The Scientist As Sleuth

Forensic researchers use an arsenal of scientific weapons to search for the hidden fingerprints in blood, fibers and evidence left at the scene

by Janet H. Weinberg

There is a saying heard frequently in law enforcement circles: A felon always leaves something and always takes something from the scene of a crime; find these things and you may find the criminal. An unknown identity can be pieced together from a tiny shred of fabric, a drop of blood, a paint chip, a single strand of hair or a bullet. Logic and intuition are still important in the search for identities, but the modern criminalist has tools that would evoke the envy of Sherlock Holmes and Dick Tracy—the tools of modern science.

The crime laboratory examiner puts an arsenal of scientific weapons to work in the search for criminal evidence, from simple microscopes to lasers and nuclear reactors. His work must be accurate beyond a reasonable doubt. An accused person may go to jail for 20 years on the weight of his scientific opinion before a court of law. For him to state with reasonable certainty that a blood stain or a hair could match that of a specific person, he must know the unique characteristics of that blood or hair. And he often must go to the cellular, molecular or even atomic level to find these unique characteristics. The forensic science researcher provides the examiner with the most powerful scientific tools available in his search for identities.

Forensic science case work is done in hundreds of crime laboratories around the United States. Many local police stations have some facilities, but the trend in recent years has been toward regional crime laboratories with sophisticated equipment that serve many cities and counties. Some forensic science research is done in these regional crime laboratories, but most is done at the Federal Bureau of Investigation in Washington and at a few university and industrial research laboratories. Thomas F. Kelleher Jr., unit chief of the laboratory planning and evaluation unit of the FBI, says the emphasis on

Indelible laser grid for marking guns.

McWright: Investigating human tissues.

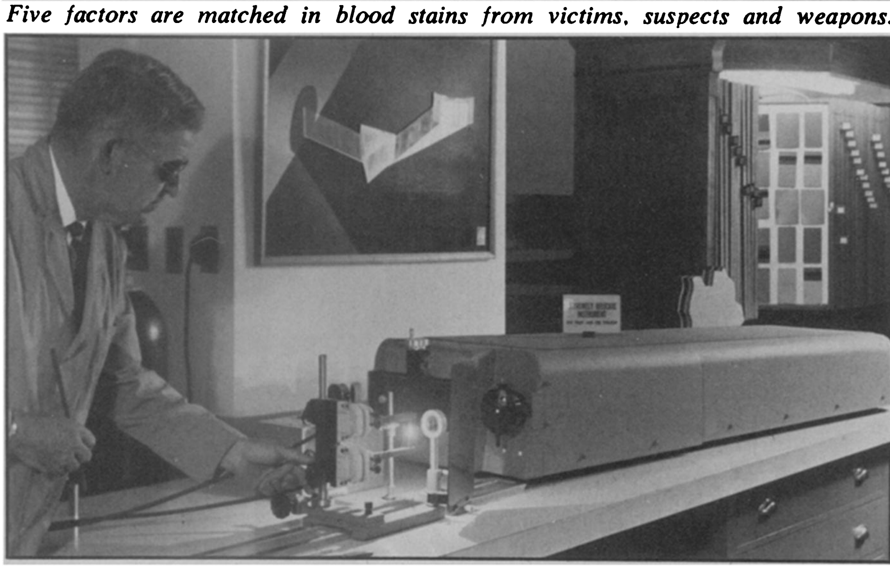
crime research has increased dramatically since Clarence Kelley became director of the agency. For the first time, Kelleher says, some examiners with scientific training have been freed from case work and assigned full time to research. Grants from the Law Enforcement Assistance Administration also are becoming available to more universities and industries.

Sophisticated instruments and methods, "borrowed" from pure science, have made it possible to squeeze more information from each piece of evidence left at the scene. Biological materials often are found, especially during violent crimes.

