CHAPTER 13

FAUNAL REMAINS

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Large numbers of animal bones were found during the Rio Nuevo Archaeology project. Analysts examined a sample of the bones to determine how humans utilized animals over the course of the last 4,000 years. Cameron studied animal bone from Early Agricultural, Early Ceramic, and Hohokam contexts, while Waters identified bone recovered from the Tucson Presidio, AZ BB:13:13 (ASM), and from a Chinese gardeners' well at the San Agustín Mission locus of the Clearwater site, AZ BB:13:6 (ASM). Pavao-Zuckerman and LaMotta analyzed bone from Pima features at the San Agustín Mission locus, Clearwater site, and Schulz identified the fish bone recovered from the Chinese gardener's well.

FAUNAL REMAINS FROM PREHISTORIC CONTEXTS

Approximately 4,000 bones recovered during investigations of prehistoric contexts at the Clearwater site and the Tucson Presidio of the Rio Nuevo project in downtown Tucson were analyzed. The contexts covered a wide temporal range, from the unnamed phase of the Early Agricultural period to the Hohokam Classic period, a range from about 2100 B.C. to A.D. 1450. Mammal remains dominated the assemblages, with a few bird, amphibian, and reptile remains also present. This section provides a general description of the faunal remains collected from prehistoric contexts at the sites and assesses patterns of faunal exploitation when adequate sample sizes allow.

Methodology

Laboratory Procedures

All of the analyses presented here were conducted following the standard faunal coding procedures used by Desert Archaeology, Inc. Several types of data were recorded for each bone, including: species and element type, side, degree and origin of fragmentation, degree of epiphyseal fusion, and the presence or absence of butchering marks, burning, and gnawmarks. The presence or absence of natural environmental modification (such as caliche-coating and root-etching) on each bone also was noted.

Taxonomic identifications were based on comparisons with a comparative collection, as well as with the aid of published keys (for mammal bones, Gilbert 1980; Olsen 1964; for bird bones, Cohen and Serjeantson 1996; Gilbert et al. 1981; Olsen 1979). Taxonomic information on fragments that could not be identified to order or below consisted primarily of the definition of size categories within classes. The size categories for mammals were defined as follows: small mammal fragments were woodrat- to rabbit-sized, medium mammal fragments were bobcat-/canid-sized, and large mammal fragments were deer-sized. Elements that fell in size between canid and jackrabbit were placed in a medium-small mammal category. A large-medium mammal category contained elements that were definitely larger than jackrabbit, but that were clearly not medium mammal or deer-sized. Many of the mammal bones were too fragmented to be placed in any of the size categories and were simply coded as mammal. A single bird bone could also not be identified below class, and it was placed in a medium-small bird category (it was larger than quail but smaller than hawk in size). One bone could not be identified to class and was categorized as unknown animal (indeterminate vertebrate).

Degree and origin of fragmentation was used to assess completeness of a bone, and, for incomplete elements, when the breakage occurred (did the bone exhibit a fresh break, or was it broken at some time prior to excavation, or both). Bones can be fractured for a number of reasons, including marrow extraction (Enloe 1993; Kent 1993; O'Connell et al. 1992), cooking (e.g., breaking of bones so that they fit into a pot for boiling) (Gifford-Gonzalez 1993; Kent 1993; Oliver 1993; Yellen 1977), and postdepositional processes (e.g., trampling, excavation procedures) (Andrews 1990; Gifford-Gonzalez et al. 1985; Haynes 1991; Olsen and Shipman 1988). All of these processes can result in faunal elements being found anywhere from whole to highly fragmented. The faunal elements were coded as complete, more than three-quarters complete, between three-quarters and half complete, between half and one-quarter complete, or less than one-quarter complete. The portion (e.g., proximal end, distal end, and so forth) of the element that was recovered was also coded.

Degree of epiphyseal fusion was coded as fused, unfused, or partially fused (i.e., the epiphyseal lines were still visible). Degree of epiphyseal fusion was recorded for both the proximal and distal (or dorsal and ventral) portions of an element, when both ends were present. This information was used to determine the approximate age of the animals recovered from the site (fetal, juvenile, adult).

Burned bones were coded as calcined (white appearance), charred (blackened appearance), partially charred, blue/gray, and light brown. A few bones had a combination of burning patterns and were coded as brown/calcined or charred/calcined. Burned bones have frequently been interpreted as evidence for roasting, but bones can become burned through disposal in a fire, use as fuel, or by natural processes, such as brush fires (Lyman 1994b). These issues are addressed more fully below.

Gnawed bone was coded as rodent gnawed, carnivore gnawed, and indeterminate gnawing. Several studies have shown that carnivores can transport bones out of a site area, as well as consume all or parts of bones (Binford and Bertram 1977; Hudson 1993; Kent 1981, 1993; Lyon 1970; Marean and Spencer 1991). Studies of the impact of carnivores on faunal assemblages have revealed that the presence of gnawmarks varied with the frequency that dogs received bones, as well as with bone size and density (see Kent 1981). Other studies have also noted that rodents may play a role in the deposition of bones in a site (Cameron 1994).

Each bone was also examined for natural environmental modification. Environmentally modified categories included root-etched, eroded, sunbleached, and caliche-coated. Degrees of natural modification were recorded only for Caliche-coating. The data on environmental modification were used to assess preservation. Bone preservation is affected by soil conditions and by the length of time bones are exposed to the natural elements (Andrews 1990; Behrensmeyer 1978; Lyman 1984, 1985, 1994b; Lyman and Fox 1989).

Quantification

Many different techniques have been developed to quantify faunal remains (see Lyman 1994a). The most common quantification method has been the number of identifiable specimens (NISP); that is, the number of bones and fragments of bones recovered from a site. The NISP is the primary quantification procedure used in this report. Because NISP can be greatly influenced by preservation, bone breakage, and recovery procedures, these issues are also addressed. Further, to minimize the inflation of NISP due to postdepositional bone damage, all bones with fresh breaks that could be refit were counted as one element. The refitting occurred only within specimen bags; no attempts were made to match or refit bones between different specimen bags.

