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M. Edwin O'Neill

FINGERPRINTS IN CRIMINAL INVESTIGATION

M. EDWIN O'NEILL†

This brief article has been prepared primarily for the benefit of criminal investigators who are not already familiar with the elementary principles of fingerprint identification. It is also intended to be of usefulness to investigators who may have some knowledge of fingerprint evidence but who are, nevertheless, unaware of many of the possibilities and limitations involved in the examination of chance impressions left at the scene of a crime.

WHAT IS A FINGERPRINT?

The skin covering the palms of the hands and the soles of the feet, unlike the skin on other parts of the body, is elevated into minute ridges which tend to follow patterns of definite design. (See Figure 1.) Such skin is called "friction skin" and the ridges are commonly referred to as papillary ridges. On the tips of the fingers the papillary ridges form definite *patterns* which may be of the same general form on all of the fingers of the two hands or may differ from one finger to the next, with several or all of the recognized patterns represented in the same indidvidual. These patterns may be described and classified in various ways, depending upon the system used for recording and filing of inked impressions. In the Henry system of fingerprint classification, which is used in the United States, all fingerprint patterns are divisible into four main types: Arches, Loops, Whorls, and Composites.[1] Each of these may be subdivided into two or more types so that at least nine patterns may be recognized.[2] Since all fingerprints are classi-

† Microanalyst, Chicago Police Scientific Crime Detection Laboratory.

1 These types may be simply described as follows: *Arch patterns* are those in which the ridges run across the finger tip from one side to the other without recurving, and are usually slightly raised near the center, presenting an arch-like appearance; *Loop patterns* are those in which one or more of the ridges, entering from the side of the finger recurves and, after doubling back, ends on the same side as it entered; *Whorls* are patterns in which some of the ridges make a complete circuit around a central core, forming a ring or spiral; *Composite patterns* are those composed of two or more types of patterns in combination, such as two distinct loops, a loop enclosing a whorl, etc.

2 Arch, tented arch, exceptional arch, loop, whorl, central pocket loop, twin loop, lateral pocket loop, and accidental. Two classes of plain loops are recognized, *ulnar* and *radial*, the former with the loop opening toward the little finger side of the hand and the latter with the loop opening toward the thumb side.

FIGURE 1

Inked Impression of the Papillary Ridge Surface of the Hand

The single print at the lower left is that of the thumb, the complete surface of which does not show in the entire hand print when the hand is placed flat upon an uncurved object.

fied into only a few pattern types, for the purpose of identification it is necessary to examine the detailed characteristics of the fingerprint; in other words, those features of the individual ridges of which the pattern as a whole is composed. Careful observation of the ridges discloses that they are not simply a series of similar parallel lines but tend to differ from each other in various ways. For example, some ridges may run through the pattern without interruption, while others may be discontinuous, or interrupted, forming *ending ridges,* or, as they are sometimes called, *ends.* A ridge may also appear to become divided into two ridges, forming what is known as a *fork* or *bifurcation.* Again, the two branches of a divided ridge may be re-united to form a single ridge, the characteristic thus constituted being referred to as an *enclosure.* Very short ridges, containing only one or two pores, are called *islands.* In one fingerprint there may be found a score or more of these fingerprint *details,* as well as other ridge characteristics of a more unusual nature. (See Figure 2.)

FIGURE 2

Diagramatic Representation of Ridge Characteristics of Fingerprints

(A) and (3)—Islands
(B) and (5)—Ending Ridges
(C) and (4)—Hooks or Spurs
(D) and (2)—Enclosures
(E) and (1)—Bifurcation or Fork
(F) and (7)—Trifurcation
(G) and (6)—Anastomosis
(8) and (9)—Delta; Core

In the comparison of two or more fingerprint impressions, as, for example, a latent fingerprint from a crime scene and inked prints of a suspect, the identification is dependent upon the presence of these *ridge characteristics.* If the fingerprint in question is smudged, or for any other reason does not show the ridge details, an identification is impossible. (See Figure 3.) Many investigators are not familiar with this fact and submit smudges

or finger marks to the expert with the expectation that such marks can be identified, and possibly at the same time they may ignore the presence of identifiable fingerprints which are invisible or are less obvious because they are not seen during the process of a casual examination. Even inked impressions taken by persons unfamiliar with the procedure of fingerprint identification often lack the structural features necessary for purposes of comparison. (See Figure 4.)

