

Zooarchaeology

Zooarchaeology is the study of animal remains from archaeological sites. This differs from paleontology, which is simply the study of animal remains not from sites associated with humans. Zooarchaeologists identify and analyze the animal remains from an archaeological site to answer questions such as:

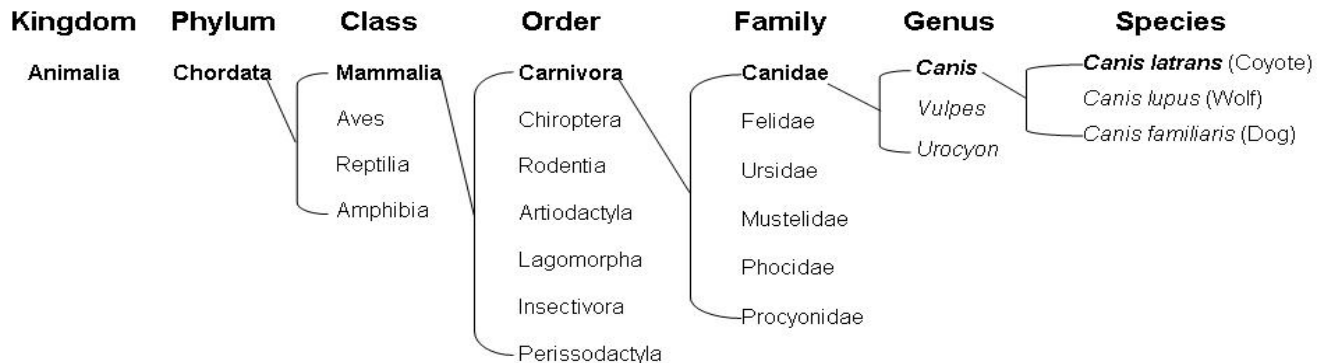
- What kinds of animals were people eating?
- How did they acquire the animals?
- How was faunal procurement integrated with their patterns of settlement and mobility?
- What kinds of animals were domesticated by humans?
- What was the environment like when the site was occupied?
- What season of the year was the site occupied?

In the next two labs, we will discuss how archaeologists answer these questions.

Bone Identification and Taxonomic Classification

The bone that zooarchaeologists identify from archaeological sites is often broken rather than whole. So identifying these fragments can be challenging. What do zooarchaeologists look at to identify a bone?

- Bone size (large, medium, small, tiny)
- Bone identified as a specific skeletal element (radius, ulna, femur)
- Features on the bone that are unique to a taxon, especially teeth but other body parts as well



Taxonomic classification of the coyote.

Zooarchaeologists try to identify each fragment to as specific a taxonomic unit as possible. These taxonomic units are the same ones used in biology. If you remember from your basic biology class, biologists use a hierarchical classification called the **Linnean System**, originally outlined by Carolus Linneus (Carl von Linne) in the 1700s. There are seven major levels of distinction: Kingdom, Phylum, Class, Order, Family, Genus, and Species.

Organisms are frequently referred to by their species names and the rest of the classification is implied because of the hierarchical nature of the system. For example, the species name for the coyote is *Canis latrans*. It belongs to the Kingdom Animalia, Phylum Chordata (animals with backbones), Class Mammalia (warm-blooded, live births), Order Carnivora (meat eaters), Family Canidae (dog-like) and Genus *Canis* (coyotes, wolves, dogs). Species names are actually two-part names, or binomials. The species name is composed of the genus (general designation) and then the species (specific designation). Because the terms are Latin, both genus and species names are underlined or italicized. When a species name is written, the generic part is capitalized, and the specific part is not (e.g., *Vulpes vulpes*, *Homo sapiens*).

The organisms within each level are assumed to be similar or related to one another. So all species in the family of cats (Felidae) are thought to be related evolutionarily, as are all the animals in the Class Mammalia.

When we talk about this classification system in general, an individual category is called taxon. So a **taxon** (**taxa** = plural) is non-specific and can be a genus, a family, a species, etc. When we are talking about taxa, we could mean a combination of several species, genera (plural of genus), or families. It is not specific to one level in the hierarchy, but can encompass any of them.

When zooarchaeologists are identifying bones and bone fragments, they try to identify them down to the species level, because this provides the most useful information for the evolutionary status and environmental implications of the specimen. However, because the bones may be highly fragmented or from a non-diagnostic element, they may only be able to identify the piece to genus, family, or class. For example, we might have a bone that is definitely from an animal in the Family Canidae (e.g., dogs, wolves, foxes). In North America, the major distinction within this family is between foxes and the other canids (i.e., coyotes, wolves, domestic dogs). Based on the features of the bone we can rule out foxes, but we cannot tell which of the other canids it might be. So the lowest level of identification we can get is to genus since dogs, wolves, and coyotes are all in the same genus (*Canis*). If we were not able to tell if the bone was from a fox or a coyote, then the lowest level we could identify the bone to would be the family level – Canidae.

