Arizona State Museum
THE UNIVERSITY OF ARIZONA

DISTINGUISHING HUMAN FROM ANIMAL BONE

James Watson and John McClelland

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. Human remains can often become mixed with those of animals. In addition, 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 animal bones; gross skeletal anatomy, bone macrostructure, and bone microstructure (histology).

Skeletal Anatomy

Cranial Morphology differs dramatically between humans and animals due to the uniquely large brains that humans have compared to body mass. Humans have small faces compared to our large, bulbous cranial vault and this minimizes facial projection compared to animals. Human vault musculature is less well developed than in animals, who often have developed saggital and occipital crests. Since animals (even large ones) have much smaller brains, their cranial bones are generally more curved and individually smaller. The interior surface of animal vault bones usually have more complex surface morphology than humans, whose interior vault surfaces are relatively smooth occasionally embedded with grooves from meningeal vessels. 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. Human crania are oriented on a vertical axis and the orbits are located in the front and above the nasal aperture. 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 animals. Some basic differences in human and animal cranial anatomy are defined in Table 1 below, but detailed information on distinguishing many North American animal species based on their cranial morphology can be found in "*Mammal Osteology*" by Gilbert (1990) and "*Mammal Remains from Archaeological Sites*" by Olsen (1964).

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 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)

Dentition varies greatly between humans and animals, and even between different species of animals. Human teeth reflect a generalized design, including a mix of slicing (incisors), puncturing (canines), and grinding (molars) teeth. They are normally more rounded than animal teeth. Most animal teeth reflect specialized dietary adaptations. Grazing animals have more grinding teeth with specialized ridges and carnivores have more shearing teeth with sharp ridges. In addition, many 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 variably, 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 animal dentitions are defined in Table 2 below, but detailed information on distinguishing species based on their dentition can be found in "*Teeth*" by Hillson (1986).

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	Carnivors 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

Much of the difference in long bone anatomy between animals and humans is the result of pattern of locomotion. As quadrupeds (expect for birds), 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, and is additionally reflected in the posterior position of the foramen magnum and bony development of posterior of the cranium due to musculature. Animal forelimbs are generally more robust and the radius and ulna may be fused to give more strength and flexibility in weight bearing. 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 of 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 tibae 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. 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. Some basic differences in animal and human post-cranial skeletal anatomy are defined in Table 3 below, but detailed information on distinguishing many North American animal species based on their cranial morphology can be found in "*Mammal Osteology*" by Gilbert (1990) and "*Mammal Remains from Archaeological Sites*" by Olsen (1964).

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

Human	Animal
Upper limbs less robust	Robust upper limbs
Radius and unla 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, weight borne mainly on toes

The most common human bones to be mistaken for animal bones are the bones of infants. They are sufficiently different from adult and even older children bones that they can cause considerable confusion. With unformed or unfused epiphyses, singular bones are separated by ossification segments and have indistinct edges. Multiple ossification centers and epiphyses increase the number of bones associated with an infant and many are not identifiable to a specific bone. Long bone diaphyses are thin and lack the trabecula of adults. Cranial bones easily disarticulate and lack the diploe structure and vault bones are the same thickness and very often confused with turtle or tortoise carapace. The petrous portion is separate in infants and, being a particularly dense bone, it often survives burial better than others. Ribs of young infants look very much like those of a small animal. It can also be very difficult to tell the difference between a very young animal and a human infant. Overall, care must be taken when the material appears that it could possibly be infant bone.

Bone Macrostructure

Animal bones have a greater density relative to size; they are less porous and are thicker in cross section than the bones of humans. In humans, humeral and femoral cortical thickness is about ¼ of the total diameter compared to about ½ of the total diameter in animal proximal limb bones. Trabecula is largely absent from the interior of animal leg bone diaphyses, resulting in a very smooth medulary surface compared to the web of trabecula covering the medulary surface in human long bones. Human cranial vault bones have thick diploe relative to cortical (tabular) bone compared to the thin, more compact vault bones of animals. Some basic differences in animal and human bone macrostructure are defined in Table 4.

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

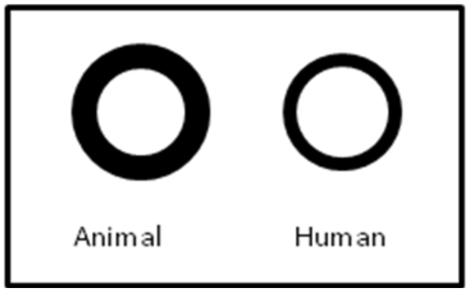

Fig. 1. Relative thickness of animal and human diaphyseal cortical bone.

Bone Microstructure (Histology)

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