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Regardless of the context (forensic or archaeological), the correct identification of human and non-human remains is a very serious issue in osteological analyses. While the difference between various species is often very striking, it can also be quite subtle (Figures 1-01 and 1-02). Case studies and textbooks have highlighted similarities between some species, for example the hand and foot bones (metacarpals and metatarsals) of the human hand and the bear paw, in the forensic realm (Byers 2005; Owsley and Mann 1990; Stewart 1979; Ubelaker 1989). These comparisons between the human and bear are also presented in Chapter 10 of this book. Sometimes the morphological similarities between species are quite unusual and counterintuitive. For example, there is a remarkable correspondence between the adult human clavicle and the adult alligator femur (Figure 1-03).

The goal of this book is to create a comprehensive photographic guide for use by experienced archaeologists and forensic scientists to distinguish human remains from a range of common animal species. The first part of the atlas (Chapters 2–6) focuses on specific skeletal elements including crania, humeri, radii/ulnae, femora, and tibiae. The next 17 chapters (7–23) are organized by species. Chapter 7 includes selected elements pertaining to humans (Homo sapiens), both newborn human bones and adult bones. For the following chapters, the non-human species have been photographed alongside their human counterparts to allow easy comparison. The larger mammal species are compared to an adult human skeleton, while the smaller mammal, bird, and reptile species are compared to a newborn human skeleton. We have chosen to photograph the Old World domesticates – cow (Bos taurus for cranial material and Bos indicus for postcranial material), sheep (Ovis aries), goat (Capra hircus), horse (Equus caballus), and pig (Sus scrofa) – since these animals are frequently found on historic archaeological sites in North America, and are commonly recovered from Neolithic and later sites in the eastern hemisphere. Furthermore, they are also common in modern contexts and could easily end up being submitted as a forensic case.

The atlas includes three domestic bird species; two of them, chicken (Gallus gallus) and duck (Anas platyrhynchos), were initially domesticated in the eastern hemisphere, while the third, turkey (Meleagris gallopavo), was first domesticated by Native Americans. We have also chosen to illustrate a range of North American wild mammals, including many that were frequently hunted by Native Americans in pre-Columbian and colonial times. These include black bear (Ursus americanus), white-tailed deer (Odocoileus virginianus), raccoon (Procyon lotor), and opossum (Didelphis virginiana). We have also included two species of rabbit.
The smaller is the native wild rabbit or cotton-tail (*Sylvilagus carolinensis*), while the larger is a domestic rabbit (*Oryctolagus cuniculus*) that is of European origin. Commensal species are frequently found in historic-period archaeological sites, and we have illustrated two of the most common: dog (*Canis familiaris*) and cat (*Felis catus*). We have also included a chapter of miscellaneous photographs (Chapter 23). In this chapter various views are presented of infant and adult human skeletons, and of selected comparisons between human and red fox (*Vulpes vulpes*), bobcat (*Lynx rufus*), rat (*Rattus norvigecus*), and snapping turtle (*Chelydra serpentina*). The snapping turtle is the only reptile that is included as many of

![Figure 1-01: Comparison of anterior/cranial views of left femora from a newborn human (A), chicken (B), and adult cat (C).](image)
the bones are distinctive in shape and they are commonly recovered from North American archaeological sites.

Most archaeological faunal remains are the leftovers from prehistoric and historic meals. Many animal bones show traces of butchery that reveal the ways in which the carcass was dismembered. In this atlas we have illustrated a range of different butchery marks and techniques (Chapter 24), including both prehistoric cut marks made with stone tools and historic cut marks made with cleavers and saws. We have also included examples of sawn and butchered faunal bones, along with schematic diagrams of modern, commercial butchery patterns. Since bone was a common raw material throughout antiquity and up until the early twentieth century, we have also illustrated a number of examples of worked bone artifacts. Finally, knife cuts and saw marks in bone are not unique to non-human remains. There are numerous cases each year of intentional body mutilation using knives and/or saws.

Figure 1-02: Posterior views of a newborn human left humerus (A) and femur (B) compared with caudal views of a fetal deer left humerus (C) and femur (D).
Figure 1-03: Comparison of an adult human left clavicle (A) with a crocodile’s (*Crocodylus acutus*) right femur (B) and an alligator’s (*Alligator mississippiensis*) right femur (C). Note the similar morphology of the human and non-human elements.
In cases of human dismemberment (usually implying sawing through bones) or disarticulation (usually implying separation between joints) it is quite possible that a badly decomposed or skeletonized human body portion may appear non-human to the untrained eye. A forensic example of postmortem human dismemberment is presented in Chapter 24 to show the similarity of tool mark evidence in human and non-human remains.