In addition to identifying the bone to a taxon, zooarchaeologists also record other information recorded such as the skeletal element, part of element if it is fragmented, whether it is a right or left, how old the animal was when it died, and factors that have affected the material such as burning, weathering, etc.

Skeletal Elements

An important part of zooarchaeology is the ability to distinguish between various skeletal

elements. The actual number of bones in each animal will vary, but in the human body, there are 206 **skeletal elements**. Skeletal elements are sorted into anatomical categories.

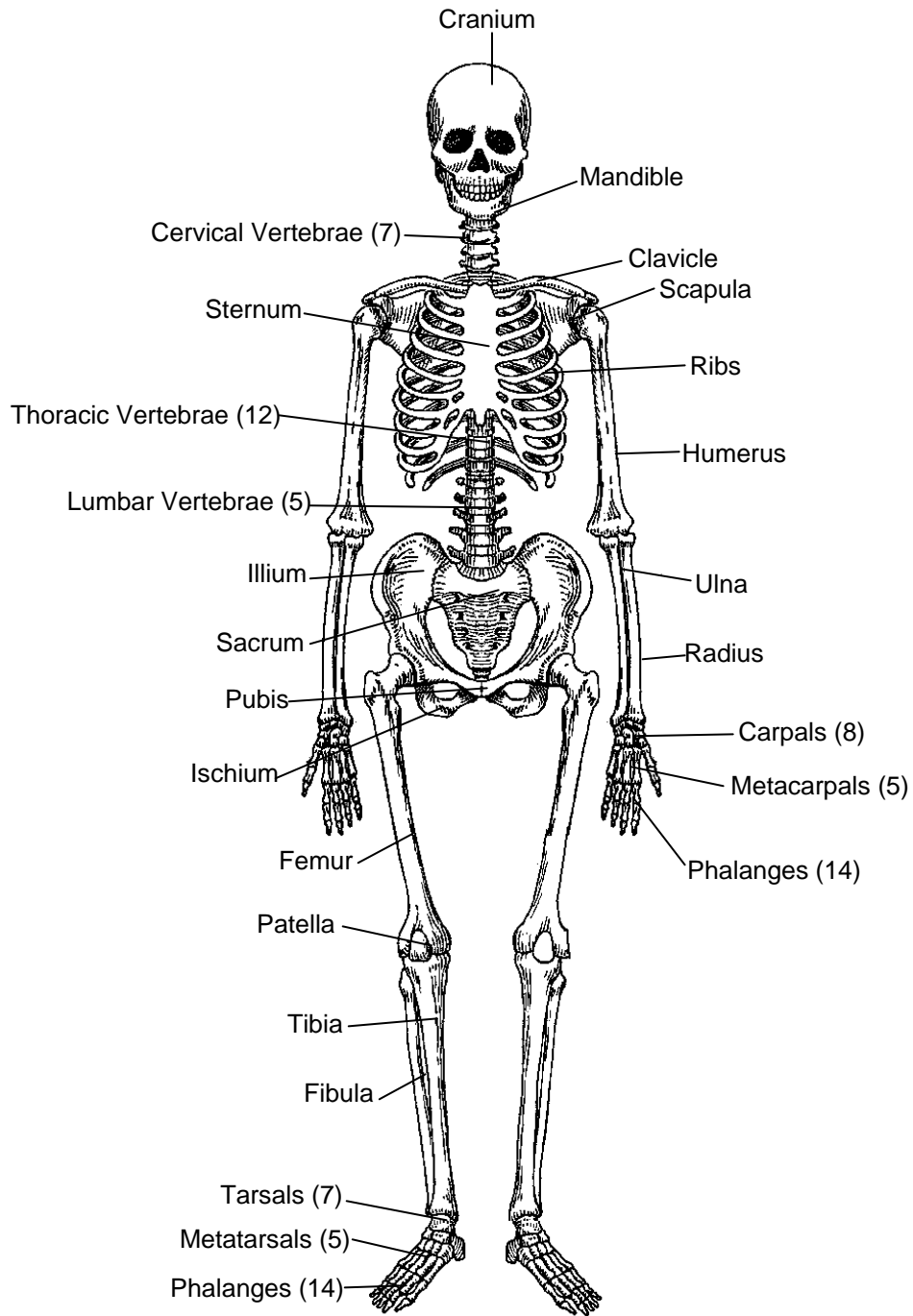
Appendicular skeletal elements are those found in the appendages or limbs. So the arm and leg bones are appendicular elements. Most of these are paired meaning that there is a right and a left of each. Limbs of animals are often the most important in terms of the meat (muscle) attached to them (think of shoulders and hams at the grocery). But the lower limbs of many animals such as deer and bison have very little meat. Those of you that have pet dogs or cats can readily tell where most of the meat is on their bodies. Limbs contain not only meat, but also marrow, especially in the proximal limb bones (those closest to the spine – the humerus and femur). People broke these and other bones to extract the extremely fatty and nutritious marrow.

