The CAC News

News of the California Association of Criminalists • Third Quarter 2000

The uncritical acceptance of the intellectual climate common to our own age and the assumption that whatever has gone out of date is on that account discredited. You must find out why it went out of date. Was it refuted (and if so by whom, where, and how conclusively) or did it merely die away as fashions do? If the latter, this tells us nothing about its truth or falsehood. From seeing this, one passes to the realization that our own age is also a 'period', and certainly has, like all periods, its own characteristic illusions. They are likeliest to lurk in those widespread assumptions which are so ingrained in the age that no one dares to attack or feels it necessary to defend them.

— C. S. Lewis

LISA**BREWER**

Contributions

!t is the active participation of its members that makes the CAC an outstanding professional organization.

The Third Joint Meeting of the California Association of Criminalists and The Forensic Science Society was definitely memorable for those in attendance. The location was excellent: Napa Valley is gorgeous, the weather was beautiful and the wine wasn't too shabby. The FSS members in attendance saw California in all its glory. The program covered an interesting variety of topics thanks to the outstanding contributions of the members of both organizations. The success of this meeting was due to the efforts of many individuals. Specifically, I'd like to thank Brian Wraxall and the SERI staff for their tremendous efforts in presenting the CAC and the FSS with an informative and thoroughly enjoyable meeting.

The banquet was a festive occasion that concluded with an exchange of gifts. The CAC presented to the FSS a glass bowl etched with a decorative combination of the CAC logo, FSS coat-of-arms, joint meeting logo and grape leaf pattern. It loses something in the description, but you can see a picture of it on the following page. The FSS presented the CAC with a watercolor of "Clarke House," the FSS office in Harrogate, North Yorkshire. The artist, Carol Rudram, was in attendance with her husband, FSS member Dave Rudram. The watercolor will add a touch of class to the CAC office once it is found.

I would like to thank all the members of the 1999-2000 Board of Directors for their hard work and efforts on behalf of the CAC. Specific recognition and thanks go to the following retiring board members: Hiram Evans, now immediate past president, who worked tirelessly on CAC's interests at both the state and national levels; Ron Nichols, who concluded his board duties as immediate past president; Kevin Andera, who made the difficult duties of the recording secretary look easy; and Pennie Laferty who guided many applicants to membership as the membership secretary.

Speaking of membership, it is the active participation of its members that makes the CAC an outstanding professional organization. The valuable professional interaction and development opportunities afforded the members are due specifically to the volunteer efforts of individuals serving on various committees. I would like to thank these individuals for their time and efforts spent on behalf of the CAC. Those individuals, who are interested in serving on a committee, please contact me now. If you are unable to serve at this time, please consider serving in the future. The CAC will flourish only through the contributions of its members —*YOU!*

Lisa

Third Quarter 2000

C O N T E N T S

Focus on Microcrystals

On the cover: "Swirling in controversy" a couple of cocaine crystals (platinic chloride) are surrounded by an apt quote from C.S. Lewis, supplied by Hiram Evans.
Photo: John Houde/Calico Press

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Notice to Contributors: We publish material of interest to our readers and are pleased to receive manuscripts from potential authors. Meetings and course announcements, employment opportunities, etc. are also solicited. Advertisements are also accepted, although a fee is charged for their inclusion in *The CACNews*. Please contact the Advertising Editor for further information. Because of the computerized typesetting employed in *The CACNews*, submissions should be made in the form of MS-DOS compatible files on 3.5 inch floppy disks or by e-mail (mccombsn@hdcdojnet.state.ca.us). Text files from word processors should be saved as ASCII files without formatting codes, e.g. bold, italic, etc. An accompanying hardcopy of the file should be submitted along with the disk. Graphics, sketches, photographs, etc. may also be placed into articles. Please contact the Editorial Secretary for details. The deadlines for submissions are: Dec. 1, March 1, June 1 and Sept. 1.

Southern Regional Director's Report

On March 24, 2000, Kern County was host to a luncheon and study group meeting. The meeting, the first held in Bakersfield in a long time, was a complete success. The meeting featured a tour of the Equilon oil refinery and the new crime lab. The crime lab is very impressive and received good comments from those who toured the lab. The luncheon speaker was Kern County District Attorney Ed Jagels giving a rebuttal to the book "Mean Justice" by Ed Hume. The luncheon was attended by over 50 persons from crime labs from San Diego to Fresno.

The following topics were discussed:

- The crime scene study group met for the first time and preliminarily covered a list of possible formats.
- The Equilon oil refinery tour started with a brief but interesting lecture on the chemistry of oil refining and continued with a tour through the different parts and stages of the refining process.
- The trace evidence group covered FTIR microscopy, "Evaluation of the Human Hair Root..." article by Linch, Smith and Prahlow from the JFS, and round table discussions on interesting cases.
- The forensic biology study group discussed body fluid identification.
- The drug and toxicology study groups also met.

I was very pleased with the attendance and want to thank all of you who took the time out of a busy schedule to come to Bakersfield. I also want to thank **Greg Laskowski** and the rest of the Kern County DA staff who helped make this meeting such a success.

This is probably the first of a permanent switch to luncheon meetings instead of the old dinner meeting format. The next meeting is scheduled for June 21 in San Diego at the Old Town Mexican Cafe with study groups held at National University before and after the luncheon. The meeting hosts are **Celia Lukomski**, **Melinda Ronka**, and **Jeanne Parsons** from the San Diego Sheriff's crime lab. If you need any information on the meeting check the CAC website at www.cacnews.org. or call the SDSO lab at (858) 467-4600. The September meeting is being hosted by the Los Angeles Sheriff's crime lab and the December meeting will be hosted by the Orange County sheriff's lab.

Please note on the CAC website is a quick survey to see if you would prefer a luncheon meeting format to the dinner meeting format. Optionally, it may be left up to the hosts of the meeting. Please let me know. My e-mail address is jns44@hotmail.com.

—Jim Stam

Postcard from New York

The New York Public Library (*see photo*) has announced their selection of **CRIME LAB: A Guide For Nonscientists by John Houde** for their ***"Books for the Teen Age 2000"*** list. The list, now in its seventy-first year of publication, includes the best of the previous year's publishing for teenagers. All of the titles chosen have been read and reviewed by young adult librarians and recommended for this very special list.

In a separate announcement, the book recently won the "IPPY 2000" in the science category. This award is presented at the annual Chicago Book Expo America meeting by *Independent Publisher* magazine.

Congratulations To Our Members

Scott Lewis—on the birth of his baby girl, Born April 10, 2000

Walter McCrone—on receiving an award in analytical chemistry from the American Chemical Society (see below).

Lucien Haag—on receiving the *Paul Greene Award* from the California Association of Criminalists

Walter McCrone Wins ACS Award in Analytical Chemistry

Dr. Walter McCrone received the ACS award in analytical chemistry.

Sponsored by Fisher Scientific Company, the ACS award recognizes and encourages outstanding contributions to the science of analytical chemistry, pure or applied, carried out in the United States or Canada.

The award consists of $5,000 and an etching. The traveling expenses of the recipient incidental to the conferring of the award are paid.

The award was established in 1947 by the Fisher Scientific Company and nominees must be residents of the United States or Canada and must have made an outstanding contribution to analytical chemistry.

Dr. McCrone may be best known for his work on the shroud of Turin. He is director emeritus of McCrone Research Institute in Chicago.

Stuff seen on the //WWWEB

(Accuracy not verified)

Criminalist II - DNA Analyst

Charlotte-Mecklenburg, NC
Police Metro-Crime Laboratory
Salary Range $41,727 - $49,091 DOE

Qualified Candidates must pass a background investigation, drug testing and polygraph examination:

Knowledge of forensic DNA principles and laboratory procedures and the ability to implement these principles and procedures in the Crime Laboratory; specific knowledge and experience with PCR and STR analysis; knowledge of laboratory safety regulations and quality assurance procedures; ability to examine, identify and analyze various types of physi-

Calico Press

cal evidence, especially body fluid evidence; ability to interpret results and testify in court. This position requires the following education and experience: a Bachelor of Science Degree in biology, chemistry, or forensic science with a minimum of 12 semester or equivalent credit hours of biochemistry, genetics, molecular biology and statistics or population genetics and at least three years experience in a forensic DNA laboratory. Graduate level education can be substituted for experience.

All interested candidates should contact: Jane Burton, Chief Criminalist, Charlotte-Mecklenburg Police Department, Crime Laboratory, 601 E. Trade Street, Charlotte, NC 28202. Phone: (704) 353-1101 Fax: (704) 353-0088. E-mail: jburton@cmpd.ci.charlotte.nc.us

Senior Criminalist

Forensic Analytical, a leading private criminalistics laboratory on the West Coast, has a unique opportunity available for an experienced criminalist. Working in the private sector with highly respected Forensic Scientists in the industry, the successful candidate will be responsible for casework in traditional areas of criminalistics, and have the opportunity to help shape a growing reliance on private sector support to both the prosecution and defense.

The candidate must possess a degree in a physical science and /or Forensic Science, and a minimum of five years of experience within the criminalistics profession, preferably with trace evidence knowledge, skills and abilities. Firearm examination expertise is highly desirable.

Forensic Analytical is an Equal Opportunity Employer, offering a competitive benefit package, and an excellent opportunity to practice criminalistics in the private sector. Please forward your resume and salary history to our Hayward address. Salary commensurate with experience.

For further information, contact: David Kahane, Forensic Analytical, Principal, 3777 Depot Road, Suite 409, Hayward, CA 94545. 1-800-827-3274, e-mail: dk@forensica.com, Carol Hunter, Forensic Analytical, Laboratory Supervisor, 2959 Pacific Commerce Drive, Rancho Dominguez, CA 90221. 310-763-2374 e-mail: chunter@forensica.com

Forensic Scientist III-Firearms and Toolmarks

Kansas Bureau of Investigation, Human Resources 1620 SW Tyler St. Topeka, KS 66612-1827 (785) 296-8247

Firearm and Toolmark Section Chief

$56,227-$84,231

Mississippi Crime Laboratory 1700 E. Woodrow Wilson Ave. Jackson, MS 39216 (601) 987-1600

Two Websites of Note:

The Virginia Institute of Forensic Science and Medicine

www.vifsm.org/hta2000.html

Kern County Jobs

www.co.kern.ca.us/person/jobs/bulletin.htm

CAC's Gift of Fine Art

Two views of the gift from the CAC to the FSS at the recent Joint Seminar.
Photos by Peter Barnett

BARFAA 2000

Seventh Annual Midwest Bioarchaeology and Forensic Anthropology Association

University of Missouri - Columbia, October 20-22, 2000

The seventh annual meeting of the Midwest Bioarchaeology and Forensic Anthropology Association will be hosted by the University of Missouri's Anthropology Students Association. The meeting will consist of formal and informal papers, open discussions and posters, and workshops offered by MU faculty. "Works in progress" and posters are strongly encouraged, as is student participation. Like past meetings, the goal of the conference is to provide an informal forum for osteologists, forensic anthropologists, and bioarchaeologists to present and get feedback on current research, methodological advances, and specimens of particular interest.

Abstracts: Electronic submission of abstracts is preferred. Either e-mail the abstract or attach it to an e-mail to mubarfaa@netscape.net. Send snail-mail abstracts to:ASA - BARFAA abstracts , Department of Anthropology, University of Missouri, 107 Swallow Hall, Columbia, MO 65211. Abstract deadline: September 15, 2000 (postmarked). Deborah Cunningham, dlcfcb@mizzou.edu or Catherine Chmidling chmidling@usa.net, or contact us at 573-882-4731.

Help Wanted— DHS Liason

The CAC needs your help. If you are interested in forensic alcohol issues, and want to help mold the future of alcohol testing in this state, consider volunteering as the Forensic Alcohol Liaison to the Department of Health Services. The position may involve travel to exotic locations (like Sacramento), providing input for new or changing regulations, and you may even get to assemble your own committee. This is actually a joint position, representing the interests of both CAC and the California Association of Crime Laboratory Directors (but don't let that scare you away). Besides, think of what this would do for your voir dire in court the next time you testify!

For more information, please contact **Jeff Thompson** at the Scientific Investigation Unit of the Huntington Beach Police Dept. at (714) 374-1582 or email: thompsoj@surfcity-hb.org.

Jeff's the current liaison and will be stepping down after 5 years of service.

NANCY**MCCOMBS**

To the General Scientific Community...

Scientific Working Groups seem to be popping up left and right for this or that, groups of approximately 20 individuals recommending minimum "standards" and guidelines for us to follow. The intent is understandable: to ensure quality in collecting, processing, analyzing, handling, reporting, testifying etc., etc. But have SWGs lost track of their own scope?

Because of constant changes in science and technology, we are continually faced with an "out with the old, in with the new" mentality. Memorably, forensic science experienced this during the "Line Counting Wars" which stirred up firearms examiners in the '50's and '60's and continues to do so today. Then began "Starch Wars" in the '70's and '80's with the disputes between multi-loci vs. single-locus techniques still persisting, only now it's in DNA. Now what's the hottest controversy? The "Crystal Wars."

Although there will always be those in our field who do not welcome change, most of us are scientists and welcome any new technology that will improve our profession. Yet despite the introduction of new methods and techniques, the old, unsophisticated practices are often the best choices in many situations and for many laboratories.

Because of constant changes in science and technology, we are continually faced with an "out with the old, in with the new" mentality.

As long as new developments and techniques arise, so will the so-called "Scientific Wars." The question is, will the latest participants on the battlefield, the forensic "governing bodies," be allies or foes to forensic science? Will the recommendations made by these small groups of individuals be acceptable to the entire forensic science community?

As "minimum standards" and "guidelines" continue to surface, let us not forget that we are the general scientific community. Old science is not synonymous with bad science, and new techniques are certainly not always better techniques.

