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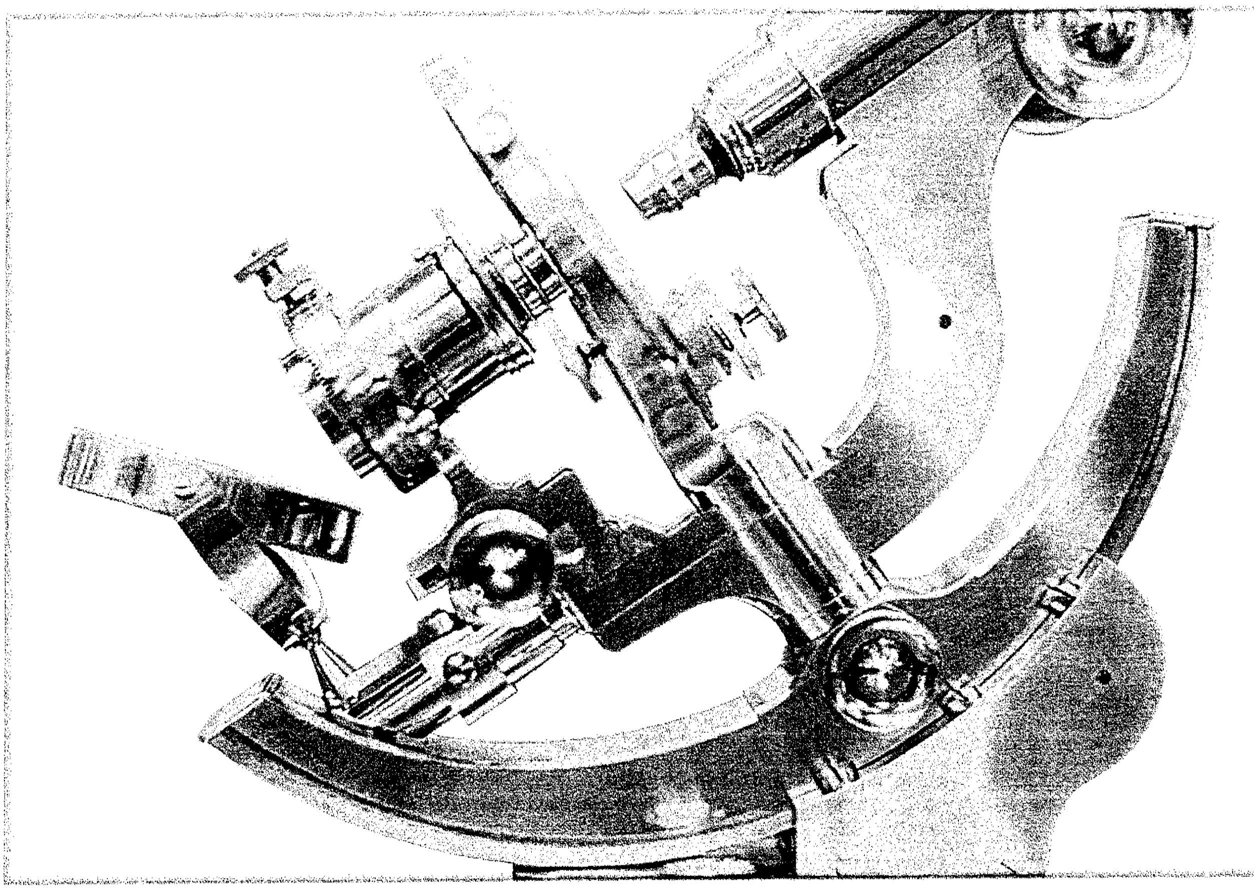
A Short History of the Radial Arm Microscope

James D. Solliday



Radial Microscope by Andrew Ross, London

In 1853,Thomas Grubb, constructed his Grubb's Sector Microscope, patented in 1854 and later improved in 1858 (Royal Irish Academy,Vol.V). This stand featured a grooved sector to the sub-stage which allowed the application of radial illumination (Mayall, 1886). Hartley states that this idea of the swinging substage began in Ireland with the Grubb design. Mayall sets the idea back to W&S Jones and the Lucernal microscope with its swinging illuminator. In the mid 1850's Nachet modified the idea with his adjustable substage mirror. In 1861, Zeiss introduced his S@tand III which featured a jointed stem holding the mirror which could be swung both sideways, forward and over the stage. Zeiss Stand VI of 1876, had the same feature, in addition Stands Vb, VIIb, IV mit Revolver, of the 1880's all featured mirrors that could be manipulated. Abbe's substage arrangement of 1872 introduced the traversing iris diaphragm. All the above innovations focused on the idea of oblique illumination which was felt improved the resolution of the image. In the case of the Grubb microscope the grooved sector was applied to the substage, in the radial microscope this "grooved sector" is applied to the limb.

The concept of lateral movement took on a whole new dimension with the introduction of the "Wale's limb" microscope. In 1860, George Wale emigrated from England to America establishing himself in Paterson, New Jersey. George Wale was the cousin to William Wales, dropping the "s" from his surname. In 1870, he began a partnership with Mr. Hawkins forming the firm of Hawkins & Wale at the Steven's Institute of Technology, Hoboken, New Jersey (1870-1877). In 1876, they exhibited their traditional student stand with the spiral-tube coarse focus. In 1878, he made a stand for the Industrial Pub. Co. featuring a chain-driven coarse adjustment (Padgitt, 1975). By late in 1877, he was no longer with Hawkins as he published a catalogue by "George Wale & Co." Hoboken, New Jersey., "Formerly of Hawkins & Wale". He issued a number of catalogues in 1877 and 1878 (Listed as a Philosophical Instrument Maker). In 1879 he invented his "New Working Microscope" featuring the concentric arm (radial or Waleís limb). His early radial arm stands usually have the signature of George Wale, New Jersey. By 1880, Wale moved to New York and became associated with The Industrial Publication Company.

Across the Atlantic a number of English firms took up the idea of the Radial Arm microscope. Swift was one of the most successful and long standing makers. However, it was the firm of Ross & Co. that produced by far the most elaborate and desirable example. In 1870, following the death of Thomas Ross, Francis Wenham was persuaded to join the firm as adviser (Ross & Co.) (1870-1882). He redesigned the Ross bar-limb with the Jackson Limb and eventually used the Zentmayer horizontal lever with its second slide as the fine adjustment (Ross-Zentmayer). Wenham also designed the famous Ross Radial Microscope of 1882 (Hartley, 1993). In 1875 he had written an article on the benefits of oblique illumination with high power objectives. However, it was in 1882 that the magnificent Ross Radial Arm microscope appeared.. When it was first an-

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nounced, Ross refereed to it as the "Wenham Universal Inclining and Rotating Microscope" (RMS, 1882). The principle behind the design was that from any inclined or lateral position the illumination would always reach the object. It also featured Wenham's V-Slide fine adjustment. The V-slide was quickly replaced by Schroeder's differential-screw fine adjustment (Mayall). This was quite difficult to manufacture and Ross soon adopted a direct acting screw which became the final form (Mayall). A complete description of the Ross Radial will be provided below. In 1885, Henri van Heurck purchased a Ross Radial in order to show his new method of illumination featuring incandescent electric light at the Universal Exhibition at Antwerp (1885).

During 1886, Bausch & Lomb put on the market their student concentric or radial arm microscope. It was patterned after the Wale's limb stand. The firm of B&L was to have bought out G. Wale (1880) and by 1885 were making the B&L "American Concentric Microscope"(Padgitt). Contemporary records state that the concentric patent and the Wale business were acquired by B&L in 1880, however, B&L has been unable to confirm this from their own records (RMS, 1964, pp.125). The American Concentric Microscope was their large and now very rare instrument.

In 1893, the World's Columbian Exposition held at Jackson Park, Chicago featured a number of microscope manufacturers. This included Bausch & Lomb with some 40 instruments and quite prominent was their Radial Arm. After the turn of the Century the popularity of the radial arm seems to have declined. However, Swift still made at least two models, one being very substantial. This pattern was very difficult to manufacture and with the advent of the inclining and high quality binocular stands the radial was doomed.

The following is a description of the Wenham Radial Microscope-stand as provided by the Ross Catalogue. It attempts to define the various mechanical motions available in the new design.

Ross & Co. Catalogue
The Ross Radial Microscope has been devised for the special purpose of obtaining the maximum range of oblique illumination in all directions, which is attained by causing all the movements of inclination and rotation to radiate from the object as a common center. Seven radial motions are here combined with the new design:

The inclination of the whole instrument (except the base) from the perpendicular to the horizontal, by means of a sector sliding between jaws attached to the upper base-plate.

The lateral inclination of the limb to either side, carrying with it the tail-piece, &c., or of the limb and stage only, the tail-piece being clamped to the sector. With the sector clamped at the usual angle, this latter arrangement furnishes very ready and practical means of varying the illumination in altitude form 0 to nearly 90 degrees, either direct from the mirror or combined with a low-power condenser, the Hemispherical Illuminator; or Wenham's Semi-disc illuminator.

The rotation of the whole instrument on the lower base-plate on an axis which is the prolongation of the optic axis when the instrument is vertical, as shown in the figure.

The swinging of the tail-piece suspended on an axis, the center line of which passes through the object on the stage, cutting the optic axis at right angles.

The complete rotation of the mechanical stage upon the optic axis, secured by the milled-heads for the rectangular motions being placed on a vertical axis on the stage and acting entirely within the circumference. This stage can be easily removed, and may be replaced by a glass or other stage.

The complete rotation of the mechanical sub-stage upon the optic axis

The partial rotation of the lamp, &c., in azimuth, upon an arm pivoted in the center of the lower base-plate.

The Coarse adjustment is on the Jackson principle, and is worked by diagonal rack and spiral pinion.

Frictionless fine adjustment (Patent). An entirely new construction of fine adjustment is applied to this microscope, consisting of a V-slide acted upon by two 'snail'-cams, between the edges of which revolves a steel roller, forming the axis of and actuated by a large milled-head passing longitudinally through the slide of the coarse adjustment, and projecting slightly on either side in a convenient position for work. The V-slide is fitted within the body-tube, carries at its lower end the nose-piece, and is pressed downwards by a spiral spring, against which it is moved by the revolution of the cams. By this system an extremely sensitive and direct focussing is obtained, which will compare favorably with any hitherto applied to the Jackson model of Microscope.