Axial skeletal elements are those that are found in the midline of the body. These include the head, ribs, vertebrae and sternum. While considerable meat and marrow are associated with these bones, they are less easy to transport, and are sometimes left at the kill/butchery site.

It is quite common to speak of skeletal elements using another dichotomy: **cranial** and **post-cranial**. The skull and jaw, with their attached teeth and possibly horns or antlers, are among the most reliable for specific identification of faunal remains, and are the favorite fossils parts for serious paleontologists and archaeologist for that purpose. Teeth maintain special status for paleontologists because they are very prone to change quickly during evolution, providing a good measure of evolutionary change. They also are important for reconstructing diet, as they vary tremendously among different groups of *herbivores*, *carnivores* and *omnivores* as we shall see later.

The cranial bones also register changes associated with domestication, including loss of horns by female sheep, and twisting of horns among some domesticated goats. In human paleontology the skull is the most important for assigning specimens to a human species or variety, while the post-cranial bones provide important data on stature (height) and locomotion. The human pelvis provides the most reliable indicator of gender, because a women's pelvis is designed for birthing.

Because you are probably more familiar with the human body than that of non-human animals, we will use the human skeleton to illustrate some of the important skeletal elements that you will encounter in zooarchaeology. ALL of them are important, but we need to introduce you now to only some key ones.



The human skeleton.

Axial Skeleton

Cranium	head, including maxillary (cheek) teeth
Mandible	jaw, including mandibular teeth
Vertebrae	spinal column

Appendicular Skeleton

Upper Body

Scapula	shoulder blade
Humerus	upper arm
Ulna	lower arm, on the pinky side
Radius	lower arm, on the thumb side

Lower Body

Pelvis	several bones forming the pelvic girdle
Femur	upper leg
Tibia	shin bone

Bone Biology

Bone in a live animal is a living organ or tissue. It is composed of blood vessels, nerves, bone, and marrow. These elements combine to form a living unit that not only provides structure for the body, but also generates new blood from the marrow cavities. **Compact or cortical bone** is very dense and is the portion of the bone that preserves best in archaeological sites. **Spongy or cancellous bone** in mammals, does not preserve as well as compact bone because it is much less dense.

In mammals, growing bones consist of several parts. The **diaphysis** is the shaft of the bone. The articular ends of the bones are called **epiphyses**. Bones grow at the **metaphysis**, the junction between the epiphyses and the diaphysis. The diaphysis and epiphyses remain separate until the bone stops growing, at which time the epiphyses fuse to the shaft and the metaphysis disappears. The age at which different elements fuse will vary, but in general, all bones are fused by the time an individual reaches adulthood. Because each element fuses at different times, zooarchaeologists can tell how old an individual is by which elements are fused or unfused.

Skeletal Structures

The skeletons of animals will usually differ in shape and structure because of two factors: **locomotor patterns** (how do the animals move about) and **food processing patterns** (what and how do they eat). There are several different types of locomotion and each type requires a different skeletal structure, particularly in the limbs. For example, animals have developed different ways to swim independent of one another. Most swimmers like penguins, seals,

dolphins, and fish, have fins, wings, tails, that help them swim through the water. These animals tend to have fins, wings, or tails are usually flat and broad so that they act like paddles to propel the animal through the water.

Differences in food processing techniques can be seen in the structure of the teeth and jaw. For example, in mammals, teeth indicate much about the diet. **Herbivores** (plant eaters, such as rodents, horses, deer, cattle) usually have flat teeth with large grinding surfaces, whereas **carnivores** usually have teeth associated with killing and eating meat. Their large canines are used to capture and kill prey, while their premolars and molars have sharp cusps used for shearing and cutting meat into smaller units that can be swallowed. **Omnivores**, such as humans, raccoons, bears, eat a variety of items so they tend to have generalized teeth that are well suited for starting the processing of both plant and animal food.

In the next sections, differences and similarities in skeletal structure of the classes of vertebrates are presented.

Mammals

Mammals show a tremendous range of variation in their dietary habits and locomotor patterns, therefore the teeth and limbs of mammals show a greater amount of variation between the orders of mammals than the rest of the body. Mammals may live in virtually all habitats around the world and have aquatic, fossorial (burrowing), arboreal (tree-dwelling), terrestrial (ground dwelling), and even avian (bird-like) locomotor systems. Your lab instructor will provide you with specimens that illustrate the range of variation that can be seen in the key skeletal elements of various mammals.

Mammal bones in archaeological sites are usually recognizable because they tend to be larger, thicker bones, although many mammals are quite small. Long bones are usually fairly robust, due to locomotion, and contain marrow cavities. Bones are usually well-ossified (highly mineralized) in adults. Flat bones (those of the skulls, pelvis, and scapulae) are present, but usually do not preserve as well as long bone portions. Teeth will often preserve well and are usually very diagnostic to species.