Nancy

F E E D B A C K

The *CACNews* prints letters to the editor that are of interest to its readers. We reserve the right to edit letters for brevity and clarity. All submissions to this page become the property of the *CACNews*.

SWGDRUG Responds

Editor:

Substantial changes recently have been made to the Methods and Reports Subcommittee Proposals issued for public comment last October. Current revisions do accommodate microcrystalline tests with proper documentation within an analytical scheme. These changes were made at the May 1 - 2, 2000 SWGDRUG Core Group Meeting which discussed the Methods and Reports Subcommittee document and public comment received about it.

Current versions of all SWGDRUG proposals and related information may be viewed at www.swgdrug.org

—Jerry Massetti
SWGDRUG Methods and
Reports Subcommittee Chairman

An Open Letter to SWGDRUG

Editor:

I have been discussing the proposal of the Methods and Reports Subcommittee of SWGDRUG with my colleagues here in California and I must write to comment on this proposal. My comments are directed towards the part of the proposal that does not allow the use of multiple microcrystal tests to identify controlled substances.

I am the Officer in Charge (Senior Criminalist) of the San Francisco Police Department Crime Lab and I oversee supervision of the Narcotics Unit. Our laboratory examines approximately 12,000 narcotics cases/year. We are mandated by the Mayor's Office and the City Attorney's Office to provide daily (Sunday-Saturday) service and 24-hour turnaround time for all narcotics cases, due to jail overcrowding issues.

For over 40 years, microcrystal tests have been used in this laboratory as one of the primary methods employed to positively identify common controlled substances. These tests are rapid and reliable and provide our customers with the results they need in a timely fashion. Furthermore, this methodology is blessed by the consensus-based ASTM and AOAC. I am unaware of any published research which challenges the reliability of this methodology. Our vigorous defense bar has not yet successfully challenged our narcotics testing methodology.

I am additionally concerned when a proposal seems to usurp my responsibility as a manager to choose, among reliable methodologies, one which best meets my customer's needs. Local crime laboratories must be allowed to exercise this type of self-government.

My question is: If a methodology is not flawed, why "fix" it by adding some other methodology? How do I explain this to my staff? And how do they explain it to the triers of fact?

Please let reason prevail and recognize that the practitioners who employ microcrystal tests are already using a reliable confirmatory methodology.

Martha Blake
Senior Criminalist
San Francisco Police Dept.

Another 'New' vs 'Old' Technology Debate

Editor,

I recently read an article questioning yet again the use of digital cameras at crime scenes. I'll share my rebuttal to that article with the membership because I think it may provide a starting point for discussion here.

The dispute about how easily digital images can be altered reminds me that this debate is not really new. Decades ago, the story goes, Pablo Picasso was shown a photograph of himself. The photographer proudly asked the famous painter how remarkably realistic this new technology was. "I don't think it's very realistic at all" Picasso complained, "I'm much bigger than this picture."

All Photos Are "Unreal."

As a nearsighted individual, I see very poorly without my spectacles, but if I focus my camera (film or digital) correctly, the picture comes out sharp. That's not the way I saw the scene, but couldn't one say that I have "altered" the image? If the scene was too dark, I may use a flash or high-speed film, or I may lighten the picture in Photoshop. Have I altered the picture? We should be asking, "Does the picture meet the requirements of the court, namely that it "fairly and accurately depicts the object or scene at the relevant time?" If I say under oath that it does, then shouldn't my photo be admitted into evidence? If not, then on what legal basis is it being excluded? Simply because it can be altered easily? I hate to burst anyone's bubble, but the vast majority of documentary and physical evidence can be altered easily. (Ever hear of backdating an application?) If I intentionally add or delete objects in an evidentiary picture I have committed fraud.

Unreal Photos Are Not Necessarily Bad.

People are accustomed to looking at "altered" photographs and generally understand that when they see billboards or black and white surveillance photos that these are not windows, but only representations. A telephoto lens on either a film or digital camera will foreshorten distances and wide-angle lenses distort landscapes and bend tall buildings. There is nothing sinister about this; it's just the limitations of applying optics and two-dimensional photography to our three-dimensional world. Thirty-five years ago, when my father was a crime scene photographer, color photos were not allowed in the courtroom. It was felt that blood looked "too red" and would "inflame the passions of the jury." Have we come so far?

The author of the critical article correctly points out that digital photos do not degrade with time or repeated copying, but he misses his own point. If film degrades with time, isn't it becoming "altered?"

Ethical Witnesses Don't Manufacture Evidence.

I share the author's fear of an unscrupulous digital "artist" placing a book of matches into a crime scene photo, for example. But this kind of behavior is a weakness with any type of physical evidence. Witnesses are examined under oath and their truthfulness evaluated by the jury. Our system of justice allows opposing sides to place evidence in front of a jury who act as "lie detectors." They have always had the burden of giving the appropriate weight to the testimony they hear.

It Boils Down to Credibility.

It is a red herring to say that the ease of altering digital images renders them suspect. I have shown here that all photography is image manipulation. The crucial issue is whether the photograph fairly and accurately depicts the scene. That fact can only be proved by the testimony of the photographer. The penalties for faking a crime scene picture are severe. Adding an electronic means to detect alterations is not the solution. Can the electronic "watchdog" tell if I have intentionally pointed the camera away from important evidence before clicking the shutter? It is the testimony of the witness and how it is believed by the jury that matters most. Let's not be fearful of embracing this new technology. Traditional film won't be around long and digital is here to stay.

—John Houde
Ventura

Microcrystals Used to Identify GHB

Editor,

I read Ron Nichols' open letter on SWGDRUG's microcrystal policy in the last issue of the *CACNews* with great interest, and I agree with his position. When I heard that the next issue of the newsletter would focus on crystal tests, I decided I wanted to speak up in favor of this technique as well. My experience focuses on a relatively "new" controlled substance: gamma-hydroxybutyrate (GHB).

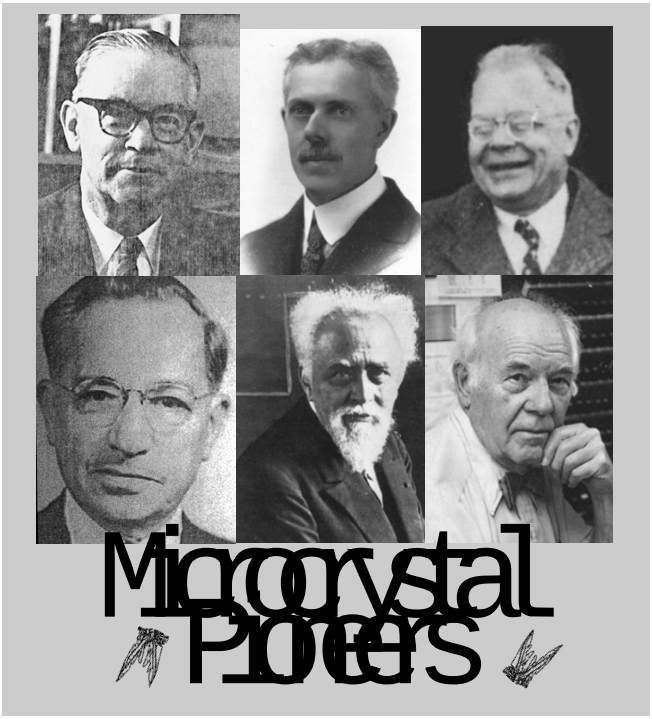
After doing some research with GHB and helping revise the GHB methodology at our lab (Orange County Sheriff-Coroner) to keep current with California law, I have learned a few things about the difficulties involved in analyzing it. Various factors such as impurities in the sample, presence of gamma-butyrolactone (GBL) and the extremely hygroscopic nature of the compound can make this a very difficult controlled substance to analyze. Identification by GC-MS or GC-IRD requires derivitization because GHB converts to GBL on the column. Preparing the derivative takes at least 30 minutes, while removing water from the sample before derivitization may require another 30 minutes or more. FTIR identification is hampered by GHB's ability to quickly absorb water from the air: after drying, the sample may pick up enough water to ruin your spectrum in the time it takes you to prepare the KBr pellet. It usually takes me at least 15 minutes to get a good FTIR spectrum, not counting the time it takes to dry the sample.

One test *is* quick, easy and accurate: the silver/copper crystal test I developed with Hiram Evans and Catherine Wojcik at the San Bernardino Sheriff's crime lab. It can be used directly on an aqueous sample of GHB (which usually is submitted as a liquid), requires only a very small amount of sample, is complete within 5 minutes and is specific to GHB. It does have the drawback of interference from impurities in the sample, but at least you know within 5 minutes that it isn't working. Having spent over an hour trying to obtain an FTIR spectrum on certain samples, I know I prefer a 5 minute test. Several labs in California use crystal tests as their primary means of identification for certain drugs because of their high degree of accuracy. So far I have not found any other compounds that give the same crystals with this reagent as GHB, so I have a good deal of confidence that it is a very accurate test.

I would encourage any scientists who have to work with GHB to take some time and experiment with it to see if you can find more crystal tests for identification. Believe me, the time you take to develop them will be made up in the analysis time saved. I will offer my time to coordinate research efforts across several laboratories if necessary. Feel free to contact me if you have any questions about GHB crystal tests.

—Kevin Andera
kma@fss.co.orange.ca.us

ED JONES'
FACE GAME



Try to identify these famous and not-so-famous figures in the development of microcrystal tests.
Answers inside this issue.

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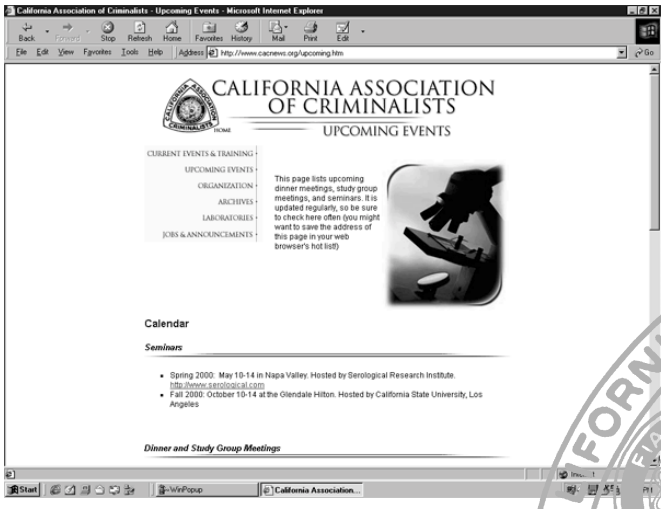
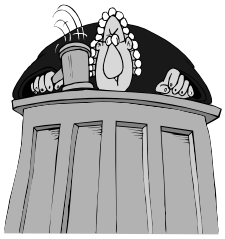
www.cacnews.org



it's just about us



Courtroom Calamities

Relating to trace evidence transfer:

Lawyer: "If the tip of an AVERAGE LENGTH penis touched the anus of another person, would you consider that "close contact"?

Criminalist: "Counselor, what you described would DEFINE "close contact"!!

—Robert M. Thompson

* * *

Lawyer: "Do you only testify for the prosecution"?
Criminalist: "Today I was called by the prostitution"

—Frank Healy

* * *

"After testifying for hours in a one room courthouse, the judge, prosecutor and defense attorney thanked me for driving such a long distance. . . as I exited the courtroom I realized I had entered a broom closet."

—Mike Waller

* * *

Lawyer: "Isn't it true that handwriting identification is not an exact science?"
Document Examiner: "Could you give me an example of an exact science?"
Lawyer: "Mathematics for instance"
Document Examiner: "Then sir, what is one apple plus one orange?"

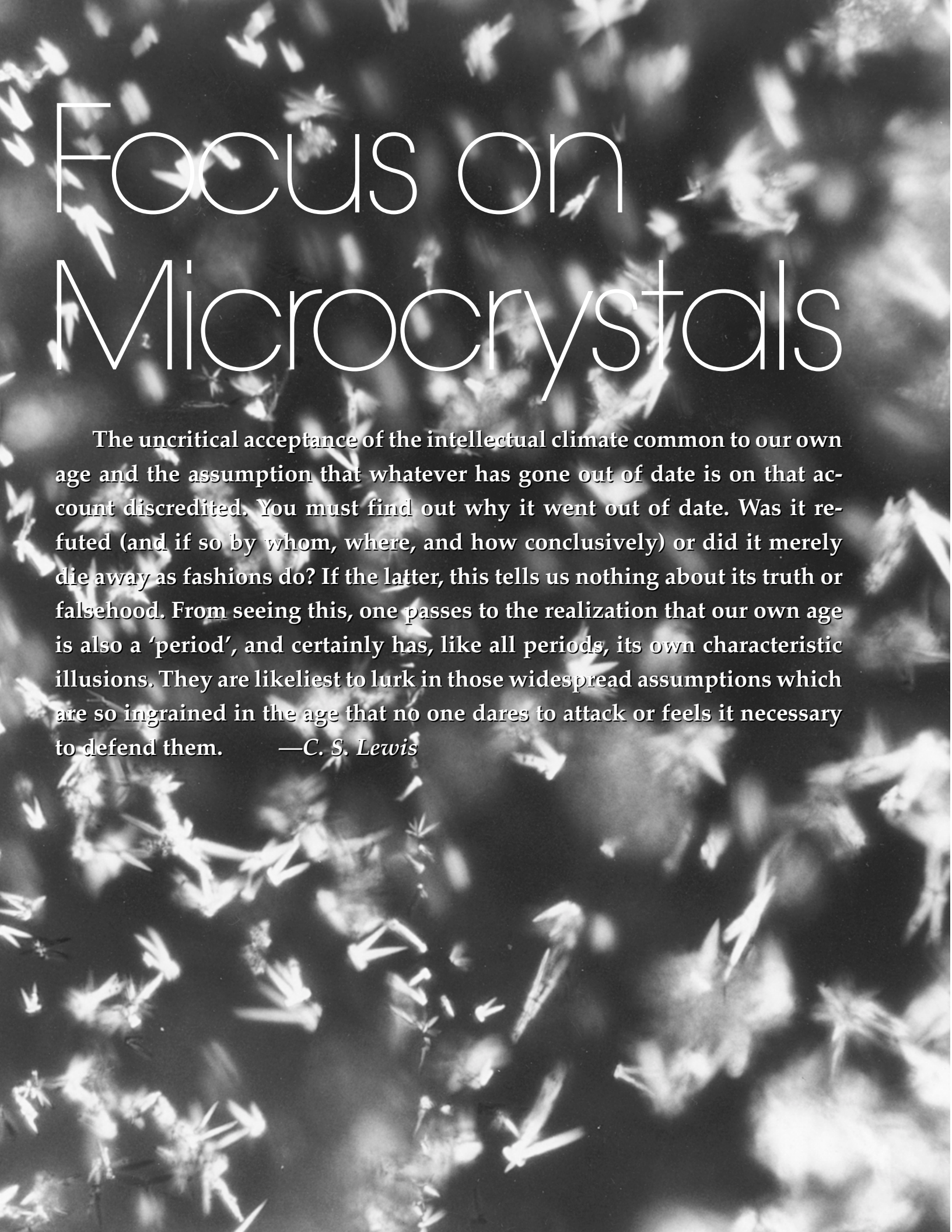
—As told by Marty Blake about a colleague.

