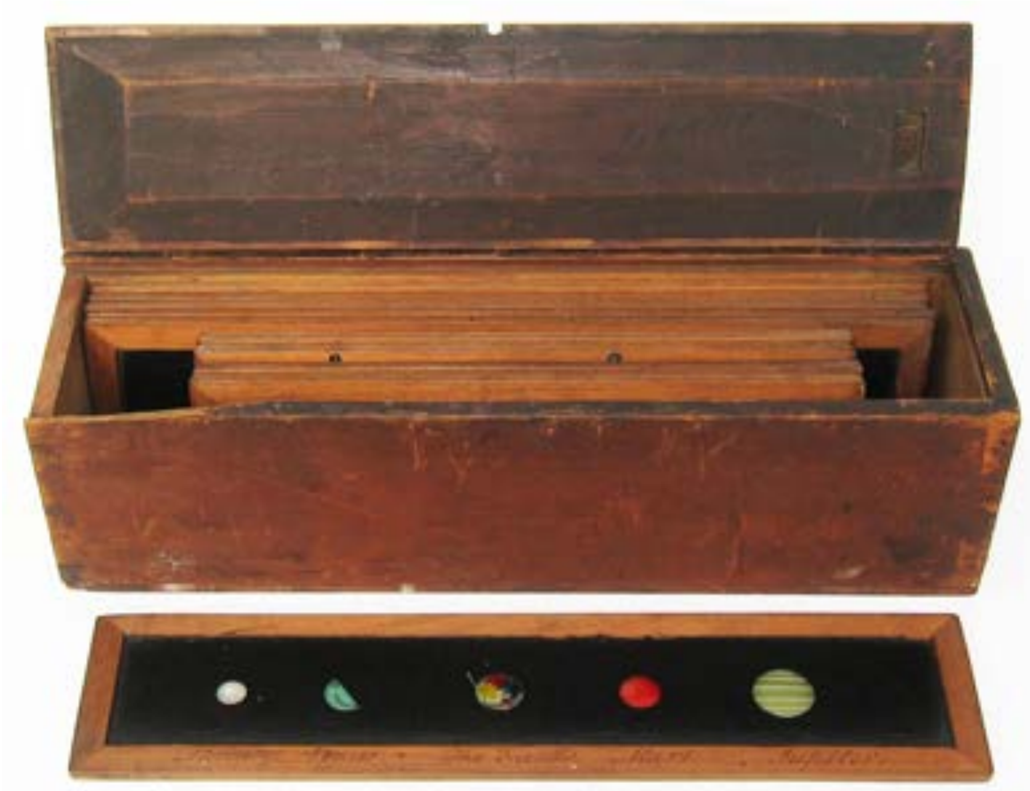
Lantern Slides

Carpenter Astronomy Lantern Slides, c1825

Lantern slides are positive images on glass that are intended to be projected for viewing. Many early slides are individual, hand-painted works. The finished product was placed within a lantern slide projector to be viewed on a wall or screen. The first projectors used oil lamps for light. By the mid nineteenth century, limelight, produced by burning oxygen and hydrogen on a pellet of lime, offered a better, although more dangerous, form of illumination. In the 1880s, the invention of the carbon arc lamp, followed by electric light, provided a safe method for displaying the lantern slide image.

The practice of projecting images from glass plates began centuries before the invention of photography. As early as the seventeenth century, the magic lantern was used to project painted images on glass for children's picture shows, religious displays, and for phantasmagoria shows. Astronomical lectures were popular forms of entertainment. The general content of the lectures represented an outline of the astronomical knowledge of the time, couched in non-technical language.

Around 1820, Philip Carpenter (1776-1833) developed a method to mass produce lantern slides using a copper plate printing process. This enabled outline images to be repeatedly printed onto glass and thus create reproducible sets of slides. These outline images could be more easily and quickly hand painted ready for sale. His first set of slides, offered around 1823 was of zoological subjects. Then, sometime in the mid 1820s, he offered a set of astronomical slides that covered all the basic principles demonstrated by the popular lecturers. The set of ten slides included strip slides (each with three or four images), slip slides, and a lever slide showing the rotundity of the earth. A booklet *A Compendium of Astronomy* accompanied the set and states on its title page "A Series of Diagrams exhibited by the improved Phantasmagoria Lantern."



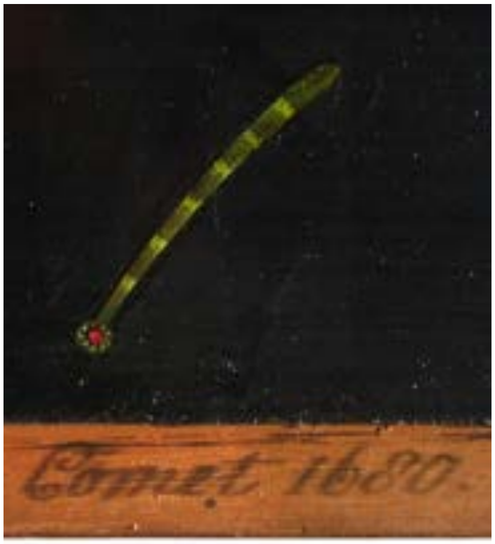
This is a remarkable set of Carpenter's astronomical slides, c1825. The slides are as follows:

Strip slides, 4" x 17"
- Zodiack, Comets Path, Solar System
- Demonstrations of the Sun's Superior Magnitude
- Mercury, Venus, The Earth, Mars, Jupiter
- Saturn, Georgium Sidus [original name of Uranus], Comet 1680 [Newton's Comet], Comet 1811 [The Great Comet of 1811]
- Milky Way, System of Ptolemy and Tycho Brake
- Ursa Major, Orion

Slip slides, 4" x 13 "
- Moon's Eclipse
- Moon [showing waxing and waning phases]
- Sun [showing eclipse]

Lever slide, 4" x 13"
- Tides, Earth's Rotundity. This slide shows an observer standing on the earth with a line of sight to the horizon. A ship is on a second glass disc attached to a lever handle. Raising and lowering the handle causes the ship to disappear or appear over the line of sight.

The slides are housed in their original pine box. The slides are labeled in large black script below the image. Overall, the slides are in excellent condition. One image has slight chipping of paint and another has a scratch. The lever slide has a large triangular section of glass missing not affecting the images.



Philip Carpenter died in 1833 and his sister Mary Carpenter continued the business alongside her husband, Philip's former apprentice William Westley. The company was named "Carpenter and Westley" in 1835 and operated until 1914. The company was highly regarded for its detailed lantern slides. This is a wooden lantern slide of “Lightning” 6 ⅞ x 3 ¾ inches. It is labeled "CARPENTER & WESTLEY, 24 REGENT S^{T}, LONDON" and "J W QUEEN, PHILAD" and dates to c1860.

In the 1840s, Philadelphia daguerreotypists, William and Frederick Langenheim, began experimenting with the magic lantern as an apparatus for displaying their photographic images. Because the opaque nature of the daguerreotype prevented its projection, the brothers looked for a medium that would create a transparent image. They employed the discoveries of the French inventor, Niépce de Saint-Victor, who had discovered a way to adhere a light sensitive solution onto glass for the creation of a negative. By using that negative to print onto another sheet of glass rather than onto paper, the Langenheims were able to create a transparent positive image, suitable for projection. The brothers patented their invention in 1850 and called it a Hyalotype (hyalo is the Greek word for glass). The following year they received a medal at the Crystal Palace Exposition in London.

The Langenheims envisioned their slides as forms of entertainment, charging a fee to watch their picture shows. However, within a few years, lantern slides began to fulfill a variety of purposes. While entertainment remained an important function well into the twentieth century, lantern slides had the greatest impact on educational lectures, especially in visual disciplines. They played a vital role in the development of disciplines such as art and architectural history. They were used in universities for teaching botany, anatomy, histology, and anatomy. In the Yale catalogue of 1886-87 under the description of the course in Normal Histology, it is stated "Lectures illustrated with the lantern are a special feature of the instruction, the transparencies being made from photographs of typical preparations and diagrams."

The painted lantern slide "Daniel in the Lions Den" was made by W. E. and F. Newton. The Newton family was established as globe makers in the 1700s. W. E. & F. Newton was established in 1851 at 3 Fleet Street in London. It became Newton & Co. in 1857. The slide of spectra is possibly by Newton & Co. (see other examples below). This slide is 4 x 7 inches, the standard size in the mid nineteenth century.

Daniel in the Lions Den

Spectra

Mechanical slides were devised to make the images move. One type was the slip slide that consisted of two painted glass slides placed one on top of the other. One slide would remain stationary and the other contained the part of the picture that would move. This c1870 slip slide is 4 x 7 inches in a wooden frame and labeled "166 Bucking Donkey." It shows a woman sitting on a donkey. When the second slide is pulled aside, the donkey is bucking. It is in excellent condition and brightly painted. A second slide shows a bird with her nest of eggs. When the slide is pulled, baby birds appear in the nest.

In a second type of mechanical slide, images are painted on two discs, one of which is moveable. The glass slides are placed one on top of the other in an orderly fashion and a hand-operated wheel is used to turn the movable disc. In this c1870, mahogany framed, humorous mechanical slide by Millikin & Lawley, London, a man is sleeping on a bed with his mouth open. A mouse is on the bed and when the crank is turned, the mouse moves over the bed into the man's mouth. The slide is 4 ½ x 7 inches, brightly colored, and the crank turns freely. Mechanical slides such as this slide were the forerunner of the motion picture.

This is another mechanical lantern slide. The mahogany slide measures 4 x 7 inches and has a brass and wood turned handle. When the handle is turned, a colored pattern changes giving a kaleidoscopic effect. The slide is stamped "J F A" at one end. The slide is in excellent condition and functions perfectly. c1870.

After the middle of the nineteenth century, lantern slides were mounted in a permanent wooden carrier which was inserted into a special opening for it in front of the condenser of the magic lantern. These slides are usually 4 x 7 inches. At the end of the century, lantern slides were 3 ¼ x 3 ¼ inches. Later, the standard size became 3 ¼ x 4 inches. The smaller lantern slides were inserted into a carrier. The photographic emulsion is protected by a second piece of thin glass, and the unit is secured around all four edges with black paper tape.

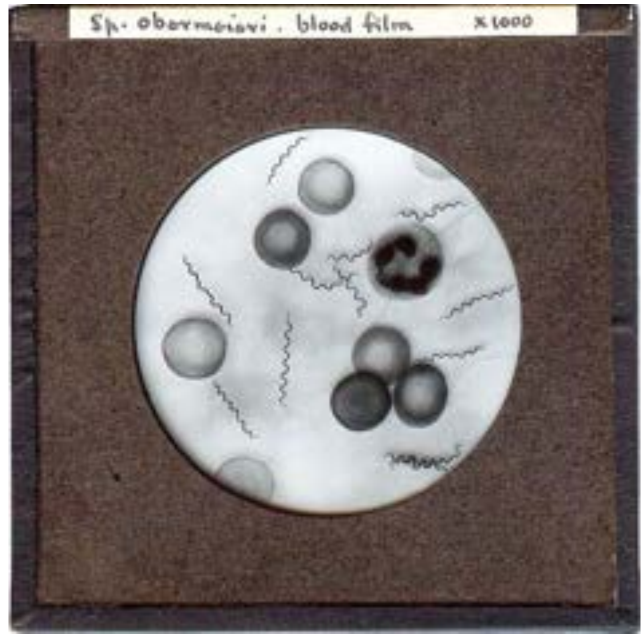
Lantern slides were increasingly used for educational purposes. This collection contains 75 lantern slides mostly on histology, microbiology, and botany. Some bear the label Newton & Co. 3, Fleet St London. Most are 3 ¼ x 3 ¼ inch slides and date from c1885 to c1910. Some are hand-painted. This is an example of a large wooden lantern slide of a photograph of the proboscis of the housefly. The slide is 4 x 7 inches and bears a label Bausch & Dransfield. This optical firm operated in Rochester, New York from about 1863 to 1885. E. E. Bausch was the brother of John Jacob Bausch of Bausch & Lomb. The slide is also an example of early photomicroscopy.

Housefly Proboscis

Blood Corpuscles

Minute Structure of Muscle

Anthrax bacilli in renal glomerulus



Spirochetes in blood

Trichinae

Diseased Pork, highly magnified showing Trichinae, Albert F. Prieger, Tampa Florida, 3 ¼ x 4 inches, colored, c1900.

Use of lantern slides lasted throughout the remainder of the nineteenth century and until the 1950s when their popularity began to decline with the introduction of smaller 2 x 2 inch transparencies. Finally, the discovery of the Kodachrome three-color process made 35mm slides less expensive to produce than lantern slides.

Hand-Painted Natural History Lantern Slides, c1890

Lantern slides originated in the 17th century and consisted of hand-painted illustrations on glass that were projected with light from a "magic lantern." Printing techniques for producing slides were introduced in the first half of the 19th century and photographic techniques in the second half. Hand-painting, though, persisted into the beginning of the 20th century. Painting on magic lantern glass slides was a laborious process that required the mastery of miniature painting on a glass substrate (Frutos, 2013). Watercolors were usually used and the painting secured using a thin layer of varnish. A second piece of glass was placed over the painted glass with a matte border in between. The pieces of glass were bound together by a strip, usually paper, pasted around the edges.

This is a set of 42 lantern slides of various forms of wildlife. The slides are 8.2 x 8.2 cm (3 ¼ x 3 ¼ inch), which became the standard size after 1885, and replaced later by 3 ¼ x 4 inch slides. Thirty-five of the slides are hand-painted and appear to be by the same unknown maker. The paintings are colored and quite realistic. Three other slide bear labels: "Magic Lantern Slide Manufacturers, W. Watson & Sons, 313, High Holborn, London;" "Flatters & Garnett, Ltd., 309, Oxford Rd., Manchester;" and "S. H. Benson, 1, Tudor St., London, E. C." The slides are bound in paper except for two slides bound in copper. All are in excellent condition.

Wildlife Lantern Slides		
Amoeba	Indian Python	Guianan Cock of the Rock
Coral	Adder	Indian Peacock
Hermit Crab and Sea Urchin	Cottonmouth	Long Bill (Hornbill)
Deaths Head Moth	Rattlesnake	Mandarin Duck
Hawk Moth	Horned Viper	Ostrich
Oleander Hawk Moth	Iguana	Long-wattled Umbrellabird
Red Underwing Moth	Basilisk Lizard	Wood Duck
Sheep Tick	Flying Lizard	White Tailed Sea Eagle
Two Fish	Egyptian Crocodile	Flamingos
Sun Fish and Serpent Eel	Long Snouted Crocodile	Egyptian Mongoose
Skate and Dogfish	Axolotl	Sea Lions
Anoconda	Crested Newt	Walruses
Boa Constrictor	Adjutant Stork	Lion Hunting
Common Adder	Cassowary	Tiger Hunting
Common Grass Snake	Bird Nest	Gorilla in the Jungle
Indian Cobra		

Egyptian Crocodile

Hawk Moth

Mandarin Duck

Boa Constrictor

Axolotl

Flying Lizard

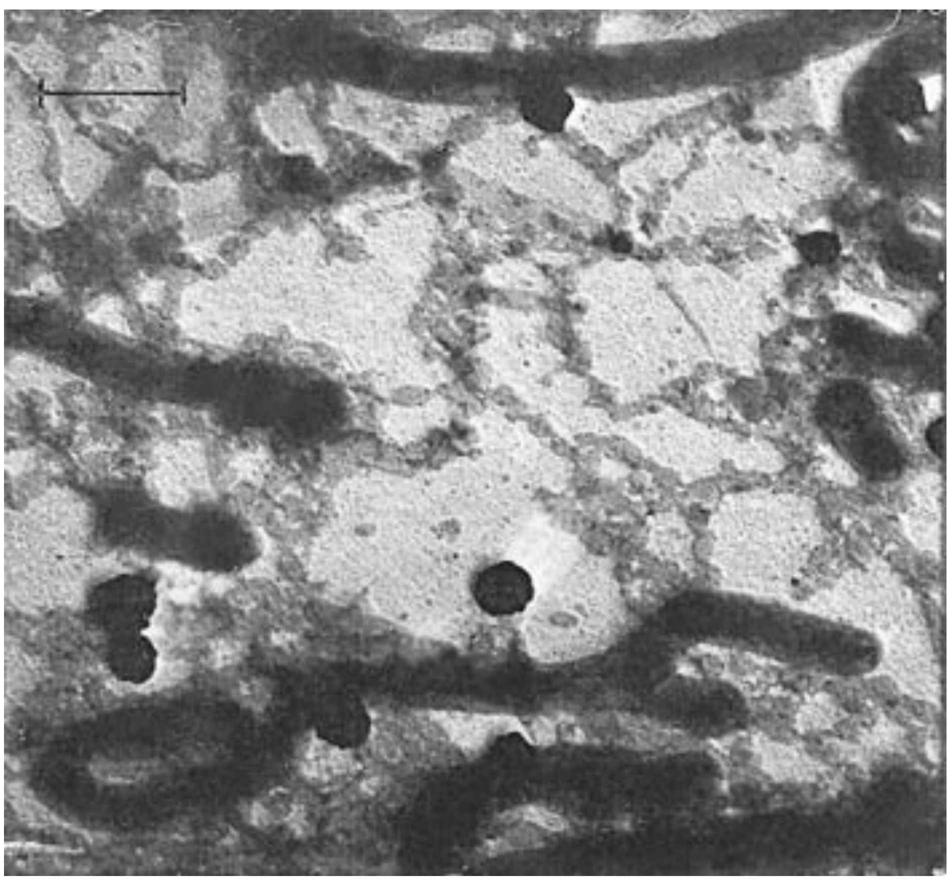
Lantern slide, "UH! YOU RAH! RAH! BOY," 1, Scott and Van Altena, 50 Pearl St. N.Y.C. Colored 3 ¼ x 4 inch, photo lantern slide of a man with a megaphone and pennants for New York, Harvard, Yale, and Columbia. c1910.

Electron Microscope Lantern Slides

Palade Collection

George E. Palade 1970

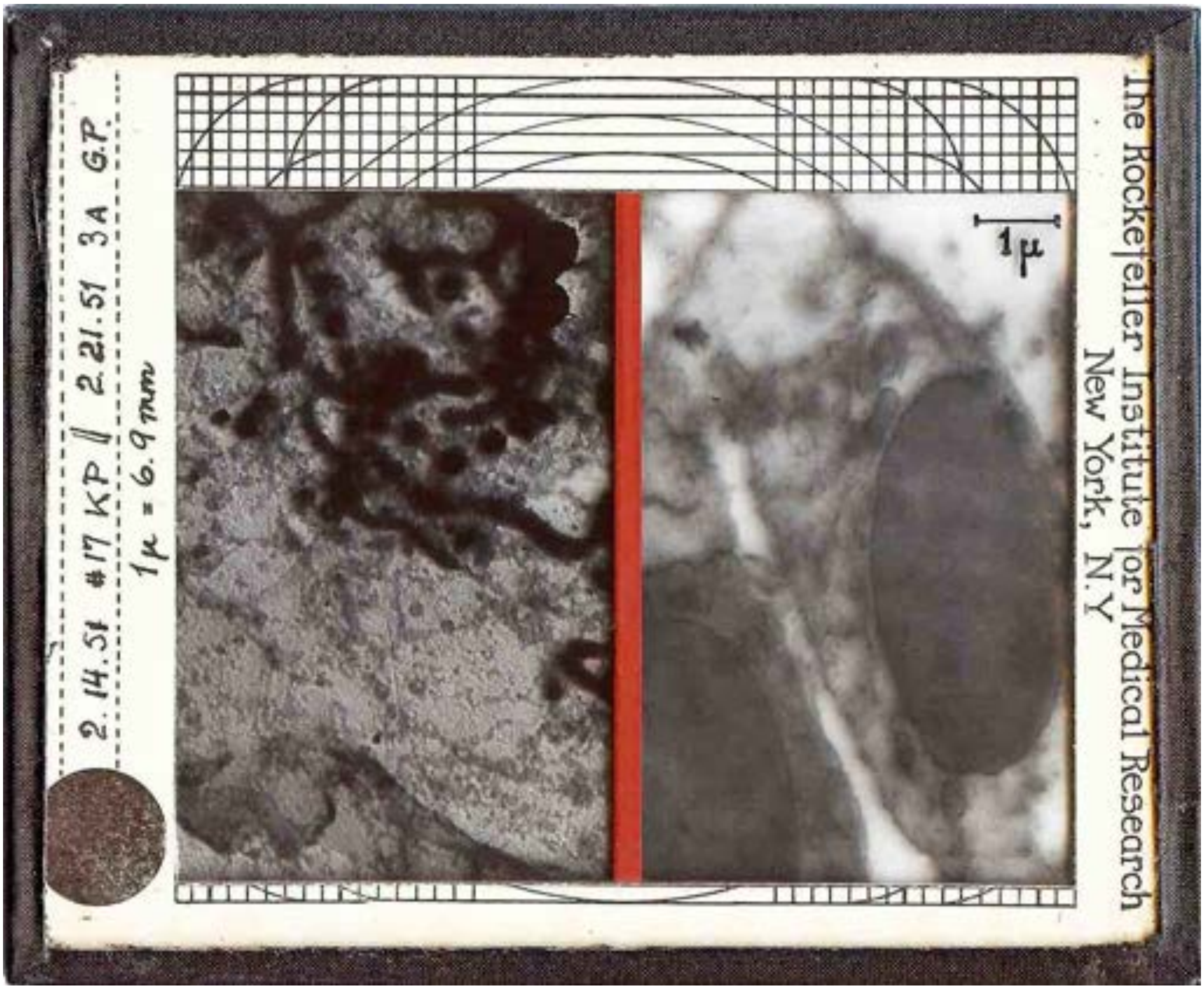
In 1973, George Palade and his associates were recruited to Yale to form a new Section of Cell Biology. George E. Palade (1912-2008) received his M. D. from the School of Medicine of the University of Bucharest, Romania. He was a member of the faculty of that school until 1945 when he came to the United States for postdoctoral studies. He joined Albert Claude at the Rockefeller Institute for Medical Research in 1946 and was appointed Assistant Professor at the Rockefeller in 1948. He progressed from Assistant Professor to full Professor and head of the Laboratory of Cell Biology until 1973 when he moved to Yale as Professor and chair of the Section of Cell Biology. He was Sterling Professor of Cell Biology from 1975 to 1983. He became a Senior Research Scientist, Professor Emeritus of Cell Biology and Special Advisor to the Dean in 1983. In 1990, he moved to the University of California San Diego as Professor of Medicine in Residence, and Dean for Scientific Affairs. Palade's studies, using an integrated approach using cell fractionation, electron microscopy, and autoradiography, led to the identification of the compartments of the secretory pathway. He received a number of honorary degrees and prizes, which include a Nobel Prize in 1974 and the National Medal of Science, USA, in 1986.



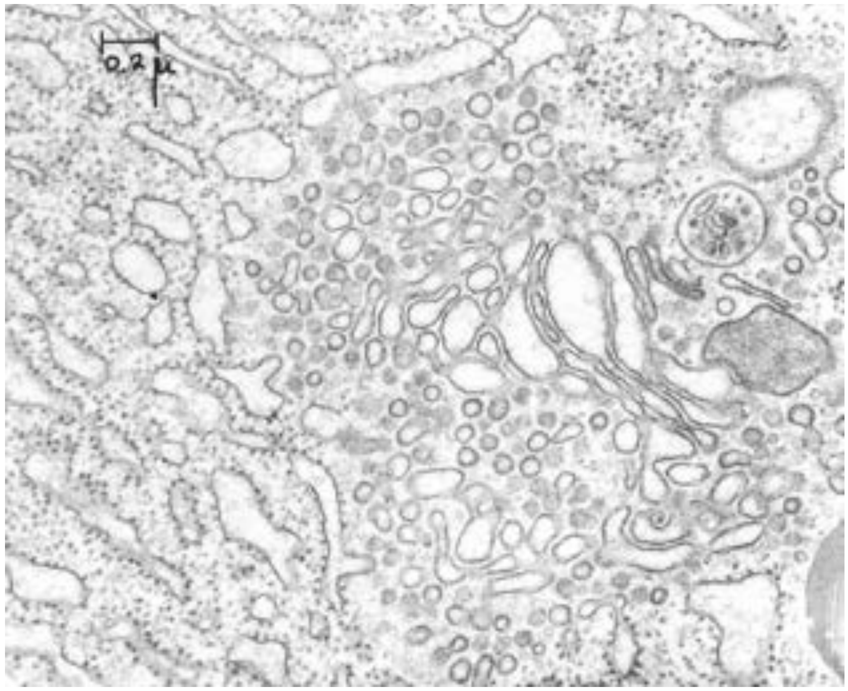
The first electron micrographs of cells, Keith Porter, 1946

Lantern slide, electron micrograph of a tissue culture cell by Keith Porter. Before sectioning of tissues was effective, Keith Porter at the Rockefeller Institute was able to take advantage of the extreme thinness of cultured cells by fixing them with OsO_4 vapors and viewing them under the electron microscope. As shown in this lantern slide, Porter was able to see mitochondria (dark rods) and the endoplasmic reticulum (delicate tubules).

The following lantern slide is of great historical importance. The image on the left is a cultured cell taken by Keith Porter (K.P.); that on the right is a thin section of a cell taken by George Palade (G.P.). These are among the first electron micrographs of cells.

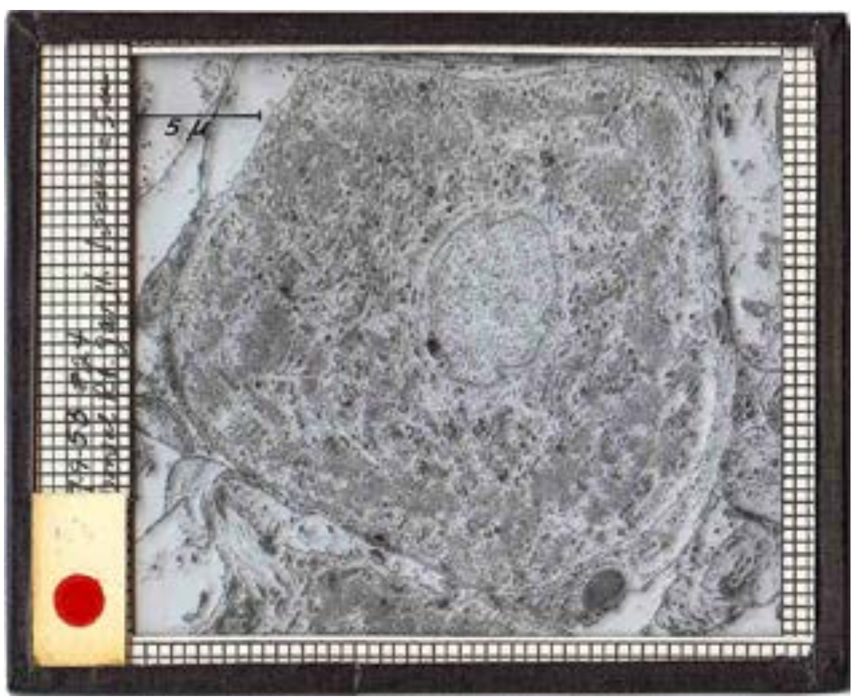


Porter-Palade Lantern Slide, 1951



Lantern Slide, Pancreas, George Palade, 1966

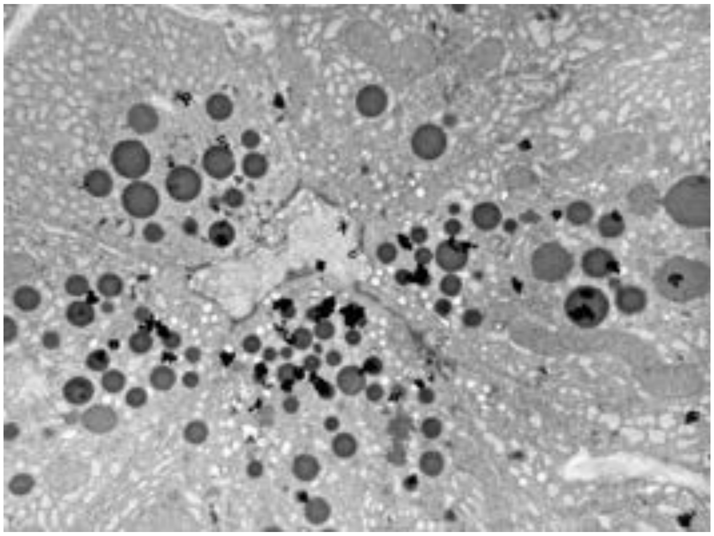
Pancreas showing rough endoplasmic reticulum, transitional vesicles, and Golgi apparatus. By this time, techniques for the fixation, embedding, and sectioning of tissues and the resolution of the transmission electron microscope had been perfected to the point where the quality of an electron micrograph such as this has not been surpassed.



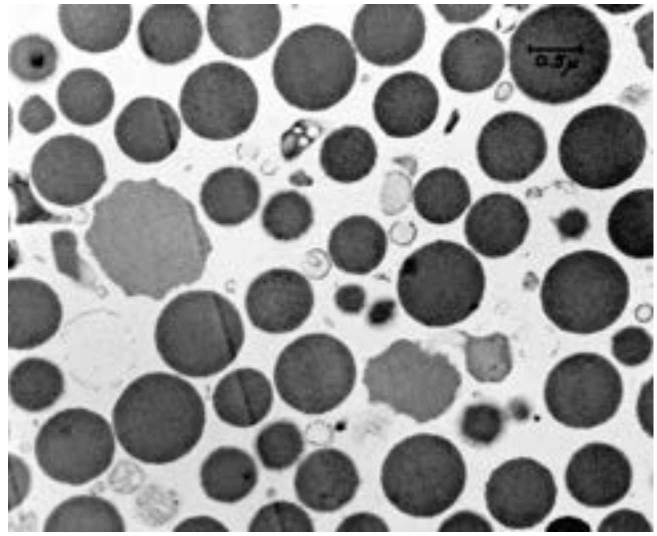
Palay and Palade Lantern Slide, Neuron, 1953

Dorsal root ganglion. Sanford Palay and George Palade took the first electron micrographs of nerve cells. Palay was a member of the Department of Anatomy at Yale from 1949 to 1956.

Lantern slides by James Jamieson (1934-2018). Jamieson was chair of the Department of Cell Biology at Yale and studied components of the intracellular transport pathway in the pancreatic acinar cell as a model of a regulated secretory system.



Autoradiography of Secretory Process



Zymogen Granule Fraction, 1967

Thomas L. Lentz (1939-) was Professor of Cell Biology at Yale and studied trophic regulation by the nervous system, development of the neuromuscular junction, structure-function relationships of the nicotinic acetylcholine receptor, and cellular receptors and intra-cellular trafficking in neurons of the neurotropic rabies virus.

Lantern Slide, Neuromuscular Junction, Thomas Lentz, 1972

Microscope Slides

Volcanic Ash and Sand Slide Set
Slide Set, Wait's Drugstore, Traverse City, Michigan. c1880
Whole Mounts of Entomological Specimens, Auburn, Alabama, 1950
Wood Sections from the Royal Botanic Garden Edinburgh by Ernie Ives, 2011
European Mineral Micromounts
Joseph Bourgogne Slide Set, c1840
Wood Sample Set, c1930

The Evolution of the Microscope Slide

The microscope slide is a small support on which a specimen can be placed and held for viewing with a microscope. The development of slides was as important to the scientific disciplines of histology and pathology as were improvements to the compound microscope. For 250 years after the invention of the compound microscope, observations were largely limited to whole specimens held on a substrate. It was not until the advent of thin sections of specimens made by a microtome and placed on a transparent slide that the microscope became a truly useful scientific instrument. This is a brief survey of the evolution of microscope slides and their applications to different fields of science.

Sliders were the original carriers of objects for microscopical observation, described as early as 1691 by Filippo Bonanni (1658-1723), an Italian Jesuit scholar. Prior to that, specimens such as small insects were placed in live boxes or on the needle of a flea glass-type microscope for observation with a simple single lens microscope. For compound microscopes with an eye lens and an objective, objects were placed on a disc beneath the objective lens and viewed with incident light. Other objects such as tissues were dissected with knives, teased, or compressed.

Sliders are rectangular slabs, beveled at one end, usually made of bone, ivory, or ebony with round compartments cut out. Specimens were placed between two round pieces of mica called talcs and held in the compartments by brass rings. The ends were beveled so it would slip easily into a spring stage on the microscope. The early sliders are small (~3⁄8–½" x 2-3") and have two or three compartments. These sliders accompanied a c1710 Culpeper screw-barrel microscope and were most likely made by Edmund Culpeper or James Wilson. A set of sliders identical in size, shape, lettering, and case is in the Museum of the History of Science, University of Oxford, and attributed to Wilson and dated c1704.

Wilson Sliders, c1704

This is a four-celled brass slider in which aquatic specimens were held between two thin sheets of glass (wet cells). The slider is 3 x 9/16 inches. It accompanied a c1710 Culpeper screw-barrel microscope. This slider is doubly stamped "EC" on one side and exhibits Culpeper's rosette pattern on the end of the other side.

Culpeper Wet Cell Slider, c1710

Sliders were used throughout the eighteenth century and the first part of the nineteenth century. They became larger and usually had four or five compartments that could be moved successively under the microscope objective. Most sliders are about a half inch wide and four or five inches long although there are larger ones for the solar microscope. Opaque specimens were attached to a cardboard substrate. Transparent specimens were placed between mica circles that were secured by brass circlips. The most common objects were insects, wood, feathers, butterfly wings, hair, plants, minerals, and shells.

Ivory Slider, c1780

Ebony Slider, c1780

This is an unusual bone microscope slider from the late eighteenth century. It is ½ x 4 inches in size and contains eight specimens rather than the configuration of four or five found in most sliders of the period. There are four entomological specimens and four fish scales, all of which are still in place. They were mounted dry between micas held in place with brass circlips. The photomicrographs of specimens illustrate the state of microscopy in the eighteenth century.

Bone Slider, c1780

The following slider is made of glass and paper and is transitional between the ivory, bone, or wood sliders and the glass slides that followed. In England, there was a tax on glass and windows that had been introduced in 1696. It was not until 1845 that the glass tax was repealed and the window tax six years later. This led to an unprecedented reduction in the price of glass. Prior to this, the effects of the tax resulted in a scarcity and variable quality of the material used in early glass microscope slides. There were often variations in color, thickness and size. In this slide, two glass slips have been hand cut to the contemporary shape of the bone sliders. Because the glass was hand cut, the edges are very rough. The paper spacer between the glasses was carefully cut to accommodate and hold each of the four specimens, which are dry mounted. The glass is glued to the paper. The slide is ½ x 4 inches and contains wood sections. The method of making these slides is described in Charles Gould's *The Companion to the Microscope* published by Cary in 1827. The advent of Canada balsam within a few years transformed slide preparation, superseding this method. These slides are very rare, probably because such a limited number were made between 1827 and 1832 and most were discarded when the new mounting medium was introduced.

Transitional Slide, c1830

Early Slide, J. West, c1820

This slide can be considered the first true slide as we know them today because of its rectangular shape, single compartment, and glass construction. It is also the earliest signed slide known. Prior to the introduction of Canada balsam, different methods for holding a specimen onto the slide were tried. The construction of this slide is the same as the transitional slide with a section of "Sasaparella" and paper spacer held between two strips of glass glued to the paper. The paper is stamped J. West. The identity of J. West is unknown but a possibility is R. J. West who was an optician in Oxford Street, London around 1820. 25 x 60 mm. c1820.

In this small glass slide of a humming bird feather, the specimen is placed on the glass slide and covered with a mica coverslip held on by red paper wrapped around the slide. Thin glass covers did not become available until the 1840s. The maker of the slide is Andrew Pritchard. Andrew Pritchard (1804-1882) was one of the earliest established commercial providers of microscope slides in London, being in business from the mid 1820s until the late 1850s. He was primarily known and highly respected as a skilled instrument maker, microscopist, and optician, as well as a prolific author. His popular and influential books on optics and microscopy, published beginning in 1827, are considered by many to have played a pivotal role in the further development and commercialization of the microscope. At the same time, they encouraged the popular interest in and investigation of the natural world. His books also contained some of the first lists and descriptions of interesting microscopic objects for study, with methods for their preparation. It is believed that many of the slides retailed by Pritchard were not actually made by him, but that he contracted with some of the early London slide makers to provide the inventory he advertised and sold through his shops. The cut out printed label "Feather of Indian Humming Bird" on the slide is probably cut from his book of 1832, *The Microscope Cabinet*. 20 x 52 mm, c1830.

Pritchard Paper Covered Slide, c1830

In this second type of slide attributed to Andrew Pritchard, the wood sections are placed between two glass slides that are sealed together at the edges with red wax. The slide is 1 x 3 inches and labeled "Eucalyptus globulus."

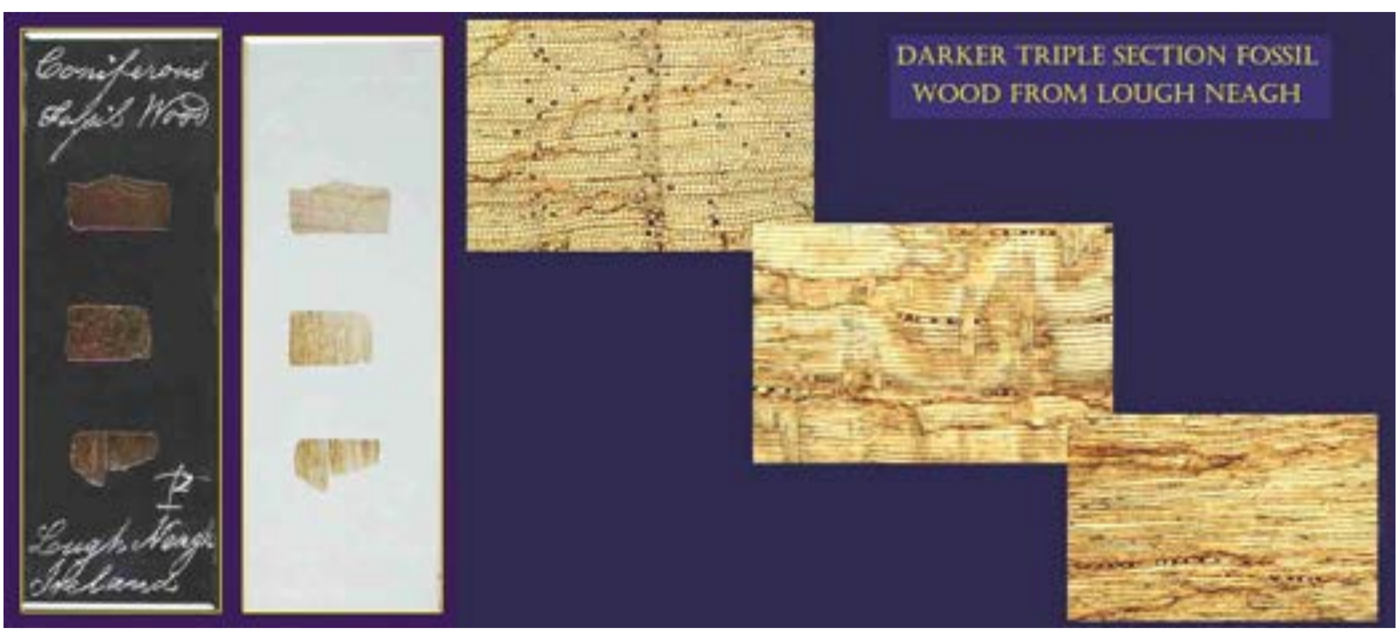
Pritchard Wax Sealed Slide, c1840

In this slide labeled "Pou Humain" (Human louse), two glass slides are held together by balsam at the edges and bound by green papers at the ends. The slide is possibly by Joseph Bourgogne who made small slides beginning around 1835 in Paris. 16 x 60 mm, c1835.

Paper-Sealed Slide

In the first part of the nineteenth century, a few lapidaries were engaged in preparing and mounting geological and fossil hard sections for viewing with the microscope. The difficult and laborious process consisted of obtaining a slice or fragment of a rock specimen and grinding and polishing so that one side was flat. It was then adhered to a glass slide and the other side ground down parallel to the glass without breaking the specimen or glass. Once the desired thinness that would allow transmitted light examination was obtained, the surface was polished. One of the first makers of these slides in London was William Hill Darker (1811-1864). Charles Morgan Topping (1800-1874) was selling sections of coal and fossils in the mid 1840s. Later, many slide makers offered slides of fossils, fossil diatoms, coal, and geological specimens. At the end of the century, reference collections of petrographic slides were used by universities for teaching mineralogy and geology.

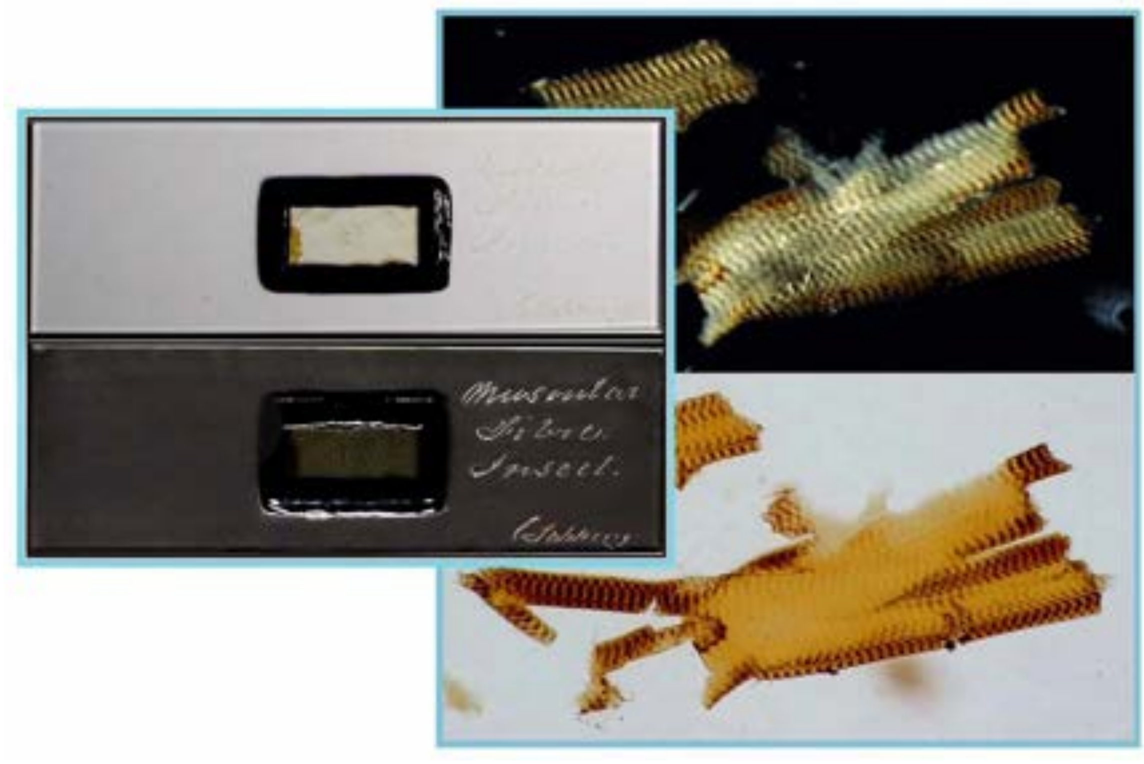
This slide is a section of agate from the East Indies by William Darker, c1840. It is viewed under polarized light.



This slide is a triple section of coniferous wood fossil from Lough Neagh in Northern Ireland by William Darker. Sections were usually cut transversely, longitudinally, and tangentially. c1850.

The first paper on the microscopic structure of tissues was published by Hodgkin and Lister in 1827. In the 1830s and 40s, most scientific investigation of tissues was performed in Germany. In England, John T. Quekett made superb preparations of plant and animal histology. The first commercial mounters to prepare histology slides were C. M. Topping and Andrew Pritchard in the 1840s. When the importance of histology to medical science was realized and it was introduced into medical school curricula around 1850, the production of histological slides expanded greatly.

This is an important early histology slide by Charles Morgan Topping (1800-1874), with diamond point engraved writing. The slide, titled "Muscular Fibre Insect" is one of Topping's early histology preparations, having been made around 1840. It is a rare example signed with his full last name “Topping”. This slide shows teased muscle fibers from an insect. In the upper image, the specimen is viewed with polarized light. The A bands (for anisotropic) are birefringent and appear light while the I bands (for isotropic) are dark. In the lower image viewed with transmitted light, the A bands are dark and the I bands light. Topping is one of the most famous mounters in history and began mounting professionally in the late 1830s. He worked closely with a number of medical professionals including John Quekett, and was renowned for his injected and corroded histology mounts.



Histology Preparation by C. M. Topping, c1840

This slide was prepared by John Thomas Quekett (1815-1861) who was Conservator and Professor of Histology at the Hunterian Museum of the Royal College of Surgeons. Quekett's work was of great importance towards making the microscope a vital scientific research instrument. His histological preparations were advanced and innovative for the time and set the standard for others. In 1848, he published a book that included detailed instructions on specimen and slide preparation. Quekett never made slides for commercial purposes. His slides remained with the Hunterian Museum and are almost unknown outside the Museum. This small glass slide is 21 x 62 mm. The glass is beveled on three sides and jagged on one. The glass coverslip is irregularly cut. The slide is labeled "Portion Choroid Frog" and bears Quekett's distinctive numbering system. It is diamond-engraved "John Quekett." The slide appears to be one of Quekett's early efforts. c1840.

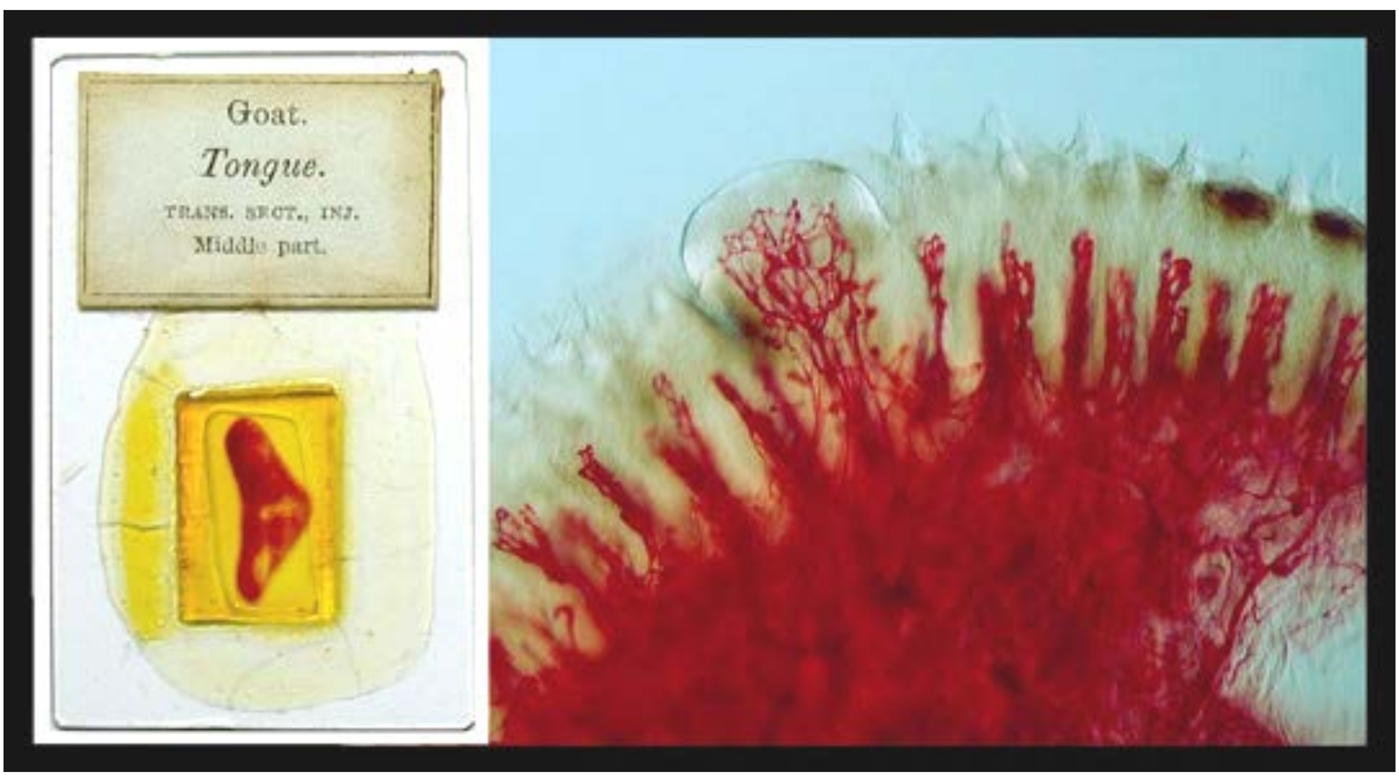
Slide by John Quekett, c1840

No standardization of slide size existed until a resolution by the committee for the members of the Microscopical Society of London was passed in 1839. It suggested slide sizes of 1 x 3 inches and 1 ½ x 3 inches. Individuals still cut the glass for their own slides and cover glasses, using a cutting-board and diamond kept by the Curator. These sizes were meant for the Society's own cabinet but they began to be used by some commercial mounters and eventually were accepted universally.

Prior to the ability to adequately section tissues, early tissue samples were often mounted in a deep cell filled with fluid, usually alcohol, formalin, or acetic acid. Many of these are still intact after 150 years. This example is the "Ciliary processes Young Pig." After injection, the surrounding tissues were corroded away, leaving a cast of the blood vessels. c1850.

Deep Cell Fluid Mount, Ciliary Processes, c1850

The next slide shows several advances in slide preparation. The coverslip is held on by Canada balsam. Mounting with Canada balsam was introduced around 1830 and had the advantages of being transparent and holding the coverslip on the slide. Second, the specimen is a thin section of a tissue. Microtomes at the time were used primarily for sectioning of wood. Tissues were probably sectioned with a Valentin knife or a hand microtome. The blood vessels of the tissue have been injected with a dye. Capillaries are visible in the papillae. The label reads "Goat. Tongue. Trans. Sect. Inj. Middle part." These slides were prepared by Karl Thiersch (1822-1895), a German surgeon, and imported by Smith and Beck in London in the 1850s. 34 x 55 mm.



Transparent Injected Specimen, c1850

Transparent specimens embedded in balsam were poorly visualized because of lack of contrast. Stains began to employed in the 1850s and by the end of the century virtually every colored substance had been tested as a stain. One of the earliest stains, first used in the eighteenth century, was logwood which contains hematoxylin, a stain used commonly today. This slide "Parenchymatous Nephritis of Liver" by Arthur J. Doherty bears the notation "Stained Logwood." c1885.

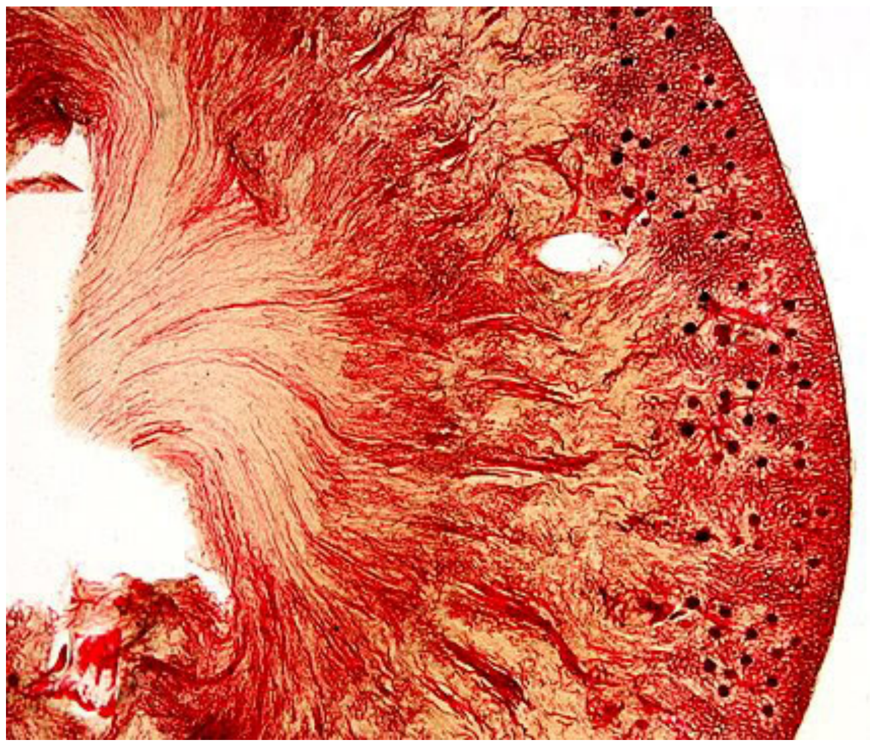
Section Stained with Logwood

Early Medical Slide, 1857

In addition to their use in teaching histology and pathology, slides began to have a direct medical application to the treatment of patients. This is an early slide in which microscopy appears to have been used diagnostically on a living patient. The label reads "Uric acid from a patient with Ascites. 1 ½ dram gave 6 times the quantity here shown taken before tapping no such quantity after-wards. Seen by Dr Tweedie & W Burke Ryan 28 Sept 1857." Dr. Alexander Tweedie (1794-1884) F.R.S. was an expert on fevers and wrote a book *Clinical Illustrations of Fever*. He was Physician to the London Fever Hospital. Dr. William Burke Ryan (1810-1874) F.R.C.S. received his M.D. in 1857 from the Uni-versity of London. He was Surgeon to the South Middlesex Rifle Volunteers and en-gaged in general prac-tice at Norfolk Terrace, Bayswater.

In 1858, Rudolph Virchow articulated what became the accepted form of the cell theory, *omnis cellula e cellula* ("every cell is derived from a [preexisting] cell") He founded the medical discipline of cellular pathology, namely, that all diseases are basically disturbances of cells. It followed that if cells comprised the organism and could grow and divide and that diseases arose in cells, cells were extremely important subjects for research and teaching. As a result, slides of normal and diseased tissues were prepared for research and teaching in medical schools.

Edmund Wheeler was a professional mounter by 1866 and prepared very fine histology and pathology slides among many other subjects. He retired in 1884 and sold his business and stock, including over 40,000 slides, to W. Watson & Sons. This is a very fine injected specimen of mouse kidney for study of normal histology.



Injected Kidney of Mouse by Wheeler, c1870

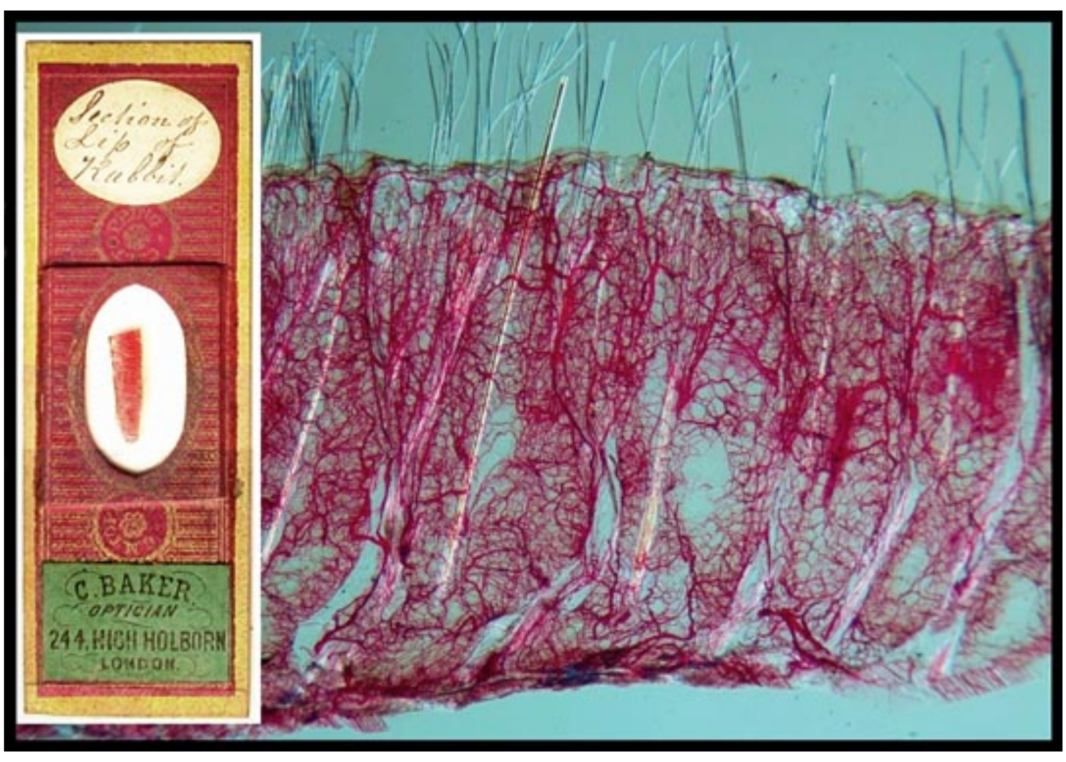
At the same time, slides of pathological specimens were prepared. This slide by Cole is a section of tubercular lung. Although several firms offered histology and pathology slides, Arthur C. Cole (1821-1900) appears to have been the first to offer them in sets.

Tubercular Lung, c1870

Paper covers were first used to hold the mica or glass covering slips to glass slides or to hold two pieces of glass with the specimens in between together. Although the paper covers were no longer necessary to hold the coverslip on after the introduction of Canada balsam in the 1830s, they continued to be used to cover slides. They became highly decorative, lithographed in bright colors and gilt, and sometimes included the mounter's name or monogram. During the Victorian period, microscope slides were made for education of science and medical students, but also for the entertainment of the public. This paper covered slide by Edmund Wheeler bears a secondary label for T. H. McAllister, New York. The specimen is "Hoof of Mustang" which is birefringent. The label "For Polariscope" indicates it should be viewed under a polarizing microscope. Red and gold patterned paper-covered slide, yellow border. c1875.