The ability to differentiate between human and non-human bones, both complete and fragmentary, is dependent on the training of the analyst and the available reference and/or comparative material. It is truly a skill that requires years of training and experience and is not something that can be gleaned entirely from books. There is no substitute for coursework and training in osteology with actual skeletal material in order to appreciate the range of variation within all animal species. An experienced osteologist should always be consulted for confirmation of element type and species if there is any doubt.

**Archaeological Context**

Animal bones have played critical roles in archaeological interpretation for more than 150 years of scientific endeavor. The discovery of the bones of extinct animals in association with simple chipped stone tools in sites in France and Britain helped to establish the antiquity of the human presence in Europe and to overthrow the traditional 6000-year biblical chronology for human life on earth. Faunal remains have also played a crucial role in the reconstruction of early human subsistence practices, in the study of animal domestication in both the eastern hemisphere and the Americas, and in the analysis of the ways in which historic cities were provisioned with food. Large numbers of animal bones are often recovered from archaeological sites, and these bones can be used to study past hunting practices, animal husbandry patterns, and diet. In order to use animal bones in archaeological interpretation, zooarchaeologists (archaeologists who specialize in the study of faunal remains) must be able to identify the bones, determine sex and age at death when possible, and examine the bones for evidence of butchery marks and traces of bone working.

While archaeologists expect to find human remains in cemeteries, human bones are often found in other contexts. For example, two adult human burials and the remains of several infants were unexpectedly recovered from the habitation area of the early Anglo-Saxon village site of West Stow in eastern England (West 1985: 58–59). This was the case even though the settlement site was associated with a nearby contemporary cemetery. In another example, at the late Neolithic site of Hougang near Anyang in China, burials of infants in pits or urns were associated with house construction activities (Chang 1986: 270). In short, zooarchaeologists and physical anthropologists must be able to confidently identify both animal bones and human remains in order to accurately interpret past cultures.

The first step in the analysis of animal bones recovered from archaeological sites is the careful identification of both body part and animal species. Precise identification requires a good
comparative collection of modern specimens whose species, sex, and age are well documented. However, a comparative collection must be supplemented by identification guides and atlases that can help the researcher distinguish between different species. Most zooarchaeological identification guides focus solely on non-human species (e.g., Brown and Gustafson 1979; Cornwall 1956; Gilbert 1990; Gilbert et al. 1981; Olsen 1964, 1968), even though human remains are commonly found in archaeological sites. Exceptions to this are Schmid (1972) and Hillson (1995) who illustrate human bones, but there is no comparison with subadult human bones, and France (2009) which includes photographs of both human and non-human skeletal remains.

**Forensic Context**

It is equally important for forensic scientists working with human skeletal remains to be able to differentiate between human and non-human bones. In the modern forensic context, it is quite common for non-human bones to be mistaken for human remains and end up in the medical examiner’s or coroner’s system. It is of obvious importance that they are correctly identified, or the consequences could be substantial. It is usually the role of a forensic anthropologist to make this assessment of “human versus non-human” and generate the appropriate report. In most forensic scenarios, once a determination of non-human is made it is seldom of investigative significance to correctly identify the species. There are numerous skeletal anatomy books dedicated to human osteology (e.g., Bass 2005; Brothwell 1981; Schaefer, et al. 2009; Scheuer and Black 2000; Steele and Bramblett 1988; White 2000; White and Folkens 2005). Some guides and textbooks on human osteology and forensic anthropology do include sections on differentiating between human and non-human remains (e.g., Bass 2005; Byers 2010; Ubelaker 1989) but these are more cursory discussions.

When attempting to differentiate between human and non-human skeletal remains, fragmentation only compounds the problem. If fragmentation is so extreme that gross identification of human versus non-human bone is not possible, microscopic (i.e., histological) techniques can be employed (e.g., Cattaneo, et al. 2009; Hillier and Bell 2007; Mulhern and Ubelaker 2001). Under magnification, the shape of the bone cells may be indicative of non-human bone, but this technique is not foolproof as some non-human animals (e.g., large dogs, bovines, and non-human primates) are nearly identical to humans microscopically. This atlas will only focus on the gross assessment of bones.