Note that mammals are unique in that they have both adult teeth, and deciduous or baby teeth, in most cases. Within these two classes, there are four types of teeth, each of which has a different function. The type of teeth an animal has will depend on what it eats and not all mammals have all four types. For example, most herbivores do not have canines. Instead, they have well-developed premolars and molars for chewing plant material. The four types of teeth and their functions are listed below.

Mammal Dentition

Differentiated teeth are a hallmark of the mammals that they inherited from the group of reptiles they evolved from. Different groups of mammals have teeth that are specialized for actions including biting, tearing, chewing, grasping and grinding. Here are the four

categories of mammal teeth.

Incisors -Normally a maximum of three; small, single rooted teeth positioned toward the front of the mouth. Incisors serve for nipping or biting off portions of food so that they are small enough to chew.

Canines-Normally one large single rooted tooth positioned immediately distal to the incisors. These teeth serve for display to other animals, and for the grasping of prey. Most herbivores, notably the rabbits and rodents, do not have these teeth, and the artiodactyls including deer and bison lack them in their maxillary (cheek) teeth (see table below). Instead they often have a gap between the incisors and premolars that is called a diastema.

Premolars-These are single, double or three-rooted teeth. There is normally a maximum of four premolars. They are located behind the canine, along the cheek. The crowns or top of the teeth may be similar to either the incisors or the molars, or they may be distinctive with one to two cusps. Structurally the premolars are the most variable teeth in the dental arcade. These teeth serve for helping to chew the food in herbivores and omnivores, and help in shearing of meat in carnivores.

Molars-These are the distal most teeth in the dental arcade. Usually, there is a maximum of three molars. The roots may be two to four in number and the crown, usually complex containing several distinct cusps. These teeth serve for helping to chew the food in herbivores and omnivores, and help in shearing of meat in carnivores. They are often the most important teeth for processing food. Unlike the other teeth, molars have no deciduous precursors. The timing of tooth eruption can be used to determine the age of an animal. The amount of wear on the teeth can also tell us about how old the animal is.

Determining the age of animals in a faunal assemblage from an archaeological site is very important. This can tell us whether hunters focus on vulnerable groups, either the old or young, or perhaps what we call prime adults- the largest and most healthy animals. In a context of domestication of sheep, goat, cattle, etc., it can often be shown that young males were preferentially slaughtered, preserving the females for dairy products and selecting only the most robust males for breeding. In your lab you will have the chance to assign ages to animals based on skeletal data.

Birds (Class Aves)

The general plan of the avian and mammalian skeleton is similar enough so that most homologous bones can be recognized. Most of the differences in structure have to do with flight. In order to fly, the body weight of birds had to be greatly reduced. A reduction in the weight of many bones and the loss of teeth has allowed for the lighter bodies for flight. Bird bones are light, usually hollow, long bones with marrow cavities, and are very fragile. Often, V-shaped bony struts are visible on the insides of broken long bones.

The biggest difference between birds and mammals is seen in the bones of the wing (forelimb)

and in the metatarsal area of the hind limb or leg. The length of the bones of the wing varies greatly, depending on the type of flight utilized by each species of birds. The humerus is comparable in form to those seen in mammals; however the proximal end of the ulna is quite different and the radius is small and straight to fit the thicker, curved ulna. Birds usually have three digits at the end of their wings

Flying also requires large flight muscles and the keel on the carina (the sternum or breastplate in mammals) is a special adaptation to provide a place for the attachment of these wing-moving muscles.

Amphibians and Reptiles

In general, the amphibian skeleton is composed of poorly ossified bone, thus their bones do not preserve very well in archeological sites. Reptiles have a broader range in size and their bones are better ossified than amphibians, so their bones are more commonly found in sites.

A common reptile found in Texas are turtles (Order Chelonia). Their shells, in particular, preserve very well. The upper portion of the shell is called the carapace and the flatter, ventral portion is the plastron. The bony shell is made of dermal bone that is overlain by keratinized plates or scutes. Keratin is the same material that is in our hair and fingernails. Turtle carapace and plastron fragments are easily recognized in faunas from archaeological sites, but only some of them can be assigned to particular species. Because turtles are so easy to procure, and so nutritious, they are especially common in New World archaeological sites. The Lowland Maya essentially farmed turtles in their system of raised fields that were separated by constructed canals.

Fish

In this section, you will briefly examine a generalized fish skeleton. Fish are very different structurally from the other taxa we have discussed. The most useful elements for distinguishing between different varieties of fish include the otoliths (ear bones), scales, and vertebrae of fish. These three elements have proven most useful in both identification and in providing information about the size and the life of the fish. Fish remains, however, are some of the poorest represented in the archaeological record because many fish elements do not preserve well. Scales are rare and other bony elements are not as dense as mammalian bone. Hence, they do not preserve as well.

Seasonality

Seasonality refers to the time of the year when an animal was taken. Some animals are present in an area for only a short period of time during the year. Thus, if this animal is found in an archaeological site, we can say that the site was occupied during that period of time.