ASSEMBLAGE COMPOSITION

The Clearwater Site, AZ BB:13:6 (ASM)

A total of 3,932 faunal remains collected from three loci at the Clearwater site were analyzed. The contexts ranged in date from circa 2100 B.C. to A.D. 1700, with most of the remains from Cienega phase features. The loci are located within a few hundred meters of each other, and the site itself is located on the Holocene floodplain of the western bank of the Santa Cruz River. Portions of a late eighteenth century mission overlay some of the loci from which prehistoric fauna were recovered, while other areas lay below an undeveloped former agricultural field and a historic-era brickyard. Because one of the goals of the project was to examine temporal trends, the following description of the faunal assemblage from this site is organized around the various temporal periods rather than the different loci. However, any major spatial differences or trends within temporal phases are noted as necessary. One bone, an unburned, unsized mammal indeterminate element fragment, was recovered from a nonfeature context that was not assigned to any temporal period.

Unnamed Phase of the Early Agricultural Period (2100-1200 B.C.)

Twenty-seven faunal remains recovered from strata 503 and 504 contexts dating to the unnamed phase of the Early Agricultural period were analyzed, including 24 unworked remains (Table 13.1) and

Table 13.1. Unworked taxa recovered from Stratum 504 contexts at the Clearwater site, AZ BB:13:6 (ASM).

Taxa	*n* (%)
Identifiable mammal (Mammalia)	
Black-tailed jackrabbit (*Lepus californicus*)	5 (20.8)
Cottontail (*Sylvilagus* sp.)	1 (4.2)
Medium rodent	2 (8.3)
Unidentifiable mammal	
Unsized mammal	8 (33.3)
Small mammal	7 (29.2)
Large-medium mammal	1 (4.2)
Total	24 (100.0)

Table 13.2. Worked bone artifacts recovered from the Clearwater site, AZ BB:13:6 (ASM) (all time periods).

Bag No.	Taxa	Element	Artifact	Feature	Comments[a]
Stratum 503 (circa 1500 B.C.)					
9271	Large-medium mammal	Indeterminate	Awl shaft (?)	3368	Calcined (L = 1.3)
Stratum 504 (circa 2100 B.C.)					
9267	Large mammal	Indeterminate	Awl shaft	3364	Charred/Calcined (L = 1.4)
9278	Large-medium mammal	Shaft fragment	Awl shaft	3368	Partially charred (L = 6.5)
Cienega phase					
5853	Large mammal	Indeterminate	Awl shaft	15	Unburned (L = 2.7)
6004	Large-medium mammal	Indeterminate	Polished (awl?)	15	Charred (L = 1.4)
6148	Medium artiodactyl	Metapodial	Awl handle	15	Charred (L = 5.4)
6173	Mammal	Indeterminate	Worked	57	Unburned (L = 1.9), fragment with shaped edge
6111	Large mammal	Indeterminate	Awl shaft	65	Partially charred (L = 7.3)
6440	Large-medium mammal	Indeterminate	Awl shaft (?)	121	Charred (L = 2.2)
6278	Large mammal	Shaft fragment	Awl shaft	126	Charred (L = 2.9)
6279	Large mammal	Shaft fragment	Worked	126	Unburned (L = 3.8 cm; D = 2.5), beveled edge, bead fragment?
6583	Large mammal	Indeterminate	Awl shaft (?)	128	Unburned (L = 5.1)
6650	Large mammal	Indeterminate	Awl shaft (?)	128	Charred (L = 1.6)
8669	Large mammal	Indeterminate	Worked	3270	Unburned (L = 3.0), shaped edges, one side flattened
8769	Large mammal	Indeterminate	Awl shaft (?)	3294	Calcined (L = 1.9)
8775	Large mammal	Shaft fragment	Awl shaft	3294	Charred (L = 4.7)
9069	Large mammal	Indeterminate	Awl shaft	3327	Charred (L = 1.6)
8368	Large mammal	Indeterminate	Worked	9357	Partially charred (L = 1.9), polished fragment
Early Ceramic period					
8172	Large-medium mammal	Shaft fragment	Worked (awl?)	3014	Partially charred (L = 2.5)
Hohokam periods					
9050	Large mammal	Indeterminate	Awl shaft	3293	Charred (L = 5.8)
9050	Large-medium mammal	Indeterminate	Awl tip	3293	Charred (L = 1.7 cm; T = 1.5 mm)

[a]L = Length measurement; T = tip measurement, tip measurement taken 2 mm from tip end; D = diameter measurement; all measurements in cm unless otherwise indicated.

three worked bones (Table 13.2). The remains were collected from several pithouses and small pit features in Stratum 504 at the Congress Street locus, and all but one—a worked bone—were found in Stratum 504 features that dated to circa 2100 B.C. Most of the unworked bones in this assemblage were highly fragmented, with most being less than one-quarter complete (*n* = 20, 83.3 percent). Nearly two-thirds of the unworked bones exhibited a combination of past and recent breakage (*n* = 15, 62.5 percent), which suggests recovery procedures and more recent bone handling had some impact on the degree of bone fragmentation in the assemblage. Slightly more than 30 percent of the bones exhibited evidence of only past breakage (*n* = 8, 33.3 percent). None of the bones were unbroken, and one had fresh breaks only.

Environmental modification was common, with more than three-quarters of the unworked bones covered to varying degrees with a hard, unidentifiable sedimentary substance (*n* = 20, 83.3 percent). No gnawed bones were noted, which suggests carnivores had relatively little impact on the assemblage. The majority of the bones were also burned (*n* = 13, 54.2 percent), with roughly equal proportions of charred (*n* = 5, 38 percent) and partially charred (*n* = 7, 54 percent) bones. One bone was calcined. Most of the burned remains were unidentifiable mammal (*n* = 4, 31 percent), small mammal (*n* = 5, 38 percent), and large-medium mammal (*n* = 1, 8 percent) bones. Burned bones were recovered from four of the seven features, with eight of the burned remains collected from pithouse Feature 3364. Small sample sizes from individual features (all but Feature 3364 had less than five elements) preclude any interpretations of burned taxa recovered in the different features.