Victorian Paper Covered Slide, Hoof of Mustang, c1875

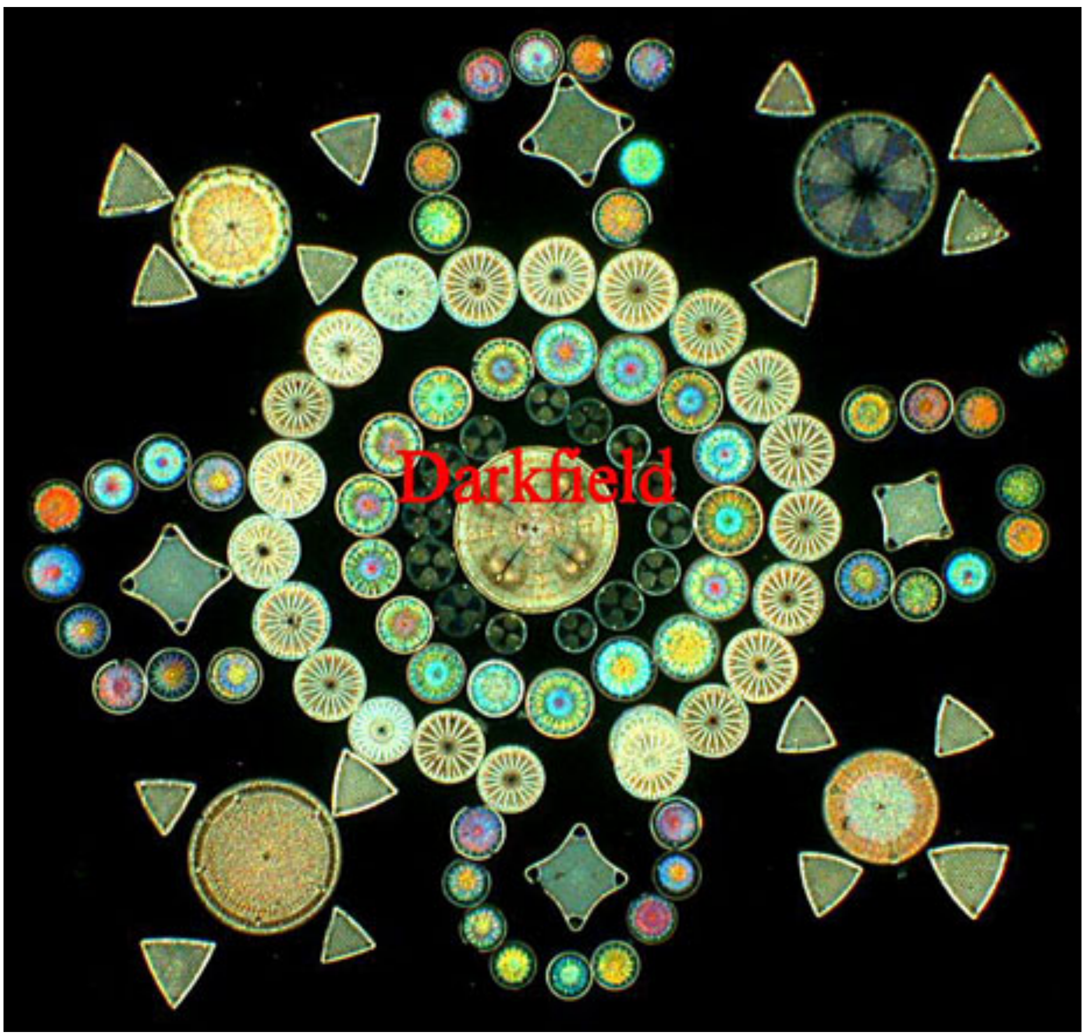
Shown below is an example of an injected specimen by Charles Topping. It clearly demonstrates the microvasculature. The slide bears a secondary label of Charles Baker.



Section of lip of rabbit, injected and showing the microvasculature. C. M. Topping, c1870

Exhibition slides of unusual objects were very popular in Victorian times. Although these "exhibition" slides were meant for entertainment and amusement in Victorian parlors, they heightened public awareness and interest in the fields of biology, botany, archeology, oceanography, paleontology, geology, and science in general. Among the most popular nineteenth century subjects were the mineral skeletons of diatoms, foraminifera, radiolarians, and polycystina.

Diatoms are a group of algae and among the most common types of phytoplankton. They are unicellular organisms with a cell wall made of silica. Diatoms were a favorite subject for mounters during the Victorian era because of the intricate patterns in their cell walls. They were also useful objects for testing the resolving power of microscope objectives. They were classified by scientists and about 100,000 species have been identified. They remain a useful tool for measuring environmental conditions presently and in the past. This is an attractive complex arrangement of diatoms in concentric circles by A. C. Cole viewed with darkfield illumination. Arthur C. Cole (1821-1900) was an organist but was making slides by 1867. He mounted diatoms and histological subjects of high quality. They carried a small label with a crest and the words Cole Deum (Worship God).



A. C. Cole Diatom Circle

Insects were another popular subject for slides. Frederick Enoch (1845-1916) was a mounter of whole insects prepared in a lifelike manner without pressure. His slides are of the highest quality and perhaps unequaled. This slide is labeled "Order Hymenoptera, Family Cynipidae, Genus Andricus, Species terminalis, Fred^{c} Enock Preparer, The Oak-Apple Fly, Showing the internal and muscular structure, Polariscope or Paraboloid, 2 inch to ½ inch." The oak apple fly is one of the most striking and informative of Frederick Enock's very small insect mounts. It is the smallest of those that he was able to clear leaving the internal and muscular structure intact.

The Oak Apple Fly, c1885

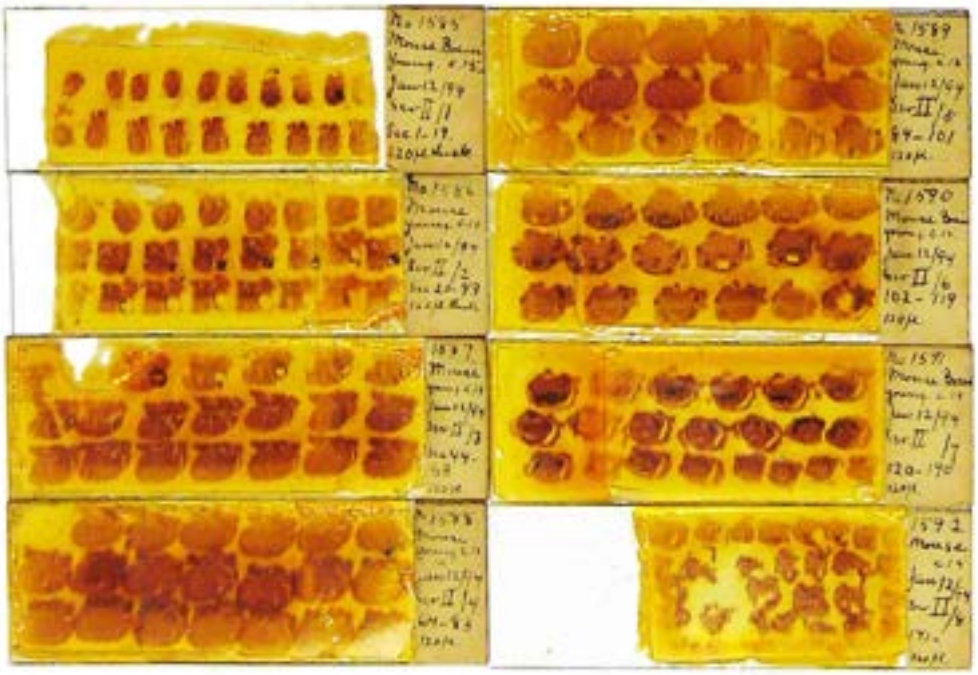
Although Antonie van Leeuwenhoek observed bacteria in 1674, the scientific field of bacteriology was founded in the nineteenth century as a result of the work of Ferdinand Cohn, Louis Pasteur, and Robert Koch. The germ theory of disease, namely that specific diseases were caused by specific pathogenic microorganisms, was validated. It therefore became important to observe and classify bacteria and other microorganisms. In Jena, Germany, the remarkable combination of Carl Zeiss, a machinist, Ernst Abbe, an optical theorist, and Otto Schott, an optical glass maker, resulted in the development of microscopes with unsurpassed apochromatic optics. It was now possible to clearly observe and study bacteria and even viruses with the microscope. Late nineteenth century microbiology slides include the causative agents of diseases such as tuberculosis, smallpox, anthrax, and leprosy that are absent or less commonly seen today. This is an example of a slide of "Bacillus Tuberculosis Human Lung" by W. Watson & Sons. c1890.

Bacillus Tuberculosis, c1890

Paper covers were used less frequently after about 1880. Coverslips were held on the slide with balsam. The edge of the coverslip was often ringed with a cement to seal and finish them. Colored ringing cements were sometimes used to give the finished mount a decorative appeal. Ringing largely died out in the first part of the twentieth century. This was unfortunate because the mounting media of unringed slides is more likely to become dried and cracked at the edges of the coverslip. This ringed slide by W. Watson & Sons is the "Junction of Retina with Ligament of Cilliary" "From the Human Eye." c1890.

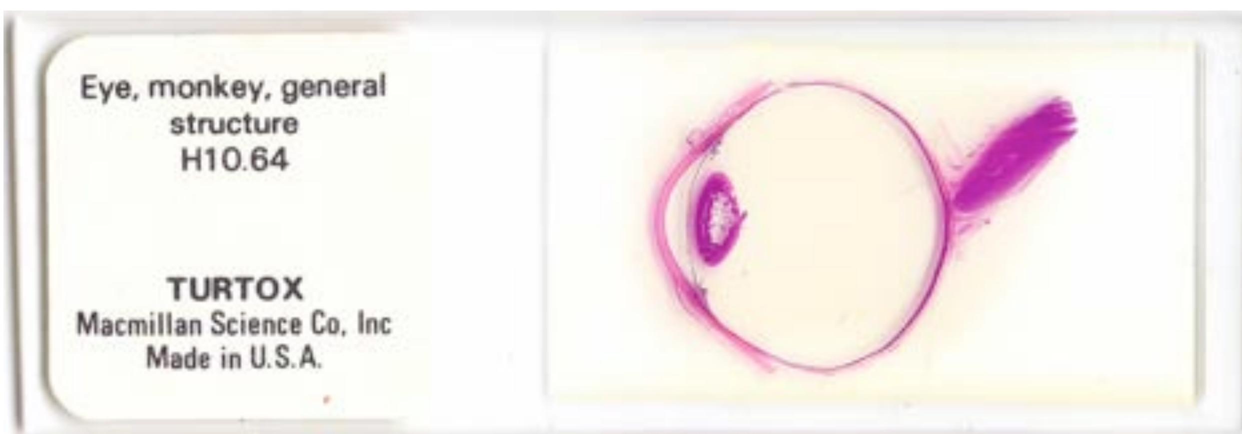
Ringed Slide, c1890

Around 1885, microtomes were developed in which the knife is fixed and the object moves to and fro past the knife. The most notable of these microtomes were the Cambridge Rocking microtome and the Minot rotary microtome. These microtomes allow for the production of serial sections of a specimen. The sections can be taken off the knife as a ribbon and mounted on a slide. Simon Henry Gage (1851-1944) published with Theobald Smith in 1883 a paper on serial sectioning that was one of the first serious discussions on the use of serial sections in histology and embryology. Gage, with his wife Susanna Phelps Gage (1857-1915), used serial sections to create three-dimensional models of the specimen. Susanna Phelps Gage was herself an independent investigator and one of the first woman histologists. This is a set of serial sections of mouse brain prepared by Susanna Gage in 1894.



Susanna Phelps Gage Serial Sections

In the twentieth century, the use of microscope slides for entertainment decreased and they became almost exclusively used for educational, scientific, and medical purposes. Firms produced large numbers of slides for educational use in courses for science and medical students. These slides, often of high quality, were practical and utilitarian. This exceptional slide of the monkey eye was prepared by Dr. James B. McCormick. McCormick founded and ran the Histoslides Company from 1945 to 1955. The company produced slides for universities and also for firms such as Turtox, Ward's Scientific, and Scientific Products. This was Histoslide No. 131 and was provided to Turtox in 1949/50.



Eye of Monkey, c1950

Around 1890, microtomes were developed that could cut sections of large specimens, some as large as whole human brains. These sections are useful because they allow structure to be visualized from the anatomical to the tissue and down to the cellular level. Shown below are slides containing sections of large structures.

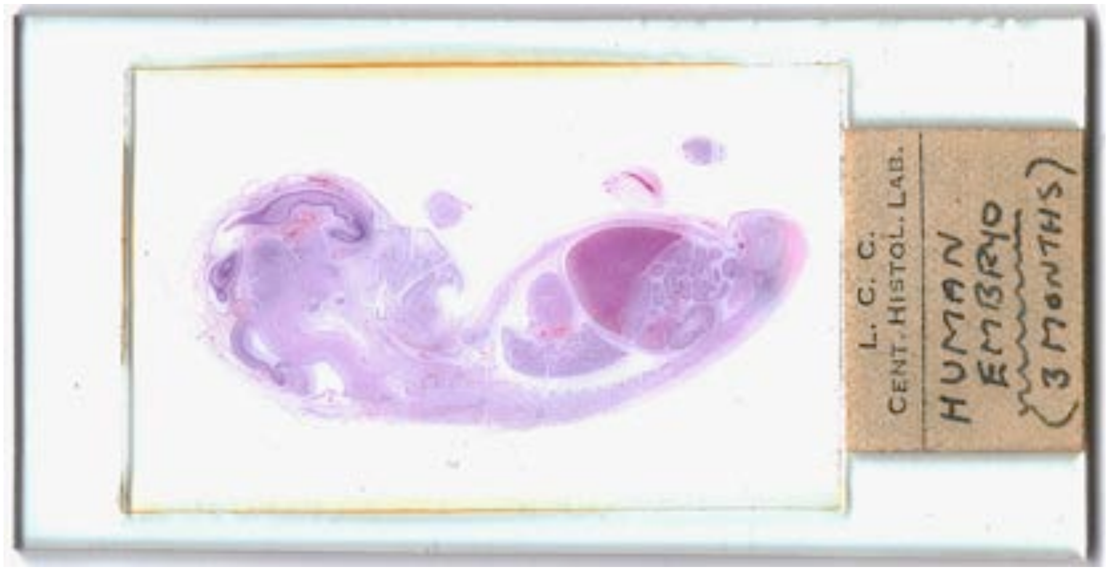
The maker of this remarkable slide of a fetal hand is unknown. Fourth quarter nineteenth century.

Human Fetal Hand

Human Heart, 1935

This is another large slide through the entire human heart showing the right and left ventricles. It measures 3 ¼″ x 4 ¼.″ The slide is accompanied by a note with the letterhead of Kings College, University of London, Hambleden Department of Anatomy and dated July 22nd 35. It was presented to an unnamed person and prepared by Edmund J. Westin, FRMS. The nerves are stained black in the slide.

This slide is a sagittal section of a three month human embryo. The slide is 1 ½ x 3 inches. Slides of whole human embryos are rare.



Human Embryo Slide, c1960

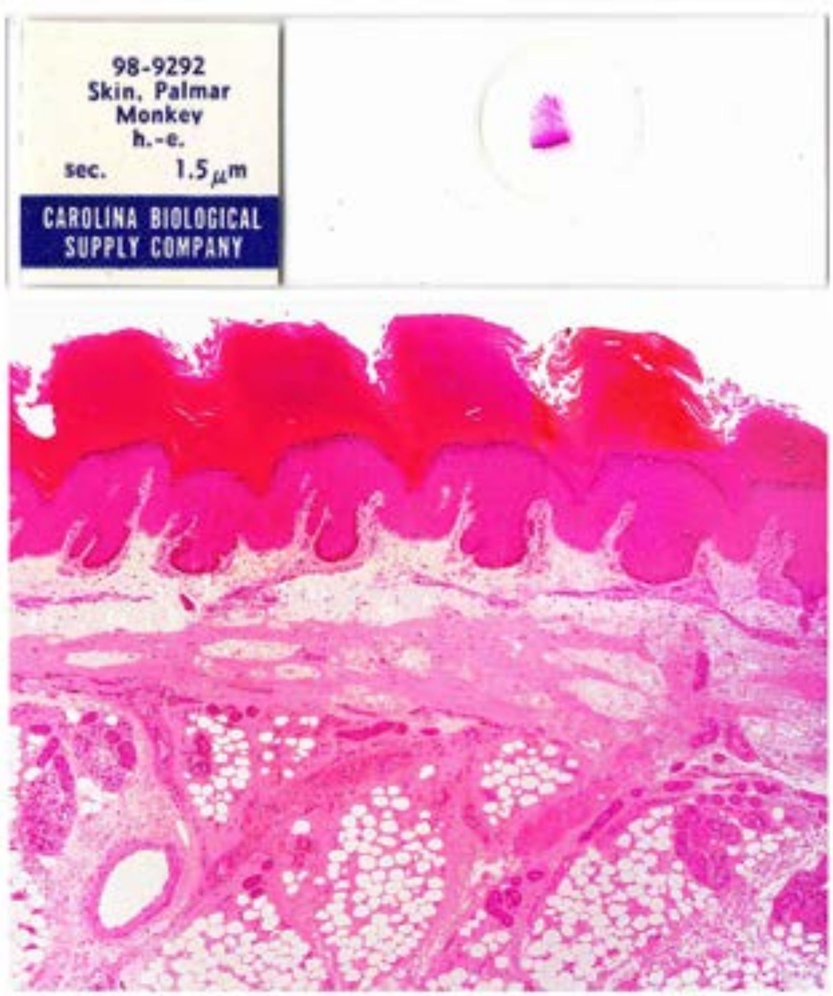
These slides are coronal serial sections through the occipital region of the cerebrum and the cerebellum of a monkey. One slide is stained with cresyl violet for cells and the other with Weigert's stain for myelin. 38 x 76 mm. Yale University, c1970.

Monkey Brain

Beginning in the 1970s, the Carolina Biological Supply Company began producing slides of tissues fixed and embedded in the same manner as for electron microscopy. Tissues are fixed with osmium tetroxide and embedded in epoxy resin. This allows for better preservation of tissues and the ability to make thin sections with an ultramicrotome. The sections are 1.5 μm thick whereas conventional paraffin sections are about 7 μm thick. As a result, these slides are probably the finest ever made for observing fine detail of tissues at the light microscopic level.

1.5 μm Section of Monkey Skin, c1980

The future of the microscope slide is uncertain. Medical schools are increasingly turning to the virtual microscope in which a very high resolution scan of a slide is viewed and manipulated on a computer screen. It is no longer necessary, as in the past, to supply each student with a set of slides in histology, neuroanatomy, pathology, and microbiology courses. Slides will still be needed to perform scans for the virtual microscope, in research laboratories, and diagnostically in clinical medicine. However, the large scale production of teaching slides is probably over. It is, therefore, all the more important that microscope slides depicting one of the most important eras in the history of science and medicine be preserved.



1.5 µm Section of Monkey Skin showing epidermis, dermis, and hypodermis with fat cells and sweat glands, c1980

Sliders

Early Sliders, c1704

Sliders were the original carriers of objects for microscopical observation, described as early as 1691 by Filippo Bonanni (1658-1723), an Italian Jesuit scholar. Sliders are rectangular slabs, beveled at one end, usually made of bone, ivory, or ebony with round compartments cut out. Specimens were placed between two round pieces of mica and held in the compartments by brass rings. These sliders are small (~3⁄8" x 2"), have two or three compartments, and fit into a fish skin case. They accompanied the Culpeper screw-barrel microscope and were most likely made by Edmund Culpeper or James Wilson. A set of sliders identical in size, shape, lettering, and case is in the Museum of the History of Science, University of Oxford, and attributed to Wilson and dated c1704. The date is plausible because the sliders are the same as one illustrated in Wilson's 1706 pamphlet describing his pocket microscopes.

Early Sliders, c1704

Sliders pictured in Wilson's 1706 Pamphlet

Nuremberg Slider, c1770

This is a wooden Nuremberg slider for use with the Nuremberg toy microscopes. It is 6 ¼ inches long, ¾ inches wide, and ¼ inch thick. The ends are beveled. There are six cells with the specimens held between micas and secured with steel rings. The wood appears to be walnut.

Sliders, c1780

This is a set of seven ivory and eight ebony sliders in a case, eighteenth century. These sliders are larger and have more compartments than the earlier sliders. The sliders have four compartments which can be moved successively under the objective. The specimens in the ebony sliders are attached to a substrate. Those in the ivory sliders are secured by micas and brass clips. There are a variety of objects: insects, wood, feathers, butterfly wings, hair, plants, minerals, shells, etc. All specimens are intact.

Slide Collections and Cabinets

Set of Circular "Slides" by Abraham Ypelaar, 1808-1811

What can be considered the first slides are round bone or ivory rings of various sizes. Some are hexagonal. Within the circle, transparent objects were held in place between two micas by a brass or gilded ring. Opaque objects like pieces of shell, insects, stone or small seeds could be glued on carton. These can be considered slides because they could be placed on a stage and moved around. They were made from about 1790 to 1820 when rectangular slides began to be made.

The first round slides were made by Abraham Ypelaar (1736-1811) in Amsterdam. At a young age, Ypelaar developed a fascination for microscopy and the writings of Antoni van Leeuwenhoek and Jan Swammerdam, the great Dutch microscopists of the seventeenth century. A diamond setter by origin, Ypelaar later turned his hobby of preparing zoological, botanical and inorganic microscopical specimens into an important business. With the help of his cousin, Ypelaar started a "factory" for the commercial production in ready-made microscopical preparations. They picked up on the growing awareness of scientific culture by the middle classes. Instrument makers usually would provide most commercial microscopes with an amount of ready-made preparations in long bone-sliders. Ypelaar, however, produced round bone rings. The preparations produced by Ypelaar drew on both aesthetics and natural history. The opaque specimens in particular were arranged in attractive geometric patterns or formed as flowers. Ypelaar himself even referred to his specimens as "artistic objects" and he wrote about his own artistic ability as being appreciated by competent art experts. He produced specimens in sets and cabinets ranging in size from 20 to 1,600. In 1808 he was awarded a silver medal at the Holland Industry Exhibition. Ypelaar's slides are extremely rare outside of museums.

This is a set specimens prepared by Ypelaar and contained in the original 6.5 x 8.5 cm mahogany box with pull-out tray with glass cover. There are 24 prepared ivory cells of opaque specimens in exceptional condition. Over a third are arrangements of multiple pieces, including two in the form of charming flowers Others are eight-sided kaleidoscopic patters, early forms of the later diatom and butterfly scale arrangements. Other specimens are insects, plants, and minerals. All of the cells are numbered in pencil. Included is the original identification list in manuscript (in Dutch) signed by Ypelaar in wood block print. Ypelaar's name is followed by "& comp" indicating this set was made between 1808 and 1811.


Ypelaar "Slides"

Circular "slides" 1780-1810

These are 12 circular and two hexagonal slides. The six cells with thin walls were made by Abraham Ypelaar in Amsterdam. Some of the others are French. Some are opaque preparation and in others the specimens is held between micas.

Set of Continental Circular Slides, c1790

This is a numbered set of 11 (of 12) circular ivory cells, 5/8 inches (16mm) in diameter, set with botanic specimens between transparent disks of mica and held in place by brass spring rings. Many objects are as-collected; some are thin sections. One or two specimens seem lacking; otherwise the set is in very fine condition, complete with its little cylindrical paper and leather-bound card case.

Set of French Circular Slides, c1790

This is a very rare complete set of twenty circular, ivory slides. The varied specimens are set between two micas and held by a brass circlip. All of the cells are labeled in French. Some of the cells have the letter "T" on the reverse, perhaps the sign of the maker. The cells are 15 mm in diameter. The cells are held in a mahogany case 88 mm x 77 mm with a sliding lid. All of the slides are in excellent condition with clear writing and no loss to micas and specimens.

Set of French Circular Slides

Set of French Circular Slides with Microscope, c1820

This is a set of circular slides probably made in France. These specimens are held in a plate screwed into the bottom of a small drum microscope. The brass microscope focuses by rack and pinion and has a mirror below the stage. It is missing the eyepiece and glass circle for the stage.

The specimens are listed (in French) on paper on the inside of the baseplate:

1. aphid wing
2. wood of red gooseberry
3. bedbug
4. wing of collibelle
5. egret ?
6. flea

Early Paper-covered Slides

This is a group of papered cardboard slides dating to the period 1835-1850. The slides are of plants: Nasturtian, Sea Weed, Godetia, Mallow, Evening Primrose, Begonia Seed, Hop, Campanula, Oriental Mallow, Holyoake. The slides are made of cardboard, have a piece of thick glass over the object, and are wrapped in paper. The different sizes, types and patterns of the papers used, and the use of a thick irregular piece of glass for a cover illustrate developments in the preparation of slides at this time. In England, there was a tax on glass and windows that had been introduced in 1696. It was not until 1845 that the glass tax was repealed and the window tax six years later. This led to an unprecedented reduction in the price of glass. Prior to this, the effects of the tax resulted in a scarcity and variable quality of the material used in early glass microscope slides. There were often variations in color, thickness and size. These slides are of cardboard, probably to conserve glass, and have a smaller glass cover. The slides are of different sizes. No standardization of slide size existed until a resolution by the committee for the members of the Microscopical Society of London was passed in 1839. It suggested slide sizes of 1" x 3" and 1 ½" x 3". The blue slide to the left is standard size. Individuals still cut the glass for their own slides and cover glasses, using a cutting-board and diamond kept by the Curator. Eventually, these sizes were accepted universally.

Regarding the papers, the Rotary press printing machine invented by Richard March Hoe, in New York City in 1843, speeded up the printing process for chromolithography and reduced the price of printed papers of all kinds. It is therefore possible to date the introduction of patterned printed papers suitable for microscope slides to the early years of the 1840s. Paper as a covering for glass slides came into use in the 1830s. These slides show a number of different types of paper, the earliest of which is the plain and marbled papers (upper right). There are various printed patterns of the 1840s one of which is the Star pattern.

John T. Quekett Slides, c1850

These important slides in were prepared by John Thomas Quekett (1815-1861) who was Conservator and Professor of Histology at the Hunterian Museum of the Royal College of Surgeons. Quekett's work was of great importance towards making the microscope a vital scientific research instrument. His histological preparations were advanced and innovative for the time and set the standard for others. There are 11,000 of his slides in the Hunterian Museum. These slides are examples of the two main types that he made, one with a diamond-engraved description “Part of the lung of the Boa constrictor lower end” in Quekett's own hand; and the other with a handwritten description “Muc Memb. Crop Fowl” and numbering system for his slides. Quekett never made slides for commercial purposes. His slides remained with the Hunterian Museum and are almost unknown outside the Museum .

Born in England in 1815, John Thomas Quekett was the youngest of four brothers, each with a predilection for natural history. He developed an interest in microscopes early in life and at the age of sixteen built his own microscope with a roasting-jack, parasol, and some fragments of brass. Quekett chose the field of medicine as a career and entered King's College and the London Hospital Medical College as an apprentice to his brother Edwin. In 1840, Quekett was awarded his Diploma of Membership in the Royal College of Surgeons and gained a three-year studentship there in Human and Comparative Anatomy. He was involved in the repair and maintenance of specimens in the Hunterian Museum. At the end of his three year term, his ability in making and arranging microscopical preparations was recognized and he was appointed Assistant Conservator of the Museum. He prepared a series of microscope slides closely related to and illustrative of the finer structure of many of the preparations in the Physiological Series of the Hunterian collection. Many of these are fine injected specimens. The slides, numbering nearly 3,000, were purchased by the College in 1846. He gave lectures on histology that were published in two volumes in 1852 and 1854 as "Lectures on Histology." In 1848, he wrote "A Practical Treatise on the Use of the Microscope," an important work leading to rapid growth in the popularity and scientific potential of microscopy. It was also the first work to address specimen preparation techniques for the newly effective achromatic compound microscopes. In 1852, he was rewarded with a professorship in Histology at the Royal College of Surgeons. He was appointed Resident Conservator of the Hunterian Museum, succeeding Sir Richard Owen in 1856.

In 1839, Quekett and his brother Edwin were among the seventeen founding members of The Microscopical Society of London, the world's first microscopical organization, renamed the Royal Microscopical Society in 1866. He was made honorary secretary of the Microscopical Society in 1841, a position he retained for 18 years. In 1857, he was made a Fellow of the Linnaean Society, and in 1860, a Fellow of the Royal Society. He was elected president of the Royal Society in 1861. He held office for only a brief period, however, dying only six months later of Bright's disease at the age of 46.

The Blenkins Cabinet

George Eliezer Blenkins

George Eliezer Blenkins, F.R.C.S. (1815-1894), was one of the earliest members of the London Microscopical Society, joining in 1848. The London Microscopical Society became the Royal Microscopical Society in 1866. Blenkins was Surgeon to the Grenadier Guards serving in the Crimean campaign and a Lecturer in Anatomy at St. George's School of Medicine in London. Beginning in 1851, he was one of the first to introduce histology into a medical school curriculum and taught a course of practical histology in which every student was provided with a microscope and taught how to make their own preparations. He was Secretary of the Royal Microscopical Society from 1858 to 1867.

Blenkins life is described in his obituary which appeared in the British Medical Journal No. 1762, October 6, 1894, p 789.

DEPUTY INSPECTOR-GENERAL G. E. BLENKINS, F.R.C.S.

We have to announce with regret the death of Deputy Inspector-General G. E. Blenkins, F.R.C.S., late Grenadier Guards. He entered the regiment in April, 1838, and served in the Crimean campaign including the fall of Sebastopol, receiving the gold medal with clasp, the 5th Class of Medjidie, and the Turkish medal. After serving more than thirty years in the regiment he retired, in December, 1868. Mr. Blenkins has so long retired from active work that the younger generation will hardly recognize his name as one of the most active and valued workers some thirty years ago. He was one of that distinguished class of army surgeons, then by no means too numerous, who to a thorough knowledge of his profession and departmental duties, added a great love of scientific research in the active study of its most difficult departments. He was a practical and skilful histologist, when to be so was a rare distinction even in the schools in civil life.

We incline to believe that he was the first amongst the teachers of histology in the metropolitan medical schools who instituted classes of practical microscopic work and demonstration. He lectured and taught at Lane's School of Anatomy and Medicine adjoining St. George's Hospital, and as far back as 1851 he carried on there a class of practical histology, in which every student was provided with a microscope, and was taught himself to make, prepare, and put up the specimens. This class Mr. Blenkins conducted while a surgeon in the Guards, and it had, at that time at least, few if any parallels in this country, for what is now an every day rule of teaching was then a rare and brilliant exception.

This brief tribute is due to the memory of one of the most lovable and accomplished surgeons of his day, for to a handsome presence, great dignity and refinement of manner, of which the only fault perhaps was a somewhat marked reserve, Mr. Blenkins joined singular modesty, unfailing kindness of heart, and an interest in the personal welfare of his pupils which lasted throughout his and their lives.

Blenkins' slides are housed in a very fine mahogany cabinet of the 1850 period measuring 22 ½ inches in height, 14 ½ inches deep, and 12 inches wide. It weighs 50 pounds with slides. This cabinet is of great historical significance because the owner and maker of most of the slides is identified, its date is established, and it was undertaken at a time when the making of glass slides, especially of a histological nature, was in its infancy.

Some of the drawers contain blank slides, mounting papers, specimens wrapped in paper, and an envelope with Blenkins name on it. All of this material that was used in mounting has been left intact and its presence suggests that this was a working cabinet that has been untouched since the time it was in use. The cabinet could justifiably be described as a time capsule of the histology slide collection of a surgeon of the mid 19th century.

The cabinet was purchased from Brian Davidson in England. He is a scholar of early microscopy and holder of probably the largest and best collection of microscope slides in private hands. It was his wish that this cabinet be preserved intact. The provenance of the cabinet is unknown. Davidson purchased it at auction in London about 30 years ago. It had been in the hands of a dealer for a short while, and possibly sold to the dealer by a descendant of Blenkins.

Drawer knobs with paper labels

There are fourteen drawers each with three knobs. Each knob has a paper label identifying the contents of drawer. The knobs on the drawers are labeled Diatoma; Diatoma; Spicula of Spong; Shell; Bone; Bone; Skin, Fat; Epithelium, Spermatozoa; Fibrous Tissue, Fat; Teeth; Cartilage; Quill, Hair, Feather; Muscle; Tongue, Mouth; Pharynx, Stomach, Oesophagus; Nose, Lung, Air Tubes; Liver; Eye; Spleen, Pancreas; Urine; Intestine; Brain, Nerve; Entozoa, Epizoa; Eye, Ear, Arteries; Knob missing (Scales); Limbs, Antennae, Insects; Ovipositor, Spiracles, Stings; Vegetable Cells, Hairs; Scales, Cuticle, Spiral Vess; Nuts, Woody Tissue; Scalaus Tissue, Spiral Vess; Photographs, Metal; Algae, Seaweed; Polariscope; Seeds, Vegetables; Anthozoa; Skin; Intestine; Liver; Lung; Kidney; Uterus.

Drawer with diamond engraved slides

Drawers with deep cell fluid mounts.

All except the bottom two drawers have the slides upright in slots. The lower ones contain a number of deep cell fluid mounts which are horizontal and held in place by two removable mahogany strips. There are about 950 slides in the collection and about half of them are histological in nature. The majority of the slides are diamond engraved, undoubtedly in Blenkins' own hand. Each slide is engraved with a description and its number, drawer, and division (row in the drawer). A few have Blenkins' initials and some are dated, the earliest being 1847. Most of the slides are likely the work of Blenkins himself and were made between 1850 and 1865. There are also a few microphotographs of Blenkins.

Diamond-engraved writing, microphotograph of Blenkins.

Fluid mounts of human skin

Blenkins' collection contains two fluid mount slides with the following notations: "Villi of Chorion, Human Ovum, Described & Figured, Microscopl Transact, June 10th, 1857"; and "Human Ovum, Described & Figured, Microscopl Transactions, June 10, 1857". These slides were the basis of his note entitled "On an early Human Ovum" published in the Society's Transactions in 1858. This is one of the first microscopic accounts of an early human embryo. The embryo can be identified as about Stage 13, 32 days.

Human Ovum

Described & figured
Microscop'-Transactions
June 10 - 1857

Drawing of the "Ovum" from Blenkins' paper

Blenkins' fluid mount slide of a human embryo ("Ovum"), description published in the Transactions of The Microscopical Society of London, N. S., 6: 5-9, 1858, one of the first microscopical accounts of an early human embryo.

Histology – Pathology Cabinet

This is a very fine cabinet of histology and pathology slides. They appear to have been the collection of one man, probably the maker of the slides. They may have been the teaching slides of a professor. The histology slides cover all the tissues of the body with only one or two exceptions and represent a set sufficient to teach a course. Similarly, the pathology slides cover the diseases most prevalent at the time. The cabinet is 15 inches wide at the base and 19 ½ inches high. There are 50 large 1½ x 3 inch slides and 109 slides of normal size. The slides appear to date from the latter part of the 19th century. The cabinet is of very fine quality with mahogany double doors and a handle on each side. The ten drawers are inlaid at the front with a contrasting light-colored wood and have a pair of turned bone knobs. Each of the slides has its own compartment separated from the next one by a wooden partition. This cabinet with individual cells would have been expensive to make and indicates the importance the owner attached to the collection. The cabinet was obtained from Brian Davidson in 2008.

Drawer 3

Nineteenth Century Cabinet with Entomological Slides

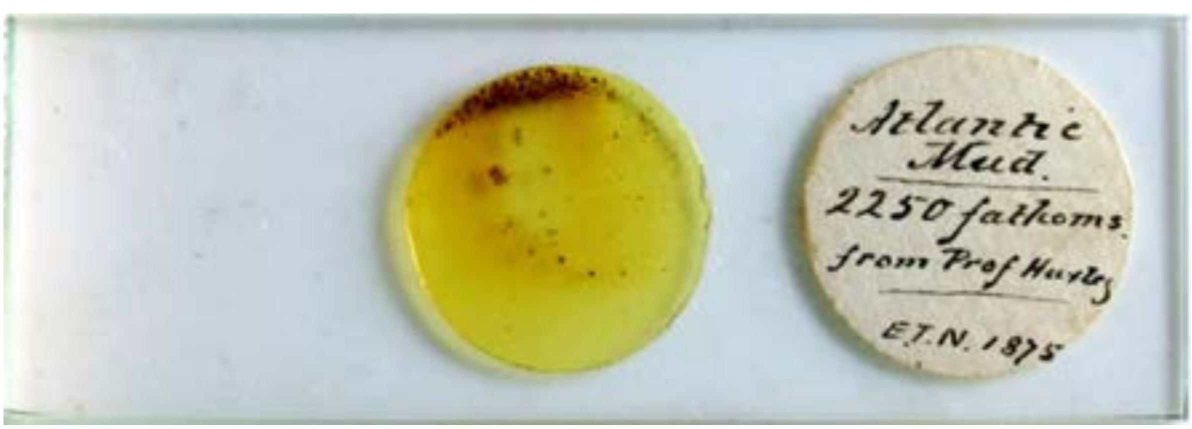
This is an 11 x 10 x 11½ inch cabinet containing 500 slides. The first 128 slides are butterfly and moth wings with about 70 being British butterflies and the rest from around the world. The labels show the Latin and common names of the butterflies. These may be amateur preparations by an entomologist but the slides are of high quality. The remaining slides are professional mounts by makers including Smith, Beck & Beck, Enock, Russell, Wheeler, Topping, Norman, Bourgogne, Cole, and Dancer. Most are colored paper-covered slides and others are diamond-engraved. Many of the latter are signed "T" [Topping]. These slides are representative of the subjects, including diatoms, polycistina, foraminifera, insects, plants, objects for polariscope, etc., most popular for viewing with the microscope in Victorian England. A few slides are dated between 1872 and 1875.

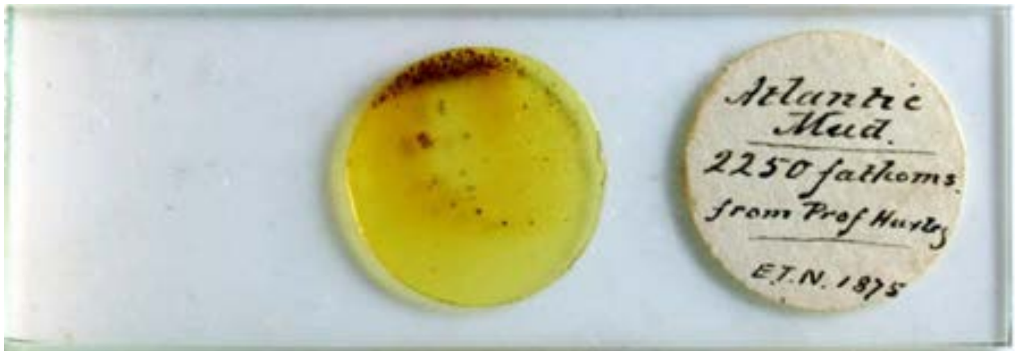
Newton-Huxley Slides

This collection of eight slides has a close connection with Professor Thomas Henry Huxley (1825-1895). Huxley was a champion of Charles Darwin. His keen and vocal support, and his public debate with William Wilberforce, did much to convert many to Darwinism. Huxley was a comparative anatomist, interested in fossils, geology and evolution. After spending time in the Navy as a Surgeon, he was elected Fellow of The Royal Society in 1850. In July 1854, he became Professor of Natural History at the Royal School of Mines and naturalist to the Geological Survey in 1855.

These slides were made by Professor Huxley's assistant, Edwin Tulley Newton, (1840-1930). In 1868 Newton was appointed assistant to Huxley who was at that time naturalist to the Geological Survey. These slides were made in this period. In 1882 he was promoted to be paleontologist to the Geological Survey, a position which he occupied until his retirement in 1905. One of Newton's earliest successes was his preparation of the first satisfactory microscopic sections of coal, which were used by Huxley in a lecture at Leeds in 1870 and they were described and discussed by Newton himself in his first scientific paper, which was contributed to the "Geological Magazine" in 1875. His chief official duty as paleontologist to the Geological Survey was the naming of the fossils collected and the preparation of lists of these fossils for the memoirs that accompanied the maps.

These slides, labeled in Newton's own meticulous hand, are all dated 1875. Three slides of Atlantic sea bed mud from 2250 fathoms, mention Professor Huxley by name. Other slides are of Norfolk Island Pine. Two of these are from the Thames Embankment at the Houses of Parliament. Finally there is a slide of sections through a sea urchin's spines. The slides are in a nineteenth century wooden box labeled on the inside of the lid "E. G. Howard, F. R. M. S." There is a lantern slide of Professor Huxley in the lantern slide collection.



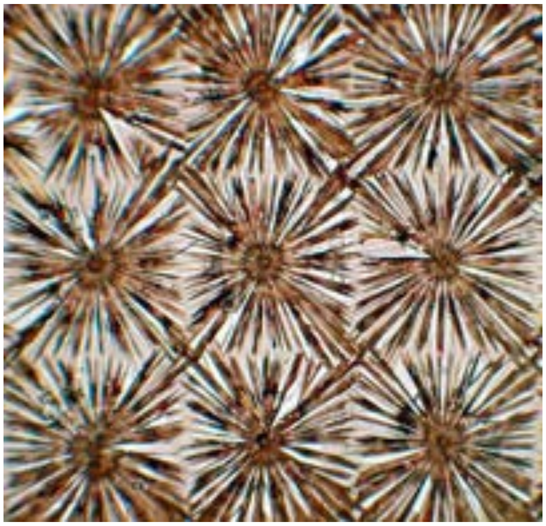


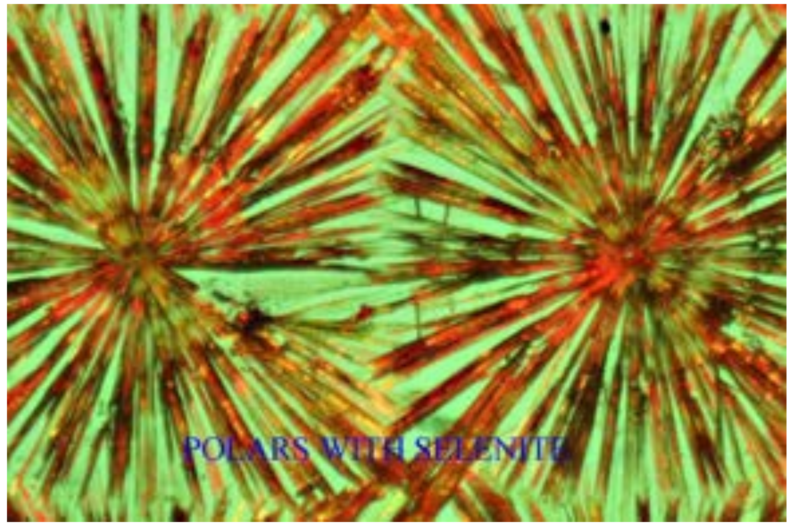
Atlantic Mud, 2250 fathoms, from Prof. Huxley, E. T. N. 1875

Norfolk Island Pine, Thames Embankment, House of Parliament, 1875, ET. Newton

Dancer Chemical Preparations, c1870

This is a set of ten chemical preparations by John Benjamin Dancer (1812-1887). Dancer sold a wide range of scientific equipment, but he is best known as the originator of microphotographs. He produced a long series of microphotographic slides on many subjects (see The Lord's Prayer in the Lentz Collection of slides). He also produced chemical preparations that are extremely rare. The slides bear two printed labels marked with "J.B.D." and the number. The left hand label gives the chemical name, molecular formula, and microscope viewing instructions. The right hand label provides information about the chemical. The slides are suberic acid, benzoic acid, azeliac acid, phthalic acid, palmitic acid, margaric acid, diazoamidotoluol, binitrobenzol, aniline, vanadic acid, and hematoxylin. Hematoxylin, derived from logwood, is widely used as a stain for tissue sections. It is not uncommon to see nineteenth century slides with the stain listed as "logwood."





Slides from the Challenger Expedition

Modern oceanography began with the Challenger Expedition that took place between 1872 and 1876. It was the first expedition organized specifically to gather data on a wide range of ocean features, including ocean temperatures, seawater chemistry, currents, marine life, and the geology of the seafloor. For the expedition, HMS Challenger, a British Navy corvette (a small warship) was converted into the first dedicated oceanographic ship with its own laboratories, microscopes, and other scientific equipment onboard. The expedition was led by British naturalist John Murray and Scottish naturalist Charles Wyville Thompson. Thompson had previously dredged some curious creatures from the ocean depths in the North Atlantic and the Mediterranean Sea, and these discoveries persuaded the British government to launch a worldwide expedition to explore the ocean depths. The Challenger Expedition left Portsmouth, England, just before Christmas in 1872. The ship had many different types of samplers to grab rocks or mud from the ocean floor, and nets to capture animals from different levels in the ocean. Challenger also had different winches, mechanical engines used to lower and hoist sounding lines to measure how deep the ocean was. At each sampling station, the crew lowered trawls, nets and other samplers to different depths, from the surface to the seafloor, and then pulled them back on board loaded with animals or rocks.

Challenger first traveled south from England to the South Atlantic, and then around the Cape of Good Hope at the southern tip of Africa. It then headed across the wide and very rough seas of the southern Indian Ocean, crossing the Antarctic Circle, and then to Australia and New Zealand. After that, Challenger headed north to the Hawaiian Islands, and then south again around Cape Horn, at the southern tip of South America where the Pacific and Atlantic Oceans meet. After more exploration in the Atlantic, Challenger returned to England in May of 1876.

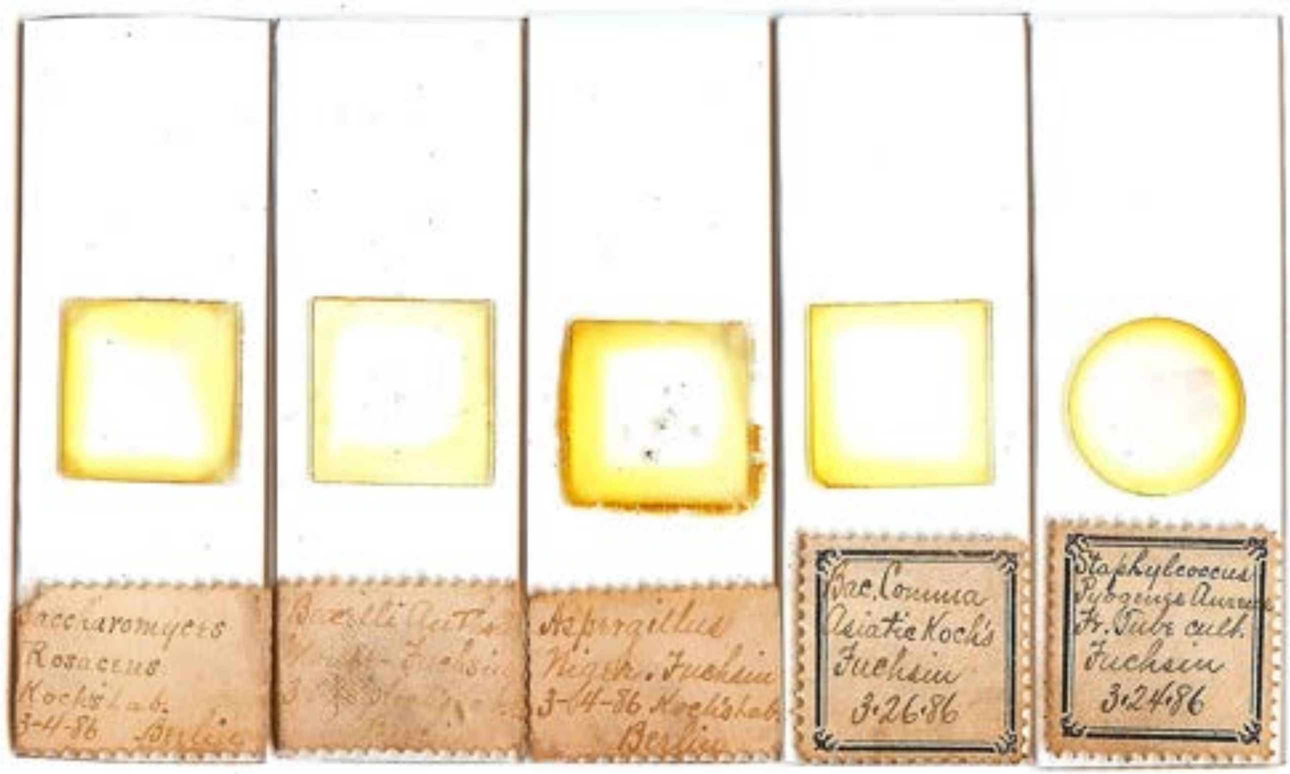
On her 68,890-nautical-mile (127,580 km) journey, 492 deep sea soundings, 133 bottom dredges, 151 open water trawls, and 263 serial water temperature observations were taken. About 4,700 new species of marine life were discovered. Among the Challenger Expedition's discoveries was one of the deepest parts of the ocean, the Marianas Trench in the western Pacific, where the seafloor is 26,850 feet, or more than 4 miles deep (8,200 meters). This is a set of six slides by different mounters of soundings from the Challenger Expedition.

Soundings from the Challenger Expedition by different mounters

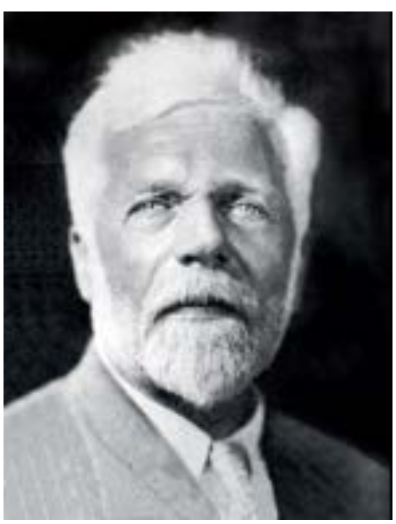
Microbiology Slides from the Laboratory of Robert Koch

Heinrich Herman Robert Koch (1843-1910) was a pioneer bacteriologist and the first to prove definitively that specific microorganisms cause specific diseases. He discovered the microorganisms causing anthrax (1876), wound infections (1878), tuberculosis (1882), conjunctivitis (1883), cholera (1884), and other diseases. He was professor at the University of Berlin from 1885 to 1891 and head of the Institute for Infectious Diseases (founded for him) from 1891 to 1904. He was awarded the Nobel Prize in Physiology or Medicine for his findings on tuberculosis in 1905. He is considered one of the founders of microbiology. This is a group of ten slides most of which bear "Koch's Lab" or "Koch's Lab Berlin" on the label. The slides are of M.

Tetragonus, B. Comma Miller's Tooth, Staph. cocci Pyogenes Alba, Staphylococcus Pyogenes Aureus, Bacilli Anthrax, Bacillus Megaterium, Aspergillus Niger, Saccharomyces Rosaceus, Bac. Comma Asiatic Koch's, and Micrococcus Prodigiosus. They are dated between 3-4-86 and 3-29-86 and were prepared not long after the discovery of these bacteria. They appear to be "working" slides prepared in the laboratory for scientific purposes. The slides were obtained from a descendant of a Polish physician who worked in Koch's lab and emigrated to the United States around 1900.



Keeley Collection of American Slides



Frank Keeley (1868-1949)

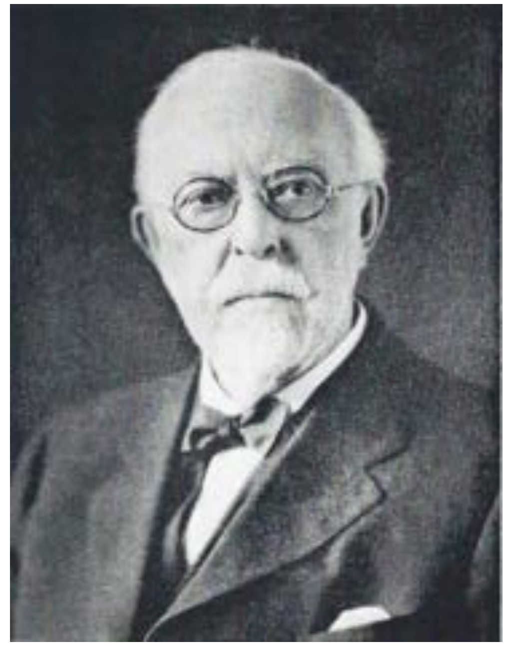
In the nineteenth century, there were a large number of commercial mounters in England, and many of these produced a large number of slides. There were fewer mounters in the United States and many of these had a relatively small production. However, at least 180 American makers have been identified. Some companies, like Queen & Co., sold English slides under the American label. In the twentieth century, American firms increasingly made slides for use in education. Medical schools often had laboratories for producing histology, pathology, microbiology, and neurobiology slides for medical students.

This is a rare collection of 72 microscope slides by American slide makers, from the late 19th century to the early 20th century. Most of these slides are from the collection of Frank J. Keeley (1868-1949). Keeley was a naturalist and microscopist who studied and contributed papers on diatoms and other biological objects and on optical mineralogy. He was initially a conservator at the Academy of Natural Sciences in Philadelphia, later the Curator of the Vaux Collection of minerals at the Academy. When he died, most of his extensive collection of microscope slides was left to the Leidy Microscopy Society in

Philadelphia. His slide collection was the basis for the best database of American slide makers through his lifetime. Many of these American slides are extremely rare. The slides are contained in a boxwood case with a hinged lid and front retained by brass catches.

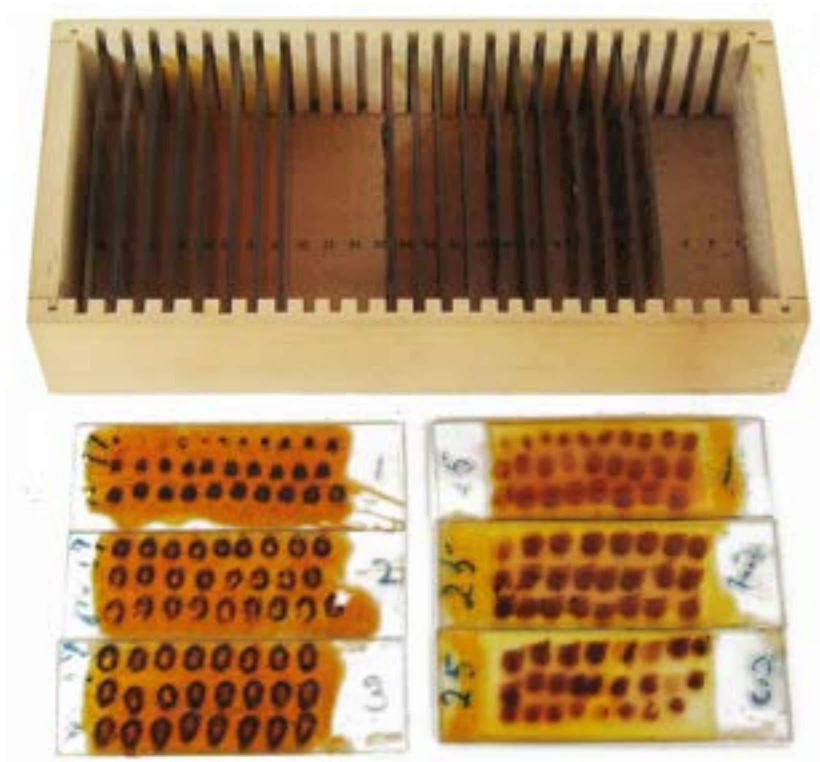
Keeley Collection
Simon Henry Gage Serial Sections, 1894

Simon Henry Gage (1851-1944) was one of the most important figures in the history of American microscopy. He was a Professor of Histology and Embryology at Cornell University. His book *The Microscope*, originally written for his students, went through seventeen editions from 1881 to 1941. In 1883, he published with Theobald Smith a paper on serial sectioning that was one of the first serious discussions of serial sections in histology and embryology. Gage, with his wife Susanna Phelps Gage, used serial sections to create three dimensional models of the specimen. He was a President of the American Microscopical Society. He was a founder and editor of the American Journal of Anatomy. He wrote numerous research papers on microtechnique, the newt, toad, lamprey, fat digestion, and comparative anatomy of the pancreas. Gage retired in 1908 but remained active for the rest of his life in teaching and research. His manuscript on *Microscopy in America (1830-1945)* was published in 1964.



