NEWSLETTER
California Association of Criminalists



SEPTEMBER 1985

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1. Minutes of Board of Directors Meeting, May 17, 1985

2. Minutes of Business Meeting, May 17, 1985

3. 1985 CAC Roster

4. Amended version of the CAC Code of

# UPCOMING MEETINGS

**NORTHWEST ASSOCIATION OF FORENSIC SCIENTISTS**
October 2 - 4, 1985

The Fall meeting of the Northwest Association of Forensic Scientists will be held October 2 - 4, 1985, at the Holiday Inn Crown Plaza Hotel, Seattle, Washington. For further information, contact Mr. Kay M. Sweeney, Washington State Patrol, Seattle Crime laboratory, 2nd Floor, Public Safety Building, Seattle WA, 98104, (206-464-7073)

**THE DRINKING DRIVER: MEDICAL AND LEGAL ISSUES OF BLOOD ALCOHOL TESTING**
October 3-4, 1985

This seminar, to be held in Washington, D.C., is cosponsored by the American Association for Clinical Chemistry and the College of American Pathologists. For further information, contact the American Association for Clinical Chemistry, 1725 K Street, Suite 1010, Washington, D.C. 20006.

**MIDWESTERN ASSOCIATION OF FORENSIC SCIENCES**
October 8-11, 1985

MAFS will hold its seminar at Holidome at the Pyramids, Indianapolis, IN.

**NORTHEASTERN ASSOCIATION OF FORENSIC SCIENCES**
October 11-12, 1985

The 11th Annual meeting of the NEAFS will be held at the Long island Marriott Hotel, Uniondale New York. For further information contact Heljena M. McKenney, 408 Elmwood Avenue, Feasterville PA 19047, 215-355-3970.

**CALIFORNIA ASSOCIATION OF CRIMINALISTS**
October 24 - 26, 1985

The fall, semi-annual seminar of the California Association of Criminalists will be help October 24 - 26 at the New Otami Hotel, Los Angeles, California. Contact Greg Matheson, Los Angeles Police Department, 150 N. Los Angeles Street, Room 435, Los Angeles, CA 90012, (213-485-2535)

**ASSOC. OF OFFICIAL ANALYTICAL CHEMISTS**
October 29-31, 1985

This meeting will be held in Washington. D.C. for further information contact Margaret Ridgell, AOAC, 1111 North State Street, Suite 210, Arlington VA 22209. (703) 522-3032.

**SOUTHWESTERN ASSOCIATION OF FORENSIC SCIENTISTS**
October 31-November 2, 1985

This meeting will be held in Houston, Texas. For further information contact Floyd McDonald, Pasadena Regional Laboratory, P. O. Box 3209, Pasadena TX 77501. (713) 475-7866.

**EASTERN ANALYTICAL SYMPOSIUM FORENSIC ANALYSIS SECTION**
November 21, 1985

This meeting will be held in New York City. Contact G.M. Nakane, EAD Printing and Direct Mail, E.R. Squibb & Sons, P.O. Box 4000, Princeton, NJ. (201) 846-1582.

**AMERICAN ACADEMY OF FORENSIC SCIENCE**
February 11 - 15, 1986

The annual meeting of the American Academy of Forensic Science will be held February 11 - 15, 1986, at the Hyatt Regency Hotel, New Orleans, Louisiana. Contact AAFS, 225 S. Academy Blvd., Colorado Springs, CO 80910, (303-596-6006)

**THE USES OF FORENSIC SCIENCE**
April 4-5, 1986

The Forensic Science Unit of the University of Strathclyde is sponsoring a conference on the uses of trace evidence. There will be four concurrent sessions: Transfer traces, Crime scenes, Investigation science, and the Trial process. For further information, contact Mr. P. F. Nelson, Continuing Education Center, University of Strathclyde, McCance Building, Richmond Street, Glasgow G1 1XQ, UK.

**NORTHWEST ASSOCIATION OF FORENSIC SCIENTISTS**
May, 1986

The Spring NWAFS seminar will be held at the Inn of the Seventh Mountain, Bend, Oregon, Contact Miuke Howard, Oregon State Police Crime Laboratory, 375 N.E. Franklin Street, D-Bend, OR 97701. 503-388-6150.

**CALIFORNIA ASSOCIATION OF CRIMINALISTS**
May 14 - 17, 1986

The Spring, 1986, Seminar of the California Association of Criminalists will be held May 14 - 17, 1985, at the Hilton Hotel in Concord, California. the meeting is being hosted by the Contra Costa County Sheriff's Office Criminalistics Laboratory. Contact Kathryn Holmes, Contra Costa County Sheriff's Office, Criminalistics Laboratory, 1122 Escobar Street, Martinez CA, 94553, (415-372-2455)

**INTERNATIONAL ASSOCIATION OF FORENSIC SCIENCES**
August 2 - 7, 1987

Vancouver, British Columbia, Canada. Contact the International Association of Forensic Sciences, 801-750 Jervis Street, Vancouver, B.C., Canada V6E 2A9.

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# ANNOUNCEMENTS

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## Notice to the General Membership

- Be advised that an Ethics Committee Investigation commenced in 1983 has been terminated. The reports have been vacated and the members under investigation continue as members in good standing of the CAC.

- John E. Murdock
President- '84-85

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## Notice to All Members

As a gesture of good faith, the Board of Directors requests that any members who may have obtained copies of records from Alameda County Superior Court Case No. 5942 18-9, a lawsuit against the CAC, destroy such records.

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## MICROSCOPE MAINTENANCE

This course is being offered by the California Academy of Sciences in Golden Gate Park, San Francisco. The course meets on two Wednesday evenings, November 13-20, 7:00-8:30 PM. The course is intended to teach the basics of microscope viewing as well as how to clean, lubricate and maintain a microscope. The cost of the course is $10.00 for members of the California Academy of Science, or $15.00 for non-members. To register, send a check for the course fee to

Adult Education Office
California Academy of Sciences
Golden Gate Park
San Francisco CA 94118

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## DIALOG(tm) Training Course to be Offered by the CAC

If there is enough interest, the CAC is sponsoring a training course in the use of the DIALOG(tm) on-line information retrieval system.

DIALOG provides a variety of information databases which can be accessed via any computer terminal or any microcomputer equipped with a modem. The facilities offered by DIALOG are very extensive, and include a variety of technical databases (Chem Abstracts, biological science abstracts, MEDLINE, and others), popular literature abstracts (similar to the Reader's Guide), and a host of other databases. All of these databases are searched using keywords for entries of interest. When references of interest are located they can be ordered through DIALOG, obtained from a local library, or, in some cases, obtained "on line."

The CAC is sponsoring 1 day training course, which will include on-line time both during the day of the course and afterwards. The normal cost of the course is $125.00. CAC members may take the course for only $60.00. The space is very limited, so your quick response to this announcement is necessary to reserve a place in the class.

The dates and locations are as follows:

Tuesday, November 19 in Marina del Rey
(for Southern Section members)

Thursday, December 5 in Palo Alto
(for Northern Section members)

Non CAC members can attend these courses, if space is available. The cost for non-members is $110.00 - a slight reduction from the normal fee. The fee includes a course syllabus and lunch.

For more information, contact:

Peter Barnett
Forensic Science Associates
P.O. Box 8313
Emeryville CA 94608
(415) 653-3530

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## STUDY GROUP AND SECTION ACTIVITIES

### NORTHERN SECTION

The northern section held a dinner meeting hosted by the Institute of Forensic Sciences-Criminalistics Laboratory on June 21. The dinner meeting followed afternoon meetings of the Trace Evidence, Drug and Biology Study Groups.

### SOUTHERN SECTION

**Southern Section Trace Evidence Study Group**

The Trace Group met prior to the July 31 dinner meeting to discuss the various approaches to soil examinations. Following this general discussions, Lynn herold and Sandy Wiersema presented a review of the papers presented at the FBI Hair Symposium held earlier this summer.

