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M. Edwin O'Neill

mistaken identity or erroneous conception of events transpiring under his very eyes? Psychological tests show that no two persons in a considerable group will perceive and describe a series of events in the same manner, though all have viewed the happenings at the same time and under the same conditions.

Are we therefore to view with suspicion even the testimony of eye witnesses, haunted by the fear that somehow, some time, someone may be convicted of a crime he did not commit? It is submitted that the basic idea underlying penal law is the protection of society, that the interests of society are paramount as against those of the individual, and that if an occasional individual's liberty or even his life is sacrificed in war or in peace for the welfare of his country or of society, the sacrifice is not in vain.

POLICE MICROANALYSIS*

M. EDWIN O'NEILL†

The use of the microscope in the detection of crime has received considerable attention in many parts of the world since its practicality was pointed out by Hans Gross over fifty years ago. Microanalytical methods have been developed and used successfully in criminal investigation in France, Germany, Austria, and Sweden by such eminent investigators as Locard, Popp, Türkel, and Söderman. These methods, or modifications of them, have been used to some extent in the United States also. However, notwithstanding the demonstrated usefulness of microscopic analysis in crime detection, its development along scientific lines has been surprisingly slow. This neglect of one of the most promising phases of criminal investigation was noted over fourteen years ago by the late Dr. Albert Schneider.[1] Since then much has been said and written about the microscopic analysis of dust, hair, fibers, soils, etc. The investigator of crime has been told that

*Under this title will appear a series of articles on the identification of debris in relation to criminal investigation. The present one represents merely an introduction. Others to follow will include methods of analysis of fibers, hair, soils, blades of grass, etc.

†Microscopist, Scientific Crime Detection Laboratory, Northwestern University School of Law. (Editor's note: Mr. O'Neill, formerly Instructor of Botany at Tulane University, holds the degrees of B.S. and M.S. from that institution. He was recently added to the staff of the S.C.D.L. to fill a vacancy created by the resignation of Mr. E. Carleton Hood. For the past three years Mr. O'Neill has devoted a considerable part of his time to chemical and microscopic analysis as applied to criminal investigation.)

[1]Schneider, Albert, "Police Microscopy," 11 J. Crim. Law 217-221 (1920).

by means of analyses of soil taken from the shoes one can discover whether or not a suspect has been in the neighborhood in which a crime was committed; that by a study of wax from the ear or dust from the clothing one may determine a person's occupation or profession; that by a microscopic study of debris from the fingernails of the victim of an attack, the expert can frequently learn something about the adversary. These and many other remarkable feats have been described, and their practical importance demonstrated by reference to actual cases in which such studies proved to be the key to the solution of what might otherwise have been unsolved crimes. Unfortunately, however, the investigators who have used microanalytical methods in such brilliant fashion, and who have written in such glowing terms of the immense possibilities of microscopic studies in crime detection, have either neglected to describe their methods at all, or else they have described the procedures in a very general way with little attention to detail. The magicians have been very reticent about "how they get the rabbit out of the hat."

In subsequent papers in this series the writer will attempt to dispense with generalities as far as possible, and to outline, in detail, the methods or procedures to be followed in the analysis of debris, so that any technician familiar with the operation of a microscope and possessed of an elementary knowledge of biology and chemistry, can determine the nature, source, composition, etc., of such particles of evidence.

Scope of Police Microanalysis

Police microanalysis may be defined broadly as the analytical study of objects in criminal investigation, principally with the aid of the microscope. Defined thus, the subject might embrace the examination of many materials, e.g., poisons, inks, and gunpowders, dealt with by specialists in other phases of crime detection. In practice, the work of the police microanalyst usually includes the study only of such materials as are not handled by other experts, viz., dust or debris, and because the field is delimited in this way we may define the science more accurately as *the analytical study of fragmentary accumulations in the investigation of crime.* Many European investigators use the term "dust analysis" for this type of study, but since the materials dealt with in actual case work frequently contain particles not found in "dust" as this word is usually understood, the term "police microanalysis" is perhaps the more inclusive and more accurate.

To list all the different kinds of materials which might be present

in fragmental deposits would be an almost endless task. Practically every conceivable object or material in man's environment undergoes disintegration and is reduced to dust. The microanalyst must be able to identify these products of pulverization and from their characteristics determine something of their history. In criminal case work he is frequently called upon to make an analysis quickly and accurately, with the least possible loss of time. Moreover, he must be able to interpret correctly the results of the analysis, showing the connection between his findings and certain phases of the crime. To do this he must possess a vast fund of information about innumerable kinds of objects, and have ready systematic schemes of procedure and analysis. In a single case he may have to deal with such a varied assortment of objects as hair, cloth fibers, epidermal scales, bits of feathers, seeds, spores, mineral and rock particles, metal shavings, starch grains, shreds of tobacco, paper, wood, and numerous manufactured products.

