FOOTPRINTS

Collection, Analysis, and Interpretation

LOUISE M. ROBBINS

Associate Professor in Anthropology
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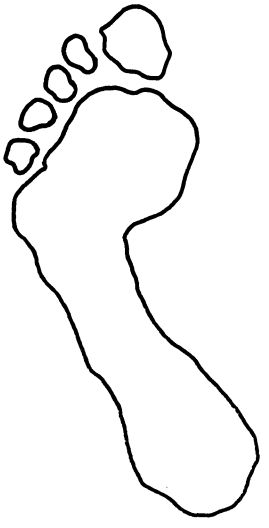

Original Drawings by ***Richard Gantt***

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To the memory of Georg Karl Neumann, the master of the intelligent eye—physical anthropologist at Indiana University for many years—who taught me to look for the differences that make each of us unique.

PREFACE

IT HAS TAKEN a number of years to develop the insight and then to formulate and test the methodology involved that relates individuals to crime scenes by way of their footprints. Through the use of specific measurements and shape expressions developed from a footprint—bare, socked, on shoe insole, or reflected in wear on the shoe tread—it is possible to identify the one individual (or several individuals, if such be the case) as the maker of the print or prints left behind at a crime scene. No two individuals possess the same constellation of footprint traits.

The process of analyzing footprints (footprints in the generic sense given above) is an exacting and tedious one. It is not a technique that can be mastered during a Saturday afternoon ball game or over coffee. But it is not difficult to learn that process and the step-by-step procedures involved in analyzing footprints. The aim of this book is to present the methodology and its techniques, along with the basic knowledge that contributed to the methodology, in enough detail that an interested investigator can develop the expertise needed to collect, analyze, and interpret footprint evidence.

The book is based on my nearly 25 years of practical experience as a physical anthropologist. Much of my work in the last decade has focused on the footprint as a critical piece of evidence in forensic cases. I have analyzed crime-scene footprint evidence in scores of cases at nearly every jurisdictional level and from many geographical areas. I have given court testimony as an expert witness in many of these investigations. This experience has made it clear that the techniques for analyzing crime-scene footprints are not widely known within the law enforcement profession.

This book, with its broad range of material directed to the techniques for analyzing footprints, is designed to remedy that situation. Lesser known forensic techniques, such as the ones on footprints described in this book, will continue to expand the investigative repertoire as they are used with more frequency and by more investigators. Ours is a growing science. I am gratified to be able to make a contribution.

Louise M. Robbins

INTRODUCTION:
THE FORENSIC ANTHROPOLOGIST AND FOOTPRINTS

FORENSIC ANTHROPOLOGY is the application of anthropological knowledge to problems of medicolegal concern. Anthropologists bring a particular perspective to forensic cases. Their focus is on people and trait similarities and differences among individuals within a population as well as among populations.

Many physical anthropologists place an emphasis on individual differences as well as populational differences. Analytical techniques are designed to sort out physical traits that help differentiate one person from another. The physical anthropologist looks for biological and biocultural traits of the living body or skeletal structure that differentiate individuals and populations.

The bones of the skeleton make up the internal structural frame in each of us. Muscles, ligaments, tendons, and other tissues hold the frame together and give it shape. A person's footprints, for example, are proportional in size and shape to the bones of the feet. A large foot cannot make a small footprint. When an individual leaves footprints while walking, a sequence of right and left footprints is formed with space between each one. The distance between the right and left footprints is the length of pace for that person. The particular placement of the foot on the ground while walking (whether the toes are directed straight ahead or angled slightly, for example) is indicative of that individual's angle of gait. The stride, pace, and the position of each footprint—its depth, angulation, and pressure—constitute the particular walking pattern for an individual. Those footprint patterns provide indirect information with regard to length of legs, range of body weight, and interrelated movement of the foot, ankle, leg, and body that are individualistic to that person.

My own work as a physical anthropologist dovetailed very naturally into the forensic field. From working in the caves of Kentucky and Tennessee (to do a census of prehistoric individuals based on the footprints they left) to developing techniques to differentiate and identify individuals from their footprints is really a very short step. Whether the footprint is a current one left at the scene of a crime or one from millions of years ago, like the ones I analyzed on the Laetoli hominid trail for Dr. Mary D. Leakey in East Africa, the shadow of the individual is reflected in the footprint left behind. From information on the size and shape of the foot, we can infer the skeletal and body structure of the person who made the footprint. The techniques for obtaining that information and for differentiating individual footprints are the focus for this book.