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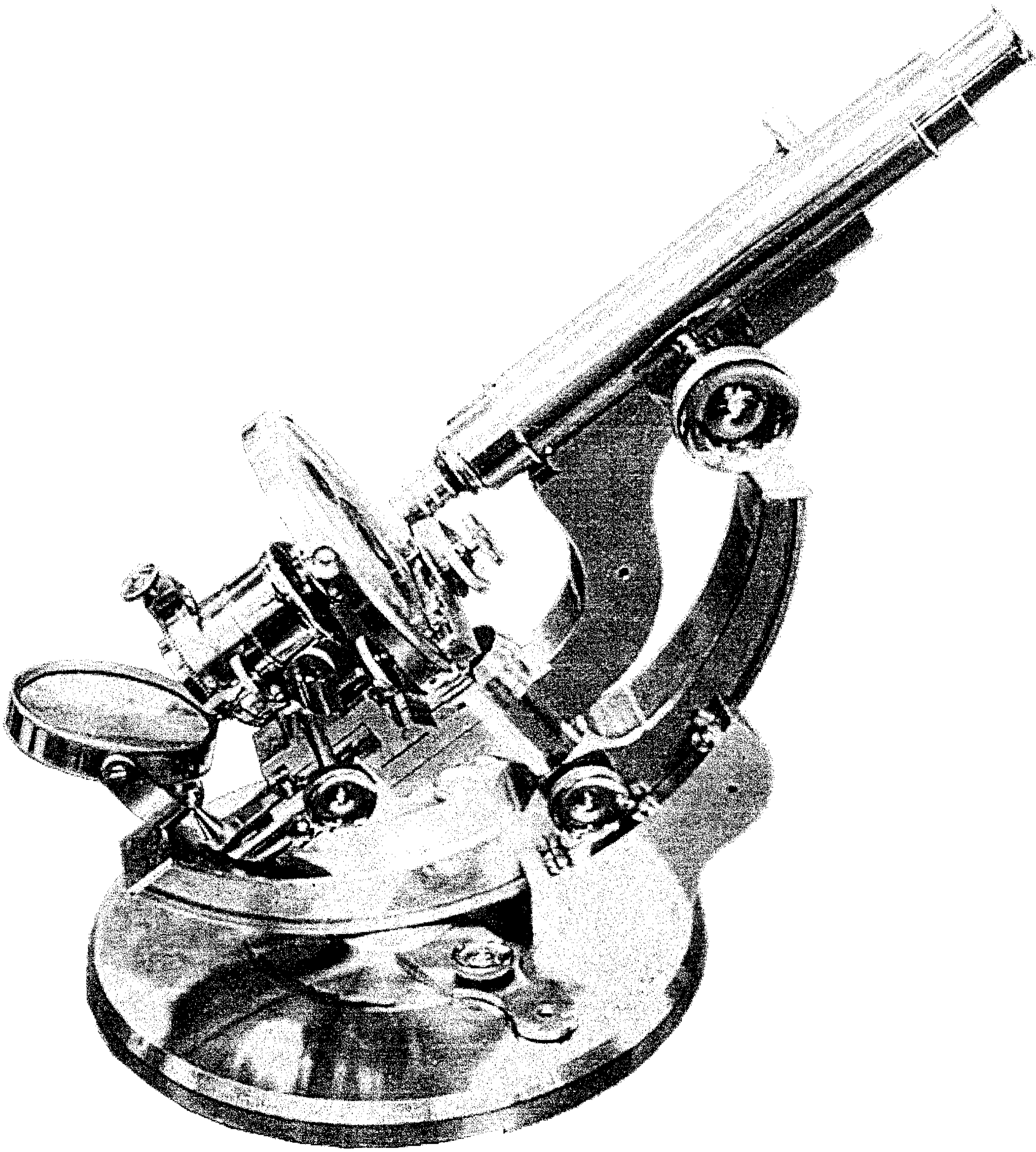

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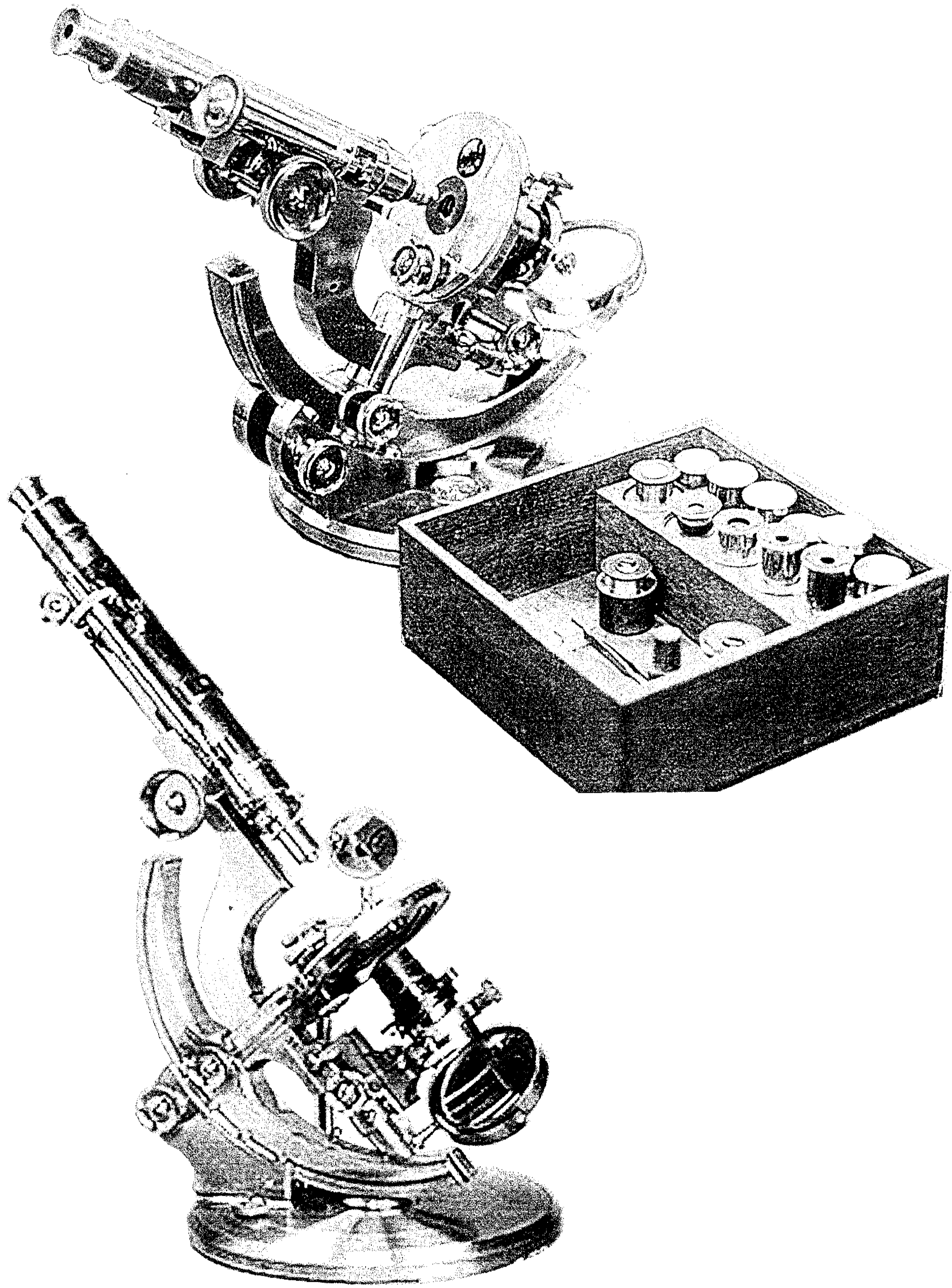

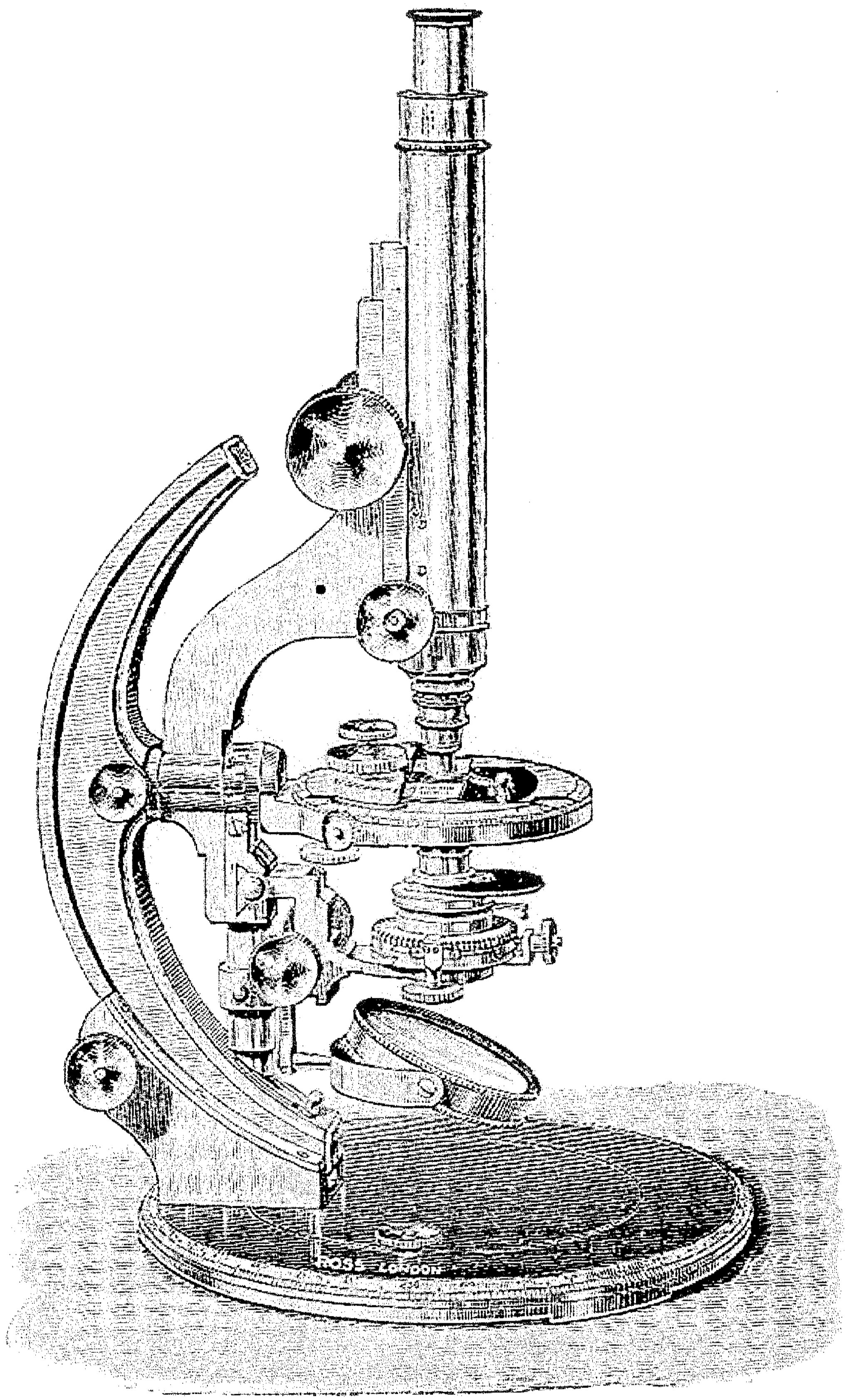

Wenham's New Patent Microscope.

