μ • NOTES 2000

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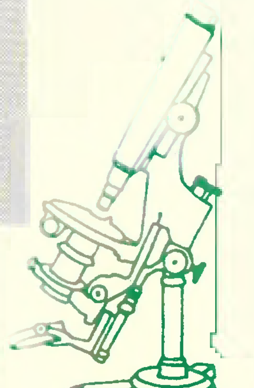

A Publication of the State Microscopical Society of Illinois

EDITORIAL

Once man experienced the images formed by microscopes and telescopes, his imagination led him to comprehend better himself and the world in which he lived. Modern science, as we think we know it , was born.

Man's exploitation of the electromagnetic discoveries dating from the later part of the 19th century up to current times have led to new kinds of microscopes, telescopes, and other devices to produce new kinds of images. Still not content by nature, man's fertile imagination drives him to examine even the very particles used for image formation. In a recent Fermilab lecture, a theoretical physicist talked of particle accelerators as large, high energy microscopes that permit us to see better the stuff of the universe. Where does all this lead us? How does one *really know* that a particular interpretation is *the* valid one.

As long as the scientist knows the rules of the game of science and maintains objectivity and scientific integrity, then images have meaning. Objectivity and scientific integrity are endangered species. If a "scientist" allows his ego, emotions, or beliefs to interfere in experimental design or data interpretation by fabricating physical laws to suit his data, then the images formed are meaningless or fraudulent.

Richard Feynman tells us "the first principle is that you must not fool yourself–and you are the easiest person to fool....After you've not fooled yourself, it's easy not to fool other scientists. You just have to be honest in a conventional way after that."

Two articles in this issue of μ-Notes relate to twists on "image" interpretation. In one (McCrone) we again, in part, learn about the shroud image and also about an "expert" who has little or no scientific training making M$ decisions in art. In another (Palenik) we learn how science can produce a non-fraudulent image.

This year SMSI grants the Émile M. Chamot Award for 1999 to Leo Barish, in part, for image enhancement techniques for the SEM.

Bill C. Mikuska

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μ • NOTES 2000 is a State Microscopical Society of Illinois publication. Its purpose is to provide a form of communication between amateur and professional microscopists, to share ideas and techniques, to ask questions, to obtain answers, to express opinions, and to publish results of experiments and research. It will also provide space for members to print wanted and for-sale notices of microscopical equipment.

All opinions expressed by contributing authors of μ • NOTES 2000 *are the responsibility of the author(s) and do not necessarily reflect the opinion of the State Microscopical Society of Illinois or of the editor.*

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Founded in 1868

Front Covers: *Obverse and Reverse sides of the SMSI Émile M. Chamot Medallion, photographs courtesy of Richard H. Lee.*

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A Protocol for Authentication of Paintings

Walter C. McCrone* and Eugene Markowski†

ABSTRACT

Strictly speaking, it is impossible to authenticate any painting to the extent of naming the artist who produced that object. One can only increase the likelihood thereof. In one celebrated case I felt I had fully proved Manet had indeed painted a particular painting (McCrone 1987) but a "scholar" on whose reaction the art world depends for final acceptance of authenticity only said "someone" could have borrowed Manet's palette one fine day and painted that picture. In a second celebrated case (McCrone 1990) I was even unable to prove to the world that a particular painting was, in fact, a painting and not an artifact produced by other means, e.g., some sort of photographic process.

We can only suggest the ways and means of increasing the likelihood of authenticity in terms of a particular artist's effort. This includes a cooperative approach by a group of experts: experts in the composition and dating of the physical components, that is, pigments, medium, and support, of the painting; scholars trained in art history; investigators able to develop the provenance for that painting; and stylists trained in the study of the attributed artist's painting techniques and style(s). The idea of authenticity extends from authenticity of the painting to authenticity of the experts themselves. They must be proven (and recognized as proven) experts in one or more of the areas of science and scholarship involved in evaluating authenticity.

There is a basic difference between the scientific contribution to the question of authenticity of an object and that of the scholars. Carbon-dating and pigment identification techniques answer a "Yes or No" question. Either they yield a date within the time of an attributed artist or they do not. On the other hand, the contributions of the scholars are still subjective and we often find such experts divided on the subject of authenticity of a given painting.

INTRODUCTION

There is a need for an organization, recognized by the art world, charged with the task of evaluating claims of authenticated-artist paintings. If this panel then states that the evidence of the experts has sufficiently proved the likelihood that a given painting is authentic, then their published conclusion to that effect should be accepted by the art world and that painting is authentic.

The only paintings I would bet my last dollar on being authentic would be *The Last Supper* by Leonardo or Michelangelo's Sistine Chapel murals. Any paintings on canvas, wood or other portable surfaces are impossible for anyone to authenticate with absolute certainty. The experience of the Rembrandt Committee during the past few years in de-authenticating dozens of previously "authentic" Rembrandts is a case in point. We can only build up positive evidence in favor of authenticity until recognized art experts concede a given painting is authentic. Even then the accolade of authenticity is an opinion and many such have been discredited by subsequent experts.

To have a chance of being acknowledged as authentic requires a body of evidence sufficient to reduce doubts to the point they can be ignored. This requires significant convincing evidence based on scientific analyses of the composition of all the painting's components (pigments, medium, and support). Equally important are the opinions of art scholars experienced in the iconographic aspects and style characteristics of the artists' works during different

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periods of their career. And finally, a convincing provenance for that painting must be determined to the degree possible. Unfortunately, it is impossible to prove to the satisfaction of every one that any painting is authentic. A confirmed skeptic can always find some reason any painting cannot be authentic. I can cite two such examples.

I once worked on a painting *The Infanta Marie Marguerite*, a painting alleged to be a lost copy of a Velásquez painting in the Louvre by Edouard Manet about 1860 (McCrone 1987). I found that the pigments not only matched Manet's known palette of that period, but amazingly to me, it contained very rare variants of three of these pigments I had never seen before. They were cobalt blue, lead white, and vermilion; all were known to, and used by Manet but not usually in the variant forms I found in *The Infanta*. The cobalt blue had a uniquely low refractive index. The lead white was lead carbonate, $PbCO_3$, rather than the usual basic lead carbonate, $PbCO_3 \cdot Pb(OH)_2$, and the vermilion was unusually pure in terms of trace elements.

Two paintings "known" to have been painted by Manet about 1860* were then analyzed and found to have these same three variant pigments. In addition, individual lead white pigment crystals from both *The Infanta* and the *Ballet Espagnol* were analyzed quantitatively for trace metals. Both contain the same nine trace metals in closely similar percentages; this can only mean they have a common source. I concluded those three pigments in three different paintings would not be more similar if they had been squeezed from the same tubes of paint. I couldn't imagine any better proof of authenticity of *The Infanta Marie Marguerite* than that; but a scholar whose opinion we sought said only "someone could have borrowed Manet's palette and painted the *Infanta*."

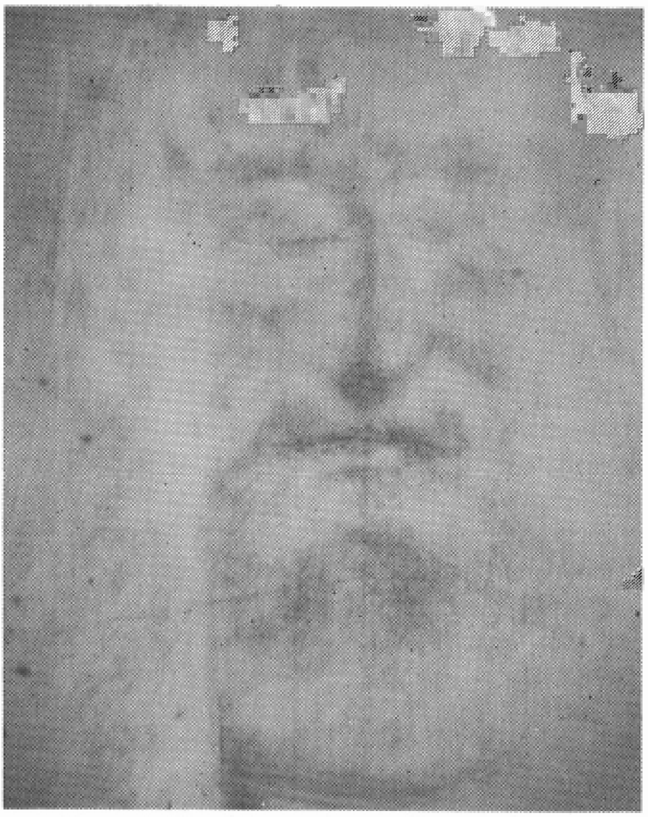

Figure1: Head Image Areas, Shroud of Turin

Another acutely frustrating experience involved a grisaille painting on linen done with red ochre and vermilion pigments in a gelatin medium (McCrone, 1990). There can be no doubt about that conclusion, but a vocal body of dissenters state in no uncertain terms that the image is blood and no pigments are present (see Figure 1). Obviously, opinions are more important than facts in some authenticity studies.

There is a great need for a better understanding of what constitutes authenticity and for a recognized panel of experts capable of evaluating claims of authenticity in order to present a "certificate" of authenticity that would be accepted by the art world. An organization, I believe, well qualified for such a responsibility is IFAR, the International Foundation for Art Research, in Manhattan. They are best known for their *Stolen Art Alert*, a record of stolen art and efforts to recover such. They also

**La Verscuse: La Femme a la Cruche* in the Ordrupgaard Collection, Copenhagen and the *Spanish Ballet* in the Phillips Collection, Washington, D.C.

accept individual authenticity problems and are very competent in evaluating art and establishing its authenticity.

Many, if not most of us are familiar with *IFAR Reports*, a publication that publicizes stolen art. This was first called the *Stolen Art Alert*, then the *Art Loss Register* and now, again, the *Stolen Art Alert*. Constance Lowenthal as Executive Director and Virgilia Pancoast as Director of the Authentication Services until recently deserve the credit for establishing IFAR as the group for the authenticating research or for evaluating the research of others. As of 1998, IFAR took on a new life with the retirement of Constance Lowenthal. Her ideal replacement is Sharon Flescher, and *IFAR Reports* is now a formal journal, *IFAR Journal*. Virgilia Pancoast, I'm pleased to see, is still "Consultant, Authentication Services." The *IFAR Journal* now publishes formal papers. With worldwide contacts and a very high reputation, IFAR has the ability to fill a real gap in authentication studies. For too long, the subjective viewpoints of many scholars have left many works of art in limbo, neither accepted or unaccepted as authentic. I believe IFAR could evaluate any existing claims of authenticity, perform additional work to test those claims, and produce a carefully considered opinion that would be accepted as a final verdict. I dearly hope they will do so. Unfortunately, they haven't accepted this fearsome responsibility perhaps because they haven't been asked. I am sending them a copy of this paper before publication to elicit a response.

Going back to my "Protocol," I would like to present as an example for authenticating paintings John Harrington's *Christ Among the Doctors* (see Figure 2). John Harrington possesses a remarkable set of qualities: an avid interest in art, an eye for quality, and an ability most historians would envy of being able to investigate and establish a credible provenance for authentic paintings. A pretty complete coverage of what was then Harrington's 12-year authentication effort has been published (McCrone, Graham, and Polizzi, 1996).

