

## A PRIMER ON PRINTS

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Learning Objectives:

### Part I

#### Classification of Fingerprints

1. To understand what is meant by friction ridge skin
2. To determine the primary landmarks of a fingerprint pattern
3. To know what part of the surface of a finger is included in a fingerprint pattern
4. To learn the three basic types of fingerprint patterns and their subcategories as used in classification
5. To learn how to count the ridges in pattern

### Part II

#### Collection of Fingerprints at a Crime Scene

6. To learn the three categories of fingerprint impressions as found at a crime scene
7. To learn the most common ways of developing latent prints at a crime scene.
8. To know how finger print evidence may be falsified

## PART I. CLASSIFICATION OF FINGERPRINTS

To the chagrin of many criminalists and prosecutors fingerprint identification, once venerated as an unassailable and absolute proof of identification, has come under fire partly because of *Daubert v. Merrell Dow Pharmaceuticals*, 509 U.S. 579 (1993) and more recently because of blunders made by law enforcement in using fingerprints to wrongly identify train terminal terrorists. Additionally, fingerprint identification has been upstaged by a new matinee idol, DNA, and its co-star, blood spatter analysis. DNA will tell that a particular person was at a scene, and it will do so whether, or not, that person left prints. Its co-star, blood spatter analysis will tell what happened at a scene. Yet the lowly fingerprint has put many men behind bars and will no doubt continue to do so in the future and for those reasons it will still have to be dealt with by defense lawyers and investigators. To be able to successfully challenge fingerprint identification the defense attorney must have at least some knowledge of the anatomy of a fingerprint pattern and of the processes used for collecting, comparing, and classifying prints. This article offers a cursory survey of those topics.

1. *What is friction ridge skin?*

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<sup>1</sup> For an excellent article on cross-examination of fingerprint experts for defense attorneys see *The Defense Challenge to Fingerprints*, Steele, Lisa, Vol. 40, No 3. *Criminal Law Bulletin*; or at <http://www.nacdl.org/public.nsf/freeform/publicwelcome?opendocument>

A specialized layer of epidermis called friction ridge skin covers the inner surfaces of the hands and feet. Under slight magnification, this skin has the appearance of ridges and furrows like a plowed field, or more apropos, like the tread on a tire. Sweat pores are spaced rather evenly on the tops of the ridges. Sweat glands in the dermis secrete sweat that flows out of the pores and down the sides of the ridges into the furrows. The pores of the friction ridge surfaces do not *secrete*<sup>2</sup> sebaceous oil nor do they have hair as does the skin on the rest of the body. Sebaceous oils coat the skin like a lotion to protect it and keep it supple, but they are greasy and would diminish the grip if they were on the hands. The pores of friction ridge surfaces secrete only sweat which is mostly water and does not counter the specialized purpose of the skin. The ridges of friction skin leave a distinct tread pattern or print on a surface. Generally speaking, other things being equal, the smoother and cleaner the surface the more clear the print. Byrd lists the following causes as additional conditioners of print quality:

- Nature of the surface
- Environment
- Weather conditions
- Amount of contaminant
- Pressure applied
- Movement during transfer
- Condition of the friction ridge detail of the skin