Unusual Zeiss Microscope Objectives

Nicholas Grossman, Rockville, Maryland

Reprinted from the Zeiss Historica, The Journal of the Zeiss Historica Society. Vol. 7. No. 1. Spring 1985
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The English Connection

The microscopes of the early nineteenth century reflected the talent and creativity of individual craftsmen. Standardization and the concept of interchangeability were not part of this period. Thus the demise of a craftsman left the microscope owner with little interchangeability for objective threads and also for the slide-in sleeve eyepieces. The Royal Microscopical Society of London finally decreed a "standard" objective thread - naturally called the "Society Thread". It followed the then-popular Whitworth thread form with 36 threads per inch, and about 0.796 inch outside diameter. A standard sleeve diameter was also established. These dimensions are still in use today - a pretty good record for durability.

The English microscopes of the nineteenth century were tall instruments in comparison with later microscopes. They used long tubes, with 10 inches being about the most popular length. Some boasted tubes two feet long!

One technical advantage of the long tube was that long focal length objectives are composed of flatter glass elements and thus are easier and cheaper to manufacture. (Without going into optical theory - think of the telephoto lens structure of a modern 35 mm. camera and compare that with a wide-angle lens for the same camera .)

Zeiss and Abbe started the scientific microscope design concept. This covered the theory of image formation, lens design and fabrication, glass formulation, and the mechanical dimensions of the complete microscope. Zeiss and Abbe felt that a shorter microscope tube had numerous advantages (again the details are outside the scope of this short article). They were not afraid to tackle the consequently more complex objective construction and standardized on a 160 mm. mechanical tube length. (See Fig. I to clarify the nomenclature.) It should be noted in passing that, by the twentieth century, most microscope makers adopted Zeiss' lead and standardized on 160 mm. or 170 mm. tube length for biological microscopes.

After the introduction of the Zeiss apochromats in 1886, Zeiss wanted to penetrate the English microscope market. Interchangeability of the microscope threads was no longer an obstacle. However, attaching a highly touted apochromat designed for the 160 mm. tube length to a long English microscope tube would have negated most of the claimed superiority for the Zeiss optics.

Zeiss decided to design and manufacture special apochromatic microscope objectives specifically for the English market. These objectives were designed for the 250 mm. tube length (about 10 inches long). This writer could not track down the exact release date for these

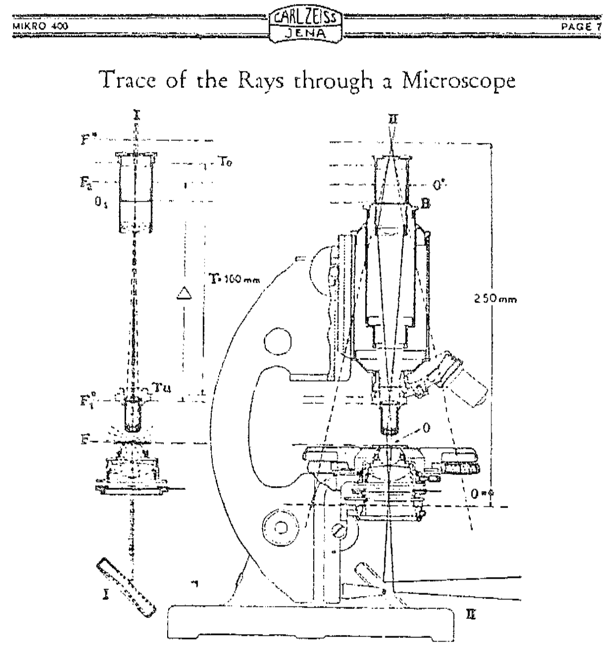


Figure 1. Catalog page shows 160 mm. tube length.

special objectives. But the following information may help to bracket the period. The 1891 Zeiss microscope catalog lists the following dry apochromatic objectives made for the 250 mm. long English tubes: 24 mm., 12 mm., and 6 mm. focal lengths, providing approximately 10x, 20x, and 40x objective magnifications respectively.

Subsequent catalogs carried this listing (see fig. 2 copied from the 1902 catalog). The 1913 catalog still mentions the special English objectives, but without the details previously provided.

It seems that after World War I, the listing was dropped from the production line - probably because by that time the English manufacturers also adopted the shorter tube lengths.

The author has a sample of the 12 mm. and 6 mm. objectives made for the long English tubes - and obtained a 4 mm. focal length apochromatic objective with cover glass thickness adjustment collar also marked for the 250 mm. tube length. It is not clear from the lack of catalog listings whether the 4 mm. was a custom order, or if it slipped by the catalogers. Figs. 3 and 4 illustrate these special objectives

Zoom Objectives

The microscope objective can be considered as a specialized lens that projects a magnified image of the object into the focal plane of the eyepiece located at the top of the microscope tube (refer to fig. I again). The effective focal length of the objective determines the primary magnification of the microscope. Magnification is varied by changing the objectives, the eyepieces, or both.

A desire to vary the instrument's magnification without changing optics led Zeiss to pioneering development of a variable focal length microscope objective. Zeiss used small and capital letters to identify specific objectives, and this variable magnification objective was designated "a*". The 1889 catalog listed this model (I could not locate earlier catalogs) and it was carried at least through the 1937 edition.

List of the Apochromatic Objectives.

	Description: Equivalent Focus mm	Description: Numerical Aperture	Initial Magnification	Combined with Compens. Eye-piece 4, Tube-length 160 mm (about 6 1/2 in.): Free Working Distance mm	Combined with Compens. Eye-piece 4, Tube-length 160 mm (about 6 1/2 in.): Diameter of visible area of object mm	Prices Marks	Code-words
Dry Series	16	0.30	15.5	5	2	80.—	Pacato
	8	0.65	31	1.0	1	100.—	Pacetor
	4	0.95	63	0.2	0.45	140.—	Pacer
	3	0.95	83	0.15	0.35	160.—	Paciencia
Water Immersion	2.5	1.25	100	0.13	0.25	250.—	Pacifleur
Homogeneous Immersion	3	1.30	83	0.16	0.35	300.—	Paclar
	3	1.40	83	0.16	0.35	400.—	Padilla
	2	1.30	125	0.14	0.25	300.—	Padrastro
	2	1.40	125	0.14	0.25	400.—	Padre
	1.5	1.30	167	0.09	0.20	350.—	Padrino

Figure 2. Objectives available in the 1902 catalog.

The 1895 catalog gives the following description: "Objective a* consists of two achromatic lenses combined after a formula peculiar to ourselves. By means of a ring rotating like a correction collar, the distance between the two lenses can be varied, whereby, using one of the lower eyepieces, the magnification is variable in the proportion from about 1 to 2". The technical specification gave the equivalent focal length as 38 to 26 mm.

It seems that the earliest variable-magnification lens commercially produced was the Zeiss a* microscope objective. The term "zoom lens" was not coined until after the advent of television, but this model was probably the first zoom lens. (Zeiss introduced a variable-magnification hand telescope in the 1920's - but that instrument used a different optical principle).

After World War 11, Zeiss Oberkochen again marketed a highly refined version of this concept. In the booklet "Optical Systems for the Microscope" (various editions in the 1960's and 1970's) it is described under the heading of special-purpose objectives for the normal transmitted-light microscope: Planachromat, 1.6-5.0 magnification, Catalog number 46 20 13. Note that Zeiss increased the zoom range to about 1 to 3, and used a flat-field design. Fig. 5. illustrates two examples of the a* objective

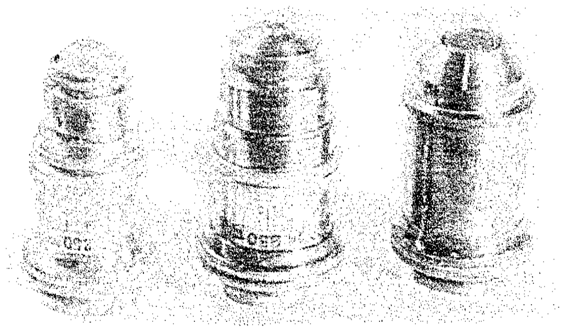


Figure 3. 4 mm., 6 mm., and 12 mm. objectives.

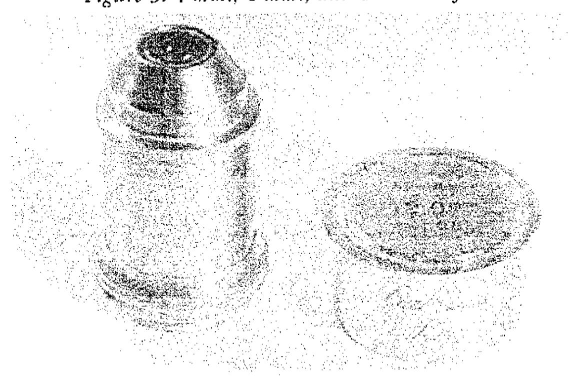


Figure 4. 12 mm. objective for the 250 mm. tube.

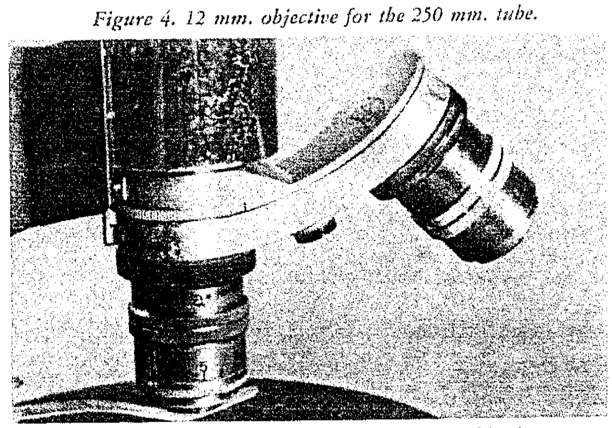


Figure 5. Two variable magnification a objectives.*

Unit Magnification

One of the first questions usually asked is "What is the power of your microscope?" Imagine an answer: it does not magnify at all! While this extreme case does not occur to my best knowledge Zeiss Oberkochen did produce a highly specialized microscope objective with a low power eyepiece, whose total magnification can be as low as 5x, lower than the magnification produced by most pocket magnifiers.

This objective was also described in the literature mentioned above, again under the listing of special purpose objectives Catalog number 46 2010, Planachromat Ix, focal length 134.7 mm. Used with the 160 mm. mechanical tube length, it managed to shorten the objective's physical dimension - just as a true telephoto lens has a shorter tube length than focal length. This objective was not parfocal with the regular objectives, and had to be used with obvious care. Fig. 6 shows such an objective along with the two conventional objectives.

Done With Mirrors

Optical instruments use lenses or mirrors - or a combination of the two to produce images. The process using lenses is called "refraction" (Latin root means "breaking", or "dioptric" meaning "see through" in Greek. For the process using mirrors the English language adopted the Latin root reflection the Greek term being "catoptric". The debate over the merits of the two types of image forming systems spans the whole history of optical instrument making.

The major advantage of the mirror system is the absence of chromatic aberration. It is then an obvious idea to use mirrors as the image-forming elements in a microscope objective. Indeed, this idea was put into practice. An early reference is found to "F.H. Smith's Reflecting Microscope" in the book *The Microscope and Its Revelations* by Carpenter, 7th edition, 1891.

The concept was again revived in Jena after World War II, probably stimulated by the success of the compact mirror-lens combination telescopes, designated as catadioptric lenses. These mirror microscope objectives are described in *Jena Review*, 1964, Special Fair Issue.