For example, for most of its life salmon live in the ocean and are infrequently caught at sea. During the summer months, the salmon return to inland rivers to spawn and die. It is during the salmon runs that they become commonplace. Using this information, we can say that coastal

sites in Siberia or the Pacific Northwest that have large amounts of salmon (fish) remains would have been occupied at least during the summer months. Other types of useful taxa include a variety of other migratory species, such as birds, whales, sea lions, seals, caribou, and even bison. By knowing their migration schedules, we can determine when they were killed, and thus when the site was utilized.

Another way in which seasonality can be estimated is by the growth of an animal. The age of an individual can be estimated by looking at the growth of the bones, eruption and deciduous loss of teeth, wear of the teeth, and other factors of age, such as arthritis, that can be indicative of age. You will see how we can establish the age of deer using these observations.

Deer are born between February and May in North America. Remains of deer less than two years old can often be aged to within one or two months based on long bone and epiphysis fusion and tooth eruption. By knowing when deer are usually born, and by determining at what age they died, an approximation can be made as to what month or season they died. Additional information can come from the deer's antlers. Since deer shed their antlers every year in the spring, and do not start to grow antlers again until the fall, a deer skull found with its antlers would have died between fall and winter. Also, based on the development of antlers, we can estimate the season as well, so long as the animal died while the antlers were still growing.

More complicated, but often more accurate ways of estimating the season of death of an animal is by incremental structures. These incremental structures are present in those hard tissues that continue to grow. For example, fish scales, vertebrae, and otoliths (ear bones) produce growth rings (like tree rings) with each year of growth. By measuring the distances between the next to last ring and comparing it with the width of the last ring, an estimation of season can be made. This is facilitated greatly by the fact that the rings grow most during warmer months and little if any during winter months. Such incremental studies have been performed on fish, animal teeth, molluscs, birds, and even some reptiles.

Environmental Reconstruction

In addition to seasonality, the kinds of animals are present at a site can be used for environmental reconstruction. By identifying the taxa present in the site, then determining where they live and when, the environment around the site can be hypothesized. For example, Dorothy Bate, working for Dorothy Garrod at Tabun Cave and EI Wad sites in the Carmel Mountains, traced shifts in the environment through time by comparing gazelle (*Gazella* spp.) and deer (*Dama* spp.) frequencies. An increase in deer indicated moister conditions and an increase in foliage and tree cover. Increases in gazelle frequencies indicated drier conditions, decrease of trees, and expansion of grasslands.

In our region, ratios of bison to deer can be used carefully (and with other supporting data like pollen records) to see changes in forested versus prairie environments. The ratio of jackrabbits (mainly prairie dwellers) to cottontail rabbits (mainly forest dwellers) can be used in similar fashion.



In cases of both seasonality and environmental reconstruction, it is best to use as many indicators as possible to get the most accurate picture as possible. By limiting yourself to only one or two taxa, the picture you find may be quite narrow. Also, some of the most diagnostic taxa are the smaller species that do not have quite specific habitat requirements and are not prone to long migrations. For this reason, extensive work in the analysis and identification of rodents has become important not only in paleontology, but also in archaeology.

Let's look at three species of rodents from our region as an illustration of their potential for environmental reconstruction. You will find these in your examination of owl pellets and also consider them in analysis of microfauna from Delaware Canyon, Oklahoma.

Three Southern Plains Rodents

The following three species of rodents are common in archaeological faunas from Southern Plains sites, including those in Texas and Oklahoma. They provide evidence for both habitats near archaeological sites as well as longer-term changes in distribution related to environmental change. Some other rodents, such as the Southern Bog Lemming lived here at the end of the Pleistocene, but were extirpated from our region when warmer Holocene climates forced them to retreat to more northern regions where they live today.

Pine Vole (*Microtus pinetorum*)

The name for this vole is constructed from the Greek word *micros* (small) and *ous* (ear), followed by *pinetum* (pine woods) and *orium* (associated with a place). This species is most common in woodlands, and is therefore most common in northeastern Texas and eastern Oklahoma (and farther east of course), where it feeds on roots, tubers, bark as well as seeds, nuts and the occasional insect. It is a good indicator of forested environments, and therefore contrasts with its relative the Prairie Vole (*Microtus ochrogaster*). These can be difficult to separate taxonomically unless the teeth are well represented. Both have the very distinctive microtine dentition, in which the molars and premolars with their "Christmas tree" like pattern appear to be one continuous tooth in the jaw and cheek teeth. These voles burrow and construct their nests just below the ground surface like moles, but also create runways on the surface.



The Prairie Vole. Notice the distinctive “Christmas tree” pattern of the molars.

Plains Pocket Gopher (*Geomys bursarius*)

Geomys is from the Greek for “earth” and “mouse”, which is an apt description of these animals, for they spend almost all of their time burrowing under ground, especially in sandy soils. You have probably seen “gopher mounds” which they construct to bring the sand from their burrows to the surface. These rodents are quite large, with males weighing up to 200 gm, and their frequency and burning in archaeological sites suggests that they were actually acquired and consumed. Their burrowing activity is intense, and can devastate an archaeological site by the process of bioturbation (churning by organisms). Their large burrows, up to 60 mm (2 ½ inches) means that they can and did move any artifacts smaller than that (which would include almost all dart points, arrow points, and many pottery sherds, not to mention all the bones smaller than their burrows).