* * *

If YOU have a Courtroom Calamity to share (and the statute of limitations has expired) please send them to:
Nancy McCombs, Editor :mccombsn@hdcdojnet.state.ca.us

FACE GAME

Answers: (l-r, top) Paul Kirk, Emile M. Chamot, Charles C. Fulton. (l-r, bottom) Harold F. Schaeffer, Theodore Wormley, Walter C. McCrone.



Focus on Microcrystals

The uncritical acceptance of the intellectual climate common to our own age and the assumption that whatever has gone out of date is on that account discredited. You must find out why it went out of date. Was it refuted (and if so by whom, where, and how conclusively) or did it merely die away as fashions do? If the latter, this tells us nothing about its truth or falsehood. From seeing this, one passes to the realization that our own age is also a 'period', and certainly has, like all periods, its own characteristic illusions. They are likeliest to lurk in those widespread assumptions which are so ingrained in the age that no one dares to attack or feels it necessary to defend them. ***—C. S. Lewis***

A Brief Background and Justification for the Continued Use of Microcrystal Tests

Wayne Moorehead, F-ABC

Absract

This paper defends the use of microcrystal tests. Briefly covered are the historical beginnings, the theory of reaction mechanisms, and the minimum required for documentation of the analyst's observations for case notes followed by responses to some of the objections raised by opponents of using microcrystal tests for drug analysis. Whether examining crystals forming on a microscope slide or reading a spectrum, the analyst has to be properly trained, actively thinking, and suitably motivated to obtain accurate results. As scientists, we should continue the use of microcrystal testing as an analytical tool.

Introduction

Recently there has been much discussion and misinformation about the use of micro-crystal tests or chemical microscopy. Most of those disapproving of these tests show their ignorance of chemistry, of the use of the tests, and of the philosophy behind their use.

Micro-crystal tests primarily involve precipitation reactions, something taught in many freshman level college courses. Chemical microscopists take the typical precipitation test one step further by looking at the reaction product microscopically to obtain specific information about the species. For some unknown reason, looking at the reaction product has become forbidden. These same precipitation principles were used to extract drugs and chemicals from plants before World War II (Culbreth 1927), before instrumentation and synthetic chemistry began in earnest. Chemical microscopy was used to assist in the elucidation of structures of organic chemicals prior to the commercial introduction of instrumentation. One need only examine organic chemistry, pharmacology, and drug books from the early part of the 20th century to prove that organic chemical structures were known. Even though instruments were being produced, Schneider (1964) in *Qualitative Organic Microanalysis,* referring to structural elucidation of truly unknown organic compounds, stated:

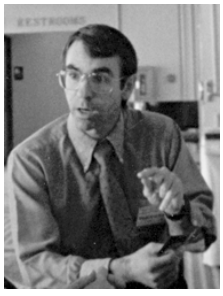
> *"In fact, as can be seen from the following pages, considerable time and work can be saved if a microscope is used. Its use is not restricted to identification of crystalline form but includes the observation and measurement of other properties such as refractive index and extinction directions. As investigation of the optical properties of various carbon compounds and their tabulation continues, these properties will become of greater importance in the identification of the compound and will permit further reduction in the time required for identification."*

Precipitation reactions observed with the microscope began as early as 1742, when Henry Baker in *The Microscope Made Easy* discussed observing salts forming out of mineral water (Fulton in Clarke 1961). Approximately 80 years later, FV Raspail is believed to be 'the first' to perform chemical microscopy. In Europe, sometime between 1820 and 1830, chemical microscopy for drugs and poisons began (Stewart & Stolman 1961). Over the proceeding years, as alkaloids were discovered, methods of micro-chemical identification were developed for their identification. One of the earliest books on chemical microscopy in the United States, was the book by T.G. Wormley, *Micro-chemistry of Poisons*, published in 1857. There have been many books written or containing chapters about chemical microscopy including Holland (1905), Stephenson (1921), Behrens-Kley (1922), Chamot & Mason (1940), Benedetti-Pichler (1964), and Fulton (1969). Journal articles concerning chemical microscopy are too numerous to mention.

Two Types of Tests

Philosophically, there are two types of tests for unknowns. The first is to identify a compound "to discover the structural formula of the unknown so that it becomes fully known"(Fulton 1969). Prior to the use of instrumental techniques, attempts at derivatization of the unknown then measuring various properties of the new material were performed (Behrens-Kley 1921, Schneider 1921). A chemical microscopist could employ the microscope to obtain morphological, crystallographic, and optical properties of the material in addition to determining if the unknown substance had polymorphic forms. If the derivatization was not successful, you ended with the starting material and still gained useful information about the unknown material. The use of instrumentation to elucidate the structure of a truly unknown compound often requires more than one spectroscopic technique (IR, UV, NMR, XRD, and MS) contrary to the assertions of some that a single instrument printout is "structural elucidation". Very rarely is the typical drug analyst engaged in the structural elucidation type of analysis. In fact, few crime laboratories have the instrumentation available to perform complete structural analysis on "unknown" compounds and few analysts have the background.

The second type of chemical identification "is simply to identify an unknown as a chemical substance already known. This may be called 'matching identification.' It is this second type with which microcrystal tests…are concerned", (Fulton 1969). The analyst compares properties of the unknown against those of known compound(s). This type of analysis precisely



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The views presented are his alone and do not reflect the views of his employers.

typifies the crime lab drug or trace evidence analyst's job.

Published in 1961, Fulton admonishes in Clark:

> *"A fundamental error, which seems to be prevalent in modern "microchemistry", is the idea that the microscope has value in chemistry only as an adjunct to procedures on a small scale. Actually, this is the least of its uses; and the early chemists, 200 to 100 years ago…had a much better appreciation of its real value."*

Continuing, Fulton points out four uses of microscopy in chemistry:

1) observing minute characteristics, regardless of the amount of material available,
2) observing characteristics not observed by the unmagnified eye, altering light and compensators to observe various properties,
3) "making identifications by microscopic observations and microcrystal tests, for which the microscope is essential, again regardless of the amount of material present," and
4) use of the microscope as an adjunct to micro scale procedures.

These are uses of the microscope that "modern chemical science seems to have forgotten, and which most modern chemists disregard or overlook" (Fulton in Clark 1961). How true nearly 40 years later!

Because the drug analyst confronts an impure solid sample, the microscope represents an ideal analytical tool, able to analyze complex or impure samples. The matching type of analysis "has tremendous advantages in speed, simplicity, and directness of proof but also takes in many kinds of tests that would not be fundamental to the structural type (of analysis)." Fulton (1969) continues that "as *chemical* (his emphasis) tests they respond to certain kinds of substances but not to others, and often can be used in the presence of excipients, diluents, adulterants, and impurities to which they do not respond: but more than mere detection by reason of some reaction, they give distinguishable results."

Seemingly, most newcomers to the field of forensic science (and criminalistics specifically) confuse the two types of analysis. Some of these individuals have thorough backgrounds in research but not much experience in the practical application of science in criminalistics. Another new concept to the novice in the criminalistics field is that an elimination can be as powerful as an inclusion. The novice (even those with PhD's) is often unaware that comparative identification, not research identification, accurately answers the questions posed to the criminalist. Similarly, while not new to the criminalist, certain techniques are foreign to many in other sciences. Those in criminalistics would not abandon firearms examinations, hair comparisons, or forensic document examination because they are not commonly taught academically nor would criminalists end DNA analysis because the function of the DNA used for analysis is not completely understood. "Microchemical tests are exceptionally good for court purposes, because they are as simple and direct as tests can be… What sometimes seems to be overlooked or not realized as it should be, is that they are also best for chemical purposes" (Fulton in Clark 1961).

Reactions

The reactions occurring on a microscope slide are typical of the chemistry of solutions of electrolytes or ions, also known as precipitation reactions. These reactions are dependent on many different factors. Among the various factors are the nature of the reaction product, its visibility, solubility product, quantity of material initially present, color of the reagent used, diffusion of reactants, separated zones of reactions (potentially different crystal forms observed), presence of electrolytes, hydrogen ion concentration, colloidal properties, the procedure employed introducing the two reactants, and other details that must be controlled, according to Rothemund in Hampel & Hawley (1973). For those interested in the specific theory of ionization, Svante Arrhenius wrote the first paper *Uber die Dissociation der in Wasser gelosten Stoffe* (On the Dissociation of Substances Dissolved in Water) in 1887. The non-German reading analyst could also read about the theory of ionization in a good book on qualitative analysis. The original theory "has been modified, but the essential postulates remain and are more firmly entrenched than ever in the structure of the science" (Meldrum & Flosdorf 1938).

Objections/Myths to the Use of Microcrystal Tests

OBJECTION-MYTH #1

They are unpredictable, i.e. you cannot look at the reagent and the structure of the molecule and know what the crystal form the reactant will have.

That is true, one cannot know ahead of time what the appearance of the crystal habit or form will be. This is an advantage because microcrystal tests permit identification (or exclusion) of very closely configured molecules by precipitating into vastly different crystal forms. The tests have been developed to optimize the drug(s) of interest. Some drugs may not precipitate, others may form apparent oil-drop-like amorphous masses, while some drugs will precipitate out in characteristic crystal forms. Other optical properties of the crystal reaction products may be quickly determined, completing the identification of isomer and analog compounds.

For instance, one can differentiate *d* from *l* and *dl* forms of a drug. This can be done quickly, accurately, and efficiently with the microscope and microchemical tests.

We are using tests that have been shown through time and scientific experimentation to be accurate for the drug species they were designed to test. All of the testing has been done, contained in the literature of decades ago. We do not have to reinvent or re-prove microchemistry or that it is scientifically valid.

OBJECTION-MYTH #2

Can you draw from memory the crystal reaction product of gold chloride with d-amphetamine?

No. Can you draw the MS or IR spectra of amphetamine from memory? I recognize the crystal when I see it. If any doubt exists, I perform a test with a known standard to refresh my memory and compare against the unknown. If there was any question about a spectrum, I would re-analyze a known standard with that instrument and compare the known spectrum against the question spectrum. This is simply good scientific technique.

OBJECTION-MYTH #3

Instrumentation is objective and microscopy is subjective.

Some view microscopy as subjective and spectroscopy as objective. Microscopy is as objective as spectroscopy or spec-

troscopy is as subjective as microscopy. Both the microscopist and spectroscopist view an item that possesses objective properties. Each may ask someone else knowledgeable about that subject to view the item in question, to gain a second opinion or to peer review their work. Each analyst must then, based on his or her examination of the item, *make a decision* as to the identification of the item. The decision process, whether crystallization reaction occurs in a particular way on a microscope slide or a spectrum is obtained (projected on a CRT monitor or printed on paper), is the *subjective factor* for both methods. Some have argued that because a computer may be involved, this renders the spectrum identification process somehow less subjective. Ultimately, the human analyst must reach a conclusion - not the computer. The human makes a *subjective decision,* regardless of whether they are a spectroscopist or a microscopist. If spectroscopy is so objective, why do so many, who use spectroscopy, miss the CTS proficiency tests? (Nichols1997).

OBJECTION-MYTH #4

Microcrystal tests have no print outs to peer review. How can a reviewer know what you saw?

That's true, microcrystal tests have no print outs to peer review. Unless the analyst has drawn a picture or made a written description of what they saw, there is no print out. An argument has been made to photograph every microchemical test in the drug lab. Let's examine this suggestion further. First we determine the number of cases each day an analyst might work (10-40 per analyst). Multipy that number times the number of analysts in the lab (two to twelve) times the number of days worked each year (approximately 220 – 20 days less than 240 due to holidays, vacations, & sick leave), at nearly two dollars each for Polaroid, about a megabyte for TIF files, and 36 exposure rolls developed at about ten dollars each (not to mention original film cost and development lag time), then add the original cost for purchasing a camera system for each microscope, whether in film or electronic versions, this could be an expensive proposition. Then there is the time factor. One of the advantages of using microcrystal tests is the reduced analysis time per test. Waiting for the development of a roll of film and then having to re-find each case to properly match and insert the photograph to the case notes would take too long.

Why is the analyst's notations or drawings of what they saw so suspect? At what point do you not trust your analyst?