All of the remains in the analyzed Stratum 504 assemblage were identified as mammals. One-third of the unworked remains were identifiable below class, the majority of these being rabbit (see Table 13.1). Two species of jackrabbit—antelope jackrabbit (*Lepus alleni*) and black-tailed jackrabbit (*L. californicus*)—and two species of cottontail—eastern cottontail (*Sylvilagus floridanus*) and desert cottontail (*S. audubonii*)—currently reside in the area (Hoffmeister 1986). Due to the difficulties in distinguishing cottontail species based on postcranial material and the fragmentary condition of most of the cranial bones, cottontail elements were not identified below genus throughout the analyses. Antelope jackrabbit and black-tailed jackrabbit can be distinguished by size, with antelope jackrabbit elements generally being larger. All elements that were significantly larger than the black-tailed jackrabbit in the comparative collection were identified as antelope jackrabbit. For elements that were only slightly larger than the black-tailed jackrabbit in the comparative collection, a more conservative classification of indeterminate jackrabbit (*Lepus* sp.) was used.

All the jackrabbit bones recovered from Stratum 504 contexts were identified as black-tailed jackrabbit. These elements included fragments of a charred mandible, a partially charred radius, and three unburned tibiae recovered from pithouse Features 3359 and 3364 and pit Feature 622, respectively. All but one of the jackrabbit bones were less than one-quarter complete, with some of the breakage occurring recently on many of the elements. A charred cottontail humerus was also recovered from Feature 3364. This element was greater than three-quarters complete, with some of the breakage occurring recently. All of the jackrabbit and cottontail bones were covered with a hard sedimentary substance. Due to the small number of rabbit bones recovered, patterns of rabbit exploitation cannot be assessed for this time period.

Additional identifiable remains included two unburned medium rodent (woodrat-sized) bones—an innominate and a femur collected from pit Features 622 and 3360, respectively. Both of these elements were between one-quarter and three-quarters complete, with some of the breakage occurring recently. Both elements were also covered with a hard sedimentary substance. These remains likely represent natural deposits, although archaeological and ethnographic evidence has shown that rodents were occasionally consumed in the region. This issue is addressed more thoroughly in the "Cienega Phase" section below.

Three worked bones also were noted. All of the worked bones are small awl or probable awl fragments made from large- or large-medium-sized mammals (see Table 13.2). Two of the fragments were recovered from pithouse contexts, Features 3364 and 3371, that date to approximately 2100 B.C. The third artifact was collected from Feature 3368, a small pit, that has been dated to 1500 B.C. Due to the small size of the fragments, as well as the presence of a hard sedimentary substance that obscured any polish or striations on two of the tools, conclusions about the specific function of these artifacts could not be made.

Cienega Phase (800 B.C.-A. D. 50)

A total of 3,858 faunal remains, including 3,843 unworked bones (Table 13.3) and 15 worked bones (see Table 3.2), recovered from Cienega phase contexts was analyzed. These remains were collected from nearly 60 features and intramural features located in the San Agustín Mission locus (*n* = 26) and the Brickyard locus (*n* = 33). Most of the features from which fauna were recovered were pithouses (*n* = 30, 50 percent) or postholes (*n* = 15, 25 percent) and pits (*n* = 10, 17 percent) located in the pithouses.

More than 60 percent of the assemblage was collected from Feature 9357, likely due to this feature's relatively large volume as compared with other Cienega phase features. Feature 9357 is a large, deep pit structure located in area RNA 8. The structure was probably originally used for communal ceremonies and was later used for trash disposal. Only three other features (pithouse Features 57, 3264, and 3294) yielded more than 100 bones, and none of these had more than 200 elements. Most features (*n* = 38, 63 percent) had assemblages of fewer than 20 bones. Due to the unequal distribution of fauna in features, detailed assessments about the faunal types in specific features were not made. Both loci yielded similar proportions of major taxa, indicating the recovered assemblages are comparable (see Table 13.3).

Table 13.3. Unworked taxa recovered from Cienega phase contexts at the Clearwater site, AZ BB:13:6 (ASM).

Taxa	San Agustín Mission Locus [*n* (%)]	Brickyard Locus [*n* (%)]	Total [*n* (%)]
Amphibian (Amphibia)			
Toad/Frog (Salientia)	–	1 (0.0)	1 (0.0)
Reptile (Reptilia)			
Snake (Serpentes)	–	1 (0.0)	1 (0.0)
Turtle (Testudinata)	1 (0.2)	10 (0.3)	11 (0.3)
Bird (Aves)			
Raven or crow (*Corvus* sp.)	1 (0.2)	–	1 (0.0)
Total non-mammals	2 (0.4)	12 (0.4)	14 (0.4)
Identifiable mammal (Mammalia)			
Rabbit or hare (Leporidae)	2 (0.4)	18 (0.5)	20 (0.5)
Jackrabbit (*Lepus* sp.)	5 (0.9)	35 (1.1)	40 (1.0)
Antelope jackrabbit (*L. alleni*)	7 (1.3)	25 (0.8)	32 (0.8)
Black-tailed jackrabbit (*L. californicus*)	78 (14.1)	656 (20.0)	734 (19.1)
Cottontail (*Sylvilagus* sp.)	25 (4.5)	109 (3.3)	134 (3.5)
Small rodent	1 (0.2)	2 (0.1)	3 (0.1)
Medium rodent	6 (1.1)	4 (0.1)	10 (0.3)
Pocket gopher (*Thomomys* sp.)	4 (0.7)	3 (0.1)	7 (0.2)
Woodrat (*Neotoma* sp.)	3 (0.5)	–	3 (0.1)
Muskrat (*Ondatra zibethicus*)	–	1 (0.0)	1 (0.0)
Small carnivore	–	2 (0.1)	2 (0.1)
Medium carnivore	–	4 (0.1)	4 (0.1)
Wolves, dog/coyote, foxes (Canidae)	–	3 (0.1)	3 (0.1)
Dog/Coyote (*Canis* sp.)	2 (0.4)	24 (0.7)	26 (0.7)
Fox (*Vulpes/Urocyon*)	1 (0.2)	9 (0.3)	10 (0.3)
Unsized artiodactyl	4 (0.7)	–	4 (0.1)
Medium artiodactyl (deer-sized)	7 (1.3)	64 (1.9)	71 (1.8)
Deer, elk, or ally (Cervidae)	1 (0.2)	2 (0.1)	3 (0.1)
Deer (*Odocoileus* sp.)	6 (1.1)	32 (1.0)	38 (1.0)
Total identifiable mammals	152 (27.4)	993 (30.2)	1,145 (29.8)
Unidentifiable mammal			
Unsized mammal	179 (32.3)	1,169 (35.6)	1,348 (35.1)
Small mammal	116 (20.9)	601 (18.3)	717 (18.7)
Medium-small mammal	3 (0.5)	5 (0.2)	8 (0.2)
Medium mammal	1 (0.2)	2 (0.1)	3 (0.1)
Large-medium mammal	46 (8.3)	272 (8.3)	318 (8.3)
Large mammal	51 (9.2)	234 (7.1)	285 (7.4)
Very large mammal	5 (0.9)	–	5 (0.1)
Total unidentifiable mammal	401 (72.3)	2,283 (69.4)	2,684 (69.8)
Total (% of assemblage)	555 (14.4)	3,288 (85.6)	3,843 (100.0)

