Trace and contact evidence

Part II: Fingerprints and other marks and impressions

4

Chapter objectives

After reading this chapter, you should be able to:

- Understand those characteristics of fingerprints that enable them to be used as a means of personal identification and allow them to be systematically classified.
- Distinguish between latent, visible and plastic fingerprints and outline the main techniques used to develop the first of these.
- Describe the methods used to recover footwear impressions from an incident scene and discuss how they may be subsequently compared with suspect footwear.
- Appreciate the significance of any bite marks present at a crime scene and their potential role in the identification of the individual responsible.
- Discuss the evidential value of tool marks connected with an incident scene and the means by which suspect tools may be identified as the instruments involved.
- Outline the valuable forensic evidence that may be afforded by recording and preserving any tyre marks left at an incident scene.
- Understand the role of textile products both in the creation of impressions and as the recipients of damage marks.

Introduction

This chapter examines the valuable evidence that can be provided by the different types of marks and impressions left at a crime scene. Of these, fingerprints[1] may be considered to be the most important type as they are unique to the individual and can therefore be used as a means of personal identification. Furthermore, they are frequently present at crime scenes and typically form an essential part of the evidential material gathered.

1 In this book, the term 'fingerprint' is used for both those found at the crime scene and those taken from an individual under controlled circumstances. It should be noted, however, that within the field a distinction is sometimes made between the former (finger marks) and the latter (fingerprints).

Other marks and impressions that may be found at an incident scene include footwear impressions, bite marks, tool marks and tyre marks. In all four of these types, it may be possible to match scene impressions with suspect items (or, in the case of bite marks, directly with suspect individuals) through the creation of test impressions. Textile products are another means by which marks and impressions may be left at an incident scene, as exemplified by the imprints made by gloved hands. Moreover, they may themselves show signs of damage, which can be used, in some cases, to identify the type(s) of implement involved in the incident. Note that for information about impressions made by indented writing, the reader is referred to Chapter 8, Section 8.7.6.

4.1 Fingerprints

4.1.1 The basis of fingerprints as a means of identification

In humans, the surface of the palms of the hands and the fingers, and the soles of the feet and the toes, are covered with a special type of thickened skin known as **friction ridge skin**. This has evolved in primates to provide a gripping surface and also, through the greater concentration of nerve endings present, to facilitate an enhanced sense of touch. As the name suggests, friction ridge skin has a ridged appearance, rather like that of a ploughed field in miniature, with furrows separating the individual ridges. However, these ridges are not arranged in straight lines but form complex patterns on the surface of the skin. Contact between an area of friction ridge skin and another surface may result in the creation of a characteristic print or impression on that surface (Section 4.1.4). Furthermore, a set of prints, for example of the fingers and thumbs, can be reproduced deliberately using inks or similar substances to produce a permanent record. Such prints can be used as a means of personal identification that is based on the following premises:

Friction ridge skin
In primates, including humans, the thickened skin that covers the plantar surfaces of the feet (i.e. the soles) and the palmar surfaces of the hands.

- *The fingerprints of an individual stay unchanged throughout life.* The friction ridge pattern of an individual is formed in the foetus, at about 28 weeks after conception. The exact arrangement of the ridges is determined by the dermal papillae, a layer of cells that separates the outer layer of skin (the epidermis) from the underlying dermis. This pattern endures throughout life, although it may be marred, for example, by deep scarring. Moreover, it persists for some time after death and may therefore prove useful in post-mortem identification (Chapter 12, Section 12.4.1).
- *No two fingerprints are identical.* Support for this principle came first from Sir Francis Galton's theoretical calculations presented in his landmark publication, *Finger prints*, in 1892. In this, he demonstrated that the odds against two individual fingerprints being exactly the same was 64 billion to 1. Perhaps even more compelling is the actual evidence accrued from fingerprinting individuals over the past 100 years. Of the many millions classified to date, no two fingerprints have yet been found to be the same, even those of identical twins.