- Did you trust that the description of the seal or evidence is correct?
- Is the weight correct (did they fudge a little bit on the "close" weight to make the enhancement weight or drop it below to avoid court)?
- Do they skim a little in each case to take home?
- Did they count the drug money correctly, found with the duffel bags of drugs?
- Did they misrepresent the color test results?
- Did they "dry lab" the weight and the color tests while having a standard spectrum already on the GC/MS of the expected drug in the case? (It is of interest that the analysts recently caught performing "dry lab" tests have been using instrumentation.)

If you can trust them to deal with these issues, the analyst description or drawing of what they saw for their result should be sufficient. If the analyst simply puts a check mark or "+" sign for their results, this would be insufficient for a description, in this author's opinion. The analyst should be providing accepted descriptions of the crystals (Stewart & Stolman 1961, Fulton 1969) or a 'quick' drawing of the observed crystal(s) should be in their notes. Use of a drawing or accepted terminology assists a reviewer in understanding what you saw.

A photomicrograph of the ideal crystal form for each microchemical reagent/drug combination analyzed in the laboratory should be available in a booklet, binder, hanging on the wall, or in the analyst's training folder to serve as a reference. Reasonable drawings of the drug standard's crystal form(s) may be substituted for a photomicrograph, though a photomicrograph is the preferred document for comparison.

One alternative to photomicrographs, if drawings or descriptions were completely unacceptable, would be to use camera-to-printer technology. One would have to retro fit microscopes to include a video/digital camera and have the computer immediately print the image. Perhaps the imaging program would permit case number and other descriptors imprinted in the image (but this again slows analysis). The printer would have to be detailed and fast (minimum 600dpi and printing a page in half a minute). Color printing is probably not necessary to show the crystal form. This would be a less expensive alternative to photomicrographs.

OBJECTION-MYTH #5

There's no chemical analysis, you're simply looking at it.

The various microchemical tests comprise different chemical reagents, each formulated for the drug(s) of interest. These microchemical tests are true chemistry, performing actual chemical reactions on a micro-scale and observing the reaction product(s) directly. You, the microscopist, become the analytical instrument.

No one yet, not even scientists, has difficulty with a medical technician, technologist, or pathologist's ability to recognize and identify stained organs, tissues, and disease states by use of morphological properties using brightfield microscopy. Often, these microscopists do not have the ability to examine the specimen with various chemicals, other independent tests, or altering the light (polarizing light and compensators) to gain more information about the sample. By contrast, the forensic chemist, who analyzes a suspected drug sample with microcrystal tests and who performs several independent tests on the sample using a polarizing light microscope, has an advantage over their medical counterparts. The drug analysts have more tools to examine their sample.

Humans can recognize thousands of items instantly, some slightly different from each other. Why not use this excellent skill for analytical work? For instance, try describing an automobile or a telephone to someone. It is difficult to do and yet we know one when we see one without performing instrumental analysis.

OBJECTION-MYTH #6

When I was in school, I did microchemical tests and some reactant products looked nearly identical. Microcrystal tests aren't any good because different chemicals can produce the same crystal form in different reagents.

To quote from Fulton (1969), *"If the different crystals of two different substances with two different reagents look alike (and perhaps even belong to the same crystal system), it does not matter in the least. The fact that they are obtained with different reagents is an absolute distinction in itself."*

One must remember that unlike an instrument where typically one thing is occurring (maybe two), many factors come into play in acquiring the crystals. "It is only necessary to make distinctions between different crystals formed with the same reagent, and here the desired feature is that when given by different substances, they should not look alike" Fulton (1969). Only when two substances give identical crystals from the reagent should there be concern.

Laboratories typically use formulations from published articles concerning microcrystal tests. These tests have been thoroughly researched and designed to optimize the reaction product for the drug(s) in question.

OBJECTION-MYTH #7

Are crystal tests simply harder to learn?

Harder to learn than what? They are not harder to learn than any other common analytical test for people who have graduated with a bachelor degree in a natural science and have studied basic chemistry. As with all instrumentation, the analyst, in their training, should examine a sufficient number of standards and read a sufficient amount of literature to be assured of the accuracy of the method or technique and its advantages and disadvantages. They should have run a sufficient number of exhibits to know various aspects of the test.

The analyst invests a little more time in their training in the beginning but saves many hours of time when analyzing casework because the techniques are faster and as accurate as the instrument. The microcrystal tests take much less time than instrumental methods.

An Exception: Individuals with 'form blindness' may have difficulties using a microscope. They may not be able to see patterns and details that the person without 'form blindness' does. These individuals should not be using a microscope. Indeed, they probably shouldn't be working in any analytical area involving pattern recognition – such as spectrum (IR, MS) or chromatogram (GC) comparisons. That is the only limitation, unless the analyst is unmotivated and not thinking about what they are doing.

OBJECTION-MYTH #8

Should the training standards be more stringent when crystal tests are the primary means of identification?

The drug analyst using the crystal tests as their primary identification should run a slightly larger number of drugs, adulterants, excipients, and diluents to show specificity than those who use it as a non-confirmatory, presumptive-like test and then use GC-MS or IR as the confirmatory test. The "crystal test only" analyst should be using a bank of color tests and no fewer than 2 crystal tests for identification.

The analyst in the *trace evidence section* should have a thorough background in polarizing light microscopy and microchemical techniques. When microchemical tests are performed on unknown samples, a standard of the suspected chemical is run with the same reagent even when published literature photomicrographs are available. Because of the infrequency of these tests, as run by trace analysts, standards should be run to refresh one's memory and be able to compare against the unknown. These two tests (questioned and standard) are typically photographed for case notes; however, drawing the results of the tests would be acceptable.

The analyst in training ought to have a mentor to assist them in their acquisition of knowledge and skill of observation when using the microscope and microcrystal tests. For "in making an identification one compares the crystals given by an 'unknown' and a known. (However) this does not mean that a casual glance at each is sufficient: one must know how to observe microcrystals understandingly and with attention to detail even for such comparisons" (Fulton 1969). Further, the mentor can assist teaching proper descriptions of crystals by using terms found in the literature.

OBJECTION-MYTH #9

Microchemical tests cannot be used for every scheduled drug. Therefore, the test should be abandoned.

The first statement is true. Not every scheduled drug has an associated crystal test (e.g. some steroids – a good project for someone), but microcrystal tests work for the cases that overwhelm most drug sections of crime laboratories: cocaine, methamphetamine, phencyclidine (PCP), and heroin. Drug analysts have used these tests successfully for years. In a retest of over 3,700 drug cases, where the microcrystal test was performed first, a conclusion reached, and then the case re-analyzed by GC/MS, only one result was different by GC/MS from the microcrystal test – a result of sample handling error giving a negative result by GC/MS (Hourigan & Ascano 2000).

Quick and accurate analysis of the vast majority of drug cases can be performed using microcrystal tests, which satisfies our clients, the narcotics investigators and attorneys. Because the MS cannot distinguish between certain types of compounds should we abandon its use? I think not. We use GC/MS for its strengths and find other techniques to use, where it is not advantageous to use the instrument. The same analytical logic should apply to microcrystal tests.

OBJECTION-MYTH #10

How does one validate a method when the principle of operation is unknown?

Qualitative (micro-chemical) tests are governed by modifications of the ionic theory of Arrhenius (Meldrum & Flosdorf, 1938). See above for more information.

"Thus the ionic theory has become one of the principles in the study of qualitative analysis. It offers logical explanation for most of the procedures and observations. The student of qualitative analysis who realizes that the ionic theory gives him almost certainly the actual picture of what is happening, and who considers most carefully each procedure, test, and suggested precaution, from the standpoint of the theory, is the one who will benefit most…" (Meldrum & Flosdorf,1938).

A practical example of the use of the precipitation reaction from the beginning of the 20th century was the extraction of tartaric acid from vegetables and fruits (Culbreth, 1927). Chemists knew potassium tartrate was soluble (that which came from the fruit and vegetables) but calcium tartrate was insoluble in aqueous solution. After precipitating the potassium tartrate as the calcium salt, they poured off the liquid and the precipitate was washed and removed to another container. Combining the precipitate with sulfuric acid, the calcium tartrate converted into tartaric acid with a by-product of calcium sulfate. The tartaric acid was soluble in water so they could separate it from the insoluble calcium sulfate. Real chemistry in action!

The empirical use of the precipitation reactions has occurred for about 170 years with the theory of ionization understood since at least the latter part of the 19th century. Two ions, one inorganic (reagent) and one organic (the drug), are introduced in solution. Several outcomes are possible: they may

stay in solution and not react, they may form amorphous products, such as oily globs or they may may form a colloidal precipitate (crystals too small to discern with the optical microscope) or begin to crystallize from solution. If the latter dominates, then as more ions add to the crystal, the crystal grows. Eventually the crystal form is observed with a microscope for characterization and identification. Usually, depending on the amount of starting material, hundreds to millions of crystals grow in the reaction mixture.

Typically, the tests employ an acid against a basic (alkaline) drug. These drugs "yield precipitates in the following ways: 1) by reaction with basic reagents that precipitate the free base; 2) by combination with oxygen acids belonging to Groups 4, 5B, 6A, and 7 of the periodic table; 3) by halogenation; 4) by forming double or complex salts with certain metals of the B-groups of the periodic table; and 5) by uniting with organic compounds, mostly acids" (Stewart & Stolman, 1961).

The fundamental crystal reaction mechanisms and crystal growth can be read in the crystallography sections of mineralogy books or physical chemistry books, and can be found in books specific about crystal chemistry (Bunn 1945, Bloss 1971).

OBJECTION-MYTH #11

An important part of any method validation is to understand why the method works, and then to test for possible limitations and interferences based on this understanding. It is simply not feasible to test for all known chemicals.

While true not every compound in the world can be tested, the same applies for nearly every analytical method, or instrument. It was recently reported in the literature that pharmaceutical and biotechnology firms are synthesizing upwards of 100,000 "new" compounds each year; fortunately, few of these ever leave their laboratories.

"However, the microcrystal tests are usually so highly characteristic, that two or three of them, even just using the ordinary microscope, and making comparisons, as necessary, with a known sample, will often make an identification certain, without necessarily having or obtaining any other type of information" (Fulton in Clark, 1961).

The Association of Official Analytical Chemists (AOAC) in their Official Methods of Analysis, as of 2000, the 17th edition, contains methods for chemical microscopy. In the 15th edition, they devoted 8 pages to listing drugs and their crystal reagents with the reagent formulas. The ASTM recently instituted guidelines for performing microcrystal tests for certain drugs and the SWGDRUG group accepted microcrystal tests as part of a valid scientific scheme for drug identification. Clearly, prestigious scientific bodies still consider microcrystal tests as valuable analytical tools for drugs.

Conclusion

The mechanism of microcrystal tests are known and published. The tests have been shown, overtime, to be scientifically valid, and their specificity has been documented. Criminalistics remains an *applied* science not a science of theoretical research. Criminalists answer real world questions using comparative or "matching identification" in an accurate and timely manner for the clients we serve. Most drug laboratories do not perform true structural determinations, they perform "matching identification" even when using GC-MS and it is misleading to state otherwise. As determined over the last 150 years, microcrystal tests and precipitation reactions are scientifically valid, accurate, and time efficient.

At the end of the section of Qualitative Microscopy in Hampel & Hawley, Rothemund points out what most books omit from obtaining accurate analytical results, the difference between a good analyst and a poor analyst: "equally important are the personal equation, and often the enthusiasm of the observer." Whether examining crystals forming on a microscope slide or reading a spectrum, the analyst has to be properly trained, actively thinking, and suitably motivated to obtain accurate results. As scientists, we should continue the use of microcrystal tests as an analytical tool.

Acknowledgement:

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A Comment on SWGDRUG's Proposal for Microcrystal Testing

Thank you for the opportunity to comment on the Scientific Working Group on the Forensic Analysis of Drugs (SWGDRUG) Methods and Reports Subcommittee proposal. As currently written, we are OPPOSED to the proposal.

Among the missions assigned itself by SWGDRUG is "providing guidelines for drug examinations and reporting" and "gaining international acceptance of SWGDRUG Standards." The Methods and Reports Subcommittee's mission is to "assess and evaluate available analytical methodologies and reporting methods." Ultimately the method must have as its goal the obtaining of the correct answer to the identification of a suspected controlled substance.

SWGDRUG in the most recent draft of the Methods and Reports Committee has chosen to relegate microchemical/microcrystal tests to the status of presumptive test, requiring, at least in 2005, that an identification include analysis by gas chromatography/mass spectrometry, infrared spectrometry, or nuclear magnetic resonance spectrometry. It is my understanding that the objections to microcrystal tests among SWGDRUG appointees include that they do not provide structural information and that the literature regarding microcrystal tests is old. We shall endeavor to put forward the reasons we believe that decision is incorrect.

1. "When it is not necessary to change it is necessary not to change"[1]

There has been no evidence presented that microcrystal tests are inaccurate, that is that they are incapable of correctly identifying suspected controlled substances. Indeed, there is evidence that instrumental analysis produces more errors of identification than do microcrystal tests[2].