On September 26 the group toured the Anja Engineering Company, 141 W. Maple, Monrovia. Anja manufactures ink and parts for the Scripto Pen Company. Their guide was Mr. Robert Massey.

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# EMPLOYMENT OPPORTUNITIES

( Job openings are obtained from a variety of sources. Given publication deadlines and delay in receiving announcements from other parts of the country, some of the openings announced here may be filled by the time this Newsletter is received. Job announcements will normally be run only one time. Members actively seeking employment are encouraged to contact the editorial secretary for information about openings which become available between newsletters. )

**CRIMINALIST**
Arkansas State Crime Laboratory. Contact Jim Clark, Asst. Director, Arkansas State Crime Laboratory, #3 Natural resources Drive, P. O. Box 5274, Little Rock, AK 72215.

**FORENSIC CHEMIST**
United States Army Criminal Investigation Command. Contact LTC Michael Moore, CX1C, United States Army Criminal Investigation Command, USACIL - Europe, APO New York 09757.

**DRUG CHEMIST**
**TOXICOLOGIST**
**FIREARMS EXAMINER**
**CRIMINALIST**
**SEROLOGIST**
New York State Police Crime Laboratory. Contact Robert Horn, Director, SP Laboratories, New York State Police Crime Laboratory, Building #22, State Campus, Albany NY 12226. (518) 457-1208

**ASSOCIATE DIRECTOR**
Center for Human Toxicology Contact Douglas Rollins, MD PhD, 38 Skaggs Hall, University of Utah, Salt Lake City, UT 84112.

**QUESTIONED DOCUMENT EXAMINER**
State Department of Public Safety. Contact Personnel Bureau, 4501 South 2700 West, 1st Floor, Salt Lake City, UT 84119.

**FIREARMS EXAMINER**
**SEROLOGIST**
**DRUG CHEMIST**
New Mexico State Police Crime Laboratory. Contact Larry Renner, New Mexico State Police Crime Laboratory, P.O. Box 1628, Santa Fe, NM 87501. 505-827-9136.

**CRIME LABORATORY ANALYST - FORENSIC SEROLOGY**
Wisconsin Department of Justice; Crime Laboratory, Milwaukee. $1634-$2142 starting salary, depending on qualifications. Contact Division of Merit Recruitment and Selection, 149 East Wilson Street, P.O. Box 7855, Madison WI 53707.

**SENIOR CRIMINALIST**
Contact Henry Lee, Director, Forensic Laboratory, 294 Colony Street, meriden, CT 06450. (203) 238-6324.

**CRIMINALIST I (SEROLOGY)**
**CRIMINALIST I (BALLISTICS)**
Contact Vincent Crispino, Chief, Suffolk County Crime Laboratory, Building 77, Veteran's memorial Highway, Hauppage NY 11788.

**CHIEF - FORENSIC SERVICES**
**FORENSIC SCIENTIST**
Contact C. Nicholas Hodnett, Director of Toxicological and Forensic Science Services, Department of Labs and Research, Valhalla NY 10595. (914) 347-6213.

**EVIDENCE TECHNICIAN**
Contact City of San Diego, personnel development, 2-2 C Street, M.S. 6A, San Diego CA 92101. (619) 236-2753.

**FIREARMS EXAMINER**
This position offers an opportunity to be the lead firearms examiner in the headquarters laboratory. Contact Lab Administrator, Kansas Bureau of Investigation, 1620 SW Tyler, Topeka KS 66612. (913) 232-6000.

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## CRIME LAB RELIABILITY

The following news article and letters written in response, were published in Chemical and Engineering News. They are reprinted here for the information of our membership.

"Crime Labs Not Reliable Criminalist Claims"

(Reprinted with permission from Chemical & Engineering News, May 20, 1985, 63, 40-41)

What's the difference between a barber and a forensic serologist? Sounds like a dumb question. But according to Benjamin W. Grunbaum, there is at least one major difference: A barber has to have a license to practice: a forensic serologist does not. For that reason and several others, Grunbaum says, crime laboratory analyses of physical stain evidence are unreliable and should not be admissible as evidence in court trials.

Criminalist Grunbaum, trained as a biochemist, is also an environmental physiologist at the University of California, Berkeley. At a symposium on forensic chem-istry sponsored by the Division of Analytical Chemistry, he explained that forensic serology is the term rather loosely applied to the analysis of blood, bloodstains, semen stains, and other physiological materials that may be important as evidence in a variety of criminal cases, including murder and rape.

The usefulness of blood and other body fluids as evidence derives from their containing numerous genetic markers, such as the familiar ABO blood types, that can be detected and identified by appropriate analytical procedures. The most frequent use of blood evidence in the cause of justice is in paternity disputes, Grunbaum notes.

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(con't from previous page) There, tests can either exclude a man as the father of a child or, in the absence of such exclusion, help assess the probability that he is indeed the father. In these situations, there is normally no problem in obtaining ample amounts of fresh blood from the mother, child, and putative father.

Similarly, physiological stains containing blood, semen, saliva, or other body fluids, either from victims or suspects, can provide useful evidence in more violent criminal cases. With these, however, the crime laboratory analyst must work with whatever samples can be obtained, and these are often old, contaminated, and limited in quantity.

"Unfortunately, these analyses often fail to meet expected standards for accurate, complete, and unbiased scientific evidence," Grunbaum says. He cites the example of a murder case in which five different analysts reached three different conclusions with regard to the ABO antigens present in a bloodstain. "It is possible that one, two, three, four, or all the analysts were wrong," he comments. In another instance a laboratory reported finding sperm in what was in fact aspermic semen.

"My own review of casework as a consultant and expert witness, my review of the professional literature, and my assessment of proficiency test results have led me to conclude that crime laboratory analysis of physiological stain evidence is currently unreliable and should be inadmissible," Grunbaum says.

Of course the crime laboratory analyst often is handicapped by the type, amount and condition of the sample, Grunbaum adds. "In such instances, the interpretations become increasingly subjective, and the inexperienced, improperly educated, or overzealous analyst is apt to make errors." However, other fundamental problems also contribute to "the current unsatisfactory state of the art."

One problem is lack of specialization among criminalists. Analysts in so-called "full-service laboratories" are expected to be expert in several diverse areas. Instead, they are ill-prepared for what should be a highly specialized area of sophisticated testing. "These analyses are potentially more damaging than if no analysis had been performed," Grunbaum asserts.

Furthermore, "There is widespread use of novel and unvalidated methods," Grunbaum says. Not only do crime labs not recognize the need for standardized methodology in physiological stain analysis, they often oppose efforts to impose such standardization, on grounds that the varied samples aren't well handled with standard methods. On the contrary, Grunbaum says, a basic requirement for a valid analytical determination is the elimination of all variables. Therefore, it's particularly important to use standardized methodology. Adjustment to fit the condition of a sample -- longer extraction or staining time, for example- can be incorporated into these standard procedures.

Another problem stems from lack of agreement on the qualifications necessary to perform analyses of physiological evidence. In the past, Grunbaum says, criminalists -have rejected proposals to establish certification programs. He notes that many of them were rejecting not the principle of certification but the particular plans presented. Nevertheless, he says, "By failing to agree on qualifications for certification in their specialized disciplines, the criminalists have passed up at least one opportunity to define themselves as members of a scientific professional community."

Grunbaum also deplores the "orientation of the analyst within the criminal justice system." Most such analysts, he notes, are employees of prosecution-oriented government labs; as such, they're expected to help bring about convictions. "This orientation makes it difficult to maintain scientific objectivity and avoid involuntary bias."

In addition, there is no coordination among the many crime labs in the U.S. There are no codified standards of practice, no common requirements for education and internship of analysts. "There is undoubtedly a high degree of proficiency and a strict enforcement of quality control in some public crime laboratories," Grunbaum says. "But there are also laboratories that tolerate careless work, fundamental errors, and faulty or inappropriate methodology."

Quality-assurance programs are a matter of primary concern and routine practice in medical labs and bloodbanks, Grunbaum says, adding that the establishment of similar programs for crime labs would benefit both prosecution and defense.