4.1.2 The classification of fingerprints

The presence of recognisable ridge pattern types has allowed fingerprints to be systematically classified. The fingerprint classification system adopted in most English-speaking countries (including England and Wales from 1901) was the Henry System. This ten-print classification system was developed by Sir Edward Richard Henry (1850–1931), based on the observations made by Sir Francis Galton (1822–1911) of three basic types of fingerprint patterns – loops, arches and whorls. Each of these three types, and their subtypes, are described below and illustrated in Figures 4.1–4.3.

Figure 4.1 Fingerprint patterns: the radial loop, showing the four features used in its classification

Note that the ulnar loop pattern (not illustrated) differs from the radial loop pattern in only one respect, i.e. the loop opens in the direction of the little finger and not in the direction of the thumb

Loops

Approximately 60 per cent of all fingerprints fall into the loop pattern category, making it the commonest of the three basic types. In this pattern, at least one ridge must enter from one side, curve around and then exit at the same side (Figure 4.1). Two subtypes are recognised – the *radial loop* and the *ulnar loop* – depending on the direction of flow of the ridges. In simple terms, if the loop opens in the direction of the thumb (i.e. towards the radial bone of the forearm), it is termed a radial loop and if it opens in the direction of the little finger (i.e. towards the ulnar bone of the forearm) it is known as an ulnar loop.

To be classified as a true loop pattern, *all* of the four features listed below, and illustrated in Figure 4.1, must be present:

- a single delta (an area where the ridges diverge);
- a core (the pattern's centre);
- a minimum of one recurving ridge that flows between the delta and the core;
- a minimum **ridge count** of one.

Ridge count
In fingerprint patterns categorised as loops, the number of ridges that traverse an imaginary line connecting the core with the delta.

Arches

The arch pattern accounts for about 5 per cent of all fingerprint patterns. Two subtypes are recognised: the *plain arch* and the *tented arch* (Figure 4.2). In the plain arch, which is the simplest fingerprint pattern of all, the friction ridges flow from one side to the other rising smoothly in the centre, like a wave. In contrast, the tented arch, which may be considered as an intermediate between an arch and a loop, usually has either a central upthrusting ridge or ridges meeting at an angle of 90° or less at the apex of the arch. However, as may be expected, there are also tented arches that show some, but not all, of the four characteristics of the loop pattern.

Whorls

The whorl pattern accounts for about 35 per cent of all fingerprint patterns. The situation regarding the classification of whorl patterns based on the Henry System is complicated because different ways of subdividing whorl patterns are used. One categorisation that is in common usage, and is recognised by the Federal Bureau of Investigation (FBI), places whorls into the following four types – plain, central pocket, double loop and accidental. The simplest of these is the *plain whorl*, which has two deltas and a minimum of one ridge that completely encircles the core, describing the shape of a circle, oval or spiral in so doing (Figure 4.3a). If an imaginary line connecting the two deltas encounters at least one ridge circling the core, then the pattern belongs to the plain whorl subtype. However, if it does not, the pattern is distinguished as a *central pocket whorl* (Figure 4.3b). A more complicated whorl pattern is the *double loop whorl*, which consists of two loop patterns in combination (Figure 4.3c). The fourth and final subtype, the *accidental whorl*, is applied to fingerprints that either consist of a combination of two or more pattern types (with the exception of the plain arch) or whose pattern does not fit into any of the recognised categories previously described.