Similar to the strata 503/504 assemblage, most of the unworked bone in the Cienega assemblage was highly fragmented, with many being less than one-quarter complete (*n* = 3,188, 83.0 percent). Slightly more than half of the unworked bones exhibited a combination of past and recent breakage (*n* = 2,103, 54.7 percent), which suggests recovery procedures and more recent bone handling had some impact on the degree of bone fragmentation in the assemblage. Approximately 40 percent of the bones exhibited evidence of only past breakage (*n* = 1,498, 39.0 percent). Less than 5 percent (*n* = 178, 4.6 percent) of the bones had only recent breakage, and about 2 percent (*n* = 64, 1.7 percent) were unbroken.

Nearly 90 percent of the unworked remains were environmentally modified (*n* = 3,449, 89.7 percent). The majority of the environmentally modified bones were covered, to varying degrees, by a hard, unidentifiable sedimentary substance (*n* = 3,193, 92.6 percent). Other environmental modifications to the bones were erosion (*n* = 193, 5.6 percent), root-etching (*n* = 33, 1.0 percent), or a combination of environmental modifications (*n* = 29, 0.8 percent). One bone was stained. The types and proportions of environmentally modified bones were comparable in both loci. A few bones were rodent gnawed, including a cottontail bone, two jackrabbit elements, and a medium artiodactyl fragment. A large mammal bone and a large-medium mammal element were carnivore gnawed, indicating carnivores had some impact on the assemblage.

Approximately 40 percent of the unworked bones were burned (*n* = 1,534, 39.9 percent), with the majority being partially charred (*n* = 755, 49.2 percent) or charred (*n* = 586, 38.2 percent). Slightly more than 10 percent of the burned bones were calcined (*n* = 124, 8.1 percent) or blue/gray in color (*n* = 59, 3.8 percent), suggesting they had been exposed to relatively high temperatures, or had relatively little meat on them when exposed to heat, or both. A few bones were light brown in color (*n* = 3) or had a combination of burning patterns (*n* = 7). Most of the burned remains were unidentifiable mammal (*n* = 452), small mammal (*n* = 342), and large-medium mammal (*n* = 117) bones about which little else can be said. Patterns of burning for identifiable taxa are assessed below.

Burned bones were recovered from all 21 features, with more than 20 analyzed elements. The proportions of burned bones in these features ranged from 5 percent to 95 percent, with most between 20 percent and 40 percent. A few features, however, had relatively high proportions of burned remains (>70 percent). Several of these features exhibited evidence of burning; therefore, some of the burned faunal remains may have burned at the times the features burned. This may be particularly true for the remains recovered from pithouse Features 15 and 3273, which appear to have burned during use. The faunal remains recovered from these two structures were found primarily in the roof/wall collapse strata.

Other features with high proportions of burned faunal remains—including pithouse Features 112, 121, 128, and 9372—appear to have been cleaned out prior to burning and were later used for trash disposal. Pithouse Feature 151 and intramural pit Feature 191.01, although they also had high proportions of burned remains, did not have any evidence of burning. The evidence on feature burning, combined with the distribution of burned remains throughout the Cienega phase contexts and the intermixing of these bones with a number of unburned bones generally indicates that, with the possible exception of many of the remains in Features 15 and 3273, the burned faunal bones are in secondary contexts and are not the result of a single event.

The majority of the faunal remains analyzed from Cienega phase contexts were identified as mammal (see Table 13.3). Non-mammalian remains included an unburned frog/toad (Salientia) humerus collected from pithouse Feature 9357, and an unburned, unbroken *Corvus* sp., possibly crow, wing phalanx recovered from pithouse Feature 57. The frog/toad element was more than half complete and probably represents a natural deposit. Both the amphibian and the bird bones were partially covered with a hard sedimentary substance.

A number of reptile remains were recovered, including an unburned, unidentifiable snake vertebra from pithouse Feature 3270 and several Testudinata (turtle or tortoise) carapace fragments collected from pithouse Features 121, 9168, and 9357. The snake element was less than one-quarter complete and probably represents a natural deposit. Due to the fragmentary condition of the carapace fragments, as well as an absence of comparative material for some of the turtle taxa in the area, none of the carapace fragments could be identified below order. However, based on size, many of the unidentifiable carapace elements probably represent Sonoran mud turtle (*Kinosternon sonoriense*). One of the unidentifiable carapace fragments is thicker than the others, and it may represent desert tortoise (*Gopherus agassizii*). Desert tortoise remains have been noted at other sites in the Tucson region, including the Dairy site, AZ AA:12:285 (ASM), an Early Agricultural period Hohokam site located in the northern Tucson Basin, and the Yuma Wash site, AZ CC:2:7 (ASM), a Hohokam site near Marana (Cameron 2003a, 2003c).

Five of the turtle remains were burned, including two charred and three partially charred fragments; these were recovered from all the features that yielded turtle remains. Most of the turtle remains were environmentally modified; many (*n* = 7, 63.6

percent) were covered with a hard sedimentary substance. One carapace fragment had an eroded surface area. None of the turtle fragments exhibited evidence of cultural modification, although turtle shells were commonly used to make rattles by later Southwestern groups (Henderson and Harrington 1914; Lange 1959; Whitman 1947), and some worked turtle remains have been recovered in archaeological (Hohokam) contexts (Gillespie 1987; James 1989) in southeastern Arizona. It is currently unclear to what extent turtles were used as food.