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"Crime labs in the U.S."

July 8, C&EN

SIR: The article "Crime labs not reliable, criminalist claims" (C&EN, May 20, page 40) contains several very questionable statements. Benjamin Grunbaum, being only peripherally involved in the field, appears to be out of touch. He indicates that there "is no coordination among the many crime labs in the U.S."

The American Society of Crime Laboratory Directors (ASCLD) has been in existence now for well over 10 years and its members represent a vast majority of all crime laboratory directors. We hold an annual meeting each year which is extremely well attended (150 to 200

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labs represented). In addition there are six regional forensic science organizations of considerable vigor which also hold regular, well attended meetings. The informal interchange of information at these meetings rivals the sizable amount of information presented in formal papers.

Grunbaum also decries a lack of quality assurance programs for crime labs. The last ASCLD meeting in September 1984 was largely devoted to presentations on quality assurance from many different viewpoints. ASCLD itself has made contributions in this area by sponsoring an annual set of proficiency test samples. The labors of the ASCLD committee helps keep costs under control. The number of subscribers has steadily increased and now even includes labs from a number of foreign countries.

There is, indeed, great diversity of method and approach among the crime laboratories of the U.S. This is largely a reflection of the diversity of jurisdictions they serve. From my vantage point, it appears that there is enormous vitality in the field with each lab striving to provide ever improving service to its constituency.

Howard A. Harris,
President ASCLD

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"The forensic science arena"

June 17, 1985 C&EN

SIR: It is very unfortunate to see reports such as Benjamin Grunbaum's "Crime labs not reliable, criminalist claims" (C&EN, May 20, page 40) go unchallenged. Some of his points appear to be based on bias or personal interests. Unfortunately, the general public, even those individuals with a scientific background, frequently cannot sort these biases because of the specialized nature of forensic science.

One particularly unfortunate and questionable remark made by Grunbaum, which I think may reflect the particular bias which I see in his paper, is the comment "Such analysts... are employees of prosecution-oriented government; as such they're expected to help bring about convictions." I have met and instructed literally hundreds of state-level forensic scientists and I take particular umbrage to that statement, and further note that virtually all "government" forensic scientists are civil servants whose salaries are set by law. To them it makes absolutely no difference what their results are in a particular case just so long as their laboratory supervisor knows that they are doing a credible job.

On the other hand, Grunbaum is paid generally by the defense on a contractual basis, sometimes thousands of dollars per case. I anyone is interested in keeping their job opportunities open and impressing the right people with results, it would be the Grunbaums in the forensic science arena (those in private practice). They would have the higher potential for having a basis- to help bring about acquittals.

Stephen P. Allen Jr.
Quantico, VA

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The following letter to the editor has been sent by CAC President Stephen Cooper. It has not yet been published.

SIR: The article "Crime labs not reliable, criminalist claims" (C&EN, May 20, page 40) can be summarized, I believe, by Grunbaum's own statement, "My own review...have led me to conclude that crime laboratory analysis of physiological stain evidence is currently unreliable and should be inadmissible" His conclusion is WRONG.

Grunbaum has taken some valid areas of interest in the forensic science community and, for whatever reason, has twisted some and extrapolated others to the ridiculous.

There is NO fundamental disagreement within the relevant, knowledgeable scientific community about the use of genetic marker typing of body fluid stains. Both the California Association of Criminalists (CAC) and the American Academy of Forensic Sciences have studied the technique and have issued reports in support. The methods have been well established by appropriate and properly controlled scientific investigation. Substantial international scientific literature on the subject exists in support of this conclusion.

One statement of Grunbaum's is especially repugnant to me. He states, "employees of prosecution-oriented government labs...expected to help bring about convictions". The CAC is the oldest and one of the largest regional forensic science societies in the United States. Our membership consists of criminalists from private laboratories doing mainly defense work as well as criminalists associated with various law enforcement agencies. One of the basic responsibilities of our members is to apply only <u>proven</u> <u>and</u> <u>accepted</u> techniques to the examination of evidentiary materials and to present the results in both written and oral form in a comprehensive and <u>objective</u> way. Our highly respected Code of Ethics speaks directly to these issues. It is not unusual for the work of a criminalist to result in charges being dropped against a defendant. These

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instances do not make the headlines but they occur because of the impartiality of criminalists.

Sincerely,

Stephen Cooper, President
California Association of Criminalists

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**THE WEBER TEST**

A Color test for the Presence of Psilocin in Mushrooms

Allen Steve Garrett, Steven R. Clemens and James H. Gaskill, Weber State College, Ogden, Utah.

Those of you who work with identification of controlled mushrooms know that there are several factors that make such identification difficult:

1. There are literally thousands of different species off which only a few mushrooms are hallucinogenic and not all of these are in the same genus.

2. Even with fresh samples, genus and species identification is a real challenge. When samples are in a dried, crushed, and/or frozen state, botanical identification is almost impossible.

3. Psilocin and psilocybin are light and heat sensitive and can decompose very quickly.

4. Most labs use analytical methods to identify controlled mushrooms. These methods can be challenging when used to identify the hallucinogenic components in mushrooms.

Using a gas chromatograph with an FID or hot wire detector can be very tricky. GC/MS is excellent and quick, but not all labs are fortunate enough to possess one. Sample clean-up and preparation for TLC, IR, or UV can take several hours. Much Valuable lab time can be wasted on the analysis of bogus mushrooms.

At the Weber (pronounced "Weeber") State College Crime Lab, we have devised a simple color test to distinguish non-controlled mushroom samples quickly. It is a preliminary test, not a complete analytical procedure. A negative test result, however, should eliminate any need for further testing.

The chemicals used react with psilocin, which is typically present in the hallucinogenic mushrooms. Some literature reports that there are species of hallucinogenic mushrooms that contain only psilocybin, but we have not found any "magic mushrooms" that do not contain at least some psilocin. This may be due to the fact that psilocybin hydrolyzes to psilocin very easily.

Over the past two years, the Weber State College Crime Lab has tested all mushrooms samples that have been submitted. In no case did a sample test negatively with the color test and subsequently show the presence of psilocin by TLC and IR.

We have tested the mushroom collection of Brigham Young University (a total of 55 different species) as well as numerous unidentified species collected from our local environment, with no false positive or false negative results being received using this color test.

The procedure is a very simple one, consisting of a two-part chemical addition to small fragment of a mushroom.

Step 1: Make fresh daily, a 0.1% solution of Fast Blue B or Diazo Blue B (o-dianisidine, tetrazotized by dissolving .01 grams in 10ml distilled water. Two or three drops of this solution is added to a sample of mushrooms, at room temperature. The solution will turn red if psilocin is present.

Step 2: One or two drops of concentrated hydrochloric acid is added to the (red) solution of mushroom sample and Fast Blue B reagent. In the presence of psilocin, the solution will change from red to blue in color. If psilocin is not present, no color is obtained or, in a few incidents, a pink or orange color will appear with no change in the HCL addition. Where colors were obtained, they were not confused with those of a positive test for psilocin.

WEBER STATE COLLEGE, Laboratory of Criminalistics, Ogden, Utah 84408 (801) 626-6147.

**CRIME LAB LIABILITY**

Reprinted with permission from 85-2 issue of Law Enforcement Legal Defense Manual, 421 Ridgewood Avenue, Glen Ellyn, Illinois 60137. 

Negligent Crime Lab and Forensic Procedures

Both the Police and the crime lab can be held liable for negligent investigations. In Cantwell v. Allegheny Co., 466 A.2d 145 (Pa. App. 1983), it was alleged that a negligent investigation of a rape resulted in imprisonment of

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the wrong man for a lengthy time. In this case, semen was found on a pair of pants, but the crime lab decided not to do a test for blood type until a suspect was in custody. At that point, the crime lab said that the samples were now too old for a test. One lab employee later disputed this fact. The suspect stayed in jail for five months, after which a test *was* conducted and demonstrated that his blood-type was different from the sample, after which he was released and filed this lawsuit. The court refused, under the circumstances, to find any immunity which protected the department or the crime lab.