Since that publication at least two additional art scholars have studied *Christ Among the Doctors* and concluded it to be a long-lost Leonardo painting as determined by John Harrington. Klára Garas of Budapest has a long and important background in the arts. Starting with a degree in History of Art and Ar-

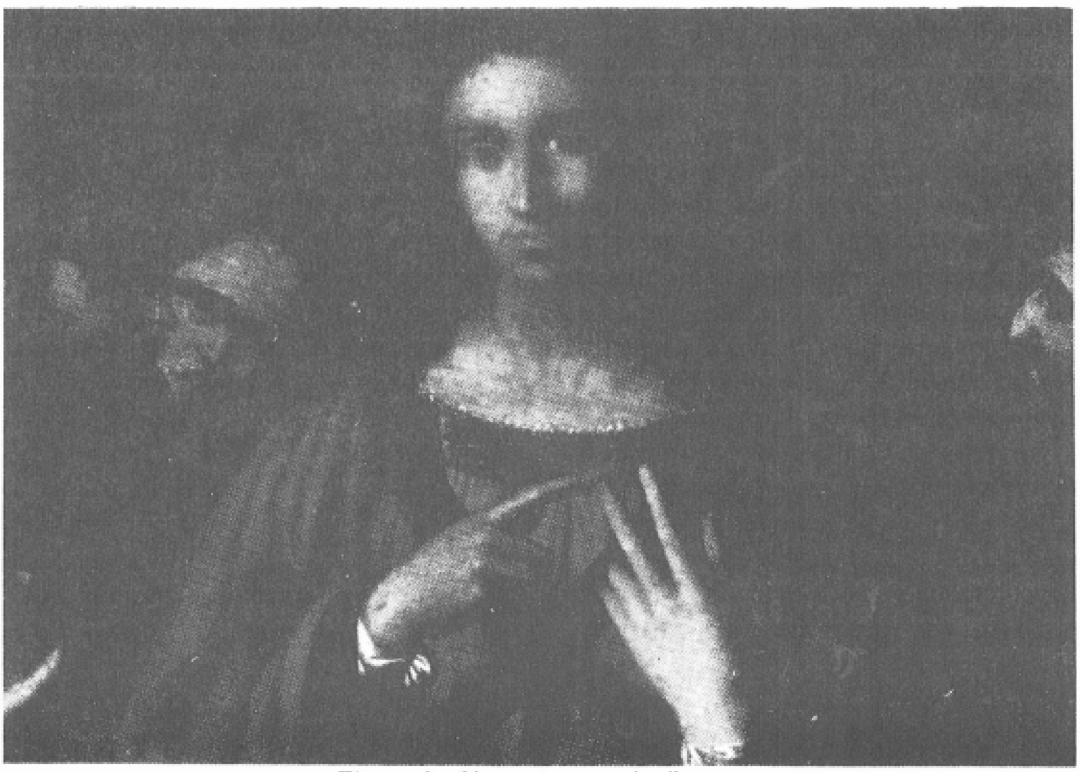

Figure 2: Christ Among the Doctors

cheology from the University of Budapest, she went on to become Assistant Curator, Curator, and finally Director of the Museum of Fine Arts in Budapest (1964-1984). She is a member of the Hungarian Academy of Sciences and has published more than 100 articles in art magazines and scientific journals and at least 10 books including *Paintings in Hungary in the 17th Century*, followed by the same title but in the 18th Century, *Venetian Paintings of the 18th Century,* and *Italian Portraits of the Renaissance.* An as -yet unpublished book covers in detail the paintings of Giorgione.

Her study of *Christ Among the Doctors*-Harrington led to strong evidence that this painting had been owned by the noted Italian Martinelli family since the 16th Century. The Martinellis were then, and later, closely associated with the theatre and the arts in Italy. John Harrington purchased *Christ Among the Doctors* in 1984 from a present member of that family. Klára Garas' conclusion after her historical study was that Leonardo painted John Harrington's picture.

The other well-known scholar, Professor of Art History, Eugene Markowski, of Trinity College in Washington D.C. has made an independent detailed study of *Christ Among the Doctors*-Harrington and his critical analysis follows:

1. THE ICONOGRAPHY

A. Christ's Vestments: The cloth bands which criss-cross the *Christ figure in Christ Among* the Doctors are a representation of the liturgical stole worn as part of the priest's liturgical vestments during the time of Christ. During this period the stole represented the priest's authority as teacher, or presider, one who led the congregation in religious ceremonies. For priests in the Roman Catholic Church, the stole was worn over the other vestments; by the time of Vatican II and until recently, the stole was worn under the other vestments. Presently, the stole is worn over the priest's shoulders and hangs down alongside the arms.

The color of the vestment under the stole worn by the Christ figure is red, the color for priestly vestments worn during the Feast Day of Pentecost. This feast day is the celebration (memorial) of the event in which the power of the Holy Spirit (traditionally represented as flames, hence the color red for the vestments) descended upon the apostles empowering them with knowledge of, and the ability to speak in other languages and to teach the new religion of Christianity.

B. Christ's hands: The hands of the Christ figure are held close to one another with three fingers extended, two on the left hand, and one on the right hand, to form a triangle. The triangle is often used, especially by the Roman Catholic Church, to represent the Triune God, three in one: the Father, the Son, and the Holy Ghost. While just two fingers form the lateral sides of the triangle, the near forefinger of the left hand suggests a part in the triangular representation of the Triune God.

C. The figures in the background: To the left and to the right of the Christ figure are depictions of the priests of the temple, representing the old church/ temple, (the Old Testament of the Bible), while the central figure of Christ represents the new church/ temple (the New Testament). The various styles of clothing worn by these figures refer to the various positions held by the temple priests.

D. The title of the painting *Christ Among the Doctors* refers to St. Lukes's description in the New Testament (2: 42, 46, 47, 49, 50) of Christ teaching to the priests in the temple. St. Luke says that Christ was about twelve years old at this time and that it was Christ's first teaching experience. Leonardo's representation of Christ in this painting is that of a very young man, perhaps in his teens.

E. Conclusion: The various forms of iconography used by Leonardo for this painting direct attention to Christ as a teacher, founder of the new church, and the doctrines as well. Quite possibly, Leonardo conferred with a priest advisor concerning the iconography just as Michelanglelo certainly did concerning his frescos for the Sistine Chapel. It is also possible that Leonardo visited the cathedral in Prato to see the fresco of *The Feast of Herod*, painted by Fra Fillippo in 1452. In the background of this fresco, at the feast table centrally located is a figure wearing the stole of priestly authority within the temple and of teaching authority. This fresco also juxtaposes the New and Old testament, just as Leonardo does in *Christ Among the Doctors*. Finally, *Christ Among the Doctors* , intended as an image concerning teaching, may have been commissioned by a teaching order within the Church, rather than as a private commission. The facial and hand expressions for each priest represented are direct links to St. Luke's statements found in Chapter 2: 46, 47, 49. John Harrington believes that the Christ figure may well have been painted by Leonardo in support of his application to the Guild of Florentine painters in 1472.

2. PERSPECTIVE AND COMPOSITION

A. Perspective: Leonardo often used one-point perspective in his paintings and drawings. *The Last Supper* fresco in the refectory of Maria delle Grazie (Milan), *The Adoration of the Magi,* 1481, Uffizi Gallery (Florence), *The Annunciation*, 1470, Uffizi (Florence), and the *Mona Lisa*, 1503, Louvre (Paris) are among the more obvious examples. Nearly always, the vanishing point among his one-point compositions may be located behind the central figure or object. The horizon line, located on a single vanishing point, is placed about one third of the picture plane's proportion from the top. This proportion ties in with Leonardo's preference for a strong vertical and horizontal axis. The vertical minor axis and the horizontal may be the axes that hold groups of figures or objects.

B. Composition: When Leonardo uses a single vanishing point perspective, his compositions tend to be symmetrical, lending a certain formality to the overall image. Within the rather formal composition of symmetrical arrangements he activates figures and objects into movement through gesture and placement. When a single figure or groups of figures are used in one of these compositions, depicting the vanishing point from about the waist to the top of the head, he suggests that it is, in fact, the entire figure, or person who is being represented, implying therefore, a full-length figure portrait. This suggestion of a full-length portrait is accomplished by the relationship of the figure's hands relative to the bottom of the picture plane (about 1/3 to 1/4 from the bottom), and the head with about the same proportional relationship to the top of the picture plane. One may find that throughout all of Leonardo's compositions a mathematical permutation is in play. These are, in effect, compositions that visually read as "right" and "correct", and quite architectural.

Hands as shapes in Leonardo's compositions always play a major role in the success of his compositions, but more important than shape within the composition is the hand as a key to understanding the content of the painting or drawing. Furthermore, hands as Leonardo depicts them are in fact outward manifestations of an inward emotion, thought, or doctrine. The hands of the Christ figure in *The Last Supper* relay two doctrines, the left hand is extended in an offering of bread symbolizing the consecration of the bread at the sacrifice of the Mass (this is my body), while the right hand is extended in blessing of the wine, or consecration of the wine (this is my blood). The expression, or position of the hand is also the position of the priest's hand in the final blessing at the conclusion of the Mass toward the congregation (go in peace). The hands of the apostles, depicted in a great variety of positions and placement within the composition, are quite clearly intended to be outward visual expressions of each apostle's inward emotional and intellectual response to Christ's revelations through hand gestures.

While the hand of the Virgin in Leonardo's painting *Madonna of the Rocks*, 1483, in the Louvre, is extended in blessing over the Christ child, her hand is in the very same position that Leonardo used for his Christ in *The Last Supper*. For both paintings Leonardo used the triangle as the central geometric shape for both Christ and the Virgin. The Christ figure in *Christ Among the Doctors* is also shaped within a centrally located triangle. For each of these paintings, the central triangle is proportionally the larger geometric shape and is contrasted against other triangles within the totality of the composition. Leonardo uses the triangle with mathematical permutations that create the underlying architecture of his compositions, thus lending a firm structural whole. In several of these composition types such as the *Mona Lisa*, *Woman with an Ermine*, and *Christ Among the Doctors*-Harrington, the hand or hands are used as a visual lead-in to the composition. In each of these compositions the hands may be active or at rest, but they are, without question, significant symbols in not only understanding Leonardo's genius for composition, but important leads to the content.

C. Conclusion: The perspective, both linear and aerial, and composition for *Christ Among the Doctors* are directly related to the other Leonardo paintings mentioned, and as such, could not be understood by a copyist to the degree of execution seen in this painting. Further, the perspective and composition for this painting are used by Leonardo to underscore that this painting was indeed a "teaching painting". Leonardo used all his knowledge in mathematical permutations within the compositional and perspective guidelines to support his iconographic information to form an image that was not only a fulfillment of the patron's desires, but was also an early signature work whose visual and intellectual content may be found in other later paintings.