*2. How to determine the basic landmarks of a fingerprint pattern.*

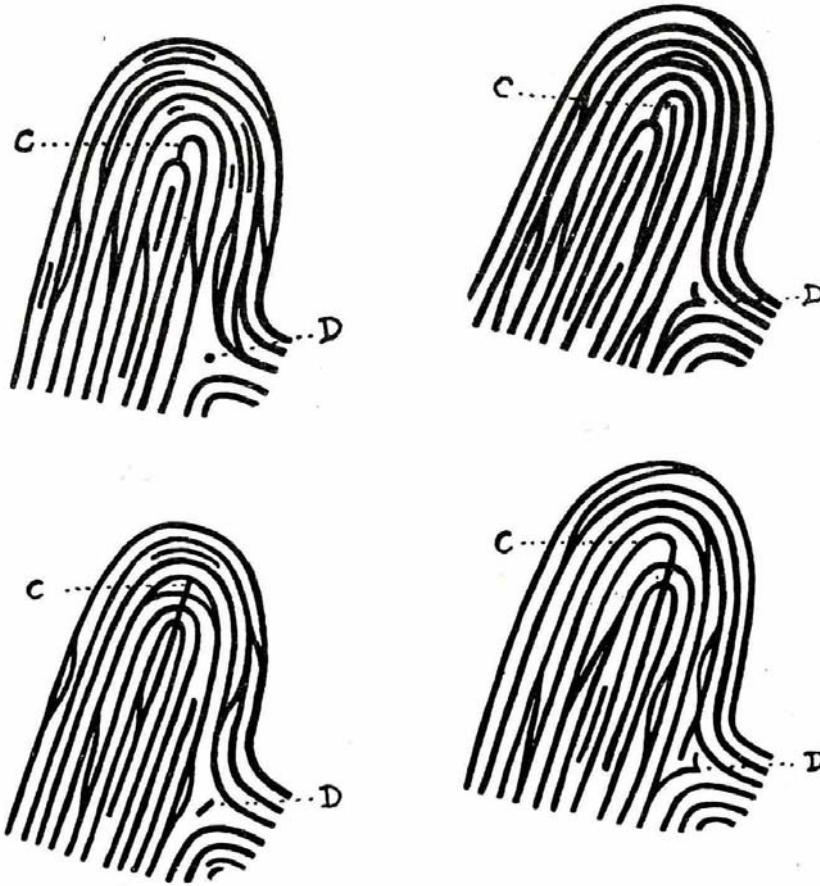
The two primary landmarks or focal points of the loop and whorl pattern are the *Delta* and the *Core*. There are complex rules used to determine the exact location of the delta and core of a fingerprint pattern. For instance, the delta is the ridge at or in front of and nearest the center of the divergence of the type lines and it may be: a bifurcation that opens towards the core, an abrupt ending ridge, a dot, a short ridge, a meeting of two ridges, a point on the first recurving ridge located nearest the center and in front of the divergence of the type lines.

The core is the landmark roughly located on the innermost ridge of the pattern and the rules for determining the correct core location are as specific as those for the delta. The important point here is that the rules were forged through trial and error in an attempt to create a uniform way of classifying prints. They are not based on any sort of scientific principles. Their value is merely and solely descriptive. Figure 1 illustrates the deltas and cores of various fingerprints<sup>3</sup>.

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<sup>2</sup> Exocrine glands *secrete* sweat, oil, milk, sebum, semen, and such. Someone who hides something does not *secrete* it, but he or she may *secret* it.

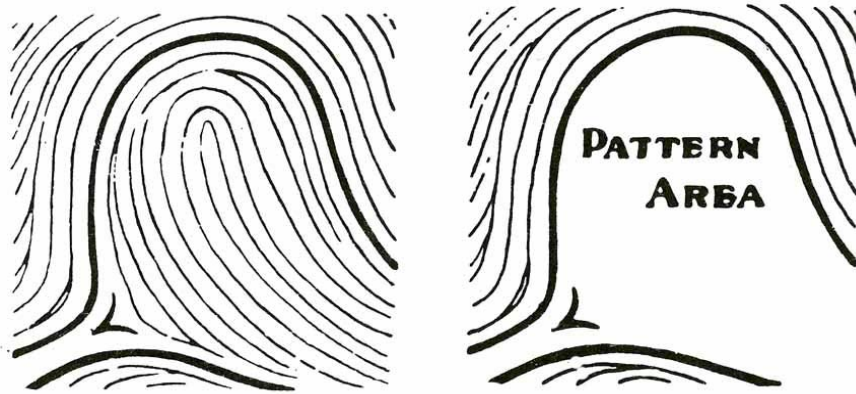
<sup>3</sup> The Science of Fingerprints, US Department of Justice, Federal Bureau of Investigation, Rev 12-84, GPO



**Figure 1. Various kinds of deltas and cores of fingerprint patterns.**

3. *What part of the friction surface of a finger is included in a fingerprint pattern?*

The pattern area of a print is enclosed within delineated *type lines* and includes primary identifying landmarks such as the delta and core and ridges that intervene between them. Lists of tedious rules and exceptions to rules are used to determine the type lines of a pattern. Generally, the type lines begin at the Delta and encompass the print pattern. The rules become important when a type line ends or bifurcates and a new line must be designated as the continuance of the type line. Type lines are the two innermost ridges which start parallel, diverge, and surround the pattern area. The bold lines in Figure 2 below are type lines.