Rabbits were the most common identifiable remain recovered, and they constituted one-quarter of the Cienega phase assemblage (n = 960, 25.0 percent) (see Table 13.3). More than 75 percent of the rabbit elements were identified as black-tailed jackrabbit. Antelope jackrabbit and indeterminate jackrabbit elements each accounted for less than 5 percent of the lagomorph total. Antelope jackrabbit remains are not generally common in assemblages in the region, but they have been recovered from both earlier and later sites (Cameron 2003c; Gillespie 1987; James 1987; Szuter and Brown 1986). Cottontail remains constituted approximately 15 percent of the rabbit bones.

The remaining rabbit elements could not be identified below order and included fragments of 2 crania, a mandible, a lumbar vertebra, a sternebra, 2 scapulae, a humerus, 3 radii, an innominate, a femur, 4 tibiae, and 3 mid-sized phalanges. A few of these elements were from immature or fetal individuals. More than 85 percent of all identifiable and unidentifiable rabbit bones were environmentally modified—most covered by a hard sedimentary substance.

Black-tailed jackrabbit bones were distributed throughout the two loci and were recovered from all of the features that yielded more than 10 faunal remains. They were also found in 50 percent of the features with 10 elements or less. In RNA 8, all of the features with assemblages with 40 or more bones yielded comparable proportions of black-tailed jackrabbit remains (about 20 percent), indicating there were no unusual concentrations of bones for this taxa in that locus. In RNA 2, the proportions of black-tailed jackrabbit bones in features with total assemblages of more than 40 elements were more variable, ranging from 3-16 percent. It is not clear why the features in this locus yielded lower proportions of this taxa compared with RNA 8, or why the proportions are relatively variable.

Cottontail remains were not as widely distributed as the black-tailed jackrabbit remains and were recovered from only 23 features. Most of the features without cottontail remains had less than 10 elements, although five features with more than 20 remains also did not yield cottontail bones. The relatively small sample size of cottontail remains compared with black-tailed jackrabbit elements probably accounts for many of the differences noted in the distributions of the two taxa. No concentrations of cottontail bones were noted in specific features, and overall, the proportion of cottontail remains from the two loci is comparable. The sample sizes for antelope jackrabbit and indeterminate jackrabbit were too small to assess general feature distribution patterns.

Jackrabbit and cottontail element types are listed in Tables 13.4 and 13.5, respectively. The majority of element types are present, although many, particularly crania, vertebrae, and foot bones, are under-

Table 13.4. Jackrabbit elements recovered from Cienega phase contexts at the Clearwater site, AZ BB:13:6 (ASM).

Element	Jackrabbit [*n* (%)]	Antelope Jackrabbit [*n* (%)]	Black-tailed Jackrabbit [*n* (%)]
Crania	–	–	1 (0.1)
Premaxillae	–	–	6 (0.8)
Maxillae	1 (2.5)	–	6 (0.8)
Mandibles	–	–	12 (1.6)
Teeth	–	–	7 (1.0)
Atlases	–	–	2 (0.3)
Cervical vertebrae	–	–	2 (0.3)
Thoracic vertebrae	–	–	2 (0.3)
Lumbar vertebrae	–	–	14 (1.9)
Sacra	–	–	1 (0.1)
Ribs	2 (5.0)	–	7 (1.0)
Sternebrae	–	–	2 (0.3)
Scapulae	6 (15.0)	2 (6.3)	57 (7.8)
Humeri	2 (5.0)	13 (40.6)	63 (8.6)
Radii	–	2 (6.3)	84 (11.4)
Ulnae	3 (7.5)	5 (15.6)	44 (6.0)
Metacarpals	–	–	15 (2.0)
Innominates	3 (7.5)	2 (6.3)	70 (9.5)
Femora	6 (15.0)	1 (3.1)	58 (7.9)
Tibiae	3 (7.5)	3 (9.4)	71 (9.7)
Astragali	1 (2.5)	–	8 (1.1)
Calcanea	1 (2.5)	4 (12.5)	62 (8.4)
Tarsals	–	–	10 (1.4)
Metatarsals	2 (5.0)	–	63 (8.6)
Phalanges	8 (20.0)	–	36 (4.9)
Metapodials, indeterminate	2 (5.0)	–	29 (4.0)
Long bone fragments	–	–	2 (0.3)
Total	40	32	734

Table 13.5. Cottontail elements recovered from Cienega phase contexts at the Clearwater site, AZ BB:13:6 (ASM).

Element	*n* (%)
Premaxillae	1 (0.7)
Maxillaee	4 (3.0)
Premaxillae/Maxillae	1 (0.7)
Mandibles	8 (6.0)
Lumbar vertebrae	4 (3.0)
Ribs	1 (0.7)
Sternebrae	1 (0.7)
Scapulae	10 (7.5)
Humeri	11 (8.2)
Radii	8 (6.0)
Ulnae	6 (4.5)
Innominates	22 (16.4)
Femora	14 (10.4)
Tibiae	22 (16.4)
Astragali	1 (0.7)
Calcanea	13 (9.7)
Metatarsals	3 (2.2)
Phalanges	2 (1.5)
Metapodials, indeterminate	2 (1.5)
Total	134

represented. Element types may be underrepresented for a variety of reasons, including prehistoric behavioral practices (such as butchering or disposal practices), bone preservation (elements such as vertebrae are often less dense and do not preserve as well), and difficulties in identifying certain elements in highly fragmented form (such as vertebra and skull fragments). Recovery procedures, particularly screen size, can also play a role, and numerous studies have shown that smaller elements, such as cottontail foot bones, as well as highly fragmented elements, often fall through ¼-inch mesh, the primary screen size used in this project (see Cameron 2002; James 1997; Shaffer 1992; Shaffer and Sanchez 1994; Thomas 1969).

Data on fragmentation indicate the rabbit bones were highly fragmented, with more than 70 percent of the bones for all of the rabbit taxonomic categories less than half complete and 40-55 percent less than one-quarter complete. These data suggest some elements may have been lost during the excavation process. Despite the underrepresentation of certain elements, however, complete carcasses were likely primarily butchered at the site, given the relatively small size of rabbits.