3. STYLISTIC ANALYSIS

Chiaroscuro aside, which is so clearly related to other Leonardo paintings, there appears to be stylistic similarities between *Christ Among the Doctors* and other paintings by Leonardo that are important enough to establish this painting as one of Leonardo's.

The hair in this painting is not linearly treated as it is in some of his other paintings, but is more softly brushed with pigment, as it is in the treatment of the hair of the Christ figure in *The Last Supper*. Christ's hair in *The Last Supper* is parted off-center and is parted off-center in *Christ Among the Doctors* as well. The proportion of the fingers to the body of the hand are greater than one would find normally. This odd proportional preference by Leonardo may be found in his other paintings such as *St. John the Baptist*, *Lady with Ermine*, *Madonna of the Rocks* and the *Mona Lisa*. This extension of the fingers by about one-fourth more than normal, is certainly intended for expressive purposes. Given the importance Leonardo placed on hands in his compositions, it is easy to understand why he stylized the fingers as he did. The lips of the Christ figure in *The Last Supper* are dearly outlined and color filled. The *Christ Among the Doctors* painting reveals that the lips of the Christ figure are treated in the same stylistic manner as are the eyes. The eyes are not on a perfect horizontal, and the nose is long and thin. These facial characteristics may be found in most of Leonardo's representations of the human face. It is rare to find a perfect symmetrical face in his paintings or drawings. Through study of Leonardo's "study sketches," he visually states that no true symmetry exists in nature including the human form, except for mathematical symmetry such as one to one, two to two, etc.

Finally, the light source in most of Leonardo's work is left-hand oriented, that is, the light appears to come from a source that is located to the left of the picture plane. At times, this light source offers a very strong light, producing clear cast shadows, or at times a softly diffused light with cast shadows not dearly defined. Since Leonardo was left-handed, this would be a natural if not automatic choice for a light source. *Christ Among the Doctors* reveals a light source that comes from the left of the picture plane, a strong light source producing the chiaroscuro effects of light, shade, cast shadow, reflected light, and highlight. Through this lighting mode, the modeling is carried out to the highest degree in order to produce volumes that will give the most convincing illusion: a third dimension. Leonardo focuses the light directly upon the left hand of Christ (this could be a subconscious placement by Leonardo because of his left-handedness, or, a connection to his own spirituality) intending to bring the observer's attention to the hands which form the central triangle of the Christ figure.

CONCLUSION

Throughout Leonardo's career his use of light in his paintings and drawings is consistent (nearly always left-handed orientation) along with his compositional techniques. It is this very consistency that one finds in *Christ Among the Doctors*-Harrington. Each one of the visual elements in this painting, if examined separately and placed within the context of any other of his paintings, shows that the transfer would make a perfect fit technically and stylistically.

Stylistically, Leonardo creates a very fine tension between the figures and objects he represents, a tension that one may visually read as a frozen moment in time, but one that never excludes the observer. He brings the observer into the space and activity through his technical ability and force of genius, a space that is always represented as one devoid of sound, a quiet stillness of peace. *Christ Among the Doctors* exemplifies these qualities and stands finally in the place of progression from this early work to later works.

As of today, there are scholars who do not accept the attribution of *Christ Among the Doctors* - Harrington to Leonardo. All of those, however, who have made a serious study like Joseph Polizzi, Lanier Graham, Walter McCrone, Klára Garas, Eugene Markowski and, of course, John Harrington, are in full agreement that the available evidence fully supports the attribution to Leonardo da Vinci.

This, then, is where IFAR is needed. The owners, John and Elfriede Harrington, want nothing more than to share this fine painting with the public by seeing it hanging in a major art museum. Now, however, it can be exhibited only in their home where only they and their friends can envy it. IFAR, by a careful and complete study of all past authentication studies and their own added effort, could draw their conclusion with a published paper—a decision that like those of the Rembrandt Committee would justify a universal agreement accepted by all parties and remove a fine painting from limbo.

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A Case of Art Fraud Unmasked

Skip Palenik*

An interesting application of analytical microscopy is the detection of art and archaeology hoaxes. The benefits of a microscopical approach to these problems arise not only from the capacity to deal with microscopic samples but also the "resolving" ability of the microscope to distinguish a small inhomogeneity and exploit it. Such was the case in a recent problem submitted by a long time client of ours who is a dealer in prehistoric art with galleries in New York city. He explained that while on a buying trip in Switzerland, he had the opportunity to examine an extraordinary early Greek bronze statue which was being offered for sale at a reasonable price. The item, if authentic, would be the world's best example of this particular subject, exceeding that of the best example known at the time, which was displayed in a museum in Turkey. The price, however, was reasonable which made him cautious.

The studio which offered the item for sale permitted him time to examine it and to take small samples to help in his purchase decision. Our dealer originally trained as a metallurgist and conservator and was used to taking small samples. During his inspection of the entire object with a low magnification stereomicroscope, he noticed what appeared to be an encrusted fiber sticking out of the patina which covered the surface of the statuette. Using a pair of forceps, he broke off a small piece of the corrosion which contained the encrusted fiber. He sent the specimen to us on his return to New York.

The sample which we received consisted of a small quantity of particles of a blue copper corrosion product. One of these had an apparent fiber sticking out of it (Figure 1). Previous experience with ancient fibers trapped in corrosion products on coins and other archaeological specimens taught us that there may or may not have been a fiber inside. In previous cases these have ranged all the way from

Figure 1: "Blue" fiber as first seen, 40X

intact fibers (usually wool or cotton) to pseudomorphs where replacement by the corrosion minerals is complete. Most archaeological fibers fall somewhere in between, but in almost every case where there is still something remaining, it can at least be identified as a cellulosic (cotton or linen) or protein (wool) fiber.

One thing archaeological fibers all have in common is their brittleness. We, therefore, took great care to attempt to remove the fiber intact. We first isolated the particle containing the apparent fiber (Figure 2). Next we chipped away as much of the corrosion product as possible using tungsten needles while observing through a stereomicroscope (Figure 3). Finally, we used dilute acid to gently dissolve the remaining corrosion compounds, a technique which had worked well in the past on coins from ancient

*Microtrace, 1750 Grandstand Place, Elgin, IL 60123

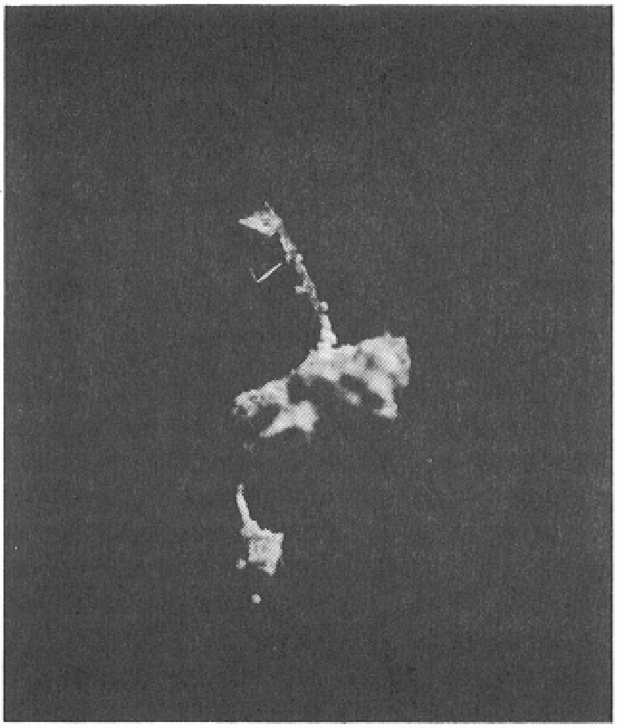


Figure 2: 'Blue" fiber after removal from the bulk of corrosion, 40X

Carthage. The remaining fiber was washed in successive droplets of distilled water. A segment of the fiber was cut from the whole length, mounted in a drop of water, and examined with the polarizing microscope (Figures 4 and 5).

The fiber was easily identified as cellulose on the basis of its morphological features and behavior between crossed polars. It was remarkable, however, because of its freshness. There appeared to be little or no physical attrition to the fiber. The gradual loss of morphology is one of the most obvious characteristics of fibers recovered from corrosion crusts. This fiber looked as fresh as if it had originated from a dustball in the corner of a bedroom. Since there is nothing odd about a cotton fiber being found in an ancient corrosion product, we decided to proceed a step further.

The piece of the fiber which had been cut off for the morphological examination
described above was now examined with the fluorescence microscope using ultraviolet excitation. The colorless fiber exhibits the strong blue-white fluorescence characteristic of an optical brightener. Optical brighteners are fluorescent compounds (usually derivatives of stilbene) which are added to textiles to make them "whiter than white." Their brightness is

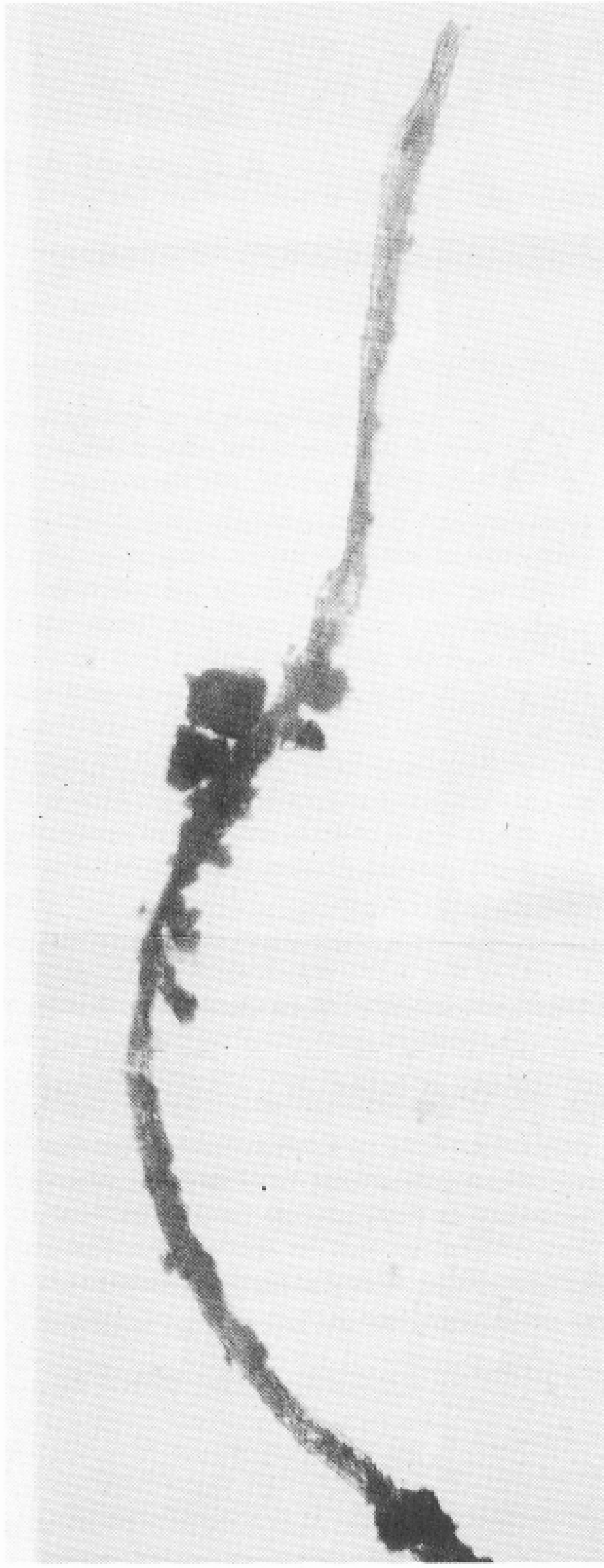


Figure 3: Composite Photomicrograph showing the fiber after the completion of mechanical cleaning. Multiple exposures with transmitted plane polarized and reflected light, 130X

based on their fluorescence when illuminated with ultraviolet light from fluorescent lamps or sunlight. Since they fluoresce in the blue region of the visible spectrum, they appear whiter (i.e., bluer) to our eyes which regard the yellow end of the spectrum as duller or dirtier. Optical brighteners are either added directly to synthetic fibers (e.g., polyester for cotton/polyester shirts and blouses) during manufacturing or in laundry detergents which is the way most cotton fibers pick them up. They are also added to writing and copy papers. These compounds were invented in the 1940's in Germany, but were not used commercially in laundry detergents or paper until the early 1950's.