**Figure 2. An illustration of type lines and the pattern area of a loop fingerprint.**

Fingerprint patterns are sometimes compared to bodies of water. In the illustration above, the water would flow into the pattern from a tributary at the location of the delta on the lower left side. It would flow out the lower right side of the picture.

*4. Three basic types of fingerprint patterns and their subdivisions*

The three basic classifications or types of fingerprints are *Arches*, *Loops*, and *Whorls* and each type has subsumed variations.

**1. Arches**

- a. Plain
- b. Tented

**2. Loops**

- a. Radial
- b. Ulnar

**3. Whorls**

- a. Plain
- b. Central Pocket
- c. Double Loop
- d. Accidental



**Figure 3. Plain Arch**

In the plain arch the ridges enter on one side of the impression and flow out the other with a rise or wave in the center. The plain arch is the most simple of the fingerprint patterns.<sup>4</sup>

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<sup>4</sup> Definitions for figures 3 – 9 come from *The Science of Fingerprints*, US Department of Justice, Federal Bureau of Investigation, Rev 12-84, GPO pp 29-57

**Figure 4. Tented Arch**

In the tented arch, most of the ridges enter on one side of the impression and flow out the other side as in the plain arch; however, the ridges at the center do not. They form a tent pole or a close facsimile thereof.



**Figure 5. The Loop**

The loop is the most common fingerprint. The terms *radial* and *ulnar* derive from the radius and ulnar bones of the forearm and the loop pattern is subdivided into radial and ulnar groups. Loops which flow toward the little finger are ulnar loops and those that flow towards the thumb, or radial bone, are radial loops. The definition of a loop is a pattern in which one or more of the ridges enter on either side of the impression, recurve, touch, or pass an imaginary line drawn from the delta to the core, and terminate on or toward the same side of the impression from whence it entered.



**Figure 6. The Whorl**

The whorl pattern has two deltas and at least one ridge making a complete circuit, which may be spiral, oval, or circular. Whorls comprise 30% of all fingerprints and the plain whorl is the most common type of whorl. An imaginary line drawn between the two deltas must touch at one of the recurring ridges.



**Figure 7. Central Pocket Whorl**

As with other whorls, the central pocket loop has two deltas and at least one ridge that completes a curving circuit that crosses in front of each delta. The circuit may be a spiral, oval, or circular.



**Figure 8. Double Loop Whorl.**

The double loop whorl is a hybrid that is classified as a whorl since it best fits the description of a whorl. The double loop consists of two separate loop formations with two separate and distinct sets of shoulders and two deltas.



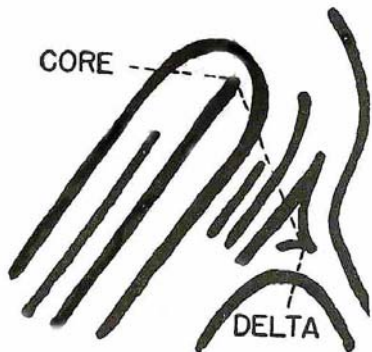
**Figure 9. Accidental**

The accidental pattern doesn't fit into one of the other descriptions.

### *5. How to count the ridges in a pattern*

The ridge count is part of the description of a fingerprint that is used to distinguish it from others of a similar classification. For instance, one fingerprint may be an ulnar loop with a ridge count of 7 while another ulnar loop may have a ridge count of 11. The ridges

counted are the ones that touch or cross an imaginary line between the delta and the core as in Figure 10 below. The delta and core are not counted. The ridge count for the pattern in Figure 10 would be three. Average ridge counts in loops range between 1 and 20.