The Plains Pocket Gopher. Note the double cusped premolar (left tooth), a distinctive feature of the gophers among other rodents.

The dental formula for gophers is distinctive among small rodents, because they have single premolars (see table above). Normally you would want to find intact tooth rows in their jaws or

skulls to observe this, for the isolated molars and premolars are difficult to identify by non-specialists. Even if the teeth are missing, you can look for the root sockets to see if premolars were present in a rodent skull or jaw. [You should look for their remains in your owl pellet samples, and examples will be provided by your lab instructor.]

Today, Plains Pocket Gophers range over all of Texas except the drier environments in the Rio Grande Valley, the southern Rolling Plains and all of the Trans-Pecos. In those regions other species of gophers are found. During periods of dry climate, however, the Plains Pocket Gopher's range was contracted to wetter, eastern settings.

Hispid Cotton Rat (*Sigmodon hispidus*)



The Hispid Cotton Rat. Notice the “S” shaped cusp pattern of the second and third molars.

The name *Sigmodon* is derived from the Greek letter “S” and the word for tooth (*odous*). You will appreciate this choice, as the cotton rat has a very distinctive “S-shaped” cusp pattern on their molars. Their teeth make is very easy to separate them from voles and gophers.



Cotton rats live principally in grassy environments, but occur over most of Texas today. Their numbers are higher in the wetter regions, and their populations are especially prone to local fluctuations even with short-term changes in precipitation. Cotton rats have very high reproduction rates, and females give birth to an average of five litters per year, each litter having 2-10 young! They are weaned in just 5-6 days, and pass puberty at 40 days. It is no wonder that they are so common in archaeological sites!

These rodents are also busy burrowers, although their burrows are somewhat smaller than those of the gophers; cotton rats frequently inhabit the burrows of other animals. They feed almost exclusively on plant material.

Variability in Archaeological Faunas

Variability in archaeological faunas is the source of our insights into changing practices of food procurement (subsistence) among past cultures. But we cannot just assume that the fauna remains we find in a site are a simple and easy record of what people chose to eat, for there are a number of factors that can influence the composition and character of the faunal remains in an archaeological site. This is a huge issue in zooarchaeology, and here we will briefly some of the main issues that are important for you to consider in the course of studying faunal remains in your labs.

Availability

People can only acquire what is available to them, so what are the main factors that influence availability of animals they might wish to procure and consume? The most important factor is the composition of the animal communities in the habitats (as opposed to regional environments) near the site. Let's look at home first. In north central Texas you can easily see habitats that are very close to each other, yet each supports very different populations of animals. **Aquatic habitats** provide fish, mussels, turtles and things that feed on them, such as raccoons, weasels, and the like. **Riparian forest habitats** (those along streams) are occupied by cottontail rabbits, deer, large numbers of birds, foxes, squirrels, and beavers. **Upland forest habitats** (woodlands) are home to some of the riparian taxa, but will lack evidence of the proximity of aquatic settings. **Prairie habitats** are (or were) the home of bison, jackrabbits, prairie chickens, ground squirrels, antelope and elk. These differences mean that we can investigate our archaeological faunas from a perspective of habitat exploitation, and it is very common to see that groups did in fact use multiple habitats during the course of their occupations.

If we move to regions with different climate, then the composition of faunas will reflect those conditions, such that sites in two regions occupied at the same time will be expected to contain faunas that denote the local availability of animal food resources.

Changes in availability are the most important aspect of changes in past climates and environments. The onset of drought for example can result in changes in both population densities (quite hard to reconstruct) and changes in community composition (somewhat easier to reconstruct). Changes in composition and density of animal populations can result in adaptive shifts to new resources, new technologies (trapping, snaring) or increased mobility.

Changes in environment occur at different scales. Periodic droughts in the Holocene (the last 10,000 years) are well documented in many regions. These usually result in reversible changes in both plant and animal communities to which people could adapt.

On the other hand, large-scale changes are evident during the Pleistocene, in response to global climate change, with its attendant changes in temperature, precipitation, glacial advances, sea level fluctuations, etc. In the Old world this is of great importance, because those regions were occupied by prehistoric populations over several glacial-interglacial cycles, as you now know from having considered the Paleolithic occupations of Europe.

In the New World, the record is restricted to the end of the last glacial cycle, which ended at the Pleistocene-Holocene boundary. This was accompanied by large-scale extinctions of Pleistocene megafauna including mammoth, mastodon, camel, horse, sloths, and many other species. Those animals were hunted by Paleoindian populations which contributed in some ways to their extinction, but just how important hunting versus environmental change was in those extinctions is a matter of deep debate. Environmental change at the Pleistocene-Holocene boundary did result in well-documented shifts in animal distributions, including many local extirpations from regions that experienced significant shifts in climate and vegetation.