Simon Henry Gage

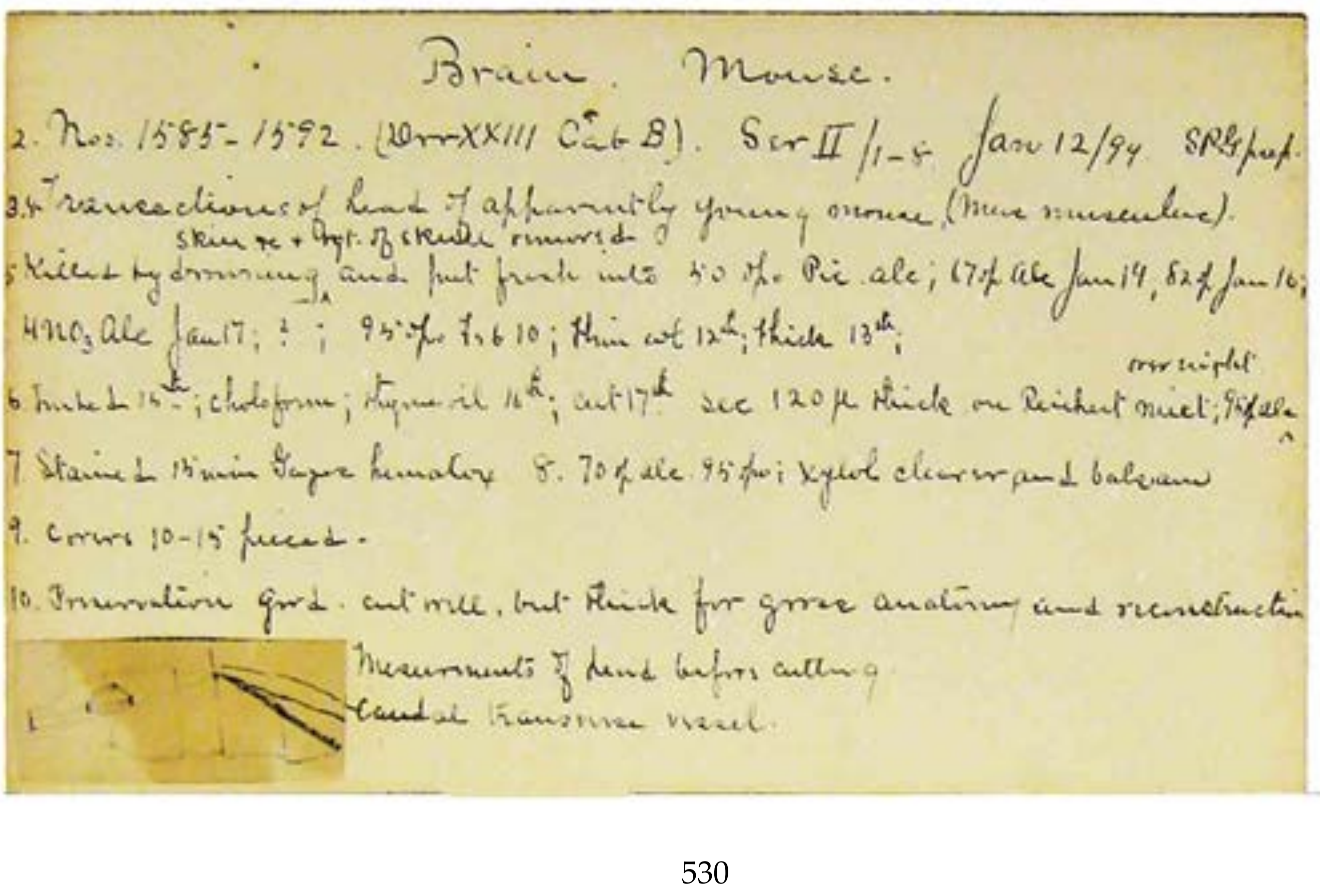
This is a set of 25 slides with serial sections of several different specimens. On 14 slides, the sections are covered in a thick uneven layer of balsam. The other eleven slides have coverslips. There are handwritten notes in the box dated June 94. The notes indicate the specimens are of white mice and describe the sections and stains used. The slide box is lightly initialed in pencil "SPG" for Susanna Phelps Gage. The set was originally obtained from a descendant of Simon Gage.



Simon Henry Gage Serial Sections
Susanna Phelps Gage Serial Sections of Mouse Brain, 1894

Susanna Phelps Gage (1857-1915) attended Cornell University where she earned a PhB degree in 1880. While at Cornell, she earned the distinction of being the first woman in the history of the university to take a laboratory course in physics. In 1881, she married Simon Henry Gage, a professor of histology and embryology at Cornell. After graduating from Cornell, she became a respected embryologist and comparative anatomist. However, like most other women scientists of the late 19th and early 20th centuries who were married to scientists, Gage's research was often viewed as a mere adjunct to her husband's projects. In 1904, she joined the research team at the Bermuda Biological Station. The following year, she began to study neurology, first at Johns Hopkins Medical School and, in 1905, at Harvard University. She incorporated her education in neurology into her research on the comparative morphology of the brain. She also explored the development of the human brain, the comparative anatomy of the nervous system, and the structure of muscle. She published several papers on these topics. An adept artist, Gage illustrated her papers, as well as those of her husband, with meticulous detail. She was elected a fellow of the American Association for the Advancement of Science and was also a member of the Association of American Anatomists. She was one of only 25 women to be highlighted as particularly significant contributors to their fields in the 1910 edition of *American Men and Women of Science.*

This is a collection of 25 slides of serial sections of mouse brain. The slides are accompanied by three cards, dated January 12 and 13, 1894, that list the steps taken in the preparation of the slides: fixation, embedding, sectioning, staining (Gage's hematoxylin), and mounting. The preparer is "SPG" (Susanna Phelps Gage) and "SPGage." The cards are significant in describing the steps taken in the preparation of histological slides at the end of the nineteenth century. Serial sections like this were used by the Gages in preparing three dimensional models of the brain. They also confirm the status of Susanna Phelps Gage as an independent investigator and one of the first woman histologists. (see J. Comp. Neur. **27**:5-18, 1916)



Brain. Mouse.

2. Nos. 1585-1592. Ser II/1-8 Jan 12/94 SPG prep.

3.4 Transections of head of apparently young mouse, (Mus musculus).

5 Killed by drowning and put fresh into 50 % Pic. alc; 67 % alc Jan 14, 82 % Jan 16;

HNO_3 alc Jan 17; 95 % ; Thin cut 12th; thick 13th;

6. chloroform; cut 17th sec 120 μ thick on Reichert micr.

7. Stained Gage's hematox 8. 70 % alc 95 %; Xylol clearer and balsam

9. Covers 10-15 pieces.

10. Preservation good. cut well, but thick for gross anatomy and reconstruction

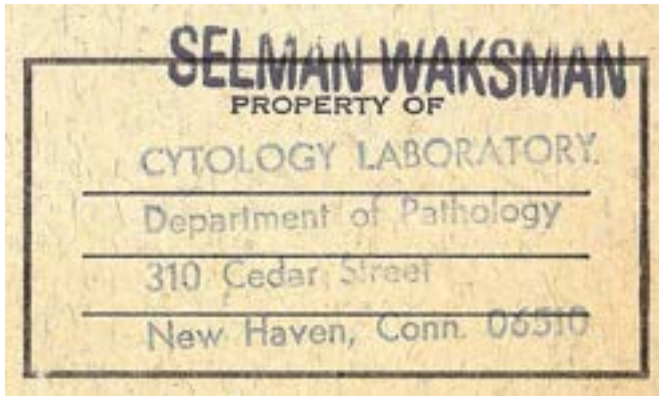
Measurements of head before cutting

Susanna Phelps Gage Serial Sections of Mouse Brain

Meteorite Petrographic Slides

This is a collection of 15 1" x 2" thin section, petrographic microscope slides of meteorites. They were made in the A. P. Karpinsky All-Russian Institute of Geological Research (VSEGEI) thin section workshop.

Waksman Collection of Microscope Slides



This collection was purchased on eBay in 2009 for $999. The seller said he purchased them from members of Byron Waksman's family. The collection consists of eight folders each holding 20 slides. All of the folders are stamped with the name Selman Waksman. Some also bear a stamp for the Cytology Laboratory at Yale. The subjects of most of the slides are histology, pathology, and microbiology. The slides bear various labels: Neuropathology Department; Mass. Gen. Hosp. Boston; Dept. of Pathology, Yale University; and others.

Selman A. Waksman (1888-1973) received the Nobel Prize in Physiology or Medicine in 1952. He isolated a number of antibiotics, most notably streptomycin in 1943 and neomycin in 1948. Selman's son, Byron, was a Professor of Microbiology at Yale. In my opinion, most of the slides were Byron's and that he used Selman's slide folders. A few microbiology slides in storage in the

Yale TAC building are the same as in this collection. It is possible some of the older slides were Selman's.

Histoslides

James B. McCormick, M.D. is a pathologist, inventor, and consultant to the scientific and healthcare industry. He received his M.D. degree at the University of Illinois in 1949. While in medical school, he formed the Histoslide Company to prepare and sell teaching slides and models for the biological sciences. Between 1957 and 2011, he was granted 50 patents for a broad variety of laboratory and clinical science applications. Dr. and Mrs. McCormick founded Science Heritage Ltd. in 1975. This firm produced high quality reproductions of historic microscopes, several of which are in this collection. The microscopes are described in *The Atlas Catalogue of Replica Rara Ltd. Antique Microscopes (1675-1840)*. Presently, Dr. McCormick is associated with the Swedish Covenant Hospital in Chicago where he serves as Chairman of the Swedish Covenant Hospital Foundation. This is a collection of four slides prepared around 1950.

Histoslide by James B. McCormick, c1950

Brian Bracegirdle Slide Collection

No 300 Human Hand of 3 months foetus, 4 ½ months Hor. sec., J J Hunter Preparer. Illustrated in Bracegirdle's *A History of Microtechnique* (1978, p.195).
239 J.N., Human Stomach Sect : trans. Wooden slide.
379 J.N. Frog. Lung. Inj J.N. -/79.
Lung Human, Sect. injected J.N. 1879.
Human Liver. Port: red, Hep: yellow. A doubly injected slide.
Section of Human Liver, Injected.
Rabbit Kidney, injected Trans. Sect. Prize Medal Paris 1867 Cole.
Section Hoof of Ox injected, for 1 ½ inch.
Longl Section Toe of Kitten (injected), Richard Suter, 5, Highweek Road, Tottenham.
Human Kidney V.S. Injected Carmine, Stained Logwood In Canada Balsam, No. 17. Prize Medal Paris 1867 Cole.
Foot of Still born Infant V.S. Prize Medal Paris 1867 Cole.
Section of injected emphysemus human lung. 1872.

These high quality anatomical slides belonged to Brian Bracegirdle (1933-2015). In 1976, the Wellcome Institute for the History of Medicine transferred its extensive collections to the Science Museum in South Kensington, London. Brian became Keeper of the Wellcome Museum in 1977 and retired in 1989. He was a prolific writer on a number of topics. Two books of relevance to this collection are *A History of Microtechnique* published in 1987 and *Microscopical Mounts and Mounters* published in 1998. The latter has descriptions of all known microscope slide makers and illustrations of nearly 1000 slides. It is the bible for collectors and scholars of microscope slides.

Fetal hand and stillborn hand

Lentz Collection of Microscope Slides, c1820-2008

The collection of 1000 slides contains examples of the types of microscopic preparations from the early nineteenth century to the present time. There are two main groups of slides. The first are exhibition preparations, diatoms, insects, zoology, botany, and mineralogy. Many, especially the exhibition slides, were made for the entertainment and enjoyment of those able to afford them and others were made commercially for educational purposes. Most of these slides were made in the Victorian age that is considered to be the golden age of microscopy. The second group are medically-related slides, particularly histology, and including embryology, neuroanatomy, pathology, microbiology, and materia medica. The collection is housed in two Victorian mahogany cabinets, each holding 504 slides. Representative examples of slides in the different categories are shown below.

Collection of Slides

Cabinet 1	Cabinet 2	
Early slides	Early histology slides	Teeth
Exhibition slides	The Cell	Digestive system
Test slides	Epithelium	Liver and pancreas
Diatoms and protozoa	Skin and derivatives	Nervous system
Insects and spiders	Connective tissue	Eye
Zoology	Bone and cartilage	Other Sensory organs
Botany	Blood and bone marrow	Endocrine glands
Pathology	Muscle	Male reproductive system
Microbiology	Blood vessels	Female reproductive system
Materia medica	Lymphoid organs	Embryology
Petrography	Respiratory system	Neuroanatomy
American slides	Urinary System	Evolution of microscope slides

Lentz Collection Slide Cabinets

Early Slides – 1830-1857

In the first part of the nineteenth century, the slider evolved into small glass slides of various sizes that fit the smaller stands of the period. Because thin glass was scarce and expensive, micas continued to be used for coverslips and were held on to the slide by covering papers. In some cases, the specimen was held between two glass slides held together by paper. In 1839, a committee of the Microscopical Society of London recommended two sizes for slides: 1 x 3 and 1 ½ x 3 inches. The 1 x 3 inch size was adopted by commercial preparers and soon became the most widely used standard. Some examples of early slides are shown here.

The slides are as follows:

Crab shell. 13 x 46mm, mica cover held on by green paper, possibly by James W. Bond, from the collection of Brian Stevenson. c1830.

Pou Humain. Human louse, 16 x 60mm, two slides held together by balsam and bound by green papers at the ends, possibly Joseph Bourgogne, from the collection of Brian Stevenson. c1830.

Wing of moth. 19 x 51mm, mica cover, red paper-covered cardboard slide, yellow border. Probably Andrew Pritchard. c1830.

Feather of Indian Humming Bird. 20 x 52mm, cut out printed label, mica cover, red paper-covered glass slide. Andrew Pritchard. c1835.

Pinus insignus. Andrew Pritchard. Specimens between two slides sealed at the edges with red wax. Printed label that may be cut from his book of 1832, *The Microscope Cabinet*. c1835.

Guiacum. Andrew Pritchard. Specimen under coverglass sealed onto slide, red paper edging. c1840.

Goat, Small Intestine, Tr. Vert. Sect., INJ. and IMB, Shewing the Peyer's glands, the epithelial cells, and the Lieberkuhn's glands. This is a transparent injected specimen prepared by Karl Thiersch (1822-1895), a German surgeon. Smith and Beck imported the slides from Germany in the 1850s. The slides are unnecessarily large for the size of the section and have a bluish tint. The labels are often informative as in this case where Peyer's patches and glands of Lieberkuhn are mentioned. There are several more of these slides among the histology slides. 35 x 72mm. c1850.

Superior Surface of Child's Tongue, Surface of Childs Tongue, 1857, B C. Opaque whole mount, diamond-inscribed, injected and corroded, showing blood vessels on surface. From the collection of Brian Davidson.

Child's tongue. In the top image, the slide has been placed on black paper to reveal the diamond engraving. 1857.

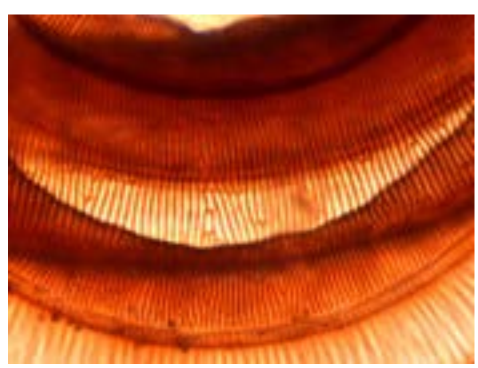
The preparation of tongue has been injected and corroded to reveal the surface blood vessels.

Human Bone Femur, Trans Sec. Diamond-engraved label, black paper over cover held on by typical Pritchard sealing wax, c1840.

Spermatozoa of the Dog, 1847. Mica sealed onto the slide with green paper. 24 x 64mm, from the Blenkins cabinet.

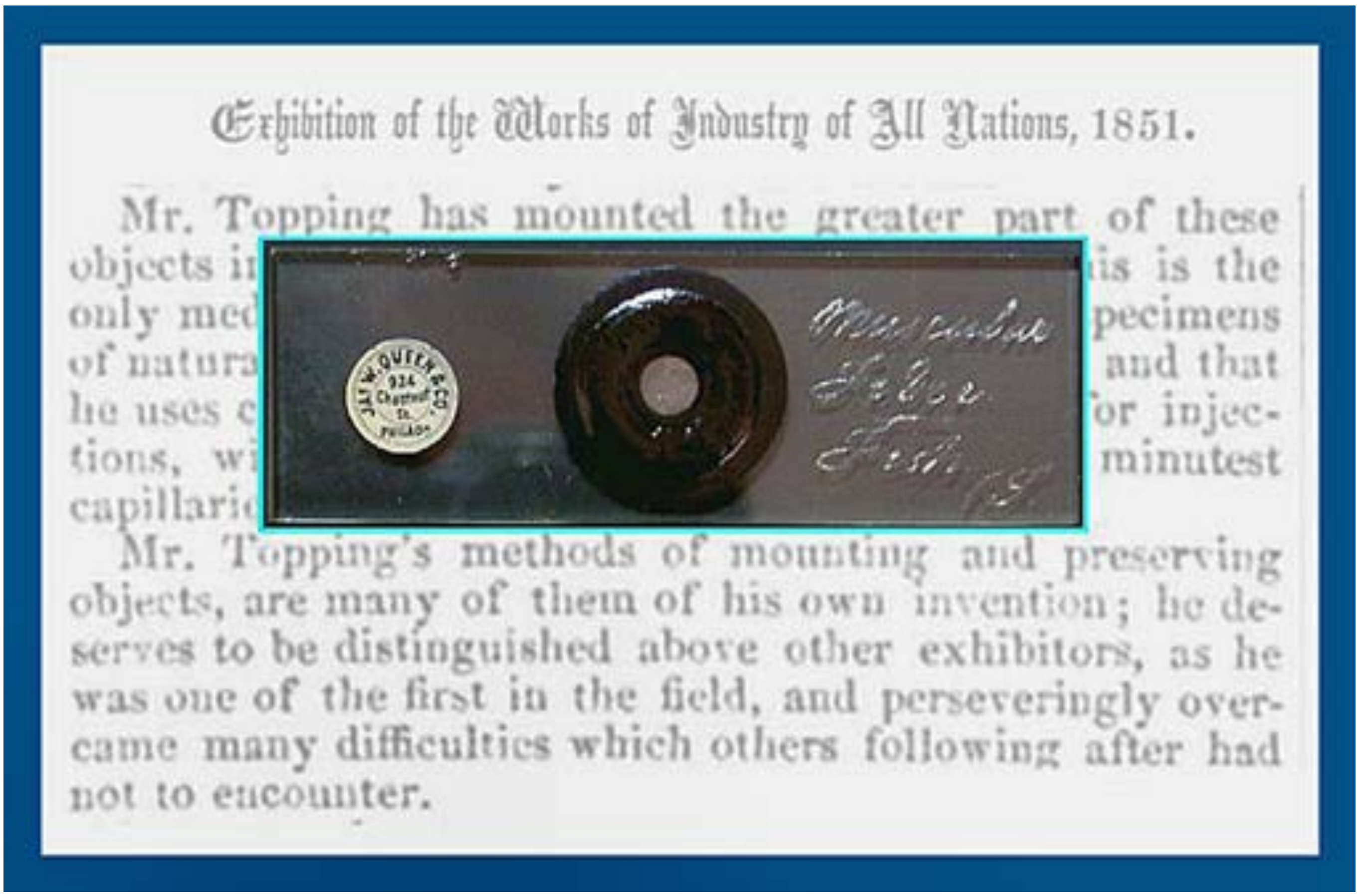
Ciliary processes & Iris of the Eye of the young Ox, 1850. Alexander Hett first advertised his slides in 1852. The slides are opaque injections having a large and deep glass cavity filled with fluid and cemented to a slide. There is a set of Hett slides in the collection.

Small slides, about 16 X 60mm, were made beginning around 1835 by Joseph Bourgogne in Paris and continued by his sons Charles and Eugene for many years. These “Continental” sized slides were made in great numbers for the small French drum microscopes.



Proboscis of Butterfly

This is an important early histology slide by Charles Morgan Topping (1800-1874), with diamond point engraved label and signed "T". The slide, titled "Muscular Fibre Fish" is one of Topping's early histology preparations, having been made in the mid to late 1840s. In Bracegirdle's *Microscopical Mounts and Mounters* for the entry on Topping, these slides are described: "Very occasionally his slides are named and signed only with a diamond point, using a handwritten monogram." The slide is shown superimposed over text from the comments in the report of the Jury at the 1851 Great Exhibition. This event would have been several years after this slide was probably made, but indicates the esteem in which he and his work were viewed. C. M. Topping is one of the most famous mounters in history and began mounting professionally in the late 1830s. The slide bears a secondary label of James W. Queen & Co. which sold scientific supplies in Philadelphia from 1853 to 1908.



Muscular Fibre Fish by Topping

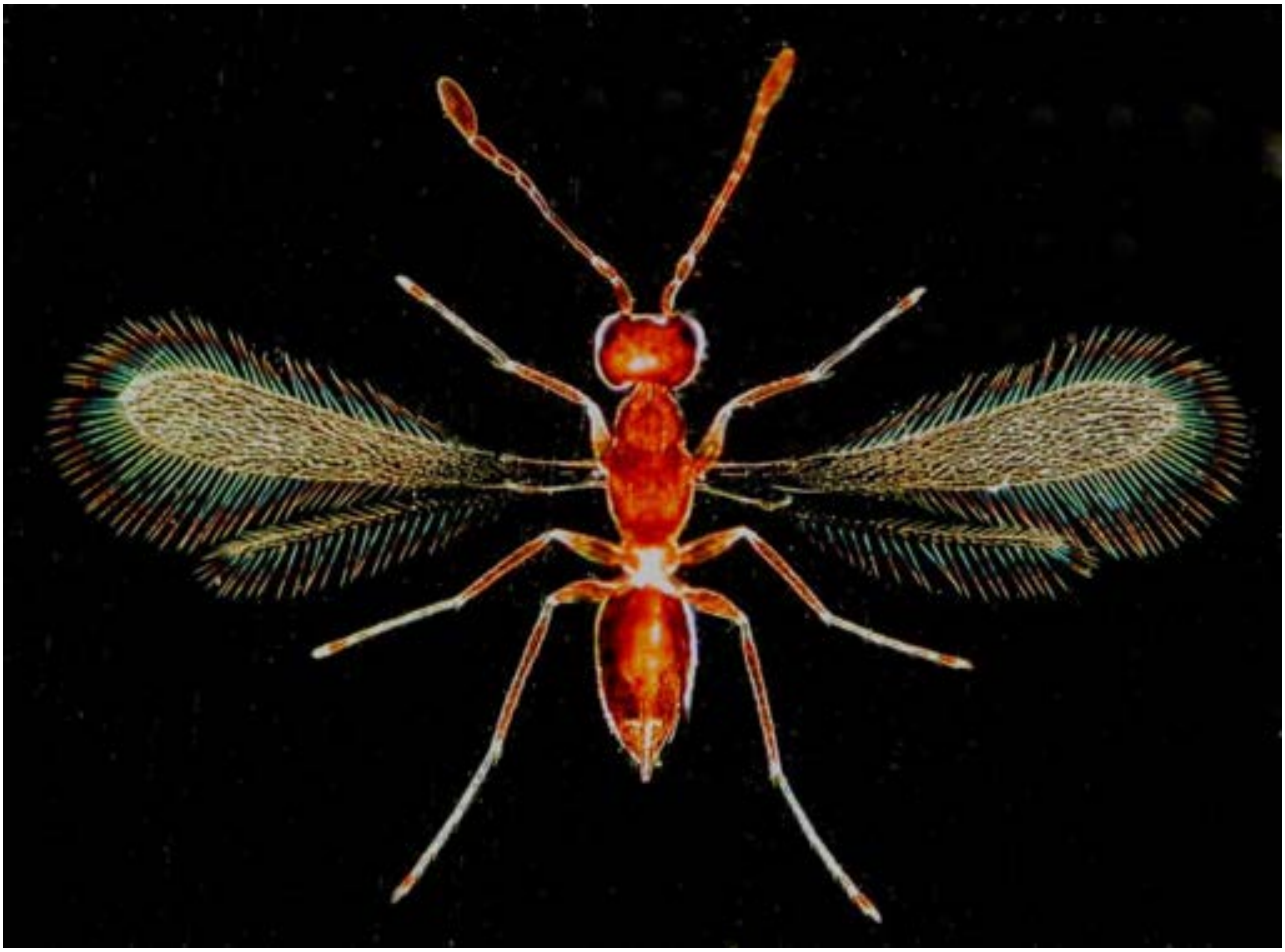
Victorian Paper-Covered Slides

Paper covers were first used to attach the mica covering slips to glass slides or to hold two slides together. Although they were not necessary after the introduction of Canada balsam in the 1830s, they continued to be used to cover slides. They became highly decorative, lithographed in bright color and gilt, and sometimes included the mounter's name or monogram. They were used less frequently after about 1880. Another type of decoration used by some mounters was polychrome ringing, in this example a gold colored shamrock cover.

Exhibition Slides

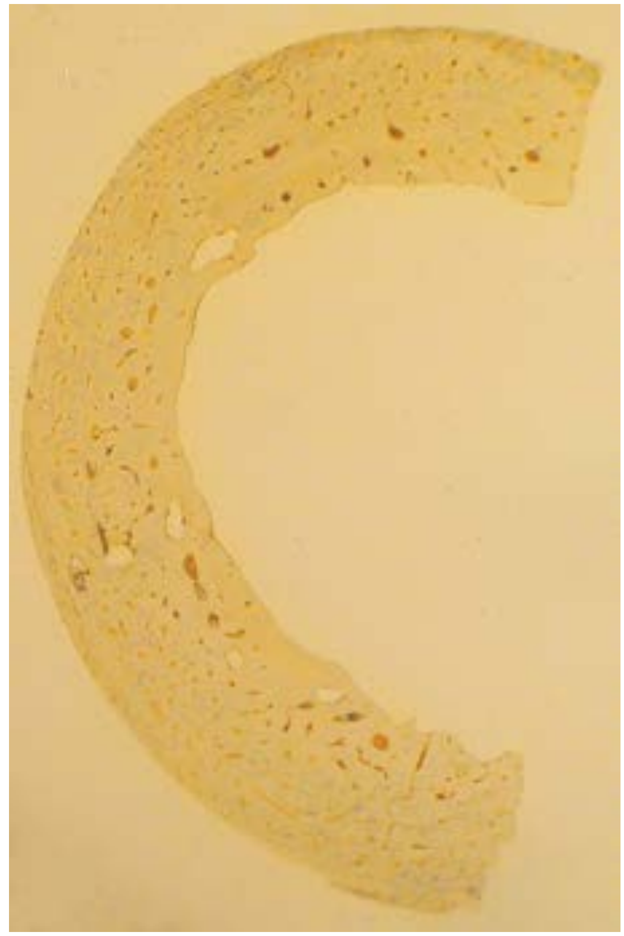
Exhibition slides of unusual objects were very popular in Victorian times. In some slides, small objects were arranged into intricate designs and patterns. Although the "exhibition" slides were meant for entertainment and amusement in Victorian parlors, they heightened public awareness and interest in the fields of biology, botany, archeology, oceanography, paleontology, geology, and science in general.

The fairy fly by Frederick Enock is one of the most famous slide ever made. Frederick Enock (1845-1916) was a mounter of whole insects prepared in a lifelike manner without pressure. His slides are of the highest quality and perhaps unequaled. One of the most famous and sought after slides is Enock's fairy fly. He bred the flies himself from parasitized aphids. Around 1870 he worked for his uncle Edmund Wheeler and set up business on his own in 1878. The slide is from the collection of Brian Davidson.



Cosmocoma, the Fairy Fly by Enock

Silkworm Skin by R. & J. Beck



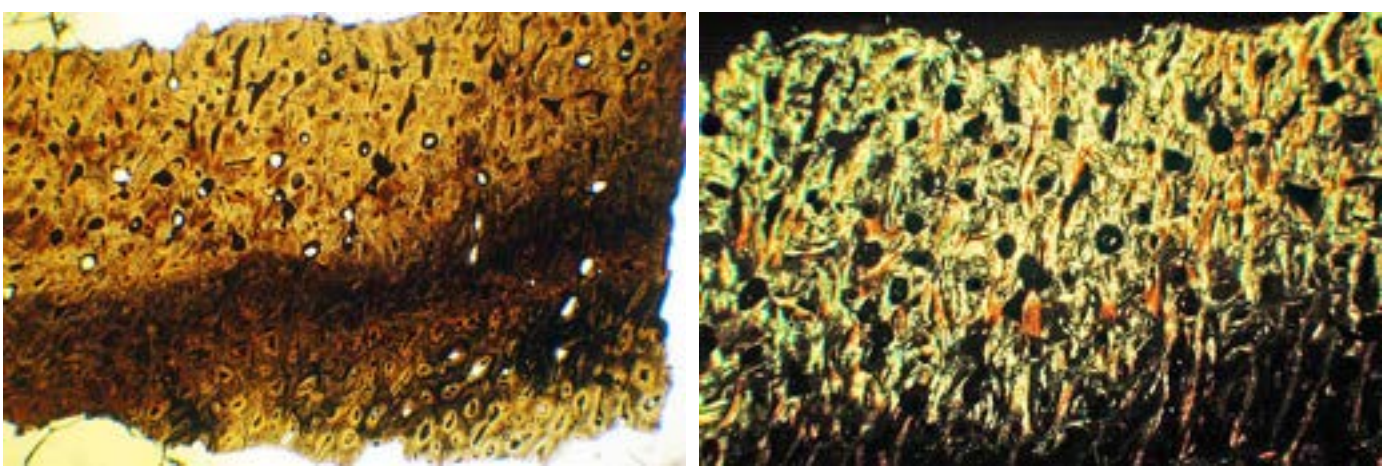
Mummy Cloth **Femur of Mummy**

Both slides c1880, the Mummy Cloth slide with later labels and showing the provenance.

Among the most popular nineteenth century subjects were the mineral skeletons of diatoms, foraminifera, radiolarians, and polycystina. They were often arranged in intricate patterns. This is an example of "Selected Polycistina Various" arranged in a rosette pattern by Edmund Wheeler. c1875. The slide is also an example of an opaque preparation in which the specimen was mounted on a substrate and viewed with incident light from above, usually focused onto the specimen with a condenser lens on a stand. This type of preparation was useful for visualization of surface details.

Arranged Polycystina, c1875

Butterfly wing, 1876



Mastodon Bone

This is a section of mastodon bone by C. M. Topping viewed under transmitted and polarized light. Haversian canals are evident. The fact that it is birefringent shows that collagen is still present.

Cedar from Solomon's Temple

Soundings, 1869

Cedar of Lebanon was brought back to England from the Palestine Exploration of 1869 and said to have come from the ruins of Solomon's Temple which had an altar made of cedar wood. The authenticity of the wood is doubtful as the location of the Temple is unknown. Nonetheless, the slide is of interest as a Judaica relic.

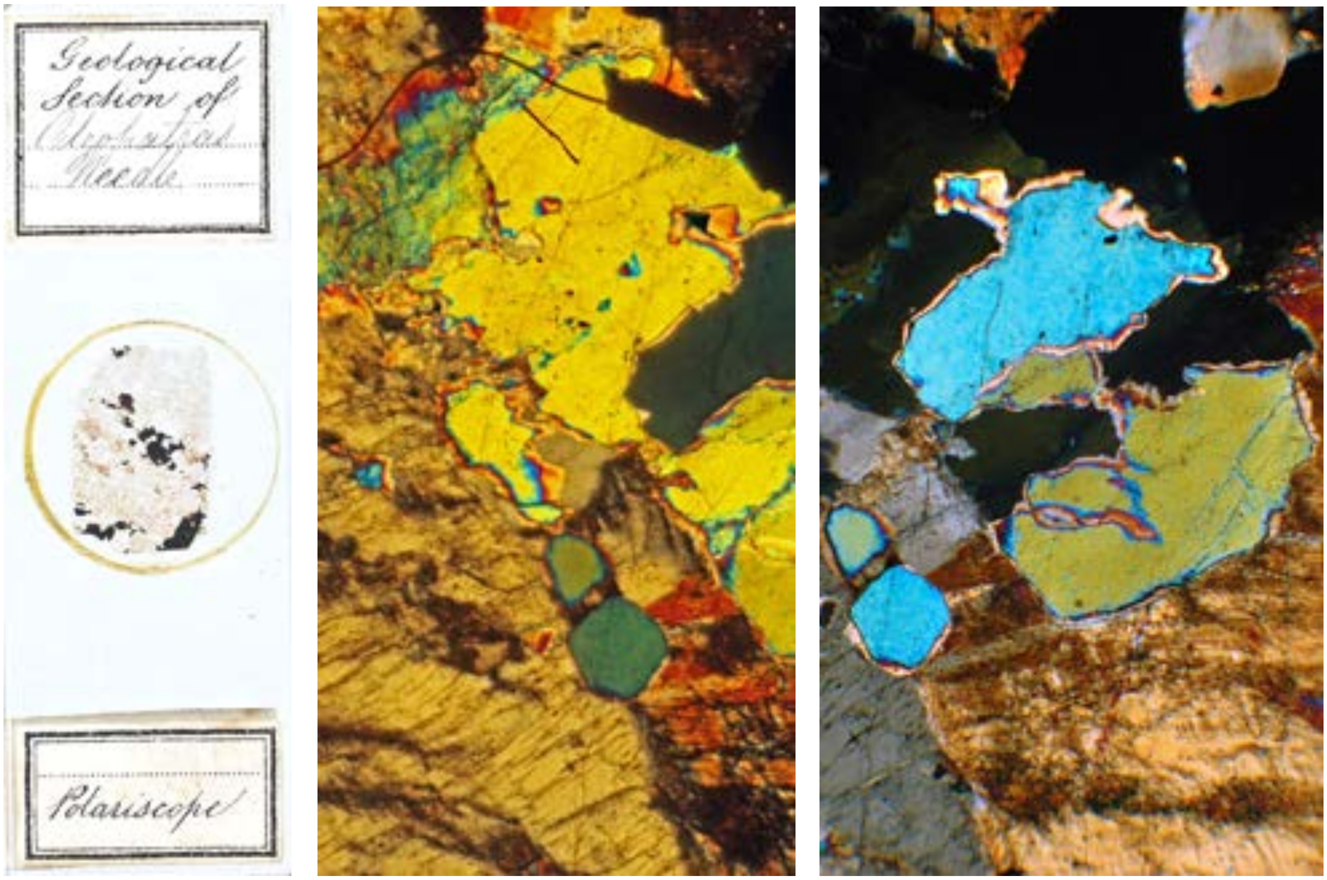
Sounding from the deep-sea dredging expedition of HMS Porcupine in the North Atlantic in 1869. These soundings represented the beginnings of the science of oceanography. They revealed the presence of life in the deep sea and were popular subjects for microscope slides.

Arranged butterfly scales were another popular type of exhibition slide. This beautiful slide by K. D. Kemp is a flower arrangement of butterfly scales, 50 forms (left). Klaus D. Kemp (1937-) originally joined the staff of Flatters & Garnett Ltd. in 1953. When they went bankrupt in 1967, he worked for other firms before setting up on his own in 1993. He made arranged mounts of diatoms, such as this 25 form star pattern (right), and butterfly scales, equal to the best ever made.

In this example, butterfly scales were used to form a garden scene. The printed trade label on this slide reads "Scales of Butterfly arranged as Flowers &c, For 3", 426 Scales," and the monogram for John Thomas Norman. Norman produced high quality slides of all types from 1846 to 1892 in London.

Victorian Exhibition Slide of Arranged Butterfly Scales

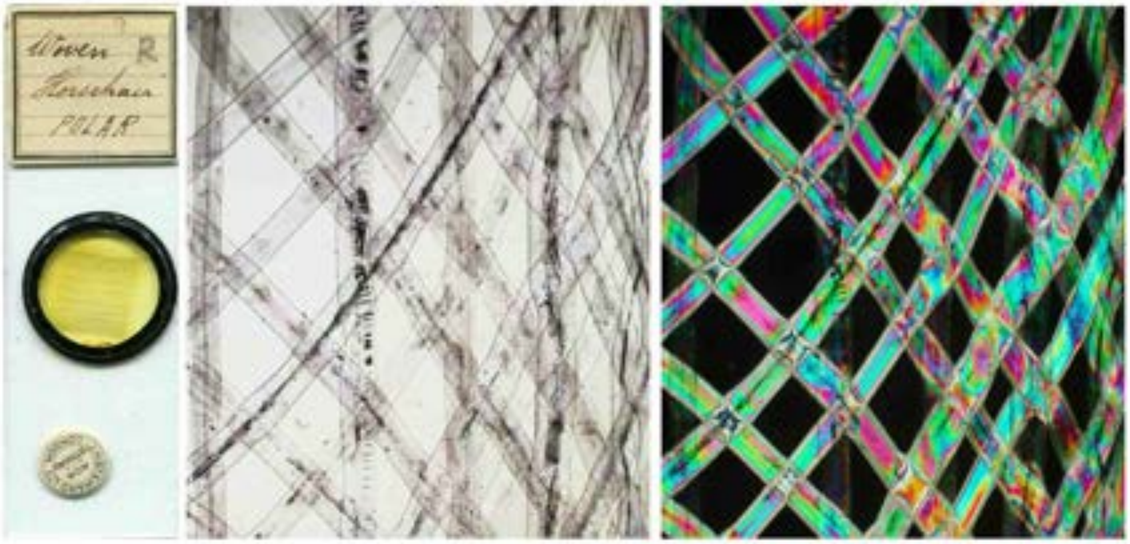
Petrography is a section of petrology that deals with the microscopic details of rocks and minerals. A thin sliver of rock is cut from the sample and ground optically flat. It is then mounted on a glass slide and then ground smooth using progressively finer abrasive grit until the sample is only 30 μm thick. This is a slide of red granite from Cleopatra's Needle viewed under polarized light. Cleopatra's needle is an ancient Egyptian obelisk that was moved to London in 1878. Although this is an exhibition slide, reference collections of petrographic slides are used by universities for teaching mineralogy and geology.



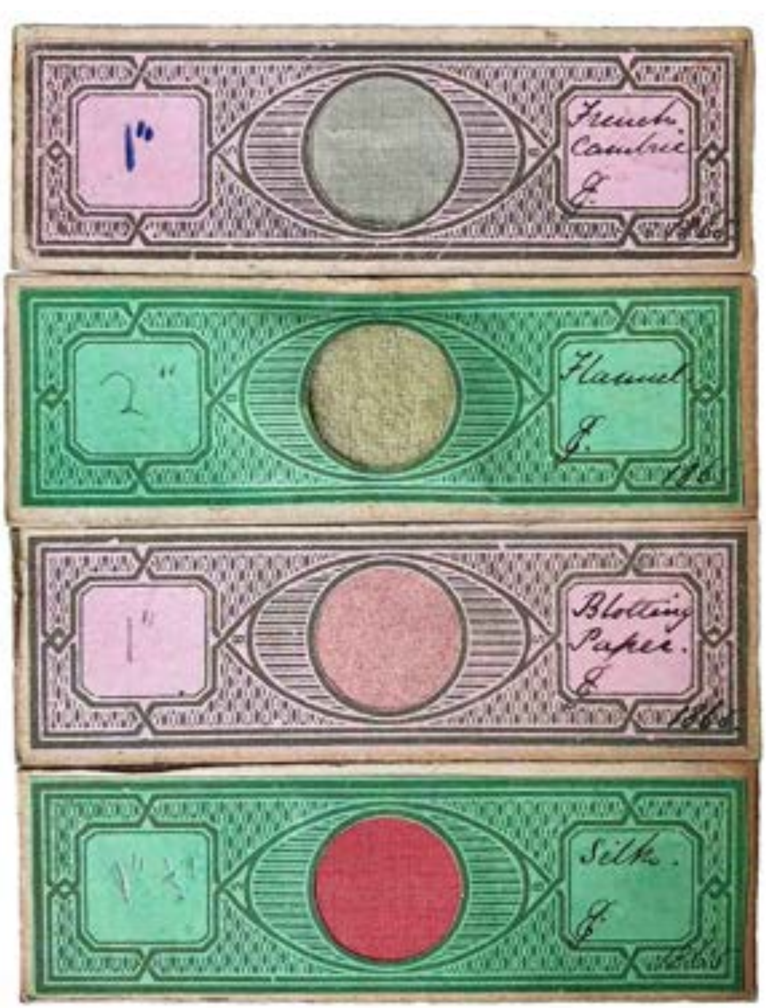
Red Granite from Cleopatra's Needle

Radium Scintillation Slide

This is a microscope slide designed to allow one to view the streaks of light given off when the alpha particles produced by the radioactive decay of radium, discovered by Marie and Pierre Curie in 1898, strike a zinc sulfide phosphor screen. The Scientific Shop sold scientific equipment in Chicago in the early part of the twentieth century.



Woven Horsehair, J. H. Steward Ltd. 406 Strand, London. Viewed under transmitted and polarized light. James Henry Steward (1817-1896) was at 406 Strand from 1865 to c1915. He supplied microscopes and optical, mathematical, and photographic equipment.



Four slides of textiles; French cambric, flannel, blotting paper, and silk. Labeled “S B” and dated 1865.

Microphotographs

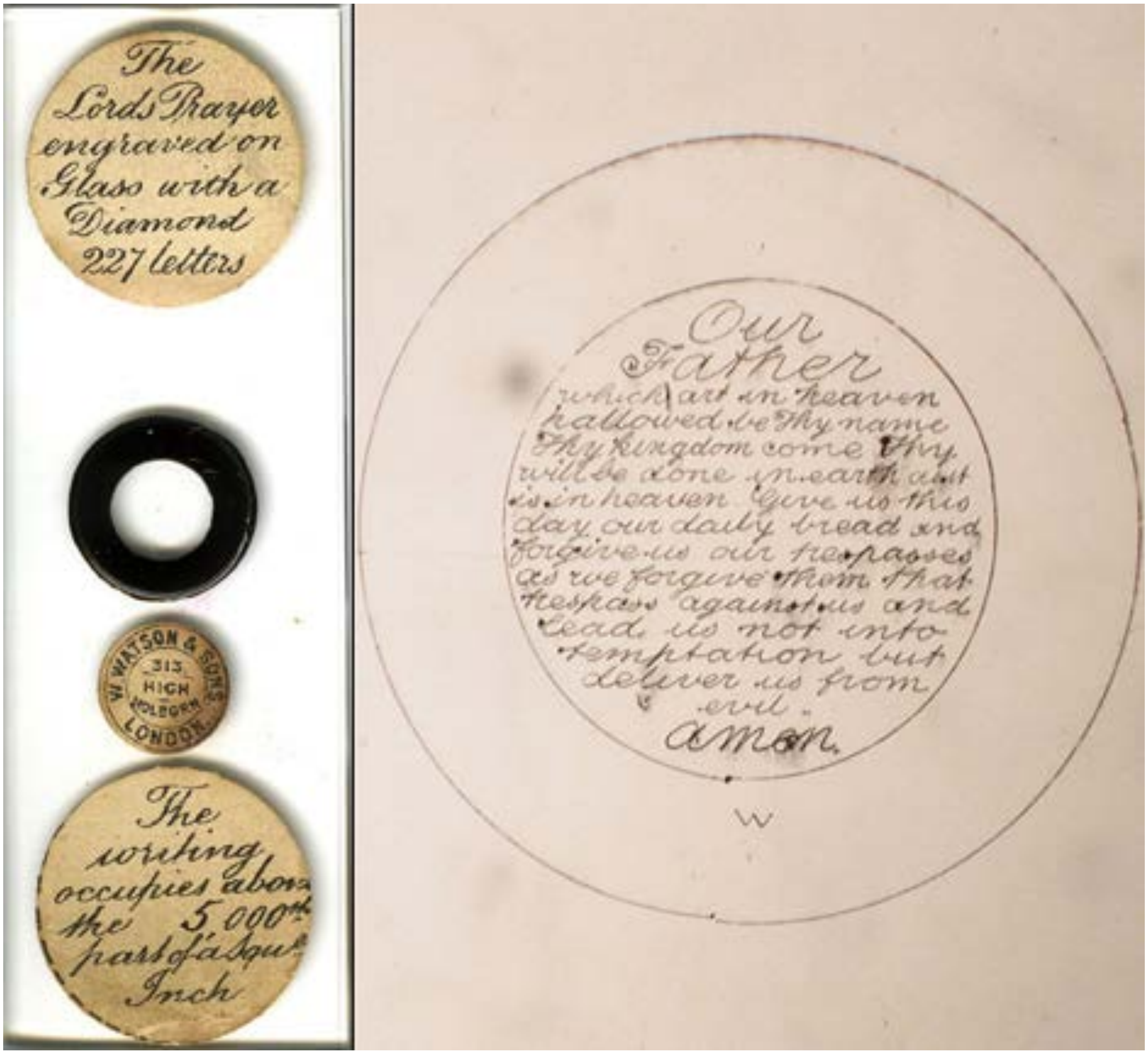
Photomicrographs were prepared of a variety of subjects including famous persons, bible passages, celestial bodies, buildings, paintings, nudes, etc. This photograph shows two gentlemen using a microscope and an oil lamp on a rotating microscope table in 1865. The man on the left is Richard Beck, a cofounder of one of the most important British microscope manufacturers. Anthony J. DiDonato.

John Benjamin Dancer (1812-1887) is considered the father of microphotography. Using the daguerreotype process, he was one of the first to produce microphotographs in 1839. He achieved a reduction ratio of 160:1. Dancer perfected his reduction procedures with Frederick Scott Archer's wet collodion process, developed in 1850–51. This microphotograph is "The Lord's Prayer, Illuminated."

Webb Microengraving

William Webb (1815-1888) used fine diamonds to etch words and pictures onto glass. He was a Law Courts shorthand reporter who developed a machine for making minute writing on glass. The machine consisted of levers and gears that reduced the movements of a hand-operated stylus to extremely small dimensions. His texts were written at a scale of "bibles per square inch," that is, the entire text of how many bibles that could be written in a square inch, varying from one to 59. Webb engraved upon the underside of the cover slip, not on the actual 1x3 slide, reporting that this permitted their use as tests of higher-powered objective lenses. He first demonstrated his machine at the London International Exhibition in 1862 where it made an impressive showing. He sold his writings direct and through the trade and continued to at least 1887.

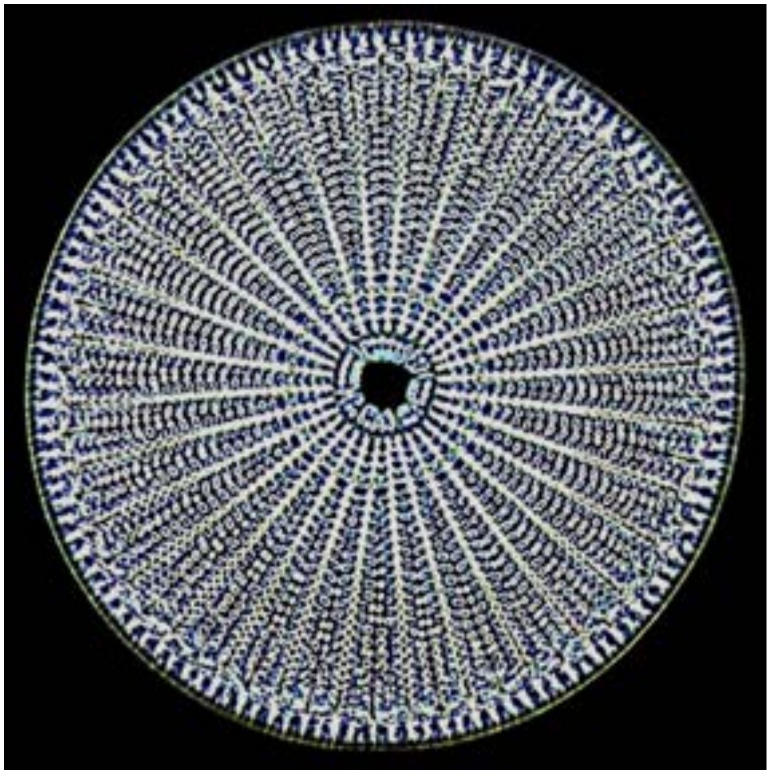
Webb was especially well known for his microscopic writing of the Lord's Prayer which cost between £1 and £10 depending on fineness. A brief article *Webb's Lord's Prayer*, appeared in the Journal of the Royal Microscopical Society, Series 2, Vol. 6, pages 147-148 (1886). Edmund Wheeler was the sole proprietor of the "Microscopic Engravings by W. Webb, Esq." until 1884 when he sold his business and slides to the Watsons. This slide bears the label of the Watsons and the notations "The Lords Prayer engraved on glass with a Diamond 227 letters" and "The writing occupies above the 5,000th part of a Squ Inch." Thus, this slide dates between 1884 and 1887, unless it is an earlier slide from Wheeler's stock with Watson's label. The slide is signed with a "W."



Test Slides

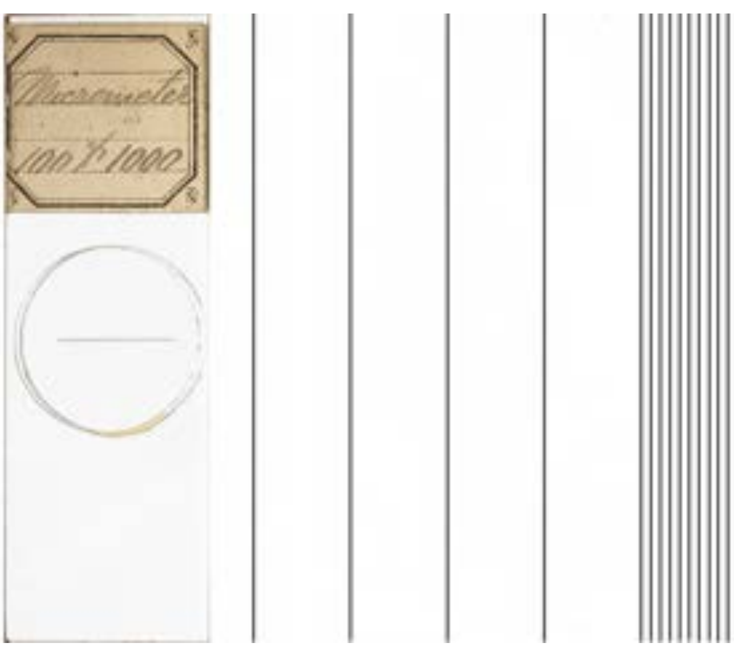
Blowfly Proboscis by C. M. Topping

Test objects were used to test and compare the quality of microscope objectives. Insect scales were early test objects and diatoms of various species were widely used. The blowfly proboscis was also used. Diamond rulings of increasing fineness were developed. These test objects were of considerable importance to microscopy as makers used them to improve the resolution of their instruments.



Adinoplychus heliopelia by R. I. Firth

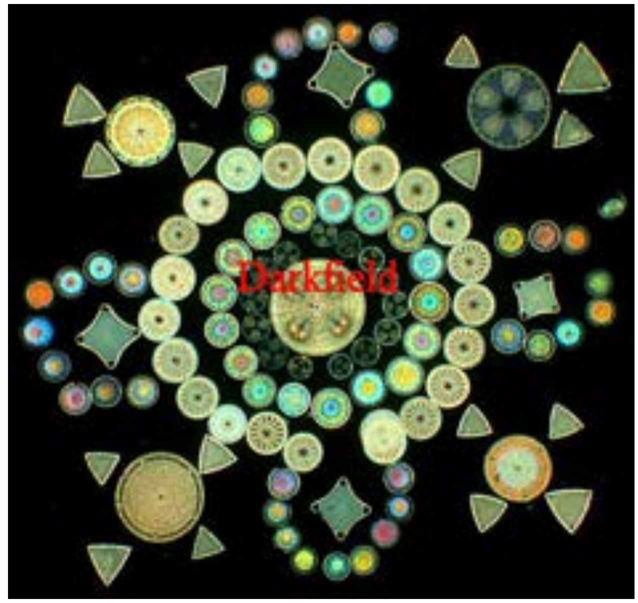
Stage Micrometer

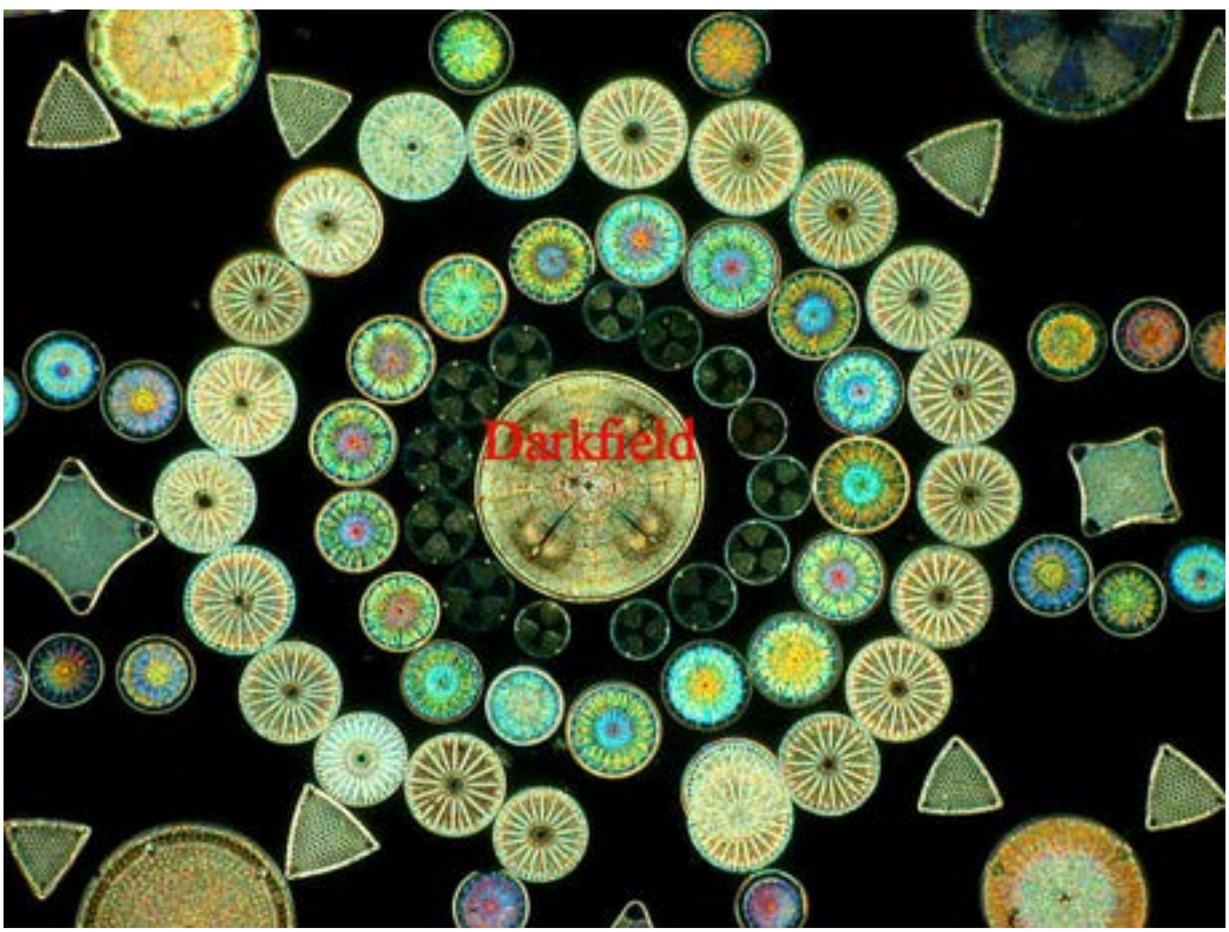


This is a stage micrometer by John T. Norman with his monogram. Micrometers are used to calibrate microscopes and microscope cameras and to measure the apparent diameter of microscopic objects. They are inscribed with scales for measurement. This Victorian slide has 1/100 and 1/1000 inch divisions.

Diatoms, Foraminifera, Radiolaria, Algae, and Protozoa

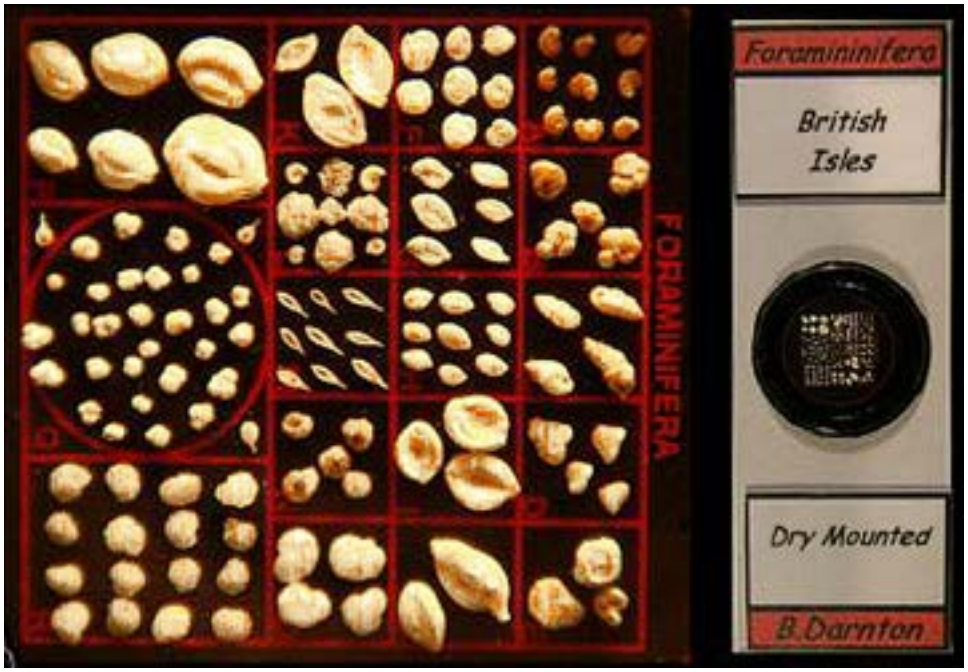
Among the most popular nineteenth century subjects were the mineral skeletons of diatoms, foraminifera, radiolarians, and polycystina. These were often arranged on slides in intricate patterns.