**Figure 10. Counting ridges (3) between the delta and core.**

## **PART II. COLLECTION OF FINGERPRINTS AT A CRIME SCENE**

Learning Objectives:

6. To learn the three categories of fingerprint impressions as found at a crime scene
7. To learn the most common ways of developing latent prints at a crime scene.
8. To know when finger print evidence may be fabricated

The information covered in this article thus far pertains to the classification of fingerprints. Classification is a process usually performed at the police station. Crime scene technicians and investigators at the scene handle the collection of fingerprint evidence. Their responsibility is to detect and collect prints that can be classified and used for identifying a suspect.

### **The Patent Print**

Crime scene technicians and criminalists deal with three types of fingerprint *impressions* at the scene of a crime. The fingerprint may be *Patent*, or clearly visible to the naked eye. Patent prints may be left by a person who has blood, paint, ink, or some other transferable material on his hands. The patent print is grossly evident. "Patent impressions are visible and usually need no enhancement. They are simply photographed and the item that they are deposited on is collected if necessary."<sup>5</sup>

### **The Latent Print**

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<sup>5</sup> Byrd, Mike: Ridge Detail at a Crime Scene, Miami-Dade Police Department [www.crime-scene-investigator.net](http://www.crime-scene-investigator.net) 2

The second category of impression is the *Latent* print. This is the print that we see television detectives dusting furniture and weapons to develop. The print is not readily visible by the eye. It may need to be viewed from very close, or from a certain angle, or it may need an alternate light source, powders, or chemicals to become visible. Using available or oblique lighting on most surfaces will reveal the impression. The impression must be enhanced or developed to be seen fully and collected.<sup>6</sup>

Ideally, all prints would be photographed before anything else is done to them. After photographing the prints the print must be developed by whatever means the technician chooses to use. The latent impression is lifted with a clear tape or lifting medium and placed on a backing card with a contrasting background. The area where the lift was taken from is documented on the back of the card along with the case number designating it to a particular investigation, the name and identification number of the investigator lifting the impression, and the date of the lift.<sup>7</sup>

### **The Plastic Print**

*Plastic* fingerprints refer to prints that are left in an impressionable material such as window putty, warm wax, wet paint, blood, or other such items that will mold to the print pattern and retain the shape. Plastic prints are usually visible to the naked eye but are classified separately.

““Is a bloody print the same as a print in blood?” The answer to this question would be, no. The print in blood would be an example of depositing a plastic or molded impression into the surface of blood. The bloody print would be an example of having a foreign substance, such as the blood, coating the hand and depositing an impression from the blood coating to another surface.”<sup>8</sup>

### **Developing Latent Fingerprint Impressions**

The sole purpose in developing a latent impression is to make it visible so that it may be preserved and compared to other prints. Various powders and chemicals are used for this purpose.<sup>9</sup>

Powder brushed over a surface bearing latent prints will cling to the moisture in the ridges of the print and make it more clearly visible. Different powders are used on different surfaces and for different contrast purposes. While black and gray powders were traditionally used most, there are now various colors and compositions available now such as aluminum, gold, red bronze, and dragon’s blood powder. Only a small amount of

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<sup>6</sup> Ibid

<sup>7</sup> Byrd, Mike: Ridge Detail at a Crime Scene, Miami-Dade Police Department [www.crime-scene-investigator.net](http://www.crime-scene-investigator.net) page 2

<sup>8</sup> Ibid

<sup>9</sup> The Science of Fingerprints, US Department of Justice, Federal Bureau of Investigation, Rev 12-84, GPO 174

powder should be used and it should be brushed with the grain or tread of the print. Too much powder and too little brushing are the chief faults of novice print technicians.

Prints should be photographed at a 90 degree angle before they are lifted. After cutting a piece of cellulose tape sufficiently large enough to cover the powdered print, the adhesive side is applied to the surface containing the print. When the adhesive is lifted away, the powder print sticks to it. The adhesive is then applied to a white or black card, depending on the color of the powder and the print can be seen through the tape. Effort must be made to avoid getting air bubbles under the tape when it is applied to the surface so that parts of the print will not be left blank and again when it is applied to the card so that the print lays flat and undistorted.