Investigative services which are established to aid the prosecution have a responsibility, in general, to serve not only to protect the public and the crime victim, but also to protect the accused or potential suspect against false charges. *Commonwealth v. Blagman*, 458 Pa. 326 A.2d 296 (1974). At the same time, the mere fact that the police fail to investigate particular exculpatory evidence is not necessarily a violation of due process. *People v. Jenkins*, 40 Cal. App. 3d 1054, 115 Cal. Rptr. 622 (1974) (failure of police to provide a blood-alcohol test that may have been useful in negating intent). In *Harris v. People*, 174 Colo. 483, 484 P.2d 1223 (1971), poli failure to conduct tests determine whether the defendant's knife contained human or animal blood was no violation of his rights. In most of these cases, the potentially exculpatory evidence is known to the defendant and there are alternate ways of proving it, besides relying on a police department conducted test. It is principally when the department's negligence destroys the possibility of presenting the exculpatory evidence, that there is a good possibility of civil liability. See also *State v. Kelly*, 110 Ariz. 196, 516 P.2d 569 (1973).

## FOR MEMBERS ONLY

The CAC is offering for sale a number of items emblazoned with the CAC Logo

Sweaters - long sleeve or sleeveless V-neck acrylic sweaters

Burgundy, brown, black, navy, camel, bone, red, light blue
Sizes S, M. L. XL (Men's sizes)
Cost: $15.50 sleeveless
15.50 long sleeves

Golf shirts - Cotton-polyester, short sleeve

Black, burgundy, slate grey, bone, navy, kelly, red, yellow
Sizes S, M, L, XL
Cost $15.00

Hats - Foam/mesh (one size fits all) $5.50
All-cloth (solid color) $7.00

Totes - 100% cotton canvas

Natural color

| | |
|---|---|
| Economy 12" x 14" | $6.50 |
| Deluxe 15" x 15" x 4" | 10.00 |
| Envelope 17" x 17" | 8.50 |

Three ring binders

Blue 1" capacity $6.50

**SEE THESE ITEMS AT THE FALL SEMINAR**

FOR FURTHER INFORMATION CONTACT:

John DeHaan
BATF (415) 556-7040

# THE CHEMISTRY OF THE LUMINOL REACTION -- WHERE TO FROM HERE?

John I. Thornton, D.Crim., and Ralph S. Maloney, B.S.

Forensic Science Group, Dept. of Biomedical and Environmental Health Science, University of California, Berkeley, Ca., 94720

## Introduction

Due to the proven carcinogenicity of benzidine and the suspicion of mutagenicity or worse on the part of a number of its structural congeners, there is a distinct need for alternative presumptive chemical tests for blood. Although the classical luminol reaction has definite drawbacks as a presumptive chemical test for blood in routine applications, luminol is *not* mutagenic by the Ames test, and would deserve to be be viewed with renewed interest by the forensic community if the specificity could be enhanced. The test as it is generally conducted is sensitive, but not particularly specific. The present work is intended to review the chemistry of the luminol reaction, the ultimate aim being to increase the specificity of the reaction by an adjustment of test parameters. Virtually all of the work that has been conducted on the luminol test up to this time has been directed toward making the reaction more *sensitive*; the chemistry of the reaction has not been subjected to any particular scrutiny to ascertain if it could be made more *specific*. The chemistry of luminol was last reviewed in the forensic literature in 1939, at a time when the nature of the reaction was poorly understood; the present work is an attempt to tidy up the chemistry so that promising avenues of further inquiry may be identified.

## History of the Luminol Reaction in Forensic Practice

When luminol (I) was first synthesized, it was known by its chemical name of 3-aminophthalhydrazide rather than by its trivial name. (Purists may be more comfortable in calling it 5-amino-2,3-dihydrophthalazine-1,4-dione). It was first synthesized in 1902 by Schmitz [1]. It was not until 1928, however, that Albrecht first drew attention to the chemiluminescent properties and carried out fundamental spectral measurements [2]. This work was then confirmed in 1936 by Gleu and Pfannstiel [3], who discovered that crystalline hemin produced an especially intense reaction. This observation concerning hemin was almost simultaneously discovered by Tamamushi [4] in 1937.

In 1929, Harvey determined that the chemiluminescence of 3-aminophthalhydrazide is a result of anodic oxidation, or, alternatively, the result of molecular oxygen activated by metals [5]. In 1934, Huntress *et al.* published [6] a much more economical synthesis, and named the compound "luminol."

In the forensic domain, luminol was first proposed as a presumptive test for blood by Specht in 1937 [7], apparently at the suggestion of Gleu and Pfannsteil, whose interests were more aligned with the pure chemistry of the compound. In 1939, two San Francisco Bay physicians, Proescher and Moody, published a rather definitive study entitled *Detection of Blood by Chemiluminescence* [8]. This is virtually the only detailed treatise on the subject from a forensic standpoint, although at that time the mechanism of the reaction was poorly understood. The first epoch in the forensic utilization of luminol ended about the time of Proescher and Moody. For a number of years thereafter, forensic consideration of hematin catalyzed luminol oxidation principally centered around differing perceptions of the specificity of the reaction [9-11], although numerous articles were published in other disciplines describing the chemiluminesence of organic hydrazides. (In other disciplines, luminol came to be a fairly prosaic way of monitoring oxidation reactions of a wide variety of sorts). In 1966, Weber [12] described a more sensitive luminol reagent, in which the concentrations of luminol and of hydrogen peroxide, found to be inhibitory, were decreased. Then in 1973, Zweidinger [13] published a somewhat cursory discussion of the utility of luminol for the location and presumptive testing of bloodstains, the principal thrust of the article dealing with photography of the reaction.

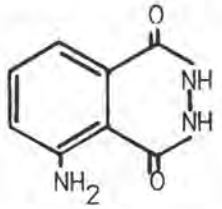
## Terminology

The chemistry of the luminol reaction can be a bit tricky, and variables in the reaction may give rise to considerable complexity in the reaction. This complexity is compounded to some extent by the confusion in nomenclature and general imprecision in terminology that occurs in the literature. As a consequence of this, an attempt will be made, to the extent possible, to standardize terminology against the International Union of Pure and Applied Chemistry *Compendium of Analytical Nomenclature* [14].

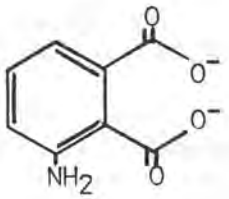
Chemistry of Luminol

Chemiluminescence is the emission of light in excess of blackbody emission during a chemical reaction; like fluorescence, it occurs when an electron moves from an excited to the ground state. Unlike fluorescence, it does not require excitation by radiant energy. It *does* require, however, a chemical reaction which will supply energy of at least 40-70 kcal/mole [15]. Many chemical reactions are capable of supplying that much energy, and indeed there must be a large number of chemiluminescent reactions; the development of instrumental means to detect as few as $10^3$ photons $cm^{-3}$ $sec^{-1}$ [16-17] has permitted studies of these weak reactions.

But only a few reactions are known where the chemiluminescence is truly brilliant. Among these is the reaction involving luminol. Albrecht [2] concluded that oxidation of luminol in alkaline solution gave 3-aminophthalate dianion (II)




(I)
Luminol




(II)
3-Aminophthalate

and nitrogen. Since after the chemiluminescence had ceased only luminol could be isolated from the reaction mixture, Albrecht concluded that luminol itself was the light emitting species. This assumption was challenged by White and co-workers [18-20], who established, during the period 1961 to 1964, that the 3-aminophthalate dianion is the light emitting species.

The work that has been done on the luminol reaction since 1964 has refined somewhat the assumptions that have been made concerning the mechanism of the reaction, but hasn't totally elucidated the precise mechanism. This is primarily the result of an inability to identify certain of the intermediate species which are being formed and altered too rapidly to permit isolation. The Albrecht mechanism [2], and that of Shevlin and Neufeld [21], both of which are outlined in the *Sourcebook in Forensic Serology, Immunology, and Biochemistry* [22], are almost certainly flawed.