FIGURE 3

Unidentifiable Smudges and Identifiable Prints

Frequently investigators, lawyers, and others expect all finger marks to be susceptible of identification. Unfortunately this is not so. For instance, when a finger is pushed or pulled along a surface the resulting effect is usually a "smudge" and not an identifiable print. Such smudges, as illustrated in *A* and *B*, are not identifiable because of the absence of ridge impressions which are essential for identification. In this illustration, *A'* and *B'* represent identifiable impressions of the same fingers which were responsible for the smudges *A* and *B*. Although *B'* is only a portion of one fingerprint, an impression of this size may contain a sufficiently large number of characteristics to permit a positive identification of the person whose finger made the impression.

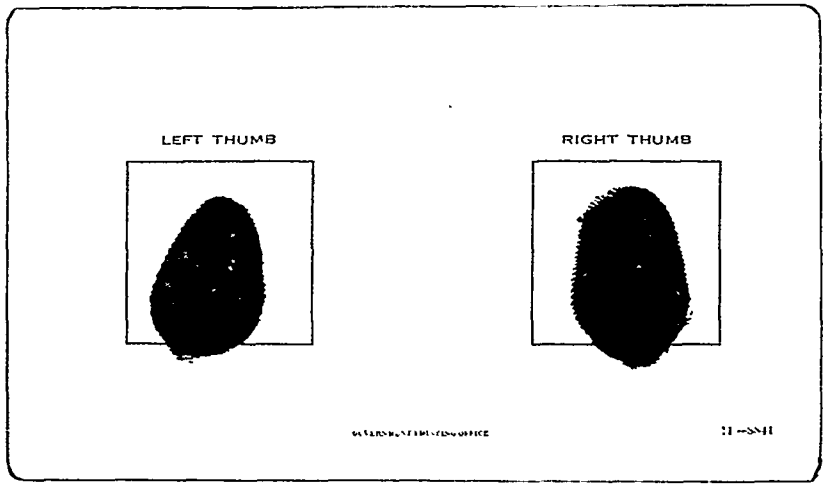

FIGURE 4

A Merchant Marine sailor's thumb prints which accompanied his medical examination record. Although this may represent an exceptional case, it is nevertheless true that the person in question could not possibly have been identified by these spots of printers' ink.

It is generally agreed among fingerprint experts that for a positive identification there must be at least twelve corresponding ridge details in the same relative positions. However, some experts hold that six to eight identical points are sufficient proof of identity if consideration is given to their grouping, angular values, presence of a core or center of exceptional form, etc.[3] On the basis of nine details it has been estimated that the mathematical probability of two different individuals making exactly the same print is about one in two quadrillion, a sum representing more than one million times the estimated population of the earth. Moreover, no two fingerprints have ever been found which were identical in all respects, and this is true even among the ten prints found on any one person's hands.

Palm prints and sole prints can be identified with the same degree of certainty as fingerprints but are of less frequent occurrence in criminal investigations.

Types of Fingerprint Traces

Fingerprint traces left at the scene of a crime are of three kinds, depending upon the nature and condition of the object touched and also upon the material coating the fingerprint ridges at the time of contact. These three types are the following:

(a) *Molded impressions,* formed by the pressure of the fingers upon a relatively soft, plastic material, thereby producing an actual mold of the fingerprint pattern. Fingerprints of this kind are found in such materials as wax, tar, soap, putty, and various articles of food. They usually require no special treatment preparatory to analytical study, but are photographed with the lighting arranged in such a manner that the impressions show most clearly.

(b) *Visible impressions,* made by contact of fingers which are coated with some foreign coloring material. Visible fingerprints may be made by fingers smeared with blood, grease, dirt, paint and the like, and when clear and sharp, are photographed in their original state. (See Figure 5.) Fingerprints in this category, however, are often blurred or smeared and do not contain the requisite ridge structure to permit an identification.

Figure 5. Photograph of edge of window sill showing visible fingerprints made by dirty fingers.

[3] If the impression is sufficiently clear for comparison purposes ordinarily it will contain many more than six, eight, or even twelve details.

(c) *Latent impressions,* those produced principally by the natural secretions of the skin which coat the fingerprint ridges, and are invisible, or nearly so, unless illuminated or viewed at a critical angle.

Of the three types of impressions the most frequently encountered, and usually the one more satisfactory than any of the others, is the latent fingerprint. The following discussion will therefore be limited to impressions of this class.