Proximal or distal ends were present on slightly more than 50 percent of the black-tailed jackrabbit, antelope jackrabbit, and cottontail remains, and more than 85 percent of these remains had fused epiphyses. Slightly less than 10 percent of the elements for these three taxa had unfused epiphyses. As noted above, a few immature and fetal unidentifiable rabbit remains were also recovered. These patterns indicate that, although most rabbits were adults, a few younger individuals also appear to have been utilized.

Approximately 40-45 percent of all the rabbit taxa bones were burned. The types of burned black-tailed jackrabbit and cottontail bones are listed in Tables 13.6 and 13.7, respectively. Burned antelope jackrabbit remains included: a partially charred humerus, ulna, femur, and 3 tibiae; 3 charred humeri, a radius, and an ulna; and a calcined humerus. Burned indeterminate jackrabbit remains included: a partially charred rib, 2 scapulae, 4 femora, a calcaneus, a metatarsal, and a metapodial; 2 charred innominates, 2 femora, 2 tibiae, an astragalus, and a metatarsal; and a calcined ulna. Burned unidentifiable rabbit remains included a charred lumbar vertebra, 2 scapulae, a radius, and a tibia; and a calcined radius and 2 tibiae. More than 60 percent of the black-tailed jackrabbit burned elements and 50 percent of the cottontail burned bones are peripheral or cranial elements that contain relatively little meat. These elements may have fallen into the fire during roasting, or were possibly tossed into the fire while preparing the animal for cooking.

The relatively high proportion of partially charred and charred bones for all of the rabbit taxa indicates many of the elements may have had some flesh attached when exposed to the heat, or they were exposed to heat of low intensity or for a short duration. This pattern has been noted elsewhere (Cameron 1998, 2003a, 2003c). No concentrations of burned rabbit bones were noted, and burned remains for all rabbit taxa were recovered from several features located in both loci.

The ratio of cottontails to the total lagomorph assemblage from a site (called the lagomorph ratio) has been previously used to address issues such as differences in cottontail and jackrabbit utilization at upland and lowland sites (Bayham and Hatch 1985a, 1985b), as well as to assess environmental modifications at different site types (Cameron 1998; Szuter 1991) and across time (Bayham and Hatch 1985b). Interpretations of this lagomorph ratio are based on ecological studies that have shown that cottontails prefer a more vegetated environment in which they can hide from predators, while jackrabbits prefer a more open environment in which they can flee from predators (Legler 1970; Madsen 1974).

Table 13.6. Burned black-tailed jackrabbit elements recovered from Cienega phase contexts at the Clearwater site, AZ BB:13:6 (ASM).

Element	Calcined [*n* (%)[a]]	Charred [*n* (%)[a]]	Partially Charred [*n* (%)[a]]	Total [*n* (%)[a]]
Crania	–	–	–	0 (0.0)
Premaxillae	–	1 (16.7)	–	1 (16.7)
Maxillae	–	3 (50.0)	–	3 (50.0)
Mandibles	–	1 (8.3)	1 (8.3)	2 (16.7)
Teeth	–	–	1 (14.3)	1 (14.3)
Atlases	–	–	–	0 (0.0)
Cervical vertebrae	–	–	–	0 (0.0)
Thoracic vertebrae	–	–	–	0 (0.0)
Lumbar vertebrae	–	2 (14.3)	3 (21.4)	5 (35.7)
Sacra	–	–	–	0 (0.0)
Ribs	–	–	1 (14.3)	1 (14.3)
Sternebrae	–	–	–	0 (0.0)
Scapulae	1 (1.8)	16 (28.1)	11 (19.3)	28 (49.1)
Humeri	4 (6.3)	5 (7.9)	16 (25.4)	25 (39.7)
Radii	4 (4.8)	15 (17.9)	17 (20.2)	36 (42.9)
Ulnae	1 (2.3)	4 (9.1)	11 (25.0)	16 (36.4)
Metacarpals	–	2 (13.3)	7 (46.7)	9 (60.0)
Innominates	1 (1.4)	23 (32.9)	13 (18.6)	37 (52.9)
Femora	2 (3.4)	3 (5.2)	12 (20.7)	17 (29.3)
Tibiae	4 (5.6)	15 (21.1)	12 (16.9)	31 (43.7)
Astragali	–	1 (12.5)	3 (37.5)	4 (50.0)
Calcanea	5 (8.1)	10 (16.1)	19 (30.6)	34 (54.8)
Tarsals	–	5 (50.0)	–	5 (50.0)
Metatarsals	1 (1.6)	10 (15.9)	14 (22.2)	25 (39.7)
Phalanges	–	7 (19.4)	11 (30.6)	18 (50.0)
Metapodials, indeterminate	–	6 (20.7)	9 (31.0)	15 (51.7)
Long bone fragments	–	–	1 (50.0)	1 (50.0)
Total (% of black-tailed jackrabbit assemblage)	23 (3.1)	129 (17.6)	162 (22.1)	314 (42.8)

Note: A charred/calcined tarsal and a light brown/calcined ulna also were recovered.
[a]Percent of element type.

Ethnographic data from the Southwest indicate this difference in habitat had consequences for the tactics utilized to hunt these animals. Specifically, jackrabbits tended to be hunted by communal drives (Spier 1933; Underhill 1946; Whitman 1940). These drives usually involved groups of men and boys flushing the rabbits out of the brush and into nets or enclosed areas where the rabbits were then clubbed or shot by bow and arrow. Conversely, cottontails were more commonly hunted by individuals or in small groups and either skewered in their burrows (Cushing 1920; Parsons 1929; Spier 1928, 1933), trapped (Pennington 1963; Spier 1933), or flushed out by setting the bush near their burrow on fire (Pennington 1963).

Consequently, larger, more intensively occupied sites tend to yield more jackrabbit remains, as these groups have modified their environment to a greater extent, creating the more open living spaces preferred by jackrabbits (Szuter 1991). These sites can also provide more hunters for communal jackrabbit drives. In Early Agricultural Cienega phase contexts at the Clearwater site, a higher lagomorph ratio is expected, as compared with the ratios at later, larger, agricultural villages. However, the lagomorph ratio is 0.14—a ratio much lower than expected, and, in fact,

Table 13.7. Burned cottontail elements recovered from Cienega phase contexts at the Clearwater site, AZ BB:13:6 (ASM).