Certain generalities may be advanced concerning the reaction mechanism, however:

1) In aprotic solvents, such as dimethylsulfoxide, dimethylformamide, or mexamethylphosphoric acid triamide, only a base and oxygen are required [23]. Aprotic solvents are consequently unsuitable for forensic work.

of superoxide. It is then necessary to add a second electron to the peroxy radical in order to prepare it for the final light emitting step [25].

5) Oxygen is required stoichiometrically [26].

6) As per electron paramagnetic resonance, free radicals are involved [27].

7) Superoxide is involved in the reaction [28], since superoxide dimutase inhibits the reaction at neutral and acidic pH in aqueous solutions.

8) Nitrogen is produced stoichiometrically [26].

9) The 3-aminophthalate dianion species is the end product [29].

10) The effects of both luminol and hydrogen peroxide concentration on the luminescence rate show normal Michaelis-Menten kinetics [27].

By the pathway outlined in Figure 1, luminol (I) is oxidized by a hydroxy anion generated from the reduction of an oxidant, in this case $H_2O_2$, to the luminol monoanion (III), which is then immediately converted to the luminol radical (IV) by a hydroxy radical present from the previous reduction of the hydrogen peroxide. This luminol radical is then attacked by another hydroxy anion to further oxidize the luminol radical to the luminol radical anion (V). This radical anion is then attacked by a superoxide radical to form a transannular peroxide, luminol endoperoxide (VI). Then, by as yet an unknown pathway, this endoperoxide is converted to an electronically excited dianion (VII) with the subsequent loss of nitrogen. Upon the return of the excited dianion to the the ground state (II), a photon with a wavelength of approximately 425 nm is emitted. The pH optimum for the *light emitting* reaction is 10.4 to 10.8 [30], a fact that has profound implications for the luminol test as a presumptive test for blood.

Catalysis of the Reaction by Blood

One severe constraint on the luminol test is that one cannot optimize the light emitting reaction without compromising the reactions that cause blood to react. When one turns to what it is in blood that causes the luminol reaction to kick over, and for that matter, other catalytic reactions as well, one runs afoul of the terminology. The classical statement is that catalytic tests for blood depend on its "peroxidase activity." The suffix "*-ase*" ordinarily suggests a protein enzyme, but in this context it does not. Heme compounds, *i.e.*, ferri- and ferroprotoporphyrins, may *mediate* oxidation of organic

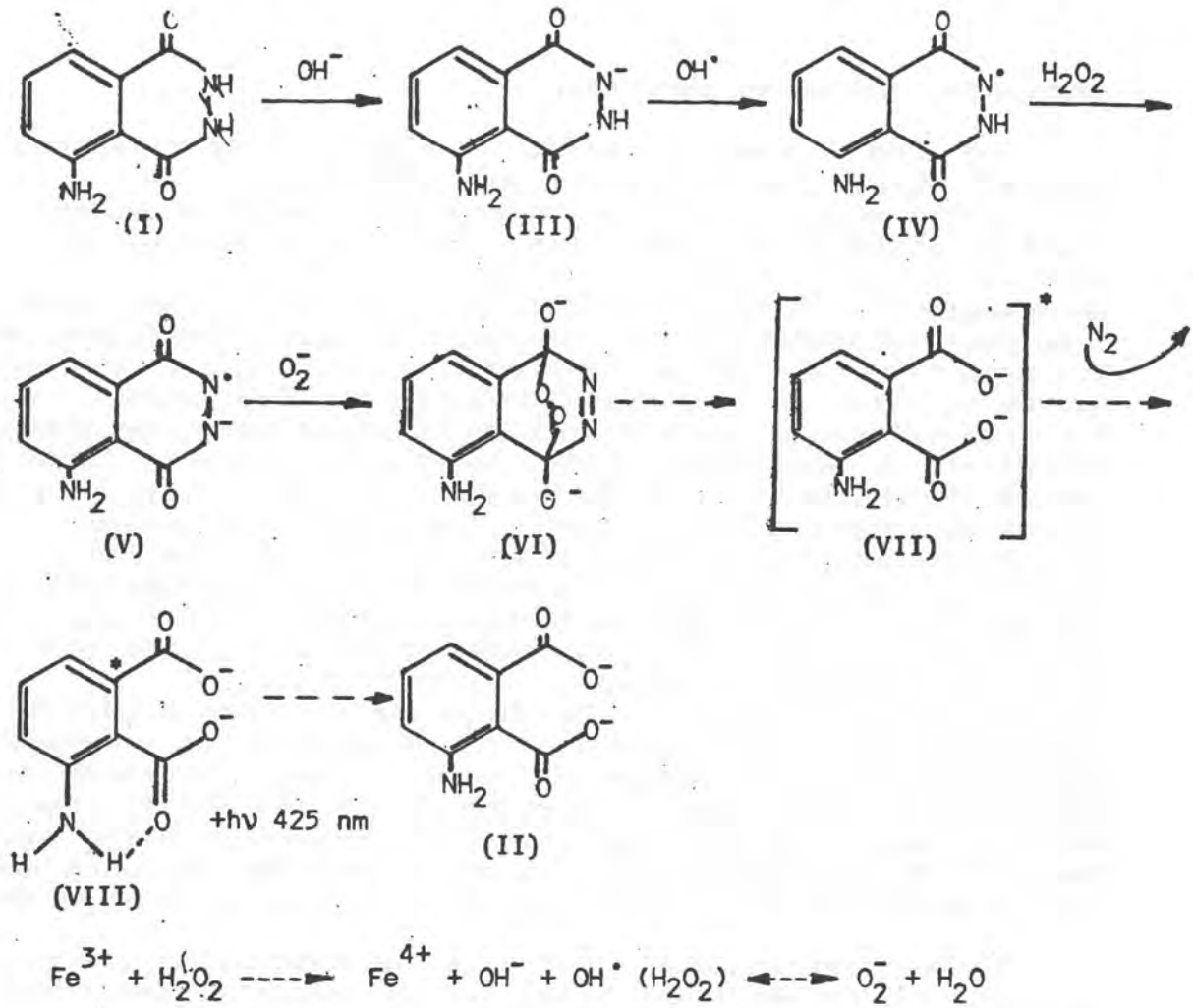



Figure 1. Oxidation of luminol. This mechanism, as presented here, is an amalgamation of the component segments of the work of a number of researchers, and assumes a hematin catalyzed peroxidase system with $H_2O_2$ as the oxidizing agent.

2) In protic solvents, *e.g.*, base, the requirements of the reaction are the base, an oxidizing agent, a catalyst, and either oxygen or a peroxy compound [23].

3) (Hemin) catalyzes the oxidation of luminol independent of the concentration of the base [24].

4) Luminol acts as a typical two electron donor in peroxidase catalyzed reactions. Chemiluminescence is initiated by a one-electron oxidation of luminol, followed by a rapid addition

compounds, including peroxide.

The iron in heme may exist in either the $Fe^{2+}$ ferrous, the $Fe^{3+}$ ferric, or the $Fe^{4+}$ transition state. $Fe^{2+}$ is the state in ferroprotoporphyrin (heme) or as the state existing in oxyhemoglobin. $Fe^{2+}$ can be easily oxidized to $Fe^{3+}$, which is the form of iron in methemoglobin. A fundamental feature of the luminol reaction is that heme can catalyze the reduction of peroxy compounds while at the same time catalyzing the oxidation of luminol. Oxyhemoglobin can be oxidized so that the iron is in the $Fe^{3+}$ state. Upon the addition of an oxidant such as hydrogen peroxide, sodium persulfate or sodium perborate, ferriprotoporphyrin (hematin) is further oxidized to the $Fe^{4+}$ transition state, while at the same time reducing the oxidant. The addition of oxygen to ferriprotoporphyrin should convert the iron to the $Fe^{5+}$ transition state; however, an extra electron is supplied from somewhere in the hemoglobin molecule, probably from the ligand attached to position 5 of the heme molecule [31], so that the highest transition attained is the $Fe^{4+}$ state. Chemiluminescence is initiated by a one electron oxidation of reducted luminol, followed by a rapid addition of a superoxide molecule; it is then necessary to add a second electron to the peroxy radical in order to prepare it for the final, light emitting step. At the same time that luminol is being oxidized, the $Fe^{4+}$ ferriprotoporphyrin is being reduced, allowing the heme molecule to again participate in the reaction as a catalyst.