This final observation put the matter to rest. The fiber is a modern cellulose fiber, most likely a paper fiber, which was trapped in the corrosion product as it was being formed. Thus, in this case, the corrosion product must have been formed since 1950. As it was being formed, a single paper fiber either settled out of the dust in the air or became in some other way attached to the copper salt as it was being grown on the object. Confronted with this information, the seller withdrew the item from sale. Our client was happy to have his doubts confirmed since he would have hated to miss out on such a great purchase opportunity had it been authentic.

A color photocopy of the fiber showing its blue fluorescence is available from the author. To obtain Figure 6 simply send a self-addressed envelope to Skip Palenik at Microtrace.

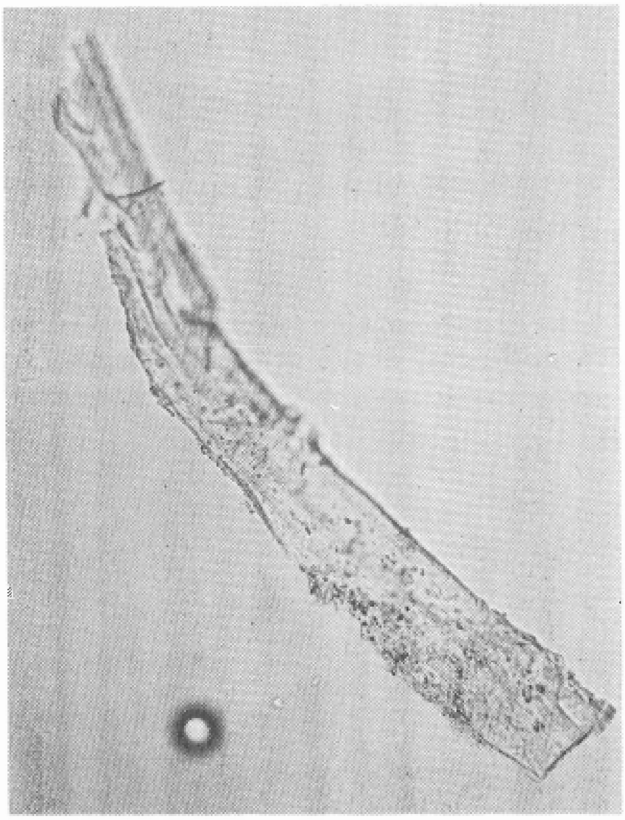


Figure 4: Cut fiber mounted in water, 340X

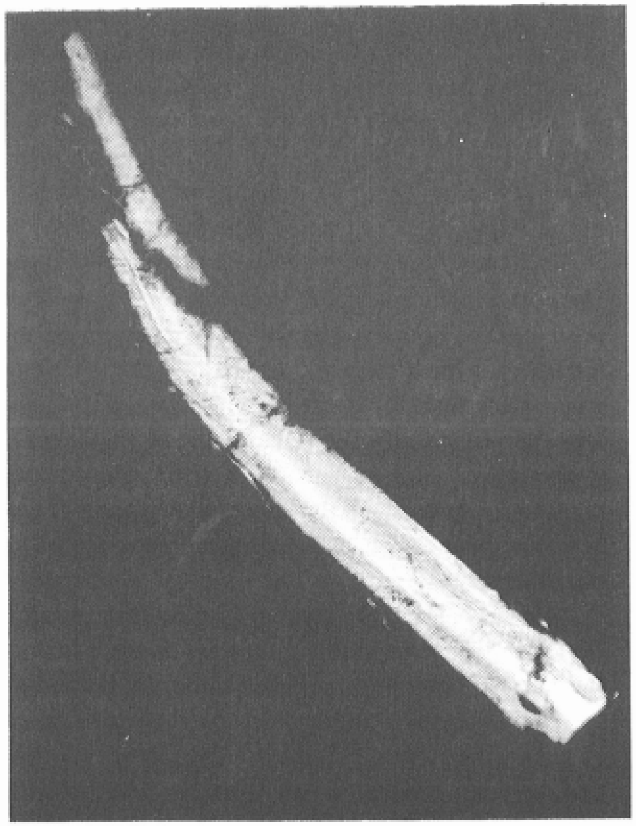


Figure 5: Cut fiber under crossed polars, 340X

Beware the Duster

Richard Hoyt Lee*

We usually assume that the compressed gas duster cans we purchase and use are of good quality. But beware of unexpected residue and contamination from additives mixed into the compressed gas used in the cans as the source of the gas for dusting!

I recently experienced serious contamination of a polished metal sample for analysis when I dusted it off with a can of commercial duster just before placing it on the microscope stage. As I focused on the sample, I saw spots of white stain and residue that should not have been there. Removing the sample, I gently huffed it and wiped it clean with a soft lens tissue. Having experienced this once before with a "lowest bidder" quality product (sorry, no brands), I did an experiment to test the amount of residue.

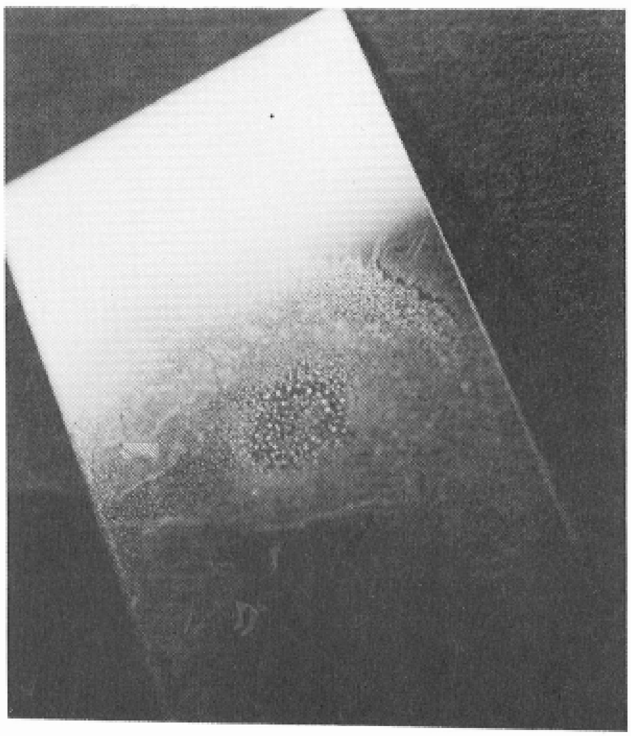
Since most commercial dusters use a liquefied gas, like a chlorofluorocarbon, inverting the can will expel a burst of liquid which will cover an exposed surface with a thick film and then evaporate. Using a clean glass slide for a test substrate for the liquid allows one to quickly see the amount of residue after evaporation. This also works well for simple compressed air dusters, which have no liquid source. Just give the clean glass slide an extra long dose of the propellant.

What is leaving the residue? In the case of liquefied gas dusters, probably a light oil or other form of lubricant is added to the liquid to help it extend the life of refrigeration units, which are the main end use of the product. With compressed air, light oil vapors always contaminate the air from the compressors, unless a special oil trap is used in the line. That is the reason most electron microscopes vent their chambers with compressed nitrogen rather than compressed air which is cheaper. Oil in the air will contaminate the vacuum systems of the electron microscopes. Oil can be trapped out, but it is difficult to remove all of it because most of the filters are just paper or polymer spun fiber types that will eventually become saturated.

Another application of dusters is the cleaning of microscope optics where no residue or deposits are tolerated due to image degradation. The incident that led to this article is the presence of a fiber visible in all the photos taken with a reflected light microscope. Disassembly of the microscope part by part eventually led to the troublesome fiber attached to the polarizing slider.

Electron microscopes are more critical because the vacuum system usually cannot be baked out to remove adsorbed deposits. There is an old "rule of thumb" about fingerprints and vacuum systems; that is, it takes 5 years to eliminate outgassing.

Below is a photo of a clean glass slide sprayed with a large blast of a low cost and unnamed product. Notice the small droplets of liquid remaining.



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Using Electrographic Techniques in Microchemical Metal Tests

James J. Benko*

Sometimes it is better to use an electric current to get metals into solution rather than acid(s), especially when it is necessary to preserve the integrity of the sample surface.

Useful for such items as coins or metallic art objects, electrographic techniques are, for all intents and purposes, virtually non-destructive since only traces of metal are removed. Sufficient metal dissolves for microchemical tests when a 10-50 milliamp current, supplied by one or two flashlight batteries, passes through a specimen for a few seconds. The specimen rests on a small piece of filter paper moistened with an aqueous electrolyte solution of sodium chloride or sodium nitrate.

A clever apparatus for doing this is described by Nordmann (1) and also by Weisz (2), both authors attributing it to Fritz (3). I have constructed this apparatus from ordinary materials readily available today. It is simple to make and simple to use.

MATERIALS

1. Aluminum cathode made from a disposable weighing dish or soda can bottom (use sand paper to remove any can liner/coating material)

2. Plastic battery holder for two "D" cells (available from Radio Shack)

3. Screw driver with plastic handle

4. Small lengths of copper wire

5. Small alligator clip (available from Radio Shack)

6. Ashless filter paper, 5.5 cm diameter.

7. Electrolyte solution, 2% NaCl in deionized water

8. Two "D" cell batteries

DIRECTIONS

1. Cut off the tip of the screwdriver with a hacksaw leaving a flat-edged rod. File this surface smooth. The screwdriver could be used "as is" but the flat edge tends to minimize scratching and provides somewhat better contact with the sample.

2. Solder one end of a copper wire to the screwdriver. This is the anode. The other end of the wire is connected to the (+) terminal of the battery holder, the anode.

3. Solder an alligator clip to another piece of copper wire. This clip is attached to the aluminum cathode. The other end of the wire is attached to the (-) terminal of the battery holder.

