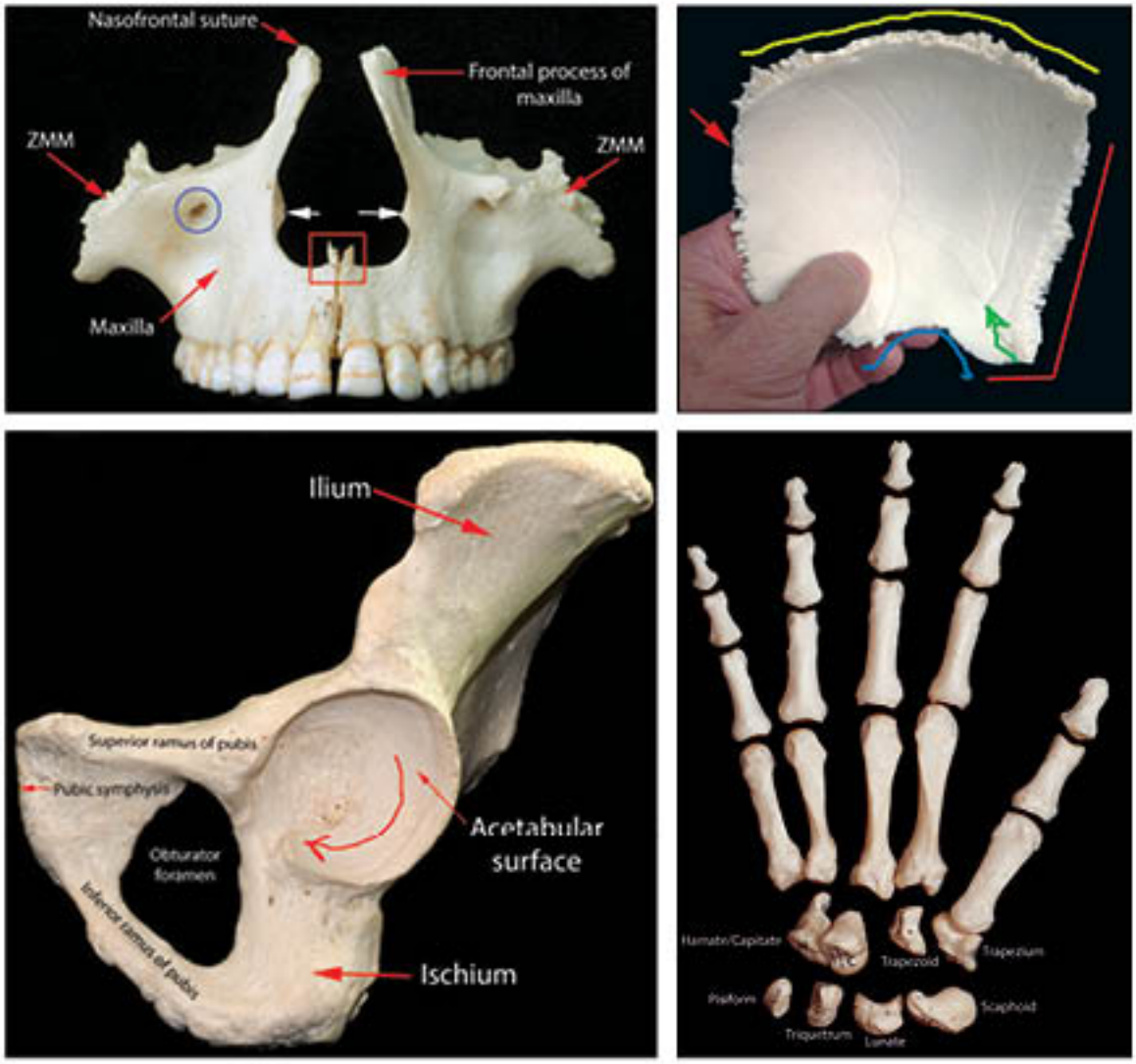
The Bone Book

A Photographic Lab Manual for Identifying and Siding Human Bones



Robert W. Mann, PH.D., D-ABFA, FCPP

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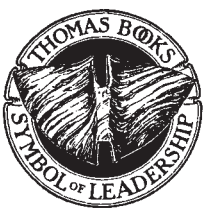
By

ROBERT W. MANN, PH.D., D-ABFA, FCPP



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FOREWORD

During half a century as a professor, I taught tens of thousands of students, including more than a thousand graduate students. I've long since forgotten most of them. But I'll always remember the brightest and best. Bob Mann is one of those.