Three other possibilities exist whereby blood can oxidize luminol, two of which are likely to be insignificant. There may be a very small amount of xanthine oxidase present which upon oxidation of iron will generate superoxide which in turn can oxidize luminol, and there may be a very small amount of peroxidase (the "true" protein peroxidase enzyme) which will oxidize the luminol. The third possibility is catalase, which is present in significant quantities in red cells.

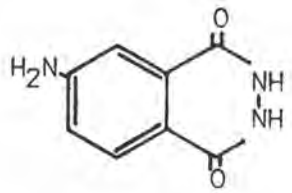
The pH optimun of catalase is approximately 7.0, and the optimum for the heme-mediated "peroxidase activity" is approximately pH 4.5. And herein lies the tragedy; the pH optimum for catalase and peroxidase is very far away from the pH optimum of the luminol reaction. If an acidic pH is necessary for the peroxidase mechanism to proceed at optimum efficiency and an alkaline pH for the oxidation of luminol, favoring the luminol will give us chemiluminescence but at the expense of the peroxidase reaction. And when we really get down to it, it isn't the luminol reaction that we are fundamentally interested in, but the peroxidase reaction; the chemiluminescence is only a tool by which we can visualize the peroxidase (and catalase) reactions.

Candidate Modifications of the Luminol Test

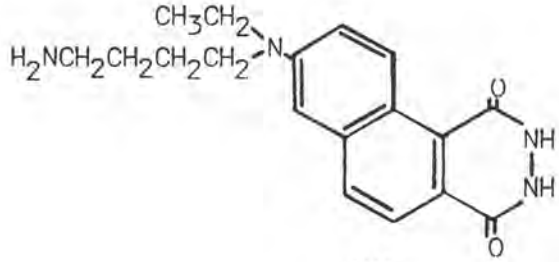
The carbonyl form of luminol is required for the production of chemiluminescence, and at pH 8 only 25% of the luminol is in the carbonyl form. Therefore, if the pH were to be reduced to

take advantage of the known catalytic mechanisms in blood, there will be a drastic diminution of the amount of light produced due to the reduction of luminol in the carbonyl form necessary for electron excitation. One way out of this would be to substitute another, more efficient compound for luminol; if a more efficient compound were available, we could afford to give up some of the quantum yield from the chemiluminescence reaction in order to gain on the peroxidase or catalase reaction which is teleologically of more interest.

Chemiluminescent compounds of greater efficiency than luminol have in fact been described. Isoluminol (IX) has only about 10% of the efficiency of luminol, but alkylation of the amino group leads to significant increases in chemiluminescence




(IX)
Isoluminol




(X)
Aminonaphthalhydrazide

capability. Similar substitution on luminol, on the other hand, leads to severe steric hindrance which decreases its efficiency. 7-(N-ethyl-N-aminobutyl)aminonaphthalene-1,2-dicarboxylic acid hydrazide (X) is 420% more efficient than luminol [32], which should permit the reaction to be run at pH 8 with approximatly the same chemiluminescent yield as luminol. This material is unfortunately not available, even from the workers having originally synthesized it [33]. The synthesis is published [34], but it is a real bitch, and the present authors are not widely known for their acumen in organic synthesis.

Another approach would be to ignore the chemiluminescence of the aminophthalate, and to concentrate on the fluorescence. Luminol is not fluorescent in alkaline medium, while aminophthalates are. Since fluorescence is a more efficient process than is chemiluminescence, oxidized luminol may be more efficiently located by means of ultraviolet fluorescence of the oxidized aminophthalate than by a strict reliance on chemiluminescence. In the author's laboratory, effort is being concentrated in this direction; the principal problem with this approach is that fluorescence following autochemiluminescence, *i.e.*, oxidation of luminol by traces in the reaction mixture of $Cu^{++}$, $Co^{++}$, or other transition metal, would be even more of a problem with respect to specificity than it is with the luminol test as it classically run. Solvent parameters would have to be carefully selected.

A combination of fluorescence *and* the use of a more

efficient aminophthalhydrazide or aminonaphthylhydrazide would seem to be a conspiciously applicable approach to the conservation of of the peroxidase reaction at lower pH. This would also have the advantage of not adversely affecting the proteins in a dried bloodstain in order that other genetic markers may later be identified.

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# DRAFT GUIDELINES FOR THE ESTABLISHMENT OF QUALITY ASSURANCE PROGRAMS IN THE FORENSIC COMPARISON OF HUMAN HAIR -

Interim Report of the Subcommittee on Quality Assurance of the Committee on Forensic Hair Comparison

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## ABSTRACT

Quality assurance is important in all aspects of laboratory science, perhaps particularly so in Forensic Science where our laboratory results routinely impact on the lives and freedom of individuals. Peculiarities of the hair comparison problem make the establishment of a quality assurance program in this area particularly difficult. A Subcommittee of the Committee on Forensic Hair Comparison met at Quantico in May of 1984 and developed a draft proposal for the establishment of quality assurance programs for those engaged in human hair comparisons.

Our proposal suggests the use of a sequence of four test sets, each in turn consisting of several known and questioned samples to be inter-compared. Each test set is circulated to all of the participants of the trial. One quality assurance trial thus consists of many examinations, each made by a series of examiners. The results for each examiner are evaluated in comparison to those of the other participants in the trial.

The proposal outlined here is currently being tested with actual samples in circulation to eight test subjects. The purpose of this field evaluation is to revise the guidelines if required before a final recommendation is made. Input is also being sought from others in the profession through the presentation of this paper.

The Subcommittee feels that quality assurance is reasonable and practical through the use of the draft guidelines presented here.

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## I HISTORICAL NOTES

The Committee on Forensic Hair Comparison had its genesis at the Inter/Micro '82 meeting in Chicago where, by coincidence, a number of papers were given on the subject of the forensic examination of human hair. A panel discussion on forensic microscopy was also held and the discussion, not surprisingly, turned to hair examination. It became apparent that there was little uniformity in the approach taken by various examiners, in what they thought significant in conducting a hair examination, and in how they viewed and expressed their conclusions.

At the suggestion of Dr. Walter McCrone, a number of those present who conducted hair examinations agreed to work together to try and reach some consensus views on a number of the aspects of hair examination. The Committee On Forensic Hair Examination was thus formed. The Committee had (and still has) no official status of any kind, no sanction by any parent group, and no official endorsements. It is simply a voluntary assembly of individuals knowledgeable on the subject of the forensic examination of human hair who have agreed to act cooperatively in their attempts to improve the state of their art.

Barry Gaudette agreed to chair the committee which initially consisted of eleven individuals and has now grown to approximately 20 individuals. There have been a total of six sub-committees established to work on the subject areas of Definition and Standardization of Terms, a Protocol for Hair Comparison, Hair Comparison Characteristics, Report Writing and Court Testimony, Training, and Quality Assurance.

The F.B.I. Research and Training Center at Quantico very kindly offered to host meetings of the committee. Two meetings of the Committee were held in the past two years, and a third, in conjunction with the International Symposium on Forensic Hair Comparison, was just held on June 27-27, 1985 at Quantico. The products of these meetings will be a volume of Proceedings, an Atlas of Photomicrographs of Hair Characteristics of Forensic Significance, and a final report of the Committee on Forensic Hair Comparison. All of these are scheduled for publication within the next year, with the Proceedings of the International Symposium probably first to press. They will be announced in the Crime Lab Digest.