Powders do not work on surfaces like paper, cardboard, unpainted wood, or other absorbant materials and chemicals are used in its place. Iodine, ninhydrin, and silver nitrate, cyanoacrylate, and crystal violet are some of the most commonly used chemicals.<sup>10</sup>

### **Iodine**

When iodine chemicals are subjected to heat they vaporize and produce violet fumes that are absorbed by oils such as the kind left by fingerprints with which they come into contact. The ridges appear yellow-brown.<sup>11</sup>

### **Ninhydrin**

Ninhydrin has a short shelf life and is usually mixed in lots to be used within thrifty days. It may be applied to a surface by praying, dipping, or brushing. Latent prints will appear within 24 hours at room temperature. Slight heat speeds up the process. Latent prints many months old can be developed by the ninhydrin method. Since the prints will eventually begin to fade, they should be photographed as soon as they are developed.<sup>12</sup>

### **Silver Nitrate**

Sodium chloride (salt) that is present on the ridges of fingerprints combines with silver nitrate to form silver chloride, which when exposed to light breaks down to its component parts of silver and chlorine. The ridges developed in this manner appear reddish-brown and should be photographed immediately before the background darkens and obliterates them.<sup>13</sup>

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<sup>10</sup> The Science of Fingerprints, US Department of Justice, Federal Bureau of Investigation, Rev 12-84, GPO 175

<sup>11</sup> Ibid

<sup>12</sup> The Science of Fingerprints, US Department of Justice, Federal Bureau of Investigation, Rev 12-84, GPO 176

<sup>13</sup> The Science of Fingerprints, US Department of Justice, Federal Bureau of Investigation, Rev 12-84, GPO 179

### **Cyanoacrylate (Glue)**

Cyanoacrylate vapors work well to develop prints on hard surfaces such as plastic bags and pliables. In a process of polymerization, the vapors adhere to the friction ridge residue, harden, and build up the ridge detail. The process has to be performed in an air tight enclosed space which can be anything from a plastic bag to a box or aquarium. The specimens are placed inside the container and a few drops of glue are put inside to vaporize. A light bulb may be placed inside to speed the vaporization process. Exposure time varies and the specimens have to be inspected periodically. Cyanoacrylate is being used more extensively with good results.

The process of preserving prints has been made easier by the use of cyanoacrylate fuming. One might say that failure to preserve them may be tantamount to misfeasance. "By NOT superglue fuming nonporous evidence before you mail it to the lab, you help the bad guys..... it's about the same as wiping the evidence clean. Do NOT expect latent finger or palm prints on a pistol, knife, can, bottle, or credit card to survive mailing to the lab if you don't either:

- A. Superglue fume the evidence before mailing. -or-
- B. Package the item in such a way that NOTHING can touch or rub against the smooth surfaces you want processed for latent prints."<sup>14</sup>

### **Crystal Violet (Gentian Violet)**

Crystal violet works by staining cats off epidermal skin cells and perspiration on almost any surface, but it is known for its use on the adhesive side of tapes and other adhesive surfaces. A dye is prepared using the crystal violet and the specimen is dipped into the dye and agitated for a few seconds. The specimen is then rinsed under cold tap water and examined. It may be returned to the dye if it is not contrasted sufficiently. On light backgrounds the print will appear dark and should be photographed as soon as possible. Latent prints on black or dark surfaces may need to go through another process using photographic paper.<sup>15</sup>

### **Laser Detection**

The FBI has developed an 18 watt continuous wave argon ion laser to detect prints on various items of evidence. It is the cleanest of methods, relatively easy, no pretreatment is required, and it doesn't alter the evidence item. It will illuminate perspiration and body oils contained in fingerprint residues. The process is merely a sniffer method and when it detects traces of a print a powder of chemical development must be used to produce an identifiable print.<sup>16</sup>

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<sup>14</sup> German, Edward, CLPE, FFS Cyanoacrylate Fuming Tips, US Army Crime Lab, 1999

<sup>15</sup> The Science of Fingerprints, US Department of Justice, Federal Bureau of Investigation, Rev 12-84, GPO 183

<sup>16</sup> The Science of Fingerprints, US Department of Justice, Federal Bureau of Investigation, Rev 12-84, GPO 185

### **Fabrication of Fingerprint Evidence**

This section is entitled fabrication of fingerprint evidence, because strictly speaking a fingerprint can't be fabricated, at least not without the use of cloned fingers or some other medical wonder to which the average house burglar doesn't ordinarily have access. So when we speak of fabrications we are really speaking of the interjection of a foreign fingerprint into a scene or, more likely, into the evidence collected at the scene. It is defined by Wertheim as a representation of print that never existed on the surface from which it purportedly came.

