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MICROSCOPIC EVIDENCE—ITS USE IN THE INVESTIGATION OF CRIME*

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Paul L. Kirk, Ph. D., Professor of Biochemistry, University of California Medical School, is a nationally recognized expert on microscopic evidence and its applications to the solution of crime. Over a period of years Professor Kirk, who is one of our Associate Editors, has contributed papers on various problems of microanalysis to this Journal and has appeared as an expert witness on these problems in numerous courts. His current paper, which should be of particular interest to progressively minded investigators and police microanalysts, describes several pieces of special equipment for the thorough collection of microscopic evidence found at crime scenes or on the clothing of suspects.—EDITOR.

The use of microscopic evidence in the investigation of crime has become progressively more important in recent years in America. Not only has considerable progress been made in the identification and study of hairs, fibers, glass and metal fragments, soil, and many other forms of fine debris, but it has been more generally appreciated that this type of evidence is usually present in most crimes even when the larger and more obvious items have been lost or their possibilities exhausted.

This fact, coupled with the well known circumstance that evidence is rarely found in large quantity, or evidential materials in a form suitable for the ordinary or macromethod, emphasizes the growing importance of the microchemist in the field of criminal investigation. While this is indisputable, it is unfortunately true that many law enforcement agencies consider that naming an individual to the position of "microchemist" automatically qualifies that individual to do microchemical examination, regardless of his training or experience. In point of fact, relatively few of the criminalists currently employed by these agencies are truly competent microchemists, however capable they may be in general. Even more unfortunate is the regrettable tendency for the "classical," or "official" method adopted by some organization such as the Association of Official Agricultural Chemists, to be required by attorneys and court officials, as the only acceptable examination procedure. While there is no a priori objection to the choice of an old and well established method which has been tested over a long period and is well understood, it is often true that such a method is markedly inferior to a newer procedure which may be more sensitive, more accurate, or more specific, or all of these together. To consider the matter otherwise is to deny the validity of progress in the field. It is a curious fact that a poison separation procedure

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such as the Stas-Otto method, which is so antique (over 100 years) that to claim it as the best possible procedure automatically denies that serious progress in the field is possible is still considered in many quarters as the best possible procedure. Another more immediate application of this curious situation is the frequent insistence by attorneys that the Gutzeit method for determination of arsenic be used because it is the "official" and "standard" method. It has been known for years that the method is grossly inaccurate as a quantitative method, and scores of papers have been published detailing the sources of error and uncertainty. Moreover, it is less sensitive than numerous superior procedures which have appeared, but when the latter are used as the basis of testimony, doubt is cast on them because they are not the "standard" method.

In the field of micromanipulative technique in handling and examining microscopic evidence, it is fortunate that no long-standing traditions and prejudices require eradication. There has not been any "standard" method for the collection, sorting, and examination of the solid and liquid debris and traces that have assumed constantly greater significance as more was done with them. It is the primary purpose of this communication to outline some useful procedures for handling, storing, and manipulating minute amounts of solid and liquid evidence of the types frequently encountered in criminal investigation. It is hoped that as real improvements are found, they will not be disregarded because of the priority of any methods described here.

Incidence of Microscopic Evidence

Microscopic evidence is carried particularly by the clothing of the perpetrator in most instances, and by the clothing of the victim in cases involving direct damage to, or contact with a victim. It is virtually impossible for a burglar to break into a building without accumulating in his pockets, pants cuffs, and on the surface of his clothing a number of significant small fragments of the materials damaged by him in effecting an entrance. In assaults, murders, rapes, and kindred crimes, contact between the criminal and his victim is the rule, and always leads to the interchange of fibers, hairs, dusts, and fragments of microscopic dimensions. In addition to clothing, the finger nail scrapings, ear wax, shoe soles, and other likely places accumulate traces of similar materials. It is the belief of the author, as a result of years of study of this type of evidence in many varieties of crime, that only a minute percentage of such evidence is ever exploited even to a reasonable extent, and that the majority of

unsolved crimes are those in which this type of evidence was entirely or partially neglected.