The topic of this paper is the work of the Sub-Committee on Quality assurance.

## II GOALS OF THE SUB-COMMITTEE

The primary goal of the Sub-Committee was to place before the professional community of forensic hair examiners a procedure which they can use for quality

assurance or proficiency testing.

We recognize that having such a procedure in existence will allow practicing forensic scientists and their laboratories to achieve several other valuable benefits, for example:

1. To determine the present performance level of the cross section of the professional community participating in the study in an experimental process which approximates the process used in casework.

2. To determine the performance level of individual examiners relative to the norm of performance established by the test.

3. To examine the relative performance levels of two groups using different methods (methods evaluation).

4. To determine the reproducibility of an examination made on different hairs of the same source.

5. To determine the reproducibility of results when the same comparison is made by different examiners.

Note that these last three points are essentially research questions which may be addressed using the testing process outlined below.

## III PLAN OF ATTACK

Our Sub-Committee began work at the close of the First Symposium on Forensic Hair Comparison in June of 1983. By May of 1984 we had formulated the draft of our Quality Assurance Program. Between May and December of 1984 we assembled a "Resource Pool" of hairs (explained below) and in April of this year we began a collaborative test to evaluate our Draft Quality Assurance Program.

We anticipate completing the collaborative test in December of this year. We will then re-evaluate the design of the Program, make any revisions which are indicated, and issue a final recommendation to the community.

Again, I emphasize that we are simply a voluntary assembly of people concerned with this problem. As such, our recommendations will be just that, recommendations. They carry no weight and there is no mechanism for forcing their use on any laboratory. We will simply place them before the community to use or ignore as individual laboratories see fit.

## IV GENERAL COMMENTS ON THE TEST PROGRAM

I should point out some general characteristics of this program.

It is a round-robin type of testing system where all participants in a given test series see and examine the same hairs. The results are evaluated as a set, all of the

results of the participants in the test series being considered in comparison with one-another.

A test series will take approximately 8 months to complete and it is anticipated that the users would participate in different test series as time passes. Thus an on-going quality assurance program within a laboratory would consist of perhaps one such series being conducted every year.

The program is designed so that larger laboratories can conduct the tests entirely in-house if they wish. Smaller laboratories could participate in such a test program on a cooperative basis with other laboratories. The test sets can be produced in-house following the guidelines given below, or they could perhaps be purchased commercially.

The program is designed to simulate the more difficult hair comparison problems, those where there are multiple, grossly similar known sources to which evidence hairs will be compared. As such, it is not truly representative of the "average" or "typical" case and it cannot produce information about the overall significance of hair evidence. It only tests the examiner's ability to distinguish grossly similar hairs.

I would point out, however, that the layman can distinguish grossly different hairs without the aid of the expert, so this is essentially a measure of the difference between the trained examiner and the layman.

As mentioned, an on-going quality assurance program might consist of one test series per year. Greater numbers might be indicated for new examiners, for examiners of questioned proficiency, for research, or for other reasons. Perhaps fewer would be required for examiners of demonstrated proficiency.

It is emphasized that this program is designed to be used continuously over time and that the interpretation of a given individual's proficiency is determined by a series of many comparisons carried out over time. It is determined relative to other examiners so that a particularly difficult comparison will not skew the picture of one individual's performance.

## V THE DRAFT PROPOSAL

The draft proposal describes a "Resource Pool", "Test Sets" drawn from that pool, test set circulation, the test participants, test questions, the test period, and evaluation of the test results. Each of these will be further described below.

## VI THE RESOURCE POOL

The resource pool, from which samples to be examined will be drawn, will have the following characteristics.

1. All included individuals will have grossly similar hair, eg. male caucasian medium brown scalp hairs.

2. Twenty donors will be sought, as follows.

    1. Ten will serve as known subjects and as questioned subjects. These donors will supply a minimum of 100 hairs each, half plucked and half combed.

    2. Ten will serve as questioned subjects only and will supply a minimum of 10 hairs each, all combed.

3. Triplicate known sets will be prepared for each of the ten known subjects. Each known set will consist of ten selected hairs, representative of the variation exhibited under reflected light stereoscopic binocular microscopy, for the known individual. Each hair selected for mounting will be measured in length and curl then mounted in synthetic resin. Each slide will be assigned a coded number for identification and the true source of the hair recorded.

4. An additional five hairs will be selected from each known individual to serve as questioned hairs. These will be measured, mounted and coded as above.

5. Five hairs will be selected from each of the questioned-only individuals to serve as additional questioned hairs. These will be measured, mounted, and coded as above.

6. The resource pool thus assembled will consist of four hundred hairs from which four test sets will be drawn.

## VII THE TEST SETS

There will be four test sets drawn from the resource pool. Each test set will have the following general characteristics.

1. Known samples consisting of 10 slides from each of 2 - 5 individuals.

    1. Occasional duplication of known sources in single test sets

    2. Occasional repeat use of known sources in different sets

2. Questioned Samples From 1 - 3 Individuals.

    1. 1 - 5 questioned hairs per individual in a set.

    2. Some set(s) containing only questioned hairs represented in the known sources for those sets.

    3. Some set(s) containing only questioned hairs not represented in the known sources for those sets.

    4. Some set(s) containing some questioned hairs represented in the known sources and some questioned hairs not represented in the known sources

for the set.

## VIII TEST SET CIRCULATION

Each test set will be circulated to each participating examiner according to a specified, rigid schedule. Each examiner will see all four test sets during the course of the test period. Each examiner will be allowed one month to examine each test set and one month free between test sets. This is designed to allow the examiners to complete the test sets without undue impact on their normal case work schedule.

## IX TEST PARTICIPANTS

The number of participants in the initial circulation of the test sets is limited by the time required to conduct the examinations, the necessity of working those examinations into a regular schedule of casework, and the necessity that all test sets be circulated to each test participant. It is anticipated that approximately 8 - 12 participants will be the reasonable maximum for a test series being circulated to many different laboratories. Perhaps 20 will be a reasonable maximum for a test series circulated within a large laboratory.

As will be seen below, the results of a test series are interpreted as a group. Individual performance is measured relative to the performance of that group on that test series. Thus it is necessary to have a base level of data for the performance of many individuals on that test set in order to interpret the performance of any single individual.

After the initial circulation of a test series, it will be possible to recirculate the series to additional groups of individuals, or to single individuals. At that point there will exist a basis for interpretation of the performance of single individuals who might take the test.

## X TEST QUESTIONS

Each participant is asked a series of questions with regard to the comparisons that are made. The most fundamental question is, of course, could the known and questioned hairs have shared a common origin. When the conclusion here is yes, the examiner is asked to specify which of the 10 known hairs most closely resembled the questioned hair. For each combination of known set and questioned hair, the examiners are asked to select one of the following three expressions of conclusion.

1. "The Q and K samples are microscopically alike and could therefore have shared a common origin."

2. "The Q and K samples are microscopically dissimilar and could not therefore have shared a common origin."

3. "No conclusion could be drawn about the possibility of common origin for the Q and K samples."

The participants are also asked to comment on the various comparisons made, on the test set, and on the testing process.

## XI TEST PERIOD

The test period will be determined in part by the number of participants, the time required for shipment of samples from one lab to the next, the amount of time allowed for the examinations, etc. The test period should not exceed one year however. For test series which are circulated to various laboratories, a 12 month test period would allow 12 examiners to participate in a test series with a reasonable schedule. In such a series each examiner would see one of the four test sets every three months and would have one month to conduct the examinations and two months between test sets.

When a test is being set up, it is critically important that a rigid test schedule be established which each participant is aware of and will follow. The success of the test process rests more on this point than on any other, and the importance of establishing and maintaining such a schedule cannot be overemphasized. The individual acting as coordinator for the circulation of the test series will have to be in regular phone contact with the participants to insure that the test sets move according to the schedule.