Formation of Latent Fingerprints

The skin covering the tips of the fingers contains thousands of sweat glands, each opening by means of a duct onto the outer surface of the papillary ridge through a small funnel-shaped opening or pore on its summit. Because of the activity of these glands there is a discharge of sweat deposited upon the ridge surfaces. This excretion is about 99% water, but in addition it contains various inorganic salts, as well as organic matter in the form of fatty acids, urea, etc. Besides the secretion of sweat, the ridges also become coated with oily matter secreted by the sebacious glands of the hair-producing parts of the skin. When, for example, the fingers are run through the hair of the head or touch the face, a small amount of sebum is transferred to the papillary ridges. Since the deposit of sweat and sebum is practically always present, when the fingers come into contact with a smooth, dry surface, some of the material is transferred from the ridges to the object touched and remains as a material, though perhaps invisible, reproduction of the skin design of the finger tips themselves. The fidelity of the latent fingerprint so formed is influenced by a number of factors: the cleanliness of the fingers; amount of secretion; degree of pressure exerted when the object is touched; whether the fingers made firm, even contact or whether they slipped or twisted, etc. The nature of the object touched also plays a part in the formation of latent fingerprints. Deposits of bodily secretion on rough surfaces, such as stones, unfinished wood, pebbled leather, etc., are not sharp and clear. Porous surfaces, such as newsprint or blotting paper produce spreading and absorption of the moist deposit. Dusty, dirty or oily surfaces also affect the formation of the fingerprint traces. However, clear latent fingerprints may be expected on most hard, smooth surfaces which are relatively clean. Identifiable latent fingerprints are frequently encountered on glass, china, polished wood, porcelain, polished metals, patent leather, writing papers, and similar surfaces.

The length of time that a latent fingerprint will remain upon an object also varies, being influenced by a number of factors. The amount of secretion deposited, the porosity of the surface, and various climatic and atmospheric conditions, as well as other factors, affect the duration of the latent print, and because of their variability it is not possible to state categorically the interval during which a fingerprint is susceptible of development. On absorbent surfaces this may be a matter of a few hours, whereas on relatively non-absorbent materials the life of a print may extend to several weeks or even months. However, in any case there is a progressive weakening of the print with the elapse of time, and it is therefore important that an examination of the traces be made as soon after their discovery as possible.

Since the sweat and oily material which constitute the latent fingerprint are nearly always colorless, the impressions are frequently invisible or not sufficiently clear for photographing directly, and therefore they must be intensified in some way to give them contrast with the object upon which they are located. The intensification process is referred to as the *development* of latent fingerprints, and although the procedure is usually a simple one, considerable skill and experience are necessary if the best results are to be obtained.

Development of Latent Fingerprints

The processes of development used by fingerprint technicians are numerous, and many different materials are employed to "bring out" invisible impressions. Various finely divided colored powders are generally used for fingerprints on hard, smooth surfaces, such as glass, painted or varnished wood, metals, etc., whereas certain vapors and liquid reagents are utilized on relatively absorbent materials such as paper, cardboard and unpainted wood.

Many different powders can be used as developers, and specially prepared fingerprint powders are available as commercial products. However, the developers commonly used are of two "colors"—one of light color, such as aluminum for fingerprints on dark surfaces, and the other black, as, for example, lampblack or charcoal powders, for latent prints on light surfaces. The need for both light and dark powders is readily apparent, of course, since it is important that the developed fingerprint presents maximum contrast with its background. Powders are sometimes sprinkled or blown onto the object being examined but are more frequently applied with a soft brush. A small quantity of powder is taken on the end of the bristles and

applied to the object by short, light strokes of the brush. (See Figure 6.) Sometimes a second or third application is necessary for complete development of the latent print, but care must always be observed in applying the powder in order that the impression is not smeared or obliterated by the use of too much powder or by too heavy brushing. After the fingerprint has been intensified the excess powder is removed with a few light strokes of the brush. This method of developing fingerprints is based upon the principle that the sweat residue constituting the latent fingerprint is slightly adhesive and will therefore cause some of the powder to adhere, whereas portions of the object not covered by the deposit—including the spaces between the sweat ridges—will not retain the particles of powder to the same extent. In the development of fingerprints with powders it necessarily follows that the surface must be free of grease or moisture, for a surface coating of such materials would destroy the difference in adhesive power of a fingerprint and the object upon which it is located.

FIGURE 6

Development of latent impressions with fingerprint powders. (Black paper placed inside glass jar to give contrast to developed prints.)