Subsequent sales leaflets from Jena featured these mirror objectives and stated. "We certainly left the beaten track in more than one respect when creating this novel type of objective. As a lens-mirror system, this new creation of ours affords a flattening of the image field and a chromatic correction which fully justifies calling it a Plane-Field Apochromat. The most outstanding feature of the new objective is its large working distance." (See Fig. 7.)

Fig. 8 shows a 20x all-mirror objective—a true catoptric device. The 63x objective (right) is composed of mirrors and lenses— actually a catadioptric device.

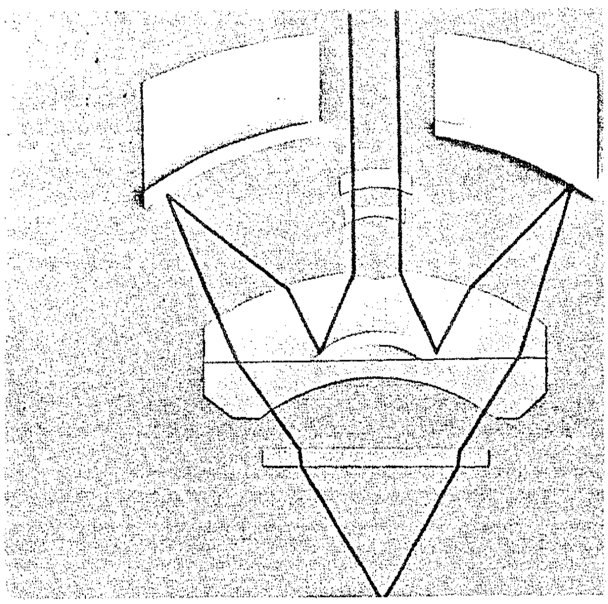


Figure 7. Diagram of Zeiss catadioptric objective.

Figure 6. Planachromat IX objective.

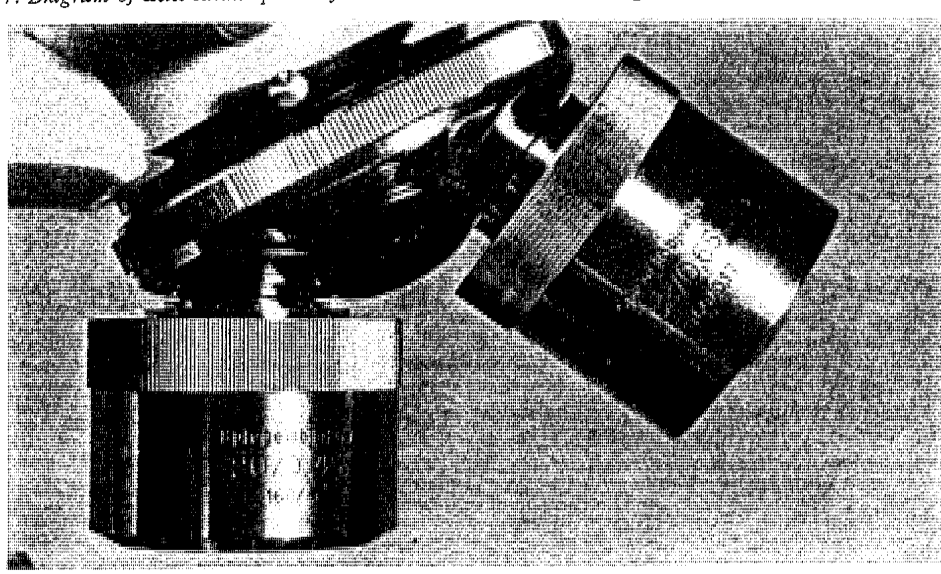


Figure 8. 20X (all mirror) and 63X (lens and mirror) objectives.

WORKSHOP of the Microscopical Society of Southern California

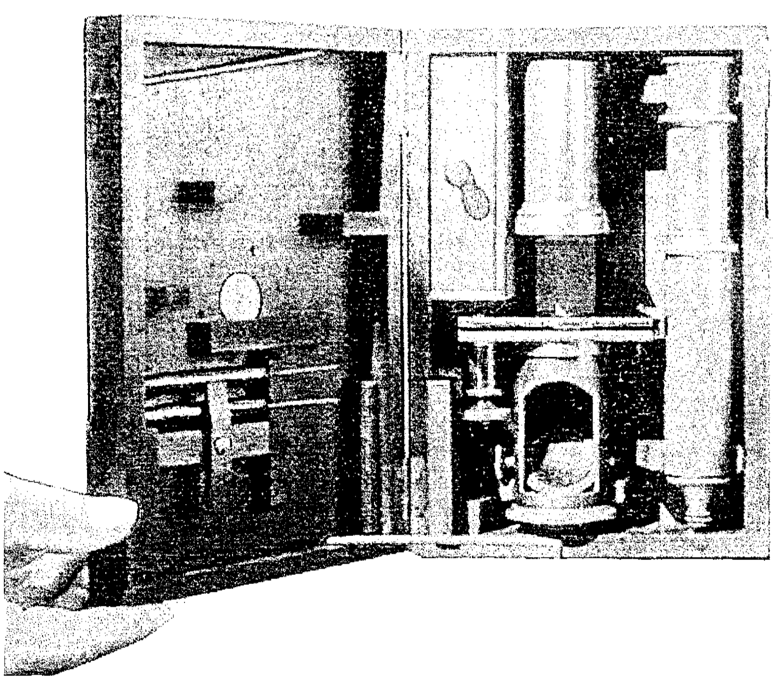
by: George G. Vitt, Jr.
Date: Saturday, 11 March 2000
Location: Ernie Meadows' residence

1. **Jim Solliday** announced that, at a forthcoming meeting, Ron Morris will be taking portrait photos of the members which will appear in a future MSSC Journal. Both George Vitt and Jim urged members to write their profiles as well as articles for publication. There was a general discussion on the Journal.

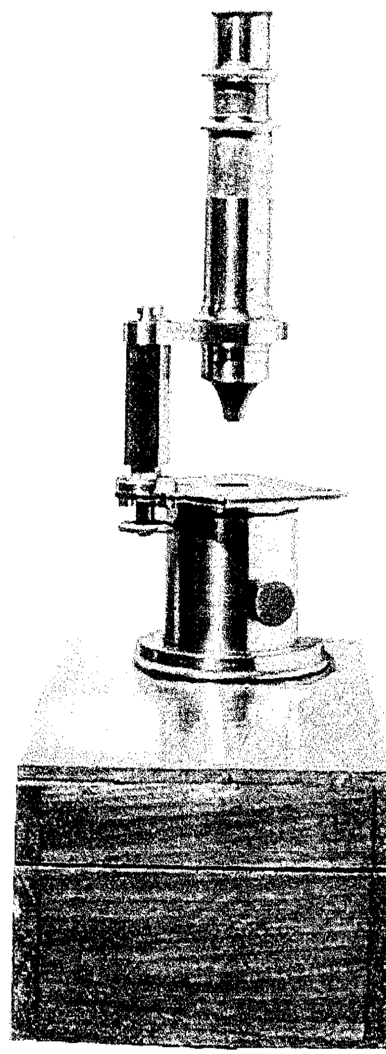
2. **George Vitt** related the usefulness of email as it affects the efficient gathering of material for the Journal, citing the an example where he quickly received via email, within two hours of it being requested, both text and photos for the profile of Australian member, Mike Dingley. There was a general discussion on the Nikon 950 digital camera and the merits of recording data on CDs, which seems to be the most economical method for backup and archiving of data.

3. **Jim Solliday** showed a cased Oberhauser drum type microscope, patterned after Fraunhofer (see photo). The unit can be mounted on its small walnut case, whose lid can be raised and locked at a 30 degree angle off the horizontal. Such microscopes were made in quantity by Hartnach.

Jim then showed a cased c.1854-56 Nachet compound microscope of the drum type (see photo). This early Nachet design is unusual in that it has a fine focus mechanism on the bottom of the pillar, and has the ability to pivot the tube on a vertical axis, to make



Oberhauser Drum Type



Nachet

easier the process of dissection. This design was the precursor to the later Continental models where the 'drum' was abandoned so that the recently 'discovered' oblique illumination could be implemented.

4. **Allen Bishop** showed Ken Gregory's early version, c.1880s, of the Zeiss "Stand VI" (see photo) which has sliding tube focus.

He then showed Alan de Haas' Spencer Mod. 40 Polarizing microscope which he had restored to fine condition (see photo). George Vitt started a general discussion on the two lenses contained within the body tube or Spencer Pol. microscopes whose purpose is to correct for tube length (due to the presence of the Ahrens prism analyzer), and astigmatism correction. Such correction lenses were first used by Fuess, then B&L and then by Spencer.

Allen then showed a fine portable, cased Zeiss "L stand" made in 1953, obtained from a German source via ebay, and which he had restored forAlan de Haas (see photo). The unit is a "first quality" Zeiss product, and the ID is engraved to this effect. The extremely well crafted portable case has an "O" ring sealing gasket running around the rim of the lid. There was a brief discussion as to the risks of damage one faces in shipments from abroad. It seems that most sellers pay no attention to any packing instructions that the buyer may specify.

5. **Dave Hirsch** showed a very fine book, *Science Preserved* by Mary Holbrook, London HMSO, obtainable from Barnes & Noble for $29.

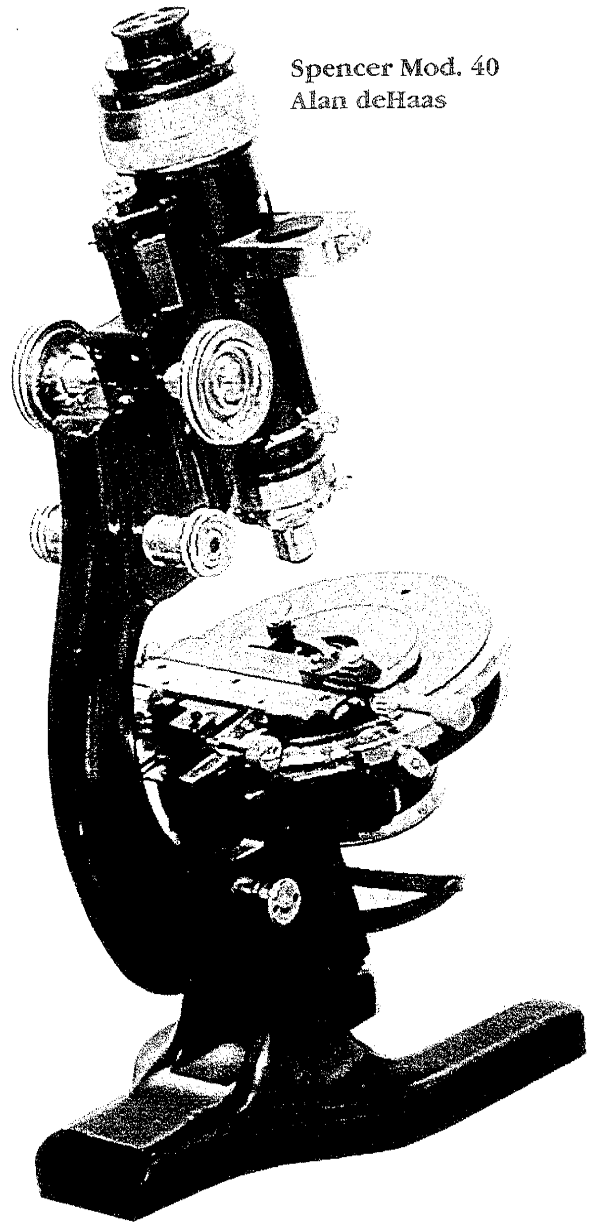
Dave then showed a c.1880 mahogany cased dissecting microscope with helical tube focus, which he had obtained in Scotland. It resembles Austrian and Italian microscopes of the period and has a square, solid base.