2. Microcrystal tests are a validated method for the identification of controlled substances.

The Association of Official Agricultural, later the Association of Official Analytical Chemists, now simply JOAC International, has published 16 editions of its Official Methods of Analysis[3] commencing in 1916. Methods included in the AOAC's Official Methods have been selected, developed or adapted by an Associate Referee. The Associate Referee then develops the in-house validation data and collaborative study protocol. The General Referee, Committee's Statistics and Safety Advisors and the Methods Committee review the protocol. Only then is the method submitted to inter-laboratory collaborators who have been recruited by the Associate Referee. The Associate Referee compiles the data, evaluates the results, and writes the collaborative study report which is submitted to the General Referee and the Methods Committee for technical review. The Official Methods Board reviews all of this information and if acceptable it's adopted as First Action, and published in The Referee and Journal of AOAC International. Two years later, a method is eligible for adoption as Final Action if no significant problems in the performance of the method have been received, the method is accepted by the General Referee and affirmative vote by members of the AOAC.[4]

Method validation guidelines currently being taught by the American Chemical Society include those derived from AOAC.[5]

Microcrystal tests for the identification of drugs, including controlled substances, have been subjected to these validation studies for the following analytes:
acetanilid[6,7],acetphenetidin[8,9], acetylsalicylic acid[10], aconitine[11] ,amidopyrine[12,13], amobarbital[14,15], d-amphetamine[16], d,l-amphetamine[17], amytal[18], anabasine[19], antipyrine[20], apomorphine[21], aprobarbital[22], arecoline[23], atropine[24,25,26], barbital[27,28], barbiturate and derivatives[29], bemegride[30], benzoic acid[31], benzocaine[32], benzylmorphine[33], berberine[34], brucine[35], butabarbital[36], butalbital[37], butethal[38], caffeine[39,40,41], chinosol[42], choline[43], cinchona[44], cinchonidine[45], cinchonine[46], cinchophen[47], cocaine[48,49], codeine[50,51,52], cotamine[53], cyclobarbital[54], cyclopal[55], diallylbarbituric acid[56], dinitrophenol[57], dyphylline[58], ephedrine[59,60], d,l-ephedrine[61], epinephrine[62], ethylhydrocupreine[63], ethylmorphine[64], heptabarbital[65], heroin[66,67], hexobarbital[68], homatropine[69,70], hydrastine[71,72], hydromorphone[73], hyoscine7[4], hyoscyamine[75,76], isoproterenol[77], lobeline[78], mandelic acid[79], d-methamphetamine[80], d,l-methamphetamine[81], methenamine[82], metharbital[83], morphine[84,85,86], narceine[87], narcotine[88], neocinchophen[89], nicotine[90], papaverine[91], pelleterine[92], pentobarbital[93], perphenazine[94], phenmetrazine[95], phenobarbital[96,97], phenylmethylbarbituric acid[98], phenylpropanolamine[99], physostigmine[100,101], pilocarpine[102], probarbital[103], procaine[104], promethazine[105], pseudoephedrine[106], pyridium[107], quinidine[108], quinine[109], salicylic acid[110], secobarbital[111], sulfanilamide[112], scopolamine[113], sparteine[114], strychnine[115,116], sulfadiazine[117], sulfapyridine[118], sulfathiazole[119], talbutal[120], theobromine[121,122], theophylline[123,124], triethanolamine[125], thienylperazine[126], trifluopromazine[127], vinbarbital[128,] vitamins[129], yohimbine[130]

Microchemical tests are contained in Chapter 18 Drugs: Part I, Subchapter 10 Microchemical Tests:

Section 18.10.01 (Final Action), Alkaloids and Related Amines in Drugs incl. Table 930.40; microchemical tests for 38 alkaloids

Section 18.10.02 (Final Action 1972) Barbiturates in Drugs incl. Table 962.21A; microchemical tests for 12 barbiturates

Section 18.10.03 (Final Action 1988), Phenothiazine Drugs incl. Table 985.44; microchemical tests for 3 synthetic drugs

Section 18.10.04 (Final Action 1970), Sympathomimetic Drugs incl. Table 960.55; microchemical tests for 12 sympathomimetic drugs.

Section 18.10.05 (Final Action) Synthetic Drugs incl. Table 962.21B incl. Table 962.21B; microchemical tests for 30 synthetic drugs

Section 18.10.06 (Final Action 1992) Xanthine Group Alkaloid Drugs incl. Table 962.21B incl. Table 960.56; microchemical tests for 4 xanthine drugs

AOAC's validated methods do NOT contain so many validated methods for gas chromatography, infra-red spectrophotometry / spectrometry, mass spectrometry, nuclear magnetic resonance spectrometry and so forth. I believe it is usual for newer methods proposed for validation to be compared to the older, previously validated methods. Based upon this, it would appear to be GC, IR, MS, and NMR which need to prove themselves, rather than microcrystal tests.

Besides AOAC International, the American Society for Testing Materials (ASTM) Committee E-30 on Forensic Sciences has recently adopted the Standard Guide for the Forensic Identification of Amphetamine/Methamphetamine and the Standard Guide for the Forensic Identification of Cocaine and has before it a proposed Standard Guide for the Forensic Identifica-

tion of Phencyclidine and Its Analogs. No standard guides or methods have been approved for GC, IR, MS or NMR.

There is nothing about microcrystal tests that are inherently incompatible with the Section 10, Validation and Verification of the SWGDRUG Quality Assurance Recommendations.

3. Structural Information

"Crystal tests are largely empirical, that is, there is no readily available theoretical explanation for the specificity of the tests."[131] Microcrystal tests do not give structural information in so far as one cannot look at a printed output and deduce the structure from that output. Indeed, instrumental techniques can not either. For mass spectrometry and infra-red spectrophotometry/spectroscopy, few, if any, forensic scientists deduce the structure from the output either. Rather, the analyst compares the instrumental output to one on file, or even more frequently has the instrument's computer algorithm compare the results to that stored in the instrument's library. These are comparative methods. If the output/results do not favorably compare to the laboratory's file or library, no conclusion can readily be drawn. Microcrystal tests, too, are comparative. If you don't know what the crystals indicate by looking at them or comparing them to a photomicrographic library, no conclusion can readily be drawn. IR and MS certainly do provide the possibility of deducing some structural units and microcrystal tests admittedly do not.

Perhaps this is best stated by E. G. C. Clarke when he said, "The microcrystal test is unsuitable as a primary method of identification of an unknown compound, as it does not lend itself to form the basis of an identification scheme. [emphasis added][132] Microcrystal tests are rarely applied to completely unknown compounds; appearance, color, smell, or prior tests have given the analyst information on a range of candidate compounds; indeed no harm would be done by applying microcrystal tests in this manner, but the analysis would be a series of shots in the dark. The real value of a microcrystal test "is as a means of final identification to confirm a provisional diagnosis made from chromatographic or spectrophotometric evidence, its extreme simplicity, the rapidity with which it may be performed, and its high degree of specificity, rendering it ideal for this purpose.[133]

4. Microcrystal Tests are Dated

Microtechniques were included in the FBI/DEA International Symposium on the Forensic Aspects of Controlled Substances in 1988.[134] The Final Action taken by AOAC with respect to the xanthine alkaloids occurred in 1992. Microcrystal tests for drugs have been the subject of technical papers given at recent meetings the Clandestine Laboratory Investigating Chemists (CLIC)[135] and the California Association of Criminalists.[136,137] They are being applied to new drugs as those become of forensic interest, but if it comes to it, the bulk of forensic drug problems, too are dated. Amphetamine, cocaine, heroin, and methamphetamine have represented the bulk of forensic casework for some time. Microcrystal tests for these drugs have been around for some time as well.

5. Documentation

ASLCD/LAB and good scientific practice requires documentation, not documents. There is simply nothing sacred or infallible about an instrumental output. At least one core committee member can relate a circumstance in a laboratory with which she is familiar in which the instrumental outputs were present to document an analysis and indeed the analysis was not done. ASLCD/LAB has found it acceptable for a laboratory to document what constitutes a positive by microcrystal test, without the need for further documentation beyond the indication of "positive" in the analyst's notes.[138]

There is nothing about microcrystal tests that are inherently incompatible with the Section 8.1, Casework Documentation of the SWGDRUG Quality Assurance Recommendations.

6. Training

"A skillful microscopist can identify many drugs solely by the shape and color of their microcrystals. No other confirmation is required by them. Because of recent improvements in chemical instrumentation and the emphasis on training and education on these instruments coupled with the lack of available training and education on microscope in universities today, identification by microcrystalline analysis is becoming less often used in the forensic science laboratory. This is indeed unfortunate because there are some situations where the microcrystal test is still the single best test for characterizing some controlled substances."[139] These words of a core committee member speak to the need for wider availability of training, NOT the need for abandonment or relegation of a technique because many or most do not know how to employ it. Indeed, perhaps it would auger for those who employ microcrystal tests, including DEA's master of microcrystal tests Joseph Koles, to 'spread the word' about this technique more so than IR, MS, or NMR which are the subject of a wide variety of university courses in instrumental analysis.

There is nothing about microcrystal tests that are inherently incompatible with the Section 9, Proficiency and Competency Testing of the SWGDRUG Quality Assurance Recommendations.

7. International Considerations

There certainly are places in the world in which the availability, quality and cost of supplies and services which those of us in the 'developed' world take for granted must be a problem. The simple availability of reliable electrical power at reasonably constant voltage and analytical quality water cannot be taken for granted in many parts of the world. A constant supply of quality gases for GC, the availability of routine maintenance supplies such as septa and vacuum pump oil, the cost of maintenance and repair services for IR and MS instruments is not a trivial consideration in places here in the US, no less for those in the Third World. To say forensic drug identifications cannot be effected without IR, MS or NMR is to deny some the ability to perform these identifications. Microcrystal tests are, at least in this context, "low tech.." "Low tech" is NOT synonymous with low quality.

8. Efficiency

While the primary imperative of forensic analysis of suspected controlled substances is obtaining the correct result, surely we must also acknowledge that we must do so within the parameters set by the judicial system on timeliness and the parameters set by our employers and ultimately the taxpayers on expense.

Microcrystal tests certainly do NOT meet the requirements of all laboratories, particularly those for which quantitation is inherent in analyses. There are other laboratories for which the turn-around or case volume requirements of their client agencies, be they investigative, prosecutorial, or

judicial, have lead them to believe microcrystal tests are the best method for them. The core committee members should not universalize their own situations of turn-around or volume to others, more than those who find microcrystal tests to fit our needs would require core committee members to employ microcrystal tests in their laboratories.

9. The Last Word

I shall leave the last word to Stuart Kind, "Although the advance of technology has given the crime investigator machine-assisted techniques which were not dreamed of 40 years ago, it has also lead to the widespread attitude that all advance in crime investigation is dependent upon the advance of technology and the production of 'guidelines.' Training people to think is more difficult than training them to operate machines."[140]

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Drug and Microcrystal Tests for Forensic Drug Identification

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The Technical Working Group on Forensic Drug Analysis formed in 1977 was recently re-named the Scientific Working Group, changing from TWGDRUG to SWGDRUG. The mission is to promote professional development in forensic drug analysis, provide a means of information exchange within the forensic science community, provide guidelines for drug examinations and reporting, perform collaborative exercises, specify requirements for analysts knowledge, skills, and abilities, establish quality assurance guidelines, and gain international acceptance of SWGDRUG standards.

The committee was apparently selected by the Drug Enforcement Administration (DEA) and consists of five representatives of DEA, along with representatives from FBI, American Society of Crime Laboratory Directors (ASCLD), ASCLD/LAB, Illinois State Police Laboratory, California Department of Justice Laboratory, Los Angeles County Sheriffs Department Laboratory, Virginia Division of Forensic Science, Michigan State University, American Society for Testing and Materials (ASTM), UK Forensic Science Service, Netherlands Ministry of Justice, Health Canada, Australian Federal Drug Laboratory, Japanese National Institute of Police Science, Budeskrim-inalamt, and UN International Drug Control.

Subcommittees were formed on Education and Training, Methods and Reports, Quality Assurance, and Communications requiring a 2/3 majority of members (absentee ballots included) to move a recommendation to the core committee and a 2/3 majority of the core committee (excluding absentees) required to determine policy. At a presentation at the International Association of Forensic Sciences meeting in Los Angeles in September, SWGDRUG announced their intention to have their recommendations adopted by forensic accrediting bodies such as ASCLD/LAB.

The Methods and Reports Subcommittee conducted a survey, by Internet and publication in January 1998 issue of Microgram, of methods used by laboratories to identify controlled substances. Based on the survey, review of CTS proficiency data, and forensic literature, the subcommittee created a proposal that included multiple TLC systems and microcrystal tests. In February 1999, this proposal was rejected by the core committee. Indirectly, the subcommittee was asked to produce a document with IR or GC/MS as a requirement for a forensic identification, but no definition of the term forensic identification was provided to the committee, nor could a clarification of the term be obtained.

Two revised proposals were created; both would require the use of NMR, IR, or MS for the forensic identification of a controlled substance. The first proposal would institute this requirement upon adoption; the second would allow a 5-year grace period during which laboratories, that do not currently meet the requirements, could move to do so. It is the latter proposal that is before the core committee for adoption at its meeting to be held in conjunction with the American Academy of Forensic Sciences meeting in Reno, NV next February. The core committee appears to believe that based upon reviewability, lack of correlation of results to molecular structure, the lack of recent publications in the area, and the age of the technique, that microcrystal tests will no longer be approved as a means of identification of controlled substances. None of the laboratories represented on the core committee uses multiple TLC or microcrystal tests as their means of identification and some of the core committee members have never tried microcrystal tests.

For those of us who routinely use microcrystal tests as a significant part of our identification of routinely encountered controlled substances, this challenge is significant both to our ability to rapidly produce results for our client agencies and the courts and in maintaining ASLCD/LAB accreditation. I encourage interested parties to contact members of the core committee, who are listed at SWGDRUGs web: http://users.erols,com/scitechz/twgroster.html or members of the ASCLD/LAB delegate assembly to whom this issue will be brought.

For a discussion of publication in this area, see INTER/MICRO-99; *Microscope*, 1999, 47, 102.

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Comments on the Proposal for Quality Assurance in Forensic Drug Analysis. *An Open Letter to SWGDRUG*

by Gary Sorgen

I have some comments on the proposed guidelines for forensic drug analysis. For those who don't know me, I'll give a brief personal background. I graduated from California State University in Sacramento with a bachelor's degree in chemistry 34 years ago. After graduating, I worked for the US Food and Drug Administration as an analytical chemist for 4 years. I then transferred to the US Department of Justice, Bureau of Narcotics and Dangerous Drugs/ Drug Enforcement Administration, where I have worked for 30 years as a forensic chemist.