Before we can examine individual differences in footprints, we must first have the footprints. Chapter One discusses a number of situations in which footprints may be found. It is intended to alert law enforcement investigators to the possibility of footprints being present in various circumstances. The initial discovery of footprints begins the

identification phase of footprint analysis.

Once footprints are identified, the investigator moves to the collection phase. Chapter Two details various techniques (such as photography and casting) that can be used to obtain maximum information for an analysis of footprints. The data on footprints must be as comprehensive as possible because it may be necessary to offer that material as evidence in court.

The investigation and analysis of footprints can be greatly expedited if one has more than a passing knowledge of the human foot. Knowing the capabilities of the foot is especially important in cases where the footprint is obscure or incomplete. The anatomical structure and the functional capabilities of the foot form the foundation for footprint analysis. Chapters Three and Four cover the anatomy and morphology of the foot. The reader is also introduced to directional definitions that help in the identification and location of specific parts of the foot. The bones that make up the foot, as well as muscles, ligaments, and tendons associated with the bones, are presented and illustrated. The combination of these anatomical and physiological parts gives the foot its specific shape—shape features that are unique to each individual. A footprint usually gives us a two-plane view of the foot. We only see those parts that are pressed on a flat surface like the ground or a floor, or slightly impressed into the insole of a shoe, boot, or other footwear. The shape contours of all parts of the foot making the footprint become very important identity markers in the absence of the three-dimensional foot itself. A range of shape contours in the different regions (toes, ball, arch, and heel) of the foot are given in Chapter Four. A number of the different forms are illustrated. We observe that the internal structure of the foot provides the framework for our analysis of the footprint. Thus, size and shape of the heelprint reflect the size and shape of the bottom of the heel bone and the muscles, ligaments, and flesh covering that part of the heel. Therefore, one portion of footprint analysis focuses on the description of the shape and morphological contours of the footprint from toes to heel.

An analysis of footprints—Chapters Five through Nine—includes multiple measurements and descriptions of their morphology. In most past studies, physical anthropologists considered the maximum foot length and ball width dimensions to be adequate indicators of foot size, but these measurements alone do not reveal individualistic features of a foot or footprint. A more extensive range of measurements was devised by physical anthropologists during the 1940s for the military in an attempt to develop size guidelines for proper fit of footwear for military personnel (Randall, 1946). These shoe design measurements revealed ranges of individual variation in different parts of the foot. Many of the reference points along the foot from which measurements can be taken are relevant to analysis of footprints. For example, many footprint landmarks—or reference points—in this book are the same as those in earlier studies. Additional landmarks are assigned by the author to assist in obtaining a comprehensive representation of the footprint being measured. Still other landmarks and measurements could be added, but the aim is to obtain a maximum amount of information from a minimum number of landmarks and selected measurements.

Footprints and traced foot outlines were collected from a sample of people from the general population. Measurements were taken on the footprints and foot outlines from the prescribed landmarks. Descriptions were recorded of the particular shape expressions of each footprint. After measurements and descriptions were collected from the footprint sample, the data from each subject were compared (for points of similarities or differences) to footprints from the larger population in which height, weight, sex, age,

and race of the individuals were also known. A profile of the footprint emerged. This information enables one to project probable height and weight ranges of an individual making footprints by comparing those footprints with the large footprint sample. It is also possible to project possible sex of the individual making the footprints by comparing those footprints with the larger comparative series.

I further demonstrate how to work from bare footprints to shoeprints, or footwear impressions, and back again to the bare foot. A footprint of a bare foot consists of only those parts that touch the ground. Those areas are important because they represent points of body weight-bearing pressure. The same weight-bearing points are impressed in the shoe insole and also appear on the bottom of the shoe as areas of increased wear. In this way the wear pattern along the bottom of a shoe provides indirect information on foot structure and shape, especially to one who becomes experienced in recognizing individual patterns of variation. There also is a positive correlation between the bare footprint size and the shoe size of an individual. The techniques that are used to derive those correlations are discussed and illustrated in Chapter Ten.

