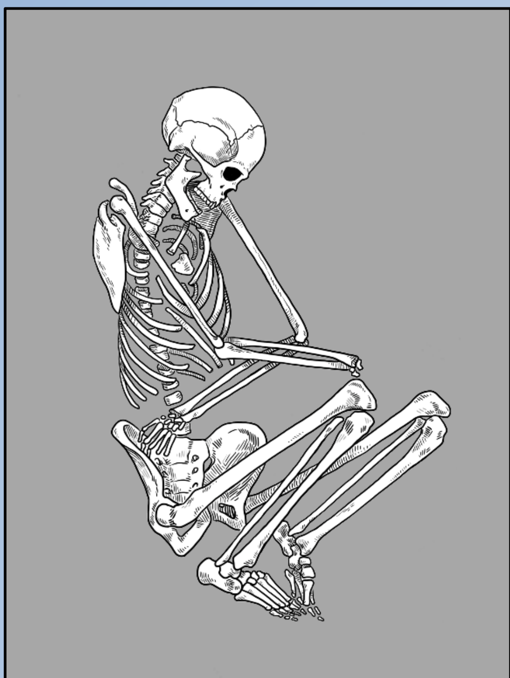
NOTE: this document contains photographs of human and animal remains that some people might find disturbing.

Distinguishing human from non-human animal bones in archaeological contexts is the first critical step in documentation. This guide provides some of the basics to help field practitioners with identification.



Distinguishing Human from Non-Human Animal Bone

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Identifying isolated or fragmentary bones can be difficult in archaeological and forensic contexts. Numerous non-osseous materials such as wood, pottery, plastics, or even stones can sometimes be mistaken for fragmented human bone. It is more common however that human remains are often confused with those of non-human animals. Identification can be further complicated by modifying factors such as burning or warping.

There are generally three levels of identification that can be utilized to distinguish between human and non-human animal bones: 1) gross skeletal anatomy, 2) bone macrostructure, and 3) bone microstructure (histology). We designed this document to briefly consider the basics for identification of human versus non-human animal bone across these three general categories. People encounter artiodactyl bone from deer, sheep, and cattle often and bring it in for identification, thinking it might be human. For this reason, we primarily focus on deer bones in this document to illustrate the differences.

I. Skeletal Anatomy

Cranial morphology differs dramatically between humans and non-human animals due to the uniquely large brains that humans have compared to body mass (Fig. 1). Humans have small faces compared to our large, bulbous cranial vault and this minimizes facial projection compared to non-human animals. Human vault musculature is less well developed than in non-human animals, which often have developed sagittal and occipital crests.

Figure 1. Adult human (left) and mule deer (right) crania. Note large, bulbous cranial vault and small face in the human compared to the small, angular cranial vault and large face in the deer.

The larger human brain results in a larger, bulbous cranial vault in humans and often more curved vault bones. In addition, the layering of cortex and diploë (often visible in fragments of vault bone) is more distinct in human bone non-human animals (Fig. 2).

The interior surface of non-human animal vault bones usually has more complex surface morphology than humans, whose interior vault surfaces are relatively smooth occasionally embedded with grooves from meningeal vessels (Fig. 3).

Figure 2. Cross-section of human cranial vault bone (above) and animal (below). Note greater curvature and more distinct layering of cortex and diploë in the human vault bone.

Figure 3. Interior surface of human (left) and deer (right) cranial vault. Note relatively smooth surface with venous groove markings on human fragment.

Non-human animal mandibles are often "V" shaped in superior/inferior view and separate at the midline as opposed to the "U" shaped singular construction of the human mandible (Fig. 4).

Human crania are oriented on a vertical axis and the orbits are in the front and above the nasal aperture. Non-human animal crania are oriented on a horizontal axis and the orbits are located behind and lateral to the nasal aperture. These orientations also cause the position of the foramen magnum to be located inferiorly in humans and posteriorly in non-human animals.