Element	Calcined [*n* (%)[a]]	Charred [*n* (%)[a]]	Partially Charred [*n* (%)[a]]	Total
Premaxillae	–	–	–	0 (0.0)
Maxillae	–	1 (25.0)	–	1 (25.0)
Premaxillae/Maxillae	–	–	–	0 (0.0)
Mandibles	1 (12.5)	1 (12.5)	–	2 (25.0)
Lumbar vertebrae	–	1 (25.0)	–	1 (25.0)
Ribs	–	1 (100.0)	–	1 (100.0)
Sternebrae	–	–	–	0 (0.0)
Scapulae	2 (20.0)	–	1 (10.0)	3 (30.0)
Humeri	–	3 (27.3)	4 (36.4)	7 (63.7)
Radii	1 (12.5)	–	–	1 (12.5)
Ulnae	2 (33.3)	1 (16.7)	2 (33.3)	5 (83.3)
Innominates	1 (4.5)	1 (4.5)	8 (36.4)	10 (45.5)
Femora	–	1 (7.1)	2 (14.3)	3 (21.4)
Tibiae	2 (9.1)	4 (18.2)	5 (22.7)	11 (50.0)
Astragali	–	–	–	0 (0.0)
Calcanea	1 (7.7)	2 (15.4)	4 (30.8)	7 (53.8)
Metatarsals	–	–	–	0 (0.0)
Phalanges	–	1 (50.0)	–	1 (50.0)
Metapodials, indeterminate	–	–	–	0 (0.0)
Total (% of cottontail assemblage)	10 (7.5)	17 (12.7)	26 (19.4)	53 (39.6)

[a]Percent of element type.

a ratio comparable with many later Hohokam agricultural villages (see Szuter 1991). This ratio could indicate the environment was relatively open during this earlier time period.

It is also possible that the Cienega phase contexts yielded a relatively high ratio of jackrabbits due to communal activities. Jackrabbits were occasionally used in community feasts by ethnographic populations (Beaglehole 1936; Parsons 1918), and the presence of a probable communal structure, Feature 9357, indicates communal activities occurred at the site during this time period. No direct evidence of jackrabbit use during communal activities is present in this particular structure, however, as most of the jackrabbit remains from this feature were derived from postabandonment fill. Jackrabbit elements were not recovered from the floor of the feature. It should also be noted that the ratio was influenced by recovery procedures, with cottontail remains underrepresented to an unknown degree due to use of ¼-inch mesh.

Rodents constituted less than 1 percent of the Cienega phase assemblage (*n* = 24, 0.6 percent). Approximately half of the rodent remains were identifiable below order. The most common identifiable rodent was pocket gopher (*Thomomys* sp.). Pocket gopher remains included a cranial fragment, a premaxilla, two mandibles, two humeri, and an innominate fragment recovered from pithouse Features 57 and 9357 and intramural pit Feature 3270.02. None of the pocket gopher remains were burned, and more than 50 percent were greater than three-quarters complete. All but two of the pocket gopher elements were covered with a hard sedimentary substance; one was root-etched and one was not environmentally modified.

Additional identifiable rodent remains included an unburned woodrat (*Neotoma* sp.) mandible, humerus, and tibia found in pithouse Features 57 and 218, and a partially charred muskrat (*Ondatra zibethicus*) caudal vertebra recovered from Feature 9357. All of the woodrat and muskrat bones were greater than three-quarters complete. Two of the woodrat bones were environmentally modified—one was partially covered with a hard sedimentary substance, and the other was root-etched. The muskrat vertebra was also partially covered with a hard sedimentary substance. Pocket gopher and woodrat remains have been commonly found at sites in the region (Szuter 1991). Muskrat remains are rare, although they have been noted at some later Tucson Basin sites, including San Xavier Bridge, AZ BB:13:14 (ASM) (Gillespie 1987), and Dakota Wash, AZ AA:16:49 (ASM) (Johnson 1989).

Unidentifiable rodent remains include: a humerus and two tibiae recovered from Features 57 and 3270.02 that were classified as small rodent (mouse-sized); and 2 incisors, a mandible, a scapula, 2 innominates, 2 femora, and 2 tibiae collected from pithouse Features 7, 57, 151, 3294, and 9168, identified as medium rodent (woodrat-sized). Two of the small rodent remains are greater than three-quarters complete, and all three were partially covered with a hard sedimentary substance. The medium rodent bones were more fragmented than the small rodent bones, with only 20 percent of the remains greater than three-quarters complete. However, the majority (80 percent) were greater than half complete. All but one of the medium rodent remains were partially covered with a hard sedimentary substance. The remaining bone was not environmentally modified. A few of the unidentifiable rodent bones were burned, including a small rodent humerus that was light brown in color, as well as a light brown, medium rodent femur; a partially charred innominate; and a calcined innominate. These bones were recovered from Features 7, 151, and 3270.02.

Ethnographic and archaeological evidence (see Cameron 1998; Sobolik 1993; Szuter 1991) indicate rodents were consumed prehistorically by numerous populations; therefore, the burned rodent remains may represent food residue. The possibility that the bones were burned when a pest was disposed of in a fire must also be considered. The light brown, small rodent element was also collected from an intramural feature (Feature 3270.02) that was burned before abandonment and as such, may represent a bone that burned when the feature burned. The relative completeness of the unburned rodent elements suggests many of these remains probably represent more recent, intrusive deposits.

Carnivore remains constituted approximately 1 percent of the assemblage (see Table 13.3). Identifiable carnivore remains were primarily fragments of dog/coyote (*Canis* sp.) elements, including: 5 maxillae, a mandible, 5 teeth, an atlas, 2 thoracic vertebrae, 3 caudal vertebrae, 3 humeri, a tibia, and 5 phalanges. All but four of the remains were recovered from Feature 9357, with two bones each collected from Features 112 and 3312. Slightly more than half of the dog/coyote remains were less than one-quarter complete, with most having some recent breakage. More than 80 percent of the remains were environmentally modified; most were covered with a hard sedimentary substance (n = 17). Two bones were root-etched, and three bones were eroded. A few of the bones were burned, including: a partially charred mandible and tibia; a charred atlas, two caudal vertebrae, and a humerus; and a calcined humerus. All of the burned bones were recovered from Feature 9357. The condition of the bones precluded identifying the remains below genus, although they likely represent domestic dog.