Bob came to the University of Tennessee with a few more years of life and experience under his belt than most students possessed. By the time he enrolled in our master's degree program, Bob already had an excellent grasp of osteology. He quickly became a valuable addition to our Forensic Response Team, which helped law enforcement agencies recover, identify, and analyze human remains. Bob quickly proved himself to be good at forensic fieldwork – so good that if I couldn't go with the team on a case call, I put Bob in charge. If Bob was on the case, I knew the fieldwork would be done right.

One such case made for sensational headlines. In 1986 a burned human torso – with no arms, no legs, no head, but three bullets embedded in it – was found at a quarry outside Knoxville. A few hours later, a fisherman found a severed head in a silver trash bag floating down the Tennessee River. Other body parts, including intestines and severed genitals, began turning up all over Knoxville. The story behind the case was as lurid as the disposal of the remains: A love triangle – two men and a woman – had gone sour, and one man turned against the other, stabbing him in the temple with an ice pick, then putting a plastic bag over his head, then bashing his skull with a hammer, and finally – just to be sure – shooting him three times. The case came to trial, and the surviving man and the woman were sent to prison, thanks in part to Bob's excellent work on recovering and analyzing the victim's remains.

In the thirty years since that case, Bob has had a stellar career as a forensic anthropologist. For almost a quarter century, he worked to identify the remains of American military personnel. Among those were two Civil War sailors who drowned when the Union ironclad *USS Monitor* sank, eight Confederates who died in the *CSS Hunley* (the first submarine to sink a ship in battle), and military personnel who died in the September 11 terrorist attack on the Pentagon.

The lion's share of Bob's work, though, has involved identifying the skeletonized remains of service personnel killed in Southeast Asia during the 1960s and '70s – pilots and ground troops and commandos killed in Vietnam, Cambodia, Laos, and Thailand. Many of those cases have hinged on partial, fragmentary skeletal material from plane crashes or decades-old burials. That's extremely difficult material, often requiring excavation in rough field conditions. Such work is challenging both scientifically and physically; it

requires skill, toughness, and dedication. Bob possesses all these in abundance. (He also plays a mean guitar, but that's a topic for another time, another book, and maybe a CD . . .)

Meanwhile, this book – *The Bone Book* – is the culmination of Bob's three decades of skeletal analysis, teaching, and research on the human skeleton. Designed for use in either the lab or the field, the book covers the material from top to bottom – from cranium to metatarsals and phalanges – with the help of more than 400 vivid, full-color photographs, clearly annotated to highlight key features. Complex bones, such as the cranium, are shown in multiple photos (including several "exploded" or disarticulated skulls showing how the complex bones fit together). In addition to the photos, the book offers easy-to-follow instructions and mnemonic tips that guide the reader, step by step, through the process of identifying every individual bone and which side of the body it came from.

The Bone Book can be used as a stand-alone reference or as a companion to other sources (such as my own time-tested *Human Osteology: A Laboratory and Field Manual*). Bob's book is useful not just to anthropology students but also to anatomists, surgeons, medical examiners, and others working with the human skeleton. Although most of the photos show adult bones, the book also includes helpful photos of subadult bones and even fetal bones, which some forensic cases involve.

Bones tell stories, as every forensic anthropologist knows. Collectively, the bones in these pages tell me the story of Bob Mann and the experience and expertise he has amassed during a long and distinguished career. In *The Bone Book*, Bob is now sharing his experience and expertise with others, just as I shared mine with him many years ago.