Wertheim warns "Cases of fabrication of latent print evidence by police officers and identification technicians occur frequently enough in the United States to make publicity of these cases a threat to the credibility of honest latent print and crime scene professionals. In addition, latent print examiners who compare latent prints developed by others run the risk of receiving submissions of fabricated evidence and being drawn unsuspectingly into such cases."<sup>17</sup>

The two definitions used by fingerprint identification technicians and criminalists in reference to falsified fingerprint evidence are forged and fabricated prints. "By considering these definitions in their practical meanings, a forged print would be a latent planted at a crime scene by the true criminal in order to fool the police, while a fabricated print is fabricated evidence produced by a police employee in order to bolster a case or frame a person. In those terms, forgery of latent print evidence is virtually nonexistent. Fabrication occurs disgustingly often."<sup>18</sup>

If one considers that a knife or gun or other object with prints on it may be planted at a staged scene to mislead the police, then it may be risky to declare that the occurrence is virtually nonexistent, but that a criminal would take a print to a scene with the intention of placing it on an object at the scene can probably safely be ruled out.

Wertheim describes three common methods used by dishonest police officers to fabricate latent print evidence: 1) a lift from an inked print. 2) a mislabeled lift, 3) a staged photograph. He warns that these fabricated latent prints frequently are "perfect" prints—the fabricator prepares a print so clear that nobody could fail to see the identification.

A "lift" is a print that has been developed on a surface and lifted off with the use of clear tape. The tape could be placed on a surface at a crime scene during the course of fingerprint dusting or at a later time in an area that wasn't dusted. It would be no harder to do that than it would be to place a bloody glove on someone's property or place a drop of blood on their sock as may have happened in the OJ case and undoubtedly has in others.

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<sup>17</sup> Wertheim, Pat A. "Detection of Forged and Fabricated Fingerprints." *Journal of Forensic Identification*, 44(6), 1994

<sup>18</sup> *Ibid*

The second tactic is to mislabel a print as have been lifted from a scene when it came from another place. Wertheim says that this is the most difficult kind of deception to detect. He advises looking at the background noise, meaning the traces of environment picked up by the tape. The tape may pick up dust or other items that are or are not consistent with the scene.

Lastly, print evidence can be planted by a staged photograph that purports to show that it was photographed at the crime scene. Again, environmental background information can be useful in detecting the falsification.

Wertheim advises criminalists and print technicians to use the following protocol to avoid being drawn into a falsification unwittingly or being undeservedly charged with falsification by a defense attorney.<sup>19</sup>

- Photograph latent prints before lifting them.
- Make sure crime scene and laboratory notes record every surface examined, every method used, and every result obtained.
- Background noise is very helpful in establishing the origin of the latent. Create your own background noise. One excellent way to do this is to use a ballpoint pen. Mark a curved line around the latent, the initial and date the latent next to the line. Re-powder the markings. When you lift, the powder will come up on the lift but the ink will remain on the surface as proof of the origin of the latent.
- By using a lift card with a unique number and recording the numbers in your notes, you make it virtually impossible to insert or swap latent prints at a later date. Each latent then has in effect a serial number which prevents alteration.
- Preserve the latent print by fuming.
- The use of a latent print log book helps document latent prints. Each case entry should be made as soon as the latent prints are lifted or brought back to the office from the scene. The entry should contain sufficient information to adequately document every lift.
- Reviews and audits. There should be both supervisory and technical reviews of the notes and reports in each case file, once completed. Such a review should include an inspection of the lifts.

Perhaps processing the prints with cyanoacrylate to preserve them should be added to this list now that the procedure is so widely accepted. END

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<sup>19</sup> Wertheim, Pat A. "Detection of Forged and Fabricated Fingerprints." *Journal of Forensic Identification*, 44(6), 1994