At the FDA there were many official methods of analysis. The methods were old and relied heavily on elaborate wet chemistry cleanups and UV/VIS assays. Identifications were done by a combination of color tests, chromatography, crystal tests etc. There was an infrared spectrophotometer, but it was seldom used for identification. There was also a great emphasis on the number of exhibits analyzed. One consequence was that they had little confidence in the analytical results so the occasional sample found to be in violation had to be retested - not a viable process for our type of work.

When I transferred into forensic work, there were no rules of analysis, written or otherwise. What we did have were the best available instruments, time, and freedom to experiment. There were two types of qualitative methods in use, the non-specific tests that were used in combination and IR analysis. Quantitation methods were done mainly by wet chemistry cleanups and UV analysis. The methods in use came mainly from the chemists who had worked for the Treasury Department analyzing narcotics, and the FDA chemists supplied methods for the pharmaceuticals and hallucinogens. There were many lively discussions on methods of analysis. All this was to the good. It forced us all to evaluate our methods of analysis. I recall no such discussions at FDA with its official methods. The other major problem at the FDA was the lack of modern instrumentation.

I agree with most of your guidelines for quality assurance and I'm encouraged that there is interest in improving the science in forensic drug work. I'm discouraged, as I am sure you are, in the slow pace of bringing all forensic laboratories into the 21st century. However, I have some problems with your minimum standards of analysis. I'm sure your intentions are to improve the overall quality of forensic drug analysis, but I would like to point out some problems and unintended consequences of your guidelines.

SWGDRUG Example #1: An unknown powder gives positive results for cocaine using the following methods:

Option #1 Cobalt Thiocyanate Spot Test: (Category C) Acceptable today FTIR Analysis: (Category A) and after 1/1/2005 Result Cocaine Identified

Option #2 Cobalt Thiocyanate Spot Test: (Category C) GC Analysis: (Category B) Acceptable today, but TLC Analysis: (Category B) not after 1/1/2005 Result Cocaine Identified

First I have to comment on the use of "FTIR." While it has not much to do with the present subject, FTIR spectra is no more specific or has any advantage over dispersive IR spectra. In fact they should be essentially the same. This is almost like telling you what brand of spectrometer to use. You don't use the term quadrupole MS, where the type of mass spectrometer does make a difference in the spectra. You do not, and correctly so, use FTNMR.

Option #1 of your example #1 is a typical forensic analysis. First you do a screening color test, then an IR. Suppose you start screening your sample by running a direct IR as several of our chemists do, and suppose the spectrum appears to be a mixture of cocaine and mannitol. After a simple extraction, another IR is run of the organic solvent solubles, which turns out to be pure cocaine hydrochloride. Would a color test be required for identification? Now suppose that the first screening IR was pure cocaine hydrochloride. Would I then be required to run a cobalt thiocyanate color test after the IR? Is any cobalt thiocyanate reagent acceptable, even the ones that turn blue with all the common caines? The color test, in this example, adds nothing to the quality of this identification.

SWGDRUG Example #2: An unknown liquid is suspected to contain diazepam. Positive results for diazepam are obtained by the following techniques:

Option #1 TLC Analysis: (Category B) Acceptable today, but HPLC/DAD Analysis: (Categories B + C) not after 1/1/2005 Result Diazepam Identified

Option #2 TLC Analysis: (Category B) Acceptable today LC/MS Analysis: (Categories B + A) and after 1/1/2005 Result Diazepam Identified

I assume in option #2 that a separate category B test and an MS would be acceptable in your proposal, but not just LC/MS. Since this is a liquid, is it necessary to do two separate samplings? I'm not sure why you think that two separate samplings are necessary for any sample, although I can think of two possible reasons. One, when you are doing lots of exhibits at the same time, you may mix up exhibits. The second reason would be in any multiple step method there is a chance of contamination. One of the reasons I prefer to start with tests like direct IR and NMR is they are simple, keeping the problems of multiple exhibits and contamination possibilities to a minimum.

SWGDRUG Example #3: An unknown powder tests positive for methamphetamine by the following methods:

Option #1 Marquis Spot Test: (Category C) Acceptable today GC/MS Analysis: (Categories B + A) and after 1/1/2005 Result Methamphetamine Identified

Option #2 Marquis Spot Test: (Category C) TLC Analysis: (Category B) Acceptable today, but Microcrystalline Test: (Category B) not after 1/1/2005 Result Methamphetamine Identified

I think both options in example #2 are poor ones to chose. Methamphetamine is a good example of a compound where MS is the method of last resort due to methamphetamine's poor spectrum and similar spectra of other compounds. When you use the term GC/MS are you saying that one must use the retention time as part of the criteria? If not, you should list MS only. Of course in the case of methamphetamine, the retention time is much more important since the spectrum alone is not sufficient. Either way the color test supplies very little information to the identification. Ask yourself, if I did the tests in the reverse order, GC/MS first, would I then run a Marquis color test? If you wouldn't, and I certainly wouldn't, then the color test should not be considered part of the identification. I analyze all powder samples by running a direct IR. If the powder turned out to be pure methamphetamine hydrochloride, then

I would consider it laughable that I would then have to run a Marquis color test to prove that the powder was methamphetamine hydrochloride.

I was trained in how to do microcrystalline tests. I didn't use microcrystalline tests because I thought they were not very universal. That is, each drug had its own separate reagent/test. My only other option at the time was IR analysis. I personally believed then and now that IR was a much more powerful method. It often requires more time than microcrystalline tests, but time was not an issue back then so I used the more specific test. Even so, I doubt there were many misidentifications using microcrystalline tests because they could only be used on common drugs. I would also bet that more drugs have been misidentified using MS than microcrystalline tests. My experience with those who did microcrystalline tests was that they were conservative in identifying drugs. They were much more likely to not identify a drug that was there, than to identify a drug that wasn't there, which can't be said about MS users.

My experience with MS goes back a long way. In the early 70s I was enthusiastic about getting a GC/MS for the laboratory. I was given the task of evaluating the relatively inexpensive mass spectrometers for DEA. It seemed at the time to be a boon to the identification of controlled substances. However, my conclusion was that GC/MS was not as accurate in identifying compounds as IR. A number of papers were published that were nothing more than running the drug on the GC/MS and stating that this was an absolutely conclusive test. I don't see where this kind of paper is of any more use than a microcrystalline paper that does the same thing. Just because one gives some structural details does not make it specific. One of the great dangers of all tests is that they tend to be oversold. This is particularly true of MS because of its frequent use due to its speed, ease of use, and great sensitivity. Most chemists are not trained in the problems of mass spectra. Identifying a compound like heroin is easy for both microcrystalline tests and MS, but a contributing factor to the identification is that the likelihood of finding a structurally similar compound is remote to say the least. The microcrystalline chemist would not attempt to identify other drugs that they see infrequently, while the MS chemist will gladly attempt to identify compounds like the fentanyls. The fentanyls have two major problems. One is that they are synthetic, which means that all combinations of structurally related compounds are a good possibility. Second they have structural isomers that tend to give spectra that can be "virtually" the same. So while MS can identify heroin (by default) it has severe limitations for some compounds. On the other hand MS readily distinguishes between steroids with very similar IR spectra. This committee, and others, tells chemists that MS is specific, which might lead to chemists being less than cautions.. This laboratory had many discussions on MS, in particular phenethylamine compounds like methamphetamine. However, even the strongest proponent of MS, started using GC/IR for methamphetamine when the instruments became available. Which tells us two things, analysts need the peer review discussions and also need the instruments to do a better analysis. No method is perfect for all drugs and to pick one test from column A and one from B approach tends to indicate that this approach will work no matter which tests are picked.

SWGDRUG Example #4: An exhibit (suspected to be cannabis) tests positive for cannabis by the following techniques:

Option #1 - Observable botanical features Macroscopic Examination: (Category B) Microscopic Analysis: (Category B) Acceptable today Duquenois-Levine Analysis: (Category C) and after 1/1/2005 Result Cannabis Identified

Option #2 - No sufficient observable botanical features Duquenois-Levine Analysis: (Category C) Acceptable today GC-MS Analysis (for THC): (Categories B + A) and after 1/1/2005 Result THC Identified

Example #4, when applied to sinsemilla marijuana, may correctly identify the material as marijuana but it would be poor science. Sinsemilla often has little detectable THC since the "THC" found is actually THC Acid until it decarboxyates in the GC/MS. Sinsemilla usually has a non-typical marijuana appearance which makes microscopic identification difficult. Yet, if the listed tests were followed, the forensic chemist would conclude that there was lots of THC in the sample. While this may be of no consequence as far as the law is concerned, it is very poor science. A proper analysis would include a simple TLC system that would show that the marijuana consisted of huge amounts of THC Acid and little or no THC. This is another case where GC/MC gives the wrong answer.

The color test, Duquenois-Levine, seems to be the most important test. This example #4, and others examples I have seen, seem to require that it must be run in order to identify marijuana, which seems very odd considering that it is just a color test and of limited use in structure elucidation. I am also surprised in the use of Duquenois-Levine and not the more specific Modified Duquenois-Levine. My suggestion would be to drop D/L and add TLC with color visualization. It's hard to imagine any argument that would conclude that the D/L is a better test than TLC, which includes a color test with a variety of spots and colors. Of all the tests commonly run on marijuana, Duquenois-Levine is by far the least informative.

I strongly dislike this method of taking one test from A, plus B and C etc. This method seems to imply that if one followed these cookbook rules you could identify anything with no thinking involved. There are no methods that don't have their weaknesses. It may seem that I am picking on MS. This is because GC/MS will be the method that replaces microcrystalline tests in most laboratories in order to continue the practice of doing large numbers of samples rapidly. No thinking will be involved and errors will follow. Many labs will have a single person actually run the instrument increasing the possibility of mixing up samples.

I think your attempts to raise the quality of drug analysis are going to have some bad unintended consequences. I particularly think that having managers decide what minimum tests are required, and requiring a minimum number of exhibits be analyzed, will force the analysts into using the minimum number of tests required even in cases where these tests are not sufficient for a correct identification. It will be difficult to keep our best analysts interested in their work and the overall competence will decrease. Technicians will replace scientists, if not in name then in deed.

My recommendation to you managers is to make sure that analysts have the equipment and time to use them. I would downgrade any laboratory that did not have the proper equipment as unacceptable, and I would consider it unacceptable if a laboratory had shop times for each type of exhibit or required a certain number of exhibits be analyzed. It takes time to do good work. While managers should have some knowledge in science, they should not be deciding how an analysis should be done. If you hire scientists, give then the time, equipment, and proper training, then you will have a great improvement in

forensic science. You can't mandate good science by making up a bunch of 'no thinking required' rules. Certainly, good science comes from the scientific process and not from a managers office. Managers are pressured for more exhibits done with the least amount of money spent. It is your job to make sure that the analysts have what they need to do the best analysis.

SWGDRUG Guidelines and Microcrystalline Tests

An Open Internal Memo

The San Diego County Sheriff's Crime Laboratory has used microcrystalline tests as a part of its routine drug analysis scheme for more than 25 years. This analytical technique has withstood Kelley-Frye court challenges and has been accepted by the courts in San Diego County.

Microcrystal testing is a tried and true method for the identification of certain controlled substances. It is by no means the only method of examination and identification available, and no criminalist assigned to the Controlled Substances Analysis Section is forced to use this technique. Its use, however, is an integral part of the full training protocol used at the San Diego Sheriff's Crime Lab and each analyst has it as an option to be used, if desired, in their arsenal of analytical techniques. Each controlled substances criminalist becomes proficient in microcrystalline techniques and mastery of the techniques is demonstrated through proficiency testing and qualifying samples.

The technique is expedient, inexpensive, and verifiable. "The crystal, or microcrystal, test is one of the oldest, the simplest, and the most sensitive tests used in toxicology. Although nowadays it has fallen into disfavor and been very largely replaced by instrumental methods, it remains of considerable value for confirmatory purposes." (Isolation and Identification of Drugs by E.G.C. Clarke). A San Diego Sheriff's Lab criminalist was not convinced about the reliability of the microcrystalline testing having come from a 29 year career as a toxicologist where GCMS was the standard. After the standard controlled substances training, this individual embarked on a project to disprove the crystal tests. The analyst, for a period of approximately 3 months, ran every sample on the GCMS in addition to the crystal tests. At the end of this project the analyst chose microcrystal tests over the GCMS for most routine analyses. Another SDSO Lab criminalist has been doing parallel analyses of routine cases by microcrystalline testing and GCMS. For 3 years this criminalist has been conducting microcrystal tests first followed by GCMS. No sample has been misidentified, and he has discovered that some samples are easier to identify by microcrystal testing than by GCMS. Actually this justifies the use of GCMS as a confirmation method by comparing it to a completely validated method-microcrystal tests.

> *"...the microcrystal is of little use in the general search for an unknown drug. Its value comes later, particularly in differentiating between compounds of very similar constitution, when the field has been considerably narrowed by chromatographic or spectrophotometric screening."* Isolation and Identification of Drugs by E.G.C. Clarke.

Microcrystal tests were not designed for analysis of a complete unknown. The value of an FTIR or GCMS examination of a complete unknown yields data that points a chemist towards a possible identification. Every technique has value depending upon the sample, the chemist's experience, and the comfort level using a particular method. There are many roads available to reach the same destination.