It's an honor to be included in these pages, and this story of a former student whose career makes me very proud.

WILLIAM M. BASS, Ph.D.
Founder of the Anthropology Research Facility –
the "Body Farm" – at the University of
Tennessee

PREFACE

This book or manual is the culmination of more than 35 years of skeletal analysis, teaching forensic anthropology and conducting skeletal research at universities and museums in the U.S., Asia, Pacific, Africa, and Europe. While there are many illustrated human osteology and anatomy books available to students and professionals, there is none that approaches the topic of identifying and siding human bones quite like *The Bone Book* with its large, annotated color photographs and easy-to-follow steps, "ID and siding tricks," as some of my students have put it.

This book was written at the suggestion of my colleagues and at the urging of my students. Both encouraged me to capture and share my unique experiences in identifying, siding, and sequencing bones. I had previously relied on handouts, journal articles, textbooks, and "lab guides" when teaching classes and workshops. In 2014, I finally decided to compile a book that would provide students and professionals with an explicit, but easy-to-use photographic reference book that includes helpful tips and techniques that I'd been taught as a student at the College of William and Mary and the University of Tennessee, that I had picked up along the way, or that I came up with after examining more than 8,000 complete and partial human skeletons from around the world. Not every method or technique for identifying, siding or sequencing bones is mentioned herein, only those that I have either found most useful, or that I tend to rely on most are included in *The Bone Book*. I will, however, continue to seek out, and when possible, refine new methods and techniques for siding, sequencing and numbering bones and include them in future editions of *The Bone Book*.

Being a visual learner, I have always tried to devise and use simple and easy-to-remember methods for identifying and siding bones. I appreciate reference materials with good photographs, descriptions, and accurate illustrations. I also appreciate having a photographic resource that uses pointers, like arrows, circles, squares, and lines to indicate exactly what I'm looking at so I don't have to "Find Waldo," as one of my students once put it. Therefore, I have used large, color photographs, many with hand-drawn arrows to give the book a more relaxed and personalized feel, to show the reader exactly what I'm referring to, and to let the reader rely on the photos without lengthy and sometimes confusing descriptions. I have done my best to provide readers with a useful laboratory and reference book that I hope is comprehensive and accurately depicted. On a technical note for those interested, the photographs in this manual were taken with a Nikon D300 camera and a 60 mm Micro Nikkor lens, mounted on a tripod, and using a manual shutter release cable to minimize camera movement.

It is my desire that *The Bone Book* will find its place on the shelves of laboratories, libraries, and offices around the world, and that experts and novices alike will deem it useful, helpful, and, on occasion, perhaps even illuminating. I trust that *The Bone Book* will contribute to filling a gap in identifying and siding bones more easily and, in that sense, add to the body of anthropological, anatomical, and medical literature. It is with these intentions that I offer *The Bone Book*.

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University of Hawaii

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Special thanks to Dr. Scott Lozanoff, Chair of Anatomy, John A. Burns School of Anatomy of the University of Hawaii; Beth Lozanoff; Steven LaBrash; Lee LaBrash; Michael Andrews-Newman; and Jesse Thompson of the JABSOM Department of Anatomy for their dedication, vision, and expertise in human anatomy, research, and the Willed Body Program. Thanks also to Dr. Alan Schiller, Chair of the Department of Pathology (JABSOM), for his wisdom and guidance in this and other areas of research.

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Special thanks to my friends, colleagues, and mentors in anthropology at the College of William and Mary in Virginia, the University of Tennessee, Knoxville, and the University of Hawaii, Manoa. My sincerest thanks to Dr. William M. Bass III at the University of Tennessee for encouraging and inspiring me to pursue a career in forensic anthropology, for allowing me to be his forensic anthropology graduate assistant, and for teaching me more about the human skeleton than I thought was possible. Special thanks to my friends and colleagues Anna Dhody at the Mütter Museum and Dr. Janet Monge of the University of Pennsylvania, Philadelphia; and to Dr. Douglas Owsley, Dr. Douglas Ubelaker, and Dr. David Hunt at the Smithsonian Institution, Washington, DC for their friendship, inspiration, support, and wisdom over the years.