Some basic differences in human and non-human animal cranial anatomy are defined in Table 1 below, but detailed information on distinguishing many North American non-human animal species based on their cranial morphology can be found in *Mammalian Osteology* (Gilbert 1990) and *Mammal Remains from Archaeological Sites* (Olsen 1964).

Dentition varies greatly between humans and non-human animals, and even between different species of non-human animals (Fig. 5). Human teeth reflect a generalized design, including a mix of slicing (incisors), puncturing (canines), and grinding (molars) teeth. They are normally more rounded than non-human

Table 1. Differential Skeletal Anatomy of Humans and Animals: Cranium

Human	Animal
Large bulbous vault, small face	Small vault, large face
Vault relatively smooth	Pronounced muscle markings, sagittal crest Inferior
Inferior Foramen Magnum	Posterior Foramen Magnum
Chin present	Chin absent
Orbits at front, above nasal aperture	Orbits at sides, posterior to nasal aperture
Minimal nasal and midface projection	Significant nasal and midface projection
"U"-shaped mandible (no midline separation)	"V"-shaped mandible (separates at midline)

Figure 4. Deer (half) mandible (left) and human mandible (right).

animal teeth. Most non-human animal teeth reflect specialized dietary adaptations. Grazing animals have more grinding teeth with specialized ridges and carnivores have more shearing teeth with sharp ridges (see deer teeth in Fig. 5).

Many non-human animals have different dental formulas compared to humans. Dental formulas are annotated with the number of each tooth type for a quadrant of the mouth. Adult humans generally have a compliment of 32 teeth, eight in each quadrant; this includes two incisors, one canine, two premolars, and three molars (2:1:2:3).

Although highly variable, many placental mammals exhibit a generalized dental formula that includes three incisors, one canine, four premolars, and three molars (3:1:4:3). Some basic differences in human and non-human animal dentitions are defined in Table 2 below, but detailed information on distinguishing species based on their dentition can be found in *Teeth* (Hillson 1990).

Much of the difference in long bone anatomy between non-human animals and humans is the result of pattern of locomotion. As quadrupeds (expect for birds), non-human animals have dual axes of orientation and their functional anatomy reflects structures of locomotion in all four limbs, lacks spinal curvature, has a long and narrow pelvis (Fig. 6), and is additionally reflected in the posterior position of the foramen magnum and bony development of posterior of the cranium due to musculature. The scapulae are oriented more toward the spine (axial), compared to humans which are wider and oriented inferiorly (Fig. 7). In addition, the ribs in humans generally display a more curved

Figure 5. Human (left) and deer (right) teeth. Note the distinctive form but more uniform nature of the deer teeth.

profile due to this difference in vertical versus horizontal orientation among quadrupedal animals (Fig. 8).

Table 2. Differential Skeletal Anatomy of Humans and Animals: Dentition

Human	Animal
Omnivorous	Carnivorous; Herbivorous; Omnivorous
Dental formula 2:1:2:3	Basic dental formula 3:1:4:3
Incisors (maxillary) are larger than other mammals	Horse maxillary incisors are larger than human incisors
Canines small	Carnivores have large conical canines; Herbivores have small or missing canines
Premolars and molars have low, rounded cusps divided by distinct grooves	Carnivores have sharp, pointed cheek teeth; Herbivores have broad, flat cheek teeth with parallel furrows and ridges

Non-human animal forelimbs are generally more robust (Fig. 9), and the radius and ulna may be fused to give more strength and flexibility in weight bearing (Fig. 10). The tibia and fibula are also often fused, sometimes with diminished or completely lacking a fibula. Humans on the other hand, as bipeds, have a singular, central vertical axis of orientation that distributes all the individual's weight through a series of bony mechanisms designed to soften the impact of bipedal locomotion. As a result, human crania are centrally placed on the vertical axis, the spinal column has four slight opposing curves, the pelvis is broad and short, the femora are angled, the tibiae have thicker proximal surfaces for greater weight bearing, the feet have dual arch structures, and the upper limbs have less pronounced musculature and a greater range of motion.