It is easy for the investigator to look for the obvious, i.e. the gun that shot the victim, the tool that opened the safe, the large items of clothing torn from a victim, or other large and apparent items of evidence, while overlooking the fact that the minute evidence of which both perpetrator and victim were unaware will remain after the larger objects have been hidden, discarded, or destroyed. In fact, it is so simple to collect from the clothing of both victims and suspects a considerable amount of such evidence that it is surprising how limited these collections usually are. Even criminalists occasionally destroy such evidence deliberately or accidentally while concerning themselves with the more obvious items. While this may be a natural action, it is an unfortunate one that should be discouraged. As an example of the application of the principles of microscopic evidence examination can be cited instances in which a gun which has shot a victim, or a knife which has stabbed one, is discarded with the body. It is useless then to stop with the proof that this is the weapon responsible for the injury, since the ownership of the weapon is the vital matter at issue. Microscopic evidence carried in the various recesses and openings of the gun or the knife may often be sufficient to prove that it was carried in a certain pocket of a particular suspect, by comparison of the materials on the weapon with those in the pocket.

Collection of Microscopic Evidence

Söderman and O'Connell mention briefly in their book "Modern Criminal Investigation" a vacuum filter by means of which clothing may be cleaned to recover from it the dust, debris, and similar microscopic evidence. The description is not detailed, and to the author's knowledge there has not been available commercially any good model of such a device. Clearly this type of instrument is useful not only for cleaning of debris from clothing, but from window sills over which burglars have climbed, automobiles, both inside and outside, when they have figured in crime, and in general, scenes of crimes in which contact of various kinds with the criminal has occurred.

A useful vacuum sweeper filter which is constructed with reasonable ease and is commercially available[1] is shown in Figure 1. It is made from a clear methacrylate plastic which allows unimpeded vision through it at all times and is strong and durable. It is made in two sections which attach at the center by means of a

[1] Obtainable from the Microchemical Specialties Co., Berkeley, Calif.

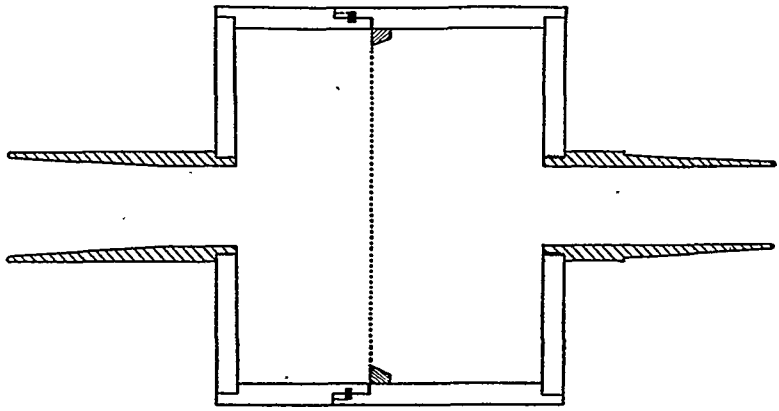

Figure 1.

bayonet or screw connection which is readily opened. In one section is mounted a screen on which is placed an ordinary filter paper which serves as the filter to collect all materials removed from the evidence source. This section is attached to any good vacuum sweeper by means of a rubber hose furnished with the sweeper. The other section carries the sweeping nozzle proper which is not too large to allow the application of a good vacuum. It is passed over the clothing or other object to be swept, and in a matter of minutes will accumulate much more evidence than could be directly removed by forceps and visual inspection in many hours of labor.

In use, the vacuum filter is passed over clothing, inserted into pockets and pants cuffs, or passed over other surfaces which may contain microscopic evidence. All sweepings are collected on the paper filter, a new one being used each time.

A vacuum sweeper and filter installed in an interrogation room at a police department could in about 5 minutes collect nearly all significant microscopic materials from the clothing of a suspect being questioned. If the latter is released for lack of evidence, he does not remove the significant debris with him to be lost or destroyed. If examination of the debris later implicates the suspect, as frequently has happened, the latter may be again taken into custody. If it does not, the amounts involved are readily destroyed. The expenditure of time is vastly less than that used in interrogation, much of which is often fruitless. The knowledge that he is definitely implicated by the microscopic evidence has often resulted in confessions and guilty pleas, thus demonstrating the essential economy of this method of investigation. The cost of installing a sweeper device is insignificant by comparison with almost any of the other costs of criminal inves-

tigation, and there is no valid reason for failure in its general adoption. Necessarily, laboratory examination of the collected evidence remains to be performed, but the department which lacks a laboratory can in most cases obtain such services from state laboratories, neighboring city police laboratories, or private laboratories. Without the evidence, no laboratory can provide helpful information, and when the police officer allows a suspect to carry out with him evidence which otherwise might prove his guilt or innocence, it is indeed a situation calling for correction.