4. Put batteries in the battery holder when ready to use.

The finished apparatus is shown in Figure 1. Obviously, numerous variations can be made such as adding an ammeter, using different sized batteries/holders (Nordmann' uses a 1.5-volt dry cell), using different metals for anodes/cathodes, using different electrolytes, etc.

*Microspec Analytical, 3352 128th Ave., Holland, MI, 49442

Figure 1: Electrographic apparatus showing copper coin on an Al cathode before analysis

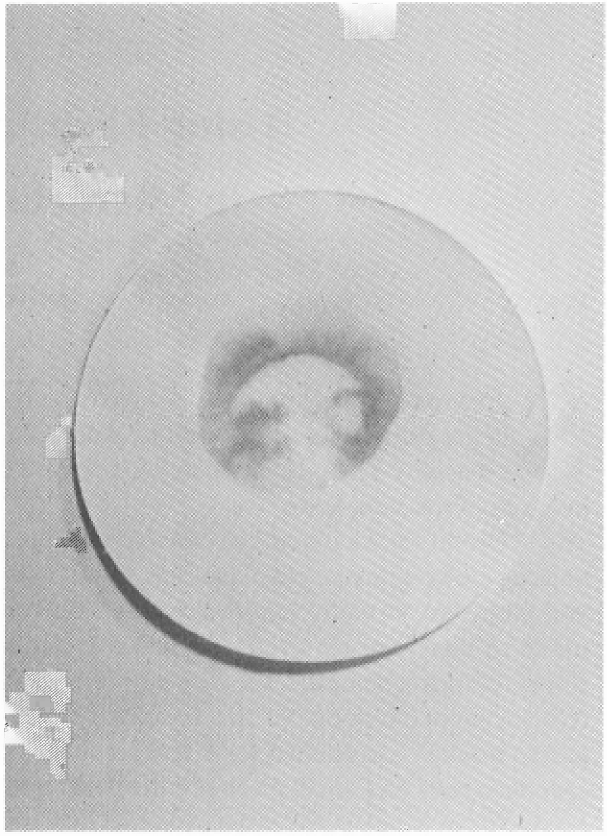

Figure 2: After 4 seconds contact with the electrodes, copper transferred to the filter paper tested positive with 0.1% cuproine in ethanol

METHOD

1. Place a circle of filter paper moistened with electrolyte on the aluminum cathode.

2. Place the sample to be tested which can be a piece of metal, coin, conductive mineral, or conductive powder on top of the paper.

3. Connect the alligator clip to the cathode.

4. To complete the connection firmly press the screwdriver post onto the sample for 3-4 seconds.

This should allow enough metal to be transferred to the filter paper for analysis (Figure 2). Microchemical tests for suspected metals can then be made using reagents commonly employed such as dithizone, dimethylglyoxime, thioacetamide, etc. The filter paper discs can also be used in ring-oven tests for further separation and identification as described by Weisz (2). Changing the physical size of the anode/cathode may be necessary to test large objects such as lamps, statues, etc., but the basic principle remains the same.

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2. Weisz, H., *Microanalysis by the Ring Oven Technique*, Pergamon Press, 1961, pp. 17-119.

3. Fritz, H., *Z. Anal. Chem*, **78**, 418 (1929).

Julian D. Corrington and the Bausch & Lomb Model R Microscope

John Gustav Delly*

The name Julian D. Corrington and Bausch & Lomb's Model R microscope for young people and other beginners are forever linked in the history of amateur microscopy in America. Members of the State Microscopical Society of Illinois (SMSI) will be familiar with at least one of Corrington's books, probably *Adventures with the Microscope* or *Working with the Microscope*, but are less likely to be familiar with the elusive and scarce Model R microscope, even though it is illustrated and featured in *Adventures with the Microscope*. During the depression years of the early 1930's in America, Bausch & Lomb Optical Company of Rochester, New York, produced several smaller microscopes for amateurs, including the New Gem and the Model R. Bausch & Lomb turned to a local talent, Julian D. Corrington to write several booklets to accompany the new microscopes. Corrington was, at the time, employed by Ward's Natural Science Establishment, also in Rochester, New York, as Editor of their Bulletin and catalogs.

But this part of the history and biography is, perhaps, best told in Corrington's own words. The New York Microscopical Society (NYMS) celebrated its Centennial shortly after SMSI celebrated its Centennial (1869-1969). In the year following the NYMS Centennial, Hal Bowser, who was Editor of NYMS's excellent newsletter, invited Corrington, who was then living in Florida, to update the membership through a "Greetings From An Old Friend." In the invitation, Hal Bowser referred to Corrington as the person who "practically invented amateur microscopy." I have a copy of the response, but do not know in which issue of the *NYMS Newsletter* it was published because a flooded basement destroyed all of my copies of the newsletter. Corrington, in responding to his contributions to amateur microscopy, written when he was 86 years old, had this to say:

At the time of my first articles on this subject I was, at age 40, head of the microscope slide department and editor of their Bulletin and catalogs for Ward's Natural Science Establishment at Rochester, NY. I had written my Ph.D. thesis in zoology, at Cornell University, and had produced a few scientific papers, but I was by no means what could be called a "writer." Then the Bausch & Lomb Optical Company asked me to do some booklets to accompany sales of their small New Gem and later Model R microscopes for young people and other amateurs and beginners. These booklets proved so successful that finally they authorized me to do a full-sized book (455 pages) *Adventures with the Microscope*, 1934. As I was under full-time employment at Ward's, I had to write and rewrite and rewrite this large volume nights, weekends, and holidays. But at length it was done, and I had learned to write by writing—and that's the best advice any aspiring author could receive.

Since that time my bibliography shows a total of 450 publications, including eight of book length, the best known being McGraw-Hill volumes, *Working with the Microscope*, 1941, the (*sic*) *Exploring with Your Microscope*, 1957, the latter also having a Serbo-Croat translation published in Beograd in 1972. My longest series of monthly articles ran in *Modern Mechanix* (later *Mechanix Illustrated*), *Leisure*, *Practical Microscopy*, *Bios*, and above all *Nature Magazine*, to which I was a contributor for 22 years. These years also saw the formation of the American Society of Amateur Microscopy (A.S.A.M.) for which I did thousands of hours of dogged but very rewarding labor.

Before coming to Rochester I had, like the great majority of people, associated the microscope only with the biological laboratory in high school, college, and medical schools and hospitals, but my

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*McCrone Research Institute, Chicago, Illinois

connections with Ward's and Bausch & Lomb soon disabused me of such a narrow view. For magnifying instruments of many types have a widespread use in industries of many sorts—paper, textiles, paints, glass, rubber, leather, and so on through a long list. And so my aim in all of these series of books and magazine articles has been to start the beginner off with easily prepared slides: I advise them to mount a postage stamp, a piece of newsprint, a small square of silk, or cotton cloth clipped from the hem of a dress, grains of sand, a fingerprint—and only later to take up the much more complicated procedures of fixing, sectioning, mounting, and staining of, say, a section of frog liver or cat intestine. I urge newcomers to microscopy to start with fundamentals and build up gradually into the numberless fields of use for the microscope. To this end, I employ simple language, hoping that the beginner will establish a solid foundation for his or her later specialized work. It is for this system and approach that I believe I can claim any originality in my writings.

In 1944, I came to the University of Miami, where I have taught mainly premedical courses—comparative anatomy, histology, and embryology—retiring in 1962. Now, at age 86 I am enjoying senior citizen leisure, and am happy in the fact that many former students, readers, and friends tell me I have been of help to them in their careers.

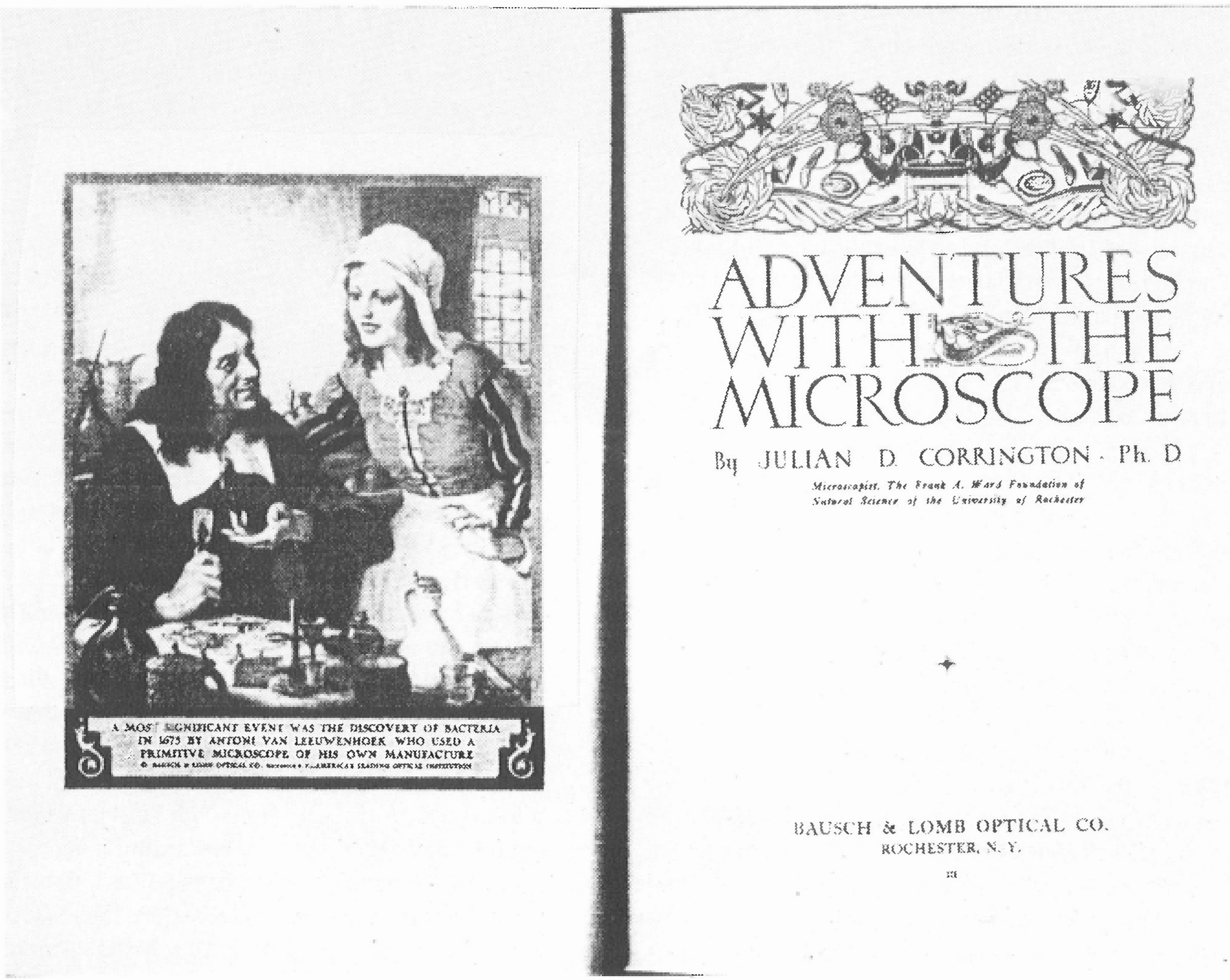


Figure 1: The Adventures with the Microscope, published in 1934

The Adventures with the Microscope (Figure 1) mentioned by Corrington was published in 1934. In this volume are illustrations of the New Gem microscope and the Model R microscope as well as a photomicrographic apparatus being used with the Model R.