Figure 6. Deer (left) and human (right) pelvic bone. Note the long, narrow orientation of the deer compared to the broad, short orientation of the human pelvis.

Figure 7. Deer (left) and human (right) scapulae. Note long, narrow orientation of the deer compared to the broad, inferior orientation of the human scapula.

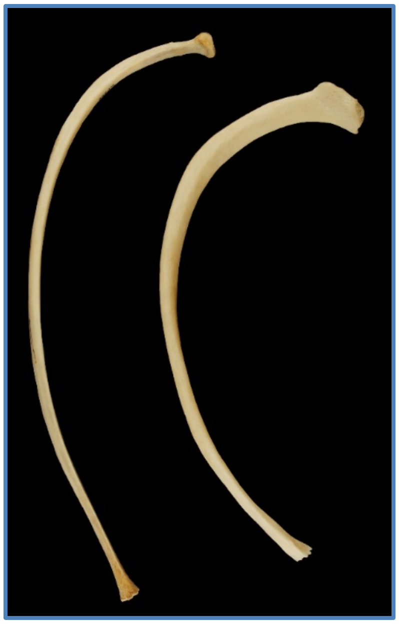

Figure 8. Deer (left) and human (right) rib. Note greater curvature to human rib.

Although birds are also bipedal, bird bones are very different in shape from human bones, but they are additionally very light in weight. Bird long bones have very thin walls and only minimal trabecular structure in the ends. Figure 11 displays a bird humerus compared to an infant human humerus. Both are lightweight and of similar size, but the human bone is still developing and missing the epiphyses. The ends of the bones are therefore rough and distinctive from the fully developed bird humerus. More on avian osteology can be found in *Avian Osteology* (Gilbert et al. 1996).

The most common human bones to be mistaken for non-human animal bones are those of infants (see Fig. 11). They are sufficiently different from adult and even the bones of older children that they can cause considerable confusion (Fig. 12).

With unformed or unfused epiphyses, singular bones are separated by ossification segments and have indistinct, rough edges. Multiple ossification centers and epiphyses increase the number of bones associated with an infant and many are not identifiable to a specific bone. Young juvenile long bone diaphyses are thin and lack the trabeculae of adults.

Juvenile cranial vault bones easily disarticulate after decomposition and lack the diploë structure common to adult cranial vault bones. Juvenile vault bones also have a similar thickness as, and are very often confused with, turtle or tortoise carapace or plastron bones (Fig. 13).

The petrous portion (Fig. 14) is separate in infants and, being a particularly dense bone,

Figure 9. Human (left) and deer (right) humerus. Note the deer humerus is shorter, broader, and more robust than the human humerus.

Figure 10. Human (left) and deer (right) radius and ulna. Note the reduced distal ulna and expanded radius.

often survives burial better than others. Ribs of young infants look very much like those of a small non-human animal. It can also be very difficult to tell the difference between a very young non-human animal and a human infant. Overall, care must be taken when the material appears that it could possibly be infant bone.

Some basic differences in non-human animal and human post-cranial skeletal anatomy are defined in Table 3 below, but detailed information on distinguishing many North American non-human animal species based on their post-cranial morphology can similarly be found in *Mammalian Osteology* (Gilbert 1990) and *Mammal Remains from Archaeological Sites* (Olsen 1964).

Figure 11. Human infant (left) and turkey (right) humerus.

Table 3. Differential Skeletal Anatomy of Humans and Animals: Post-cranium

Human	Animal
Upper limbs less robust	Robust upper limbs
Radius and ulna are separate bones	Radius and ulna often fused
Large, flat and broad vertebral bodies with short spinous processes	Small vertebrtal bodies with convex/ concave surfaces and long spinous processes
Sacrum with 5 fused vertebrae, short and broad	Sacrum with 3 or 4 fused vertebrae, long and narrow
Pelvis is broad and short, bowl-shaped	Pelvis is long and narrow, blade-shaped
Femur is longest bone in body, linea aspera is singular feature	Femur is similar length to other limb bones, linea aspera double or plateau
Separate tibia and fibula	Tibia and fibula are often fused
Foot is long and narrow, weight borne on heel and toes	Foot is broad, foot elements are dense, and may have claws or hooves

II. Bone Macrostructure

Figure 12. The development of the human femur. from left to right: fetal, infant, child, adolescent, and adult.