Following the development of the latent impression a photograph may be taken as a permanent record and also for subsequent comparison with inked fingerprints. If the photograph is to be made at the crime scene a specially designed portable camera is ordinarily employed. One type of camera in common use has a self-contained lighting system and is easily operated. (See Figure 7.) Photographs are made in natural size and from the negatives suit-

FIGURE 7

Fingerprint Camera

To operate this camera (a Folmer Graflex) it is only necessary to locate the fingerprint in the front aperture of the camera and press the release lever, which automatically lights the self-contained lamps and opens the shutter, thus making the exposure. (Batteries are located in the camera case.)

able enlargements can be prepared, or the examination may be made from contact prints with the aid of a magnifier.

Although a photographic reproduction is used whenever possible, in some instances this is not feasible and the developed latent print must then be preserved by "lifting" it from the object with an adhesive material of some kind. A "lifter" commonly used for this purpose is transparent cellulose tape. A piece of tape of sufficient size to cover the print is placed over the powdered print and pressed against it by stroking with the tip of the finger to insure even contact. The tape is then peeled off, and the fingerprint is thus transferred to the adhesive surface of the tape. It is then protected by placing it on a piece of cellophane or other backing material to form a permanent mount. Considerable care is required for accomplishing a successful "lift" and for this reason photography should be used whenever possible.

Although powders are most frequently used for the development of latent fingerprints, there are certain surfaces (e. g., paper and cardboard) on which vapors or liquid reagents can be utilized to greater advantage. Among the agents of this type in common usage are iodine fumes, osmic acid vapor and silver nitrate solution. The selection of any one of these three depends upon such factors

as the age (or probable age) of the prints, type of surface, etc. Not all of the methods can be used in combination, the application of one sometimes precluding the use of others. The action of such agents is either one of absorption (as in the case of iodine fumes taken up by the fingerprint deposit), or of chemical reaction with one or more of the components of the latent fingerprint, which results in a coloration of the print. Silver nitrate reacts with the ordinary salt which is present in the trace and the osmic acid vapors react with the fatty substances secreted by the skin. (For illustrations of the results obtainable by using these reagents see Figure 8-B, C, D.)

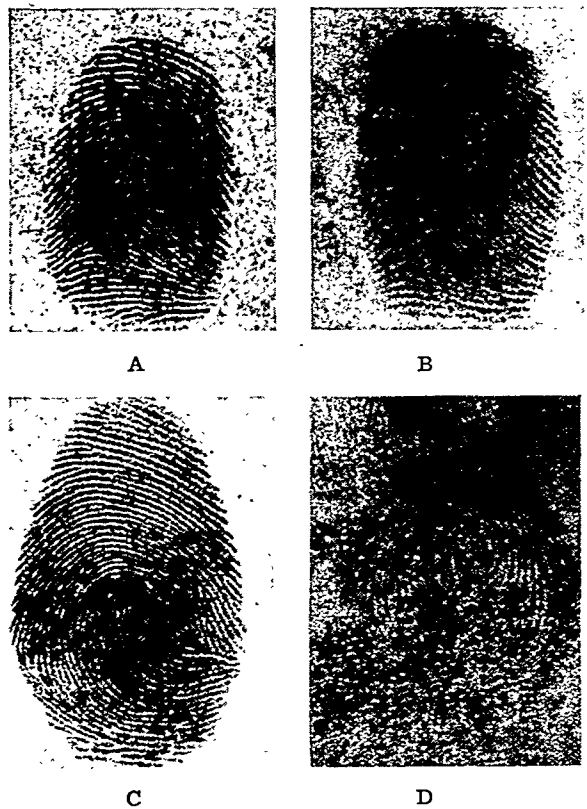

FIGURE 8

Latent Fingerprints on Paper Developed by Means of (A) Powder, (B) Iodine, (C) Osmic Acid, and (D) Silver Nitrate.