The scientific examination of such materials has a definite place in the field of scientific crime detection. Researches of this kind are obviously not applicable to all problems of criminal investigation. In a great many cases microanalytical methods may not be used at all. In some investigations they may represent the only logical approach to the problem. In others they may prove useful to the police officer in limiting the field of investigation or in directing it toward the proper channels of procedure. By way of illustration, let us consider a recent case in which microscopic analysis played an important part:

A young girl, while walking through a park late at night, was attacked by an unidentified man. Because of the darkness the victim was unable to see her assailant and therefore could tell the police nothing whatever about him. A microscopic analysis of scrapings from the victim's finger nails disclosed fragments of hair and skin of negroid origin, and the examination of certain fibers from her coat indicated that her assailant wore a suit of a certain kind and color. When this information was secured the police wasted no time in looking for a white man, but confined their investigation to a negro settlement in the neighborhood of the park. A negro youth was picked up and he later confessed to the crime.

Methods of Collecting Debris

If the microscopic study of minute particles of evidence is to be of value, the acting officer and the expert must cooperate to the full-

est extent in the collection, preservation, analysis and interpretation of the material. The investigating officer must use a reasonable amount of care in collecting and preserving fragmental material before submitting it to the expert for analysis, for otherwise the examination of such material may be unproductive, or the results valueless as evidence.

The following outline of the methods commonly employed in the collection of debris may serve as a guide to the investigating officer who wishes to gather such evidence:

Debris in Pockets

The debris in pockets of various articles of clothing may be collected in either of two ways: the pockets may be turned out over a large sheet of clean white paper and the dust removed with forceps or a small stiff brush, or, the entire pocket may be cut away from the garment, sealed, and placed in a heavy paper envelope. If the entire pocket is removed it may be opened in the laboratory by cutting or by ripping the seam, and the dust transferred to the proper receptacles for examination. By following this procedure a more complete collection may be obtained, and there is less chance of loss by scattering. The first procedure would be applicable also in collecting material from trouser cuffs, coat collars and other folds of cloth. If the investigating officer does not have the proper equipment for collecting the material in this way, the entire garment should be placed in a clean box or wrapped carefully in heavy paper and submitted to the expert.

Debris in Cloth

Fragments of many kinds become lodged in the clothing, either adhering to the surface or imbedded within the meshes of the cloth. For the extraction of debris of this kind, a number of methods have been utilized, the more important of which are as follows:

(1) *Scraping and brushing*—This method is particularly useful in collecting the larger particles or localized deposits on cloth and on many other objects as well. Fragments large enough to be recognizable with the unaided eye should be removed first with forceps and placed in a separate receptacle, such as a small vial with screw cap. The finer material, such as spots of dust, particles of food, and dried soil, may be scraped off with a knife or steel spatula onto a sheet of clean paper and then placed in a vial or paper envelope. Brushing the cloth or other object over a large sheet of paper is a method

sometimes used, but since the very fine material is often scattered by this procedure it should seldom be resorted to.

(2) *Beating in a closed container*—The early investigators[2] collected the dust lodged in cloth by placing the clothing in a heavy paper bag, and beating it with sticks or wire beaters. The dust separating from the cloth settled to the bottom of the bag and was then removed for microscopic study. A modification of this technique was suggested by Schneider[3] who advised the use of a rubber sac, since it could be beaten more vigorously and was more easily cleaned. The method of extraction by beating has been largely supplanted by the more recent aspiration process, and at the present time is seldom used.

(3) *Vacuum cleaning*—A few researchers have experimented with small electric vacuum cleaners in gathering dust from clothing, but many difficulties are encountered in using the types now on the market, since they are extremely hard to clean and contamination of the collections frequently results.

(4) *Use of the dust pump*—Various types of dust pumps or aspirators have been devised for the extraction of fine debris embedded in the meshes of cloth. They are of two general types: (a) a small hand suction pump so constructed that the particles of dirt, carried by a stream of air, are sprayed upon a glass plate coated with vaseline or glycerine. The plate may be removed and placed directly upon the stage of a microscope for detailed examination. (b) an electric aspirator[4] so designed that the debris borne by the current of air is passed through a series of sieves of different sizes which automatically sort the dust, the finest material, passing through all the sieves, being caught in a sac of filter paper placed at the end of the aspirator. This apparatus may be taken apart easily and may be cleaned quickly and thoroughly. It has been used with much success in several European countries, and is probably the best device which has appeared for collection of dusts.

Since the investigator in the field is seldom equipped with the necessary apparatus for the collection of debris embedded in cloth, the entire garment should be carefully wrapped, labelled, and submitted to the microanalyst.

[2]Gross, Hans, "Criminal Investigation" (3d ed. 1934, adapted by Adam).

[3]Schneider, Albert. "The Compound Microscope in Detective Work," 9 The Police Review (Hagerstown) 10-40 (1930).