6. **Izzy Lieberman** related that Ilford (UK) has recently introduced dye-based archival inks for ink-jet printers. This is a long awaited development because previous dye-based inks fade. George Vitt noted that recent issues of *Shutterbug* magazine have articles on digital photography where other manufacturers of archival inks are mentioned.

There was a coffee/conversation break at 11:25am.

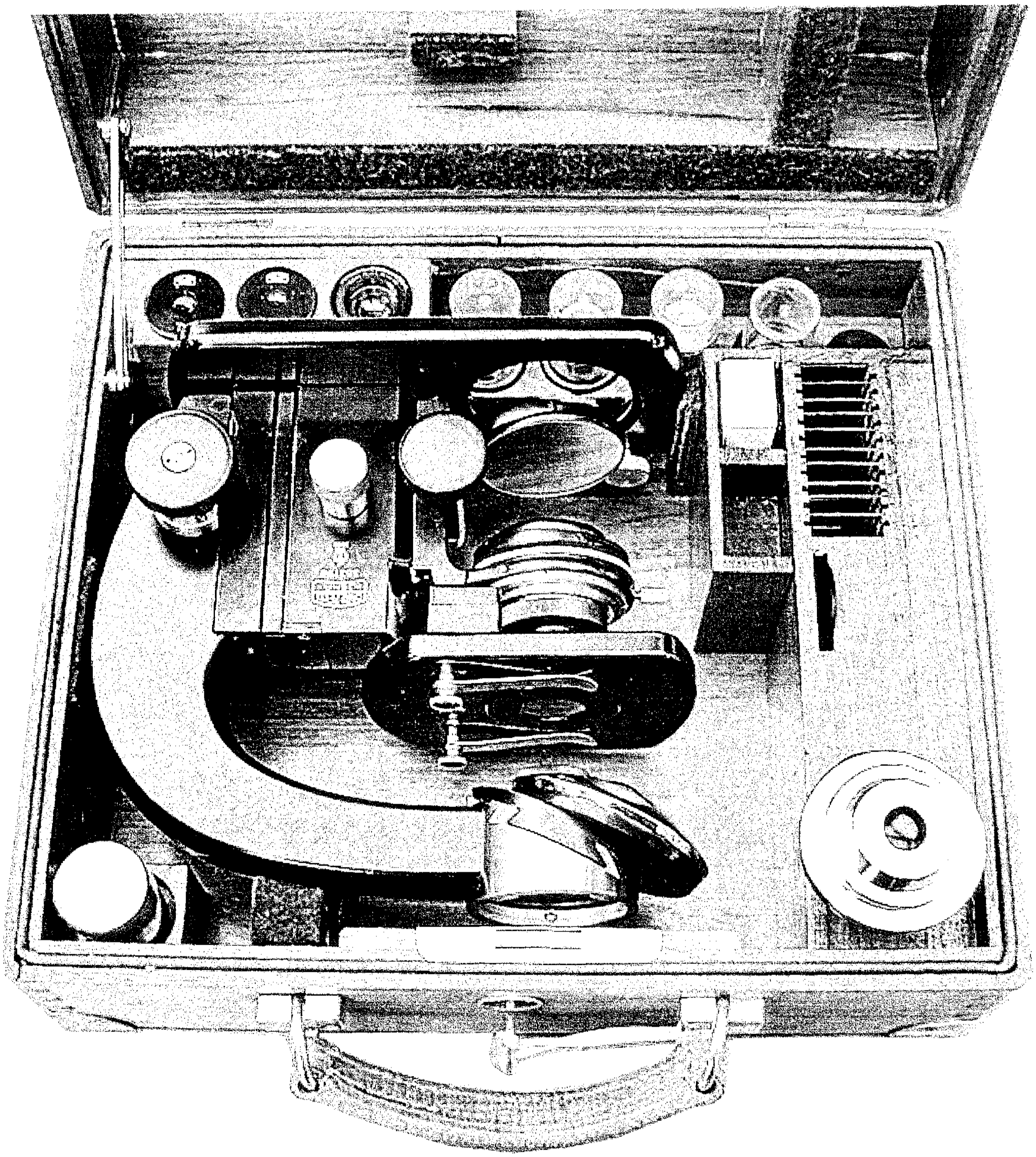
7. **Dario Solares** displayed and described an adapter he had made for using Minolta cameras on his Nikon PFX photomicrographic unit (see photo). Dario has done an excellent job.

8. **Jack Levy** showed a fiber optics illumination unit, that he had designed and constructed, in Ernie Meadows' amazing workshop, for photographing small-to-medium size living subjects such as insects. Supported on adjustable Bogen "Magic Arms", the quartz-halogen lamp power supply and its associated pair of flexible fiber optic arms can be slid fore & aft in the ways of the machined aluminum base, enabling precise alignment of the illumination on the subject. There was a general discussion on the NA of fiber optic light guides and the positioning of the quartz-halogen reflector lamp for maximum transfer of light into the light guide. Alan de Haas informed us that the Oleson Co. (on Ivar, near Sunset Blvd.) has available free swatch books of color filters (1"x2") with spectral transmission curves for each filter. Such material is perfect for making Rheinberg filters, for example.



Spencer Mod. 40
Alan deHaas

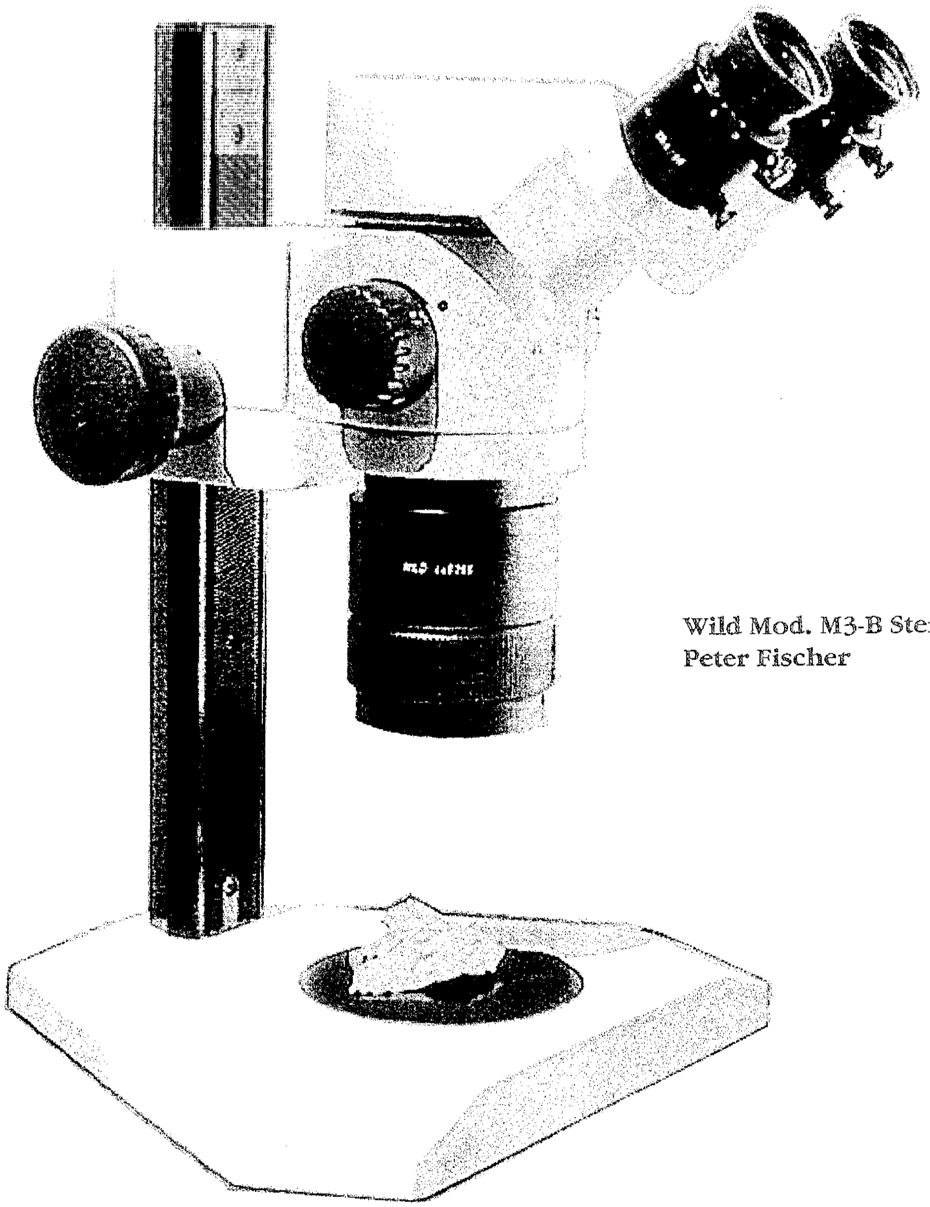
9. **Ed Jones** gave away many Zip-bagged samples of diatoms, and also stoppered glass vials of black sand which he had recently obtained from the tailings of



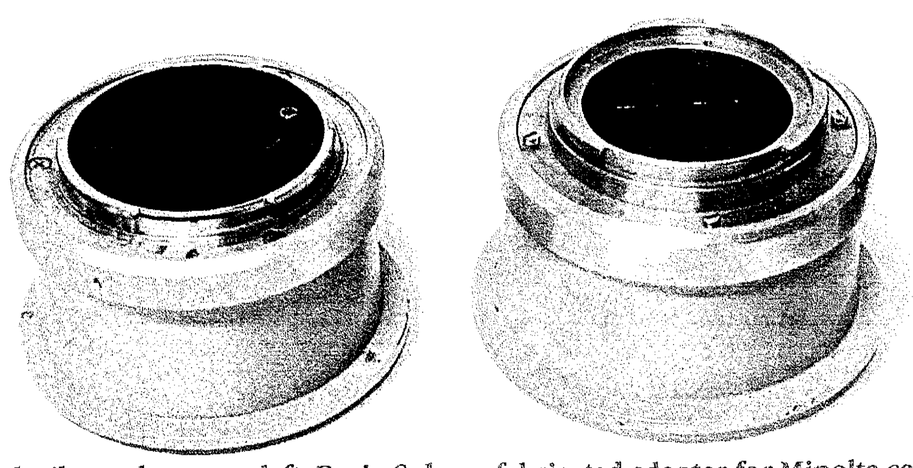
Portable Cased Zeiss "Lr" Stand, 1953
Allen Bishop

old mining operations at Yosemite. Ed related his attendance in Reno, Nevada, at the American Academy of Forensic Scientists during which courses/workshops were conducted on the identification of color and fibers.