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Lastly, I thank my wife Vara as this book could not have been started nor finished without her unwavering love, dedication, and support.

Mistakes, omissions, or misinterpretations in this book are exclusively mine.

"Simplicity is the ultimate sophistication."

– Leonardo da Vinci

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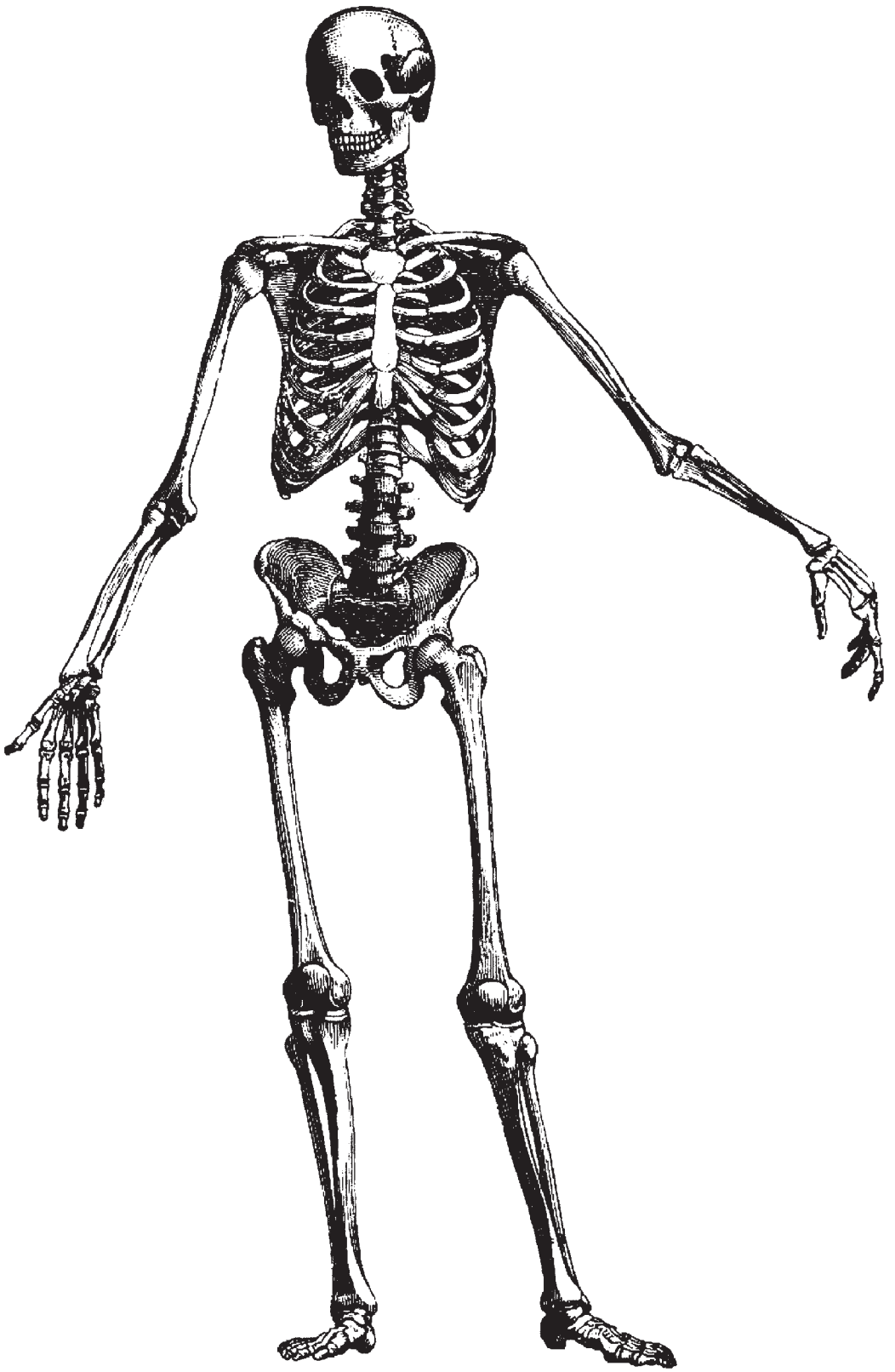

From Bernhard Siegfried Albinus' *Tabulae sceleti et musculorum corporis humani* (London, 1749).