The biggest current effort in forensic science research, according to Cornelius G. McWright, head of the FBI's biological research unit, is toward the individualization of biological materials. The more closely blood from a homicide victim can be matched with blood found on the clothes of a suspect, for example, the stronger the evidence for conviction. It is possible to determine from a small spot of fresh or dried blood all three membrane antigen blood types—the international (A,B,O) blood group, the M-N blood group and the Rh blood group. McWright is now studying blood isoenzymes as another identification system. There are many enzymes in blood, and they can take different forms. They will catalyze the same part of a biological reaction, but they have different chemical and physical properties and thus can be separated by electrophoresis. Two isoenzymes, phosphoglucomutase and erythrocyte acid phosphotase, are being used on a limited basis to "fingerprint" blood more specifically.

Since blood is often found dried, clotted or partly deteriorated, it is important to know what effects the blood's environment may have on the eventual appearance of the electrophoresis patterns used to identify the isoenzymes. McWright reported to the forensic science symposium at the recent American Chemical Society meeting in Atlantic City that under certain environmental conditions, some liquid blood samples may change, altering the isoenzymes so that an erroneous analysis could be made. But, for the most part, he reported, erythrocyte acid phosphotase isoenzymes are stable and will persist unchanged under various environ-

Five factors are matched in blood stains from victims, suspects and weapons.



Emission spectrograph is used to determine exact composition of a paint chip.

Photos: FBI

mental conditions for several months.

McWright says he would like to determine sex from a blood sample. It is sometimes possible to find in fresh blood a "nuclear appendage" or small chromosome-containing body in the nucleus of the white blood cell whose presence indicates a female donor. Another experimental technique is staining blood to reveal the male Y-chromosome. The third, and most promising, approach, he says, is the use of radio immunoassay to detect the hormones testosterone, progesterone and estradiol, which appear in different ratios in the blood of males and females.

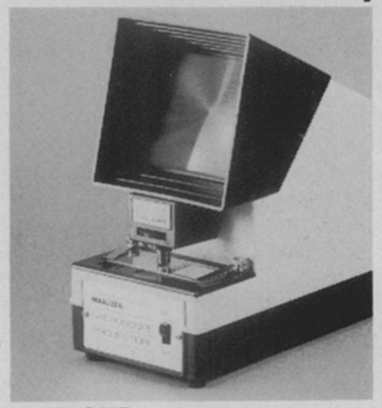
Another biological material—semen—is important evidence found after sex crimes. It is being studied for specific biological markers. Researchers can now determine a man's international blood type from a semen stain if the male is a secretor of these antigens into his body fluids—and about 80 percent are. Broad screens also are being conducted to determine what useful polymorphic enzymes exist in semen.

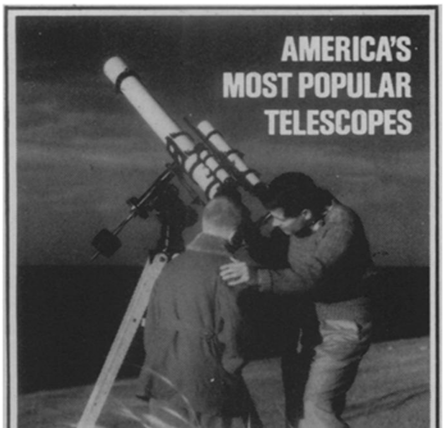
Strands of hair frequently are found at the scene of a crime, and many different characteristics can now be determined microscopically from a single strand. These include the type of animal, and if human, the race; the place of origin on the body; whether the hair was bleached; whether it fell out naturally or was cut, crushed, pulled or burned. Receptor sites for the major blood group antigens exist in hair, and blood type can now be determined experimentally from a hair in some cases. McWright's group is studying the structural proteins in hair to determine whether they are polymorphic and thus potentially useful for identification. The group is also working on ways to determine sex from a strand of hair. Sex chromatin sometimes can be found in the hair root, but the hair must be fixed and studied immediately after detachment. This makes it impractical for the crime laboratory examiner who often is given samples days or even months after a crime. The challenge of forensic sicence research, McWright says, is to modify such pure research findings and techniques into formulas that will be useful for the thousands of case workers across the country.