10. **Peter Fischer** displayed a mint Wild Mod. M3-B stereo microscope (see photo). It features a Galilean 3-step magnification changer for magnifications between 6.4x and 40x. It features low-slung surgical operating high eyepoint eyepieces with a locking diopter adjustment on each eyepiece. The objective on this microscope is something to behold! It is a Plan-Apo 1x objective, which weighs about 1 Kg and costs about $3.00/gram! This is the finest objective that has ever been made for this type of stereo microscope. The M3-B was made in this configuration only with a non-round post. Peter related that the mainland Chinese are now making copies of the M-5 Wild which



Wild Mod. M3-B Stereo
Peter Fischer



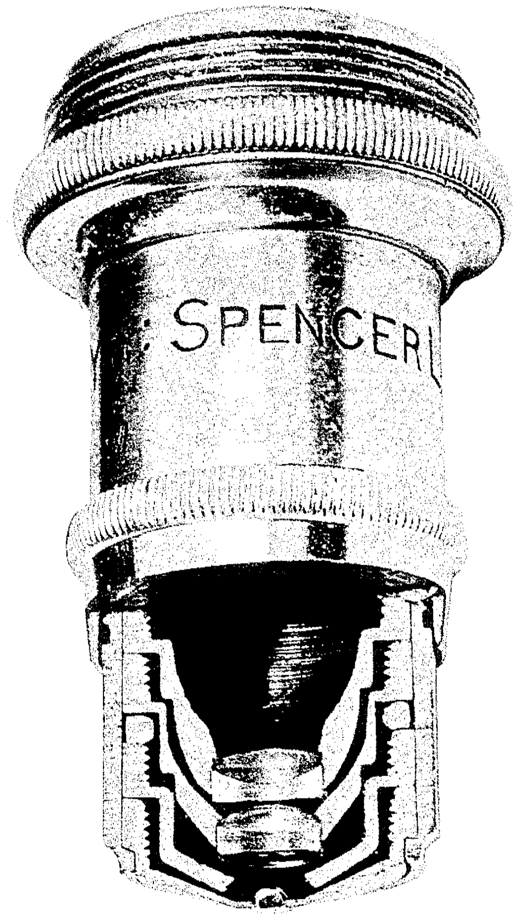
Standard Nikon adapter on left, Dario Solares fabricated adapter for Minolta camera to Nikon PFX photographic unit on right..

had been designed by Zeiss before WWII and that the Galilean approach appeared in the 1950s. There followed a discussion on the products of Meopta (Czechoslovakia) and the excellent Polish PZO microscopical and precision products.

11. John Fedel cited a Los Angeles Times article on Russians using algae scum as a source of fuel.

We all thank **Mr.& Mrs Ernie Meadows** for their exemplary hospitality to our Workshops and also to Pete Teti for obtaining and setting up all the tasty goodies and refreshments, without which the workshop could not sustain itself!

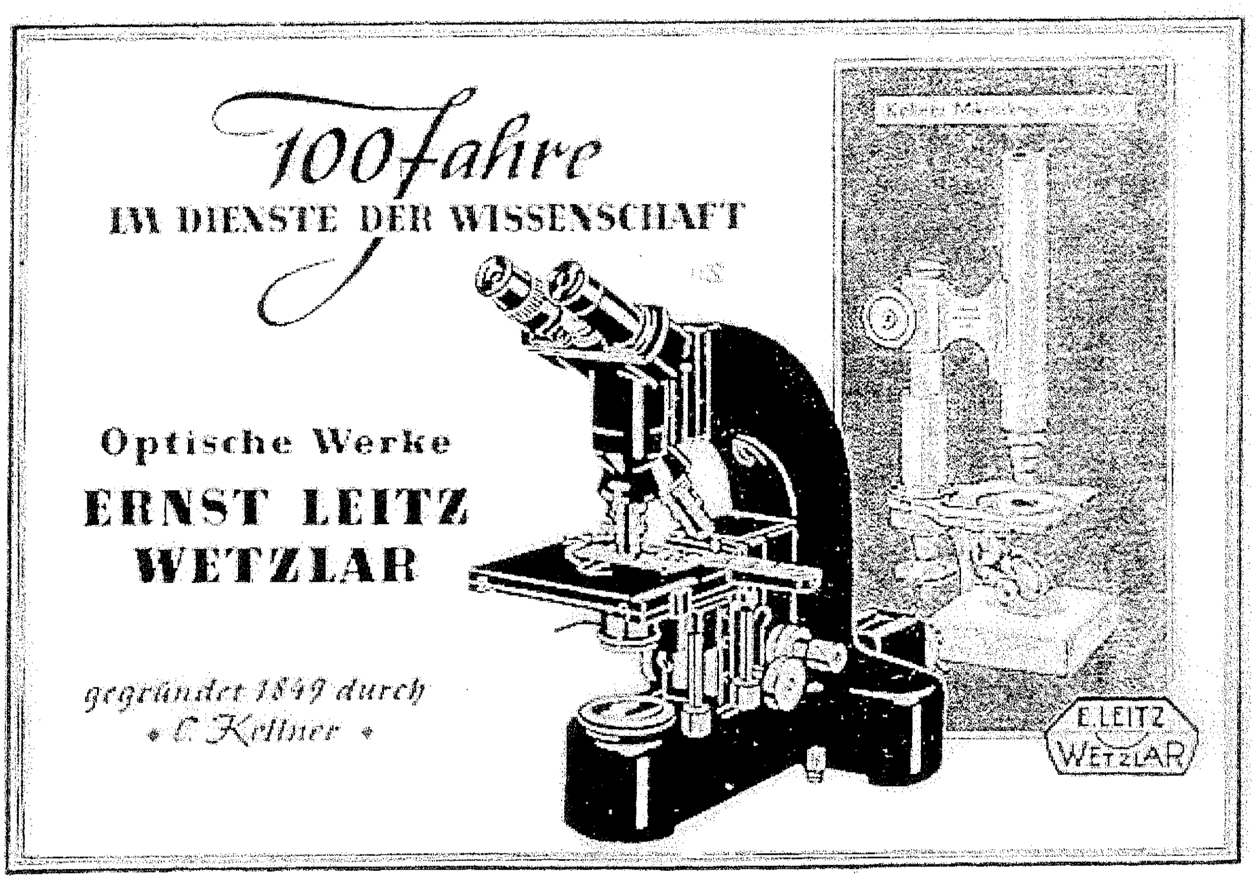
Photo credits. Photos by George G. Vitt Jr.
Equipment: Nikon 950 digital camera, Adobe Photoshop 4 and various MacIntosh computers.

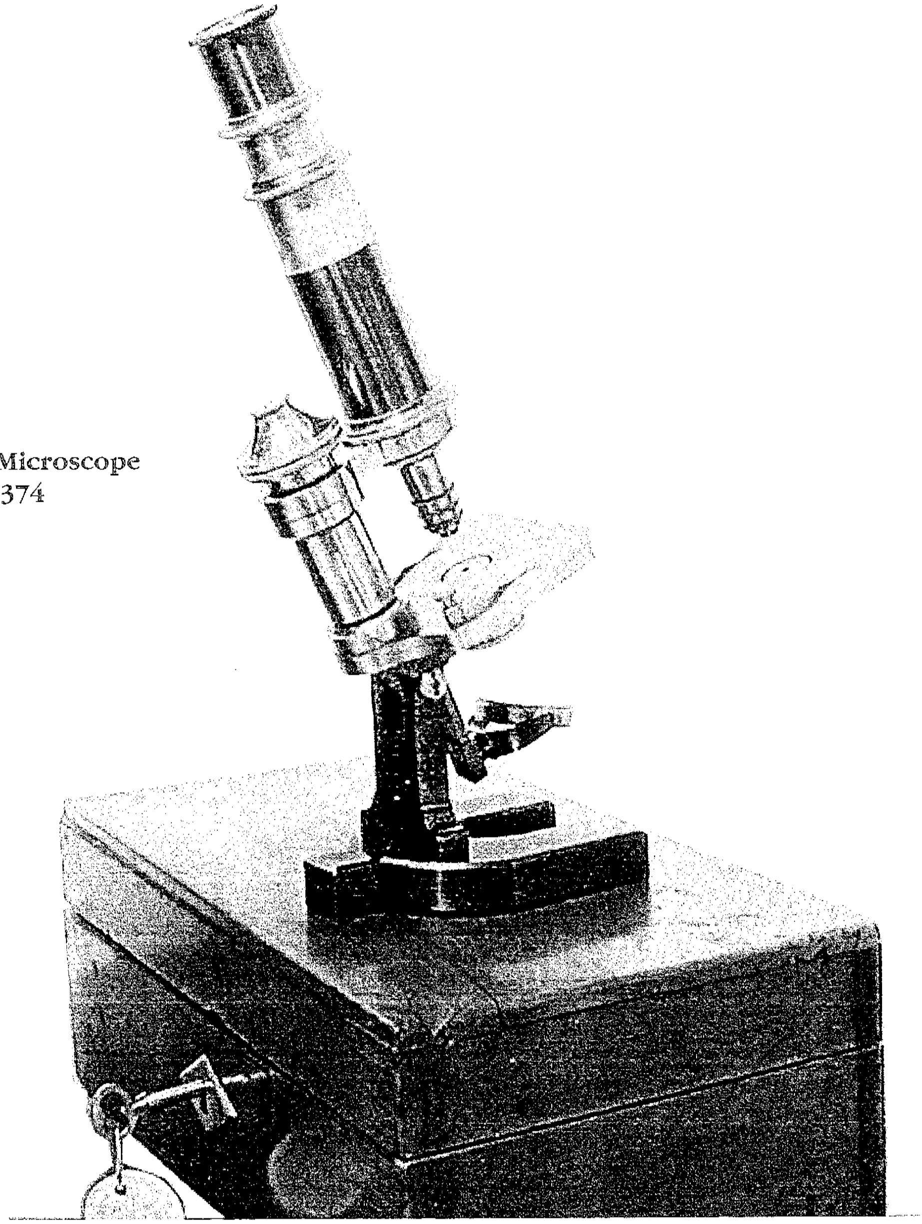


Cutaway Spencer oil immersion objective. These were often provided by manufacturers for educational purposes.