A. C. Cole Diatom Circle

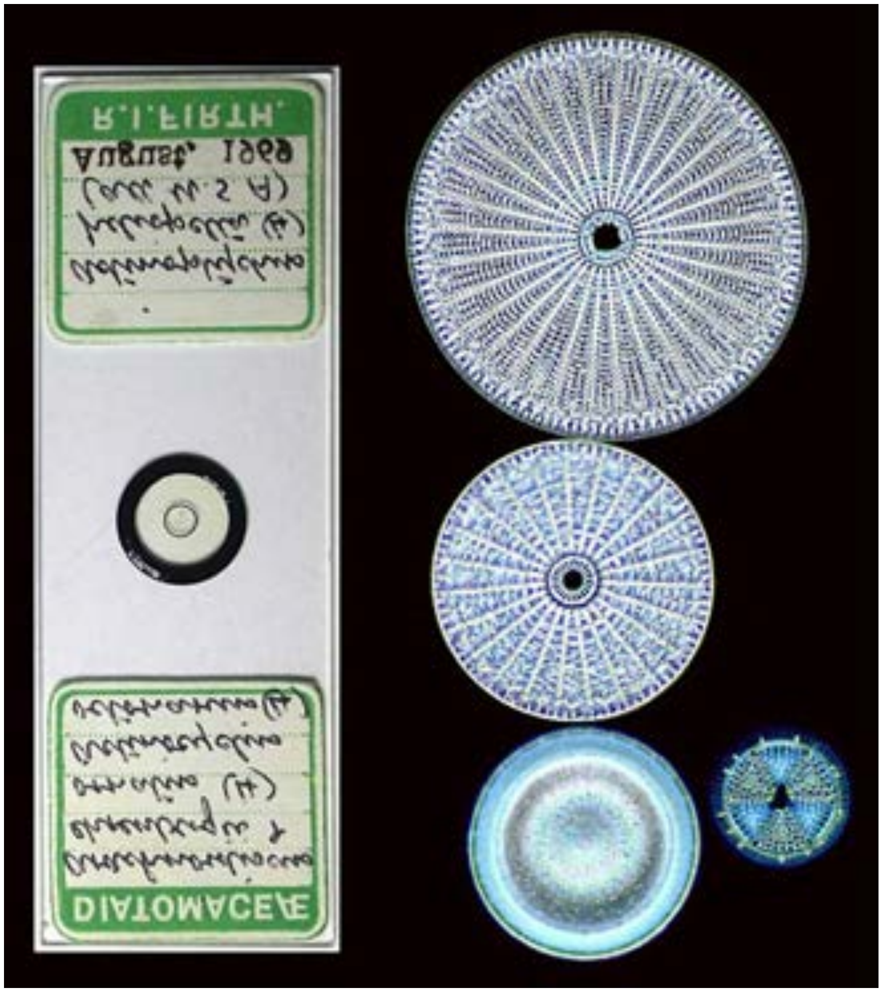
A most attractive complex arrangement of diatoms in concentric circles by A. C. Cole. The diatoms have mainly been chosen to give a diffraction effect under either transmitted or darkfield illumination. Diatoms are a major group of algae, among the most common types of phytoplankton, with intricate cell walls made of silica.



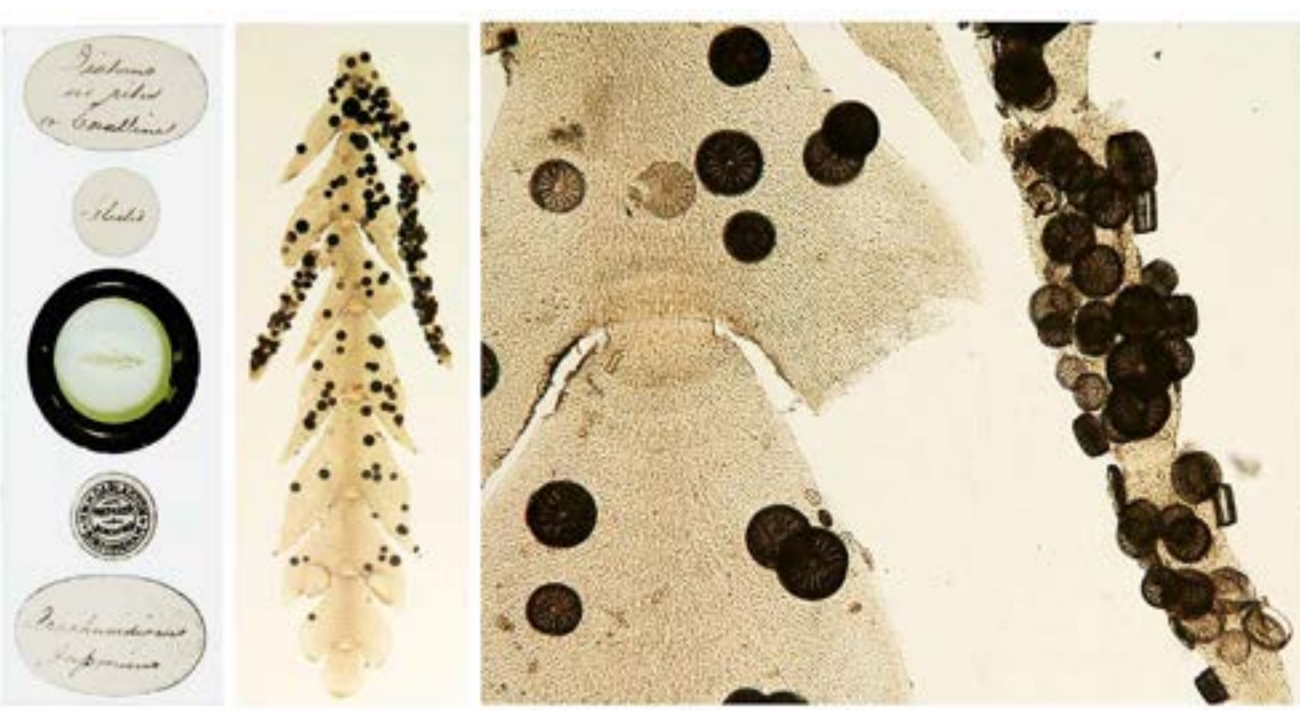
Foraminifera, British Isles, Dry Mounted, B. Darnton. Foraminifera are amoeboid protists with a test or shell made of calcium carbonate. Brian Darnton (1935-) is well-known for his mounts of Foraminifera, usually in dry cells and on grids. This is a type slide of the tests of recent Nearshore Foraminifera from around the British Isles. The tests in the circle are actually from an antique source of planktonic species collected by the now famous HMS Porcupine in the mid nineteenth century.

This is an antique microscope slide by Watson & Sons, London. The slide is of "Polycystina, From Cambridge Estate [Barbados]." Polycystina belong to a group of amoeboid protozoa that produce a siliceous skeleton. The intricate detail and variety of these forms have long attracted microscopists. These specimens have been dry mounted in a deep cell on black opaque background for viewing using incident lighting techniques. The image shows the slide and a photomicrograph taken from the mount imaged using incident (top) lighting.

This is a slide of four diatoms by Noted English diatomist R. I. Firth (1902-1982). The diatoms are *Arachnoidiscus ehrenbergii* and *ornalus*, *Actinocyclus octonarius*, and *Actinoplyclus heliopella.*

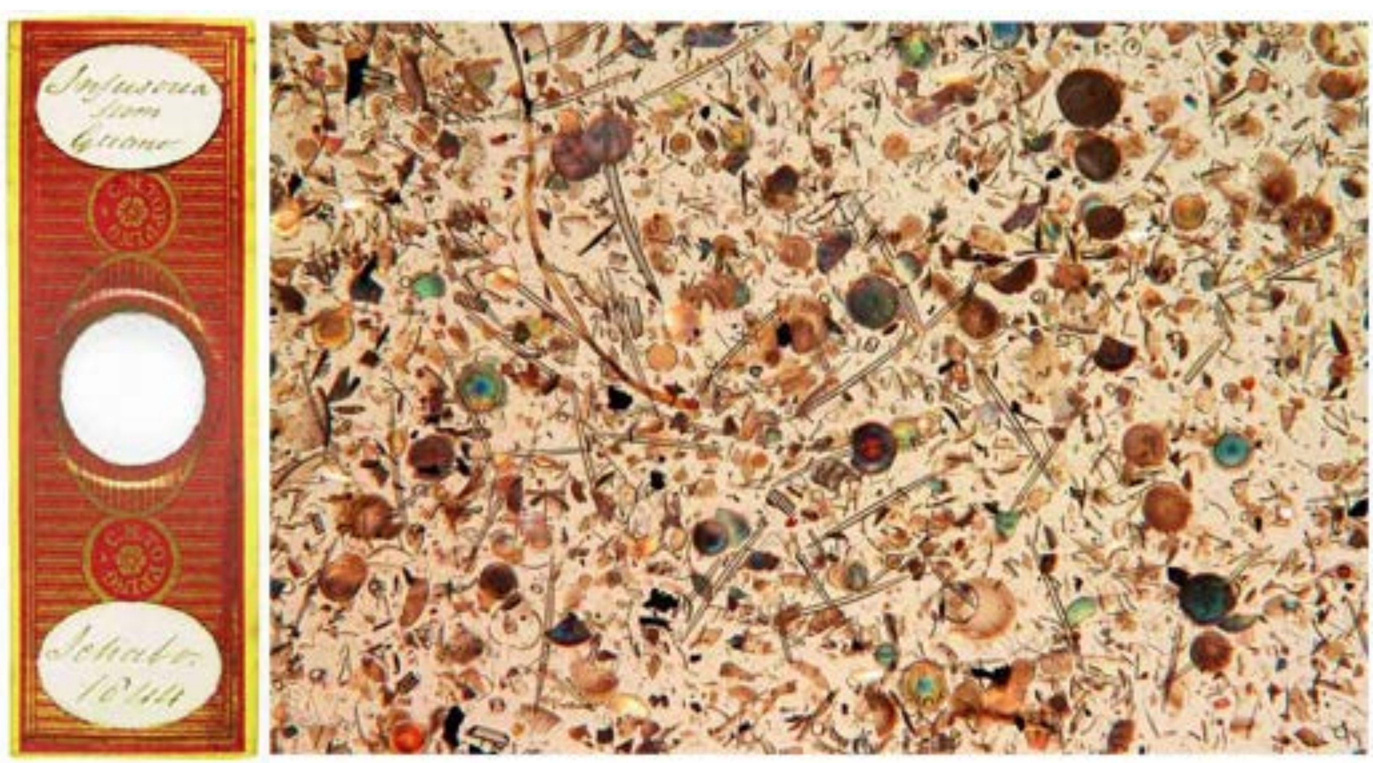


Diatoms

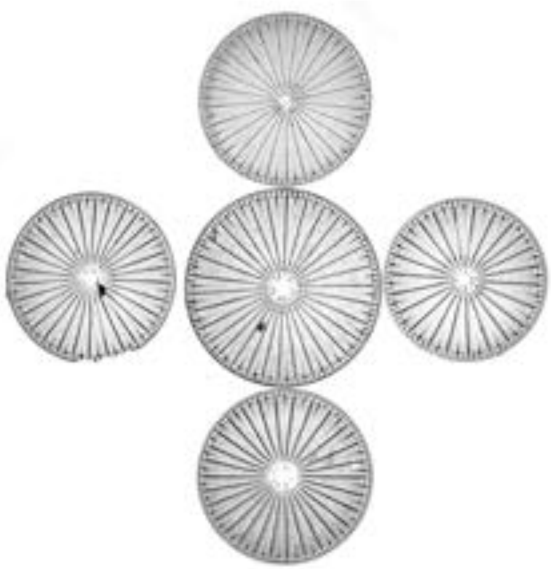


Diatoms in situ on Coralline by H.W.H. Darlaston

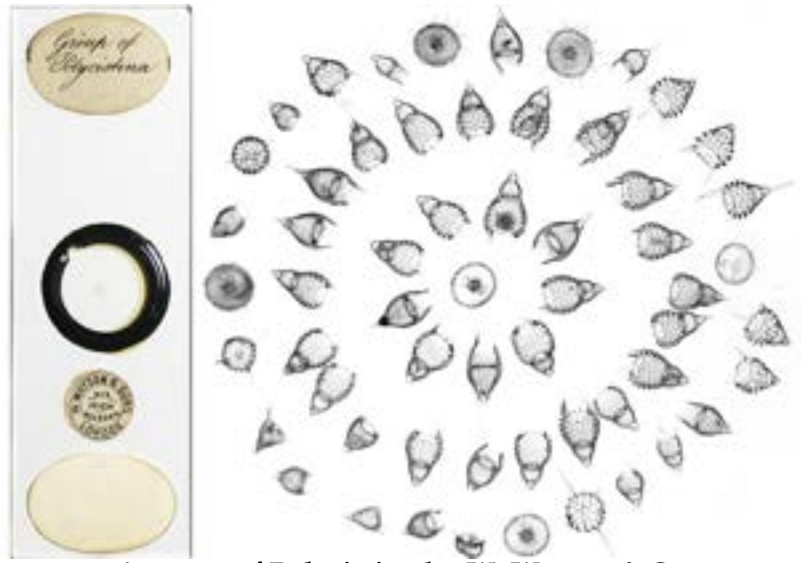
Foraminifera from Post Glacial Sands by Stanley. William Ford Stanley (1828-1909) was a retail optician from the 1860s to the early 20th century.



Infusoria (obsolete term for various microscopic organisms found in decaying organic matter) from Guano by Charles Morgan Topping.



Arranged diatoms, Arachnoidiscus Ehrenbergi



A group of Polycistina by W. Watson & Sons.

Foraminifera Mediterranean. Green paper-covered slide by a preparer known only as "Green Papers."

Marine algae by J. Bourgogne

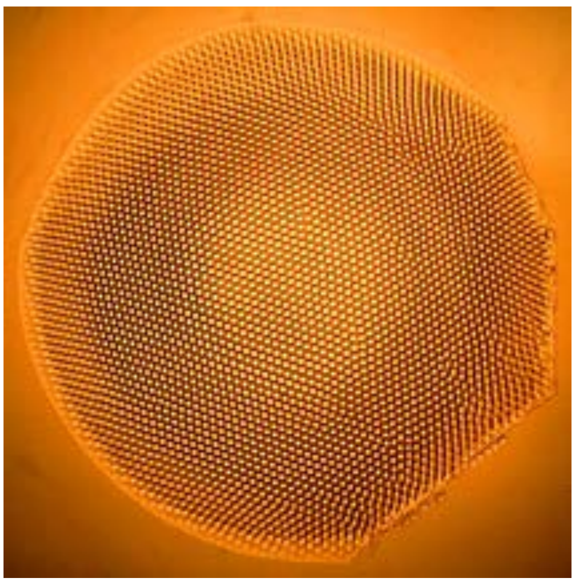
Insects

Parasite of Goat by Topping

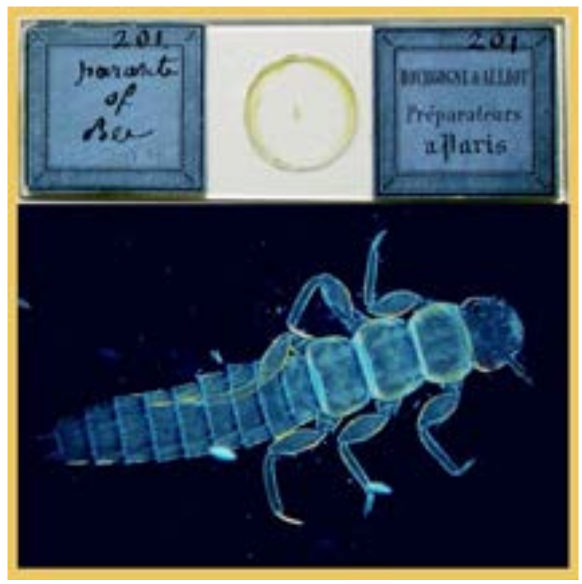
Yellow Ant by Darlaston

Parasite of the Hessian Fly by Enock

House Spider by Enock



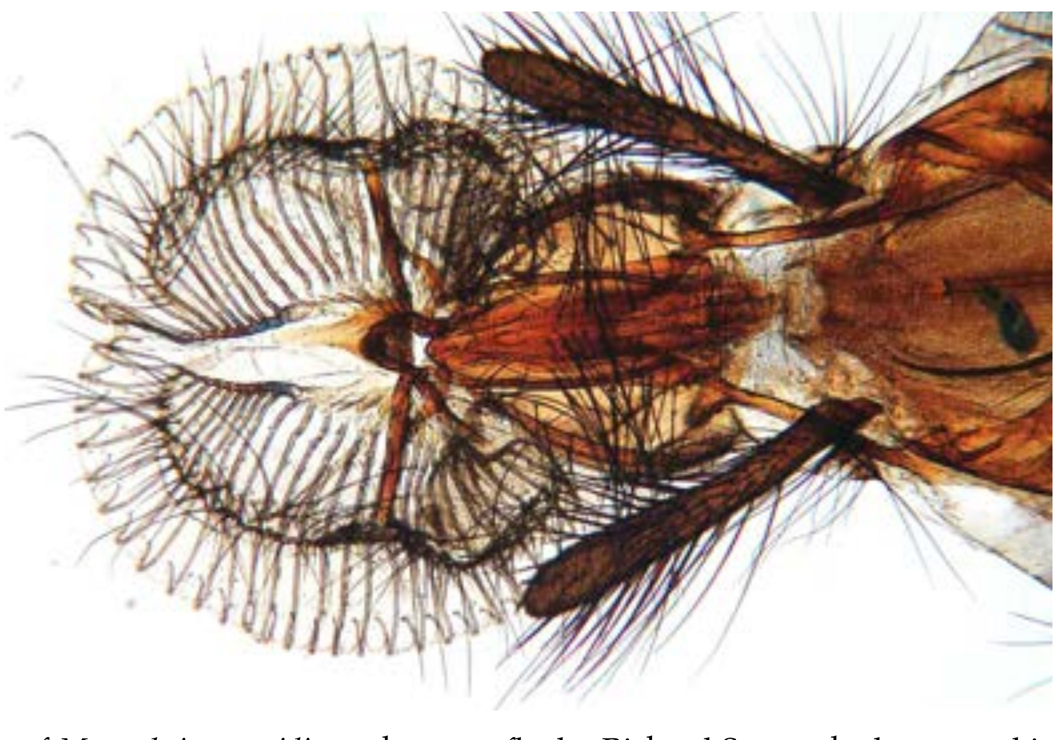
Eye of beetle by W. Watson & Sons



Parasite of Bee by Bourgogne & Alliot

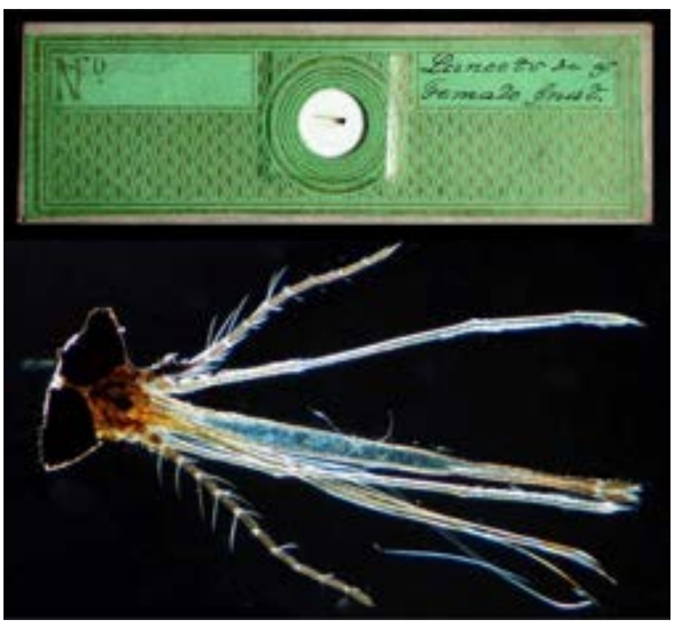
This is an antique microscope slide of "Bed Fleas (Sexes)," by Amos Topping, c1880. Both a male and female flea have been carefully prepared and expertly mounted for viewing. Although unsigned, the handwriting is unquestionably that of Amos. The image shows the slide, and includes two photomicrographs taken from the mount, using polarizing and darkfield lighting.

Female flea, Victorian paper-covered slide



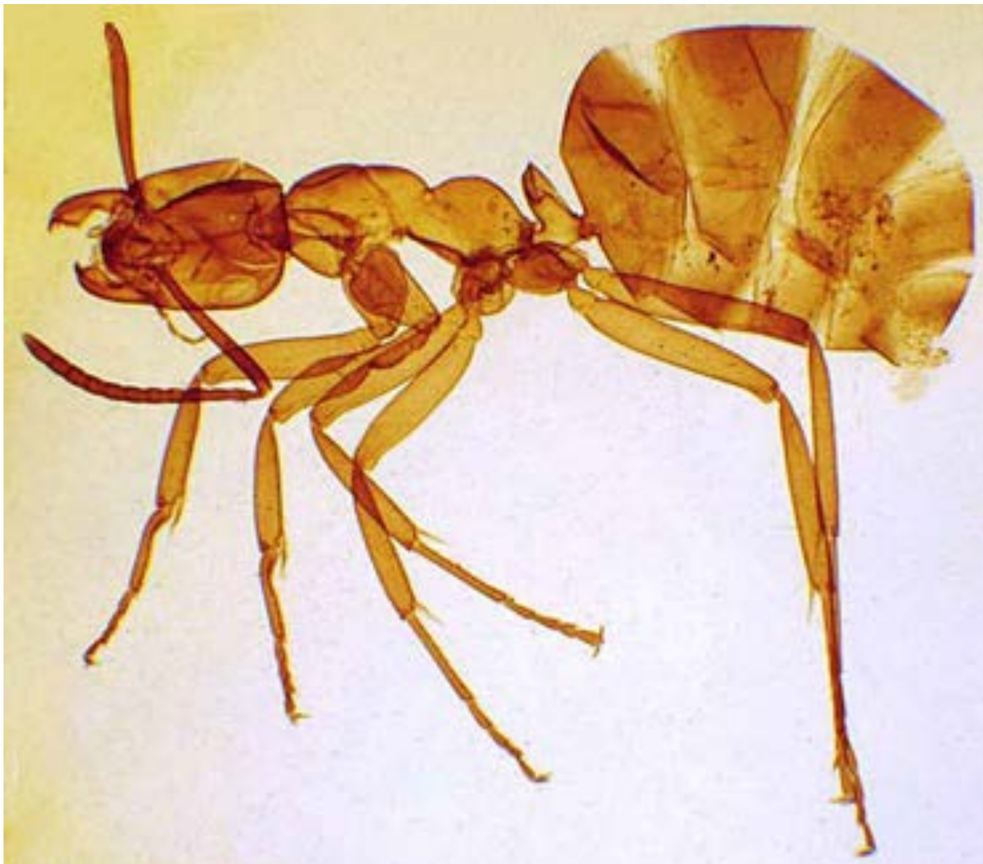
Tongue of *Mesembrina meridiana*, the noon fly, by Richard Suter who began making slides by at least 1887.

Slide of “Pond Skater pupa” by Edmund Wheeler. Viewed with oblique transmitted and darkfield lighting.



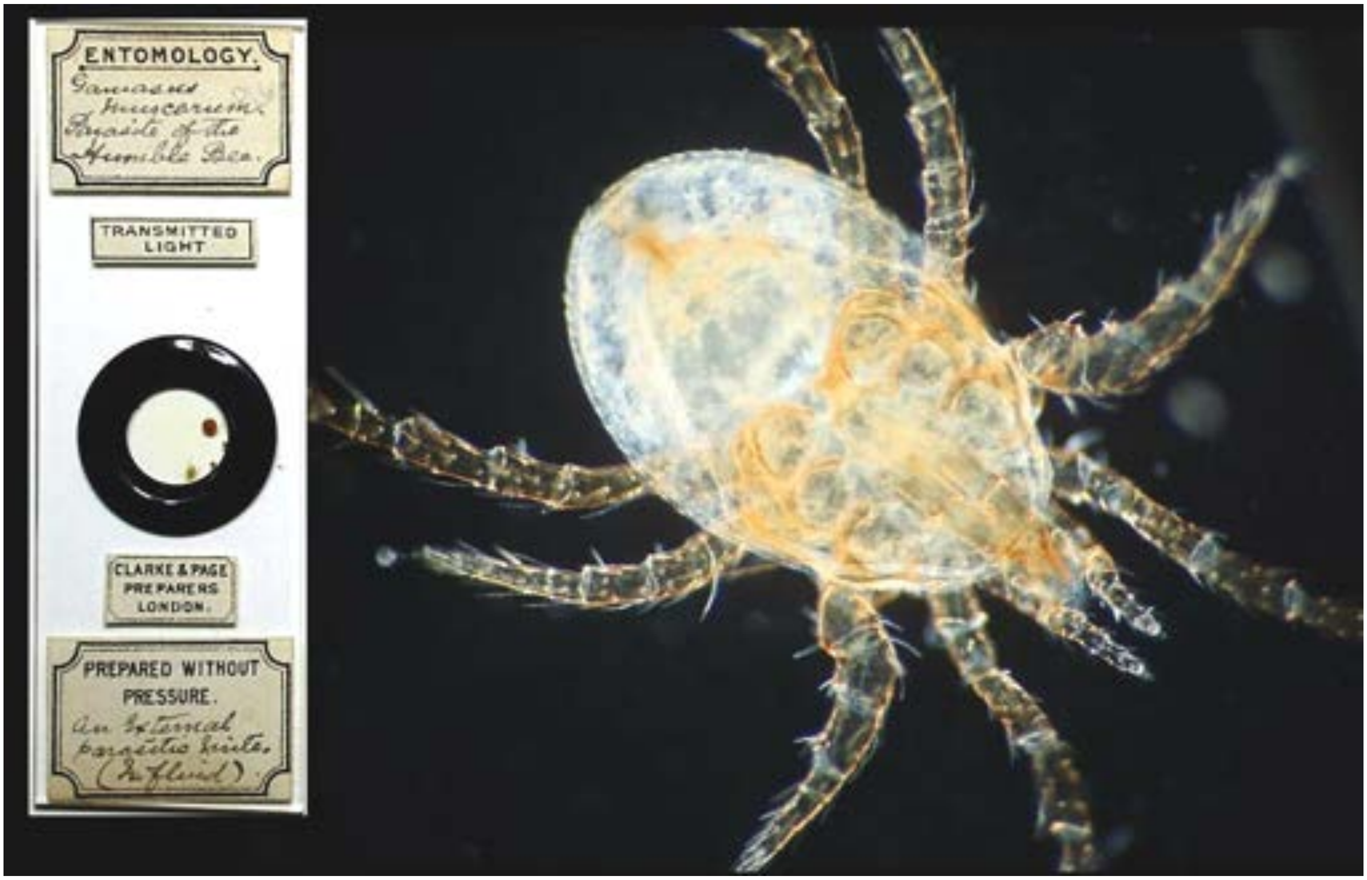
Early papered microscope slide of "Lancets &c of Female Gnat" by Cornelius Poulton, labeled in his hand. Poulton was one of the early commercial mounters, his career cut short by his death in 1854. Image taken using darkfield lighting.

Punaise le Lit, Ch.Bourgogne, Préparateur. Whole bed bug by Charles Bourgogne, a member of the Bourgogne family of microscope slide preparers in France, c1860s.

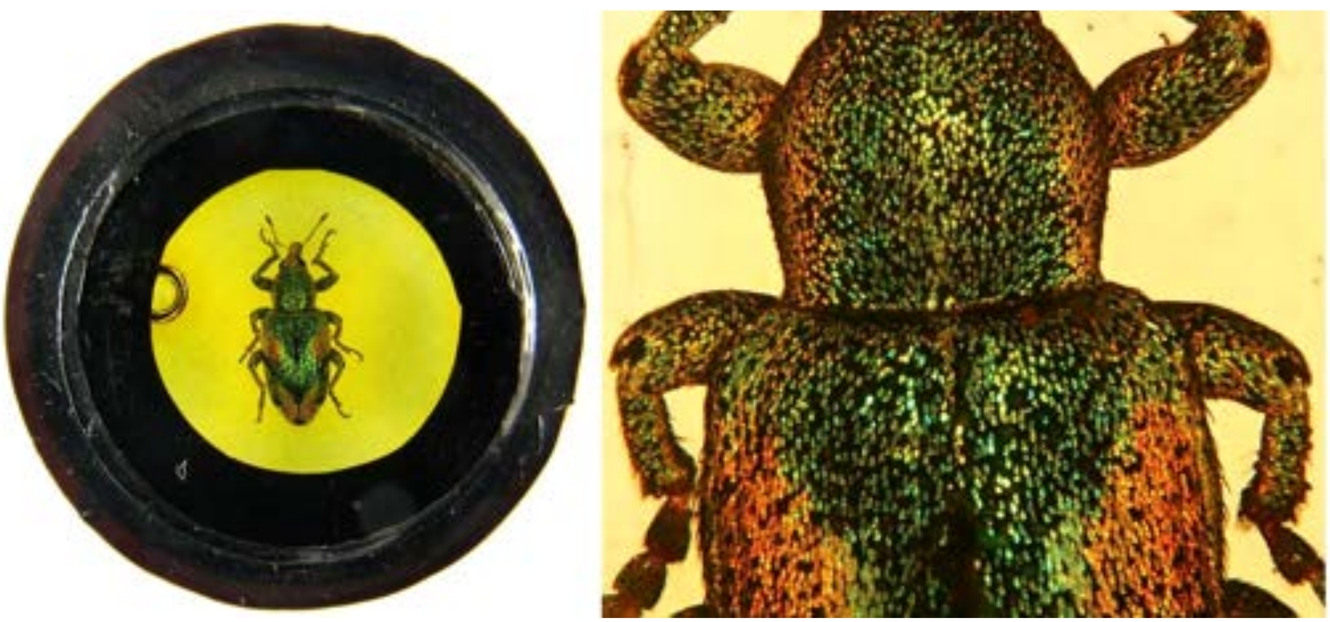


Brown Ant, *Formica fusca*, Philip Harris & Co., Ltd., Birmingham, c1900.

Dissected specimens were popular subjects in Victorian slides. This example is a dissection of the trophi of a butterfly. Trophi are the mouthparts of an arthropod including the labrum, labium, maxillae, mandibles, and hypopharynx with their appendages.



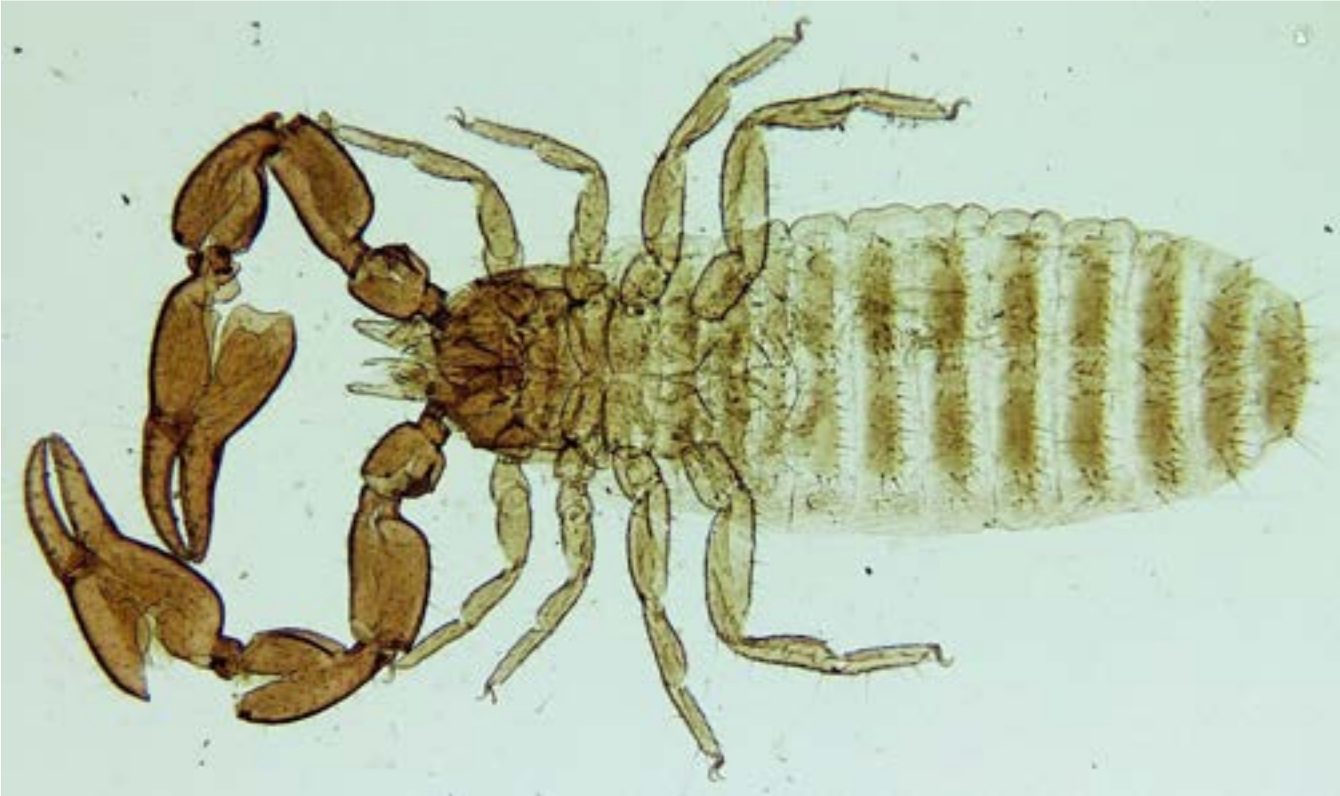
This is a slide of a parasite of the humble bee viewed with darkfield lighting. Clarke & Page in London offered “insect slides without pressure” beginning in 1909.



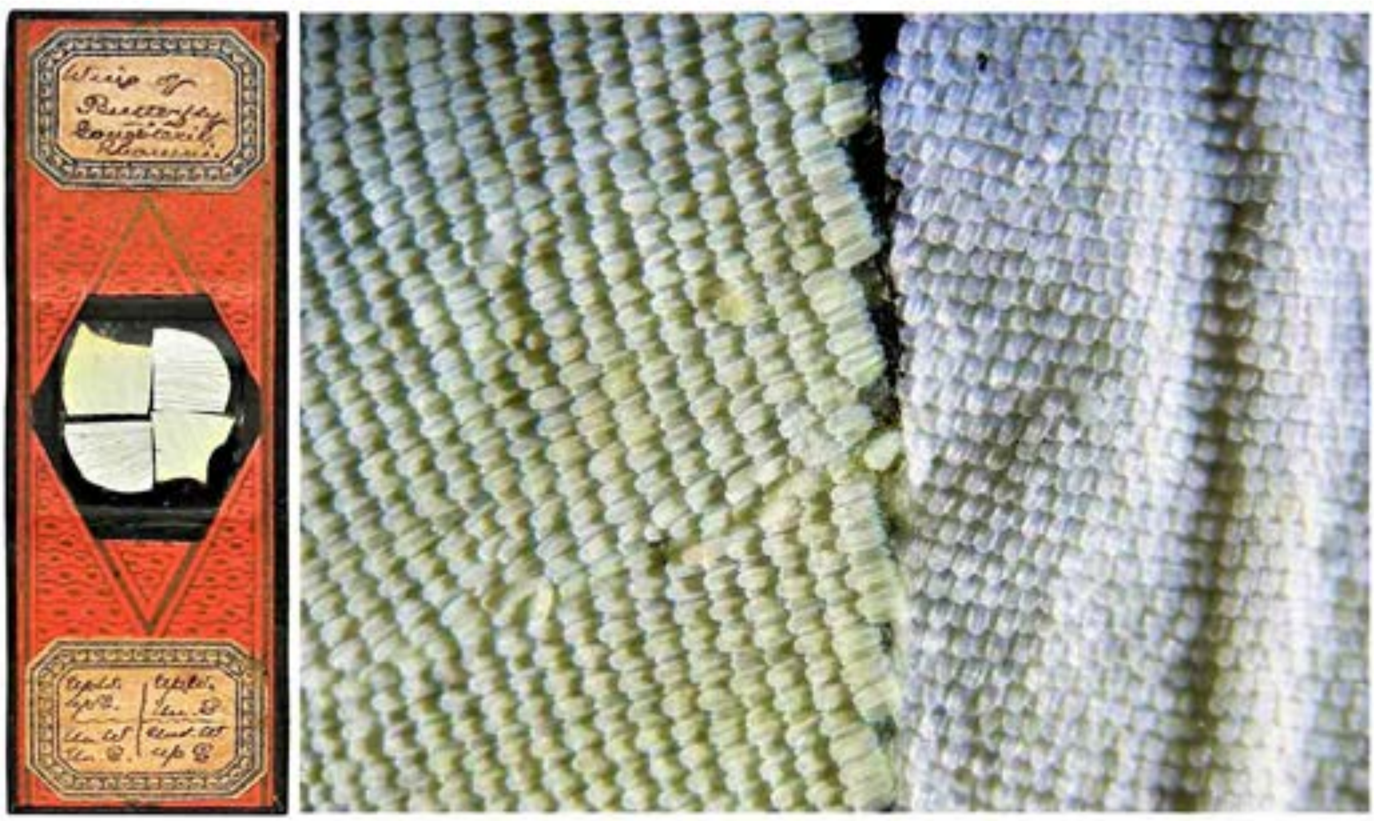
This is a slide of a whole beetle labeled “Coraeabus tamarisi.” It is known as a jewel beetle because of the iridescence of its epicuticle. The label bears the monogram “SIS.”

Slide of male, female, and larval scabies (mites) from human by J. Bourgogne and dated 1860.

Head of Crane Fly by Watson & Sons.



British Pseudoscorpion, Chelifer. A pseudoscorpion is an arachnid that resembles a scorpion.



Wing of Butterfly. Paper-covered slide.

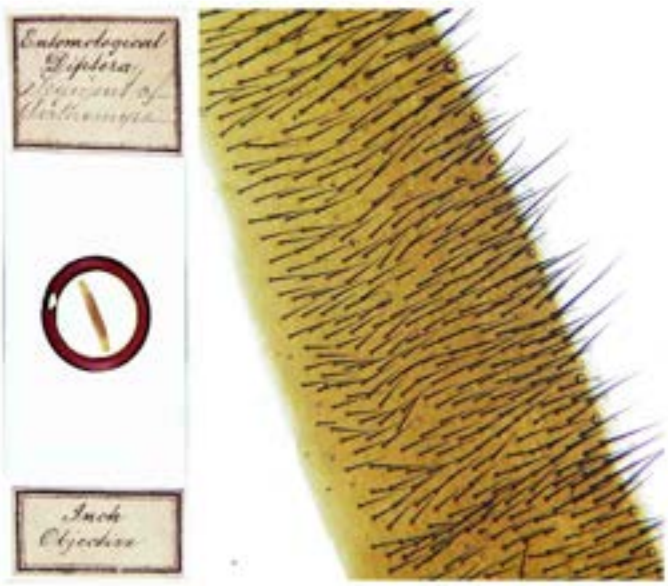
Parasite of Guinea [Fowl]. Prepared by John T. Norman.

Tongue of Spider. Prepared by John T. Norman. Paper-covered slide with his monogram.

RedVelvet Mite

Wing of Moth from Borneo

Snipe Fly, Empis. Whole mount of a snipe fly by Amos Topping.



Hairs of a Fly

Parasite of Rook, Food in Stomach

Blue paper-covered slide of the foot of a water beetle. An early slide by John T. Norman (1807-1893) bearing his monogram.

Lace Bug

Cuckoo Spit

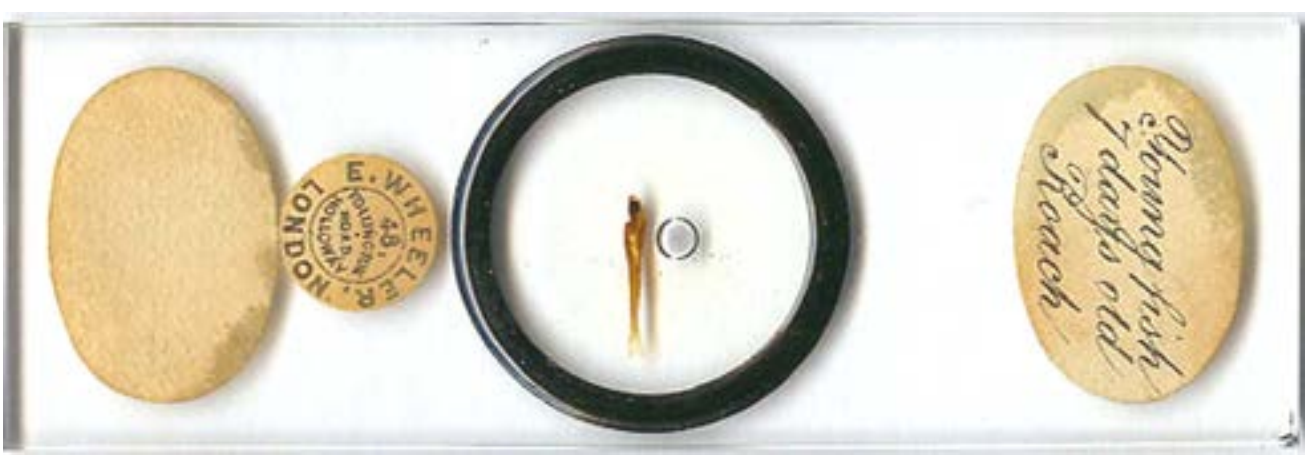
Ichneumon Flies by C. R. Percival

Wing of Hornet by T. Burrell

Head of Cockroach by Edmund Wheeler

Zoology

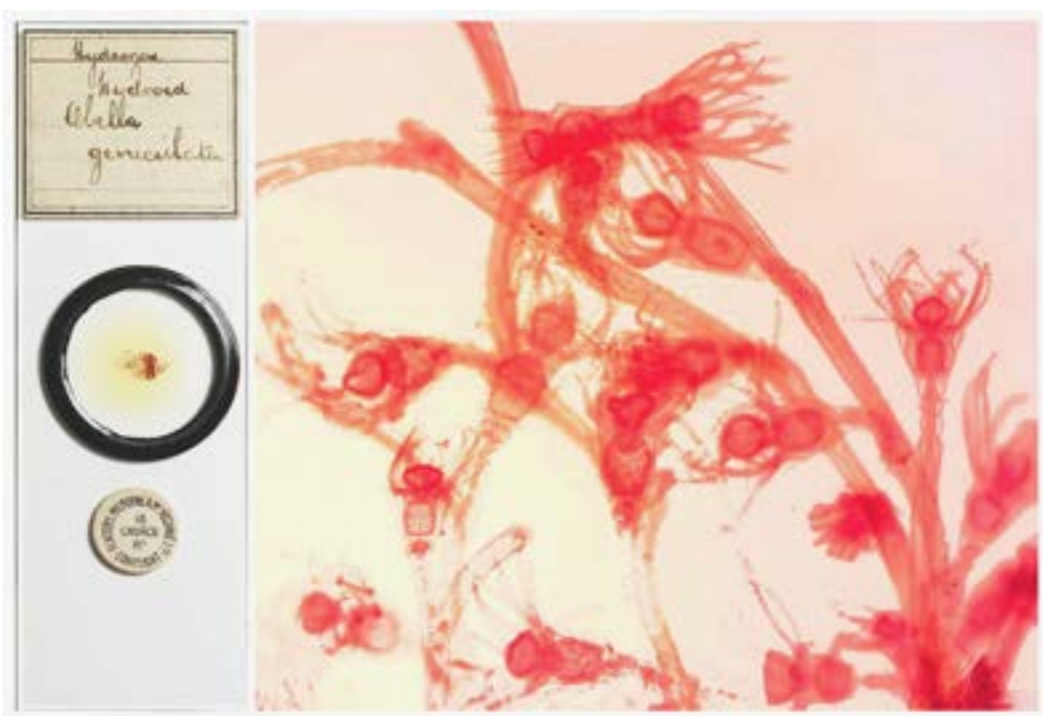
Colenterata Hydrozoa, Cordylophora by C. Baker. Charles Baker (c1814-1893) sold instruments and slides by 1851. The firm continued to sell slides into the 1920s.



Fluid mount of a fish by Wheeler

Edmund Wheeler was a professional mounter by 1866. He retired in 1884 and sold his business and stock, including over 40,000 slides, to the Watsons.

Polyzoa, *Plumatella repens*, fluid mount by Clark & Page, London. This firm operated in the early twentieth century.



Obellia by Flatters, Milborne & McKechnie Ltd. Flatters, Milborne & McKechnie succeeded Flatters & Garnett in 1909.

Zoophytes, early paper-covered slides

Zoophyte is an obsolete term for invertebrate animals such as corals, sponges, and sea anemones that attach to surfaces and superficially resemble plants in appearance. One slide is labeled "from Yarmouth."

Scale of Boar Fish

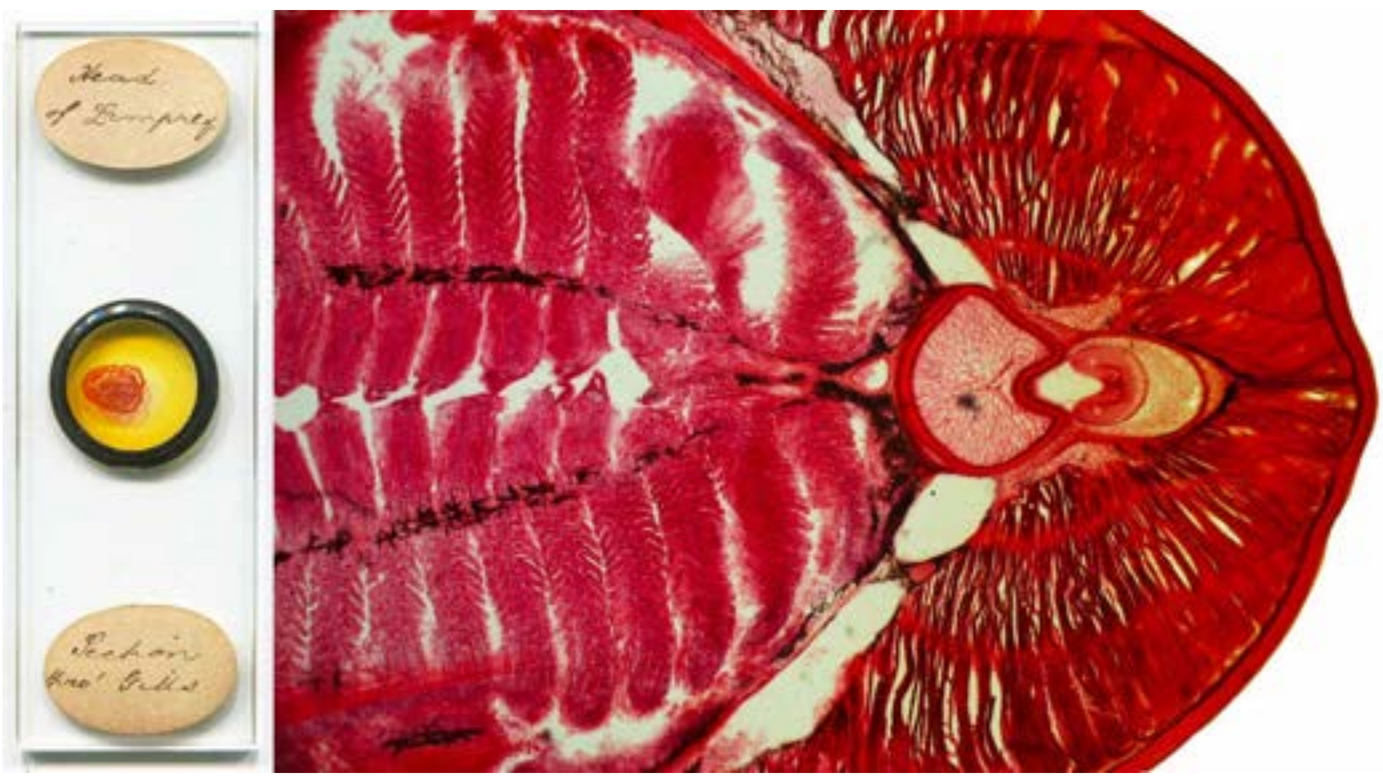
Gill Plates of Dogfish

These are two slides of fish scales by Charles Collins Jr. who worked from about 1885 to1895. He worked using the title "Micro-Naturalist" and some of his slides carry this distinctive label on the rear of the slide. The bottom front label indicates a mount for use with polarizing filters, and includes the hand written suggestion of use of a selenite filter for enhanced viewing. The "Scale of Boar Fish" was imaged using crossed polars with a selenite filter.

This is an antique microscope slide of "Gill plates of Dogfish Trans sect" by W. Watson & Sons Ltd, London which operated after 1908. One photomicrograph is imaged using transmitted light in darkfield, while the inset is a higher magnification in brightfield.

Hoof of Mustang, For Polariscope, E. Wheeler, London, T. H. McAllister, New York

Objects such as hooves, horns, hair, bone, and minerals that are birefringent were very popular during Victorian times and were viewed with a polarizing microscope ("polariscope").



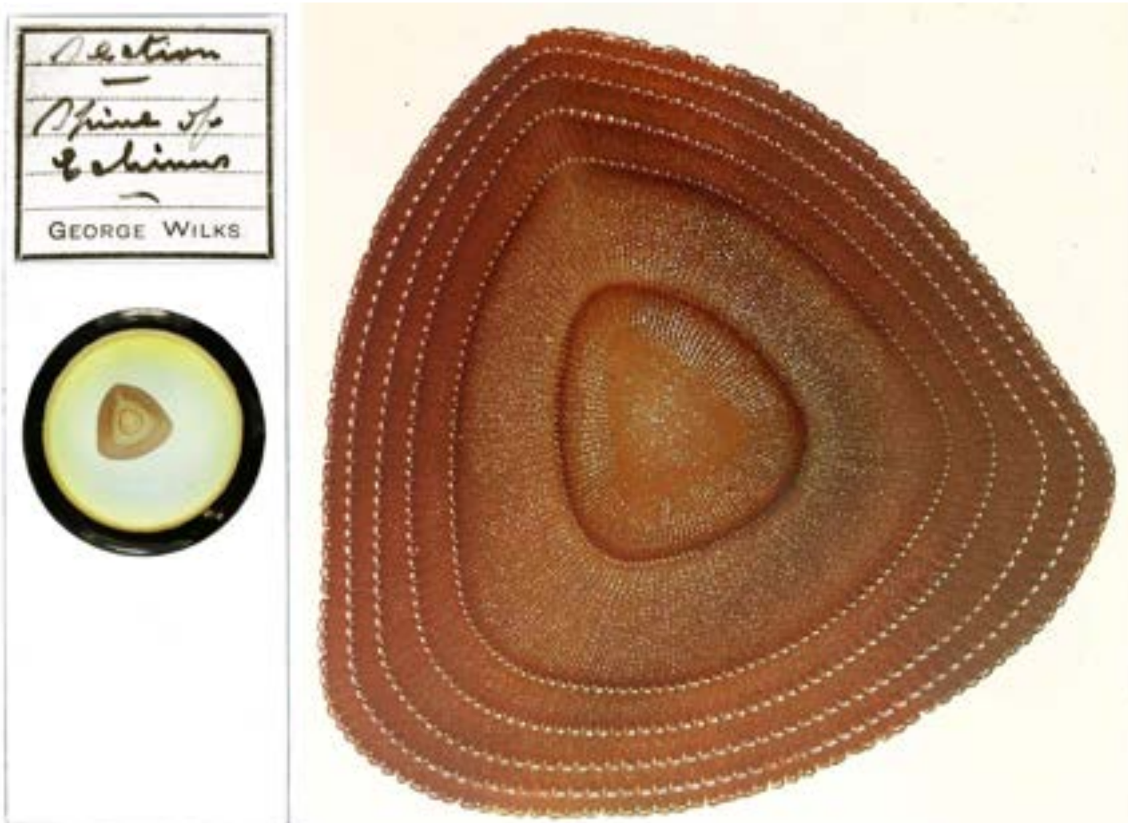
Head of Lamprey

This slide is labeled "Head of Lamprey" and "Section thro' Gills."

Phantom shrimp by Watson & Sons.

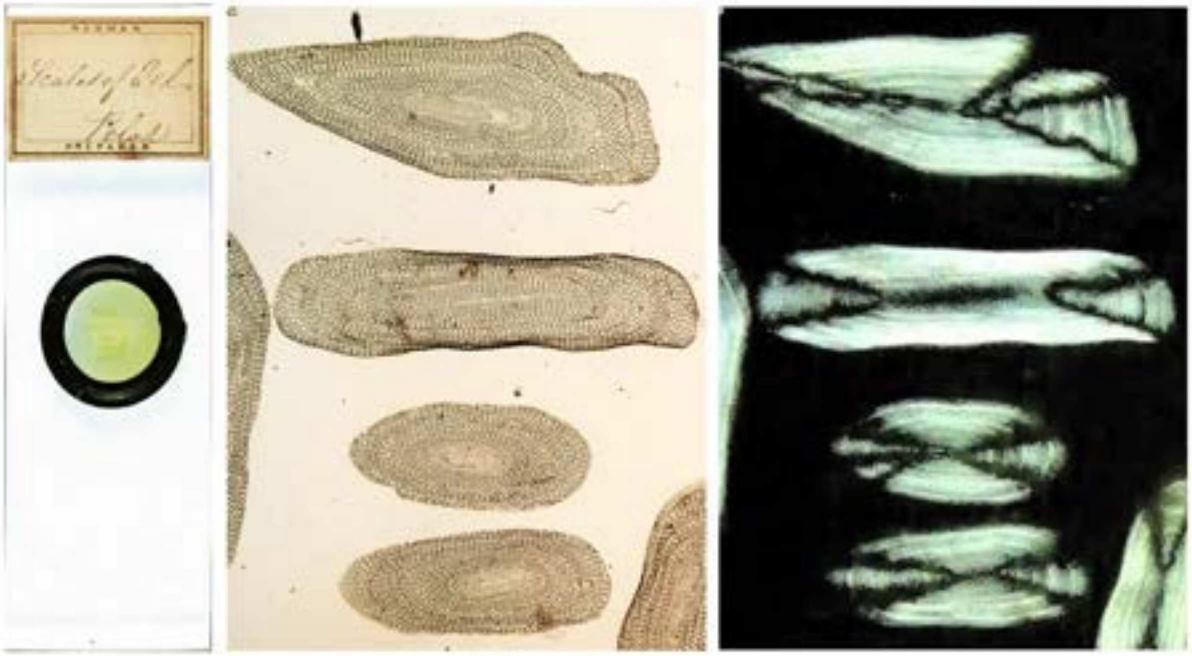
Early slide of a freshwater snail.

Brittle Star by Brian Darnton. Brian Darnton (1935-) is a mounter of high quality slides, best known for his slides of foraminifera.

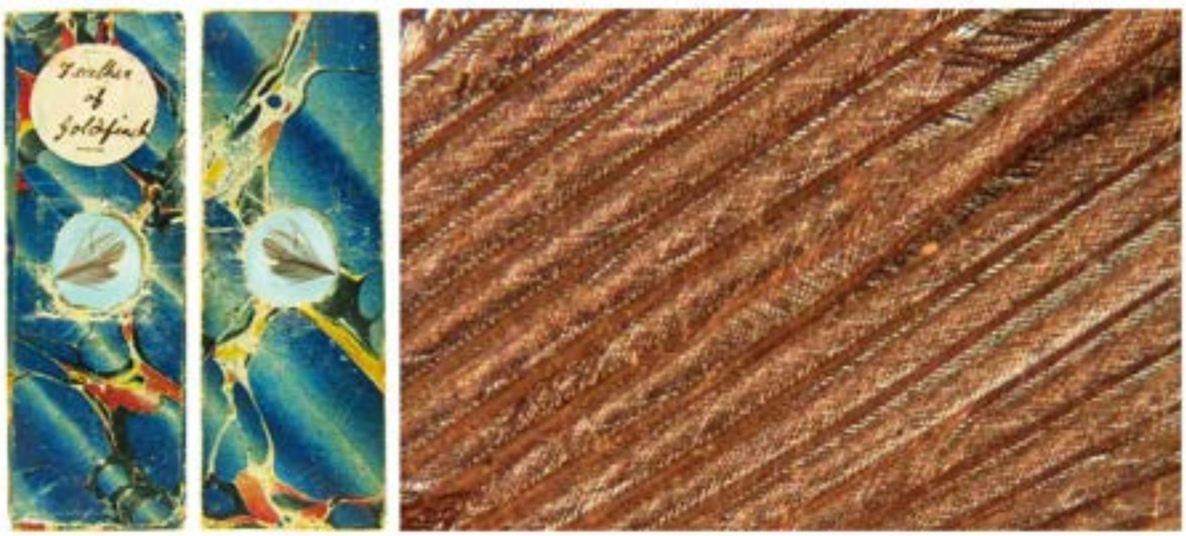


Section through the spine of the sea urchin Echinus by George Wilks who made mounts in the 1890s.

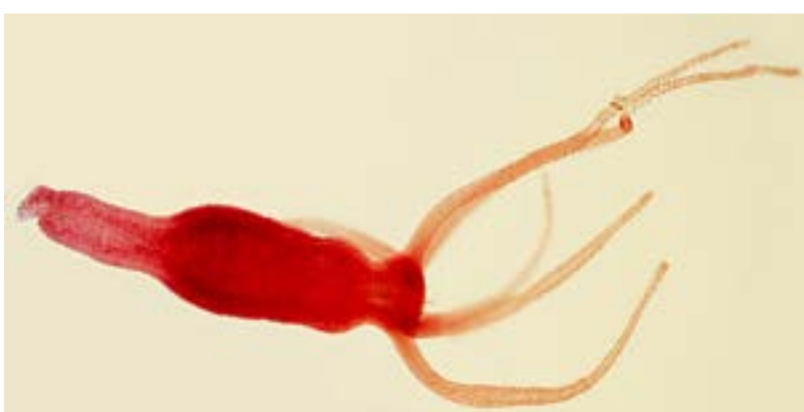
Spines of a heart urchin by C. Baker. Charles Baker (c1814-1893) sold instruments and slides by 1851.



Scales of eel by John Thomas Norman (c1814-1893) viewed in transmitted and polarized light.