The final chapter illustrates the application of footprint evidence in law enforcement situations. It will become apparent that our footprints are uniquely our own. In gaining an understanding of the methods for using footprints to identify the individual who made them, law enforcement agents are able to add a significant forensic tool to the techniques available to them.

The Table of Contents has been made as complete as possible to indicate the scope of each chapter. Because major topics which would normally become index descriptors occur almost on a page-by-page basis (i.e. shoeprint, footprint, heel, arch) while others are confined to a single chapter (i.e. casting techniques, measuring instruments). I decided, therefore, that an index would be redundant in this instance.

ACKNOWLEDGMENTS

THIS BOOK contains much of the footprint material that I have shared with many law enforcement persons over the years. Those inquisitive investigators are the very ones for whom this book is written. Their questions were not only ones about the analysis of the evidence at hand, but also about the appropriate techniques for collecting the footprint evidence. I have learned much (and still do) from the many crime-scene investigators and prosecuting and defense attorneys about the way in which footprint evidence is collected and exhibited. Each one helped in his and her own way to make the information in this book understandable to the nonanalyst. I am greatly in their debt.

While members of the law enforcement community provided the impetus for drawing together the material for this book, many friends, strangers, and former students provided the footprints, foot outlines, and shoeprints that were studied. Their enthusiastic cooperation in supplying the footprints for developing a body of data for analyses is held in warm regard. At one point, I intended to acknowledge specific individuals who participated in the study, but the list soon reached a proportion where individual recognition for all was not possible. Some individuals must, however, be singled out for their contribution to making this publication happen.

William L. Coleman, an academic colleague, gave many hours and enormous energy to help the footprint project along and to seek out and work with support personnel on illustrations of the materials. The line drawings of the foot, muscles, and muscular actions were drawn by Richard Gantt, an artist with extensive medical illustration experience. The footprint shapes in Chapter 7 are from many subjects, but the footprint in Chapter 8 belongs to Ralph Becker, a subject who willingly stepped in paint, ink, and water upon request. He also provided a selection of shoes and his own feet for photographic illustrations of specific situations.

Statistical analyses of the footprint data (of which only a small portion is in this book) were done at the University of North Carolina, Greensboro, Academic Computing Center. The support of personnel there, especially Marlene Pratto, greatly facilitated the processing of data. Jackie Gillis, the computer programmer, gave intelligent direction to that process. My sincere appreciation goes to all of those individuals for their assistance.

It goes without saying that an author is greatly indebted to those who type into coherent prose the seemingly undecipherable pages of a manuscript. I thank them one and all, from Betsy Few who began typing early drafts of Chapter One to the final typing done by Margaret Thompson and Elizabeth Hunt. Margaret Bushnell receives an even stronger note of appreciation for the many hours she has given to editing the final manuscript copy, the text, the tables, and figures. A true test of friendship.

Louise M. Robbins

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FOOTPRINTS

Collection, Analysis, and Interpretation

PART I

DISCOVERING AND COLLECTING FOOTPRINTS

PART I is concerned with identifying locations where one can expect to find footprints and describing what is to be done once they are found. Most of us have seen footprints of humans and animals in freshly-poured concrete in sidewalks, driveways, and streets. We see footprints in snow, on rain-covered surfaces, around swimming pools, on newly waxed floors, in dust, and in mud. We are so accustomed to seeing footprints that we do not give them conscious attention. We observe them but dismiss them unless there is something unusual about the shape or location of the footprints.

Footprints at the crime scenes become another matter. Not all crimes have footprints at the scene. However, footprints may be overlooked at the scene because their presence is not anticipated or because they are obscure and not easily recognized. If, while committing a crime, the perpetrator walked around in the crime area, there is a strong possibility that footprints are present. Thus, an early part of the investigative procedure should be to look for footprints.

What is to be done with footprints once they are found is a question of paramount importance. The action taken at this early stage determines the kinds of information that can be obtained from the footprints when they are later analyzed. The initial collection of the footprint record is crucial to all succeeding phases of analysis and interpretation. Every precaution must be taken to protect the footprints so that important human identification data can be collected from them.

Chapter 1

FINDING FOOTPRINTS AND SHOEPRINTS

CRIMINAL INVESTIGATORS search a crime scene to gather evidence associated with a crime. The location and identification of weapons and fingerprints, for example, are routinely done. It is only in recent years, however, that the importance of footprints at the crime scene has become recognized. We now have scientific studies that allow us to link footprints to the individual who made the prints. We can now use measurements and characteristics of shape and sole-wear patterns to link these prints to the one individual—the only individual—who could have made them. These identification techniques add a critical dimension to traditional investigative procedures.