Although forensic biologists have to locate and use the natural "tags" that exist in body fluids and tissues, artificial tags are being added to some materials before they reach a felon's hands. Bill C. Giessen, a chemist at Northeastern University in Boston, has developed a method of marking firearms permanently. Serial numbers are now stamped on all firearms during manufacture, but criminals often file or grind them off. Sophisticated equipment must then be used by ballistics experts to detect magnetic changes made in the metal during the original stamping so the number can be revealed and the weapon traced. Giessen proposes the use of a laser to drill minute holes in special grid patterns during firearms manufacture. These grids would be much smaller than serial numbers and thus harder to find, and the holes would go completely through the metal for permanency. Giessen says the serial-grid could be located on a critical area so it would be impossible to drill out the grid without destroying the usefulness of the item.

The tagging of other potential weapons—gasoline and petroleum products—could assist in the identification of the flammable liquids used for arson. At the ACS symposium, Cecil E. Yates Jr., head of the FBI's chemical research unit, summarized techniques for recovering and identifying flammable liquid residues from suspected arson debris. If each type and brand of petroleum product could be associated with a specific gas chromatograph or other analytical technique spectrum, and be chemically tagged before distribution, it would be much easier to trace the purchase of a flammable agent, he notes. The FBI chemical unit is also developing invisible tracers that could be used to coat articles demanded by kidnapers, hijackers or bank robbers and that will mark their fingers for future detection after the article is handled.

Other research efforts toward chemical tags for inks and explosives are being coordinated by the Treasury Deparment's Bureau of Alcohol, Tobacco and Firearms to help solve white-collar crimes and bombings. The bureau keeps on file the formulations and physical and chemical properties of 3,000 inks manufactured around the world. If forgery, fraud or backdating is suspected, the ink used on a document can be analyzed and compared with these known formulations. Bureau chemists Richard L. Brunelle and Antonio A. Cantu recently developed a series of tests including infrared luminescence, ultraviolet fluorescence and thin-layer chromatography for identify-





ing and comparing inks. The bureau's assistant director, A. Atley Peterson, says the bureau's goal is, with the cooperation of ink manufacturers, to tag inks chemically with a marker that can be changed several times per year. This would make identification easier for the forensic case worker and would help him determine the period of time during which a document was forged within narrower limits than now are possible.

The use of explosives for criminal activity is increasing, Peterson says, and bureau chemists, along with workers at Government and private industrial laboratories, are developing chemical tags for explosives. By adding 15 or more elements in different combinations and concentrations, explosives may be labeled and more easily traced to manufacturer and date of production, either before or after explosion.

Biological and chemical tagging are just two of the many areas being studied by forensic researchers. Data processing techniques are being applied to fingerprint and crime information retrieval; the unique characteristics of gun powders, paints, bullets and tool marks are being identified and new methods are being developed and used in forensic medicine, dentistry and anthropology for the identification of crime and accident victims.

Growing along with the sophistication and accuracy of crime laboratory findings are their importance during criminal proceedings. Although other types of evidence (confessions, witnesses' statements, etc.) are used much more frequently, law enforcement officials on the state and local levels are being educated to rely upon physical evidence, and its use during trials is increasing. The fact that blood is found at the scene and on a suspect is important in itself, but McWright says, multisystem typing can provide the court with much stronger evidence. The chances of finding any one particular sequence of blood factors (for example, AB, Rh+, M, EAP type B, etc.) can often be as little as one in a million. If the stain on a suspect's clothing matches a victim's blood and that exact blood type only is found in one out of a million persons, the prosecution will have a stronger case.

"But," McWright warns, "we still have not gotten to the stage of positive proof of identification with biological materials. We can state that blood and hair matches, but we cannot say that it originates from one person to the exclusion of all others like you can with fingerprints. Scientific evidence only forms part of the total picture of guilt or innocence and I don't foresee a time during my life when we will be able to find a 'fingerprint' in the body's fluids or tissues." □