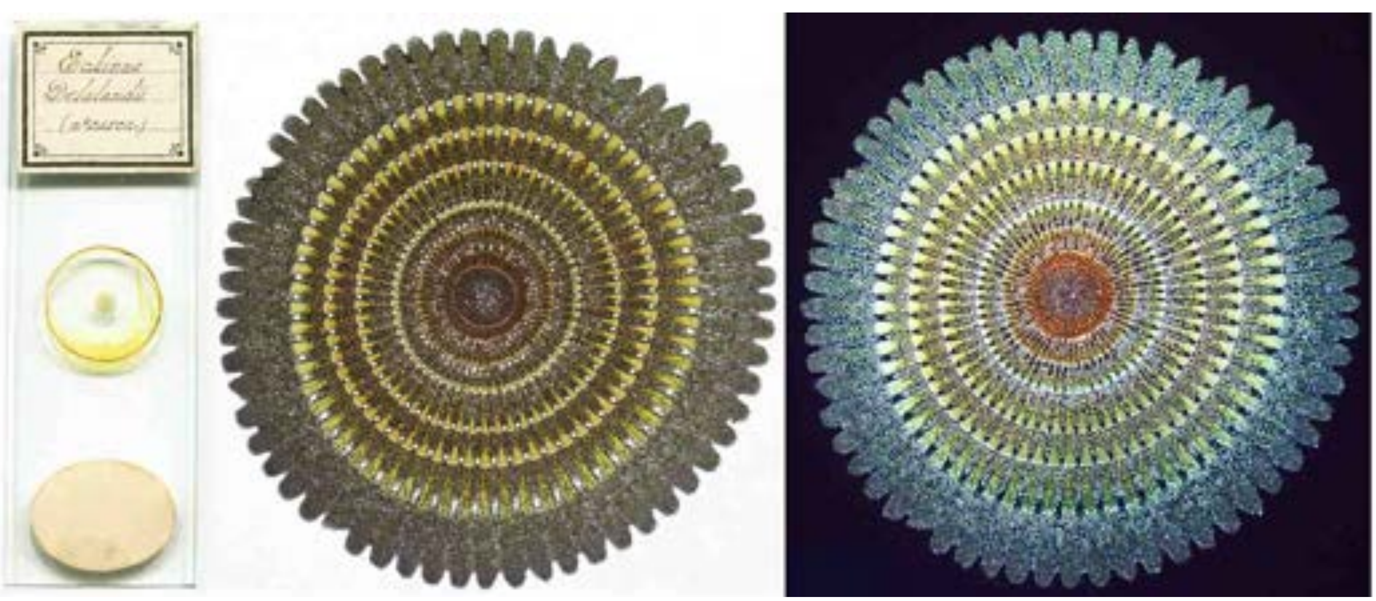


Feather of a Goldfinch. Victorian slide covered with marbled paper.



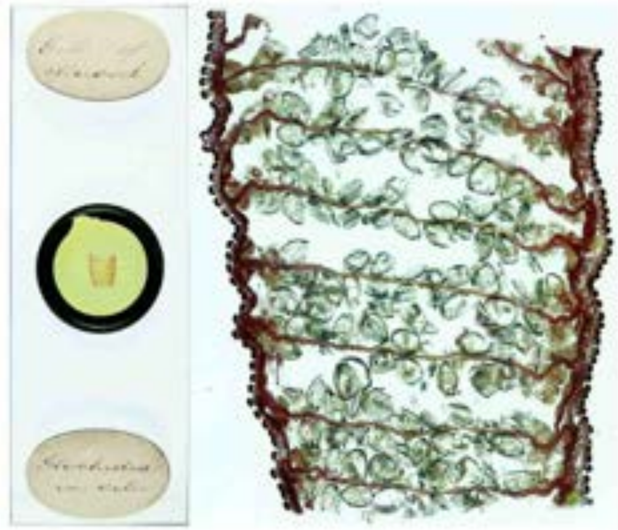
Hydra vulgaris. Prepared by Richard Suter.

Fluid mount of ova of toad.

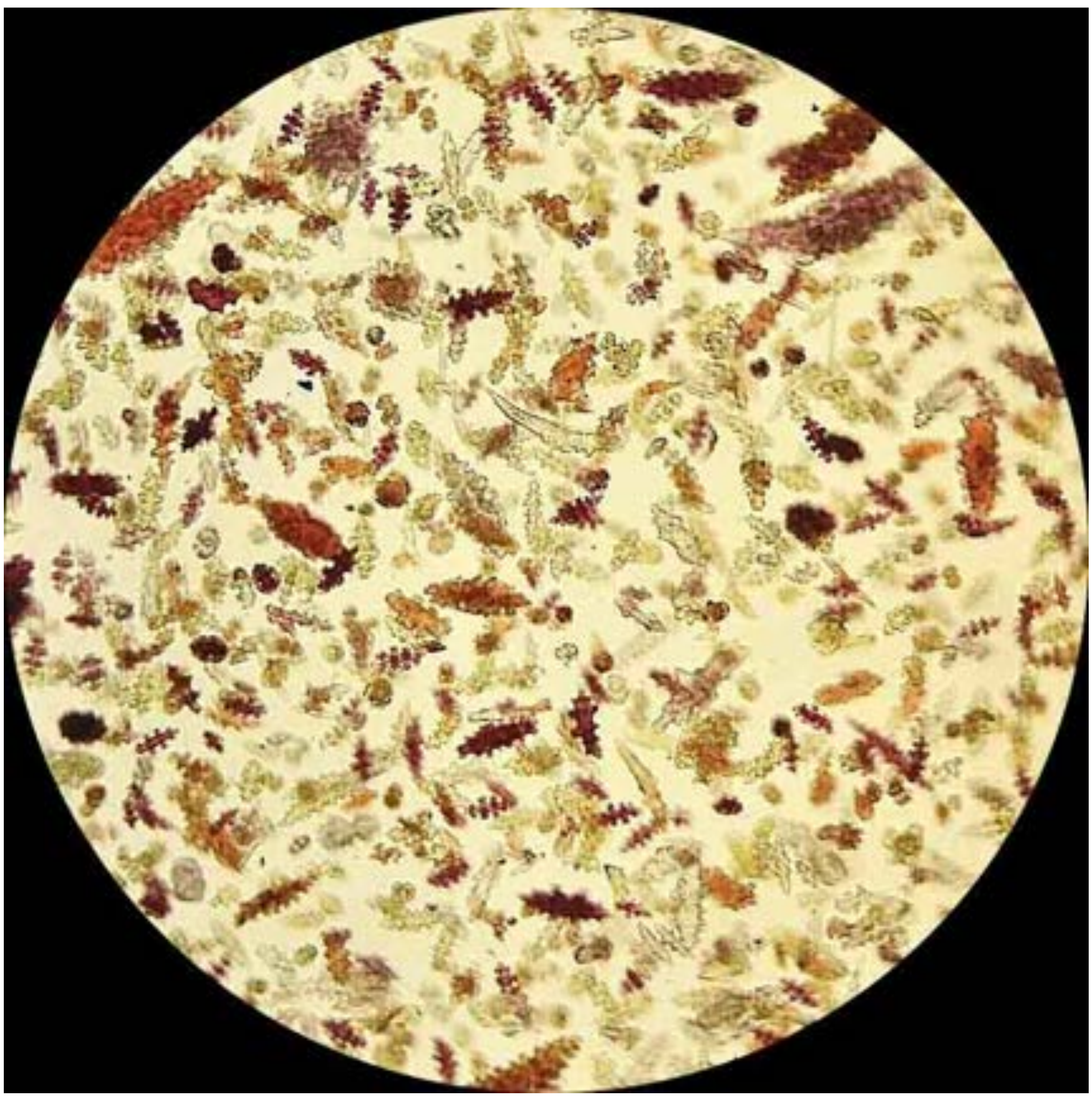


Thin section of a sea urchin spine (Echinus dalelandii), prepared by Frederick Marshall. The maker's delicate handwriting is distinctive. View with transmitted and polarized light.

Tongue of lamprey



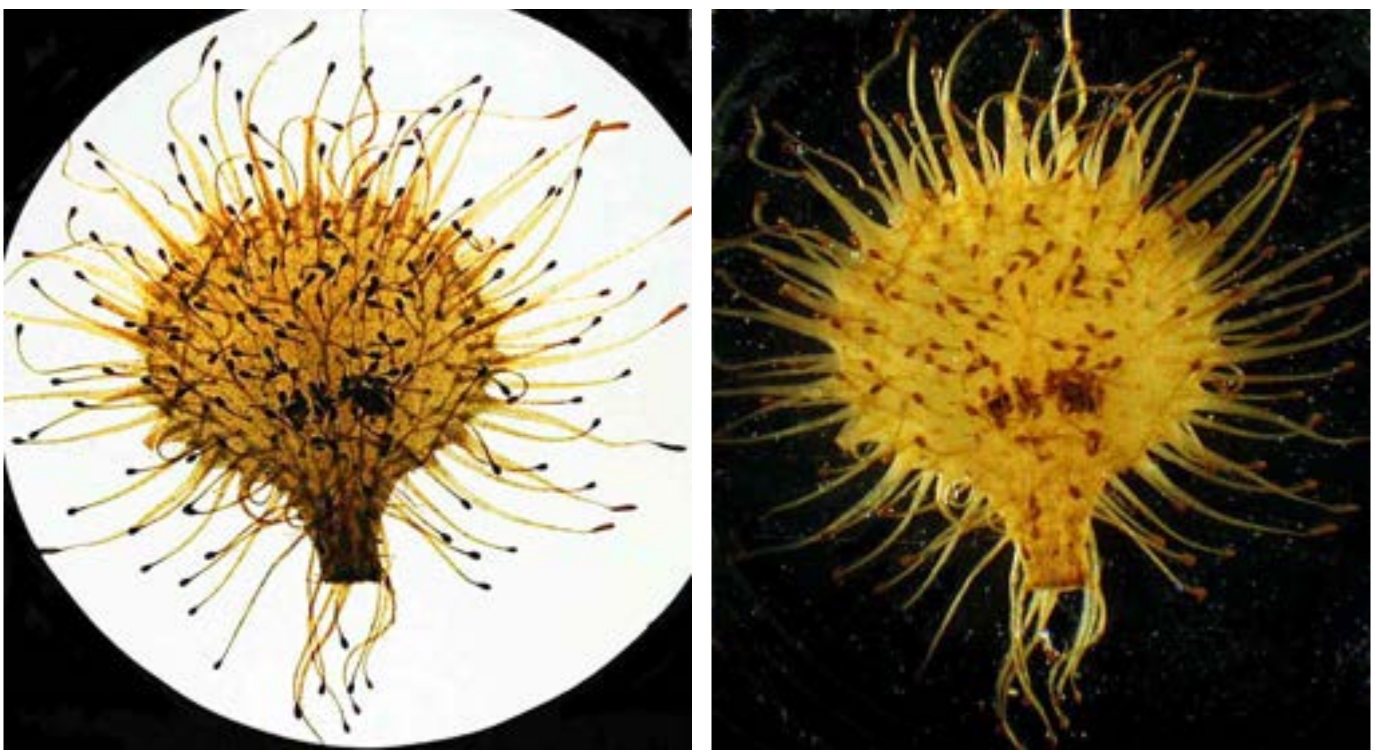
Gill of mussel



Spicules of Gorgonia, calcareous spicules of a soft coral.

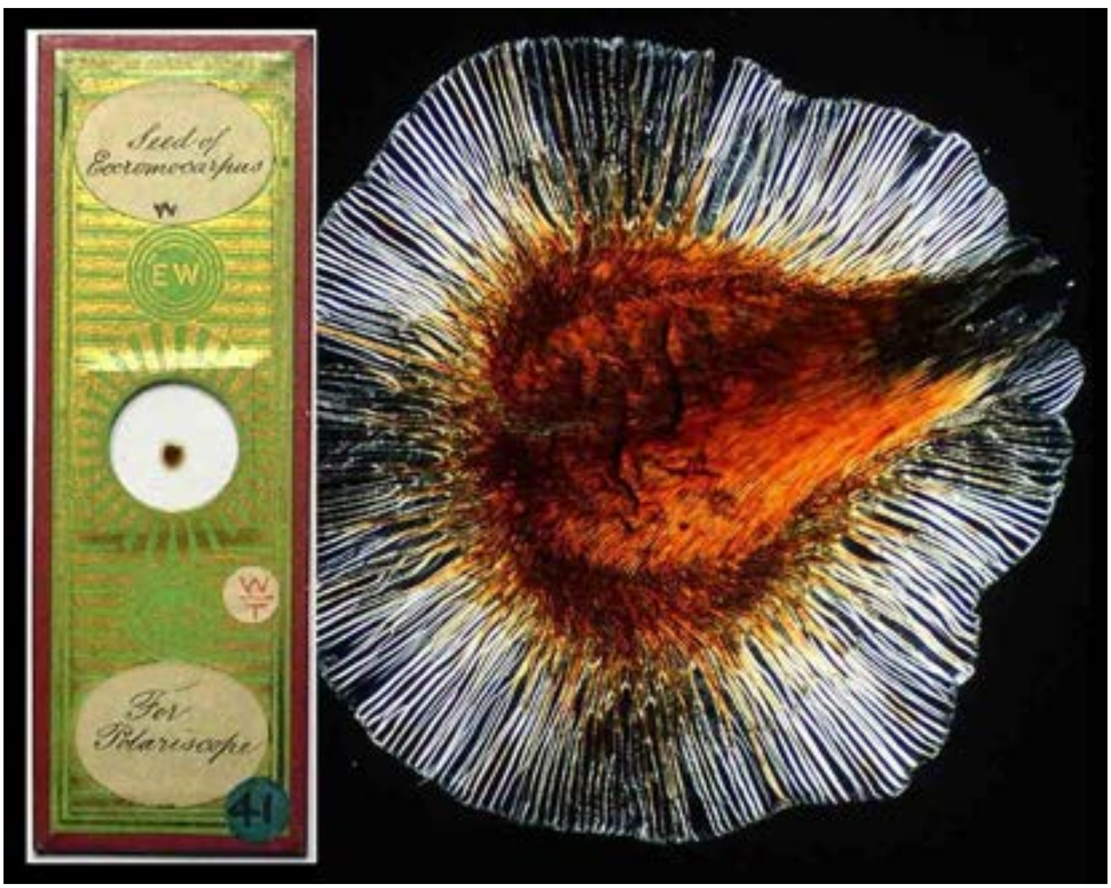
Botany

This is a microscope slide of "Tr. Sect. Ovary Foxglove Digitalis purpurea" by Richard Suter. Richard Suter (1864-1955) began making slides by at least 1887 and offered slides on all subjects for over 50 years. It also carries a rare secondary label from the optical shop of A. H. Baird in Edinburgh. The image shows the slide and includes two photomicrographs taken from the actual mount, imaged using transmitted light with crossed polarizing filters and a selenite and darkfield lighting. Digitalis is a cardiac glycoside that increases cardiac contractility and acts as an antiarrythmic agent. Its use for heart ailments was first described by William Withering in 1785 which is considered the beginning of modern therapeutics.



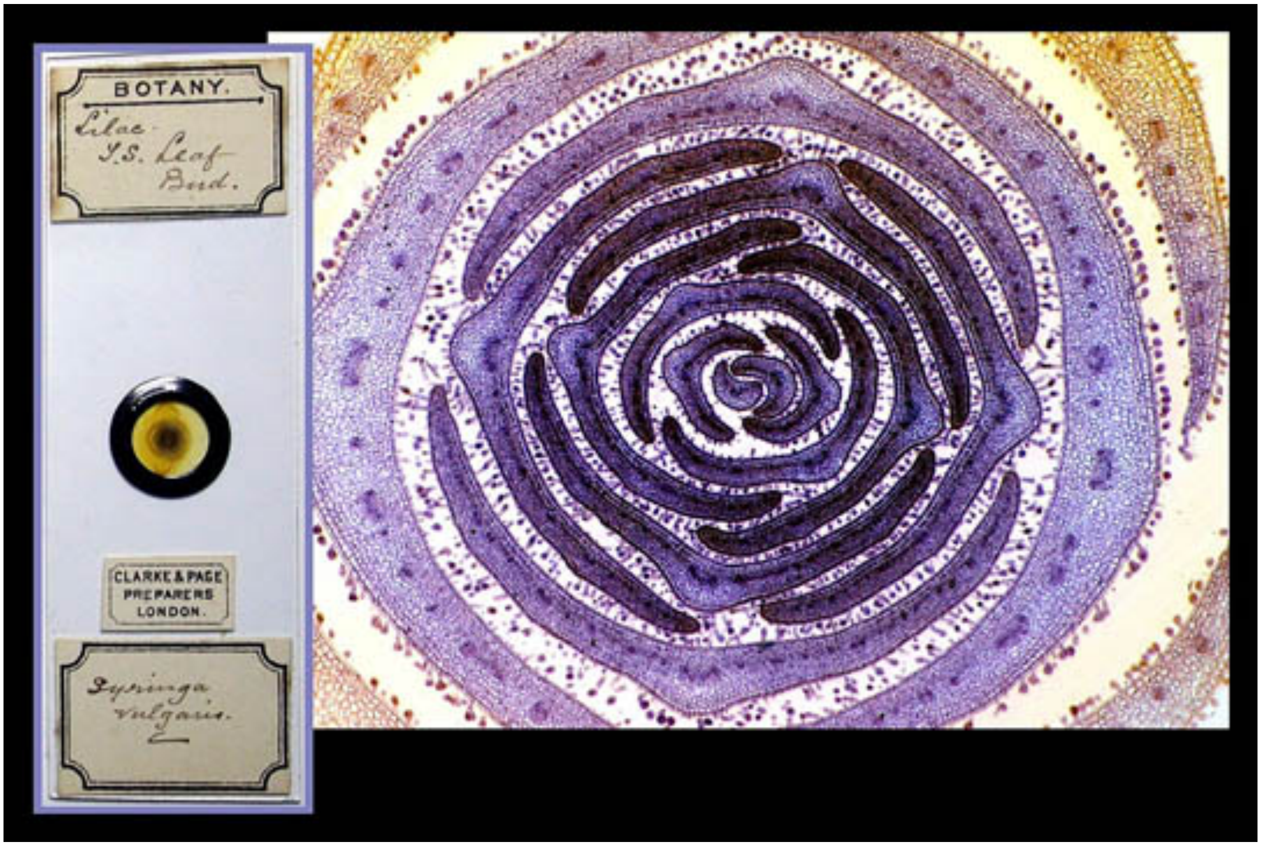
Drosera, an insectivorous plant, brightfield and darkfield

Double mount by J. C. Tempère. Leaf rust. The lower specimen shows the underside of the leaf structure. The top specimen shows the characteristic red-orange pustules that erupt from the upper epidermis of the leaf. Jean-Clodius Tempère (1847-1926) came to England from Paris in 1871 and advertised slides in 1878. He returned to Paris in 1883 and offered a vast range of mounts. In his early years in England and Paris, many of his slides were marked S. L., for "S. Louis," in a diamond or circle. He also used a shield-shape label with distinctive handwriting.



Seed of Eccremocarpus

This is a slide of "Seed of Eccremocarpus"(Chilean glory flower), c1870, by Edmund Wheeler viewed with the polarizing microscope.



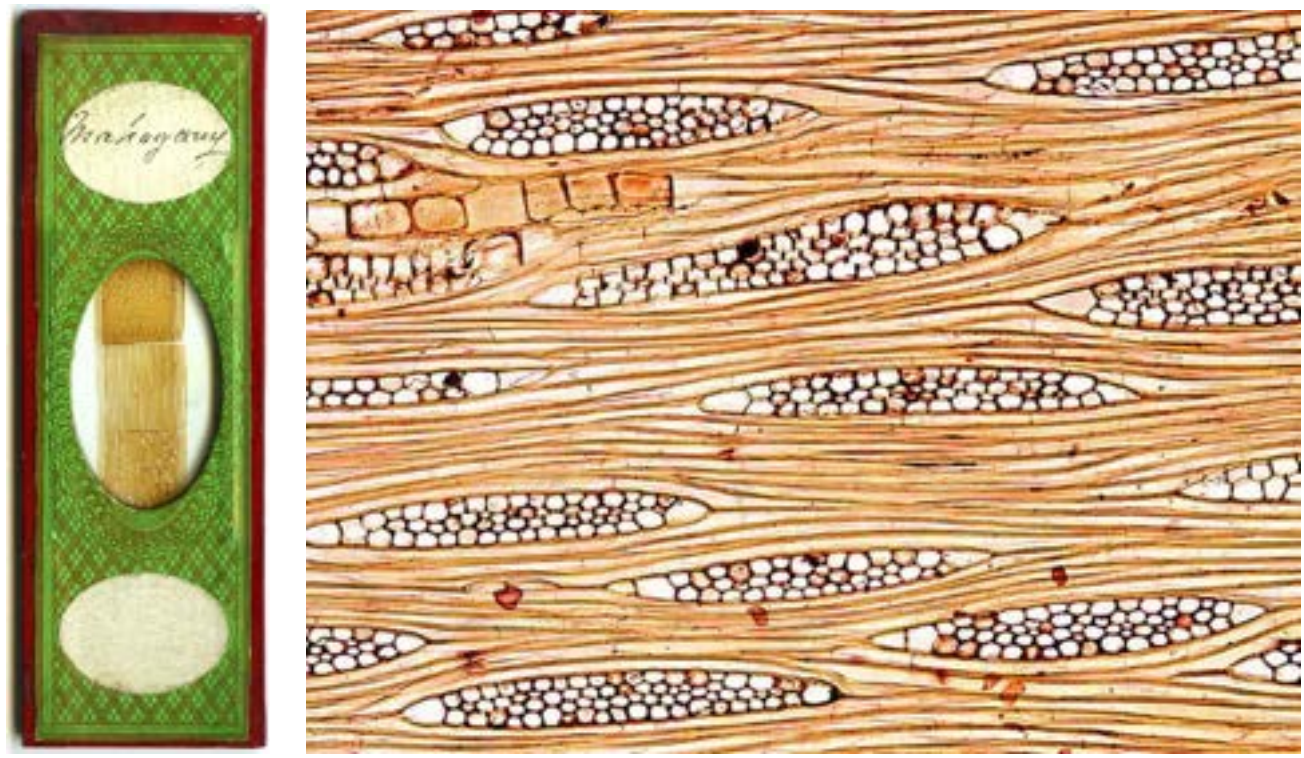
Leaf Bud of lilac

Transverse section through the leaf bud of lilac. Clarke & Page, "Specialists in Microscopy," operated in London in the early 1900s.

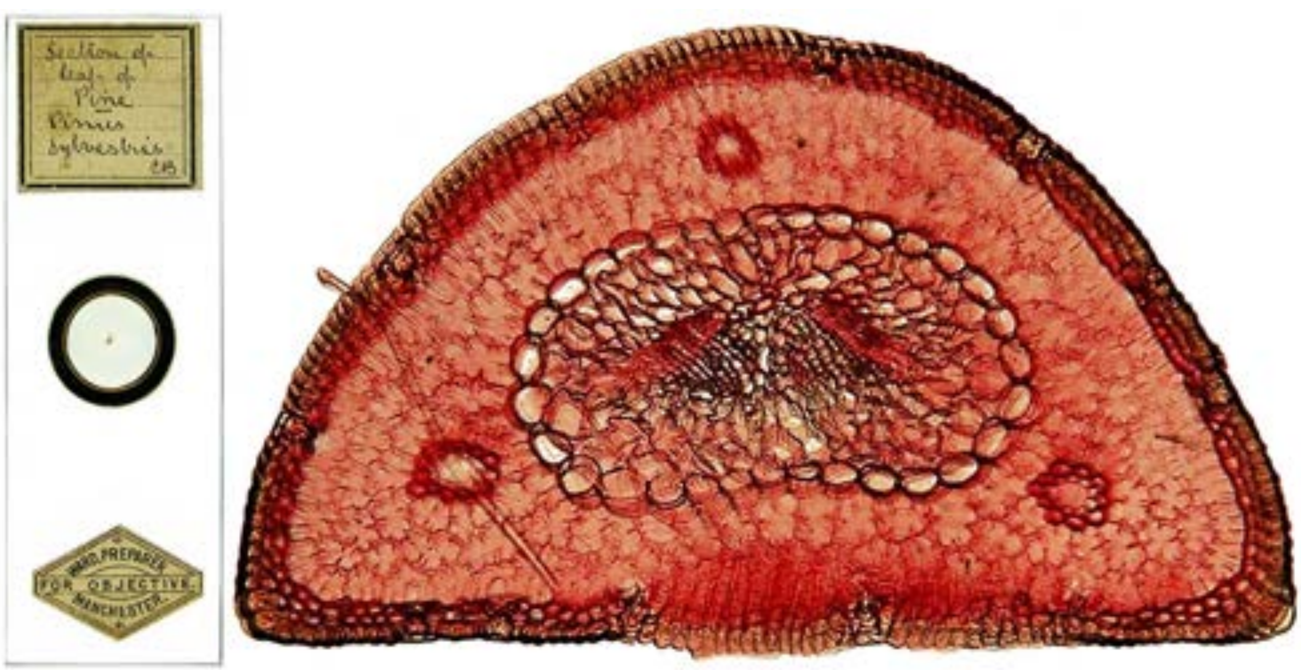
Anatomy of a leaf

Anatomy of a leaf, *Buxus sempervirens*, by Edmund Wheeler, shown by polarized and transmitted light. c1870.

Sections of timber were some of the earliest sections ever made and remained popular throughout the nineteenth century. This Victorian era slide displays three samples of mahogany. The handwriting indicates this slide was prepared by John Barnett.

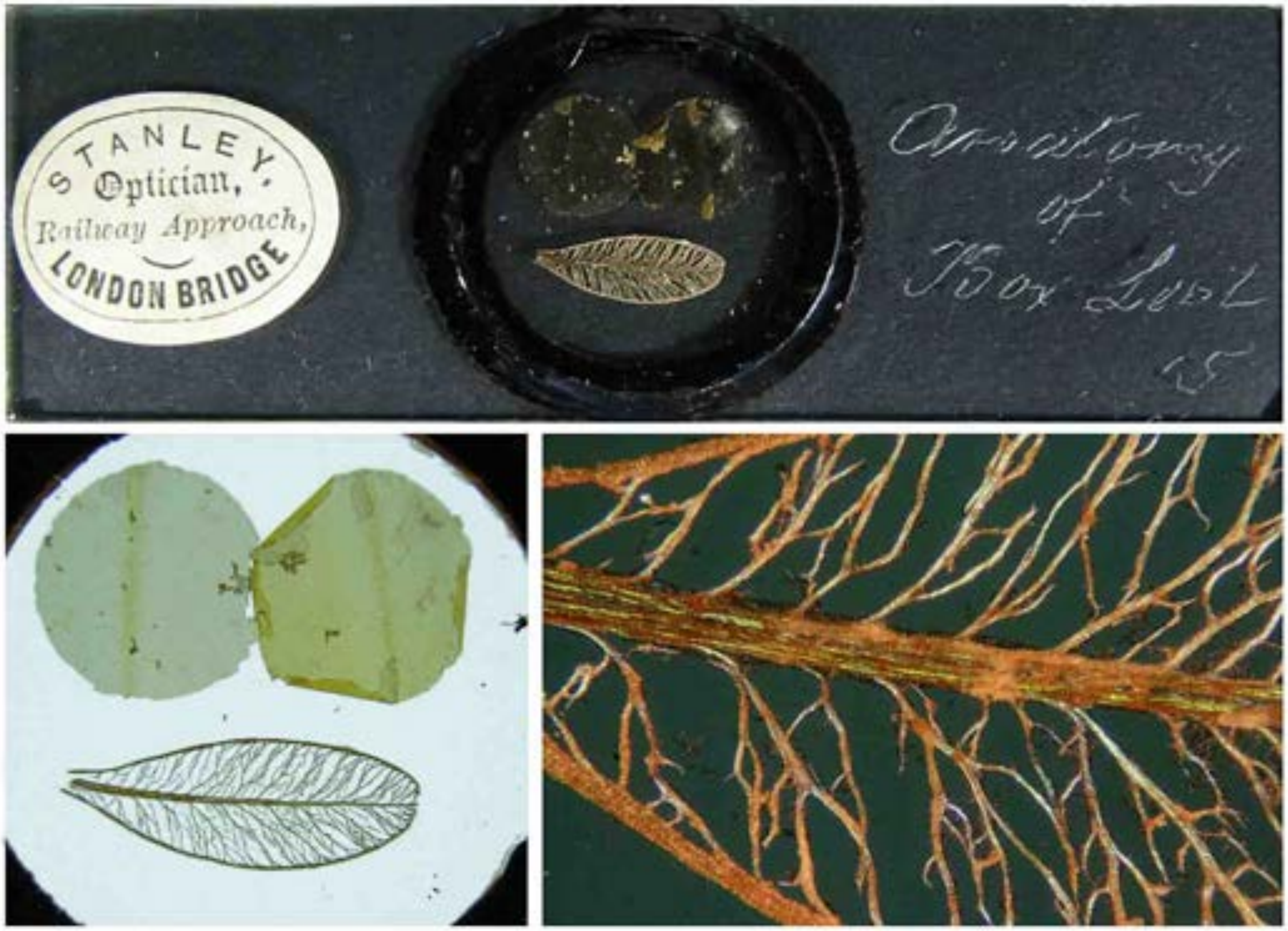


Section of Mahogany



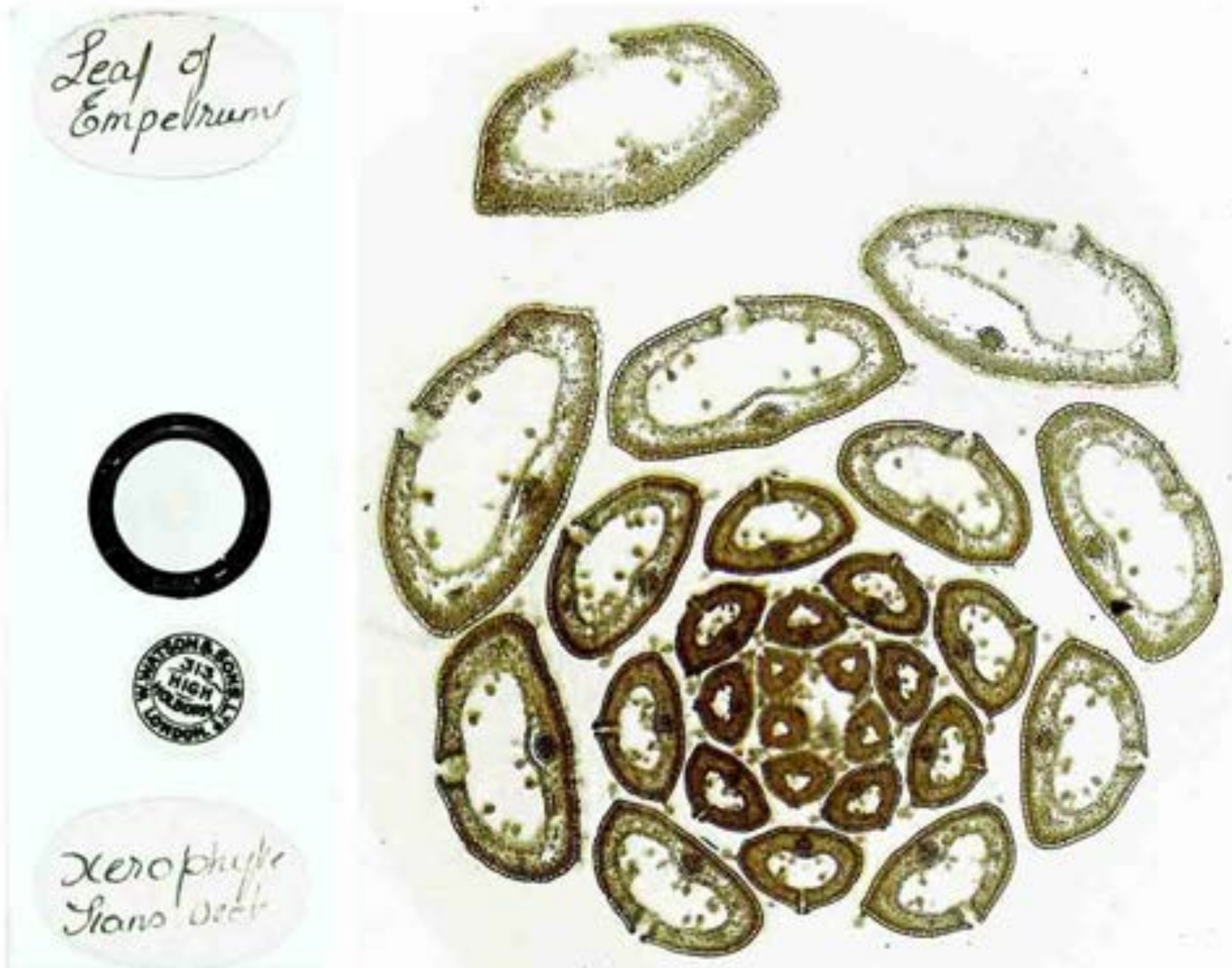
Section of a leaf of pine by Ward. Edward Ward (c1844-c1915) offered a wide variety of slides in Manchester.

Portulaca grandiflora Anthers, Wm. H. Pratt, Taunton. Anthers of the moss rose. William H. Pratt was an amateur microscopist who produced quality slides in the 1880s-1890s in Taunton, MA.



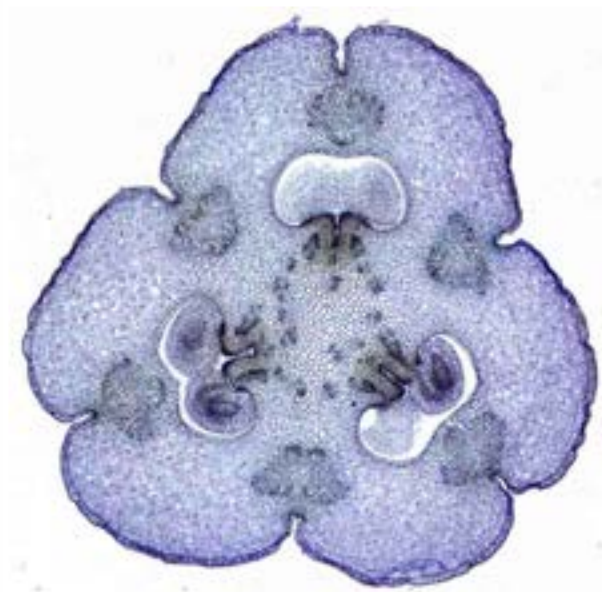
Anatomy of a box leaf, by C. M. Topping, retailed by Stanley.

Leaf of palm and leaf of sphagnum by Smith, Beck & Beck.

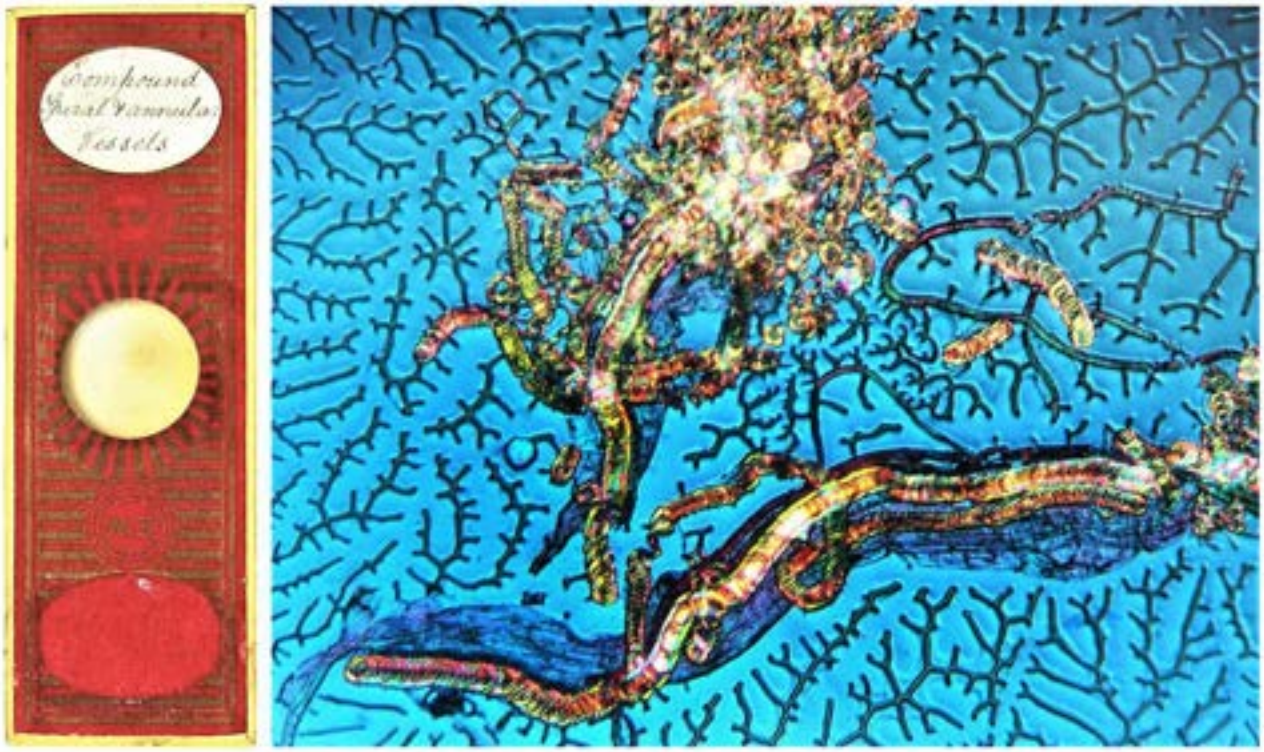


Leaf of Empetrum, Crowberry.

Bract of the Flower of Hornbeam



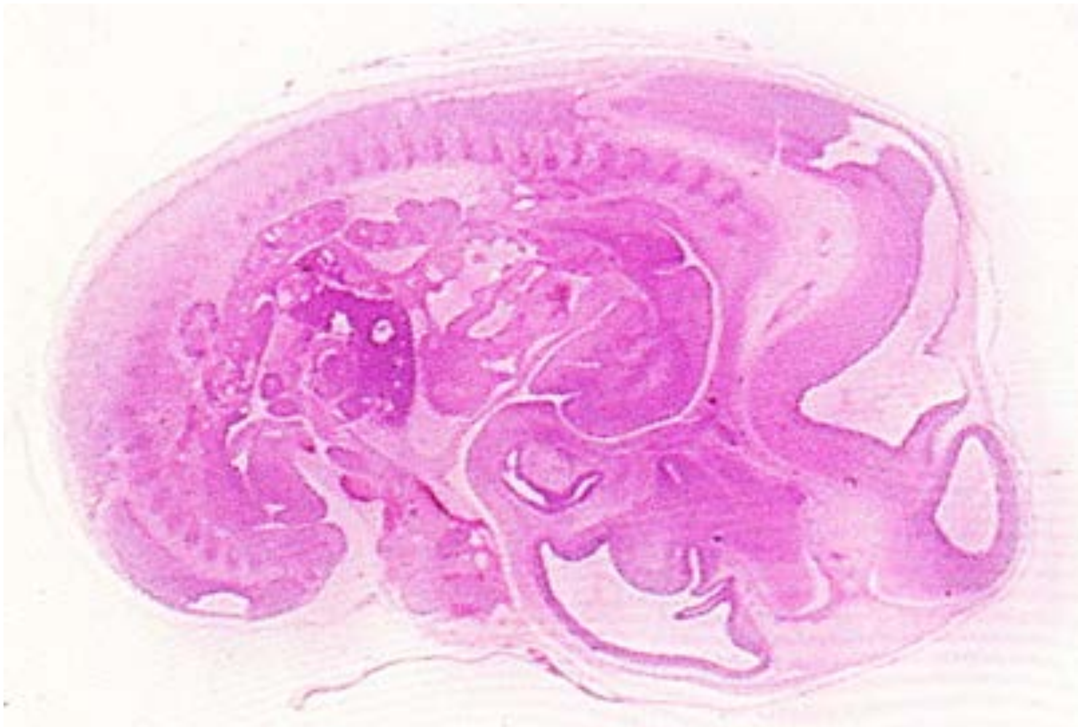
Ovary of Lily



Compound Spiral & annular Vessels by Edmund Wheeler. Vessels in plants that transport water.

Transverse section of the Petiole of Plantain, by H.W.H. Darlaston

Embryology



10 mm Rabbit Embryo, T. Gerrard & Co., London

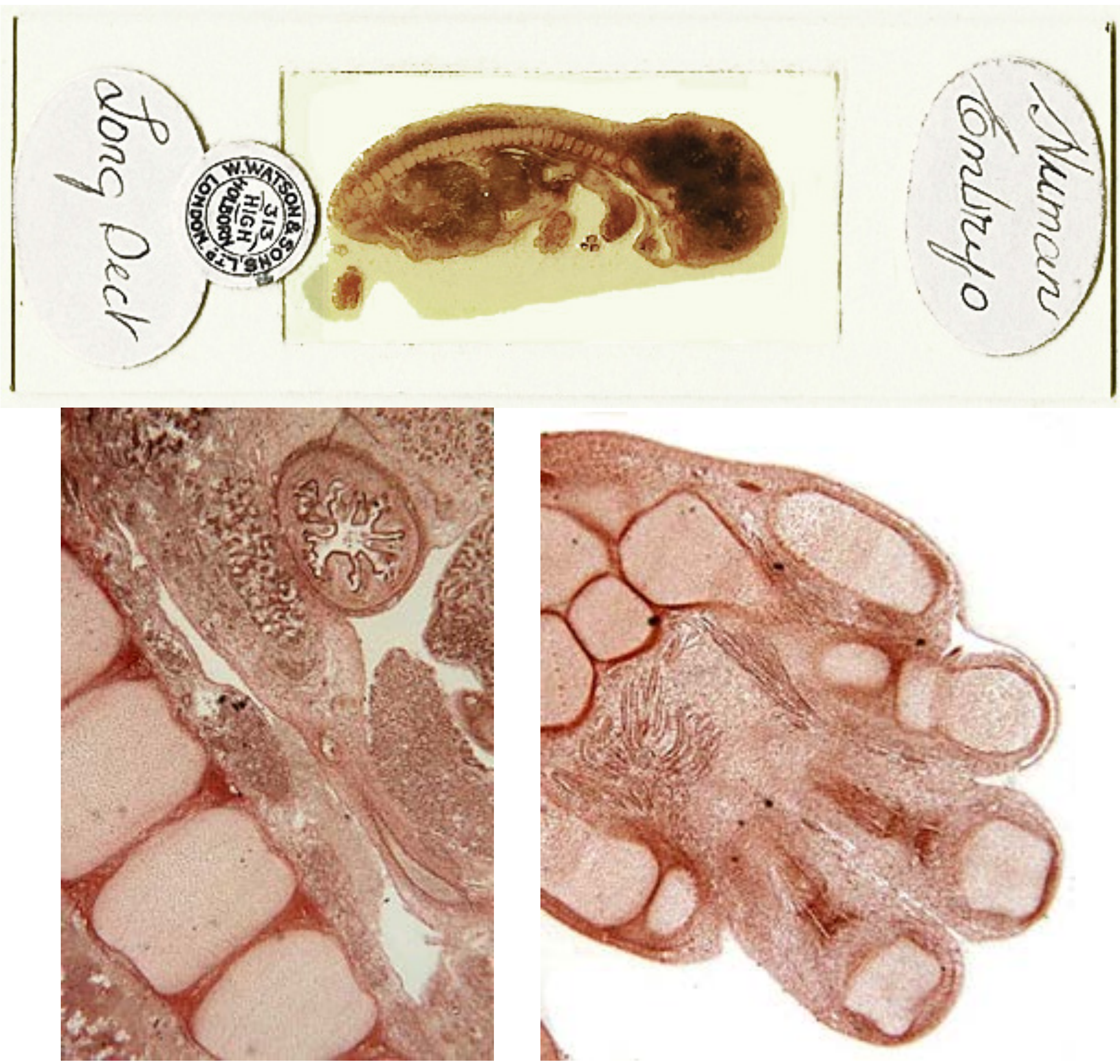
Gerrard & Co. was founded in 1850 and produced a wide range of plant and animal histological preparations. Around 1950 the firm was T. Gerrard & Co.

Chick embryo, injected, 72 hours, Carolina Biological Supply Co.

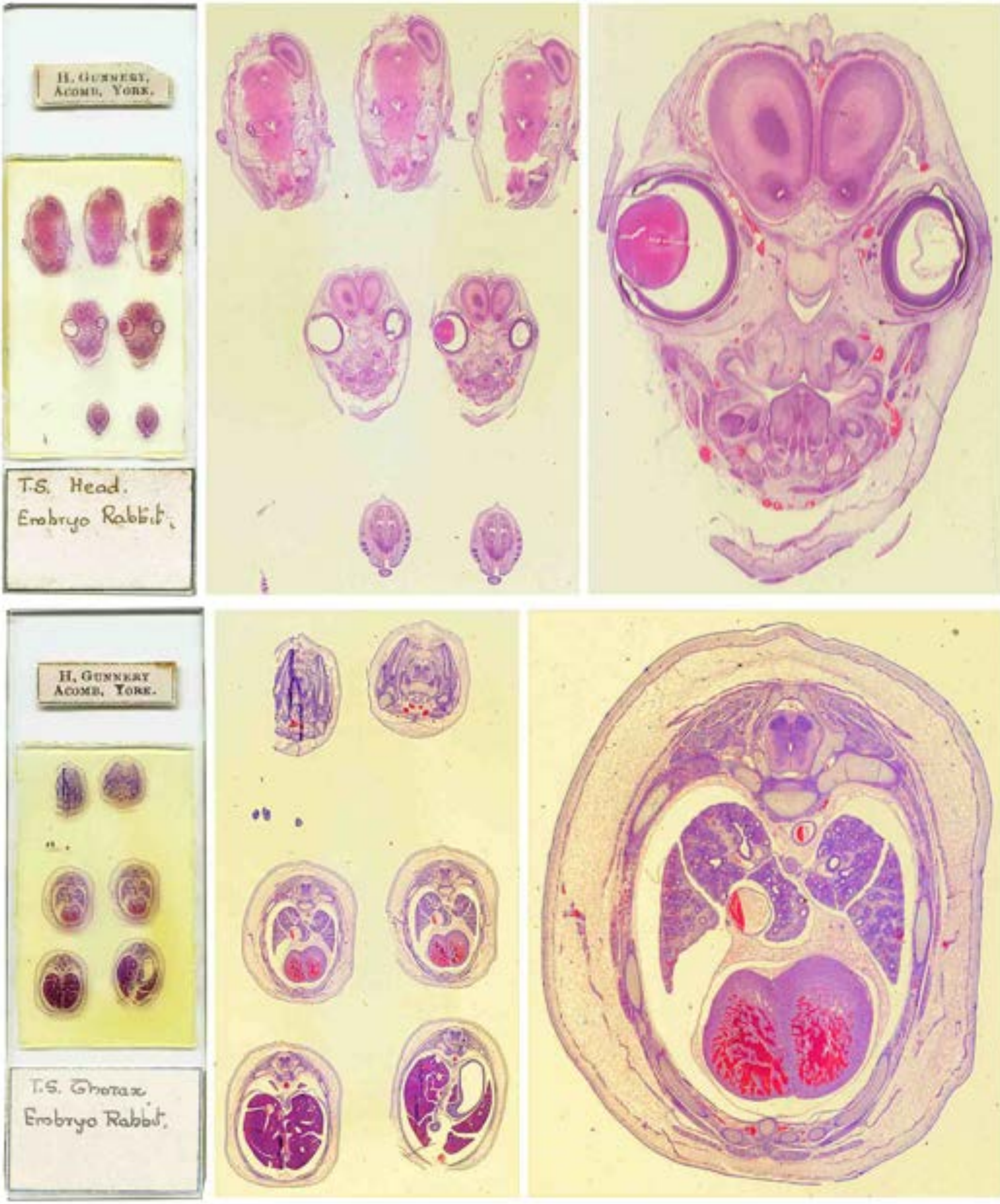
Carolina Biological Supply Company was founded in 1927 by Thomas E. Powell in Burlington, NC, USA. It is now run by his son. They offer very fine slides on a variety of subjects. Beginning in the 1970s, they produced thin (1.5μ) sections of epoxy-embedded tissues that are probably the finest slides ever made for fine detail. A complete set of these slides, most of which are no longer made, was purchased in 1980 and is a part of the Yale collection.

Human Embryo by Watson & Sons

This is a rare slide of a longitudinal section of a whole human embryo. It bears the label of W. Watson & Sons Ltd, 313 High Holborn, London. After 1908.



Longitudinal section of whole human embryo by Watson & Sons, Ltd.

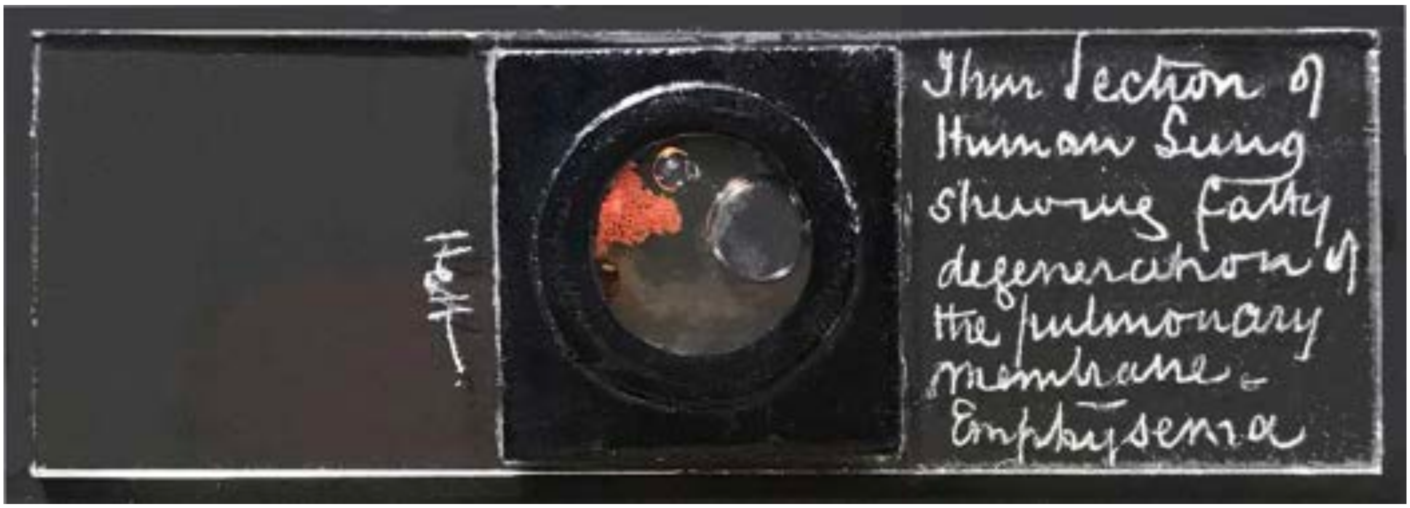


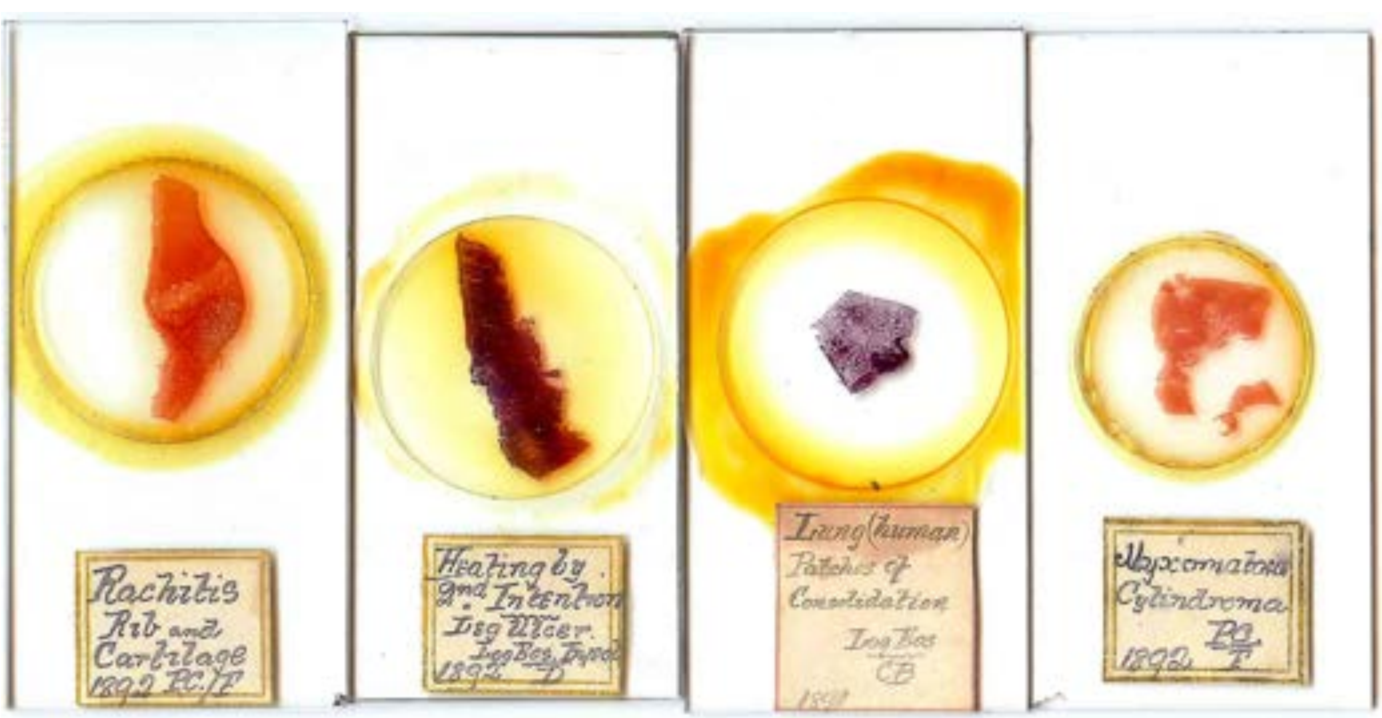
Serial sections of the head and thorax of a rabbit embryo by H. Gunnery. Herbert J. Gunnery (1882-1978) operated a microscope slide business, The Laboratory, Acomb York, in 1911. Much of his later life was spent as a professional botanist.

Pathology

Deep Cell Slide of Diseased Lung by Hett, c1860

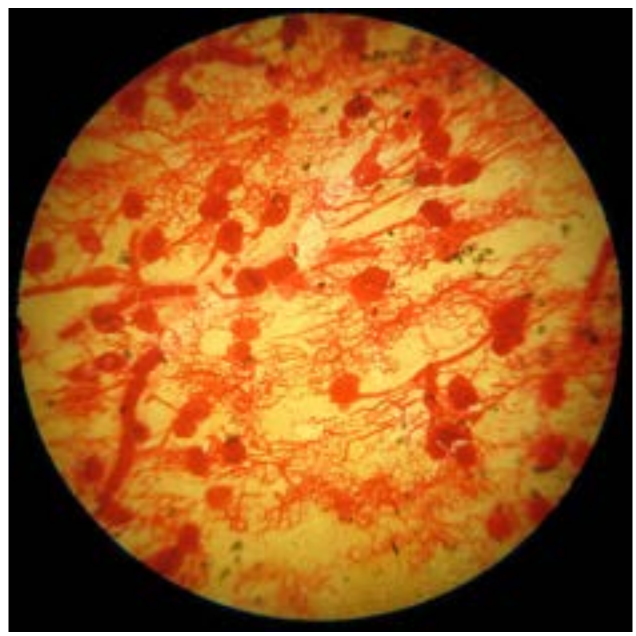
With the founding of the discipline of cellular pathology by Rudolph Virchow, slides of pathological specimens were prepared for teaching in medical schools. This is an important early pathology specimen prepared by Alexander Hett. Hett (1807-1870) FRCS was a surgeon and inventor who prepared microscope slides beginning in the late 1840s. His distinctive slides are opaque specimens held in deep, fluid filled glass cells. This is a diamond-engraved and signed slide of diseased lung. See other slides and a set by Hett in the collection.





Pathology Slides, 1892

Wheeler and Watson Urinary Series, 1880-1910

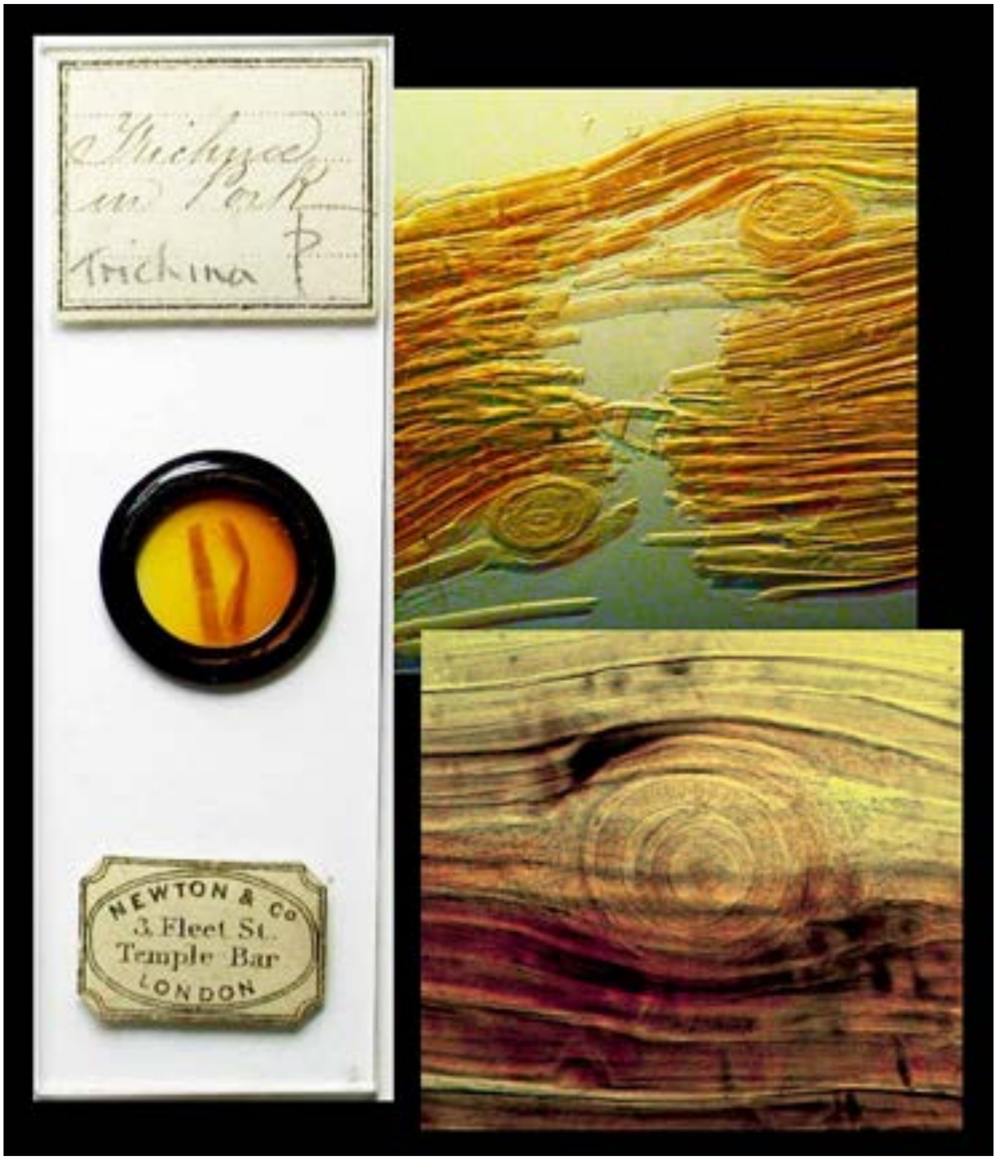


This is a fine slide of "Dropsy" by Edmund Wheeler, c1875. The kidney is injected showing the glomeruli and blood vessels.