Figure 4.2 Fingerprint patterns: (a) plain arch and (b) tented arch

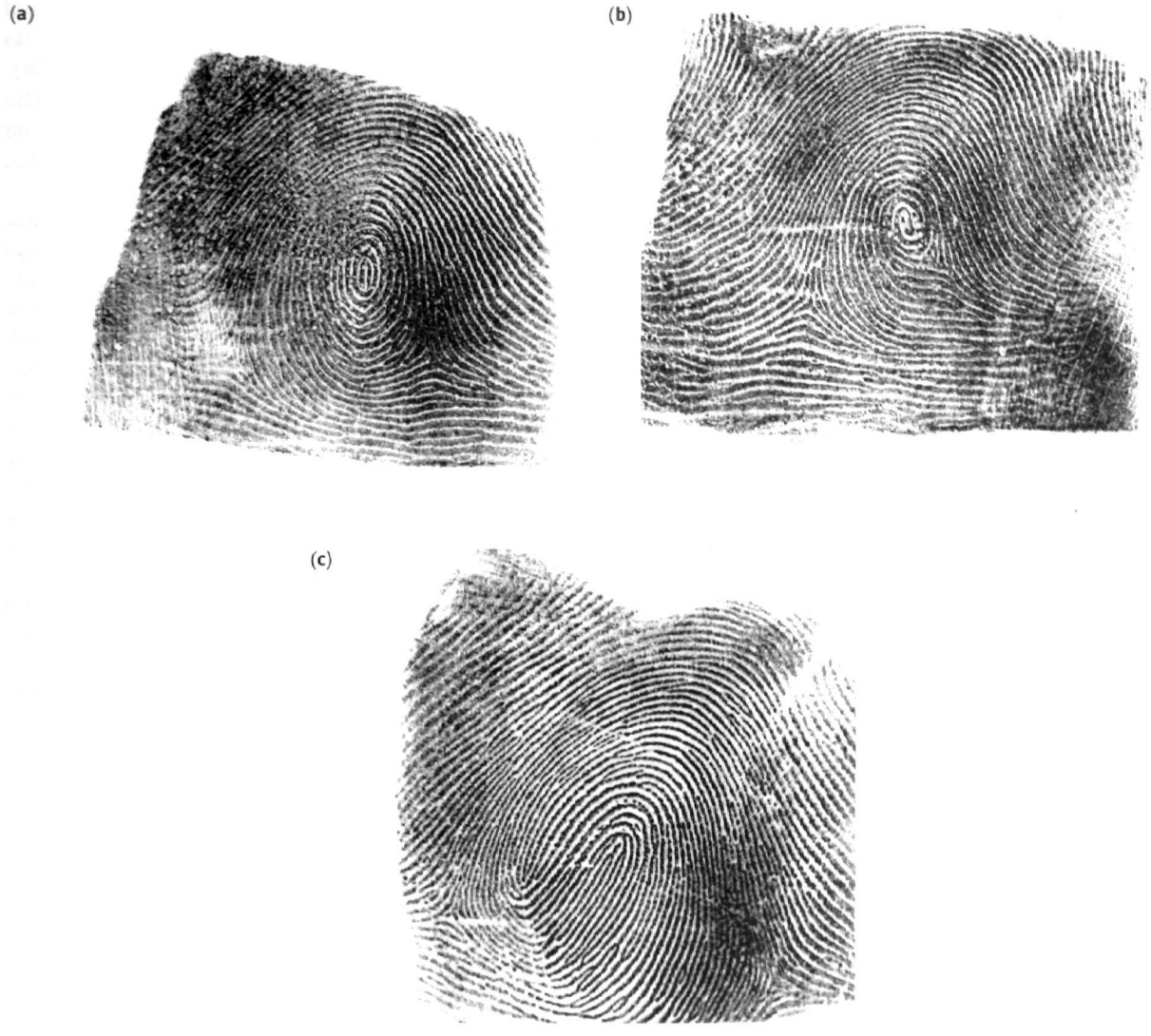

Figure 4.3 Fingerprint patterns: (a) plain whorl; (b) central pocket whorl; and (c) double loop whorl

4.1.3 The comparison and identification of fingerprints

Within each police force in England and Wales, the comparison and identification of fingerprints are carried out by highly trained fingerprint experts within the Fingerprint Bureau (Chapter 2, Box 2.1). In the past, fingerprint information was held on a series of card indices that had to be filed, searched and retrieved by hand – a long and laborious process. Each individual police force maintained its own locally based fingerprint collection, while a 'national collection' was kept at New Scotland Yard for further reference. However, this situation was revolutionised by the development of the Automated Fingerprint Recognition (AFR) system – a

computerised system introduced in 1992 that was taken up by most (but not all) of the forces in England and Wales. This AFR technology was then incorporated into its successor, the National Automated Fingerprint Identification System (**NAFIS**), which, by 2001, had become available to all police forces in England and Wales. The benefits of using NAFIS are enormous and include improved matching accuracy, an increase in the speed of search times and improved communication between police forces, to name but a few.