Working with the Microscope (Figure 2) was published in 1941. The microscope shown being used on the dust jacket is not one of the "baby" microscopes; it looks more like the Model H Professional Laboratory Microscope, which in 1938 was being sold for $83.

Exploring with Your Microscope (Figure 3) was a much later book, published in 1957.

One of the favorite chapters in *Adventures with the Microscope* for many readers is the last chapter, "Sherlock Holmes Buys a Microscope"; it is in narrative form, as related by Dr. Watson. A number of Bausch & Lomb microscopes are illustrated here, including the Model FFSB student monocular microscope, the Comparison Microscope used by document examiners, the Bullet Comparison Microscope (with and without the photomicrographic apparatus), and the AKW-5 Wide-Field Binocular Microscope. This chapter also illustrates a fingerprint card, and gives an introduction to fingerprint characteristics and matching.

By 1957, *Adventures with the Microscope* had already been out of print for a number of years and so it was deemed advisable to come out with a new work, which in general plan was to be an abridged and revised version of the 1934 work. Some of the material and illustrations were taken from the more technical *Working With the Microscope* (1941), but the

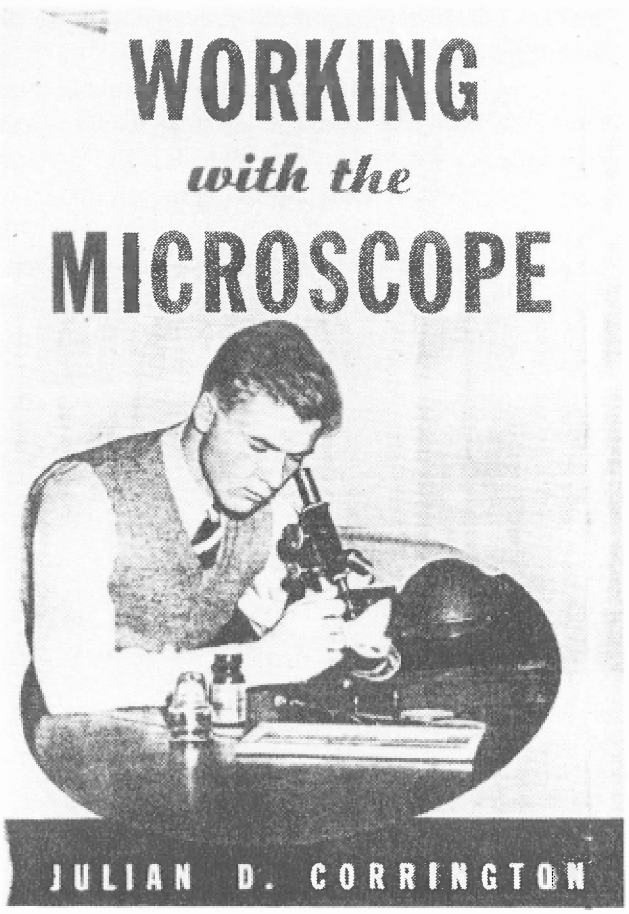


Figure 2: Working with the Microscope, published in 1941

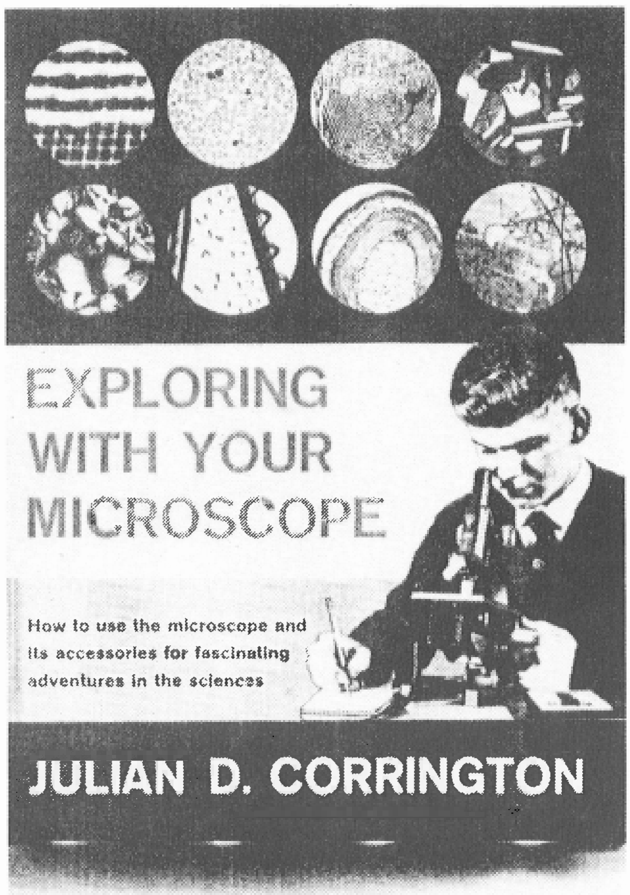


Figure 3: Exploring with Your Microscope, published in 1957

bulk of the new book, *Exploring With Your Microscope*, was new in scope and purpose. The last chapter in *Exploring With Your Microscope* parallels the last chapter in *Adventures with the Microscope* in that it is titled, "Adventuring with Sherlock Holmes." The chapter opens with a quotation from Arthur Conan Doyle's "Adventure of Shoscombe Old Place"; specifically, where Sherlock Holmes "had been bending for a long time over a low-power microscope," and then invites Watson to observe the glue, epithelial scales, dust, and threads from a tweed coat. A wonderful photomicrograph at 11X is provided to illustrate the field of view. The fingerprint information is here, but the comparison microscope illustration has been updated. There is also a photomicrograph of a bat hair (741X).

The Model R microscope is scarce because during the early 1930's depression years when the microscope sold for $21 with a copy of *Adventures with the Microscope,* not too many people could afford it, and by the end of the decade, Bausch & Lomb had already converted over to the manufacture of binoculars and other optical equipment for the military; World War II had already started in Europe. Bausch & Lomb never resumed the manufacture of the Model R after the war.

The Model R microscope came in a beautiful walnut carrying case (Figure 4) together with some blank slides, and a prepared slide of a flea—the preparation featured in the *Adventures with the Microscope*. The front of the walnut carrying case had a stenciled label giving the model and manufacturer's name (Figure 5).

The microscope itself was capable of a range of magnifications through use of a drawtube (~3-1/4"), a divisible objective, and an optional low-power eyepiece substituted for the standard 10X. With fully-closed drawtube (Figure 6) the magnification is 75X-150X; with 1" extension the magnification is 125X-250X; with fully-extended drawtube (Figure 7) the magnification is 150X-300X. Fully opened, the bodytube is ~7-3/8". The image quality fully extended is not very good because the maximum useful magnification based on the numerical aperture is exceeded, but use of the lower-magnification eyepiece improves the image quality.

A very interesting feature of this microscope is that the pillar and base separate from the stage and bodytube in the same way that Bausch & Lomb's and American Optical Company's stereomicroscopes separate from their transmitted light bases for use with incident light. The mirror could be removed from the base and mounted suprastage in a hole provided to supply reflected light for opaque objects, such as

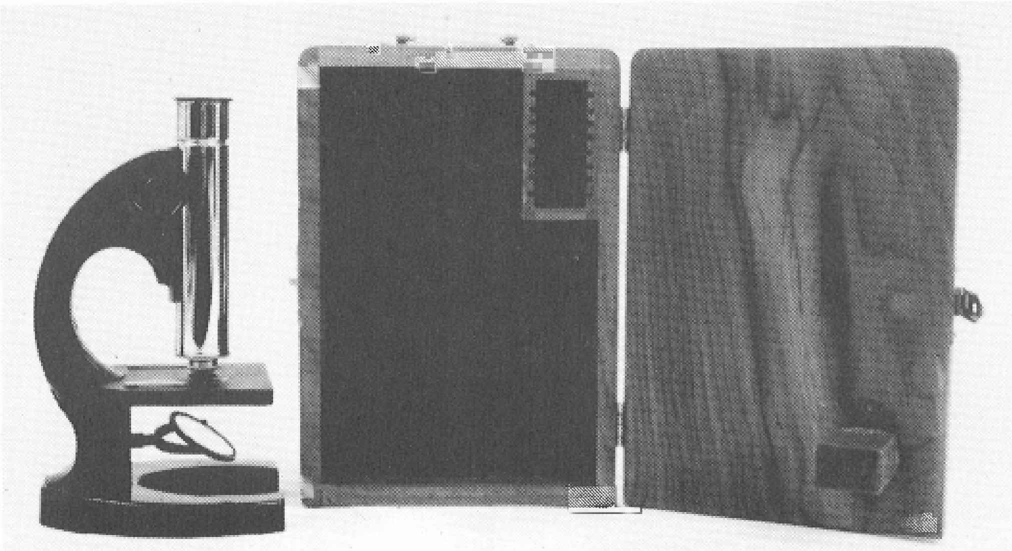


Figure 4: Bausch & Lomb Model R microscope with walnut carrying case

Figure 5: Front of walnut carrying case illustrating stenciled label giving model and manufacturer's name