## XII REVIEW AND INTERPRETATION OF THE TEST RESULTS

As examinations are completed, test results will be forwarded to a collection point for tabulation and evaluation. The results, together with comments generated during the testing process, will be evaluated by the administrator of the series and the product of this review process returned to the participants. The "administrator of the series" may be an individual within the laboratory or laboratory system conducting the test, or may be one outside of the participating laboratories when a cooperative test series is undertaken.

Hair comparisons based on microscopic characteristics suffer from the same fundamental limitation shared by other class-type comparisons made in forensic science. Finding that a questioned hair is similar to the hairs in a known set indicates that the questioned hair could have come from the same source as the known set or from some other source which coincidentally exhibits the same combination of characteristics. It is universally recognized that the microscopic comparison of hair does not allow a unique or individual association of an evidence hair with one person to the exclusion of all others. This is acknowledged both in written reports and in court testimony. However, this class-type of comparison presents certain difficulties when attempting to measure or guarantee "quality" in the work product.

When the factual condition is that a questioned hair did come from particular know source and the stated comparison conclusion is that it did not, then one of two possibilities exist. One possibility is that the known set did not adequately represent the actual variation expressed within the known source and the questioned hair was in fact dissimilar to the sample of the known source which was examined. Here the comparison process was carried our correctly but the conclusion is that they are not similar when they are in fact from the same source. The second possibility is that the questioned hair was in fact similar to the sample of the known source which was examined and the

examiner made an error in concluding that they were not. This is an error in the comparison process which results in an error in the conclusion.

When the factual condition is that a questioned hair did come from a particular known source and the stated comparison conclusion is that it is similar, then, perhaps surprisingly, there are still two possibilities. One is that the known set did not adequately represent the actual variation expressed within the known source and the questioned hair was in fact dissimilar to the sample of the known source which was examined. Here the correct conclusion was reached but for the wrong reason and an error of comparison was reached while an error of conclusion was not. The second possibility is that the questioned hair was in fact similar to the sample of the known source and the correct result was obtained.

When the factual condition is that a questioned hair did not come from particular know source and the stated comparison conclusion is that it is similar, then again one of two possibilities exists. One possibility is that there exists a coincidental but genuine similarity between the questioned hair and the hairs of the known source that was examined. Here there is no error of comparison but the conclusion is that they are similar when in fact they are from different sources. The second possibility is that the questioned hair was in fact not similar to the known source which was examined and the examiner made an error in concluding that it was. This again is an error of comparison leading to an error of conclusion.

When the factual condition is that a questioned hair did not come from particular know source and the stated comparison conclusion is also that it did not, once again one of two possibilities exists. One possibility is that there exists a coincidental but genuine similarity between the questioned hair and the hairs of the known source that was examined, but that this similarity was not detected. Thus here, as above, we see an error of comparison but no error in conclusion. The second possibility is that the questioned hair was not in fact similar to the known source which was examined and the examiner correctly recognized the difference.

Thus in each combination of factual condition and reported conclusion, there are two possible explanations. Each involves a potential for error of comparison and error of conclusion. However our interest in quality assurance is to make a clear distinction between these two. Errors of comparison call for corrective action directed at the examiner while errors of conclusion when there is no error of comparison simply illustrate the limitations of the hair comparison process.

The decision to have all participants examine the same hairs was made so that individuals' performance could be evaluated in comparison to the performance of others. This is in an attempt to differentiate between errors of comparison and errors of conclusion. It is expected that an error of comparison on the part of an individual being tested will be detected because most examiners will not make such an error. Whether a questioned hair is microscopically similar to a known set or not is essentially defined by the condition of most examiners finding that it is, in their views, similar.

The determination of the quality of an individual's work should not be made on the basis of one or a very few comparisons. Thus the test sequence involves the examination of a large number of hairs and the comparison of many questioned hairs to known sources. In the interpretation of the test results, the actual relationships between known

and questioned hairs will be known.

Good performance will be indicated by two non-independent factors. One factor will be a lower than average (for the test series) "error" rate where "error" here means a difference between actual and reported relationships between known and questioned hairs. The second indicator of good performance will be an above average ability to distinguish similar hairs. Thus for those particular combinations of known and questioned hairs for which a significant number of inconclusive or incorrect results are reported, the consistent reporting of correct results will be regarded as and indication of good performance. Poor performance will also be indicated by two non-independent factors which are just the opposite of those given above for good performance. Average performance will be indicated by no significant difference between the individual's performance and the norm of performance established in that test series.

The fact that all hairs in the test series are selected to be grossly similar means that the results will be relevant only for the type of hair included in the test. Thus a test using medium-brown caucasian head hair is distinctly different from one involving negroid pubic hair. Care must be taken not to assume or report that the results with one type of hair will be directly related to those with another type.

## XIII ADMINISTRATION OF THE QUALITY ASSURANCE PROGRAM

The ultimate administration of a quality assurance program is, of course, not the function of the hair committee or of our sub-committee. That will be up to individual laboratories or outside entities such as the Forensic Science Foundation. The sub-committee does believe that quality assurance programs should be used but we recognize that that decision is ultimately in the hands of individual laboratories and examiners.

We also believe that there are advantages to tests administered over many laboratories instead of entirely in-house. Such tests can reveal differences in performance between laboratories, leading perhaps to the identification of improved methods in use at the better performing laboratories. They would promote the exchange of information between laboratories. They would also result in the development of a greater data base of results and more information about the profession-wide performance level.

## XIV MISCELLANEOUS RECOMMENDATIONS

The sub-committee believes that all practicing examiners should be subjected to at least one test set as described above per year, ideally to one test series per year, as outlined in the entire program above.

We believe that quality assurance testing should be an on-going process for several reasons. It would provide for a gradual accumulation of a large amount of data on the performance of examiners under varying conditions. There would be the gradual accumulation of extensive, well characterized sets of hairs for training, research, and on-going quality assurance. And, most importantly, the proficiency of the individual, participating examiners would be established.

## XV A COLLABORATIVE TEST EVALUATION OF THE DRAFT PROPOSAL

A collaborative test to evaluate the draft proposal is under way at the present time (June, 1985). Eight volunteers were recruited at the Second Symposium on Forensic Hair Comparison to participate in the collaborative test. The purpose of this test is to evaluate the draft proposal, to identify any necessary revisions in the proposal, and to make such revisions before the final report of the Committee on Forensic Hair Comparison is issued.

The test period for the collaborative test is from April 1 to December 1, 1985, an eight month period. During this period each participant will receive all four test sets. A specified, rigid schedule for the circulation of the samples was established which provides for one month examination periods for each test set with one month free between the receipt of sets for each examiner. This is designed to allow the examiners to complete the test sets without undue impact on their normal case work schedule. Within the month each set is assigned to a single participant that person must complete the examinations called for and forward the samples to the next examiner.

As examinations are completed, test results will be forwarded to a collection point for tabulation and evaluation. The results, together with comments generated during the testing process, will then be evaluated by the sub-committee. The primary purpose of the evaluation of results in the trial now under way will be to identify and correct deficiencies in the Draft Proposal. When this is completed a final recommendation will be made.

We decided to do an additional experiment while conducting this trial evaluation of the testing process because many of those participating are interested in this question. For each of the questioned hairs in each test set each examiner is being given a data sheet to fill out. These data sheets offer the examiner the opportunity to check-off various characteristics expressed in the particular hair. We are interested in seeing what degree of similarity or difference is expressed when eight examiners characterize the same hairs according to the same system of description.

## XVI CONCLUDING REMARKS

My purpose in presenting this paper to you today is to let you know the direction of our thinking and the nature of the recommendation that may be made when the evaluation of the draft program is completed. The sub-committee solicits your input and thoughts on this Draft prior to finalizing our recommendations. We could be happy to receive any comments or to discuss the Draft Proposal with anyone interested. Once again, the sub-committee members, in addition to myself, are Ed Burwitz, Thom Kubic, Ted Mozer, and Larry Peterson. All of these people are present at this meeting. If you don't get a chance to speak with any of us today, you may contact me at the address shown here. I will forward copies of any correspondence received to the other sub-committee members.