[4]Söderman, Harry, "En ny apparat för uppsamling av damm I förbrytares kläder," 1 Nordisk Kriminalteknisk Tidskrift 38-41 (1931).

Debris on Shoes

Dirt adhering to the sides or bottom of shoes should be detached with a scalpel or knife, any large fragments, such as rock particles, blades of grass, slivers of wood, seeds, etc., being removed with tweezers and placed in separate containers. If a considerable quantity of mud is present on the sole or heel, it may be cut into perpendicularly and if distinct strata or layers are observed these should be removed separately by careful scraping, for the reason that a study of such layers often yields much information about different localities in which the person travelled.[5]

Finger Nail Deposits

The sub-ungual deposits should be collected by scraping the nails with a small scalpel or knife, or better, with one of the broad pointed, steel tools made for this purpose. The nature of the debris has been found to vary on the right and left hands, and differences in composition have been observed occasionally in the deposits under each nail. It is advisable then, to place the scrapings from each nail in separate containers, each being properly labelled or marked to indicate the source of the material. The small screw-cap vials used in drug stores are satisfactory receptacles for the collections since they may be kept air-tight and free from contamination.

Cerumen

The wax or cerumen from the ears may be used in the study of occupational dust following the technique devised by Icard.[6] If material from this source is to be studied, the cerumen or other matter in the ear may be removed with an aural scoop and transferred to a glass slide, which is then covered with a large cover glass. If slides are not available the material may be placed in a small vial or bottle.

Debris From Other Sources

Articles carried about the person, such as keys, knives, watches, purses, weapons, etc., nearly always have associated with them a quantity of debris, which when analyzed may tell the investigator a great deal about the owner of the articles. The removal of the debris from these sources is a rather delicate operation and may be

[5]2 Locard, Edmond, Traité de Criminalistique 841-842 (1931).

[6]Icard, Severin, and Jean Maurel (In La Nature, No. 2457, May 7, 1921).

performed more satisfactorily in the laboratory. Therefore, any evidence of this kind should be sealed in envelopes, labelled, and delivered to the analyst for the extraction of all fragmental materials.

Analysis of Debris

Before going into the detailed methods of analysis of the various components of debris, it will be well to point out the procedures necessary in the preparation of the material. The actual work of microanalysis may be divided into three parts: (1) *Preliminary examination,* including the general inspection of the sample as a whole, usually with the aid of a lens, and the division of the material into more or less natural groups for convenience in testing. We may include here also the simple physical or chemical tests sometimes applied to the sample to determine the general nature of the substance under observation—fluorescence analysis, for example. (2) *Microscopic analysis,*[7] in which the fragments are observed under relatively high magnification, and usually without special chemical treatment; (3) *Microchemical analysis,* consisting of confirmatory tests, or tests for materials not identifiable by microscopic methods.

Preliminary Examination:

Dust or debris is not usually homogeneous, but is composed of a mixture of elements from different sources. Hence the analysis of the material is greatly simplified if the constituents of the sample are separated and grouped according to such characteristics as size, color, form, apparent origin, etc. This preliminary sorting process is not a standardized one, and several different methods have been employed by microanalysts, the exact steps in the process being conditioned by the nature, source, and amount of material examined. For this reason it is impossible to present a systematic scheme of analysis, and we may outline only a few of the operations involved:

(a) Examine the sample with the unaided sense organs, noting the general appearance, color, odor, consistency, whether amorphous or crystalline, etc.

(b) Place the sample on a small square of white (or black) glazed paper and examine with a reading glass or low power hand magnifier. If large fragments are present, remove them with forceps and preserve for separate examination. If dark colored metallic or

[7]Microscopic and microchemical procedures will be discussed in subsequent papers in connection with the analysis of the various kinds of fragments.

mineral particles are present, try the effect of a small bar magnet, removing any particles which are attracted. If the sample is large, a portion may be burned in a small test tube or crucible to destroy any organic matter present, and the ash preserved for microchemical testing.

(c) If the sample is granular, and present in sufficient quantity, the material may be passed through a small nest of sieves and the fractions examined separately. If the sample is small in amount and amorphous (as in fine dusts) a rough fractionation may be obtained by using an electrified rod of sealing wax or hard rubber as recommended by Heindl.[8]

(d) The debris may be placed upon the stage of small dissecting microscope equipped with a 10x magnifier. Then, with fine pointed forceps and dissecting needles the components of the mixture can be separated into groups, or, the various fragments in which the investigator is interested may be removed for special tests or for identification under greater magnification. For minute quantities, a medium power binocular dissecting microscope should be substituted for the simple microscope.

[8]Heindl, Robert, "Un nuevo método de recollectión de polvos con fines de investigación criminal o científica," 19 Revista de Crim., Psiq., y Medicina Legal 415-424 (1932).