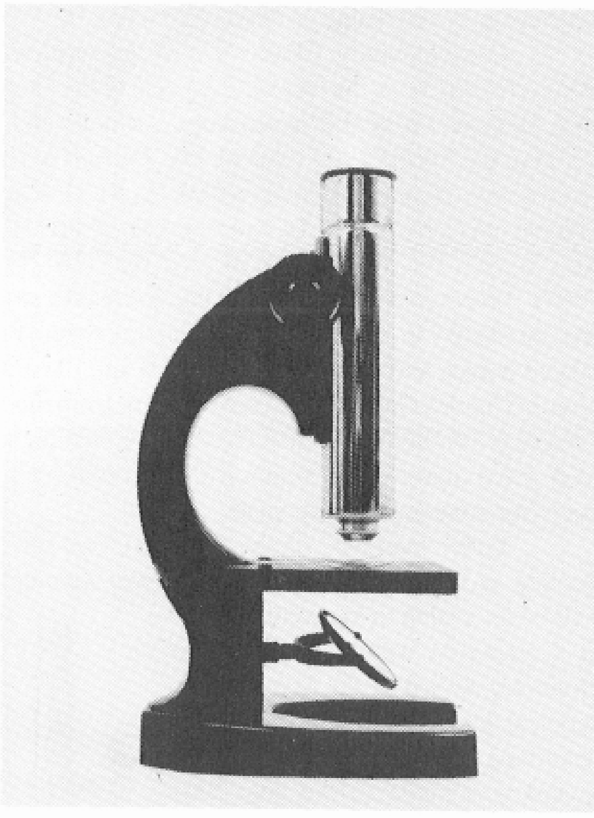


Figure 6: Bausch & Lomb Model R microscope with fully closed draw tube

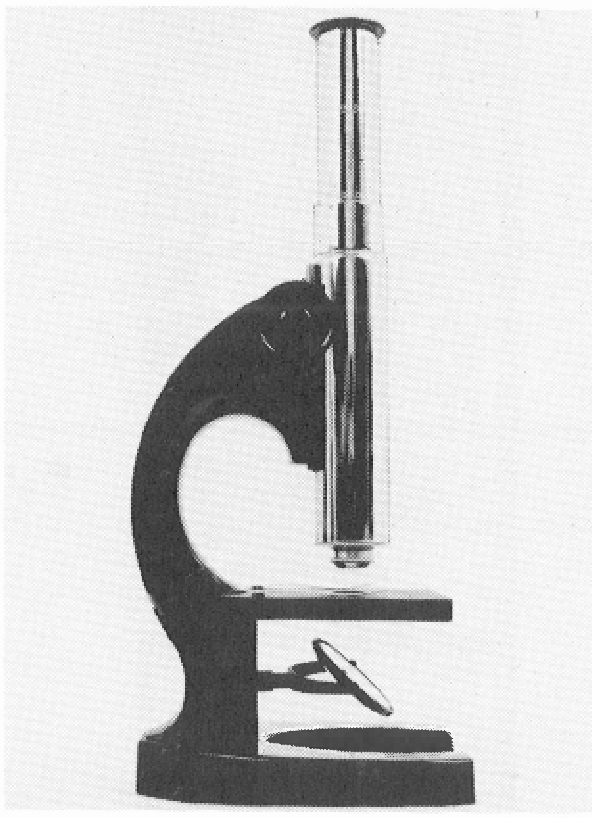


Figure 7: ***Bausch U Lomb Model R*** *microscope with fully opened draw tube*

Figure 8: A 1930's ad in Popular Science Monthly for the Bausch & Lomb Model R microscope

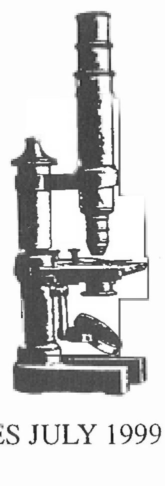
metal surfaces, postage stamps, insects, etc.

The Model R microscope was extensively advertised (Figure 8) in the 1930's, especially in the pages of *Popular Science Monthly*, which also ran articles of interest to the amateur microscopist. Note in the ad in Figure 8 that the New Gem Microscope, together with walnut case and "20,000-word book," sold for $14.50. The Model R microscope, together with "solid walnut case and 455-page book"—*Adventures with the Microscope*—sold for $21.00. The photomicrographic outfit, using 127 film, cost $12.00. The Gem Science Kit with microscope and 49-piece portable laboratory cost $9.50.

The three books mentioned are not scarce, but they are coming on the market less often, and the cost has gone up; *Adventures with the Microscope* is available in good used condition from a local dealer for $65.00. The microscopes themselves are very difficult to find, especially in mint condition. I found mine in an antique mall, and I know of only one other. These are the only ones I have seen in three decades of looking. Prices are commensurate with condition, scarcity, and knowledge of the dealer/seller.

Coincidentally, Charles Gellis has written a wonderful article on the technical aspects of the Gem, New Gem, and Model R microscopes, which can be found in the Spring 1998 issue of *The Journal of the Microscope Historical Society*, Vol. 6, #1 (Editor: Manuel del Cerro, M.D., 14 Tall Acres Dr., Pittsford, New York. Tel. 716-381-4658 (H); fax 716-244-5667). I recommend this Society and journal to anyone interested in any aspect of older microscopes, related books, and accessories. The ads and illustrations in Charles Gellis' article are different from those here, and I highly recommend it to those wishing to read more about these wonderful old instruments made for amateur microscopists.

Older members of the State Microscopical Society of Illinois may recall, and newer members will be interested to know, that Julian D. Corrington was recipient of the Honorary Award of the State Microscopical Society of Illinois for his contributions to amateur microscopy; the award was made in the year Skip Palenik was SMSI President.



CORRECTION

The drawings that should appear in Joseph G. Barabe's article, *A Microscopical Approach to Writing Sequence Determination,* on p. 27 of μ • *NOTES* Vol. 2 No. 2 appear below.

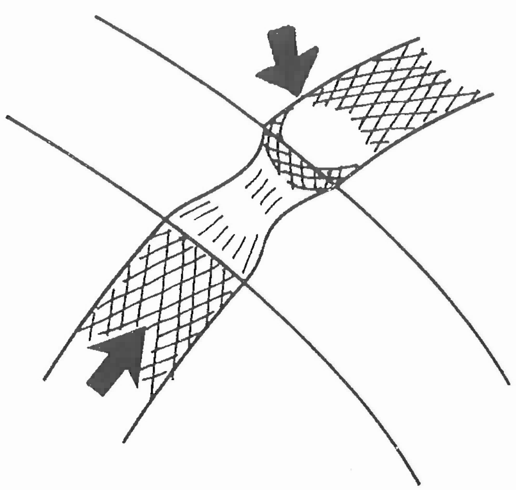


Figure 3. Skipping

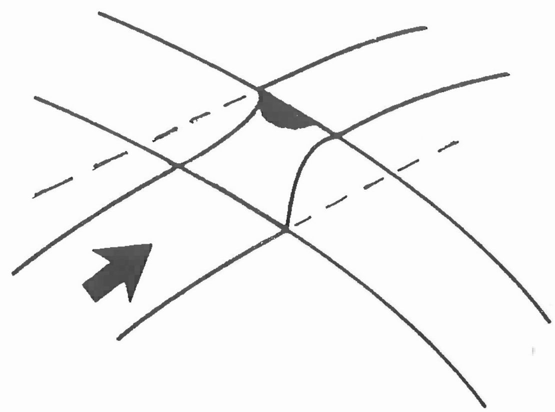
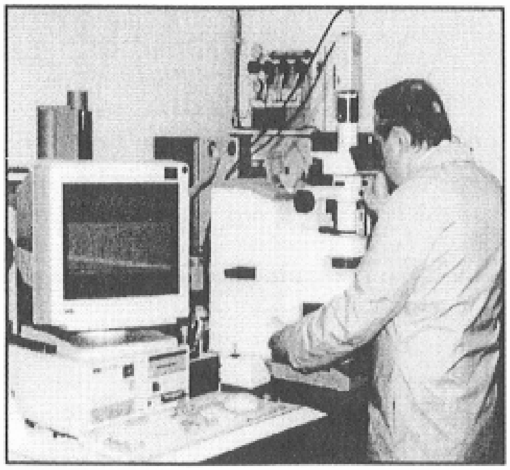


Figure 4. Jogging

Case History #M-368

Failure of Black Paint Coating

A consumer products manufacturer experienced a premature coating failure, and suspected that the wrong paint carrier system was used during the finishing operation. Using micro pyrolysis techniques with FTIR microscopy, *Microspec Analytical* was able to match the coating from the failed part to one of several possibly used at the facility.



Case History #M-519

White Corrosion on Hinges

An office furniture manufacturer noticed white deposits developing on hinges inside one of their products. Optical microscopy combined with microchemical analyses showed the deposit to be zinc oxide. The project was completed in a manner of minutes.

MICROSPEC
ANALYTICAL

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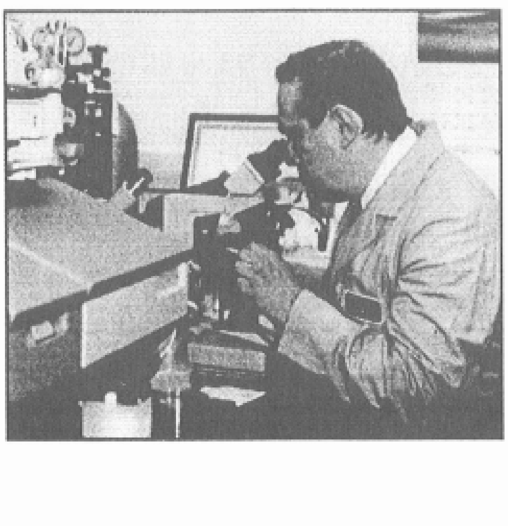
Internet: *www.mspec.com*

Case History #M-699

Industrial Fire Investigation

Optical microscopic examination of debris from the source of a fire at a furniture manufacturer showed pigmentary iron oxide. Micro extraction revealed a combustible oil. Sparks from a welding torch apparently ignited a container of dried wood stain that still had enough oil content to start a fire.



Case History #M-947

Particles in Powder Coatings

A metal finisher experienced occasional fiber contamination on finished parts. Though a powder coating was suspected as the source, no visible contaminants were obvious. *Microspec Analytical* was able to isolate and identify several types of fibers by optical and FTIR microscopy.

SMSI Treasurer's Report - 1998

Susan N. Young*

Income		Expenses	
Dues	$582.00	Meeting fliers, postage	$703.01
Interest	$294.64	Meeting refreshments	$1,388.60
1998 Auction (receipts-expenses)	$3,966.50	Meetings, honoraria	$600.00
Silent Auction (Amateur Night)	$166.00	Award medals	$2,000.00
Workshop net (receipts-expenses)	$166.66	Picnic	$75.00
Meeting receipts for refreshments	$1,077.00	μ-Notes, preparation	$980.00
1997 Auction (late receipts)	$275.00	μ-Notes, printing	$2,087.00
1997 Silent Auction (late receipts)	$41.00	μ-Notes, envelopes & postage	$302.08
Pin sales	$110.00	Commemorative pins	$1,175.00
		Members' directory printing	$330.00
		Prize for Amateur Night	$25.00
		Errors found in 1997 records	$175.03
Total Receipts	**$6,678.80**	**Total Expenses**	**$9,840.72**
Opening Balance	**$14,821.77**		
Ending Balance	**$11,659.85**		

*Corn Products International/Moffett Technical Center, 6500 Archer Rd., Bedford Park, IL 60501-1933

Émile Chamot: The Man Behind the SMSI Award

Richard Hoyt Lee*

Who is the person for whom we name the annual SMSI award for excellence in microscopy in the USA? Émile Monnin Chamot ("Chammy") was a native of Buffalo, New York, and enrolled in Cornell University in 1887. He was awarded the B.S. degree in 1891 and did his senior work under G.C. Caldwell, the first head of the Chemistry Department.

Caldwell possessed two light microscopes which he applied to the study of various crystalline phases he had prepared. Chamot was appointed instructor in 1891 and continued graduate studies with Dr. Caldwell, qualifying for the doctorate degree in 1897. His interests in the organic aspects of microscopy and toxicology were stimulated by Caldwell and a classmate, Lomax. Although Chamot then traveled to Europe to work with Behrens at Delft, he became perhaps Behrens' first pupil of inorganic qualitative microscopical analysis.