**Book Terminology and Organization**

In constructing this atlas, we have chosen to illustrate examples of both adult and juvenile animal bones in addition to both adult and newborn human skeletons. Other guides to the identification of birds and mammals from archaeological sites illustrate only adult bones. However, many animal bones recovered from archaeological sites and within the forensic context are the remains of juvenile animals. Farmers who keep cattle for milk, for example,
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often slaughter excess male calves during their first year of life. In a meat-oriented economy, farmers frequently choose to slaughter adolescent animals, since these animals are nearly full-grown and continuing to feed animals beyond adolescence results in only limited increases in meat output. We have included illustrations of both adult and juvenile pigs, and we have illustrated both an adult sheep and an immature and an adult goat. We have also photographed examples of immature chickens, since most chickens consumed today are quite young.

In general, the animals in this atlas are presented in the order of their size, progressing from largest to smallest. In Chapters 7–22 the corresponding human and non-human elements are presented alongside each other in order to fully appreciate the variation in size and shape between them. To add a scaled perspective, a ruler (centimeters and inches) is present in each photograph along with a US penny. For consistency, all of the images depict left elements unless otherwise noted. When a right element was better preserved than its left counterpart, the image was reversed to show it as a left element. In most instances, the human bone is photographed on the left side of the image and is separated from the non-human counterpart by the scale and penny. Letters and arrows have been added to some images to highlight specific landmarks or skeletal elements.

Bipedalism (upright walking on two legs) is one of the most important developments in all of human evolution. However, as a result of bipedalism, many human bones are oriented in somewhat different ways to comparable bones in other mammals. In addition, the directional terms used to describe parts of the body differ somewhat between humans and other mammals (Figures 1-04 and 1-05). For example, in human osteology the term anterior is used to describe the front portion of a bone, while in quadrupeds the term cranial is used. Similarly, the back portion of the femur is described as posterior in humans, but it is described as caudal in other mammals. Different terms are also used for the lower portions of non-human limbs. For example, the surface of the forelimb (distal to the radius and ulna) that faces the ground is described as palmar (or volar), while the comparable surface in the hindlimb (distal to the tibia) is described as plantar. The opposite surfaces of the bone are described as dorsal. The terms proximal, distal, medial, and lateral are used to describe surfaces in both human and non-human bones. For humans, we have used the directional terms as described in Bass (2005). For other mammals, we have used the terms as defined in Evans and de Lahunta (1980) and Getty (1975). In describing bird bones, we have followed the terminology used by Cohen and Serjeantson (1996).

We have used the following notation for referring to adult dental formulae: upper incisors/lower incisors.upper canines/lower canines.upper premolars/lower premolars.upper molars/lower molars. For example, the adult human maxillary dentition includes 2 incisors on each side, 1 canine on each side, 2 premolars on each side, and 3 molars on each side. The mandibular dentition also includes 2 incisors, 1 canine, 2 premolars, and 3 molars on each side. The human dental formula is written as follows: 2/2.1/1.2/2.3/3.
Background of the Specimens Included in this Book

Most of the non-human skeletons that are illustrated in this atlas come from the collections of the zooarchaeology laboratory in the Anthropology Department of New York University. The bear skeleton was borrowed from the Department of Mammology of the American Museum of Natural History. Some of the horse bones that are illustrated here are from a horse skeleton that was borrowed from the Museum Applied Science Center for Archaeology (MASCA) at the University of Pennsylvania Museum. The raccoon skeleton was borrowed from Susan Antón. The alligator and crocodile femora were provided by the Herpetology Department at the American Museum of Natural History and were photographed by Ilana Solomon and Tam Nguyen. The original photograph of the turkey skull was provided courtesy of the National
Wild Turkey Federation, while Gina Santucci performed the artistic modifications to the photograph. Seth Brewington provided the photograph of the antler comb from Iceland. The horse metacarpus and metatarsus were borrowed from the Zooarchaeology Laboratory in the Anthropology Department at Hunter College. The human remains are from unidentified individuals that were analyzed at the Office of Chief Medical Examiner in New York City. We are grateful to everyone who loaned us specimens and assisted in this project.

**Photographic Credits**

Many of the original photographs used in this book were taken by Gina Santucci. Additional photographs were taken by Douglas Campana and Bradley Adams. Line drawings for the title pages of chapters 2–6 were created by Douglas Campana. The artistic images and layouts for the title pages of Chapters 7–23 were created by Gina Santucci.

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**Figure 1-05:** Schematic diagram labeled with the anatomical terminology used for faunal remains. For long bones the proper term for the forward-facing side of a bone in humans is “anterior,” while in faunal remains the term “cranial” is used instead. For the back of a long bone, it is “posterior” in humans and “caudal” in faunal elements. The terms proximal, distal, medial, and lateral are used synonymously with both human and non-human elements.