Several areas of the SWGDRUG Methods and Reports Subcommittee Minimum Recommended Analytical Scheme for Forensic Drug Identification reference "structural information" or "structural elucidation" techniques. Realistically, very few criminalists employ "structural elucidation" when identifying and confirming the presence of a controlled substance. The true method of identification when using MS or IR is pattern recognition. The identification is made by a library search of a database, comparison to literature, or by running a standard compound under the same conditions as the unknown and comparing the resultant pattern. If it is truly "structural elucidation" then reference materials are unnecessary as the analyst should be able to identify the compound by evaluating the resulting spectrum alone instead of comparing it to a known standard. The microcrystal test is the same as pattern recognition in that "identification being achieved by comparing the microscopic appearance of the crystals formed when the test solution is mixed with a certain reagent with those formed when the same reagent is mixed with a solution of a known substance." (Isolation and Identification of Drugs by E.G.C. Clarke). This pattern recognition technique is no different than what most criminalists do with GCMS and FTIR spectra.

Results of microcrystal tests can be reviewed by many different means including photography, written description, drawing, or comparison to a standard. If "dry-labbing" is a concern, and one has the inclination, it is a very simple process to falsely generate a hard copy of any analytical result. The only answer to this is through blind proficiency testing and trust in your analysts. We whole heartedly agree with Section A.4. for Minium Training Requirements for a Laboratory Analyst which states that a "Verification document demonstrating that the trainee has achieved the desired competence per specific topic area." Not only does this mean demonstration of proficiency through training in microcrystalline techniques and identification but training regarding the ethical obligations of the criminalist to be unbiased and honest in their examinations. Granted, microcrystal tests have limitations just as any analytical technique does. There are times and places for different methods to be used based on the knowledge, training, and experience of the criminalist. This is the essence of criminalistics-evaluating the evidence and choosing the appropriate method of analysis and confirmation based on training and experience. A drug chemist must be trained to recognize anomalies in resultant crystals just as the chemist must recognize anomalies in IR or MS spectra. This, again, comes down to competent training in an analytical technique. "...the degree of reliance that can be ascribed to this test (resultant microcrystals) depends heavily on the skill and experience in microscopy possessed by the analyst. A skillful microscopist can identify many drugs solely by the shape and color of their microcrystals. No other confirmation is required by them. Because of recent improvements in chemical instrumentation and the emphasis on training and education on these instruments coupled

with the lack of available training on the microscope in universities today, identification of drugs by microcrystalline analysis is becoming less often used in the forensic science laboratory. This is indeed unfortunate because there are some situations where the microcrystal test is still the single best test for characterizing some controlled substances." (Forensic Science Handbook, Volume II edited by Richard Saferstein). "Over the years, analysts have developed hundreds of crystal tests to characterize the most commonly abused drugs. These tests are rapid and often do not require the isolation of a drug from its diluents; however because diluents can sometimes alter or modify the shape of the crystal, the examiner must develop experience in interpreting the results of the test." (Criminalistics, An Introduction to Forensic Science 4th Edition by Richard Saferstein). The value of adequate training cannot be overly emphasized. As in any technique, training is critical to its success as well as recognizing its limitations as an analytical tool.

Microcrystalline techniques have been around for years and are still a staple in many forensic labs. They are fast, inexpensive, and quite reliable. Although instrumentation has come to the fore front of analytical methods, older, established techniques are still reliable and are not obsolete. There has been no data or proof generated to indicate that microcrystalline analysis is not a valid technique. Truth be told, quite to the contrary. The AOAC in its Official Methods of Analysis of AOAC International, 16th Edition continues to include microcrystal tests. In addition, the American Society for Testing Materials (ASTM) E-30 Committee on Forensic Sciences has adopted microcrystal methods for amphetamine, methamphetamine, and cocaine and has all but officially accepted phencyclidine and its analogs.

"It is important to note that most color and crystal tests are largely empirical-that is, scientists do not fully understand why they produce the results that they do. From the forensic chemist's point of view, this is not important. The fact is that when the tests are properly chosen and are used in proper combination, their results constitute an analytical scheme that is characteristic for one and only one drug." (Criminalistics, An Introduction to Forensic Science 4th Edition by Richard Saferstein). The key to a successful identification by microcrystalline analysis is the training of the chemist by competent trainers and the exhibition of competency through qualifying samples and continued monitoring through a competent proficiency program.

When referring to his work on the Shroud of Turin and subsequent confirmation by carbon dating 10 years after his original conclusion about the age of the Shroud, Dr. Walter McCrone said, "I'm pleased that the conclusion was first reached through use of an analytical instrument nearly as old (about 1590) as the Turin "Shroud" (1355)-the light microscope. This should help convince scientists everywhere that this almost universally neglected analytical tool can compete successfully with modern space-age instruments and techniques and often beat them at their own game." (Judgement Day for the Turin Shroud by Walter McCrone). This easily applies to drug microcrystal examination. Old does not mean obsolete.

Competent examiners must be allowed the continued use of this valuable analytical method and the members of the Controlled Substances Analysis Section support this position. The San Diego Sheriff's Crime Laboratory will continue to endorse the use of microcrystalline analysis for drug identification and strongly urges SWGDRUG to re-examine its stance on the eventual demise of this technique.

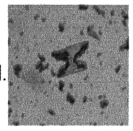
—Marty Fink
Supervising Criminalist-Controlled Substances Section
San Diego Sheriff's Crime Laboratory

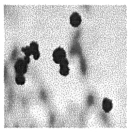

Cocaine with 5% Platinum Chloride reagent. Dissolved in 20% Acetic Acid. LAPD SOP# NARC-201. Reference #4.

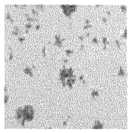

Methamphetamine with Gold Chloride in H_3PO_4 reagent. LAPD SOP# NARC-207. Reference #4.


Heroin with Mercuric Chloride reagent. Sample dissolved in 10% H_2SO_4. LAPD SOP# NARC-210. References #1,4.


Cocaine with 5% Gold Chloride reagent. Dis-Solved in 20% Acetic Acid. LAPD SOP# NARC-202. Reference #4.

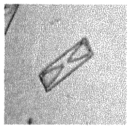

PCP with Potassium Permanganate reagent. Dissolved in 20% HOAc. LAPD SOP# NARC-208. Reference #2.

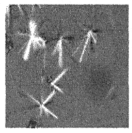

Codeine with Marme's Reagent. Dissolved in 10% H_2SO_4. LAPD SOP# NARC-210. Reference #4.


Cocaine with saturated Lead Iodide Reagent. Dissolved in 20% Acetic Acid. LAPD SOP# NARC-203. References #1,3.


PCP with Ammonium Thiocyanate reagent. Dissolved in 20% HOAc. LAPD SOP# NARC-209. Microgram vol X,9, 1977


Codeine with Potassium Iodide reagent. Dissolved in 20% HOAc. LAPD SOP# NARC-211. Reference #4.


Methamphetamine with Picric Acid reagent. LAPD SOP# NARC-206. Reference #4.


Heroin with Mercuric Iodide reagent. LAPD SOP# NARC-205. Reference #2.

LAPD Poster Presented at Reno AAFS

Above is a portion of the poster prepared by Supervising Criminalist Joe Hourigan and Criminalist Maria Ascano of the Los Angeles Police Dept. Crime Lab. The display was presented at the poster session of the American Academy of Forensic Sciences in February, 2000 in Reno, Nevada.

The Scientist 14[6]:35, Mar. 20, 2000

OPINION

Court-Appointed Expert Witnesses: *Gambit for Control*

By Rod Taber, PhD

Some elements of the legal community suggest that the cure for biased and greedy expert witnesses is the court appointment of experts as in Europe. Under the plan, litigants can apparently still hire as many lawyers as circumstances dictate and pay them freely, but only the court can appoint experts and pay them on a standard, and presumably lesser, scale. Courts would certify experts, and lawyers would then consult the database for legitimate experts.

Lawyers would greatly benefit from the reduction of scientists from free-agent professionals to fixed-price tradesmen. A list of approved experts gives lawyers a database of who plays ball and who doesn't. The proposed solution is ripe for abuse. *I won't select that expert if you don't select this one. If you select that one then I will select this one*. The net result is that lawyers stand to gain even more control over a process they almost totally control already. All of this occurs in a forum circumscribed by the very agents who are handsomely paid to advocate a position regardless of the facts—the lawyers. Lawyers want to reduce bias in experts but keep their own.

An alternative to the low scale, which the legal profession will not accept, is to pay experts at the same rate as the **highest** paid attorney on the case. We see the underlying truth: Lawyers want to downgrade science and scientists while maintaining their lofty remunerations.

Most expert charges seem to be less than $5,000 per day plus expenses. This figure comes from experience with my colleagues. Experts rarely work for a percentage of the award. Therefore, when it comes to the cut, there isn't one. A good expert who takes the time to know the subject matter of the case better than the other side may make a quarter of a million dollars for six months of very hard work in perhaps a dozen disciplines. This sounds like a bonanza until you hear what the attorneys make.

New York lawyers commonly bill 24 hours every day they are out of town on a case. Each day costs the client $12,000 to $24,000 plus expenses. They make money while they sleep. It is not unusual for a patent case to involve three law firms on each side with two or three lawyers in each firm working the case. The net result is a legal bill well into the millions, regardless of outcome. The losing side makes out very well, and the payday of the winning side makes the New York lottery look like pocket change.

A juror may attach credibility to the lawyer with the spotted tie because he resembles a famous actor. Anything the jury can identify with is a possible focal point.

The question of the day is, are experts the real mercenaries?

Lawyers optimized the existing system for lawyers, not necessarily for justice. Proposals to "keep experts in line" by the legal establishment are simply finishing touches on a job nearing completion. To wit, total control of the legal system. In my opinion, allowing total control would be a severe mistake. There is no clear and compelling evidence that court-appointed experts will do any more for justice than court-appointed lawyers. The proposal to appoint experts is simply a gambit for control by mercenary lawyers complaining about mercenary experts. There is an effective remedy for our judicial system, but it does not yield more control to lawyers. To the contrary, it reduces the control and power of the legal profession. Our legal system will therefore never adopt it. So for an academic exercise, let's look at the jury.

The jury is drawn at random from the voting records, with a highly effective screening or filtering process at work behind the scenes. Both sides can exclude some potential jurors. The first to go are often the ones with meaningful education—education related to the patents in suit. In some locales the highest educational level in the sitting jury can be as low as the 10th grade. As an expert, you will explain to them that synaptic weights in an artificial neural network may model pulse code modulation, frequency modulation, or amplitude modulation in real biologic neural systems.

During trial the jury sits passively in the jury box and is mentally shaped and molded by the lawyers and experts. Shaping and molding can be a grotesque dance of one-upmanship as lawyers bow, scrape, and posture. In some jurisdictions one or more lawyers may have substantial influence on the local population by virtue of residency and property ownership.

Consider a hypothetical patent case on digital signal processing. The jury will decide if a quasi-wavelet transform is a linear operator and whether its use with the western blot infringes a patent. It must determine if the transform is prior art. Is the patent valid—does it cover something that is novel, unobvious, and useful? If it is valid, does one side infringe it?

In weighing this problem, keep in mind that patents are reexamined by the U.S. Patent and Trademark Office for anonymous clients, and some patents are declared invalid. Even patent attorneys, patent examiners, and experts cannot always agree on these matters. The office issues patents, then invalidates some of its own patents. Yet the jury, usually untrained in technical matters, must quickly decide who is right. The jury has a real

problem on its collective hands. Those hands are handcuffed by our legal system. Part one of the problem is that a pseudorandom jury meets the current definition of a peer group. This may be taking the "all men are created equal" credo a little too far.

The jury doesn't understand wavelets or blots, so they may focus on something they can understand. A juror may attach credibility to the lawyer with the spotted tie because he resembles a famous actor. Anything the jury can identify with is a possible focal point. Sometimes, the lawyer becomes the message when in fact science should be the message. Judges try to mitigate, but there is only so much a judge can do. Some federal judges try over 400 cases a year. Unfortunately, there is a lot to be said that shouldn't be said for operant conditioning of the jury.

The solution to the problem of courtroom bias lies more in jury composition than in hired experts, or in lawyers for that matter. If bias is indeed a consideration, it behooves the court to remove the bias of attorneys by limiting them to a state-fixed and standard wage scale. No more hundred million dollar windfalls for winning a case. Then no lawyer has a vested interest in any particular outcome. Each would receive an hourly wage. As attractive as this straw-man proposal may seem to those outside the legal profession, justice could be better served in other ways that do not destroy the right of a company to select its own experts.

I propose educated **and** active juries for high-tech cases. An educated jury is a true peer group. It is on the same level as the case. If the court case concerns stochastic resonance, then acceptable jurors know calculus, statistics, and dynamical systems. If it is about DNA, then jurors know how to extract it from cells, and they have bench-level proficiency with PCR. They understand chromatography and its principles. If such highly qualified jurors are unavailable, tutors or master experts can fill in the knowledge gaps. If we proscribe educated juries we might as well take the random jury concept to its logical conclusion and hire plumbers to fly commercial jetliners and lawyers to decode the human genome.

An active jury listens to and argues with the attorneys and experts. It questions authority. It reaches a verdict not under some medieval constraint of incommunicado, but by reason and discourse.

The idea of an active jury is foreign to most readers and definitely anathema to the lawyers. It solves part two of the jury problem: passivity. An active jury listens to and argues with the attorneys and experts. It questions authority. It reaches a verdict not under some medieval constraint of incommunicado, but by reason and discourse. It decides not by fiat, but by critical thinking about understandable evidence. The jury takes the attorneys to task for questionable tactics. It grills the experts.

Every assertion must be supported with documentation or reasonable argument. The jury will devalue every unsupported assertion. Pontification will become grounds for disqualification. Let the experts answer questions until the jury is satisfied it understands the key issues. As by-products, the judge can gauge the degree to which the jury understands the case, and the court transcripts will contain better appeal material.