Upon returning to Cornell as assistant professor, Chamot initiated courses in chemical microscopy, for which Cornell was to become a center. Chamot also rendered to the community valuable service as a consultant in sanitary chemistry and proper water purification treatment. In 1910 he was promoted to Professor, teaching courses in microscopy, toxicology, and sanitary chemistry. When sanitary chemistry and toxicology were transferred to other departments, he concentrated on microscopy and metallography. Chamot published the pioneering book, *Elementary Chemical Microscopy,* in 1915 and another book with C. Mason, *Handbook of Chemical Microscopy,* in 1930. He was instrumental in planning the instruction and building the microscopy laboratories for the Department of Chemistry at Cornell. When the bachelor of chemistry degree was established in 1911, microscopical methods were made a part of the curriculum. During World War I, Professor Chamot carried out an extensive study of explosive primers for the Ordinance Department.

Chammy loved the outdoors and enjoyed hunting and fishing for trout. He always walked to the laboratory and was remembered as a small, quiet and friendly person. Because of his enormous store of knowledge, he was in demand as an expert consultant. After 53 years of association with Cornell from student to Emeritus Professor, he died in 1950 . Only his modesty would prevent him from being credited with creating the field of chemical microscopy and "preaching" its value.

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Mason, C.W., *Industrial and Engineering Chemistry* (Analytical Edition), **June 15, 1939**, *11* (6), 341-3.

*Argonne National Laboratory, Argonne, IL 60439

A Microscopist and His Shadows

Leo Barish*

My career in microscopy began as a child when I received a gift of a rudimentary polarizing Gilbert microscope. I found most fascinating viewing subjects such as pond water; thus the microscope awakened an interest in science. However, as years went by, my interest in science waned and shifted towards music; I wanted to become a professional musician, both classical and popular. I earned a relatively good salary for a young kid by playing clarinet and saxophone in bands. This interest continued through high school, and I had hopes of studying music in college. However, I didn't have enough money and would have to depend on a scholarship to attend such a school which, unfortunately, fell through. Although a major disappointment, the predicament awakened me to the realization that a career in music was not really a practical profession for me; and I decided to pursue my secondary interest: science.

I could only afford to attend a state college and live at home. Under these circumstances, I studied textile chemistry and graduated with a B.S. from the only college available to me, New Bedford Textile Institute that eventually became University of Massachusetts, Dartmouth. One of the formal courses offered there was microscopy. I then attended graduate school on a fellowship at Lowell Technological Institute that eventually became University of Massachusetts, Lowell. A course given to me there was in TEM. I received an M.S. in Textile Chemistry from Lowell. Nevertheless, throughout my college education I played in bands which was very helpful to supplement my meager income.

Upon graduation from Lowell, my friendly draft board finally caught up with me, and I was inducted into the U.S. Army Chemical Corps. Luckily, I was not shipped to Korea but actually enjoyed my assignment in England where I lived in Oxford.

Upon my discharge, I accepted a position as a Research Associate with Fabric Research Laboratories, later to become Albany International Research Co. I was involved in many projects, one of which was the study of the morphology of polymers and fibers which required quite a little work with PLM (measurement of birefringence, growing spherulites, hot stage work, etc.). This subject was taught to me by Freddy Khoury and I became proficient at it. Although I was not the principle microscopist of the lab, I took many photomicrographs, not only for my projects, but some for my colleagues as well.

John Facq was the principle microscopist at the lab and he was superb. His specialty was metal shadowing for light microscopy to exhibit surfaces. Although he did not teach this procedure to me directly, I was well aware and appreciated the metal shadowing technique as applied to light microscopy since I had learned an analogous method in the TEM course that I took in graduate school.

Shortly after John left the lab, I was called into the director's office. He told me of his decision to assign me as a dedicated microscopist to the lab. At the time I was not at all pleased with this assignment since I felt that I would be "pigeon-holed" into a narrow restricted field, acting merely as service to the lab and thus would be precluded from challenging innovative work. How wrong I was! Working in this position I quickly realized that I was really not that good a microscopist; therefore, to improve myself I read extensively on this subject, practically memorizing Shillaber's *Photomicography*. In addition, I practiced and experimented diligently on applying metal shadowing techniques to light microscopy and, in doing so, innovated valuable variations. This elegant method was most useful for displaying surfaces, and I still find it surprising that it was not as popular in the field as it should have been.

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Although the results of metal shadowing were generally very effective, it did suffer from a few problems: productivity was low, the depth of field was shallow, and it did take a great deal of skill to do it well. The advent of the scanning electron microscope corrected the above problems and eventually made the metal shadowing technique rather obsolescent. For several years I tried to convince management to purchase an SEM until we finally got one. Although relatively inexpensive, our SEM was one of the few available at that time that worked well at low accelerating voltages and so was especially valuable for low atomic number, low density subjects, such as textiles, which also had a high tendency to charge.

Although my encounter with SEM has been generally satisfactory, I found shortcomings present that in some ways SEM was inferior to the metal shadowing methods applied to light microscopy. Through the years many methods were produced to correct these deficiencies, and I have published or made presentations on most of these.

The background of some subjects was often obtrusive with SEM which led me to develop "Black Hole" techniques which largely eliminated the problem. Another obstacle with SEM was that the topographical contrast was low in many subjects, certainly inferior to that obtainable with metal shadowing techniques. By augmenting the backscatter mode, I could largely match the contrast of SEM to that of metal shadowing.

When imaging textiles with SEM, several problems can be encountered, principally charging and bright edge effects. The problems were analyzed and were largely corrected by the use of a low accelerating voltage which was not as popular years ago as it is today. Another problem with SEM noted was with the use of Polaroid type 55 P/N film. When the film was developed for the time recommended, inversion occurred on the negative at low exposure levels: A negative image actually became positive. By merely increasing the developing time, satisfactory negatives resulted. Mounting some specimens on studs for SEM can often be difficult; methods employing the common glue gun were developed and found to be very convenient.

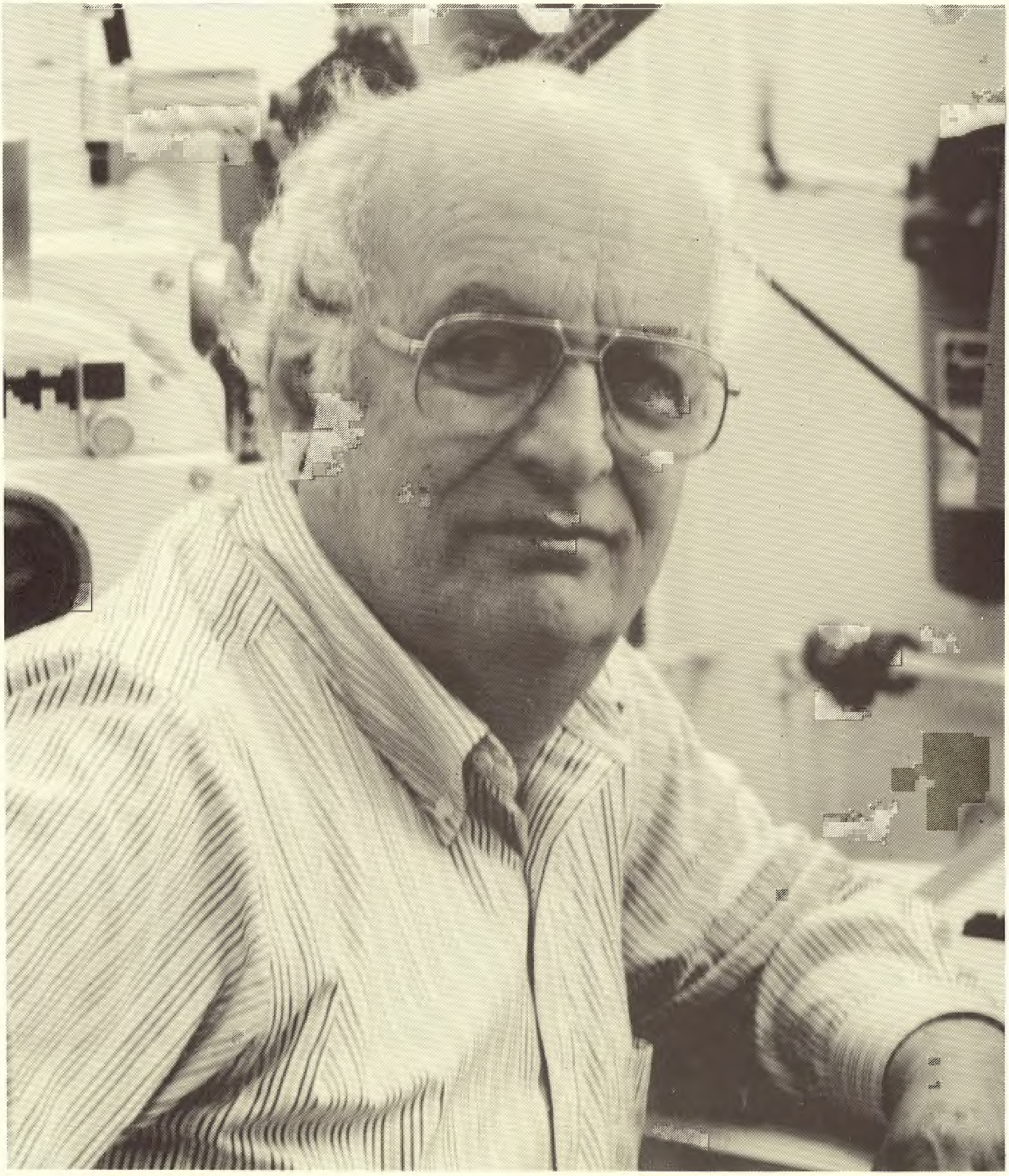
It is often advantageous to display micrographs in color. Since images in the SEM are basically in black and white, it is sometimes beneficial to colorize them. Today this is commonly done with Photoshop or similar software. Years ago I developed a method to colorize SEM's using photographic methods employing filters and double exposing.

A problem encountered with SEM is that the minimum standard magnification is often too high. To further lower magnification, I found it sometimes necessary to revert to metal shadowing techniques or sputter coated surfaces with tent lighting. Several methods were developed to lower the minimum magnification with the SEM. These included fabricating photomontages, extending the normal working distance, or adapting the ECP (Electron Channeling Pattern) mode for imaging. Advantages of the latter method is that an almost unlimited depth of field is created with a magnification of less than 1X.

In addition to overcoming problems with the SEM, I have applied this instrument to study the structure of natural fibers including medulated wool, coir (coconut) fiber, and hog bristles. The degradation of polypropylene fibers by sunlight was reported in a series of papers. Even the study of the intricate structure of a butterfly wing was astounding.

I have also published on the applications of light microscopy. Among these are: a study of failure in tire cord; the development of a stereo-macroscopic technique to study coatings on cotton fabrics; a study of chromogenic film for microscopy; and the application of sputtercoating and tent lighting. In addition, smoke and soot were found to be useful for surface enhancement in light microscopy; and by using the Bertrand Lens, the minimum magnification of a light microscope can be lowered considerably with an almost limitless depth of field.

1999 State Microscopical Society of Illinois
Émile M. Chamot Award Recipient



Leo Barish