CARE AND PRESERVATION OF FINGERPRINTS

From the foregoing discussion of the formation and development of fingerprints, it can be readily understood that considerable caution should be exercised in the handling of any object which might contain identifying traces. Careless handling not only may

introduce "foreign" prints, but may also eradicate or smear the original impressions on the object and thereby render them useless for identification purposes. In many investigations it is unnecessary to touch or handle such objects before an examination is made by the fingerprint expert, but whenever an immediate examination is considered necessary or desirable the object should be handled in such a manner that any possible fingerprint traces are not destroyed. For example, the examination of an anonymous letter can be carried out with the aid of tweezers or forceps, or even with two small pieces of wood and, while possibly not so convenient as using the fingers, this method of handling at least prevents the addition of many extraneous fingerprints and palm prints. (See Figure 9.) If the object to be handled happens to be a container such as a drinking glass, cup, or bottle, the fingers may be placed inside (as shown in Figure 6), or it may be lifted and removed by placing the

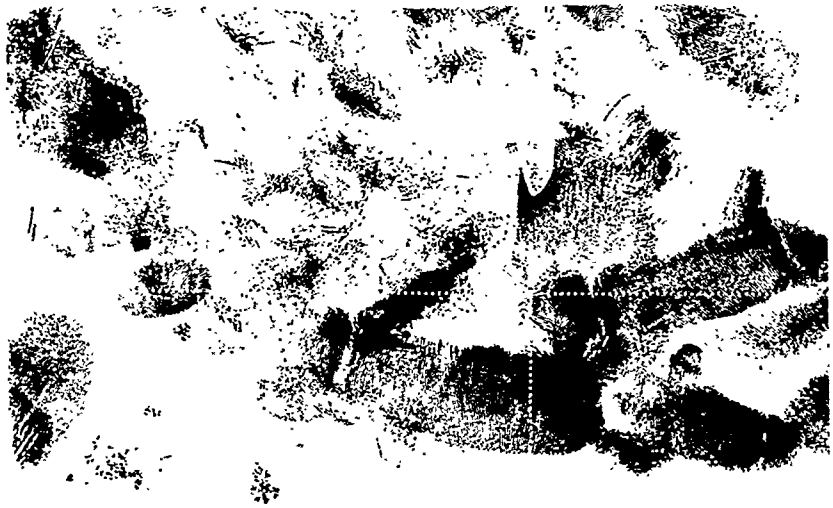

FIGURE 9

Investigators' Fingerprints and Palm Prints on Evidence Carelessly Handled

The above illustration is a photograph of the back of a sheet of checks in a check book which had been used in executing several forgeries. When the remaining checks were treated by the silver nitrate process a number of latent fingerprints were developed, but they were found to be the prints of the investigators for the company upon which the checks had been drawn. Such careless handling of evidence often results in a destruction or removal of the fingerprints of the culprit involved, and also in a loss of valuable time and effort in comparing the developed latents with the prints left by other persons who handled the evidence before it reached the fingerprint technician.

fingers on the rim of the opening and on the bottom edge. In the case of a pistol or revolver, it should be picked up by means of a pencil or a small piece of wood inserted in the barrel or through the trigger guard, or it may be handled by the grip if the stock happens to have a rough surface.

Careless transport of articles bearing latent fingerprints may also result in partial or complete obliteration. *The widespread practice of wrapping exhibits in newspapers or in pieces of cloth, such as a handkerchief, is responsible for the destruction or alteration of many identifiable traces.* The moist deposit of sweat or oil constituting a fingerprint impression is extremely delicate and only slight friction from wrapping material is sufficient to smear it or remove it completely. In the larger police departments, as well as in some other investigative bodies, the problem of transporting exhibits bearing fingerprints is seldom encountered because such exhibits are investigated at the crime scene by the fingerprint experts themselves. However, when an object must be carried some distance for a fingerprint examination, it should be supported in such a manner that the surfaces to be examined for fingerprints will not be touched or rubbed. Some experts suggest enclosing the article in a wooden frame, or, in the case of some objects, lashing them to a board with string to prevent movement and friction. In the absence of special packing materials a substitute method consists of placing the article in a cardboard or wooden box in such a position that it is supported by its edges or corners or rough surfaces (where fingerprints would not be found anyway), or in carrying it in such a manner that the smooth, relatively broad surfaces are not subjected to friction.

The value of fingerprints as a method for identifying and convicting criminals depends to a considerable extent upon the consideration given to this type of evidence by investigating officers. An uninformed, disinterested, or careless officer may in the course of his investigation ignore or destroy identifiable impressions on objects which may have been touched by the perpetrator of a crime. And once a fingerprint has been rubbed off or obliterated there is nothing an expert can do to rectify the investigator's mistake or to restore the fingerprint. This loss of valuable evidence can be prevented, of course, by cautious handling on the part of an investigator who has a knowledge of the elementary principles of fingerprint identification.