The first step in footprint investigation is being alert to the possibility of their existence. A cautious and thorough survey of the crime scene must be initiated before investigators move into the area. A delay increases the risk of a criminal's footprints being destroyed by investigators walking through the crime area. Investigating officers are well aware that they should not touch items at the scene of a crime for fear of damaging fingerprints. The same caution needs to be applied with regard to footprints; that is, investigators should take care not to walk in the crime scene where there is the possibility of crime-related footprints being present.

HOW TO DISCOVER FOOTPRINTS

Before information can be obtained from footprints, they must first be found. The discovery or recognition of footprints is not as easy as it sounds. We are not accustomed to looking for them. The investigator must become consciously alert to the possibility of finding footprints. The investigator must think *footprints* whenever approaching the crime scene. It is important that the search for footprints begin before the investigator is within the central crime scene. Even at some distance from the scene, footprints of the perpetrator entering or leaving the scene may be destroyed as the investigator approaches the site. It goes without saying that the person charged with the responsibility of searching for footprints should be the first person to explore the crime scene. The search for footprints should receive the same concentrated effort as does the search for fingerprints because footprints provide as much or more information about the individual who made them.

Those of us who work in footprint analysis have a saying: "If there is one footprint, there must be another one somewhere nearby." Unless an individual is functionally disabled in feet or legs, two feet are used for locomotion. Therefore, when one footprint is

found, the search should intensify for the next footprint that may be nearby, and then the next, and so on. If the first footprint discovered is a right one, for instance, a left footprint should be close by. However, if only the right foot made a footprint, a careful search should be made for the next step of the same foot. It is possible to gain information about movement patterns from footprints of the same foot.

The situation may arise in which the initial search for footprints indicates that footprints are not present in the residential dwelling, commercial building, or outdoor scene of crime. However, subsequent to the preliminary search, an investigator may inadvertently step on a footprint before being aware of its presence. The footprint search should then begin. The damaged footprint should be included in the record. Every footprint has the potential for providing information about the person who made it. Even if an investigator thinks that a particular footprint was made by another member of the investigative team, the footprint should be noted, recorded, and treated as though it were from an unknown person. If that footprint is not recorded, it could be that it overlies an important footprint of an unknown person that would otherwise be overlooked. Whenever footprints are found, initially or during the investigation, their presence should be recorded for later analysis.

The nature of the crime and its physical location will provide guidelines for the footprint search. Did the crime occur inside or outside a building? What was the probable entry and exit path of the perpetrator? What are the conditions of the grounds surrounding the dwelling that might be conducive to retaining footprints?

When a search for footprints is conducted outdoors, a number of factors need to be noted: conditions of the soil, time of year, and weather conditions, for example. The time of year is important when defining soil conditions. Perhaps the soil is frozen, or perhaps there is snow on the ground to retain a footprint outline. If a footprint search is conducted inside a building, the search begins at the entryway with consideration being given to the floor surface, whether it is composition tile, wood, linoleum, or carpeting.

The nature of the crime is also a major factor in this kind of situation because one can gain some idea of the perpetrator's range of movements from footprints. Is the floor surface one on which footprints would show? Is the character of the floor surface such that the intruder's range of movement can be determined? In the case of a violent homicide, there frequently is blood on the floor. It is possible that the perpetrator stepped in the blood, leaving footprints in the immediate area as well as throughout the crime scene. All of these possibilities need to be considered.

Too often footprints are discovered at the scene of a crime only after many people have moved through the scene. In those circumstances, the fact that footprints are recovered is a bonus. Much more definitive information can be collected from footprints if caution is used when entering the crime scene. When the first footprint is discovered, all movement at the scene of the crime should cease until the footprints and their sequences can be identified and followed to obtain as complete a record of the footprints as possible. A point to remember is that if one footprint is found, there is—in all probability—another footprint somewhere in the vicinity.

SUBSTANCES IN WHICH FOOTPRINTS OCCUR

Footprints may be found almost anywhere at the scene of a crime. They usually are found on the floors inside a building or on the ground immediately outside, but they may be on doors, walls, furniture, and victims. The substances in which footprints are found