Storing of Solid Evidence

Microscopic evidence collected in the sweeper is stored by unloading the sweeper as follows: The nozzle of the filter is placed inside a cellophane envelope which is held tightly around it so that no debris can escape. The loose material in the chamber may be largely tapped down into the cellophane envelope in advance. Still holding the nozzle in the left hand the sweeper is disattached at the center and the paper is allowed to fall into the bottom compartment. This is folded and pushed down through the nozzle into the cellophane bag with a small brush, preferably a good grade camel's hair artist brush. The dirt and debris remaining is then carefully swept down through the nozzle into the bag taking care that any adhering dirt on the inside of the nozzle itself is detached and falls into the bag. A label placed on the bag identifies it as to source, and the entire cellophane envelope may be readily stored.

If there is occasion for preliminary examination under the microscope it is desirable then to transfer the sweepings to a clear flat dish. This may be a glass Petri dish of the type used by bacteriologists which can be stacked, and which, being clear, allows visual examination of the contents. An alternative which is both less expensive and more satisfactory is the use of a flat plastic dish of similar dimensions. Such plastic dishes can be obtained with tight fitting covers which do not fall off readily as does the Petri cover and the dish is not subject to breakage. It is also clear and can be stacked in the same manner as the Petri dish. Storage in these dishes for considerable periods of time is both simple and convenient inasmuch as they stack in a small space and are readily labeled and easily examined as to contents. The filter paper is usually brushed off into the dish and discarded at the time of transfer from the cellophane bag.

Preliminary Sorting of Evidence

The evidence which has been collected and stored may now be subjected to preliminary observation to ascertain its general content. If this is of a tentative nature only it may be done

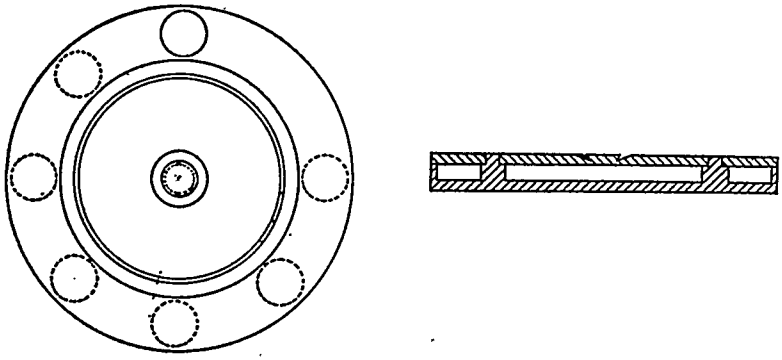

Figure 2.

directly through the dish by visual means with or without magnification. Sorting, however, requires microscopic observation under low powers of the stereoscopic binocular microscope, and it cannot be carried out through a lid. Very convenient for sorting is the use of the plastic sorting dish[1] shown in Figure 2. It consists of a relatively large central chamber which is sealed with a clear flat lid and has sufficient capacity to contain the ordinary sweepings from a man's suit. All of the sweepings are transferred to this central chamber before sorting them. Around the center is arranged a series of 7 smaller chambers 5/8 inch in diameter and 3/16 inch in depth. Over these chambers is placed a tight fitting ring carrying one hole only, the diameter of which is the same as the chambers. By rotating the ring, the hole may be placed over any chamber thus opening that one and sealing all the others. This avoids any possibility of contamination of the evidence except in the single open well. When the hole is rotated to the blank region, all the wells are sealed tightly, to retain evidence in them and to prevent all possibility of contamination. The examiner may remove the contents of any single well for mounting and examination, again having only one open at a time.