Chapter 1

HEAD AND NECK

Skull, Hyoid, Thyroid, and Cricoid

INTRODUCTION

Bones are arranged in this manual using a regional approach starting with the skull and working down to the feet. The major bones and many features of the skull are identified, as are the other bones in the human skeleton. Most of this book utilizes adult bones, but it also includes some children and adolescent bones. Also included are an articulated Beauchene "exploded" skull of a subadult and a rare disarticulated ("pre-drilled") Beauchene skull of a late adolescent or young adult, likely prepared in the 1950s or 1960s.

The majority of the bones depicted in this book are from three sources: the Forensic Science Academy (FSA) of the Central Identification Laboratory (CIL) in Hawaii, the John A. Burns School of Medicine (JABSOM) of the University of Hawaii, and the Laboratorio Di Antropologia E Odontologia Forense (LABANOF) in Milan. Also shown are bones from other institutions, including Chiang Mai University (CMU), Thailand; National Museum of Natural History of the Smithsonian Institution, Washington, DC; Tübingen University, Tübingen, Germany; Natural History Museum of Vienna, Austria, National Museum in Prague, Národní Muzeum, Czech Republic; the Mütter Museum of the College of Physicians of Philadelphia; and the Missing Person Identification Section (MPIS), Thailand.

When compiling this book, I took care to cover the majority of complete and partial skeletal elements of males and females from fetal to old age. Examples of some bones and bone fragments are represented once, while others are represented several times to provide a more diverse representation of a bone, variation of a feature or trait, and additional information for those bones that are unusually difficult to identify, side, or sequence. Simply put, some bones deserve multiple images. Judging from my own experience and what students have told me over the years, I think it's safe to say that the hands and feet have some of the most difficult bones to identify and side. Of course identifying, siding, and sequencing fetal bones can also be very difficult. Siding the tiny ear ossicles, in comparison, is usually not attempted, although there are

practitioners who can easily accomplish this task. Identifying and siding adult hand and foot bones are given added attention because these bones comprise more than half the bones in the human skeleton, possess many complex articular facets, and often are not taught in the classroom.

One always learns from teaching. One thing that I have learned is that a consistent approach to describing and recalling a siding feature is always simpler and easier for students to remember. For example, learning that "If the hook (or crest, or whatever) curves to the right, the bone is a *right*," is simpler than "If the hook (or crest, or whatever) curves to the right, the bone is a *left*." For me, the former is easy, the latter is confusing, and consistency is the key. Consequently, I have striven for consistency in all siding tips of this nature.

Most non-metric traits and anatomical variants are not presented in this book. This is not the book's intended purpose, and there are other sources and resources covering this topic. A few of the more commonly encountered pathological lesions, such as osteoarthritis and periapical abscesses of the teeth, are described to alert the viewer that these conditions can alter the appearance of bones, thereby producing artifacts that are not part of their "normal" or typical anatomy. Also included in this book are a few examples of prosthetic devices in the event the analyst encounters one of the many thousands that are put into the human skeleton (body) each year. Not all bones, epiphyses, or developmental ages are represented in this book due to extensive size and shape differences of bones at various developmental and growth stages throughout one's lifetime. In some examples to help the reader orient or identify a bone, I have included views and perspectives not often presented in osteology textbooks or manuals.

Figure 1a-d. (a-b) Frontal and right oblique views of a known-identity, adult Caucasoid male skull (JABSOM). (c-d) Left oblique and inferior (basilar) views of the same skull.