Microbiology

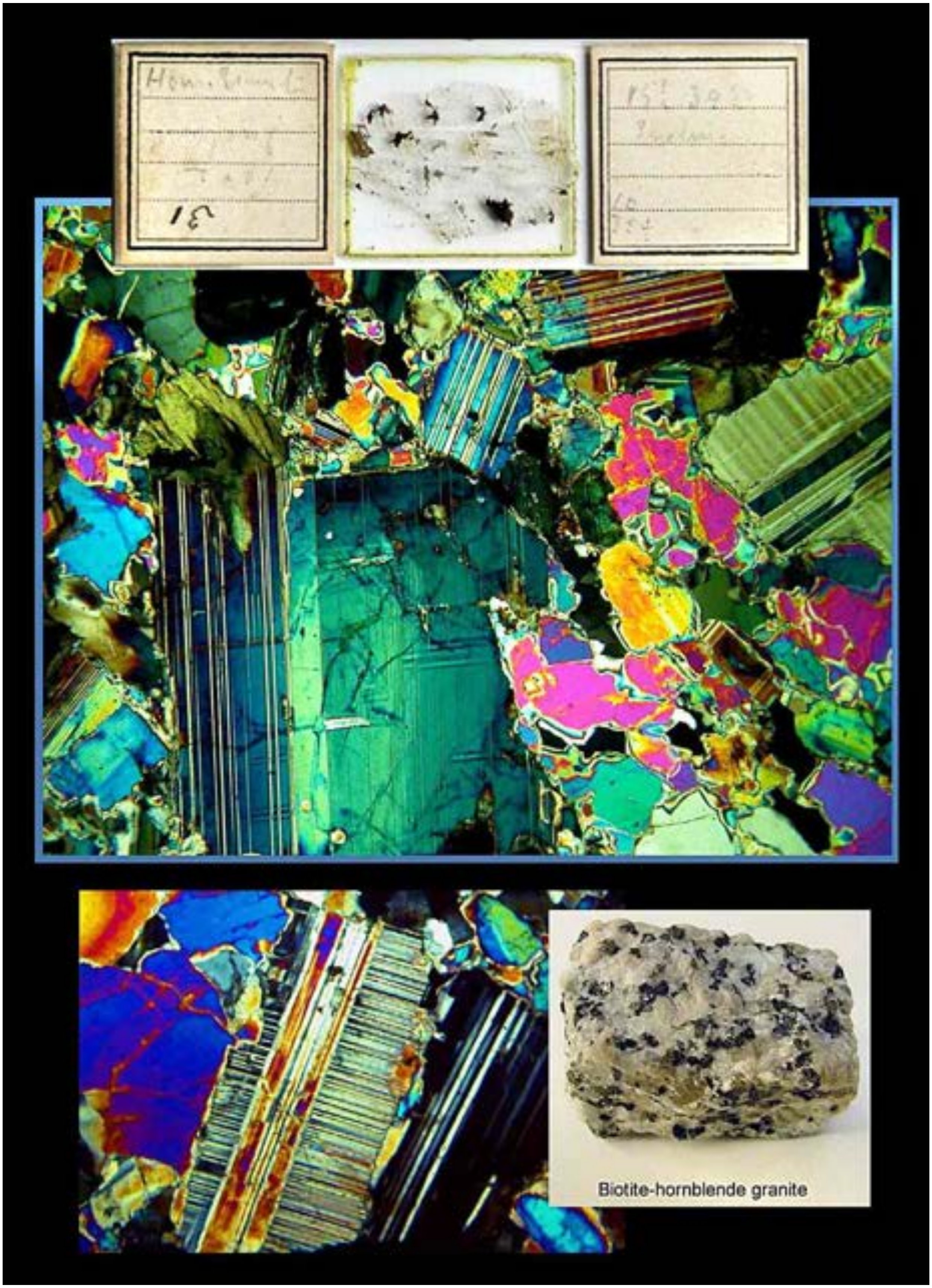
Late nineteenth century microbiology slides include the causative agents of diseases such as tuberculosis, smallpox, anthrax, and leprosy that are absent or less commonly seen today.

This is a microscope slide by the shop of John Thomas Norman (c1814-1893), although it doesn't carry the firm's label. The label bears Norman's ornate and distinctive handwriting. Norman was in business professionally by 1845 and worked until 1892 when the firm was turned over to his sons. His slides are of the highest quality. Many of his slides were sold by other professional mounters under their own labels. Many were factored through various retail optical shops, and often carry their secondary labels, as in this slide that bears the label of Newton & Co. The specimen is an interesting mount of "Trichyzed in Pork." The specimen has been carefully prepared and mounted for viewing with transmitted lighting. The image shows the slide, and includes photomicrographs taken from the actual mount, imaged using oblique transmitted lighting and partially crossed polarizing filters. The slide shows the larva of *Trichinella spiralis* within cysts of skeletal muscle. Trichinosis was a major public health problem in the nineteenth and early twentieth century.



Petrography

Minerals and thin sections of rocks were popular objects in the Victorian era. Some are especially attractive under polarized light. They also had important scientific and educational uses. Reference collections were used by universities for teaching mineralogy and geology. Preparation of thin sections of rocks is a difficult process requiring great skill. First, a rock is sliced with a diamond saw and the slice is trimmed to fit on the glass slide. One side of the slice is ground flat and the slice cemented to the glass slide. All but one mm of the cemented piece is sliced off. Then the cemented piece is ground smooth by hand using progressively finer abrasive grit until the sample is only 30 µm thick. This slide is a thin section of hornblende granite viewed with polarized light. The slide is unsigned but was most likely made by Scottish geologist Matthew Forster Heddle (1828-1897).



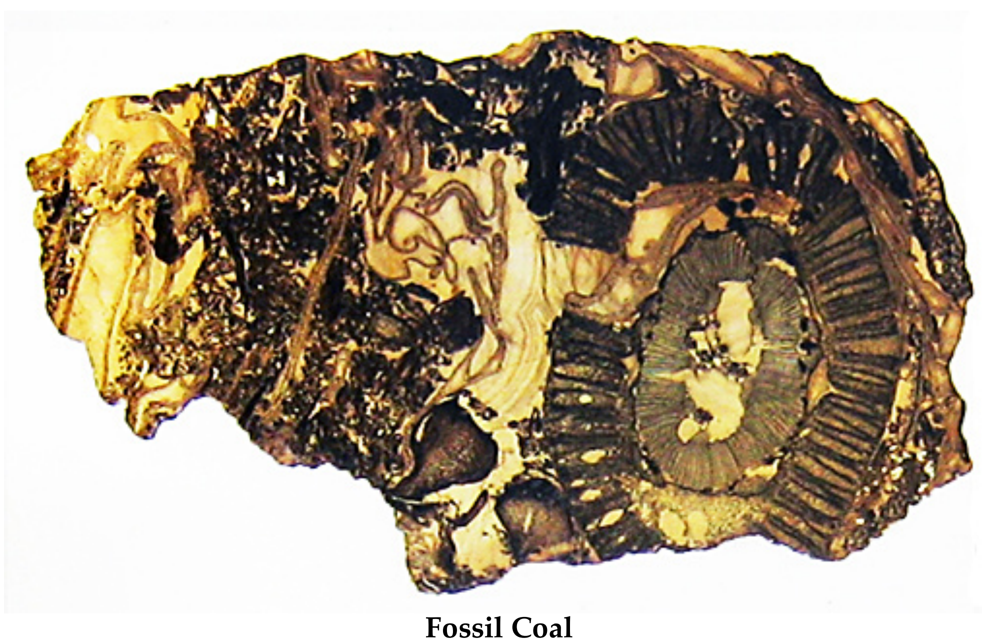
Section of hornblende granite viewed with polarized light

Thin Section of a Lunar Meteorite

This is a thin section of the lunar meteorite NWA (Northwest Africa) 11474. It measures approximately 3 x 1.25 cm. A lunar meteorite is a rock found on earth that was ejected from the moon by the impact of an asteroidal meteoroid or possibly a comet and eventually attracted by earth's gravity. This meteorite is 1 of 138 approved meteorites classified as Lunar. It consists of primarily feldspathic clasts and shock melt with lesser amounts of fragmental pyroxene and olivine. It has been characterized by Dr. Carl B. Agee, Director Institute of Meteoritics, Professor of Earth and Planetary Sciences, University of New Mexico. A detailed official description of this meteorite is in the Meteoritical Bulletin Database.

Lunar Meteorite

This slide is an early section of fossil coal. John T. Norman purchased a collection of early fossil coal slides and sold them under his label. The section is of Dictyoxylon, a Carboniferous seed fern. It shows the stem having longitudinally-oriented bands of fibres in the outer cortex. c1840.



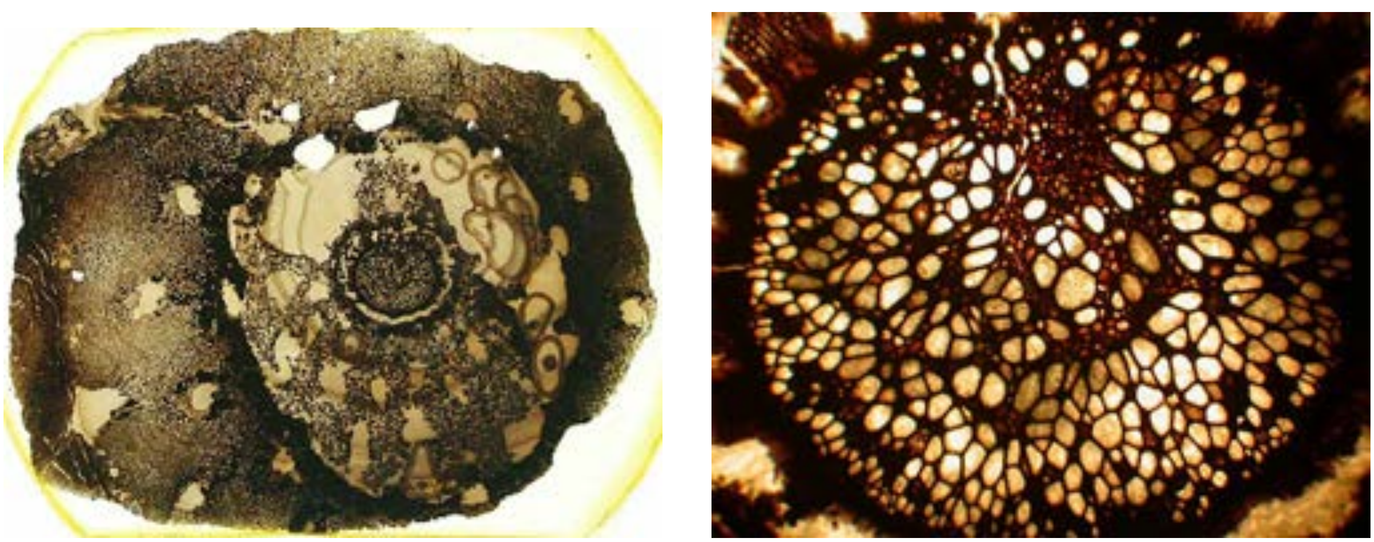
Fossil Coal

Crystals **Crystals, back**

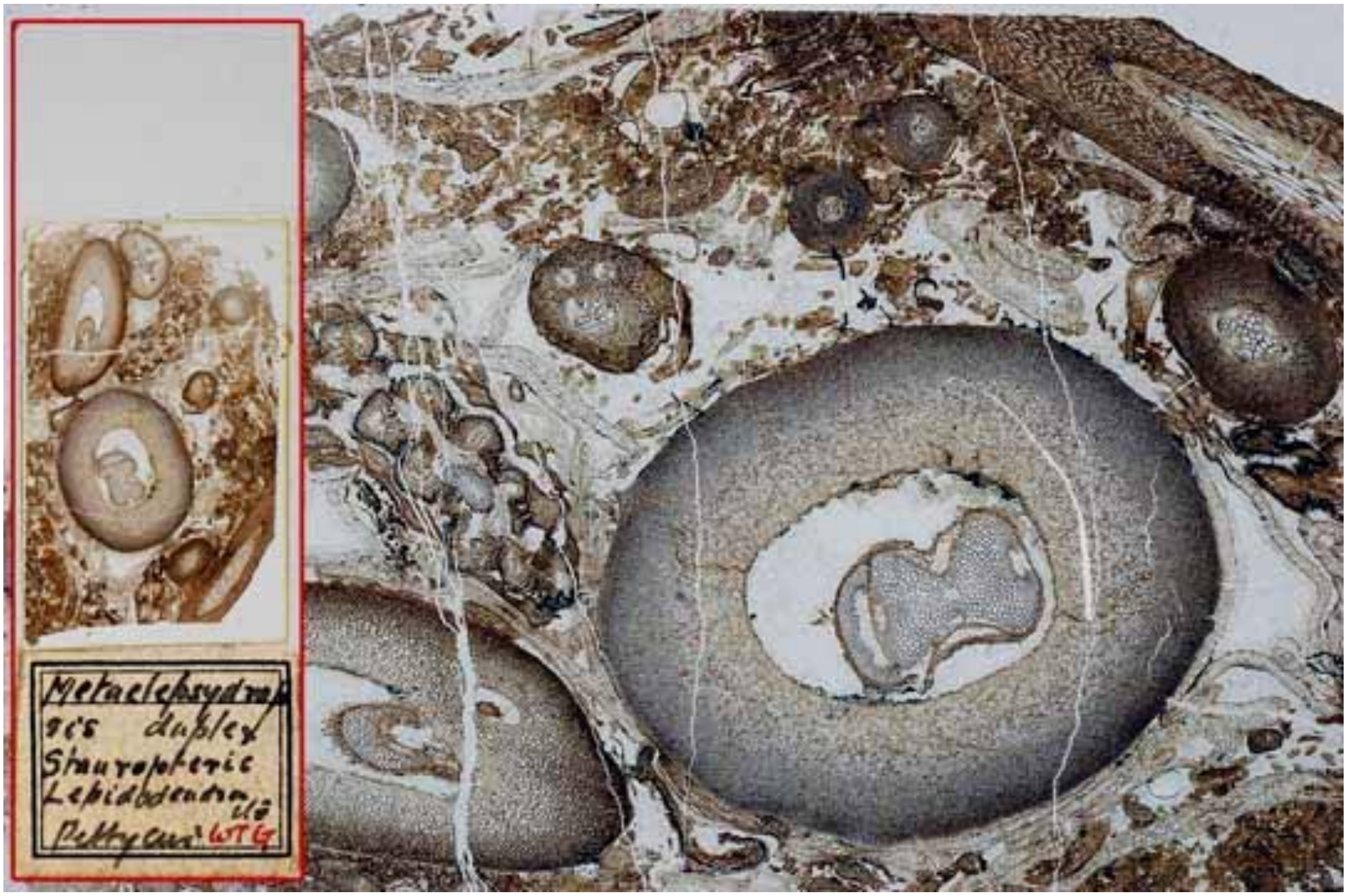
Early paper-covered slides of crystals, c1850

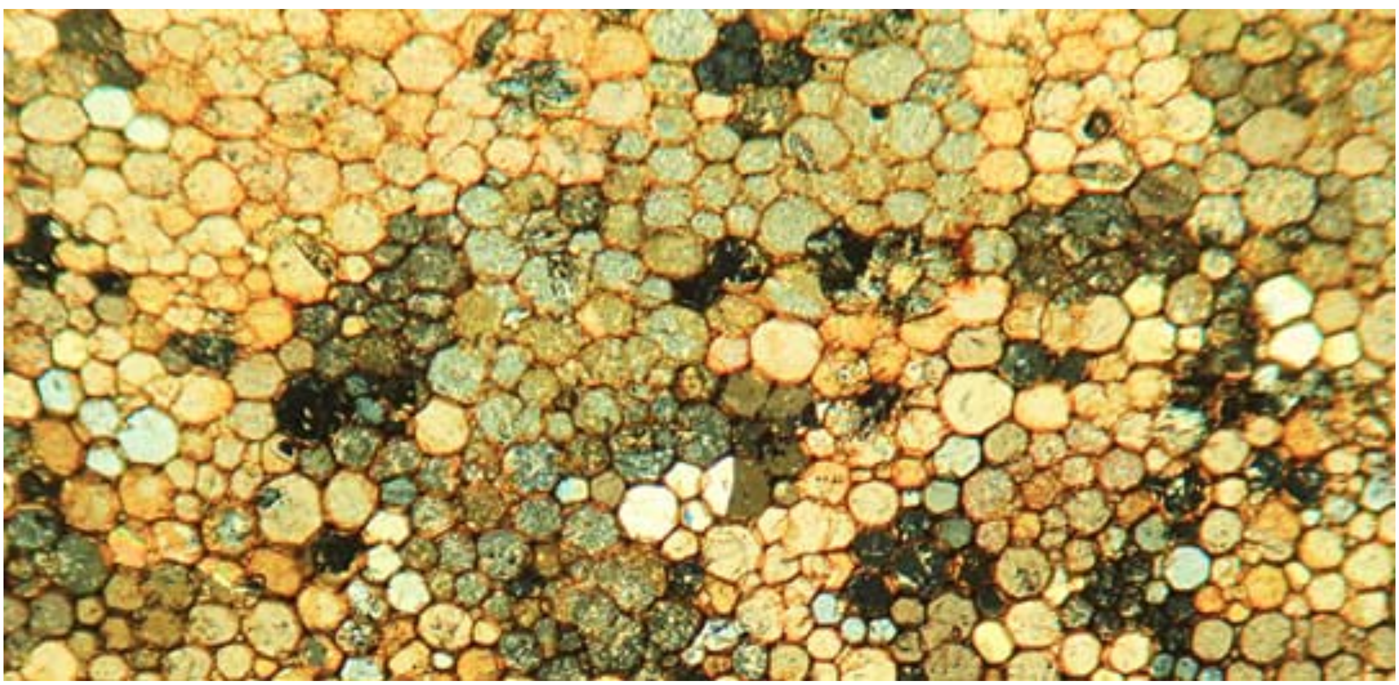
Coprolite

Coprolite, Maws Creek, Texas. From a dinosaur. By examining coprolites, paleontologists are able to learn about the diet of the animal, such as whether it was a carnivore or herbivore.

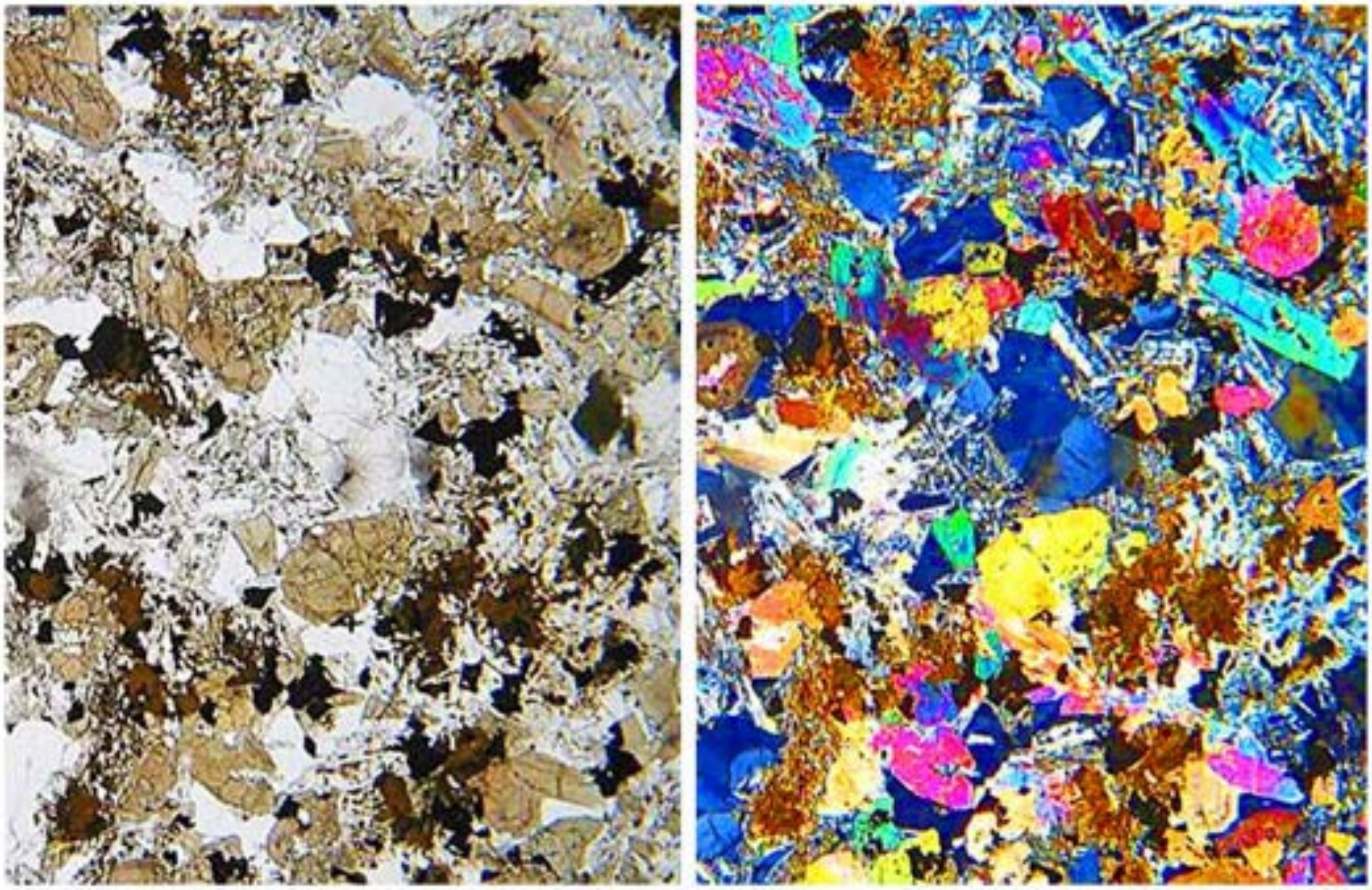


Section of Lepidodendron harcourtii, a fossil tree in which cells can be seen

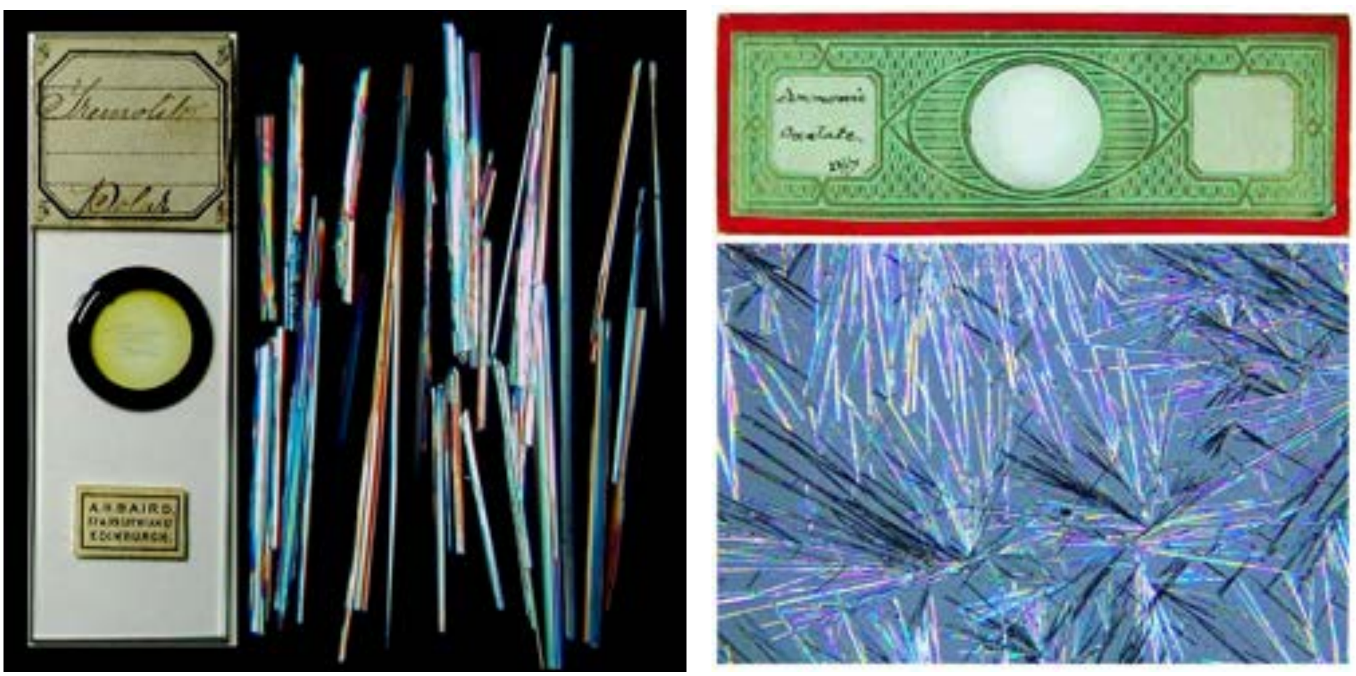




Thin section of Metaclepsydropsis duplex, a fossil fern of the Carboniferous period.



Nepheline-Crinanite viewed with transmitted and polarized light



Left: Tremolite, a form of asbestos, viewed with polarized light. The maker, Andrew H. Baird, worked in Edinburgh in the 1890s and early 1900s. Right: Ammonic Oxalate by Green Papers.

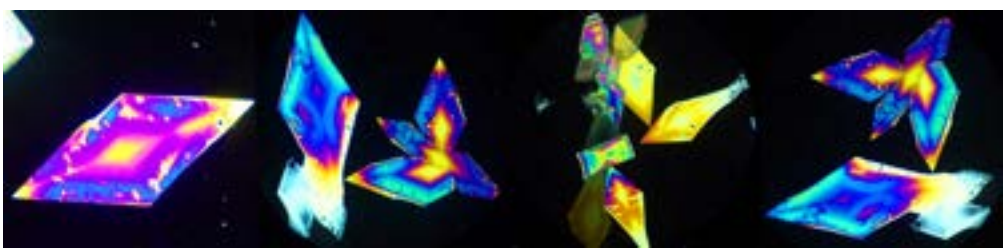
MICROSCOPICAL SOCIETY.

June 18, 1845.—Thomas Bell, Esq., F.R.S., President, in the Chair.

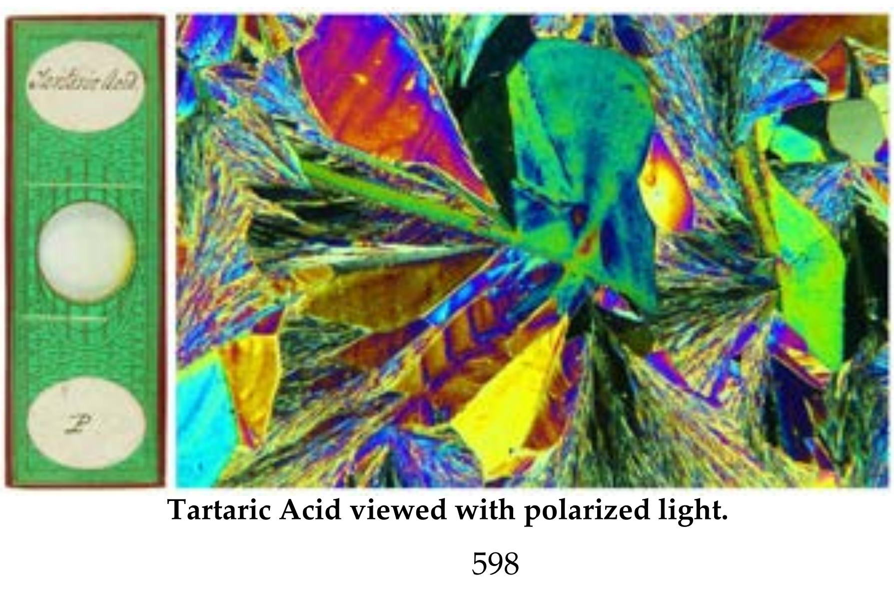
Also a paper by H. Deane, Esq., "On the Existence of Fossil *Xanthidia* in the Chalk," was read.

After mentioning that the occurrence of *Xanthidia* in a fossil state had not hitherto been observed in any other situation than in the flint-nodules of the chalk, and consequently that great doubt existed whether these fossils were really independent animal existences or only parts of some other creature, Mr. Deane stated that there is a grayish kind of chalk having no flints, but containing quantities of nodules of iron pyrites, which juts into the sea between Dover and Folkstone, forming the beach for some distance. Upon exposing a portion of this to the action of hydrochloric acid, and examining microscopically the insoluble sediment, bodies similar to, if not identical with, the *Xanthidia* in flints were exposed to view; several species were clearly to be recognised, together with casts of *Polythalamia* and other bodies frequently found in flints.

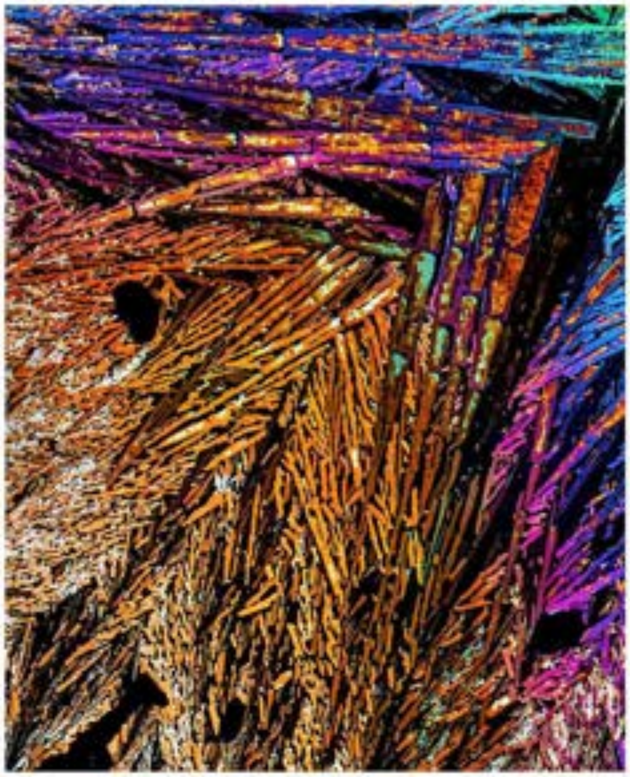
This slide is a rare engraved slide titled "Folkstone Lower Chalk" and dates from around 1845. Folkstone is located at the extreme southeast tip of England and contains chalk dating from approximately 120 to 80 million years ago. While unsigned, this particular slide is nearly identical in handwriting, with similar subject matter and mounting detail to several others bearing the engraved signature of H. Deane, an early researcher of diatoms and fossil material. The slide is beautifully finished, with chamfered and polished edges all around. The discovery in the late 1830s that many rocks and minerals were comprised of the remains of living organisms was just being investigated during this period. The slide is from a collection originally assembled by J. Rand Capron, FRS, during the 1840s and early 1850s.



Crystals of aspartic acid by Watson & Sons viewed under polarized light



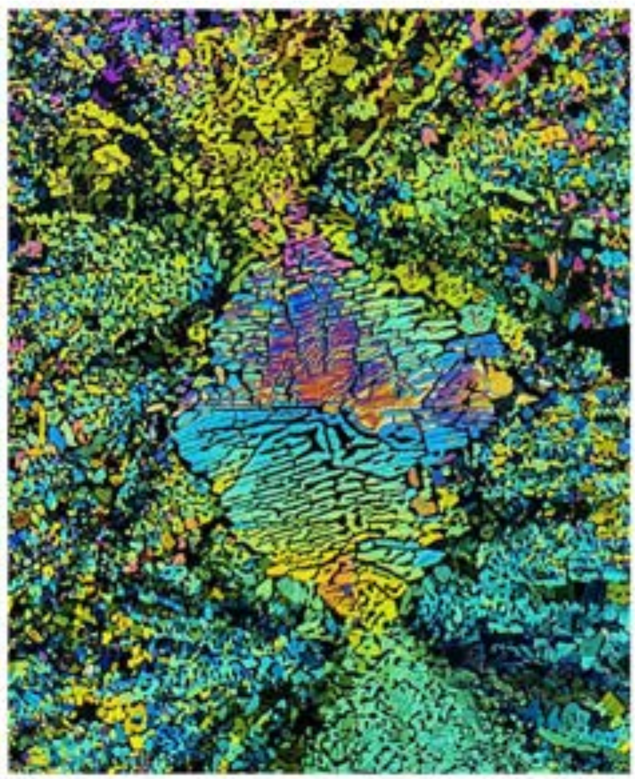
Tartaric Acid viewed with polarized light.



Oxalic acid

Glutaric acid

Pregnenolone



Niacin

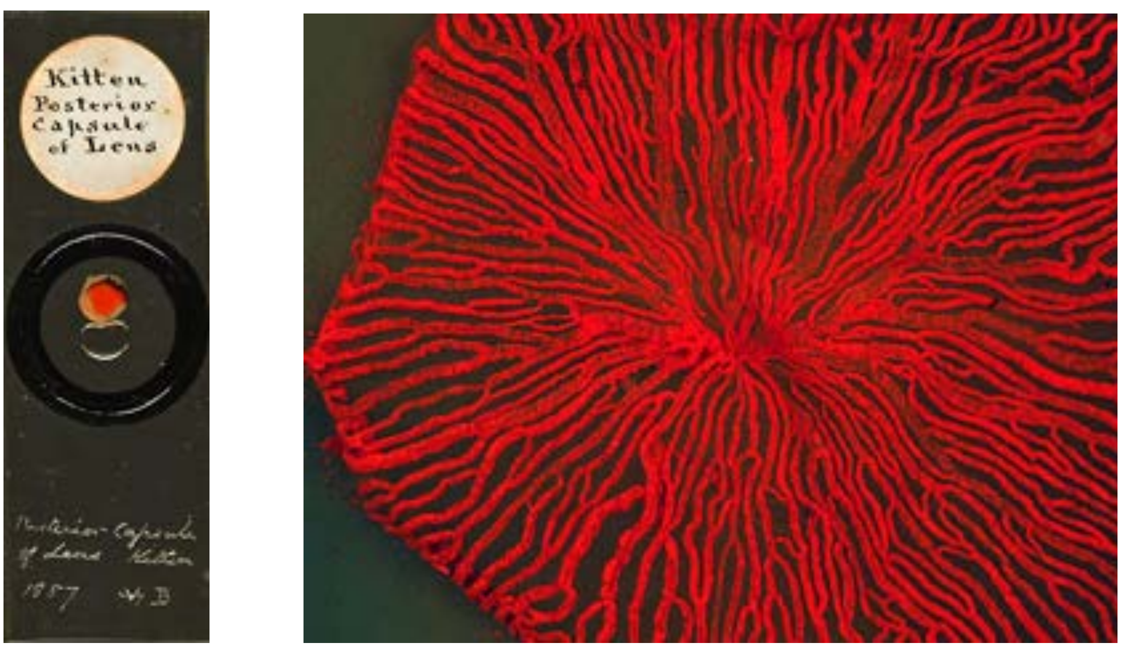
Modern preparations by Allen R. Ruttenberg in Rio Rancho, NM, of various chemical substances for viewing with a polarizing microscope.

Early Histology Slides

The first paper on the microscopic structure of tissues was published by Hodgkin and Lister in 1827. In the 1830s and 40s, most scientific investigation of tissues was performed in Germany. In England, John T. Quekett made superb preparations of plant and animal histology. The first commercial mounters to prepare histology slides were C. M. Topping and Andrew Pritchard in the 1840s. When the importance of histology to medical science was realized and it was introduced into medical school curricula around 1850, the production of histological slides expanded greatly.

Histology Preparation by C. M. Topping, c1845

This is an important early histology slide by Charles Morgan Topping (1800-1874), with diamond point engraved writing. The slide, titled "Human Muscle" is one of Topping's early histology preparations, having been made in the mid 1840s. The slide is signed with the handwritten monogram “T.” It also has an oval paper label in Topping’s hand. The specimens are teased skeletal muscle fibers in which striations can be observed. C. M. Topping is one of the most famous mounters in history and began mounting professionally in the late 1830s. He worked closely with a number of medical professionals including John Quekett, and was renowned for his injected and corroded histology mounts.

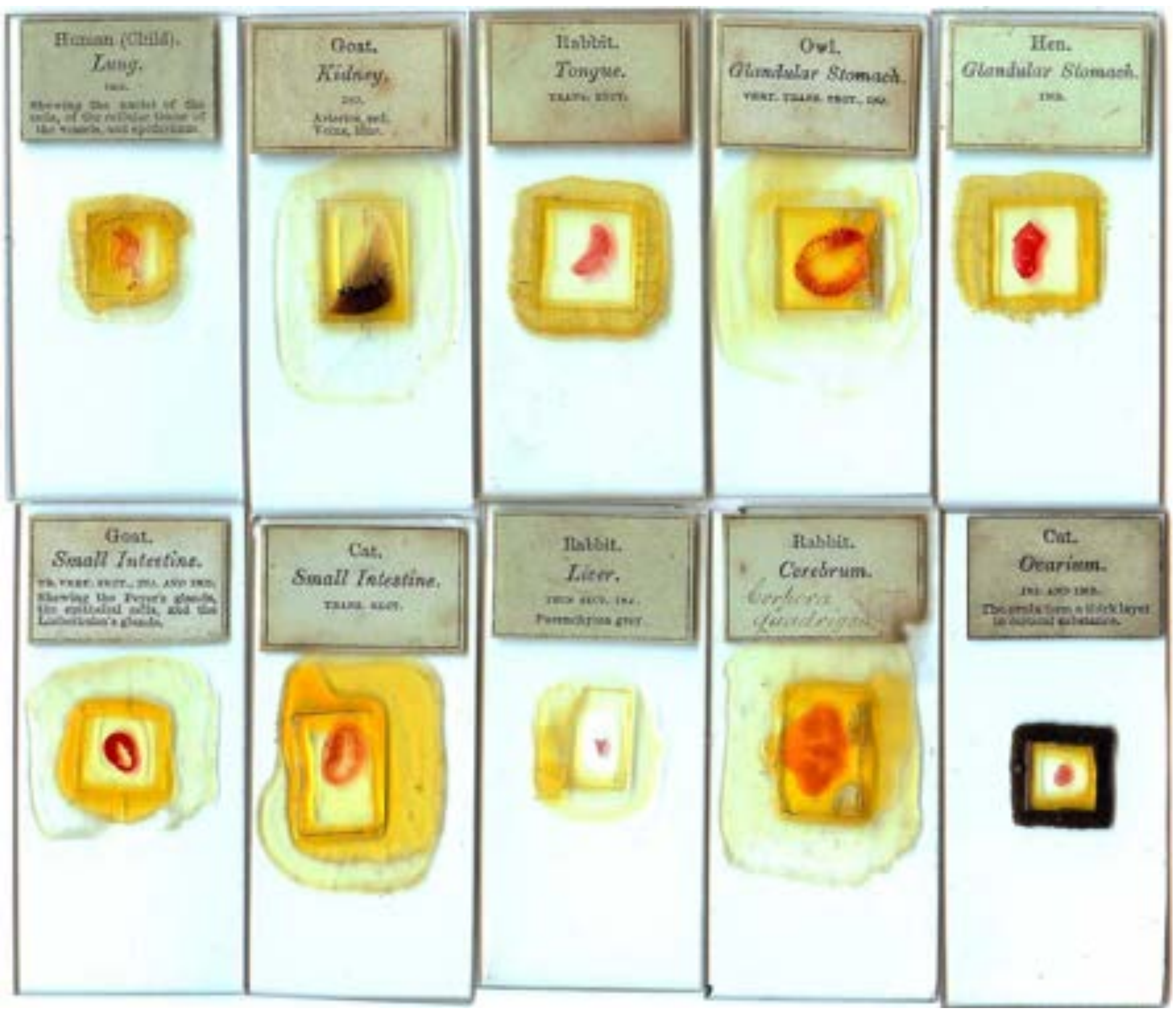


Posterior capsule of lens Kitten

This slide is dated 1857 and labeled “B.” It is a deep cell fluid mount of the developing lens of the eye with the blood vessels injected.

Pritchard, Human femur, c1840

Andrew Pritchard (1804-1882) was one of the first commercial mounters beginning in 1827 in London. His specimens were typically mounted between two slides sealed together at the edges with red wax or, as in this case, with black paper over the cover held on by sealing wax, c1840.

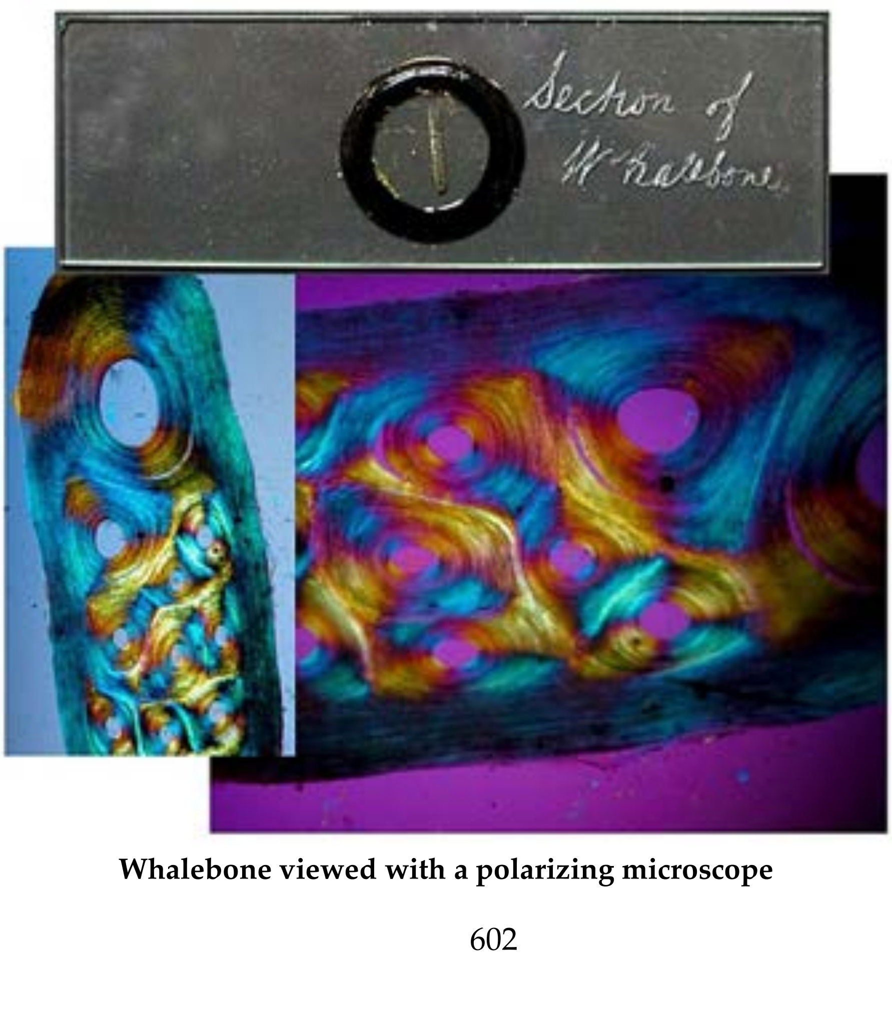


German transparent injected histology slides imported by Smith & Beck in London, 1850s

These injected specimens were imported from Germany by Smith and Beck in London in the 1850s. The slides are unnecessarily large for the size of the section and have a bluish tint. They represented an advance in histological preparations in that the specimens are thin sections for transparent viewing. They were prepared by Karl Thiersch (1822-1895), a German surgeon born in Munich. Thiersch received his doctorate from the University of Munich in 1843, where from 1848 to 1854 he served as a prosector of pathological anatomy. It is most likely that he prepared slides during this period. Afterwards he became a professor of surgery at the Universities of Erlangen (from 1854) and Leipzig (from 1867). His contributions to medical science included demonstrating the epithelial origin of carcinoma, modifying Lister's technique of antiseptic sterilization by substituting salicylic acid for carbolic acid, studies on wound healing, and developing a method of split-skin grafting.

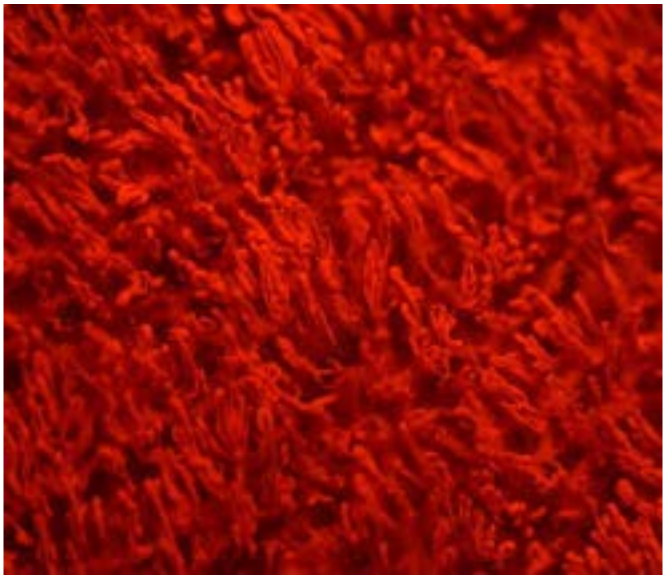
Liver, doubly injected. Portal yellow; Hepatic red, c1860

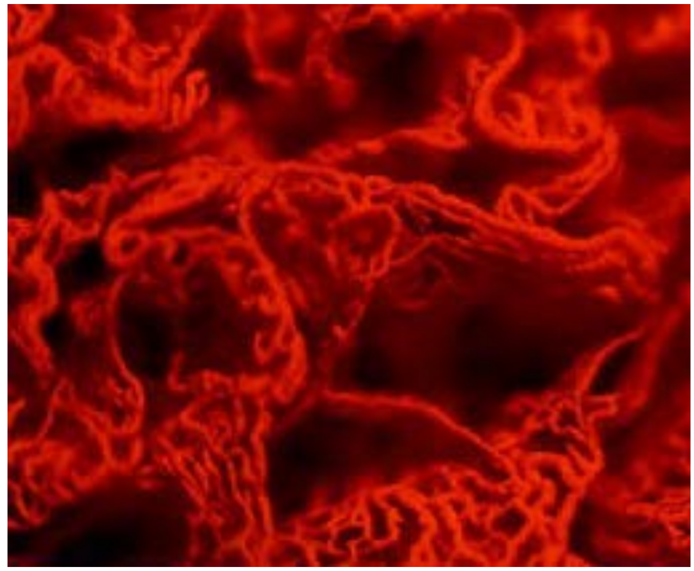
The maker of the doubly injected liver slide is unknown.



Whalebone viewed with a polarizing microscope

This is an early microscope slide, probably c1850, with engraved label entitled "Section of Whale Bone." The maker of this interesting slide has not been identified. The photomicrographs taken from the slide are imaged with a polarizing microscope using crossed polars with selenite filters and clearly show the Haversian systems of compact bone.

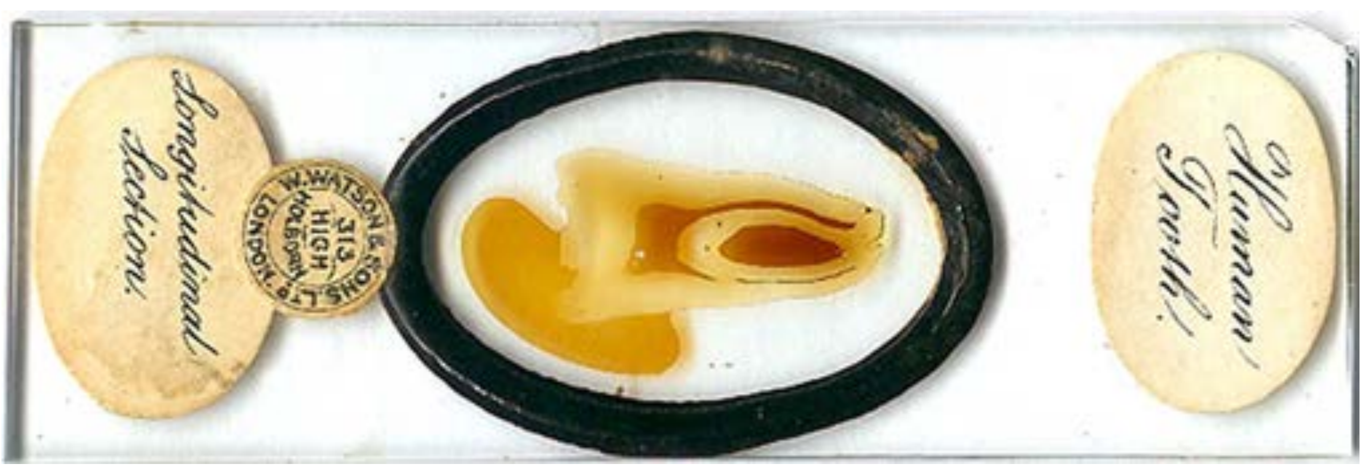




Skin (left) and Lung (right), injected and corroded, showing blood vessels, c1860

Charles Morgan Topping (1800-1874) was renowned for his injected and corroded histology mounts. After injecting the blood vessels, the surrounding tissues were corroded away. Although this technique reveals the capillaries, it yields relatively little histological information.

Histology Slides



Human tooth by Watson

William Watson set up an opticians firm in London in 1837. The name was W. Watson & Son 1867-1882, W. Watson & Sons 1882-1908, and W. Watson & Sons Ltd 1908-1957. They began supplying preparations in 1884, when they took over the business of Edmund Wheeler. They offered very fine slides on all subjects.

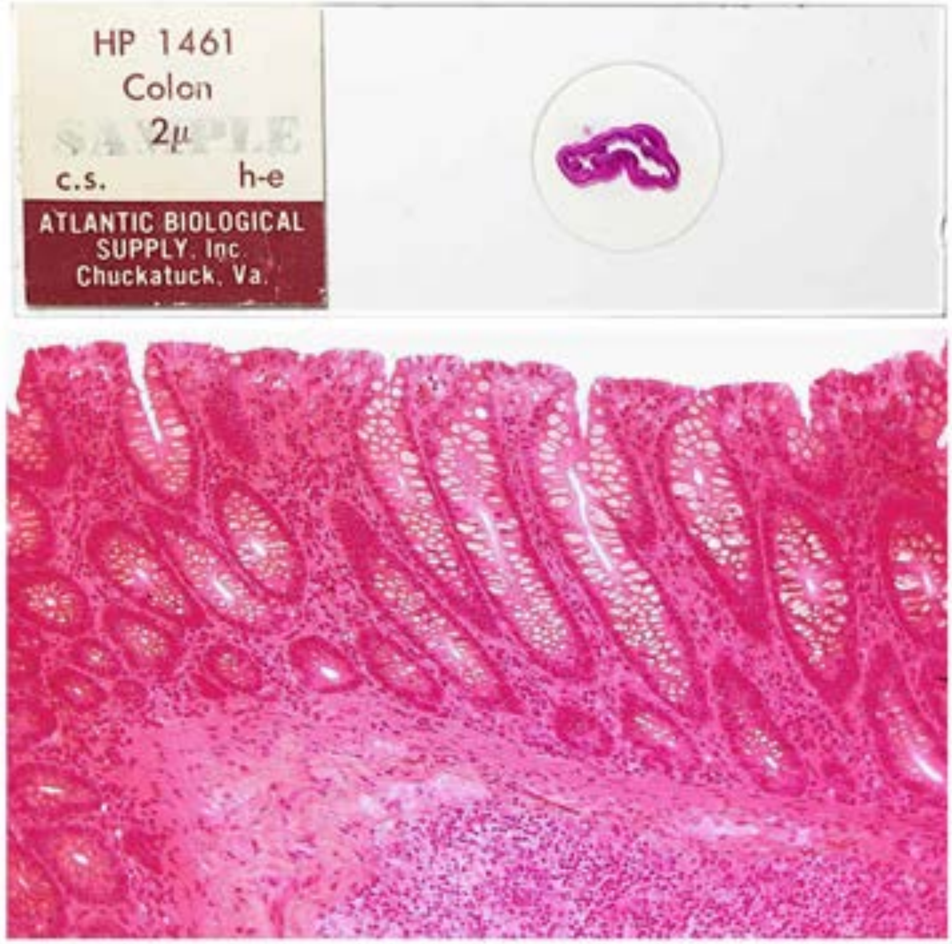
Stomach of cat by A. C. Cole with secondary label of W. F. Stanley

Blood Disks, C. M. Topping

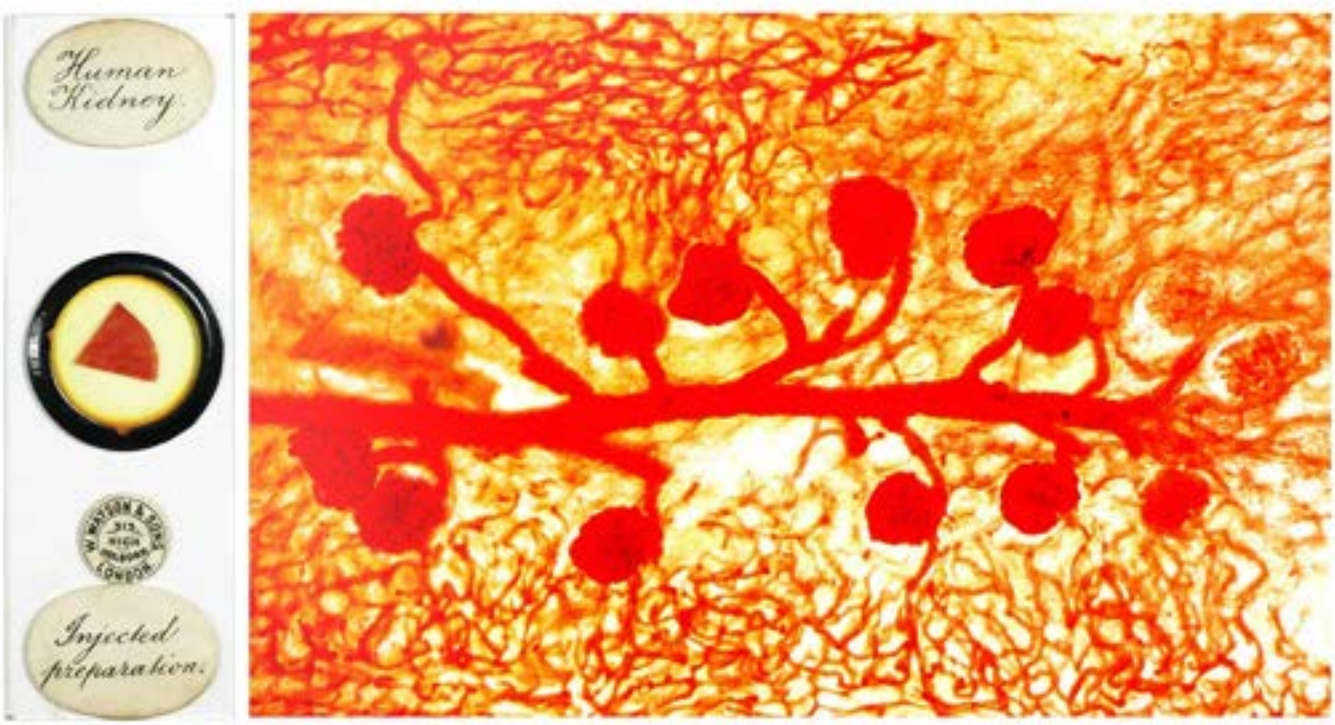
Charles Morgan Topping (1800-1874) is one of the most famous mounters, perhaps best known for his mounts of the blowfly proboscis. He began mounting professionally in 1840 and is known for his red paper-covered slides with their gilt lithographed designs. He developed the injection-corrosion method of preparing histological specimens. This revealed the veins, arteries, and capillaries more clearly than before.

A slide by A. C. Cole of human scalp showing transverse sections through hair follicles and sebaceous glands.

Foetal Scalp. Injected specimen.