NAFIS
National Automated Fingerprint Identification System: the national fingerprint database used by police forces in England and Wales.

The national fingerprint collection held on NAFIS is the only definitive database that allows the identification of individuals. Every person who has been arrested and charged, reported or summonsed for a recordable offence has his or her fingerprints taken. In some cases, these fingerprints may be electronically scanned using the Livescan system and the captured images transmitted to NAFIS. This recently developed technique has been adopted by over two-thirds of police forces. If not already on file to confirm the identity of the individual concerned, these fingerprints are added to the national database. It is worth noting that *in the past* only fingerprints taken from individuals who were subsequently convicted were kept on the database as a permanent record of identity. However, following the implementation of the Criminal Justice and Police Act 2001, fingerprints from arrested individuals who are not subsequently cautioned for, or convicted of, a criminal offence need not be eliminated from the NAFIS system, although they are held separately within it.

The comparison of fingerprints recovered from a crime scene with those held on the national database may lead to the identification of an individual present at that scene (see below). Persons who have a legitimate reason to be at a particular crime scene (such as a householder in the case of a domestic burglary) may well provide the police with their fingerprints for elimination purposes. Fingerprints taken in these circumstances are not added to the national fingerprint database.

National Automated Fingerprint Identification System (NAFIS)

The NAFIS database holds approximately five million 'ten-print' sets of fingerprints and can be used to carry out a number of different types of searches, details of the two main kinds of which are given below.

First, it can be used to unequivocally establish the identity of an individual by comparing a set of ten-prints taken from the suspect with any held for that person on the database. The majority of searches carried out using NAFIS are of this type. Currently, the individual in question would have to be arrested and taken to a custody suite for his or her prints to be taken. However, in November 2006, trials of hand-held electronic fingerprinting devices (used to scan the subject's index fingers) began in a year-long pilot scheme that will ultimately involve ten police forces (known as Operation Lantern). These mobile devices facilitate access to NAFIS and will allow police officers on patrol to check, within a matter of minutes, the identity of individuals suspected of committing an offence.

The second most-used type of search involves the comparison of fingerprints left at a crime scene with those held on NAFIS. Fingerprints recovered from a crime scene are scanned into NAFIS[2] (these must be 1 : 1 in size). In each case, the finger-

2 Note that images with white ridges and black furrows, produced by some latent fingerprint development techniques, are usually colour-inverted so that ridges appear black on a white background before identification is carried out.

print expert marks up the individual characteristics of the scene fingerprint and the computer searches through the stored images held on the database for likely matches. As a result of this process, the NAFIS computer system generates the 15 best matches, providing the fingerprint expert with a list of possible suspects. However, it should be emphasised that the decision over the identification, if any, of a scene print rests with the fingerprint experts.

In making a comparison between a scene print and one held on file, the fingerprint expert looks at the following features, whenever these are identifiable in the scene print:

- the type of fingerprint pattern (i.e. loop, arch or whorl);
- the finger type (left or right hand, thumb, etc.); and
- the **ridge characteristics**, especially the ridge endings and bifurcations (where a ridge branches into two) (Figure 4.4).

Ridge characteristics
Recognisable features of the friction ridges that may be used in the comparison and identification of fingerprints. Also known as minutiae or Galton details. Examples include ridge endings and bifurcations.

(Fingerprint visualisation by Sarah Fieldhouse, Staffordshire University, UK)

Figure 4.4 The ridge characteristics used in the comparison and identification of fingerprints
Note that the fingerprint shown is a negative image of one that was visualised using superglue fuming, hence the ridges appear in black

If there are enough ridge characteristics in the same positions on both the scene print and that held on file, the fingerprint expert can make an identification. Until recently, in the United Kingdom, the minimum number of matching characteristics required for a full identification was 16. However, today, there is no minimum quantitative standard and the decision over identification rests with the fingerprint expert concerned, whose opinion must then be validated by two other fingerprint officers.