Significant evidence is stored by categories in the outside chambers, e.g. paint flakes in one, glass in another, metal fragments in another, blue wool, brown wool, etc. in others, until all important categories of evidence are isolated. A single label identifies the case and source of all evidence in the dish. As

many dishes are used as necessary, and they may be stacked in a minimum of space with no chance of confusion, loss, or contamination. The alternative use of separate dishes for each category of evidence leads to large numbers of containers, losing of labels, occupancy of excessive space, and sometimes even to mixing or loss of evidence.

Manual Handling of Solid Evidence

To separate a single small fiber or fragment of glass from a mass of debris is not a simple operation unless the tools used for the separation are suitable. Forceps are usually employed, but nearly all forceps available commercially are unsatisfactory. Any forcep having a corrugated tip does not operate well in manipulating most small pieces of evidence. This eliminates the use of the common dissecting forcep which is designed to grasp soft tissues, not small solid objects. The jeweler's jewel forcep has a smooth finely pointed tip, thus being superior both to the dissecting and the cover-slip type of forcep. In the absence of a jewel forcep, it is possible to use another type after polishing off the corrugations and grinding or filing the tips to a narrow pointed end with a good flat contact. This may be done with almost any well constructed forcep, but is less simple than using directly the jewel forcep.

At times, very minute fragments cannot be grasped with the forceps at all, because of their size. When this is true, a needle which has been passed between the fingers to deposit a very thin film of grease is useful. The object will usually adhere to the needle tip and may be transferred. Ordinary dissecting needles are not suitable because of their coarseness. A fine sewing needle mounted in a wooden handle is preferable. The finest needles may be constructed from tungsten wire which has been pointed while hot with solid sodium nitrite. Needles of this type are still very sharp and sufficiently rigid at dimensions so small that a steel needle of the same size would be too fragile to use, and almost impossible to make.

Manual Handling of Liquids

Liquid evidence is less frequently encountered than solid and never in vacuum sweepings. It does at times occur and in very small volume. Furthermore, the addition of small volumes of liquid reagents in carrying out tests is a frequent operation which is very familiar to the microchemist. Most instructions call merely for a crude pipet drawn from a piece of glass tubing, filled by mouth suction, and emptied by gravity or blowing. This

technique is often very awkward and may lead to getting evidence or reagents in the mouth, and usually involves a relative lack of control of the flow of liquid.

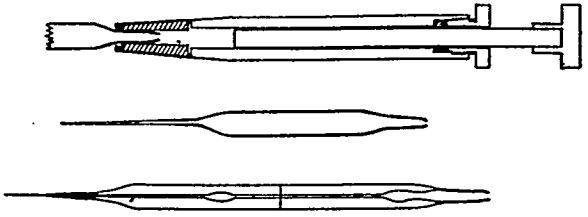

Figure 3.

Good technique in handling small volumes of liquid involves the use of a control on the pipet to apply suction or pressure more accurately than is done by the mouth. While a rubber tube to the mouth is an improvement, and a rubber bulb is useful, a syringe type control[1] such as that described by Sisco, Cunningham and Kirk (1) is more useful. With it, the liquid flow is under careful control, and unlike a rubber bulb, removal of the pressure does not cause variation of pressure in the pipet. An improved design of this control is shown along with two types of pipet in Figure 3.

The pipet may be designed for qualitative work, i.e. when the volume taken is not important, or for quantitative work, in which case it is necessary to know the volume. In the former instance, the pipet is drawn from glass tubing to a rather fine tip at one end, and a thickened taper at the other to fit the control. The quantitative pipet must be made from capillary tubing, marked and calibrated as shown. It may be used with rinsing to measure accurately volumes as small as 0.005 ml. Most liquids used by the criminalist are added in unknown volumes as qualitative reagents, and the qualitative pipet serves adequately for most purposes.

One further type of pipet is useful for qualitative addition of reagents when the volume needed is extraordinarily small, i.e. less than 0.001 ml. It consists of an extremely fine tip drawn from a fine, heavy walled capillary such as a thermometer tube. Manipulation of such a pipet is best achieved by use of the mouth blowing tube because the bore of the pipet tip is so fine that considerably pressure or suction is required to cause any movement, and under these circumstances, both syringes and bulbs are unsatisfactory. Some skill is required to construct this type of pipet, and its uses are distinctly limited.

Reference

1. Sisco, R. C., Cunningham, B. and Kirk, P. L., J. Biol. Chem., *139*, 1 (1941).