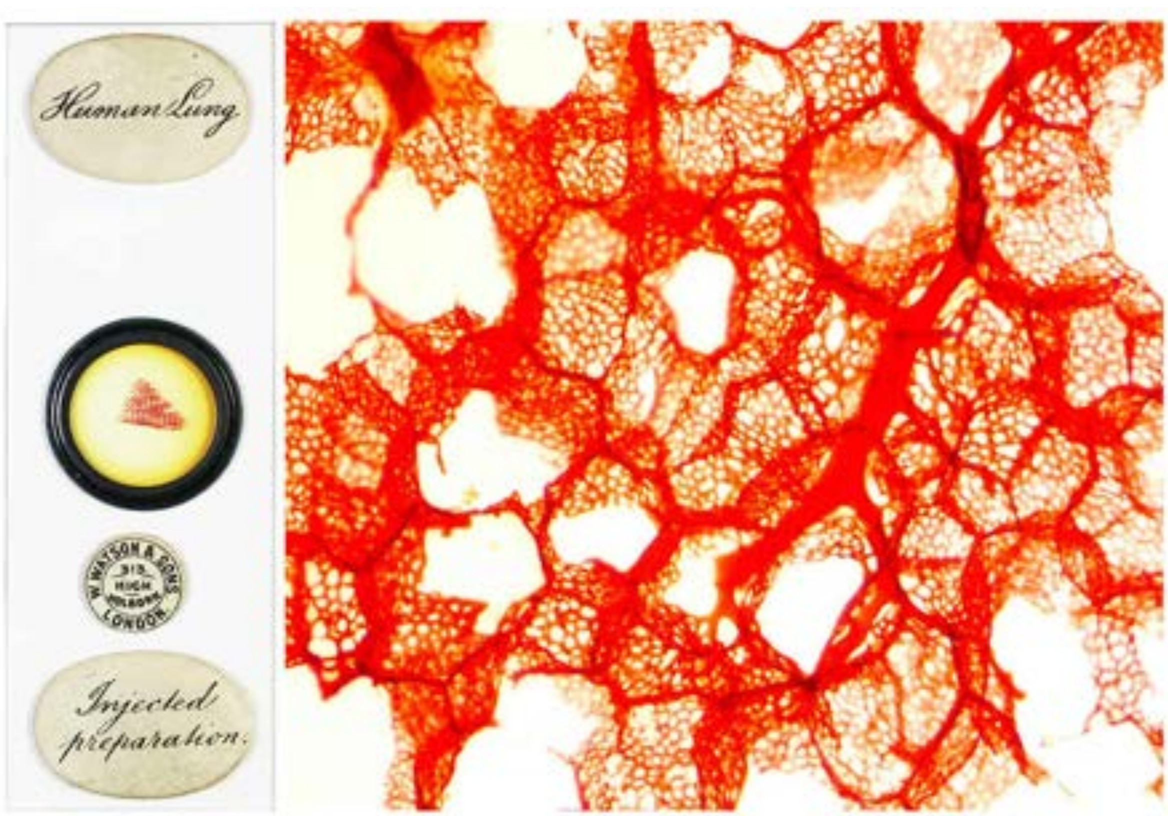


Thin section of colon by Atlantic Biological Supply, Inc. c1980



Injected kidney by Watson & Sons showing glomeruli.

Human lymph node by Watson & Sons.



Injected lung by Watson & Sons showing blood vessels and alveolar capillaries.

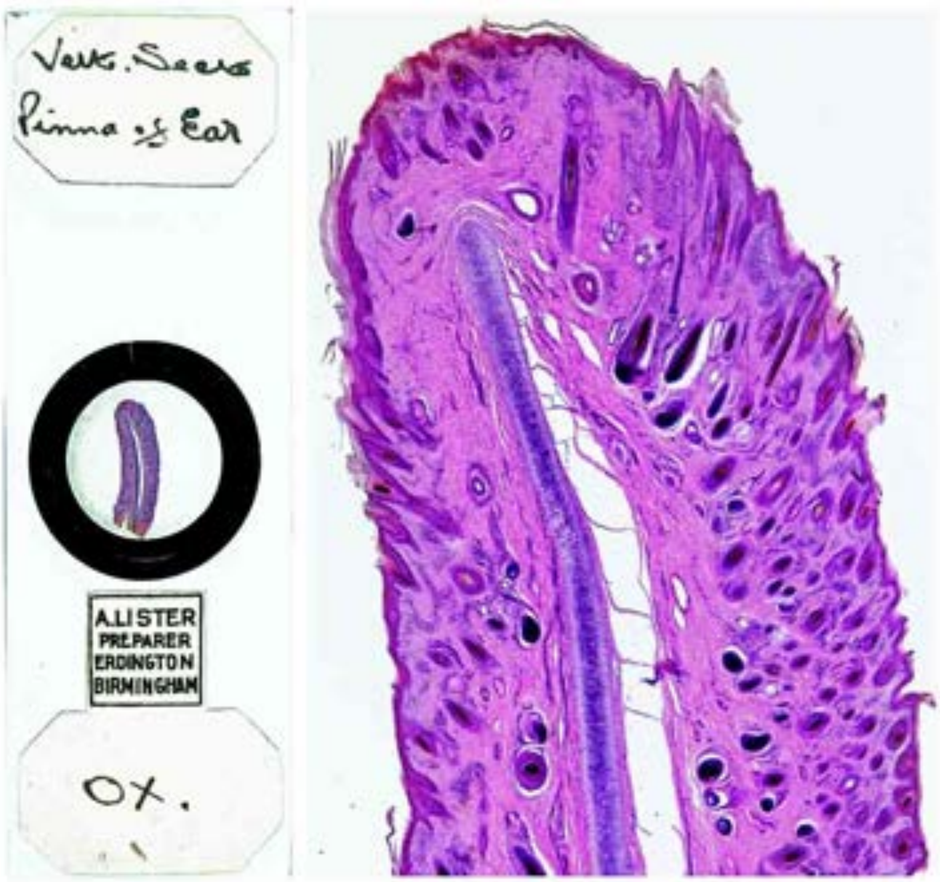
Parts of human eye by W. Watson & Sons

Isolated nerve cells from the spinal cord by G. H. J. Rogers

Cochlea by James B. McCormick

This slide of the cochlea was prepared by Dr. James B. McCormick. McCormick founded and ran the Histoslides Company from 1945 to 1955. The company produced slides for universities and also for firms such as Turtox, Ward's Scientific, and Scientific Products. This was Histoslide No. 129 and was provided to Turtox in 1949/50. General Biological Supply House in Chicago, founded in 1918, supplied slides under the name Turtox until 1980. They became Turtox, Inc., which was taken over by Ward's in 1992.

Elephant Spermatozoa by C. M. Topping



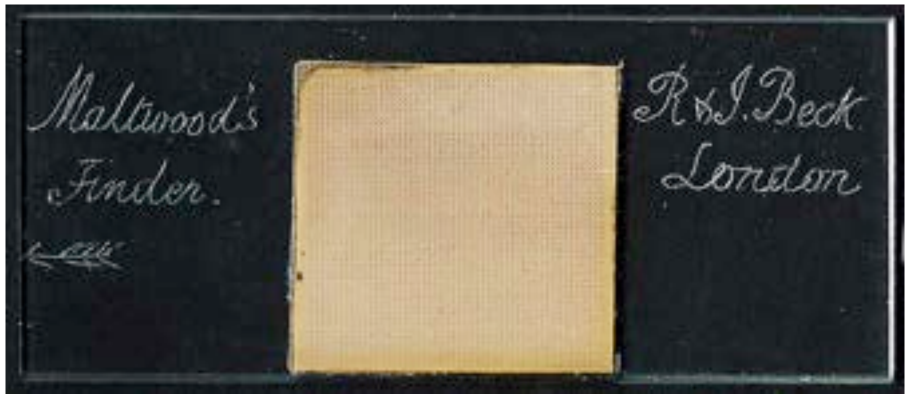
Vertical Section of Pinna of Ox Ear. A.Lister Preparer, Erdington. Birmingham.

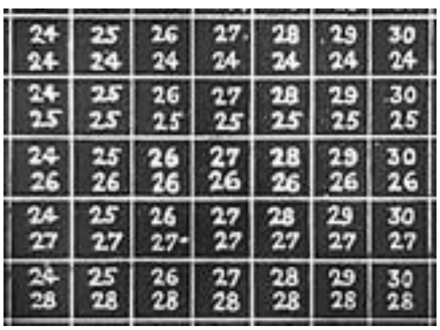
Flatters & Garnett was formed in 1901. The company continued after the departure of Flatters in 1909 and became the largest producer of slides in England, perhaps in the world, ceasing operations in 1967. This is an exceptionally fine sagittal section of a whole mouse. Detailed tissue structure is visible under the microscope.

Whole Mouse by Flatters & Garnett

Specialized Slides

Maltwood's Finder





Maltwood's finder is a slide that allows a point of interest in an object microscope slide to be located in subsequent observations of the slide. It was described by Thomas Maltwood in 1858. The finder consists of a reference grid divided into 2,500 squares. Each square contains two numbers, one of which indicates its position from left to right while the other marks the position from top to bottom. A point of interest is located in an object slide. Then the finder is substituted in place of the object slide and a reading on the grid is taken. If at some time in the future, one wishes to locate the point of interest in the object slide, the finder is placed on the stage and the grid reading located. Then the object slide is substituted for the finder and the point of interest will be in view. This slide is diamond engraved "Maltwood's Finder" and "R & J Beck London." There is a slipcase for the slide. The glass slide is a little wider than an ordinary slide and the edges are beveled. A photograph of the grid occupies a space of one square inch and is covered by a coverslip.

Stage Micrometer

A stage micrometer is a microscope slide with a scale etched on the surface. It is used for measuring the size of an object, calibrating an eyepiece micrometer, and testing the resolution of objectives. The first reported measurements performed with an optical microscope were undertaken in the late 1600s by the Dutch scientist Antonie van Leeuwenhoek, who used fine grains of sand as a gauge to determine the size of human erythrocytes. This is a very fine brass stage micrometer labeled "Micrometer 1/1000" by W. Watson & Son in a silk and velvet-lined case. c1890.

Zeiss Abbe Diffraction Plate

Abbe diffraction plate, German, c1900, signed on the original case "Carl Zeiss, Jena, Diffractionsplatte Nach Abbe. The diffraction plate consists of a glass slip with three cover glasses cemented side by side. The lower surfaces of the latter are silvered and have groups of lines ruled upon them so as to form simple and crossed gratings. The slide demonstrates the effects of diffraction in the formation of images in the microscope.

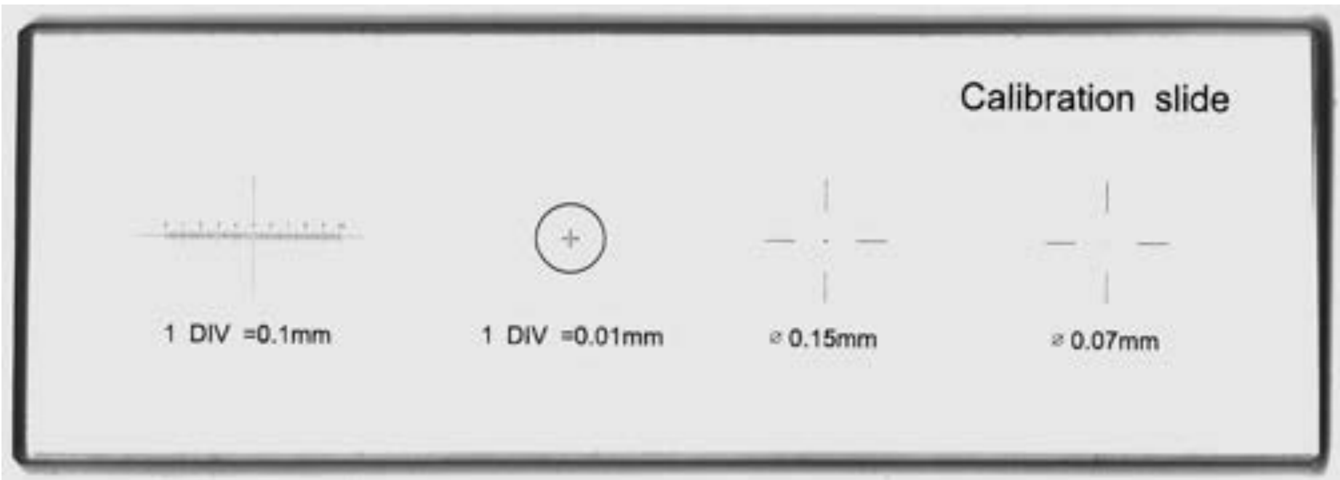
Hemocytometer

A hemocytometer (haemacytometer) consists of a thick glass microscope slide with a rectangular indentation that creates a chamber. This chamber is engraved with a grid of lines. The device is crafted so that the area bounded by the lines is known, and the depth of the chamber is also known. It is therefore possible to count the number of cells or particles in a specific volume of fluid and thereby calculate the concentration of cells in the fluid overall. In an improved Neubauer hemocytometer, the total number of cells per ml can be determined by simply multiplying the total number of cells found in the hemocytometer grid by 10^4 (10,000).

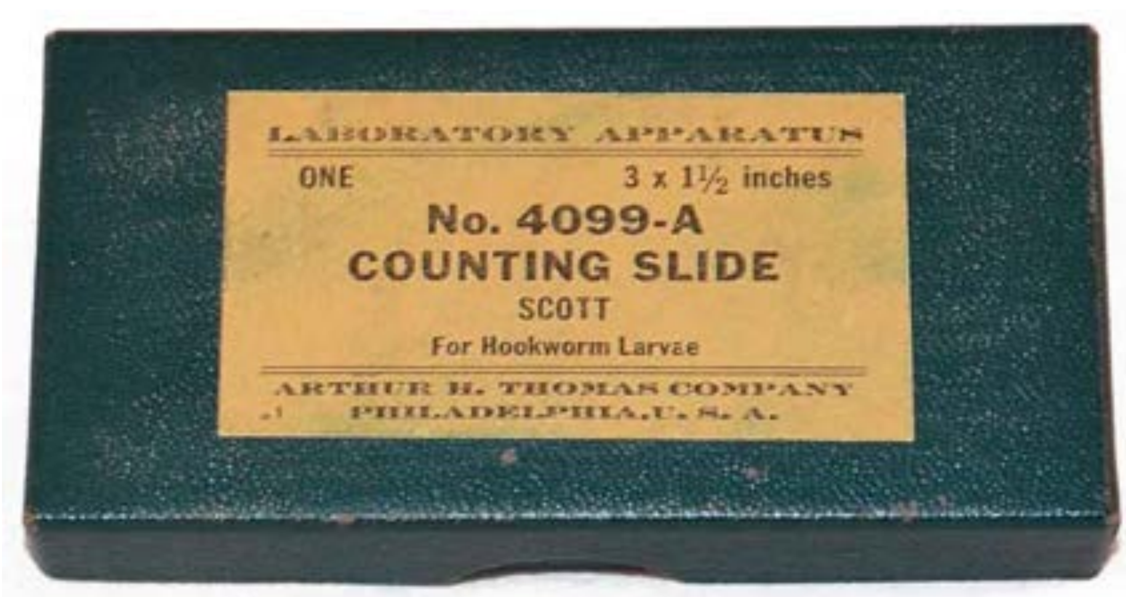
The counting chamber of this hemocytometer is a beveled glass slide divided by four parallel trenches and one short transverse center trench creating an "H" pattern. The slide is 2 ⅞ x 1 ¼ inches and marked "Improved NEUBAUER, 1/400 sq mm, 1/10 mm deep, Pat May 24 1927, Nov 1 1927, MAX LEVY USA PHILADELPHIA, and N°." The firm of Max Levy had improved the hemocytometer by fashioning it out of one piece of glass. The center cover glass support is cut with improved Neubauer ruling. There is a cover glass that is held 0.1mm off the marked grid. There are two slender glass diluting pipettes, each with a bulb just above the center that contains a small mixing bead. The pipettes fit to rubber tubes that connect to small plastic mouthpieces. Included in the set is a manual on the Levy counting chamber (Patented Jan. 30, 1917) and another on "An Improved Technique for the Counting of Blood Corpuscles, Blood Platelets, Cells in Cerebro-Spinal Fluid and Pus Cells in Urine prepared especially for use with Levy and Levy-Hausser counting chambers" published and copyright, 1940. The set is housed in a felt-lined, leather–covered maroon case 7 ⅛ inches long, 4 inches wide, and 1 ¼ inches high. The case is marked "AMERICAN STANDARD HAEMACYTOMTER WITH LEVY COUNTING CHAMBER ARTHUR H. THOMAS COMPANY PHILADELPHIA." This slide illustrates the stages in the development of the hemocytometer and is complete and, except for some scuffing of the case, is in extremely fine condition.

Calibration Slide

This is a modern microscope calibration slide that is used to calibrate microscope eyepieces and microscope digital cameras. The slide has four different calibration patterns. The first of pattern is the 0.01 mm or 10 micron gradient lines with 100 division in total. The second pattern on the calibration slide is the crossed reticule with 0.01 mm or 10 micron each division on both the X and Y axis. The third calibration pattern is a 0.15 mm diameter dot and the fourth one is a 0.07 mm diameter dot. The slide is housed in a plastic case.



Counting Slide for Hookworm Larvae



This is a microscope slide used for counting hookworm larvae in soil samples. It is in its original box labeled "Laboratory Apparatus. One 3 x 1 ½ inches. No 4099-A Counting Slide. Scott. For Hookworm Larvae. Arthur H Thomas Company Philadelphia, U.S.A." The slide is a piece of rectangular clear glass with a groove running down its length. The slide is moved laterally with a mechanical stage to count the larvae in the groove. 1930-1960.

Slide Sets

Set of Small Continental Slides, c1850

Small slides, about 16 x 50-60mm, were made beginning around 1835 by Joseph Bourgogne in Paris and continued by his sons Charles and Eugene for many years. These "Continental" sized slides were made in great numbers for the small French drum microscopes. This is a set of small slides, probably French and prepared for the English market, c1850. The 7 ½ inch (19 cm) wide mahogany carrying case contains 45 slides with three empty slots. Each slide is glass, 15 x 50 mm in size, covered in decorative colored paper, with a prepared specimen mounted under a mica cover "glass" and with a printed identification label. Subjects include seeds, hairs, feathers, scales, wood, and insect parts.

Alexander Hett Slide Set, c1850

Alexander Hett (1807-1870) FRCS was a surgeon and inventor who prepared microscope slides beginning in the late 1840s. His distinctive slides were highly regarded. The specimens were thick sections of human and animal tissues injected with a red dye and held in a thick, fluid-filled cell. The identity of the specimen and Hett's name were diamond engraved on the slide. Hett first advertised his slides in 1848 in John Quekett's *A Practical Treatise on the Microscope*. He was elected to the Microscopical Society of London in 1850 and won a Prize Medal at the Great Exhibition in London in 1851.

This is a complete set of 12 microscope slides by Alexander Hett contained in a wood box. The slides are opaque injections held in large and deep, fluid filled glass cells. The slides are diamond engraved with the name of the sample and signed "Hett." The specimens are: Gill of the Eel; Small Intestine human, shewing the Villi, Ileum, adult; Mucous membrane of the nose of the human foetus; Ciliary processes Iris, and portions of the vessels of the membrana papillaris Pia foetal; Small Intestine of the Pig, shewing villi and Peyers glands; Section of the Kidney of the Pig, shewing Malpighean bodies; Tongue of the Dog shewing the papilla; Buccal membrane of the Lamb; Small Intestine of the Frog; External surface of the Lung of the sheep; Skin from the Palmar surface of the finger shewing the papilla; Human Lung shewing Air cells. All of the cells retain their fluid.

The slots in the box are set further apart than usual to accommodate the thick cells on Hett's slides. Hett's advertisements included the following: "Parties residing at a distance from London may have a box of preparations sent for inspection, on giving a respectable town reference and paying carriage *both ways*; by this means they are enabled to examine the objects before purchasing, and to select such specimens *only* as they may require." It is possible this set of slides is one of those Hett sent out for approval. This set previously belonged to Gerard L'E. Turner.

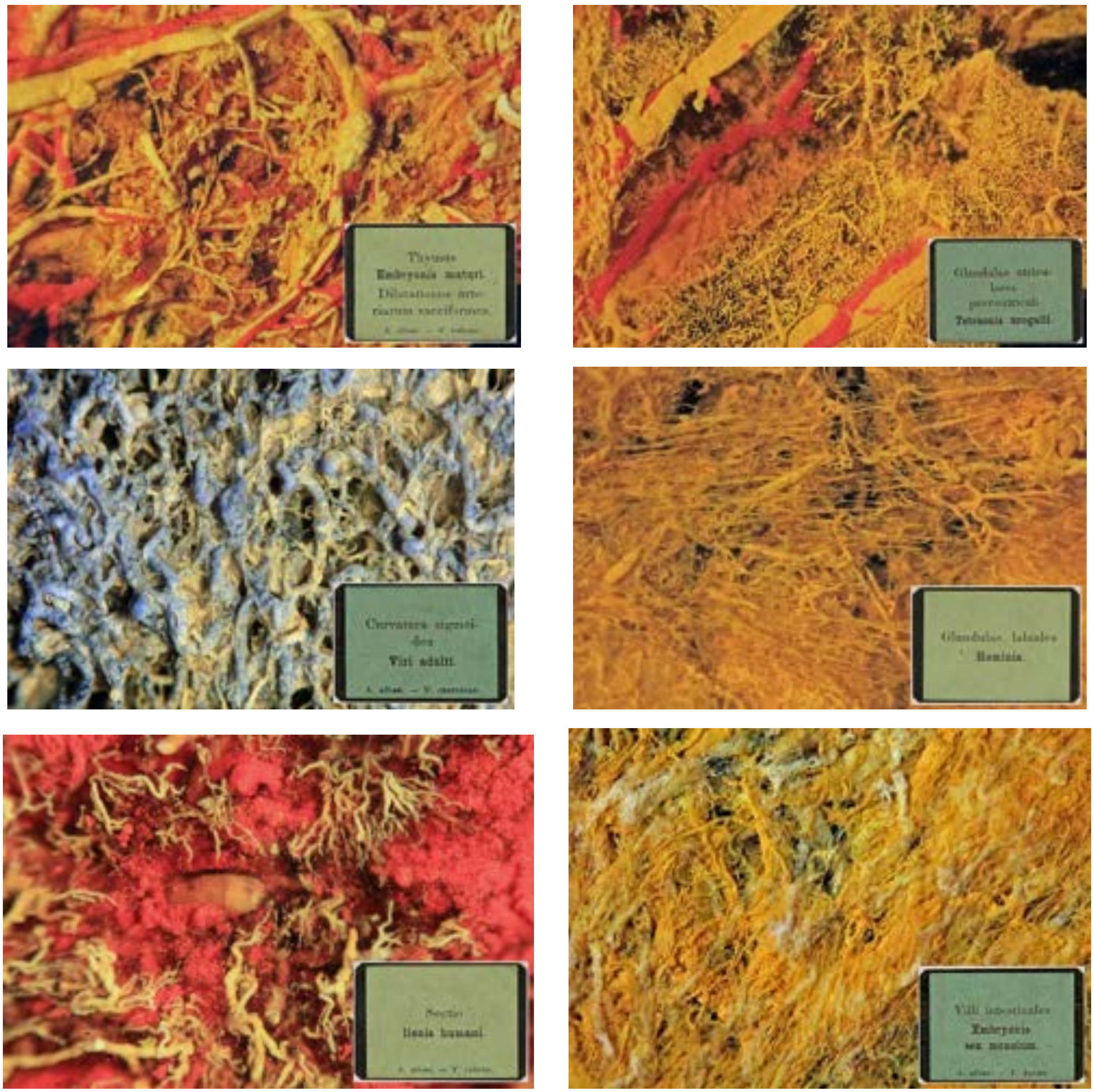
Alexander Hett Slide Set

Josef Hyrtl *Texturae variae rariores* Slide Set, c1860

This is an extremely rare cased set of 24 histology injection/corrosion slides prepared by Josef Hyrtl entitled "Texturae variae rariores." Each specimen is mounted on a paper-backed ebony tablet measuring 1 ¾ x 1 ¼ inches. Each mount consists of the prepared specimen in Canada balsam between two glass covers. They are mounted for reflected light investigation only. In some slides, the arterial and venous systems are injected with different colors. The description of each slide is on green paper on the back of the slide, printed in Latin. The superb polished case is made of mahogany and measures 11 ½ x 7 ½ inches. The case and slides are in almost mint condition.

Josef Hyrtl (1810-1894) was born at Eisenstadt in Hungary, and came from a poor family background. He took up his medical studies in Vienna in 1831, having received his preliminary education in his hometown. His circumstances meant that he had to find some means to help defray the expenses of his medical education and he began producing preserved specimens. In 1833 while a medical student, he was appointed prosector in anatomy. As a student he set up a laboratory and dissecting room in his lodgings, and his injections of anatomical material were greatly admired. In 1837, at age 26, Hyrtl was offered the professorship of anatomy at the University of Prague. It was while there that he completed his textbook of human anatomy, which went through some twenty editions. The chair of anatomy at Vienna became vacant in 1845, and he was elected. Five years later he published his "Handbook of Topographic Anatomy," the first textbook of applied anatomy of its kind ever issued

It was as a teacher that Hyrtl did his greatest work. Professor Karl von Bardeleben, himself one of the leading teachers of the nineteenth century, did not hesitate to say that in this Hyrtl was unequalled. Hyrtl's slides were the absolute zenith of histological preparations using the injection/corrosion method. The injection technique consisted of injecting the blood vessels with gelatin, which could be colored. Often, the arterial and venous systems were injected with different colors. Injected specimens could be "corroded" with a sodium hypochlorite solution, which dissolved the tissues away, leaving the cast of the vessels. Injected specimens are sometimes dismissed as yielding relatively little histological information. However, in some cases the technique is very useful, for example, in revealing the microcirculation in the lung and kidney and the arterial and venous systems of the liver. His fame spread throughout Europe, and he came to be looked upon as the jewel in the crown of the University of Vienna. In 1865, on the occasion of the celebration of the five-hundredth anniversary of the founding of the university, he was chosen rector in order that, as the most distinguished member of the university, he should represent her on that day. In 1880, there was a celebration of Hyrtl's seventieth birthday, when messages of congratulation were sent to him from universities all over the world.

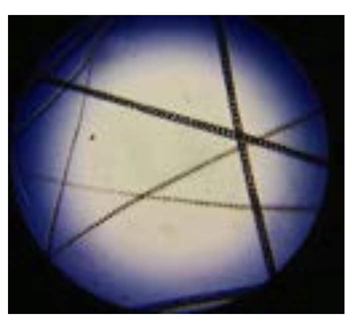


Josef Hyrtl *Texturae variae rariores* Slide Set

T. H. McAllister Slide Set, c1870

This is a boxed collection of 13 slides bearing the label T. H. McAllister, Optician, 49 Nassau St., New York. Thomas H. McAllister sold microscopes, slides, and other optical instruments in the last quarter of the nineteenth century. The slides are small, 5⁄8 x 2 3⁄16 inches, and probably French in origin. They are covered in tan paper covering the coverslip with McAllister's label pasted on. One of the slides listed on the cover of the box is missing but there are two additional slides. Some of the slides have cracked coverslips and shrinkage of the balsam but the specimens can be viewed in all. The box is worn with some paper missing at the edge but not seriously affecting the text. This rare set is of interest as an example of the type of microscopical objects available to the American public in the late nineteenth century.






Diatom Slide Set, Arthur C. Cole, c1875

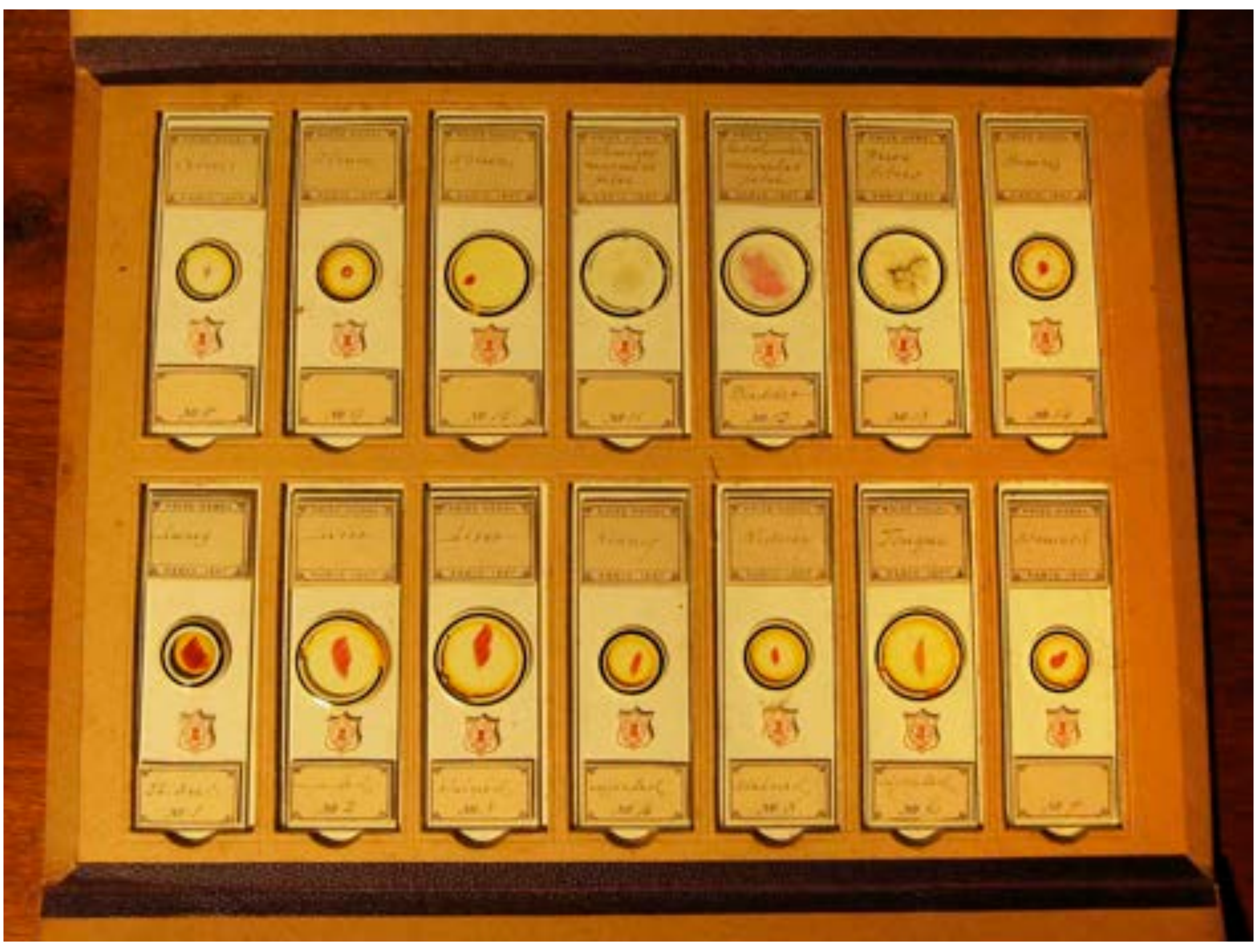
This is a rare complete set of 48 diatom microscope slides by A. C. Cole. The set is complete running from 1 to 48 with the original paper inventory pasted in the lid of the box. The label includes Cole's monogram, Prize Medal 1867, and the address 62 St Domingo Vale Everton Liverpool. It is entitled "Descriptive List of 48 Choice Selected Diatomaceae-Series A." The diatoms are from locations around the world. The label is signed Arthur C. Cole & Son. The slides are housed in a boxwood case with eight trays each holding six slides in its own compartment. This set was made around 1875.

Diatoms are a major group of algae, and are one of the most common types of phytoplankton. A characteristic feature of diatom cells is that they are encased within a unique cell wall made of silica. Diatoms were probably some of the first minute life forms observed with early microscopes. Originally referred to and included in the broad grouping known as "Animacules" or "Infusoria," the Diatomaceae have been, and remain, a subject of intense interest and study, most recently as a "window into the past" in studying climate change. All of the professional mounters during the Victorian era prepared and offered numerous diatom slides of material obtained from locations around the world. There were also a number of scientists, naturalists, and talented amateurs who specialized in their mounting, study, and classification. Importantly, diatoms were also mounted for many years specifically to be used as a way to test the resolving power of microscope objectives.

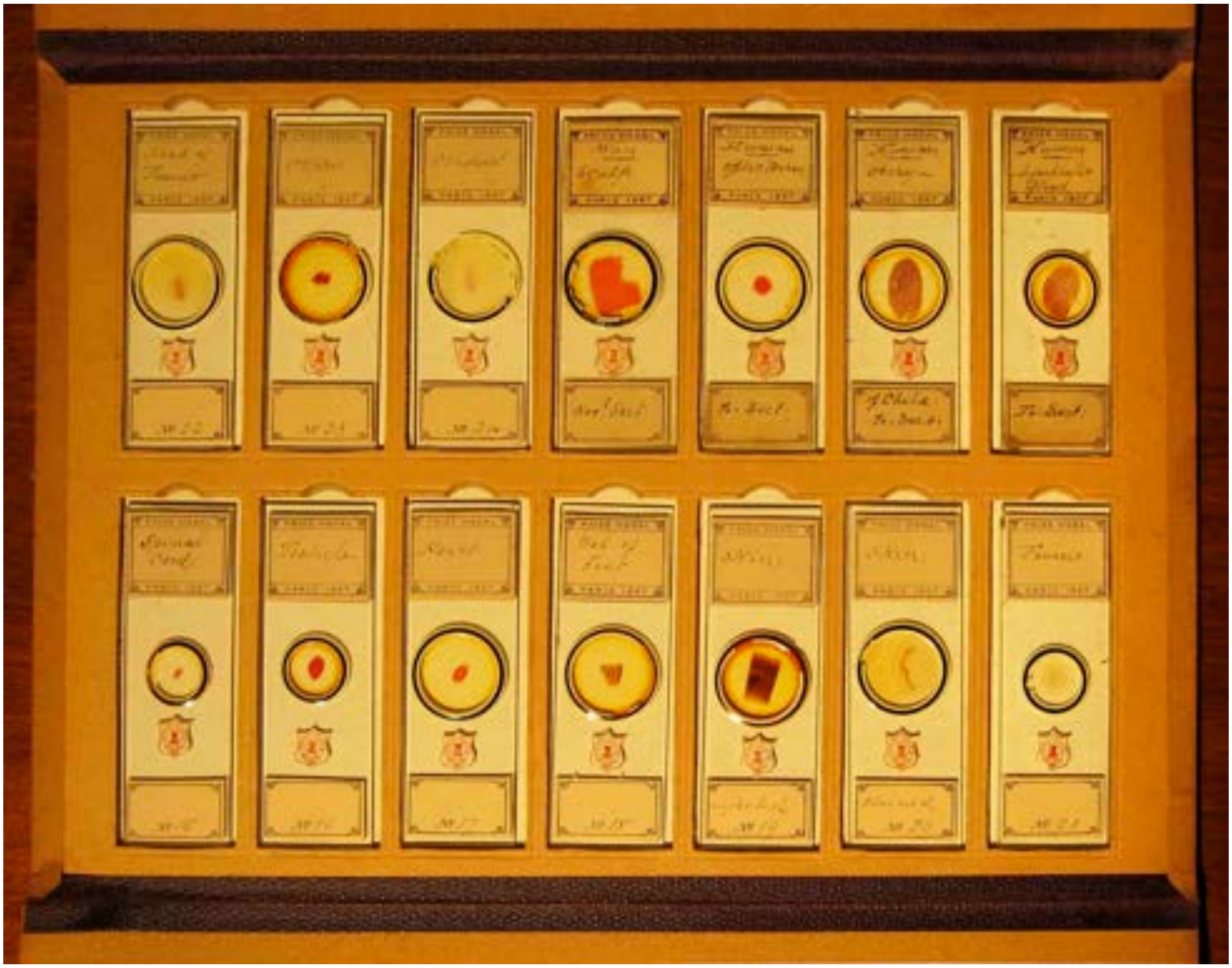
Arthur C. Cole (1821-1900) was initially an organist but was making slides by 1867. He mounted diatoms and histological subjects of high quality. They carried a small red and white label with a crest and the words Cole Deum (Worship God). He won a prize medal at the Paris Exhibition of 1867 and all of his subsequent slides bear this notation.

Histology Slide Set, Arthur C. Cole, c1880. First histology slides issued as a set

Although several firms offered histology slides, Arthur C. Cole (1821-1900) appears to have been the first to offer them in sets. He made slides of a variety of subjects, but many were of histology and pathology. In the 1880s, he offered to subscribers sets of slides accompanied by printed illustrations and descriptions. There were four volumes but, despite favorable reviews, they were not successful commercially and few complete sets remain. This is a complete set of 24 numbered slides plus four additional slides. It probably predates the issuance of the four volumes and represents one of the first sets of histology slides. It was most likely intended for medical students. The slides are of very high quality.



Folder 1



Folder 2

No. 1, Lung, Tr. Sect. No. 2, Liver, injected No. 3, Liver, Stained No. 4, Kidney, injected No. 5, Kidney, Stained No. 6, Tongue, injected No. 7, Stomach No. 8, Colon No. 9, Ileum No. 10, Spleen	No. 11, Voluntary muscular fibre No. 12, Involuntary muscular fibre, Bladder No. 13, Nerve fibres No. 14, Brain No. 15, Spinal Cord No. 16, Testicle No. 17, Heart No. 18, Web of Foot No. 19, Skin, injected	No. 20, Skin, Stained No. 21, Femur No. 22, Head of Femur No. 23, Ovary No. 24, Oviduct Man, Scalp, Hor[l]. Sect. Human, Optic Nerve, Tr. Sect. Human, Ovary of Child, Tr. Sect. Human, Lymphatic Gland, Tr. Sect.

Prudden Slide Set, College of Physicians and Surgeons, 1889

T. Mitchell Prudden, a graduate of the Sheffield Scientific School and Yale Medical School, became Director of the histological and pathological laboratory at the College of Physicians and Surgeons in 1882. He taught histology at Yale one day a week from 1880 to 1886. This set of 25 histology slides came from the laboratory in 1889 during the time Prudden was Director. The slides are sections of normal tissues. Printed on the label is "Normal Histology, Coll. Phys. & Surg., N. Y." Prudden had a distinguished career in pathology and bacteriology at Columbia.

T. (Theophil) Mitchell Prudden (1849-1924) was a founder of pathology as a field of research and teaching in the United States. He was born in Middlebury, Connecticut, the son of a Congregational minister. He attended the Sheffield Scientific School at Yale and received a Ph. B. degree in 1872. He entered the Yale School of Medicine and received the M. D. degree in 1875.

During the summer of 1873, he took part in the fossil-hunting expedition in the West headed by Othniel C. Marsh. In the spring of 1875, while in his last year at medical school, Prudden attended lectures in New York at the College of Physicians and Surgeons, and worked in the laboratory of the pathologist Francis Delafield. After graduating, he was an intern at New Haven Hospital and was given a fine microscope and this may have influenced his interest in microscopic investigation. He then studied for two years at Heidelberg under Julius Arnold and Richard Thoma. Upon returning to New Haven, he was unable to secure a position in pathology and opened an office for the practice of medicine. In 1877, alumni of the College of Physicians and Surgeons raised funds for the establishment of a histological and pathological laboratory. Undoubtedly on Delafield's recommendation, Prudden was offered a position as first assistant in the new laboratory. He accepted the position and began a long and successful career at Columbia. In 1880, he was offered a professorship in histology at Yale, but decided to stay in New York. He did agree to commute one day a week and teach histology at the Yale Medical School from 1880 to 1886. At Columbia, he became director of the laboratory in 1882 and Professor of Pathology in 1892. His first books "A Manual of Practical Histology" and, with Delafield, "A Handbook of Pathological Anatomy and Histology," later "A Text Book of Pathology," went through many editions. In 1885, he studied in the laboratory of Robert Koch in Germany. He applied his new knowledge of bacteriology to studies on the purity of water and ice supplies, the nature and spread of tuberculosis, and the causative agent of diphtheria. At the founding of the Rockefeller Institute for Medical Research in 1901, Prudden served as vice-president of its board of scientific directors. During summer vacations he made many trips to the West, and he wrote on the archaeology and Indians of the Southwest. He visited the prehistoric cliff dwellings of the region and contributed the materials gathered on his expeditions to museums including the Peabody Museum at Yale.

These slides belonged to Dr. Frank Landau Tucker who graduated from the College of Physicians and Surgeons. They were most likely used by him when he was in medical school. It is not known if they were made by Prudden, but they certainly came from the histology laboratory that Prudden directed.

College of Physicians and Surgeons, Columbia University, Teaching Set

This is a set of 218 teaching slides from around the turn of the twentieth century. The slides are held in trays housed in an 8 ½ x 8 x 4 ½ inch mahogany box that opens front and top. The slides are labeled “College P. & S. N.Y.” or “Coll. Phys. & Surg. Columbia Univ., NY.” 99 slides are “Normal Histology,” 99 slides are “Pathological Histology,” 10 slides are “Bacterial Laboratory” or “Bacteriology,” and 10 are unlabeled. The slides were prepared during the time T. Mitchell Prudden, a graduate of the Yale Medical School, was director of the histological laboratory at Columbia. This appears to be a teaching set that includes nearly all the slides a medical student would need in the first two years of study in medical school. It is an important set because it reflects the teaching in medical schools at the end of the nineteenth century and has been preserved intact. Donated by Dr. James B. McCormick.

R. Fuess Petrographic Slide Set

This is a set of 30 1 x 2 inch petrographic slides. Each slide has the trade label "R. FUESS, BERLIN." The original guide dated 1876 is titled "Sammlung Nr. 7, 30 Dünnschliffe von typischen Gesteinen." The thin sections are of Granit, Granitporphyr, Granulit, Felsitporphyr, Sanidintrachyt, Trachyt, Pechstein, Pechstein, Kugeldiorit, Metaphyr, Diabas, Diabas, Kalkdiabas, Nosean-Leucitophyr, Leucitophyr, Hauyngestein, Noseangestein, Noseanphonolith, Vesuvlava, Augitandesit, Augitandesit-Lava, Gabbro, Eklogit, Eulysit, Olivinfels, Ophicalcit, Lithographischer Kalkstein, Grauwacke, Trass, Basaltbreccie. R. Fuess was a famous instrument and optical firm in Berlin. Its specialty were exceptional mineralogical instruments including spectroscopes, refractometers, goniometers, and petrographic microscopes and their accessories.

Histology Slide Set, c1900

This is a complete set of 72 histology slides. The slides are held in 12 trays within a wooden case that opens. A list of slides is pasted on the inside of the top cover. This appears to be a commercial set intended for medical students. It dates from 1890 to 1910. The maker is not known but it is probably a slide-making firm in England, possibly Abraham Flatters. The set is complete and of high quality.

Botanical Slide Set, c1890

This is a set of 12 slides of botanical objects. All of the slides are labeled Northern College of Pharmacy, 100-102 Burlington St., Manchester and E. Coll. N. C. P. Manchester. The slides are Sori, From Jamaica Hymenophyllum Sericeum, Decoloured leaf of fuchsia, onion skin shewing Raphides, T. S. joint of stem Barley, T. S. Stem Salia universalis Osier, Seeds Rose lychnis, Seeds Oxalis tropaeoloides, Oak Fern Spore Cases, Scales Fern, T. S. Stem Phlebodium aureum, Petal of Geranium Pelargonium. The slides are sections and whole mounts. The slides are in excellent condition and very attractive with decorative ringing of different colors. The slides are held in a fitted cardboard holder with folding covers with marbled papers pasted on. The slide holder fits into a cardboard case labeled Microscopical Preparations. There is wear to the edges of the slide holder and case.

Botanical Slide Set

Outstanding histology slide set of 100 slides made by Dr. F. Sigmund in the 1920s

Professor Sigmund, Stuttgart, prepared six series of slides in the 1920s. Each series contains ten parts of ten slides and each slide has a multi-language label. One series is the Physiological Histology of Man and Mammalian Animals (Histologia Physiologica). The ten parts of this series are The Skin; Organs of Movement; Central Nervous System; Reproductive Organs; Respiratory and Urinary Organs; The Eye; Organs of Hearing, Smell, Taste, and Touch; Circulatory and Blood-forming Organs; and Digestive Organs (2 parts). This is a complete set of the Histologia Physiologica consisting of 100 slides. The slides are noteworthy because of their exceptional quality with thin sections beautifully mounted and stained. Some preparations are injected. Sigmund's slides were mainly meant for an educational market, but their beauty and quality were such that they came to the attention of non-professionals and collectors. Perhaps as a result, sets were dispersed, and single slides are now scarce and expensive and complete sets are extremely rare.

The slides are housed in a "book box," a slide box with covers in the form of a book so that the box would look like a book when placed vertically on a shelf. The slides are listed on the inside of the front cover.

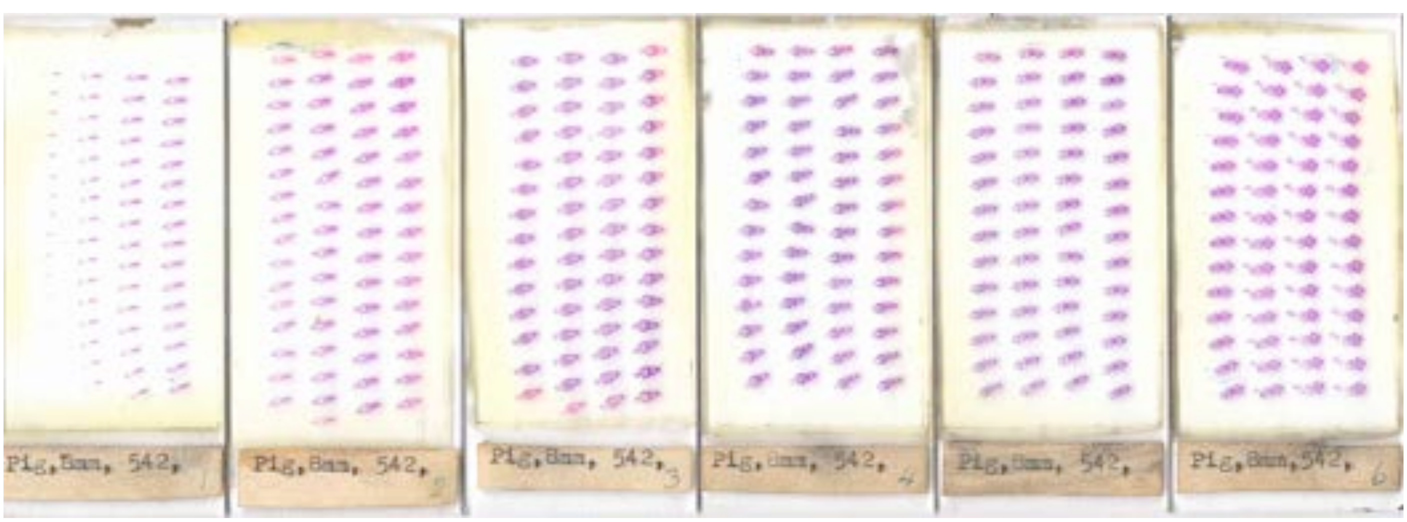
Möller Materia Medica Slide Collection

Johann Dietrich Möller (1844-1907) began making slides of diatoms around 1867. After his death, his son took over the business which produced a wide range of slides into the 1960s. This is a collection of 70 slides of leaves, flowers, fruits, herbs, roots, seeds, rhizomes, bark, and other parts of medicinal plants. The monogram in the corner of the label is a circle around the letters JM. Extracts of these plants formed much of the pharmacopoeia of the nineteenth century and first part of the twentieth century. The use of some dates from antiquity, and the active ingredients of many are still used medicinally today.

Möller Materia Medica Slides

Serial Sections of 8mm Pig Embryo, c1920

This is a set of serial sections through an entire 8mm pig embryo. The sections on 13 1 ½ X 3 inch slides are 10 microns thick and stained with Alum C and Orange G. The paper labels have "Pig, 8mm, 542" and the number of the slide in pencil. The number of the slide is also diamond engraved on the glass below the label.



Serial Sections, Pig Embryo, c1920

NBS Microslides Set of Spider Whole Mounts

Northern Biological Supplies (N. B. S.) was founded in 1938 by J. Eric Marson. Its specialty is providing natural history slides. This is N.B.S. Set 6/BH, six spider whole mounts. c1960.

NBS Microslides of Spider Whole Mounts

Volcanic Ash and Sand

This is a set of 25 slides of volcanic ash and sand from volcanoes around the world including Mount Etna, Stromboli, Pinatubo, Quizapu, Mt. St. Helens, and others. Each slide is prepared with square rings and labeled with metallic silver thermal printed labels. The largest eruption of the twentieth century occurred in 1912 on the Alaska Peninsula to form Novarupta.

Volcanic Ash from Novarupta

Slide Set, Wait's Drugstore, Traverse City, Michigan. c1880

This is an unusual American set of 12 slides in a small cardboard box labeled "Wait's Drugstore, Traverse City, Mich." The slides are small, 57 x 17 mm, and wrapped in paper. One side of each slide is labeled with the subject and "Microscopic Objects, Prepared by S. E. Wait." The other side is labeled "Nature is Man's best Teacher. She unfolds her treasures to his Search." The slides are Hen's Feather, Juniper Pine Hemlock Leaf, Live Forever Leaf, Wing of Butterfly, Caterpillar's Hair, Wing of Fly & Wasp, Lettuce Leaf, Maple Moss, Sponge, Apple Skin (specimen missing), Tea Leaf (specimen missing), Snake Skin (specimen missing). The set is in generally good condition noting a few slides with cracked coverslips and three specimens missing. c1880.

Wait's Drugstore, Traverse City, Michigan

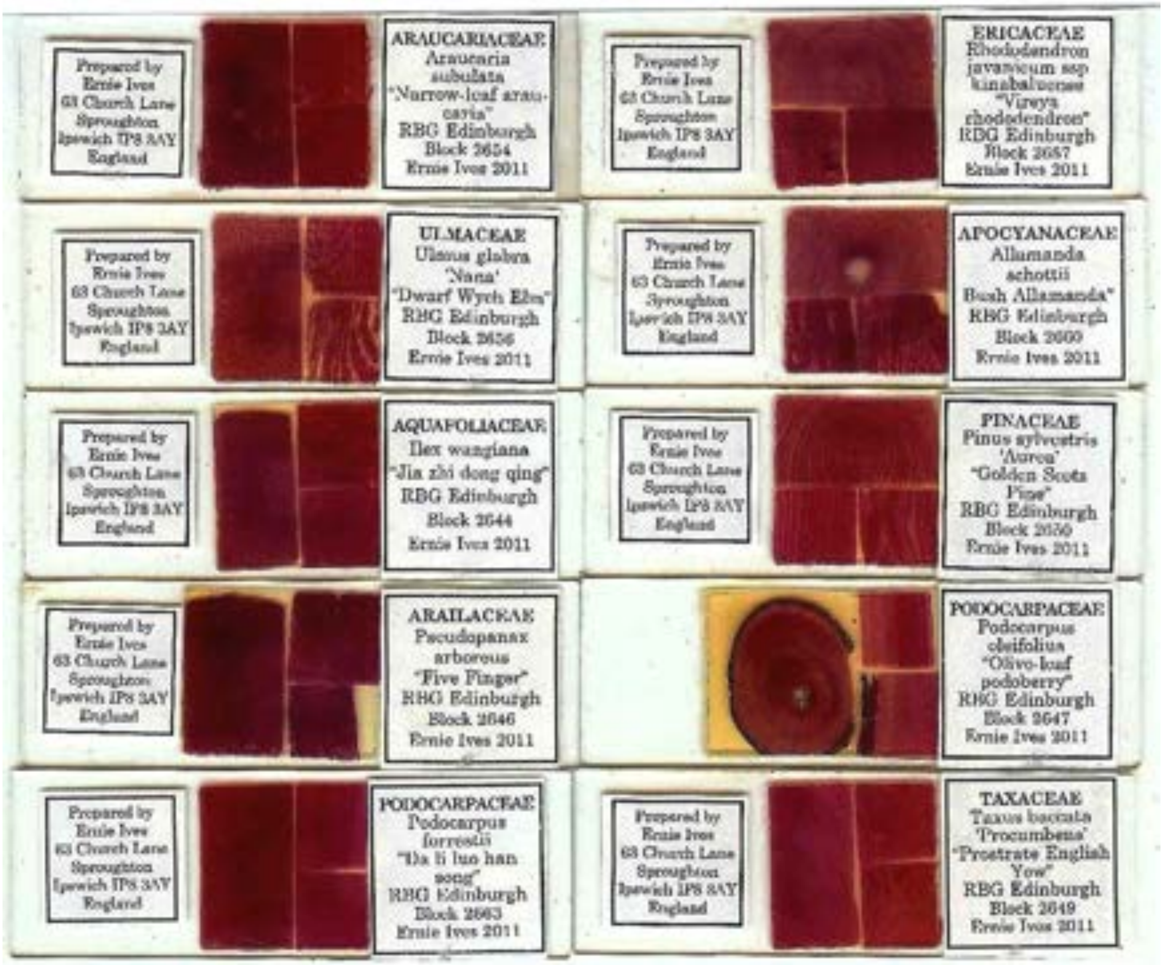
Whole Mounts of Entomological Specimens, Auburn, Alabama, 1950

This is a set of 84 entomological specimens held in wooden blocks and suitable for viewing with a dissecting microscope. The blocks are 2 ½ x 3 ½ inches in size with a cutout for the specimen. The opening is covered on both sides with thin, clear plastic and the specimen affixed to the bottom piece. Each block has a typed label with the common and Latin name of the insect, order, action of the insect, "Auburn Ala." or a few other towns in Alabama, day and month in 1950, and "Robert C. Green." Most of the insects are harmful to crops and animals and some are beneficial. The set is in generally good condition although in some cases legs have broken off or the insect has detached from the substrate. It seems likely this set was used in teaching an agricultural course, possibly at Auburn University, which has a College of Agriculture.

Insect Whole Mounts

Wood Sections from the Royal Botanic Garden Edinburgh by Ernie Ives, 2011

These are ten mounts of transverse, radial, and tangential sections of woods from the Royal Botanical Garden Edinburgh by the late Ernie Ives. The Royal Botanic Garden Edinburgh is a scientific center for the study of plants, their diversity and conservation, as well as a popular tourist attraction. It was originally founded in 1670 as a physic garden to grow medicinal plants. Ernie Ives is known for his high quality wood sections and was the author of *A Guide to Wood Microtomy*. The slides were made in 2011.



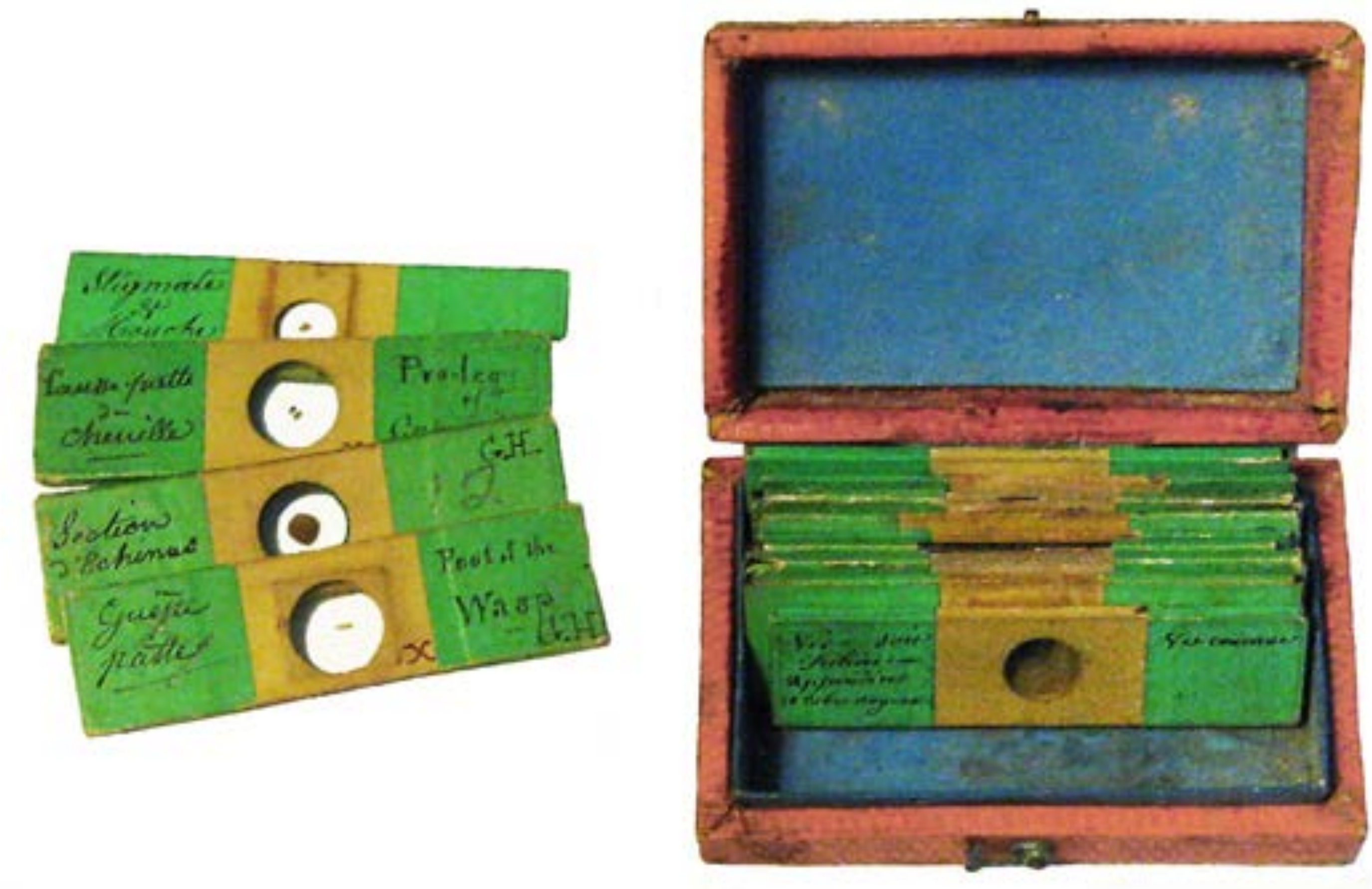
Wood Sections from the Royal Botanic Garden

European Mineral Micromounts

These are 31 European micromounts prepared by Anthony DiDonato. The minerals are mounted in 7/8" clear micromount boxes for easy viewing under the microscope. A list describes when and where the specimens were found.