Cultural Selection

Did prehistoric populations randomly harvest the animals that lived near them, or did they focus their procurement practices in some way? This is a major issue, and one that is difficult to assess because it requires that we know what was available. Unfortunately most of our data on availability is derived from the archaeological faunas themselves, not from totally “natural” settings. However, many zooarchaeologists study modern and ancient carnivore dens to gain insights into the natural faunas available (this of course raises the issue of carnivore selectivity as well, but these studies are essential nonetheless.) In many cases we use **proxy evidence** of faunal availability. The term proxy means that it is an indirect form of evidence that we substitute for the faunal data per se. For example, pollen records can be used to define the presence of changing grassland-forest communities that can be used to estimate the presence of animals adapted to those two environments.

Faunas from archaeological sites are often viewed as having passed through a “cultural filter”, reflecting the assumption that people may not have hunted randomly, and that archaeological faunas do represent what was most advantageous to their subsistence needs and the best allocation of their procurement efforts.

Selective Transport

The animals and parts of animals in sites reflect what people brought to that location. This can vary greatly depending on the size of the animal, the parts of the animal people used most, and of course the distance between the procurement and final processing locality (our site). For large animals such as bison or elk, the meaty portions, especially the upper limbs) were often moved much more than the axial skeleton. Thus humeri and femurs may be more common than lower limbs, skulls and vertebrae in camp sites. Notice that this implies quite important differences between the element composition of animals at procurement sites. Intact carcasses of small game such as rabbits are much more likely to have been brought back to sites. Game of intermediate size, such as whitetail deer could be carried intact, and often they were, but long-distances between kill and camp could also result in selective transport of meatier portions with the bones attached.

These factors provide challenges and opportunities for zooarchaeologists, for they can exploit bone element analysis to reconstruct patterns of fauna procurement and processing.

Differential Preservation

Not all bones at archaeological sites have the same chance of surviving for us to recover. There are several issues that zooarchaeologists regularly consider as part of their studies of bone taphonomy. Perhaps the first and most important is how long the bones were exposed before they were buried. Bones weather quickly at the surface, and even the most resilient elements may disappear within 15 years in a temperate environment like ours in Texas. Also, bones on the surface are vulnerable to chewing and even removal by carnivores and other scavengers after the people have left the site. Bones continue to deteriorate even after burial. In the subsurface they are attacked chemically and even by gnawing rodents. Soil chemistry is important in this regard, and bones preserve better in calcareous sediments such as in limestone rock shelters or in sediments in dry regions, as opposed to the rapid decay of wetter settings.

Different bones and parts of bones are subject to differential preservation regardless of burial conditions. In general, dense cortical bone preserves better than cancellous (spongy) bone, as do teeth and mandibles. Small bones from the feet deteriorate quite fast, and are also among the most vulnerable to carnivore chewing. Zooarchaeologists consider these patterns of differential preservation explicitly in their analyses, lest they come to erroneous conclusions concerning the composition of their faunal assemblages. This is most important when they are comparing faunas from sites that had different histories of exposure and burial.

An additional factor in differential preservation is what people did to different bones. Some were burned, others were broken up to remove marrow, and some were smashed into small pieces so they could boil them to recover bone grease, which was both nutritious and a good preservative. Plains Indians packed dried meat in bone grease which would protect the meat from decay for up to several years! Although only a few Arctic folks continue to render and consume bone grease today, it is one of the richest food substances out there, having approximately 12,000 calories per kilogram.

Archaeological Issues: Sample Size and Recovery

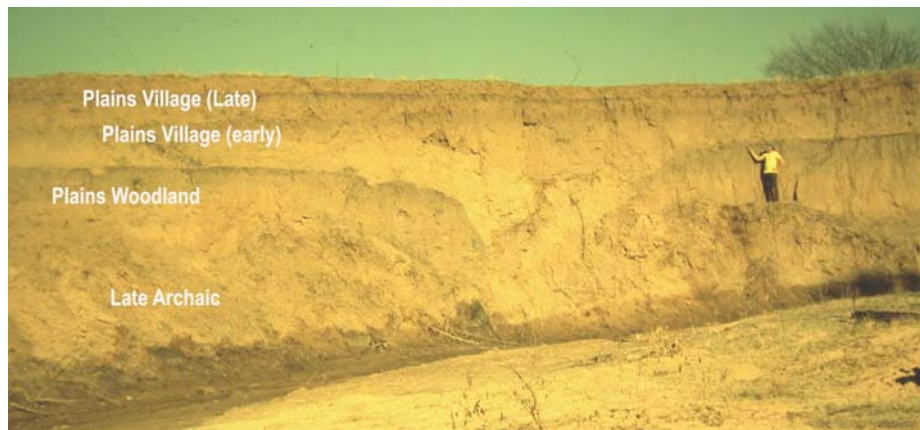
Two last considerations concerning variability in archaeological faunas are related to our research. Sample size is always an issue in science, and it is very important in zooarchaeology. Numerous studies have shown that the “richness” (number of taxa) in a recovered faunal assemblage is strongly correlated with the size of our sample. Therefore, before comparing two or more faunal assemblages, one has to account for differences in sample size, lest we conclude that one group exploited a more diverse array of species when in fact this may only reflect a larger sample from one site compared to another.