J.M Solliday

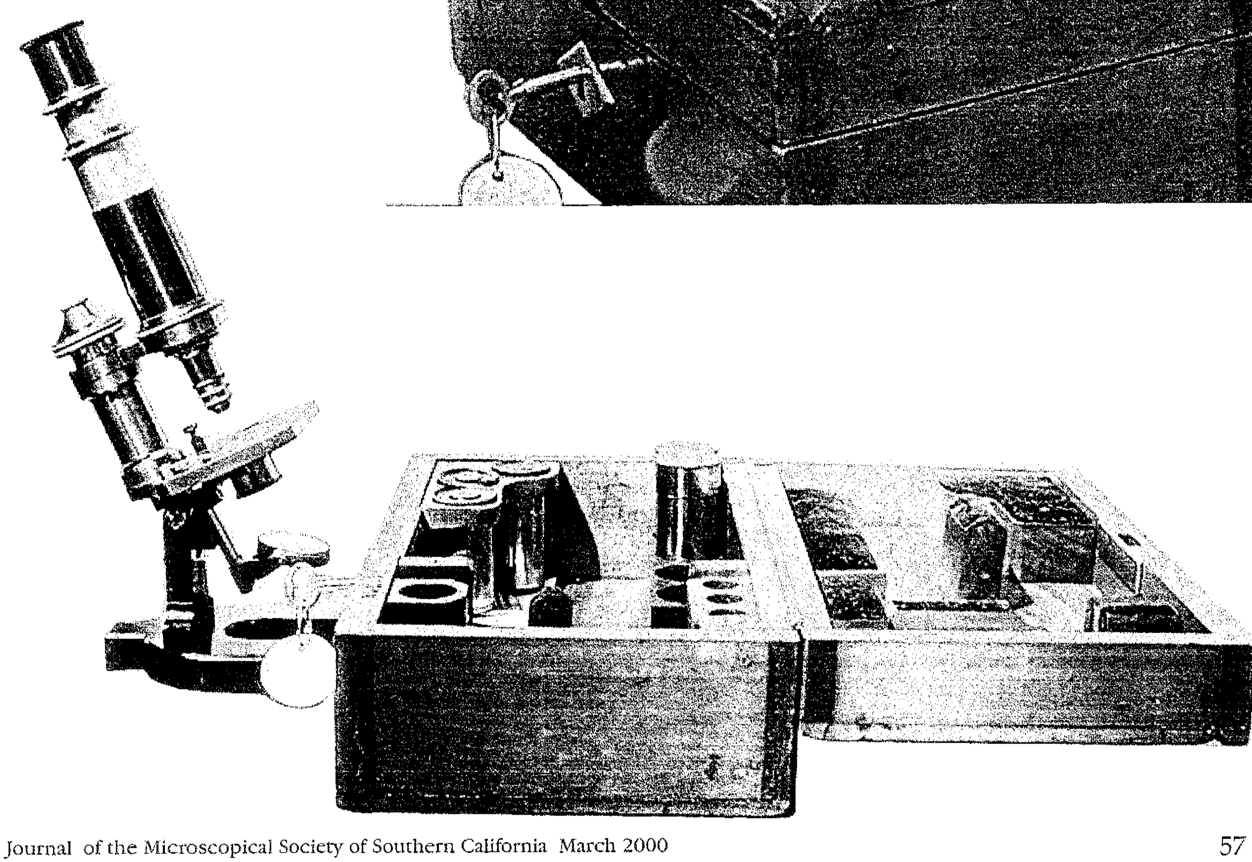
Leitz advertisement card 1939-40



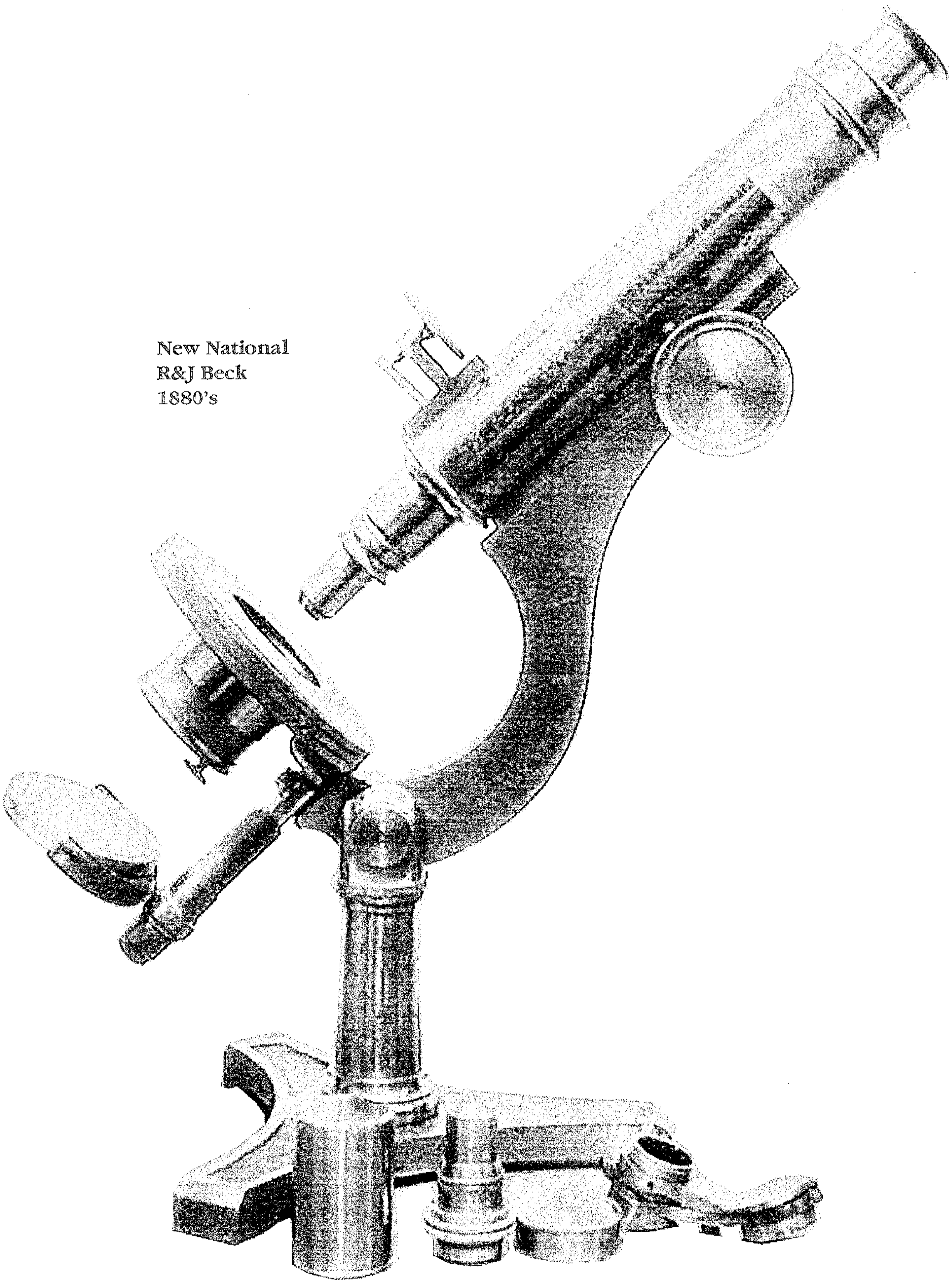


Zeiss Stand No. VI
Small Continental Microscope
Carl Zeiss Jena #13374
Circa 1890

Ken Gregory



New National
R&J Beck
1880's



MICROSCOPY IN AMERICA
Part I
Directory Listings of Microscopical Societies
Stuart L. Warter

The last quarter of the Ninteenth Century was a period that saw an explosion of interest in Natural History in the United States, and both general and specialized clubs and societies sprang up all across the nation to facilitate the exploration of many aspects of the natural world. Some of the more general organizations undoubtedly included microscopical activities within their purview, but the following is a list of only the specifically designated Microscopical societies culled from the longer lists of all natural history oriented groups listed in six of Samuel Cassino's Naturalists' Directories that span 24 years of this most fascinating period in the development of microscopy in America. Names of officers were given, and are included here for historical interest.

The far flung localities represented are an indication of widespread interest in the subject. Some organizations were associated with educational institutions such as Rutgers University, and others, like McAllister's group, met in members' homes. Some were quite small, and may not have been long lived, appearing and/or disappearing between editions of the directory; others may not have been listed for any of a variety of reasons. Note the lack of turnover among the officers of some of the organizations. Of 135 U.S. and Canadian organizations in the 1878 directory, nine were microscopical (6.7%); in 1882 12 of 172 (7%); in 1884 numbers peaked with 18 of 200 (9%); declining in 1888 to 15 of 161 (8%); and in the 1894 directory, to 13 of 174 organizations (7.5%). By 1905, there were 178 organizations, but only 9 were microscopical (5%).

Membership numbers are too incomplete to gain any meaningful picture of the numbers of people involved, but the 1878 issue contains a cross-index to subject interests of individually listed persons — of 2524 naturalists listed in the U.S. and Canada, 320 (12.7%) indicated microscopy as among their interests. By 1882, numbers of naturalists listed had doubled to an approximate 5040, with no breakdowns provided. In 1884, cross-indexed by state, of 4524 listees, 658 (14.5%) indicated an interest in microscopy — Largest states were New York, 171; Pennsylvania, 64; Massachusetts, 63; Illinois, 47; Ohio, 39; Michigan, 30; California 22, and Indiana 21. In 1888, there were 4667 entries, and in 1894, 6174 naturalists were included, but again no cross-index was provided. In 1905 there were 5408 entries.

Perhaps not too much should be made of these figures, since there is no way to guage the completeness or accuracy of Cassino's Directories, and the number of microscopes sold in this country (both domestic and imported) by the turn of the Century is known to have been many times the number of people who, by these figures (students excluded), could have bought and used them. However, there does seem to be a clear trend of a peak in interest in microscopy about 1884, with a steady decline to the end of the Century, and beyond. Perhaps not coincidentally, the first half of the decade of the '80's was the period in which there existed the largest number of American microscope manufacturers.

California

San Francisco Microscopical Society.

1878. Thurlow Block, 126 Kearny Street. Henry C. Hyde, President. Charles W. Banks, Corresponding Secretary. Cabinet and Library.
1882. Thurlow Block, 126 Kearney St. C. M. Kinney, Pres.; Chas. W. Banks, Cor. Sec. Cabinet and Library.
1884. Rooms, 120 Sutter St., Address Box 2244. C. M. Kinney, Pres.; Chas. W. Banks, Cor. Sec. Cabinet and Library*
1888. Rooms 120 Sutter St., Address Box 2244. E. J. Wickson, Pres.; Dr. C. F. Bates, Cor. Sec. Cabinet and Library.*
1894. Rooms 432 Montgomery St. Address Box 2244. E. J. Wickson, Pres.; A. H. Breckenfield, Cor. Sec. Cabinet and Library.

Canada

Montreal Microscopical Society

Org. 1868.
1894. Chas. T. Wiliams, 785 Craig St., Hon. Sec., Meetings monthly.*
1905. P. W. Richards, Pres., 252 St. James St.; I. G. McKeyon, Hon, Sec'y., Rosemount Ave., Westmount.*

District of Columbia

American Microscopical Society.

1894. Pres., M. D. Ewell, Chicago; V. Pres., Dr. Robert Reyburn, Washington; Sec., Dr. W. H. Seaman, Washington; Treas., C. C. Mellor, Pittsburgh, Pa.; Ex. Com., Dr. J. A. Miller, Buffalo, Prof. E. W. Claypole, of Akron, O., and Dr. J. M. Lamb, Washington. Publishes Proceedings.*

Microscopical Society of Washington.