Most human bones differ structurally from non-human animals because of evolutionary shifts to increased gracility, which began with our earliest *Homo* ancestors more than a million years ago. It is largely hypothesized that body size increased at the origin of our genus but became lighter to balance the energy demands of larger brains and bodies. The major difference between human and non-human animal bone structure therefore principally relates to density. Non-human animal bones have a greater density relative to size; they are less porous and are thicker in cross section than the bones of humans. For example, in humans humeral and femoral cortical thickness is about a quarter of the total diameter compared to about half of the total diameter in animal limb bones.

Trabecular bone is largely absent from the interior of non-human animal leg bone diaphyses, resulting in a very smooth medullary surface compared to the web of trabecula covering the medullary surface in human long bones (Fig. 15). Human cranial vault bones have thick diploe relative to cortical (tabular) bone compared to the thin, more compact vault bones of non-human animals. Some basic differences in non-human animal and human bone macrostructure are defined in Table 4.

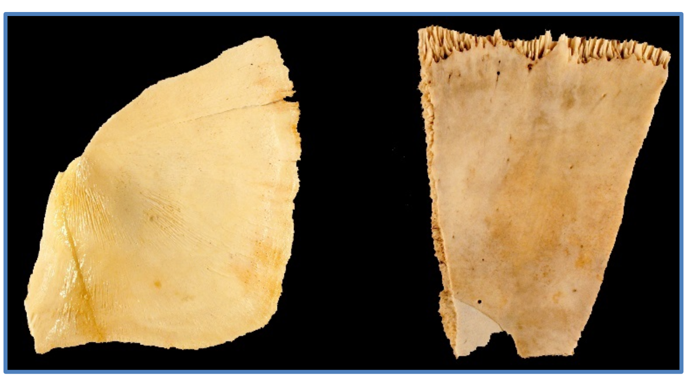

Figure 13. Infant human cranial vault bone (left) and tortoise carapace bone (right). Note the straight edges of the tortoise bone compared to the irregular edges of the fragment of cranial vault bone.

Table 4. Differential Bone Macrostructure of Humans and Animals

Human	Animal
More porous cortical bone	Less porous cortical bone
1/4 thickness of diameter of long bone	1/2 thickness of diameter of long bone
Diaphyseal trabecula present	Diaphyseal trabecula absent
Thick diploe in cranial vault bones	More compact cranial vault bones

Figure 14. Human infant petrous portion of the temporal bone.

III. Bone Microstructure

The microscopic structure of cortical bone is often diagnostic between humans and non-human animals, although not always practical in a field setting (Fig. 16). Osteons in human trabecular and cortical bone are scattered and evenly spaced whereas in many non-human animal's osteons tend to align in rows (osteon banding) or form rectanguloid structures (plexiform bone). Although osteon banding or plexiform bone indicate non-human animal bone, Ubelaker (1999) cautions that considerable variety exists between species and between bones of the same non-human animal which therefore makes the identification of scattered osteon distribution inconclusive.

Figure 15. Broken diaphyses of human (left two) and animal (right two) long bones. Note the trabecular bone lining the medullary cavity of the human bones, which is absent from the interior of the animal bones.

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Figure 16. Distal portions of human (top) and animal (bottom) long bones exposing trabecular structure and osteon organization.

Note: Images on front cover from J. Watson (human burial and dog burial from La Playa site, Sonora, Mexico). Images in text from J. McClelland from ASM Osteological Teaching Collection (anatomical specimens).

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