Educated and active juries do not tolerate theatre. The disfranchisement of lawyers from their current role to simply advisers may well have a cathartic effect on our clogged legal system. The court will not waste time on topics the jury understands (they can say they understand), and it can apply its resources to those topics of importance and confusion. Junk science rightfully fails the grade.

In light of my proposal, the red herring issue is bias. Control and money are the actual targets of the court-appointed expert proposal. As it now stands, a winning lawyer expects a large pecuniary reward. He is biased by the company that pays his bills. An expert may stumble for the same reason. It's only human to feather one's own nest. These biases are always present to some degree and may be unavoidable in an adversarial system within a free society. Under-the-table payments and financial expectations undermine justice in our system, but they cannot undermine it to the existing extent when educated and active juries are in control.

It's not a question of good and evil. Our society cannot exist without scientists or lawyers. It is a question of balance. We argue science in a court of law when we should be applying law in a court of science. We now try high-tech cases with pseudorandom juries. Let us explore a new forum: high-tech cases with high-tech juries.

Rod is a professional expert witness with trial experience. rodtaber2@mindspring.com

JOHN**SIMMS**

Quality Assured

Quality Assurance and Crystal Tests

Can microcrystal tests be used for drug identification? Can microcrystal tests be used in any format in the process of drug analysis? After years of use of microcrystal tests, these questions are now being debated in the accreditation environment and being answered by the issuance of new SWGDRUG guidelines.

First, quality assurance may be able to answer some portions of these questions but quality assurance may be the improper jurisdiction to answer the grand prize question of overall crystal test relevancy in today's modern world.

There are a number of significant issues that quality assurance can address. With regards to any general test method, there are a number of requirements that have to be met:

- ***The method is generally accepted in the scientific community.***
- ***The method must be validated before implementation.***
- ***The use of proper standards and controls is required.***
- ***The method must be subject to proper documentation.***
- ***The documentation is subject to technical and administrative review.***

Skip bullet #1 for now.

Bullet #2: Can crystal tests be validated? Of course. A method is developed from technical literature and/or from borrowed technical procedures of neighboring labs. The method is then subject to testing with the reagents and known materials to assure the method works. The final step is to test the method with unknown samples to make final assurances the system is working. The family of the most closely related compounds are run with the same crystal test to show that none of them give the same crystal test form as that of the known drug substance. Finally, there is ample literature that goes back years supporting crystal test development and use.

Bullet#3: Are crystal tests subject to proper standards and controls? Of course. Your reagents are tested on known drug materials to assure the reagents have been made properly. Every time the reagent stock is made, new quality control checks are made to assure the new stock was made correctly.

From the perspective of quality assurance, crystal tests can and do meet all the general requirements of any test method.

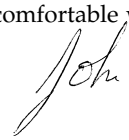
Bullet #4: Are crystal tests subject to proper documentation? Of course. Documentation can be in various forms. Worksheets with the numerous crystal tests can be listed and the resulting drug form can be drawn into the notes. Technically, a colleague can take a peek into the microscope to verify the drug form but this is not necessary. The drug forms can be photographed. Analysts have flexibility in their choice of documentation.

Bullet #5: Can crystal test documentation be technically and administratively reviewed? Of course. The notes, with drawn crystal forms or included photographs, can be examined for proper format and procedure. Is it possible that we will someday require photographs to be taken of all crystal tests? This is purely a rhetorical question.

From the perspective of quality assurance, crystal tests can and do meet all the general requirements of any test method. Validation is addressed. Documentation and review is addressed. So what seems to be the problem? Perhaps one of the final concerns is that the physical process of crystal tests cannot be explained without some hi-level explanation of physical chemistry principles. And this still does not really address the physical process. In effect, there is no structural elucidation. It seems by inference that the structural form is integral to the unique crystal formation that results from the testing.

The new SWGDRUG guidelines have been posted and crystal tests have been placed in Category B which is the mid range of discriminatory power. The bottom line is crystal tests cannot be used by themselves as an identification method…..according to the guidelines. And these are only guidelines, right?

So quality assurance, after all, is very comfortable with crystal tests.



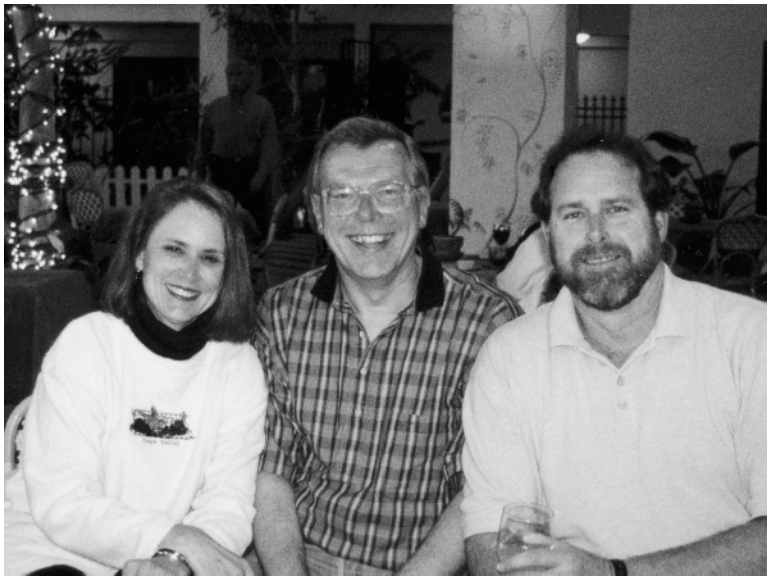
Eugene J. Wolberg
1947-2000

John Simms

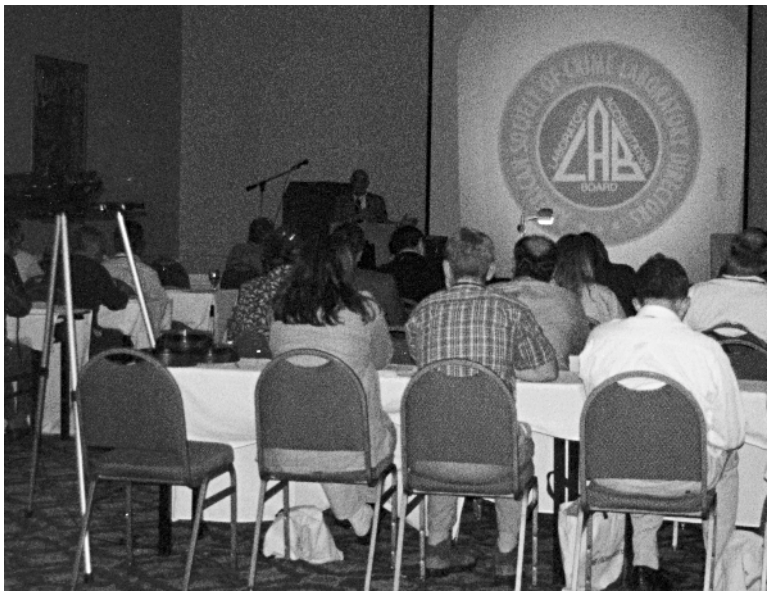
Luke Haag

Eugene J. (Gene) Wolberg passed away suddenly on May 26, 2000 due to heart failure. Gene was a well-known forensic firearms expert who for the past 20 years had been employed in the firearms section of the San Diego Police Department. He was a Vietnam Era Veteran having served in the U.S. Navy from 1967-1971. After his service Gene went to college and graduated from San Diego State University in 1976 with a B.S. in Microbiology. Prior to his employment with the San Diego Police Department he held a position as a medical microbiologist and criminalist. Within two years of his employment with the San Diego Police Department Gene was assigned to the firearms section where he remained until his untimely death. Gene's passion was not only his forensic work in firearms, but also teaching others about all other aspects of firearms. He spent much of his spare time involved helping others to understand the complexities of firearms, their use and safety. Gene was an outspoken advocate for the Second Amendment and firearms ownership. In this battle he will be sorely missed by all. Gene was a good friend to all who shared his interests and would go out of his way to help the neophyte as well as the most experienced examiner. There is no question among those who knew him that his death leaves a huge void in our lives. He is survived by his wife Rena, his sons John and Christopher as well as his parents and a brother and sister. Services were held on June 2, 2000 in San Diego, CA.

—Paul Dougherty



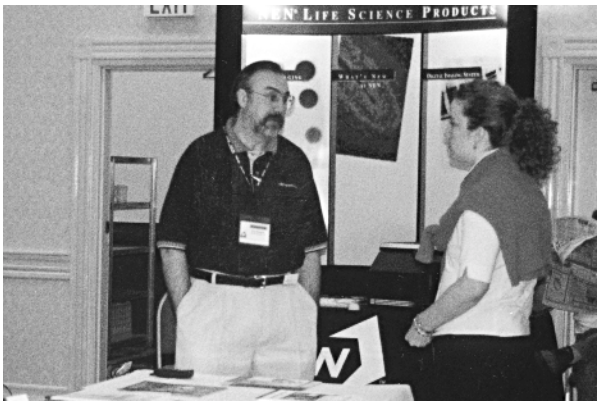
Above: Annie and Bill Casper form bookends around Michael Fereday from the FSS. Right: Suzanne Preaseaux and Fred Tulleners strike a pose.

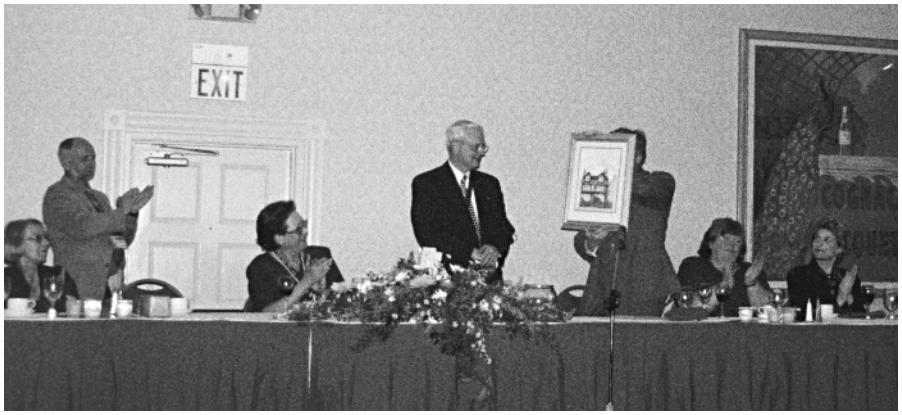


Spring '00

Above: The seminar in full swing. Below: Banquet entertainment is provided by the choir.

NAPA





Wine country was the setting for the third joint meeting of the CAC and the Forensic Science Society. The event was hosted by Serological Research Institute.

(This page, top) The vendor area is visited by attendees, right, a gift of artwork is presented to the Forensic Science Society from the CAC. *(Right, below)* Your CAC board discusses important issues. *(Lower right)* The traditional coconut is passed to incoming president Lisa Brewer by Hiram Evans. *(Below, left)* Luke Haag receives the coveted Roger Greene Award from Hiram.

Photos courtesy Nancy McCombs and Pennie Laferty

B O A R D O F D I R E C T O R S

California Association of Criminalists

Up and Coming

Southwest Association of Forensic Sciences (SWAFS)

Nov. 6-10, 2000
Colorado Springs, Colorado

Canadian Society of Forensic Science (CSFS)

Nov. 1-5, 2000
Ottawa, Ontario, Canada

California Association of Criminalists (CAC)

Oct. 11-14, 2000
Glendale, California

interested in becoming a member?

—Receive the *Journal of the Forensic Science Society* and/or *Journal of Forensic Sciences*—
—Receive *The CAC News*—
—Lower, Member registration fees at CAC Seminars—
—Receive CAC Membership Roster/Seminar Abstracts—
—Receive Salary Survey of Government Labs—
—Membership in a prestigious Forensic Society—

To join, follow these simple steps: 1. Contact the CAC Membership Secretary, Elissa Mayo-Thompson (909) 782-4170, to obtain an information packet and application. 2. Fill out and return the application to Elissa along with your first year's dues & appl. fee. 3. Two of your listed references will be contacted. 4. Applicants are screened to ensure that they meet the requirements. (Outlined in Article 11 of the CAC Membership Handbook). 5. Your application will be presented to the Board of Directors at their next quarterly meeting. If approved, your application will be voted on by the membership at the next Seminar.

Paul Kirk Award
Call For Nominations

It is time to nominate outstanding new members of our profession for the Paul Kirk Award. In 1994 it was established that the recipient of the Paul Kirk Award is also the recipient of the Presidents Award. The Presidents Award was established to encourage a collegial relationship between the CAC and the Forensic Science Society by promoting scientific exchange and fellowship between members. The recipient of the Presidents Award will be sponsored to go to a FSS meeting in 2001.

Nominations will be submitted to the Awards Committee. The Committee will screen the candidates' qualifications and submit their recommendations to the Board, who will select the recipient of the award. Although candidates must be members of the CAC, nominating parties need not be. No self-nominations will be accepted.

The nomination period will end on August 31, 2000.
No nominations will be accepted after this time.

The candidate qualifications are as follows:

1. The candidate must be employed in the profession for fewer than six years. This six year qualifying period is defined as October 1994 - October 2000.

2. Employment in the field is defined as full-time employment and shall not include time in pre-professional positions, such as an intern or laboratory technician.

3. The candidate must be a CAC member (in any status) at the time of nomination.

4. During the six-year qualifying period, the candidate should have demonstrated an interest in a professional organization, not limited to the CAC.

5. Candidates must have made at least one of the contributions to the profession outlined on the nomination form.

The CAC is pleased that we have the opportunity to recognize our newer colleagues who have contributed to the profession. We would like to encourage as many nominations as possible. All nominations should be returned to the Awards Committee Chairperson, Shanin Sullivan, at the address below.

Shanin Sullivan
Ventura County Sheriff's Crime Laboratory
800 S. Victoria Ave
Ventura, CA 93009