1894. W. W. Alleger, Cor. Sec.*
1905. Pres., Prof. M. D. Ewell, Chicago; V.-Pres., Dr. Robert Reyburn, Washington.*

Microscopical Society of Washington, D. C.
1905. E.A . Gibbs, M.D., Pres.; W. W. Alleger and Lewis M. Mooers, Secretaries.?

Illinois

State Microscopical Society of Illinois,
1869 Chartered. 263 Wabash Ave., Chicago.
1882. Dr. Lester Curtis, Pres; E. B. Stewart, Cor. Sec. Library and Cabinet.*
1884. Dr. Lester Curtis, Pres.; E. B. Stewart, Cor. Sec. Library and Cabinet.
1905. W. H. Summers, Treas., 3450 Cottage Grove Ave, Chicago, Ill.

Iowa

American Society of Microscopists.
1884. Albert McCalla, Fairfield, Iowa, Pres.; D. S. Kellicott, Buffalo, N.Y., Sec.*

Michigan

The Griffith Club of Microscopy, Detroit.
1882. E. L. Shurley, M.D., Pres.; C. J. Jennings, M.D., Sec.*
1884. W. H. Brearly, Pres.; B.W. Chase, M.D., Sec.*
1888. W. H. Brearly, Pres.; B.W. Chase, M.D., Sec.?
1894. W. H. Brearly, Pres.; B.W. Chase, M.D., Sec.?
1905. W. H. Brearly, Pres.; B.W. Chase, M.D., Sec.?

Michigan Teachers Soc'y of Microscopists.
1894. C. D. McLouth, Ypsilanti, Pres.; Geo. O. Voorhies, Ypsilanti, Sec.*

New Hampshire

Dartmouth Microscopical Club, Hanover.
1878 Prof. E. Phelps, President. Hiram A. Cutting, Secretary.

New Jersey

The American Postal Micro-Cabinet Club. [Founded 1875]
1882. Rev. Sam'l Lockwood, Freehold, N.J., Pres.; Rev. A. B. Hervey, Taunton, Mass., Sec.*

American Postal Microscopical Club
Founded 1875
1884, 1888. Reverend Samuel Lockwood, Freehold, N.J., Pres.; Rev.A. B. Hervey, Taunton, Mass., Sec.*

Camden Microscopical Society.
1882. Prof. C. Henry Cain, Sec.*
1884. A. P. Brown, Pres.; C. Henry Cain, Sec.
New Jersey Microscopical Society, New Brunswick. [Instituted April 17, 1871]
1878. F. C. Van Dyke, President. Reverend Samuel Lockwood, Secretary. (Membership, 48)

New Jersey State Microscopical Society, New Brunswick. Incorporated Feb. 16, 1880.
1882. F. C. Van Dyck, Pres.; Rev. Sam'l Lockwood, Sec. Meets monthly in Geological Hall, Rutgers College.*
1884, 1888. F. C. Van Dyck, Pre.; Rev. Samuel Lockwood, Sec., Freehold, N.J. Meets monthly in Geological Hall, Rutgers College, New Brunswick.*
1894. Rev. Samuel Lockwood, Freehold, N. J., Pres.; Prof. Julius Nelson, New Brunswick, N. J., Sec. Meets Monthly in Geological Hall, Rutgers College, New Brunswick.*
1905. C. L. Speyers, Pres.; J.A. Kelsey, Sec., New Brunswick, N. J. *

New York

American Microscopical Society of City of New York, 12 East 22nd Street.
1882. J. B. Rich, M.D., Pres.; O. G. Mason, Sec.*
1884. J. B. Rich, M.D., Pres.; O. G. Mason, Sec.
1888. J. B. Rich, M.D., Pres.; O. G. Mason, Sec.?
1894. T.H .McAllister, President; O. G. Mason, Sec., Belleview Hospital, New York City. Meetings at residences of members.*
1905. John B. Rich, M.D., Pres.; O. G. Mason, Sec., Bellevue Hosptal, New York City.*

The American Postal Micro-cabinet Club, Troy [Founded 1875]
1878. John Pierce, Providence, R.I., President. Rev. A. B. Hervey, Secretary.

American Postal Microscopical Club.
Founded 1875
1894. Prof. Samuel Lockwood, Freehold, N. J., Pres.; R. Halstead Ward, M.D., Troy, N. Y., Manager.*
1905. R. Halstead Ward, M.D., Pres.; S. G. Shanks, M.D., Albany, N. Y., Sec.*

American Society of Microscopists
1888. Hamilton L. Smith, Geneva, N.Y., Pres.; D. S. Kellicott, Buffalo, N.Y., Sec.

Brooklyn Microscopical Society
Organized, Feb, 1881
1888. Meetings second and fourth Tuesday in the month. Members, 60. G. D. Hiscox, Sec., 435 Greene Ave.*

Buffalo Microscopical Club.
1878. H. R. Hopkins, President. J. W. Ward, Secretary.
1882. H. R. Hopkins, Pres; J. W. Ward, Sec.
1884. Organized 1876. James W. Ward, Pres.; Dr. W. C. Barrett, Sec.
1888. James W. Ward, Pres.; Dr. W. C. Barrett, Sec.?
1894. Organized 1876. F. Park Lewis, Pres.; James W. Ward, Grosvenor Library, Cor. Sec.; Louis A. Bull, Rec. Sec. And Treas. Meetings on the second Tuesday of each month.*

Central New York Microscopical Club, Syracuse, N. Y. Incorporated May 28, 1883
1884. A. Clifford Mercer, M.D., F.R.M.S., Pres.; Newton Hall, 2nd Sec. Over 40 members.*
1888. A. Clifford Mercer, M.D., F.R.M.S., Pres.; Newton Hall, 2nd Sec. Over 40 Members.?
1894. A. Clifford Mercer, M.D., F.R.M.S., Pres.; Newton Hall, 2nd Sec. Over 40 members.?

Dunkirk Microscopical Society.
1878. George. E. Blackburn, President. A. P. Alling, Secretary.
1882. George E. Blackham, M.D., Pres., M. E. C. Shelton, Sec.*
1884. George E. Blackham, Pres.; M. E. C. Shelton, Sec.

Elmira MicroscopicalSociety
1888. Dr. S. O. Gleason, Pres.; Professor Ford, Ph.D., Vice Pres.;Thad. S. Up de Graff, M.D., F.R.M.S., Sec.?

Jamestown Microscopical Society
[Organized 1873]
1878. A. Waterhouse, M.D., President. Charles G. Fuller, Secretary.
1882. A. Waterhouse, M.D., Pres.; Charles G. Fuller, Sec.
1884. A. Waterhouse, M.D., Pres.; Charles G. Fuller, Sec.
[1888. A. Waterhouse, M.D., Pres.; Prof. S. G. Love, Sec.(1st entry, not current)]
1888. A. Waterhouse, M.D., Pres.; S. W. Baker, Sec.* (2nd entry, mislisted under Virginia)

Microscopical Society of Canandaigua, New York.
1882. C. A. Richardson, Pres.; J. H. Jewett, M.D., Sec.*
1884. S. D. Backus, Pres., J. H. Jewett, M.D., Sec.*
1888. Prof. D. Satterthwaite, Pres.; C. T. Mitchell, Sec.*
1894. Rev. N. M. Calhoun, Pres.; Prof. E. H. Eaton, Vice-Pres.; Dr. Chas.T. Mitchell, Sec. and Treas.*

New York Microscopical Society, New York City
[Organized November 14, 1877]
1878. J. D. Hyatt, President.;A. J. Swan, Corresponding Secretary. Annual Meeting third Friday of January. Library. Membership 9.
1882. 64 Madison Ave. R. Hitchcock, Pres; B. Braman, Cor. Sec.*
1884. 64 Madison Ave. B. Braman, Pres.; Jno. L. Wall, 338 6th Ave, N.Y. City, Cor. Sec.*
1888. 64 Madison Ave. Rev. J. L. Zabriski, Pres.; Benjamin Braman, Cor. Sec., 44 E. 30th St., New York, N. Y.*
1905. 64 Madison Ave. Dr. F. D. Skeel, Pres.; Rev. J. L. Zabriskie, Cor. Sec., 28 Regent Place, Flatbush Station, Brooklyn, N.Y.

Pennsylvania
Fairmount Microscopical Society, Philadelphia.
1878. S.Henderson Griffith, President. Wm. C. Stevenson,Jr., Secretary.
Iron City Microscopical Society. [Pittsburgh]
Founded 1880.
1894. Geo. H. Clapp, Pres.; J. F. Henirici, Sec. ("Numbers 90 members and is one of the largest of its kind in the U.S.")

Lehigh Valley Microscopical Society
Founded May 19, 1881
1888. Dr. Fraill Green, Pres.; Dr. Benjamin Clemens, Sec.*

West Chester Microscopical Society.
1882. Dr. Jesse C. Green, Pres.; Harvey Warren, Secretary.
1884. Addison May, Pres.; Harry Warren, Sec.
1888. Prof. G. M. Phillips, Pres.; B. H. Warren, Sec.*

Virginia
Richmond Microscopical Society.
Chartered 1881
1884. Dr. W. R. Weisiger, Pres.; G. A. Peple, Sec.*
1888. Chartered 1880. Dr. Henry Froeling, Pres.; Dr. Wm. Gascoyne, Vice Pres.; G. A. Pepley, Sec.; Thomas Christian,Treas.*
1894. Chartered 1880. Dr. Henry Froeling, Pres.; Dr. Wm. Gascoyne, Vice-Pres.; G. A. Pepley, Sec.; Thomas Christian,Treas.?

* Has been heard from since the last edition of the directory.

? Has not been heard from in three years and will be dropped from the next edition of the directory.

Names not so marked have failed to return the latest "blanks" sent them.

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Editor's Note

This is the first of several late make-up issues that were skipped early in the year 2000 due to a series of events; computer and printer problems, lack of material and lack of free time. All 12 issues should be complete before the end of the year so that the yearly index can be published in December.

Thanks to all those who have taken the time to submit articles and to share their knowledge. It makes the editorial job a pleasure. Most of the respondents have been collectors rather than users. I wonder if this reflects the majority interest of the members or if the collectors are just more profilic writers. If there are more "users" out there, how about some reports on what you are doing.

I wonder also, if there is anyone who can contribute information on current developments in microscopy. Even in light microscopy, there is constant progress as reported in magazines such as Photonics and Biophotonics. Has anyone built their own confocal system or one of the probe type scanning microscopes?

Recently, looking at some electron microscope photos that were shown by an art conservator at the Getty Museum, I was struck by how spectacular even low magnification EM photos were just because of their great depth of field. Several years ago, I saw the results of some German computer software which combined pictures taken at various focal distances to give combined images with great depth of field. The software was expensive. Has anyone developed their own? Perhaps some computer whiz can modify a stock program like Photoshop to combine the in-focus portions of the image at each depth.

Our Society seems to share one trait with many other microscopical groups which is that the membership is getting noticably older with few younger replacements coming along. Some cutting-edge activities like computer software development for microscopical imaging might provide interest for the newer generation as well as push us old fogies to learn something completely different.

Has anyone out there had any success with such programs? Any other ideas to invigorate the Society? If nothing is changed, I fear that the group will be extinct in a very few years. Let me know your thoughts and I will pass them on.

Gaylord Moss