Joseph Bourgogne Slide Set, c1840

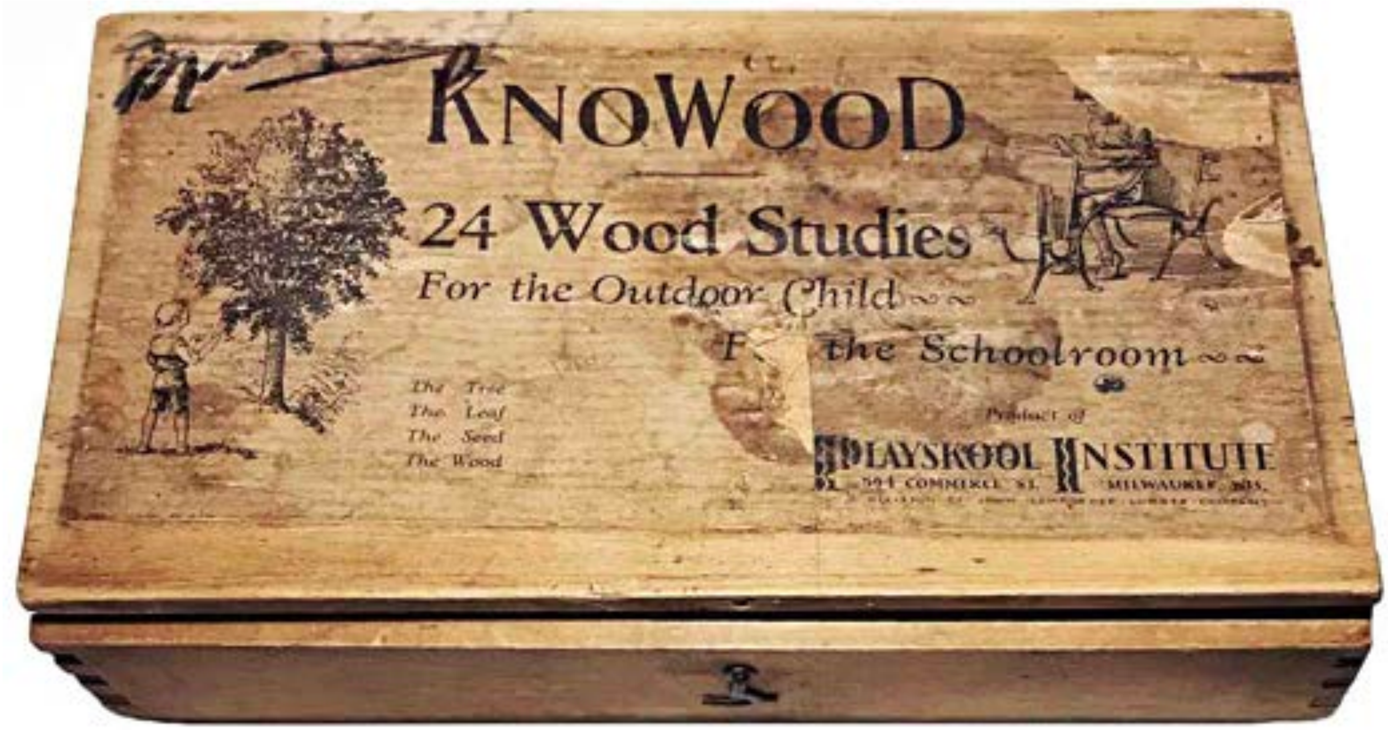
This is a set of 12 microscope slides by Joseph Bourgogne (c1805-c1885), a member of the large Bourgogne family of slide makers in France. Joseph Bourgogne established his microscopy workshop in Paris in 1835 and these slides were probably made in the 1840s. Each slide consists of a 1.6 x 6 cm (5/8 x 2 inch) plate glass slide with a small, thin cover glass, wrapped in light brown paper with bright green papers at each end. The specimens are insects or parts of insects. The slides are held in a well-worn wood and paper box with metal hinge and clasp.

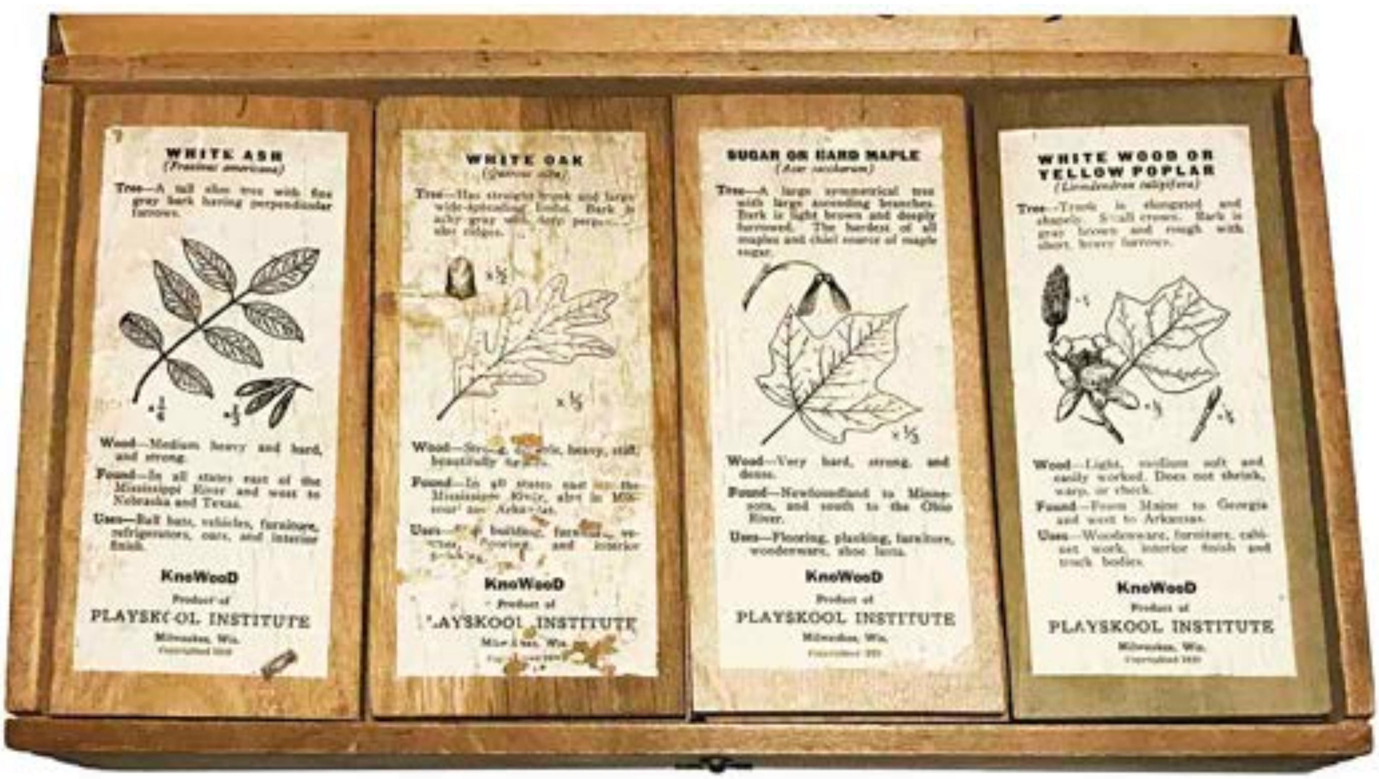


Bourgogne Slide Set

Wood Sample Set, c1930

KnoWood 24 Wood Studies For the Outdoor Child, for the Schoolroom, Playskool Institute, Milwaukee, Wis. The set consists of 24 2 ⅝ x 5 ¾ inch wood samples of 24 different trees. Each plaque has a label with information on the tree and a drawing of a leaf and a seed. The wood samples and labels are complete. c1930.





Wood Sample Set

Books

Books on Microscopy and Scientific Instruments

The Lentz Collection includes a collection of books on histology and the history of microscopes and scientific instruments. Some are illustrated here.

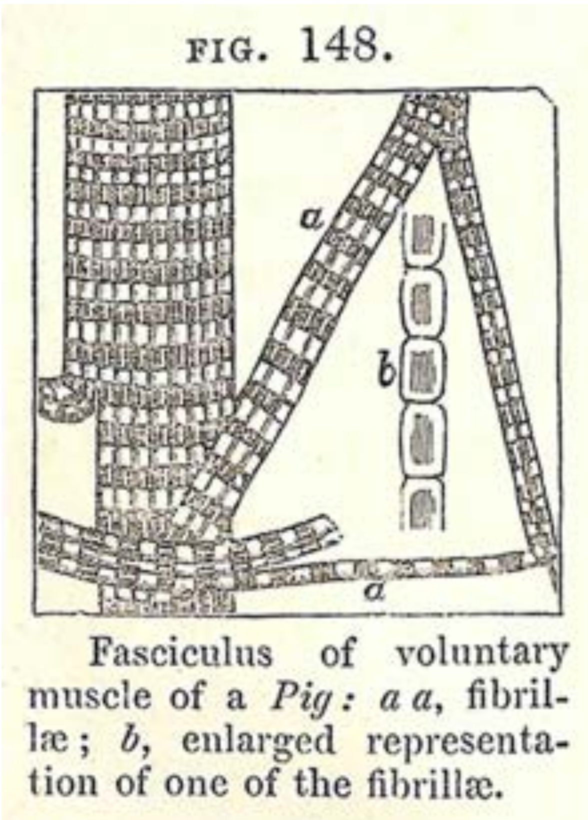
Baker, Henry 1743 *The Microscope Made Easy: Or, I. The Nature, Uses and Magnifying Powers of the best Kinds of Microscopes Described, Calculated, and Explained: For The Instruction of such, particularly, as desire to search into the Wonders of the Minute Creation, tho' they are not acquainted with Optics. Together with Full Directions how to prepare, apply, examine, and preserve all Sorts of Objects, and proper Cautions to be observed in viewing them. II. An Account of what surprizing Discoveries have been already made by the Microscope: With useful Reflections on them. And Also A great Variety of new Experiments and Observations, pointing out many uncommon Subjects for the Examination of the Curious.* 8vo, modern full tan calf with gilt lettering labels, 15 copper plates, 12 folding, fine. Second edition. Printed for R. Dodsley and sold by M. Cooper and J. Cuff, Optician, xvi, 341pp, index.

Double Reflecting Microscope

Circulation of blood in web of frog's foot

Henry Baker (1698-1774) was a typical eighteenth century polymath; naturalist, speech therapist, historian, poet, translator, editor, and correspondent. He made a series of pioneering observations of crystal morphology. He was a cofounder of the Royal Society of Arts and a Fellow of the Royal Society of Antiquaries. Experiencing difficulties in the use of current microscopes, Baker expressed his concerns to John Cuff who within a year produced his side-pillar microscope that set the standard for the next generation of microscopes. *The Microscope Made Easy* was a bestseller and greatly popularized microscopy because it gave understandable instructions on use of the microscope and the preparation of specimens. There is no doubt that *The Microscope Made Easy* was widely read not only by natural historians, but also writers, poets, and thinkers of the day. Baker's purpose in writing the book was to increase interest in the use of the microscope and instill in others a curiosity for objects previously invisible to the naked eye.

Quekett, John. 1852. *Lectures on Histology, Delivered at the Royal College of Surgeons of England, In the Session 1850-51. Elementary Tissues of Plants and Animals*. 159 woodcuts, Hippolyte Bailliere, London, viii, 215 [1] pp. Quekett's work as an histologist was remarkable for its originality and for its influence upon the histological studies of the medical profession.

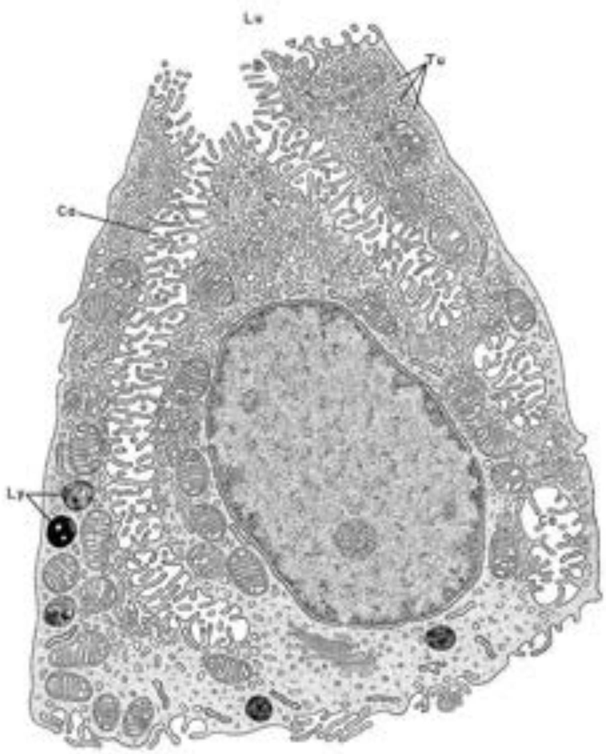


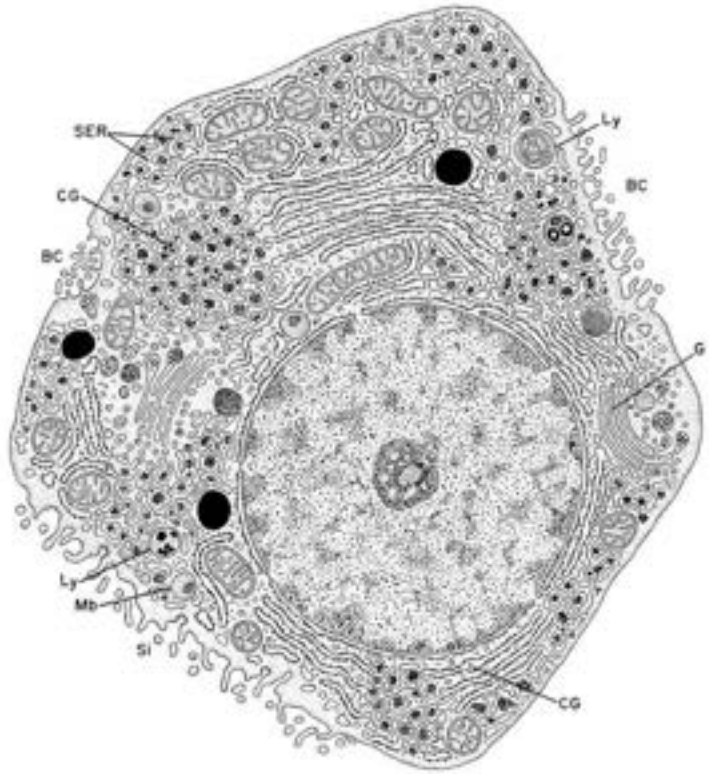
Muscle, *Lectures on Histology*, Quekett, 1852

Haversian Canal, *Manual of Human Histology*, Kölliker, 1853.

Kölliker, A. 1853. *Manual of Human Histology*. Vol. 1., xiii, (1), 498pp; Vol. 2, ix, (1), 434pp. First English edition, Sydenham Society, London. This is the first textbook of histology by one of the foremost histologists of the nineteenth century.

Lentz, Thomas L. 1971. *Cell Fine Structure. An Atlas of Drawings of Whole-Cell Structure*. W. B. Saunders Co., Philadelphia, 437pp. 35mm Slide Set. *Cell Fine Structure* consists of drawings of all of the cell types in the body, each compiled from a number of electron micrographs of the cell. The original 9 x 12 inch pen and ink drawings are included in the collection.

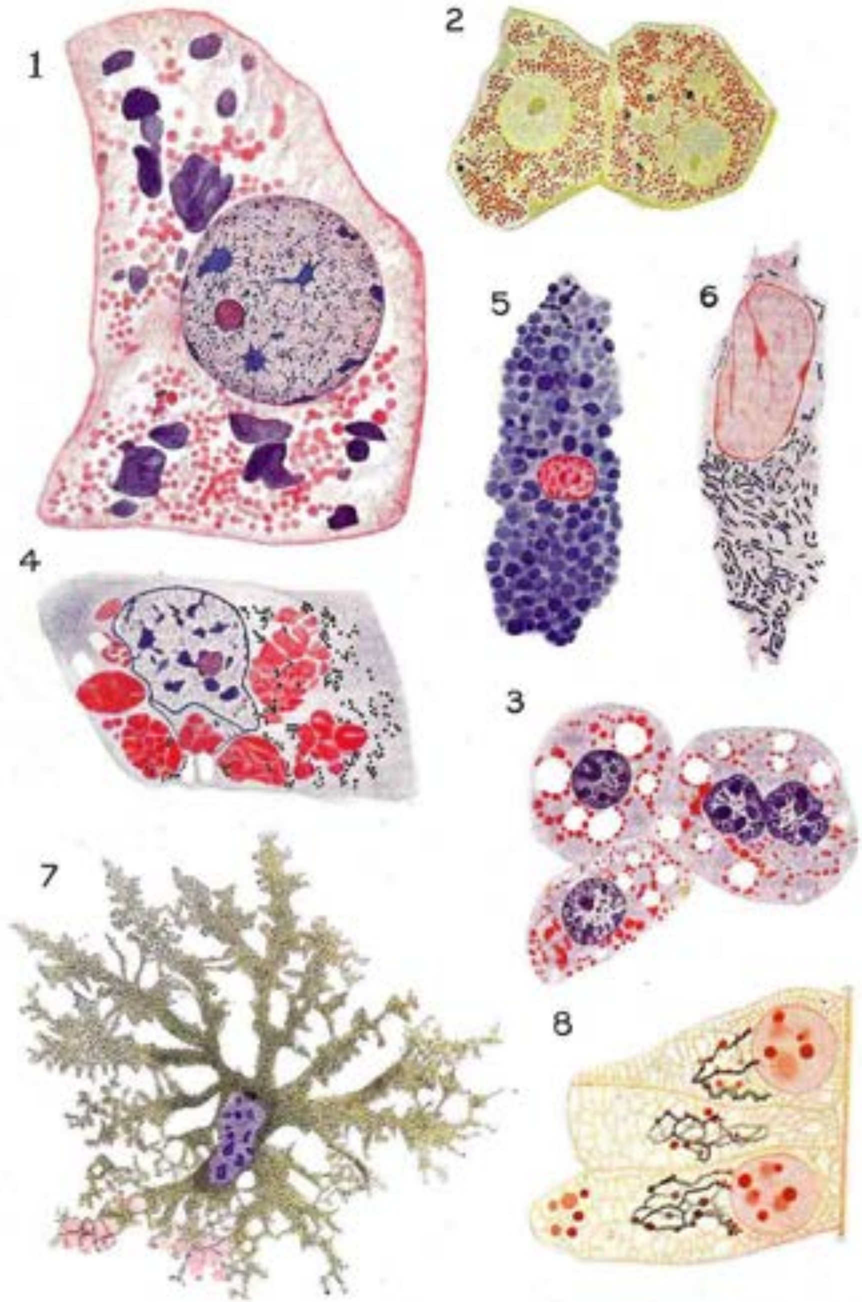




Parietal Cell, *Cell Fine Structure*, Lentz, 1971 **Hepatocyte, *Cell Fine Structure*, Lentz, 1971**

Maximov, A. A. and Bloom, W. 1930. *A Text-Book of Histology*. W. B. Saunders Co., Philadelphia, 833pp. First edition of the classical histology textbook of the twentieth century.

Alexander Alexandrowitsch Maximow (1874-1928) was a Russian-American scientist in the fields of histology and embryology. A professor in Saint Petersburg, he fled communist Russia with his family in 1922. From 1922 until his death in 1928, he served as a Professor of Anatomy at the University of Chicago and conducted his research with his sister Claudia as congenial lab technician and co-worker at his side. Maximow is renowned for his experimental work on the unitarian theory of hematopoiesis, namely, that all blood cells develop from a common precursor cell. For four years before Maximow's death, fellow histologist William Bloom worked closely with him on the *Textbook of Histology*. Bloom ultimately completed the work, which was first published in 1930. It set the standard for histology textbooks. Bloom was a graduate of the Johns Hopkins School of Medicine and later chairman of the Department of Anatomy at Chicago.

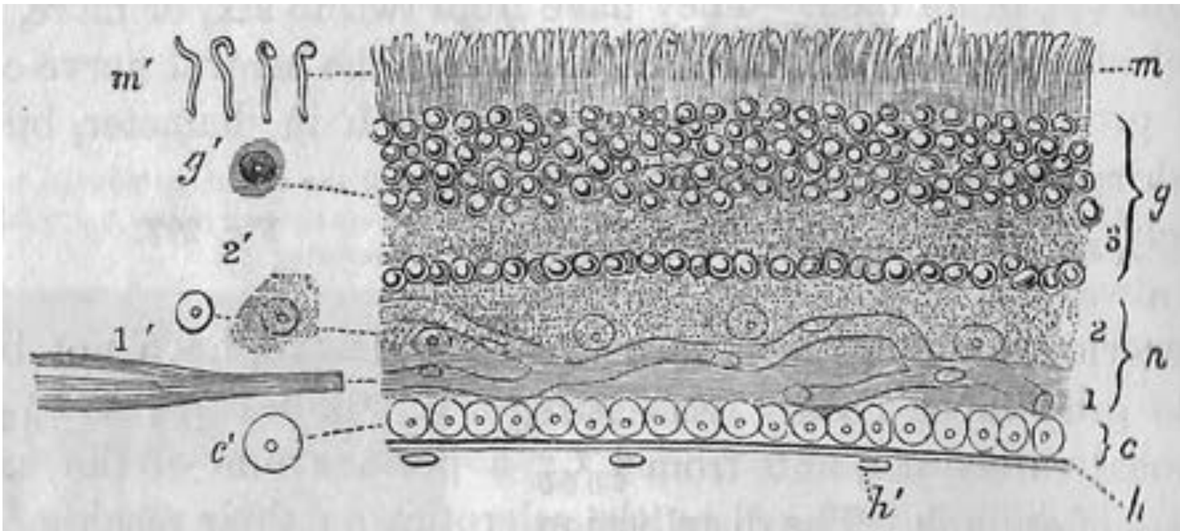


Cells, organoids and inclusions, Maximow and Bloom, 1930

Peaslee, E. R. 1857. *Human Histology In its Relations to Descriptive Anatomy, Physiology, and Pathology.* First edition, 23.5 cm, 434 woodcuts, ads, original full leather, fine. Blanchard and Lea, Philadelphia, 616 [1] pp. First American textbook of histology by graduate of Yale Medical School.

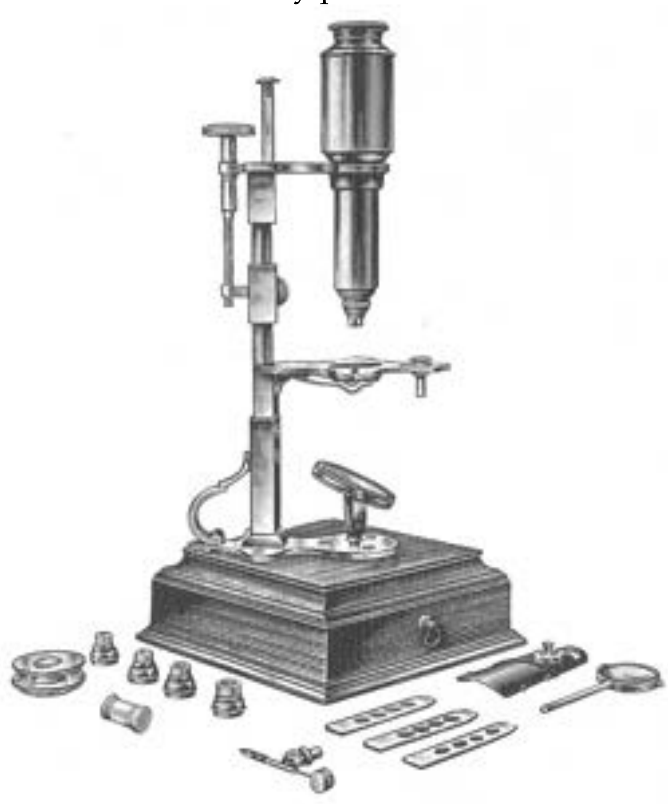
Edmund Randolph Peaslee (1814-1878) graduated from Dartmouth College in 1836 and received the degree of MD from the Yale Medical School in 1840. He became Professor of Physiology and Pathology at the New York Medical College, Professor of Anatomy at Dartmouth College, and Professor of Surgery at the Medical School of Maine. He is important in the history of American medicine as a pioneer in abdominal and pelvic surgery. He was among the first in

America to apply the microscope to teaching physiology, pathology, and histology. In 1857, he published *Human Histology*, the first American textbook of histology. The book is organized according to Peaslee's lectures and is based on European textbooks.



Retina, Textbook of Histology, Peaslee, 1857

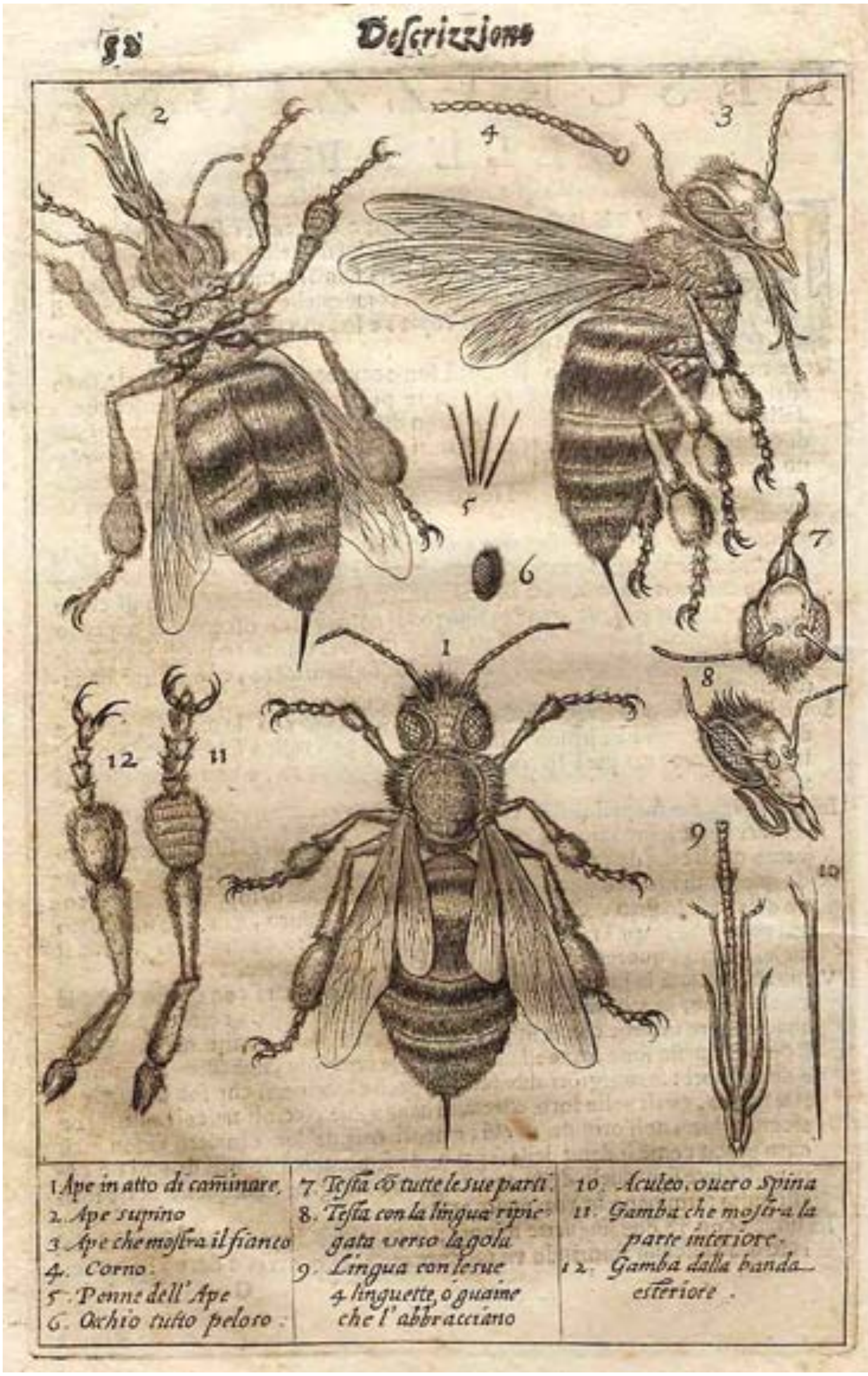
Replica Rara. 1974. *History of the Microscope 1665 to 1830*. Replica Rara, Limited. Twenty four woodcuts of the microscopes illustrated in *The Atlas Catalogue of Replica Rara Ltd. Antique Microscopes.* Set 32/1000. The prints are lithographed on high quality paper from original woodblock engravings by N. Paul Quirk, master engraver. Each 8 ½ x 11 inch print has a translucent protective cover-sheet on which is printed a brief historical note. The woodcuts are stored in a gold-embossed bookshelf library portfolio.



Woodcut of 1745 Cuff microscope from *History of the Microscope 1665 to 1830*, Replica Rara

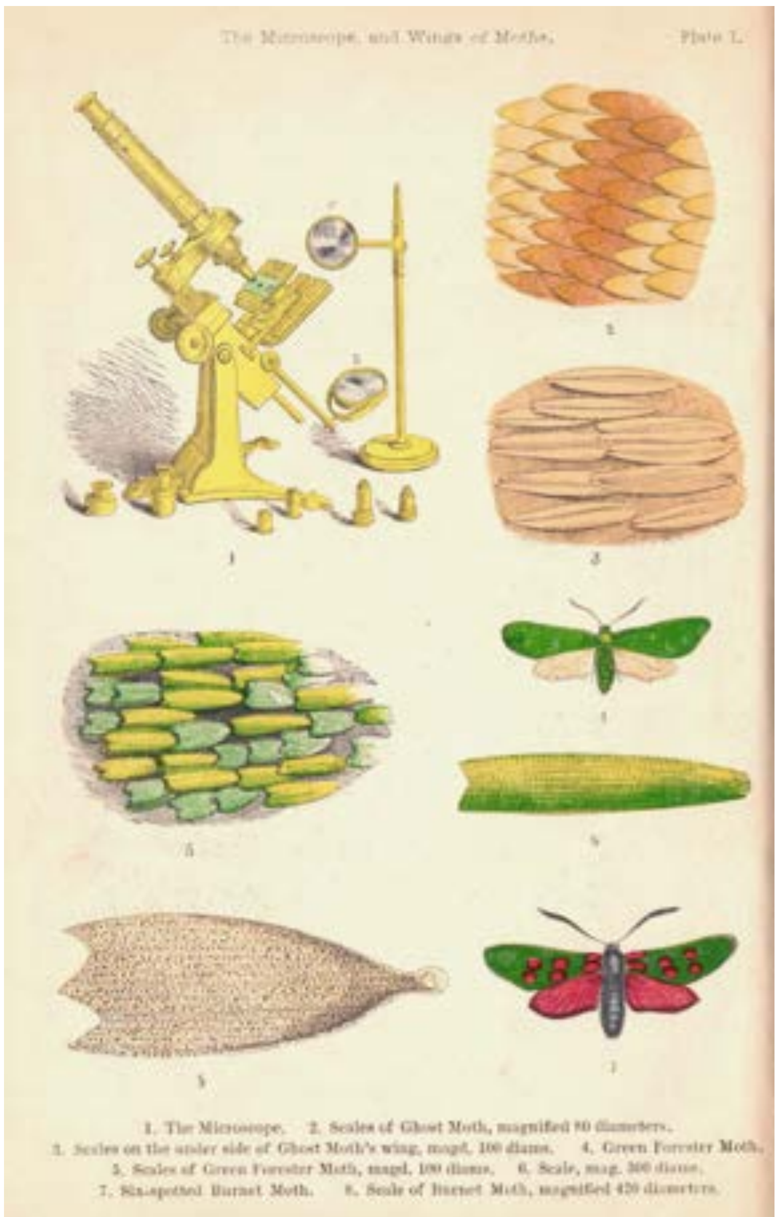
Stelluti, Francesco. *Persio Tradotto in verso sciolto e dichiarato* Da Francesco Stelluti Accad. Linceo Da Fabriano All'Ill.mo et R.mo Sig.re Il Sig. Cardinale Barberino. Appresso Giacomo Mascardi. In Roma. 1630. 4to (21.5 x 15 cm), 12 p.l., 218, [20] p. Engraved title page, text engravings, including full-page image of the parts of a bee observed with the aid of a microscope. Bound in contemporary limp vellum, title stenciled in gothic lettering on spine. Some browning, minor dampstains, page missing a corner, and lacking a preliminary leaf and pages 35 and 36, but otherwise very good.

First edition of this illustrated Italian translation of the Roman poet Persius (34-62 AD) by Francesco Stelluti (1577-1652) containing the first illustrations prepared with the aid of a microscope that were set forth in a printed book. The book's striking full-page images of a magnified bee (p. 52), show minute details of the antennae, eyes, legs, sting, head, and tongue that can only be seen with a microscope. The engraving is accompanied by the pertinent *Decrizzione Dell'Ape* - Description of the Bee. On page 127 is a smaller illustration of a magnified grain weevil, including a detail of the tip of the insect's snout and mandibles. These remarkable scientific images are found, oddly enough, in Francesco Stelluti's translation of the works of the Latin poet Persius, dedicated to the powerful Cardinal Francesco Barberini in an attempt to gain the Cardinal's patronage for the Accedemia dei Lincei. The "Academy of Lynxes," one of Europe's first scientific societies, had been founded by Stelluti, Federico Cesi, Johannes Van Heeck, and Anastasio de Filiis in 1603. Stelluti's edition of Persius was intended for the most part as a means for advertising the Accademia's activities. Whenever he could, Stelluti took a word or phrase in Persius and used it as an excuse to refer to one or another aspect of the natural historical researches of the Linceans. These include notes on Galileo's observations of Jupiter and Venus, as well as his recent work-in-progress, the 1632 *Dialogue*. An obscure reference in Persius's first satire to what may have been the ancient town of Eretum gave Stelluti his pretext for including the bee images, since the former Eretum was now Monterotondo, seat of the Barberini country estate, and the Barberini family had adopted the bee as its emblem. Stelluti's weevil image was likewise prompted by a mention of that insect in another of Persius's poems. Stelluti's bee image is similar, but not identical to, an earlier image showing magnified views of a bee, published as a broadsheet in 1625 under the title *Apiarium*; this broadsheet is extremely rare, with only two or three copies recorded. The *Apiarium* was intended to form part of a projected encyclopedia by Cesi, but this project was never realized. In 1624, Cesi had been sent a microscope by Galileo, another Lincean, and it was most likely this instrument that Cesi and Stelluti used to prepare their pioneering images of insects under magnification. See Brian J. Ford, *Images of Science: A History of Scientific Illustration*, 1993 and David Freedberg, *The Eye of the Lynx: Galileo, His Friends, and the Beginnings of Modern Natural History*, 2002.



Ward, The Hon. Mrs. 1869. *The Microscope, or Descriptions of Various Objects of Especial Interest and Beauty, Adapted for Microscopic Observation. With Directions for the Arrangement of a Microscope, and the Collection and Mounting of Objects. Illustrated by the Author's Original Drawings.* Groombridge and Sons, London. Third edition, 18.5 cm, pictorial green cloth stamped in gilt, aeg, vi, 154 [4] pp, index, 25 text woodcuts, 8 color plates each with a tissue guard. Near fine.

Mary Ward (1827-1869) was an Anglo Irish amateur astronomer, microscopist, artist, and entrepreneur. She was born at Ballylin, Co. Offaly, the youngest child of the Rev. Henry King and his wife Harriette. From an early age she showed a great interest in astronomy and natural history which was encouraged by her cousin William Parsons, 3rd Earl of Rosse, who in 1845 built a 72-inch reflecting telescope, the "Leviathan," which was the world's largest telescope until 1917. In 1854, she married Henry William Crosbie Ward of Castle Ward, Co. and had three sons and five daughters. When Ward wrote her first book, *Sketches with the Microscope* in 1857, she apparently believed that no one would print it because of her gender or lack of academic credentials. She published 250 copies of it privately, and several hundred handbills were distributed to advertise it. The printing sold during the next few weeks, and this was enough to convince a London publisher take the risk and contract for future publication. Mary did not use her full name but was referred to as The Hon. Mrs. Ward. The book was reprinted eight times between 1858 and 1880. Mary was tragically killed in 1869 when she fell under the wheels of an experimental steam car built by her cousins.

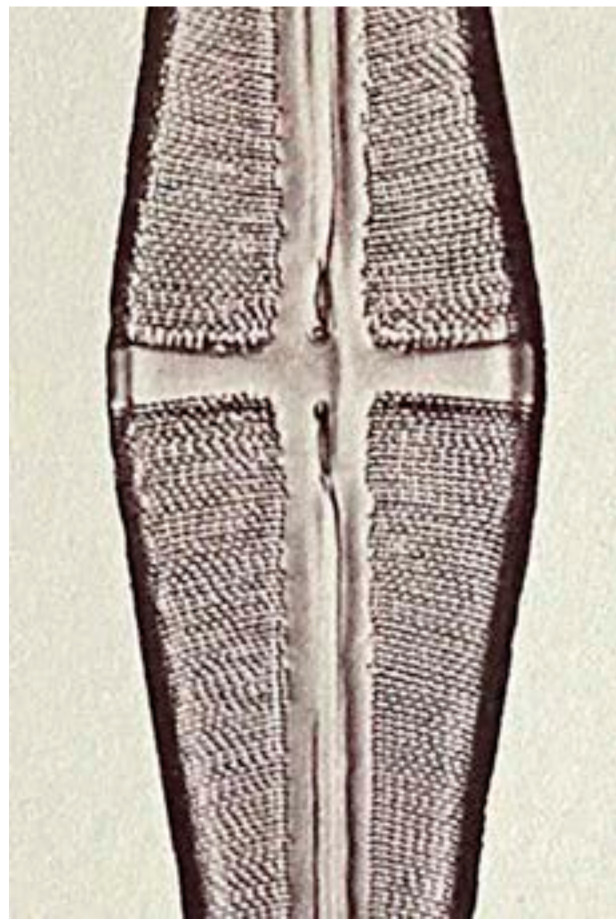


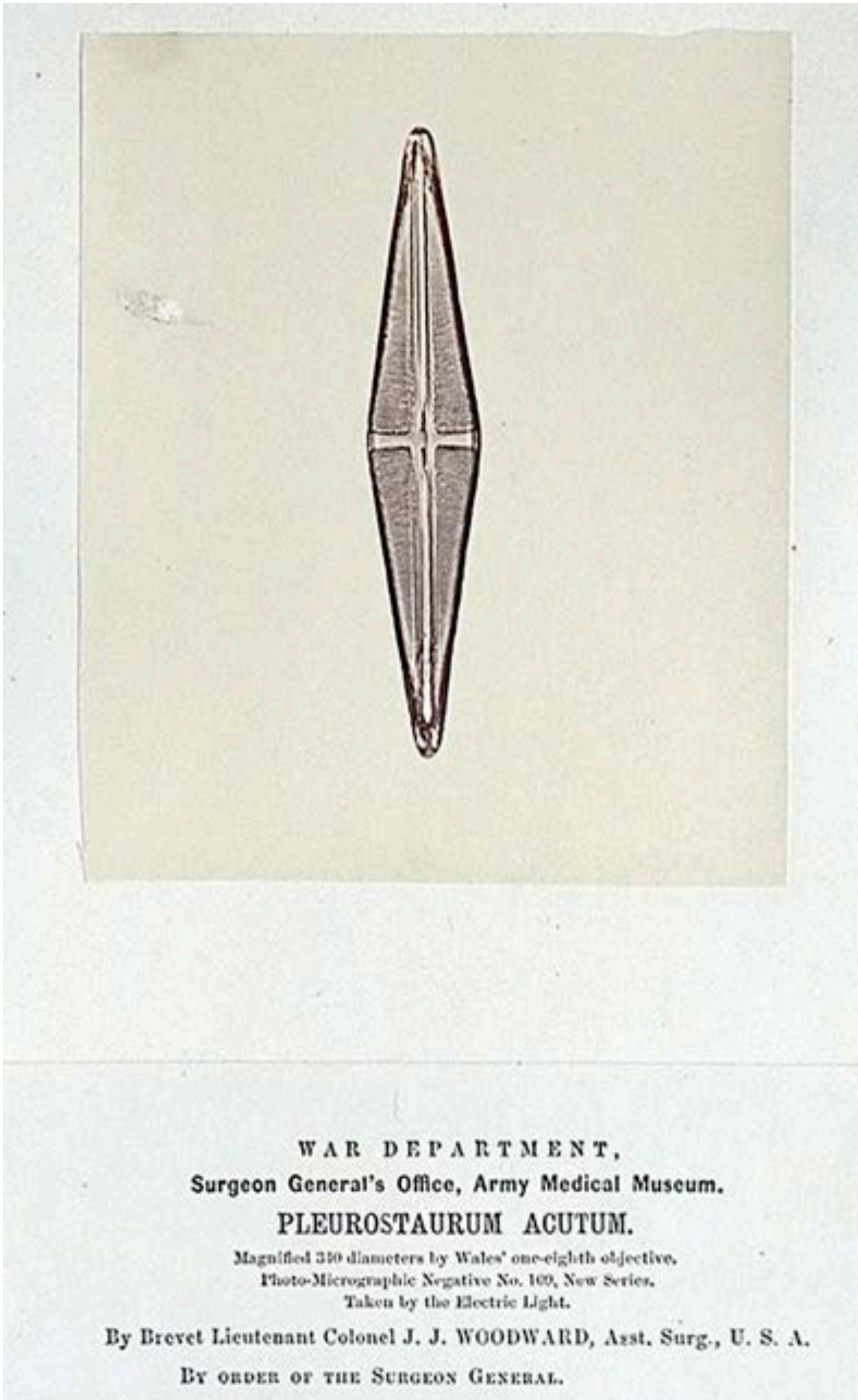
Ward, The Hon. Mrs. 1869 *The Microscope*

Albumen Photograph of a Diatom, c1870

Photographic print of a diatom by J. J. Woodward, c1870. Original albumen print. Mounted as issued on heavy card 8 ⅝" x 11" (22 x 28 cm), is a 3 ½" x 4 ¼" photographic print of a specimen of *Pleurostaurum acutum*, with applied printed legend "By Brevet Lieutenant Colonel J. J. Woodward, Asst. Surg., U.S.A., By order of the Surgeon General." It explains the technical circumstances "Magnified 340 diameters by Wales' one-eighth objective. Taken by the Electric Light." Condition is fine, noting a small scrape in the print background. The image itself resolves an extraordinary level of detail in this diatom "skeleton." Diatoms were often used to test the resolving power of microscope objectives. This is a very early example of photomicroscopy.

Joseph Janvier Woodward (1833 - 1884) served as Army Assistant Surgeon during the Civil War, and authored two volumes of the major *Medical and Surgical History of the War of the Rebellion*. It was Woodward who performed autopsies on both Lincoln and Booth. As a microscopist, his fame was worldwide; he pioneered the fields of photomicroscopy and pathology. He made extensive studies of diatoms, and was the first microscopist to resolve the finest line separations on Nobert's 19-band test plates, very near the limits of the optical microscope. In 1870 he was advocating electric illumination for photomicrography, where an intense light source is necessary. Woodward employed a Duboscq lamp attached to a 50-element Grove's battery (placed in an adjacent room and ventilated to the outdoors), using a large Powell and Lealand stand with objectives by William Wales of Fort Lee, New Jersey. Woodward, having traditionally used the sun as light source, was delighted to be independent of the weather. He was rather stunned that "European microscopists, who are exposed to a climate even more variable than our own, have not yet succeeded in placing the art of Photomicrography on such a basis." Woodward also served as head of the Medical and Microscopical Section of the Army Medical Museum, and several of his microscopes are preserved in the Billings Collection.





Albumen print of a diatom

Signed Benjamin Silliman Letter with Reference to George Peabody, 1835

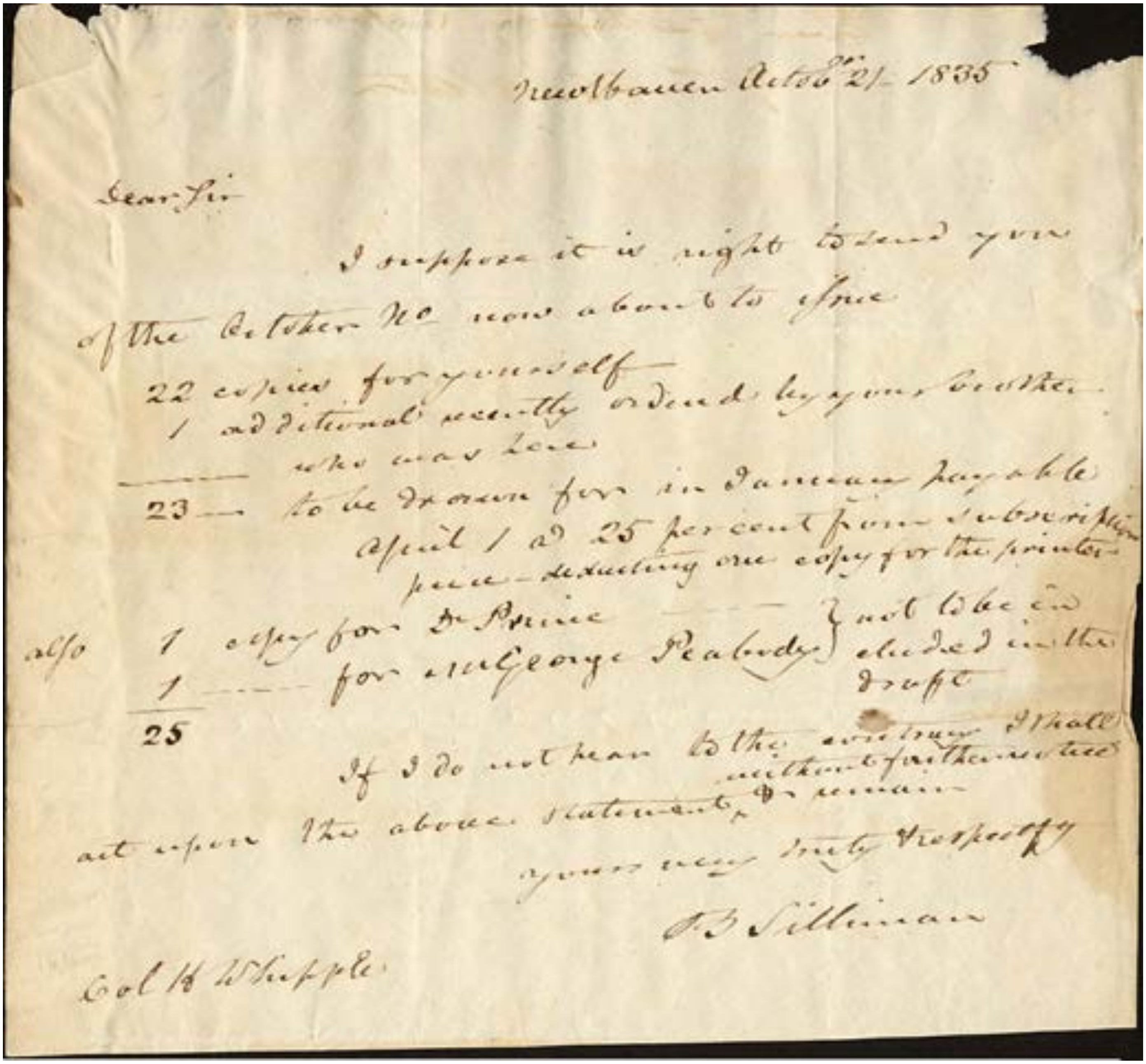
This is a letter signed "B Silliman" and dated "New Haven October 21 1835." Benjamin Silliman Sr. (1779-1864) was the first professor of chemistry and natural history at Yale. He was instrumental in expanding the college's educational resources through the acquisition of extensive mineralogical collections. In 1818, he started the *American Journal of Science and Arts* (later shortened to *American Journal of Science*), for many years known simply as *Silliman's Journal*. He wielded a powerful influence on the development of science, not only at Yale, but also in the United States as a whole.

The letter is about the disposition of copies of a number probably of the American Journal of Science. What is notable about this letter, besides Silliman's signature, is the mention of George Peabody who was to receive a copy of the issue. The letter reads:

"Dear Sir
I suppose it is right to send you of the October No now about to issue
22 copies for yourself
1 additional recently ordered by your brother who was here
23 to be drawn for in January payable April 1 at 25 per cent from subscription price deducting one copy for the printer
Also 1 copy for Dr Prince
1 for Mr George Peabody, not to be included in the draft
25
If I do not hear to the contrary I shall act upon the above statement without further notice. I remain
yours very truly & respectfully
B Silliman
Col H Whipple"

8 x 7½", small paper loss at top corners, lightly soiled, mounting adhesive remnant shows through at left edge. Overall, fine condition.

George Peabody (1795-1869) was a wealthy banker and philanthropist. At the urging of his nephew Othniel Marsh, he agreed in 1863 to donate $100,000 for the establishment of a science museum at Yale. The amount was increased to $150,000 and the Peabody Museum of Natural History was established in 1866. There is a reference indicating that Silliman had contacted Peabody much earlier about a donation. It reads that "...Prof Silliman, Sr., had years before sounded out George Peabody about aiding science at Yale, but nothing came of it." (Parker and Parker, 1997). The present letter is evidence of Silliman's attempt to attract the attention of Peabody at a time when Peabody was still in the United States. Peabody even at that time had an interest in education because his will of 1832 specified $27,000 for educational philanthropy. Silliman may have known about this interest and contacted Peabody. Further research in the Yale archives might yield additional information about Silliman's early contact with Peabody.



Newhaven Octob. 21 1835

Dear Sir

I suppose it is right to send you of the October No now about to issue

22 copies for yourself
1 additional recently ordered by your brother who was here
23 — to be drawn for in January payable April 1 at 25 per cent from subscription price — deducting one copy for the printer

also 1 copy for Dr Prince } not to be included in the draft
1 — for Mr George Peabody }
25

If I do not hear to the contrary I shall without further notice act upon the above statement & remain

yours very truly & respectfully

B Silliman

Col H Whipple

Admission Ticket to Benjamin Silliman Lectures, Yale College, 1843

In the 19th century, students in the medical school were required to buy tickets for admission to professors' lectures. The proceeds from these tickets contributed to the professor's salary. This is a ticket for a lecture by Benjamin Silliman. It reads: "Yale College, Admit Edward M Beardsley to the course of Lectures on Chemistry & Pharmacy for 1843 44, Oct 1843, B. Silliman Profeser." It measures 3 ½ x 2 ½ inches and is in good condition with light soiling.

Obituary for Edward M. Beardsley:

1845

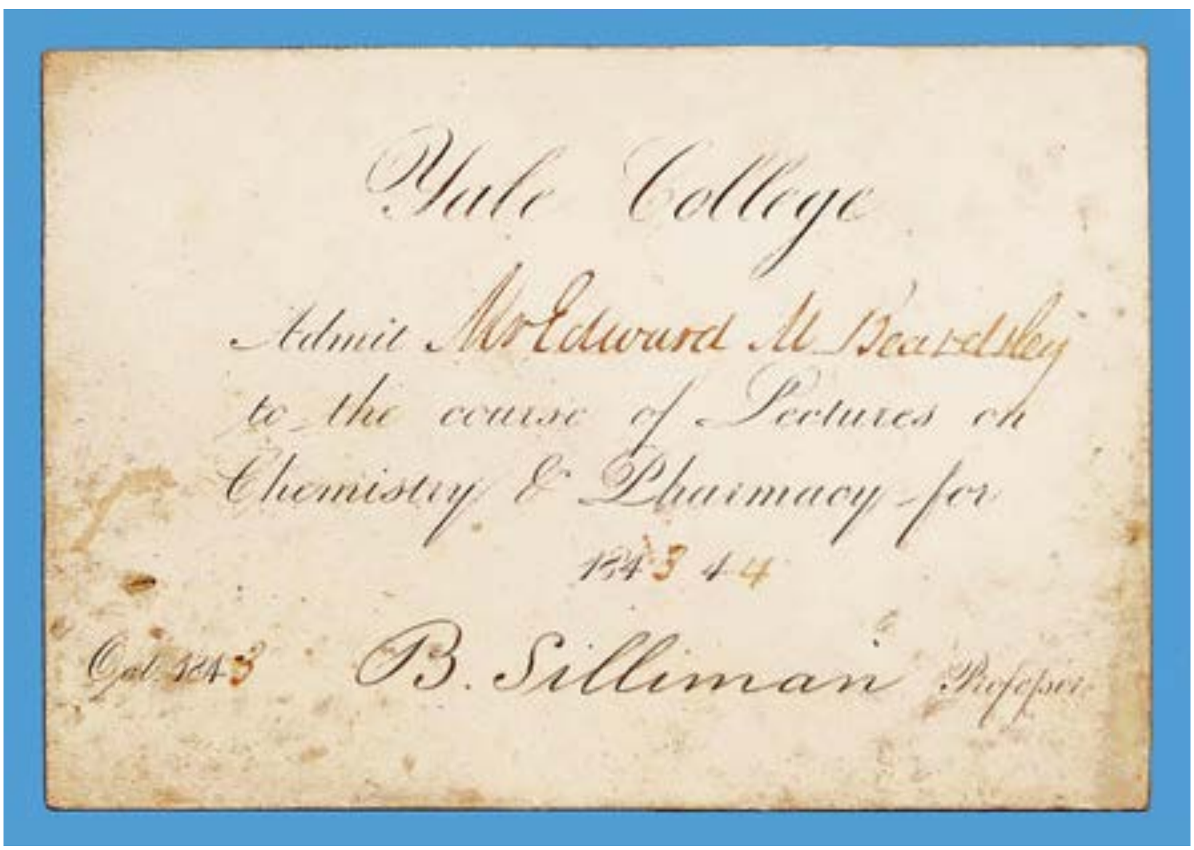
Edward McEwen Beardsley, son of Samuel Birdseye Beardsley (Yale 1815), who was for many years a teacher of a select school in Monroe, Conn., was born in Danbury, Conn., March 5, 1823. His mother was Abigail (McEwen) Beardsley. His early education was obtained from his father, whom he assisted in teaching before entering the Yale Medical School.

After graduation he was in the drug business in New Haven about two years, and then combined teaching in his father's school and the practice of medicine until 1861, after which he devoted himself entirely to his profession until he suffered a paralytic shock, in May, 1903. His services were frequently sought from distant towns. In 1879 and 1880 he was a member of the Connecticut House of Representatives, in which he served on the committee of foreign relations.

Dr. Beardsley died of paralysis at his home in Monroe, March 11, 1905, at the age of 82 years.

He married, April 22, 1855, Elizabeth A., daughter of David O. and Lucinda (Adams) Gray, of Monroe. She survives him with four sons and three daughters. From:
Obituary Record of Graduates of Yale University, Deceased from June, 1900, to June, 1910, Presented at the Annual Meetings of the Alumni, 1901-1910. The Tuttle, Morehouse & Taylor Co., New Haven, 1910, 1404pp.

Graduating from Yale in 1796, Benjamin Silliman Sr. (1779-1864) was originally trained as a lawyer before Yale University President Timothy Dwight offered him a position as a professor of chemistry and natural science in 1802. Silliman made contributions to a variety of fields, publishing the first scientific analysis of a meteor, exploring the geology of New Haven and surrounding areas, and identifying the component elements in several minerals. He was, however, best known for his role in communicating scientific discoveries among scientists and among the public at large. In 1818 he founded the *American Journal of Science*, the premier journal for scientific publication during the nineteenth century and now the longest continually published journal in the United States. He also lectured widely throughout the country on scientific developments. He was a founding member of the National Academy of Sciences. (From the National Academy of Sciences Memoirs.)



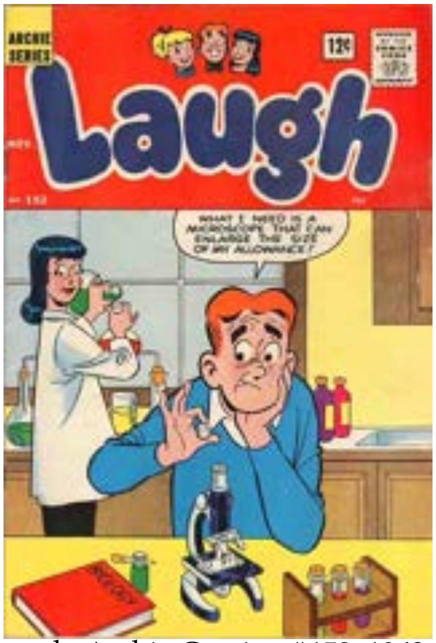
Lectures Admission Ticket

George E. Palade, Nobel Prize Press Photographs, 1974

NEW HAVEN, Conn., Oct.11–NOBEL WINNER–Dr. George Palade, who won the Nobel Prize for medicine, makes adjustments to an electron microscope in his laboratory at Yale University in New Haven Friday. The award to Palade was announced Thursday. Palade is one of three scientists to share the Nobel Prize for medicine this year. (AP WIREPHOTO) 1974

STOCKHOLM, DEC. 10 (AP)–Dr. GEORGE E. PALADE OF NEW HAVEN, CONN., USA, RECEIVES HIS NOBEL PRIZE IN MEDICINE FROM KING CARL GUSTAV IN THE CONCERT HALL HERE TUESDAY. HE SHARES HIS AWARD WITH DR. ALBERT CLAUDE, USA., AND DR. CHRISTIAN DE DUVE, BELGIUM. (AP WIREPHOTO) 1974

Three comic books with microscopes on the cover



Laugh, Archie Comics, #152, 1963.

Laugh, Archie Comics, #165, 1964.

Richie Rich, Harvey Comics, #82
1969

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