By recovery, we mean the methods used to get bones out of the sediment we excavate. This is usually accomplished by sieving, and the size of the sieve mesh determines the size of the bone fragments we will recover. By using ¼ inch screen, we are assured of losing all bones smaller than that, which includes most of the microfauna. Using small screens helps ensure full recovery, and one has to be careful to note the recovery techniques used before comparing published faunas from different sites.

Delaware Canyon

Delaware Canyon is an archaeological locality in southwestern Oklahoma that was excavated by UNT in 1978. It yielded a superb record of Late Holocene (3,000 – 500 years before present (bp), or 3Ka - 0.5 Ka) environments and adaptations. We will consider some of the ca. 250,000 fauna remains recovered from the site in the next two labs. This discussion briefly sets the stage for your analysis and thinking about the nature of those faunas and how zooarchaeology was applied in this project.

Delaware Canyon is a deeply incised tributary to the Washita River. At the turn of the century there was only a small shallow drainage, and land use has caused the erosion that exposed the sediments and soils in the canyon walls:



This geologic section shows the sediments and soils (darker horizons) at Delaware Canyon, and the approximate positions of the Archaic, Woodland and Plains Village occupations in the stratigraphy. All of this is sandy alluvium, and to the left of the figure you can clearly see a channel that was cut and then filled during a period of erosion after the Plains Woodland period.

Environmental Setting

Delaware Canyon is in the prairies of Southern Plains, but it is also near the Wichita Mountains, which supports an extension of the oak forests into the plains from the east. The forests are very similar to the Cross Timbers in Denton. Riparian forests also line the river and creek valleys. Today the area receives about the same rainfall as Denton.

Archaeological Record

The chronology of occupations was established by many radiocarbon dates. The main aspects of the three archaeological stages of occupation are as follows.

Late Archaic (ca. 2,800 years bp)

These occupations are represented by deeply buried deposits which were exposed only by small excavations, yielding small samples of artifacts and faunas. As in the broader region, these Archaic populations were quite territorial and exhibited a pattern of decreasing mobility and exploitation of locally available food resources. They were strictly hunter-gatherers. Their tools

were made from local stone materials, and included dart points, scrapers and informal flake tools. They did not make ceramics.

Plains Woodland (ca. 1900-1000 years bp)

As in other parts of central and eastern North America, the Woodland period is marked by the introduction of horticulture and manufacture of ceramics. The horticulture was not documented here, but corn has been found in Woodland hamlets (sites occupied by just a few families) along the larger rivers in this region. There were numerous occupations of Delaware Canyon during this near millennium period, as indicated by the large numbers of artifacts and fauna remains. Some of the artifacts are shown here.



Plains Woodland lithic artifacts from Delaware Canyon. Note the dart points and smaller arrow points, as well as the long exhausted knife at center right. Most of these were made from materials acquired very near the site. These were used for both hunting and butchering among other activities. Limited numbers of ceramic sherds were also recovered from these occupation horizons.

Regionally during the Plains Woodland period there is evidence for climatic conditions that were somewhat drier than in the late Archaic, but the Woodland populations appear to have retained their low mobility.

Plains Village (ca. 700-500 bp)

The name for this cultural stage can be taken literally, as during this time people lived in large villages and subsisted on corn, squash, sunflowers and beans grown in their extensive gardens. In the winter they typically broke up into smaller groups that ranged widely in search of bison and other game. They returned to their villages in late spring to plant their crops.

Delaware Canyon was occupied by these smaller groups, perhaps in winter, but the character of occupation was definitely less frequent and less intense than in the Woodland Period. Environments were generally wetter than in the preceding Woodland Period, but there were

periodic droughts, as we have seen in the historic period.

The Plains Villagers made a variety of lithic artifacts as well as pottery, which was used for cooking and for boiling broken bones to extract bone grease which was described earlier. Notably, these people had given up the spear thrower (and its dart points) in favor of the bow and arrow, which was an excellent weapon for hunting bison, deer and other game. Here are examples of Plains Village artifacts from the site:



Plains Village artifacts from Delaware Canyon. Note arrow points, drill (top left), scrapers (center), a bifacial preform (lower center) and the two large knives, one of which has a denticulated (serrated) right edge. You will use tools like these in your taphonomy lab.

The higher mobility and also probable extensive trade of Plains Villagers is indicated by the long-distance acquisition of stone raw materials.

Overall, Delaware Canyon's archaeological record provides us with an excellent opportunity to investigate changing environments and changing adaptations. And, we hope you will benefit from your analysis of faunal remains from this locality in the next two labs.