Additional identifiable carnivore remains included a number of fox (*Vulpes/Urocyon*) elements: 2 atlases, a scapula, a radius, a metacarpal, an innominate fragment, a femur, 2 calcanea, and a metatarsal. All but one of the elements were collected from Feature 9357; the other element was recovered from Feature 112. The majority of the elements (n = 8) were less than half complete, most with recent breakage, and all but one of the bones was covered with a hard sedimentary substance. The other bone was not modified. Four of the fox bones were burned, including: a partially charred femur and calcaneus, as well as a charred scapula and metacarpal. These remains were recovered from both of the features that yielded fox bones. Fox elements were not identified more specifically due to a lack of comparative material for all of the fox taxa available in the area. Fox remains are not commonly recovered from faunal assemblages in the region, but have been noted in small numbers at earlier and later sites (Cameron 2003a, 2003c; Szuter and Brown 1986).

A few elements were identified as Canidae (dog/coyote/fox), including a calcined ulna and two unburned innominate fragments collected from Feature 9357. All of the Canidae remains fell in size between the coyote and the fox remains in the comparative collection and could represent immature dog. These remains were all environmentally modified. Unidentifiable carnivore remains included two unburned mandible fragments identified as small carnivore, as well as two charred caudal vertebrae, a charred metacarpal, and an unburned phalange classified as medium carnivore. These remains were recovered from Feature 9357. All but one of the medium carnivore elements were environmentally modified.

Ethnographically, carnivores (dogs) were kept as pets, or their furs and pelts were used to manufacture ceremonial items and costumes (e.g., Henderson and Harrington 1914; Lange 1959). As noted above, most of the Cienega phase carnivore bones were recovered from Feature 9357, a possible communal structure. However, most of these remains were found in postabandonment trash fill, and thus, are unrelated to the original use of that particular feature. It is unclear why several of the carnivore bones were burned, although they could represent refuse disposal practices. They also could represent cooking practices, although, ethnographically, carnivores were not generally noted as food sources.

Artiodactyl remains constituted 3 percent of the Cienega phase assemblage (see Table 13.3). Prehistorically, several artiodactyl genera may have inhabited the site area, including mule deer (*Odocoileus hemionus*), white-tailed deer (*O. virginianus*), antelope (*Antilocapra americana*), and bighorn sheep (*Ovis canadensis*) (Hoffmeister 1986). A lack of comparative material for bighorn sheep, as well as the fragmentary nature of the elements (more than 70 percent were less than one-quarter complete), precluded the identification of most of the artiodactyl remains below order.

The majority of the identifiable artiodactyl remains were deer (*Odocoileus* sp.); deer element types are listed in Table 13.8. Most of the deer bones were environmentally modified, primarily covered with a hard sedimentary substance (*n* = 17, 45 percent). Several bones were eroded, indicating they had been exposed to surface conditions (*n* = 9, 24 percent). A few bones were root-etched (*n* = 3, 8 percent), or exhibited multiple modifications (*n* = 6, 16 percent). Burned deer bones included: 2 partially charred humeri, a carpal, an innominate fragment, 2 femora, a patella, a tibia, and an astragalus; and a charred antler fragment and humerus. Most of the burned bones were recovered from Feature 9357. Additional identifiable artiodactyl remains included three unburned cheek tooth fragments recovered from pithouse Feature 57 and intramural Feature 3327.02; these were classified as Cervidae. All three of these elements were covered, to varying degrees, by a hard sedimentary substance. These elements were larger than the deer in the comparative collection and may represent elk.

Unidentifiable medium artiodactyl elements are listed in Table 13.8. The majority of the medium artiodactyl remains were environmentally modified, with approximately equal numbers of eroded (*n* = 28, 39 percent) elements and bones that were covered to varying degrees by a hard sedimentary substance (*n* = 30, 42 percent). A few bones were root-etched (*n* = 3, 4 percent) or had multiple modifications (*n* = 7, 10 percent). Burned medium artiodactyl remains included: a partially charred tooth, 4 ribs, a scapula, a humerus, 4 innominate fragments, 5 femora, 2 tibiae, and a phalange; and a charred radius, ulna, carpal, 2 femora, and 3 phalanges. Most of the burned medium artiodactyl bones were found in Feature 9357.

A few elements—including two thoracic vertebrae fragments, an unidentifiable vertebra fragment, and an indeterminate carpal—were classified as indeterminate artiodactyl. These remains were recovered from the fill of pithouse Features 57 and 218. None of these remains were burned, but three were eroded, indicating they were exposed to surface conditions. The fourth was not environmentally modified. All of these remains were larger than the deer in the comparative collection.

A number of elements (see Table 13.8) were identified as large mammal and probably represent artiodactyl remains too fragmented to identify. All but one of the large mammal remains were less than one-quarter complete, and more than 90 percent were environmentally modified, most covered with a hard sedimentary substance (*n* = 222, 78 percent). Several others were eroded (*n* = 39, 14 percent), and a few were root-etched (*n* = 3, 1 percent) or had evidence of multiple modifications (*n* = 8, 3 percent). Approximately 50 percent of the remains were burned, including: two partially charred ribs, a scapula, shaft fragments (*n* = 16, 6 percent), and indeterminate elements (*n* = 48, 17 percent); charred shaft fragments (*n* = 22, 8 percent) and indeterminate elements (*n* = 42, 15 percent); a charred/calcined indeterminate element; a calcined rib and indeterminate elements (*n* = 8, 3 percent); and a blue/gray rib and indeterminate elements (*n* = 4, 1 percent).

Ethnographically, artiodactyl resources were used across the Southwest for a variety of purposes including for food, clothing, tools, and raw material for ritual paraphernalia. Artiodactyl meat was consumed in both domestic and ceremonial contexts (Lange 1959; Parsons 1925, 1936; Stevenson 1904). In domestic situations, artiodactyl meat was often shared among families and other members of a village (Parsons 1929; Spier 1928; Underhill 1939). There is little ethnographic mention of large-scale use of artiodactyls for ceremonies, although some researchers have suggested such behavior occurred prehistorically (Akins 1985). Small-scale ceremonial use of deer has been noted, and on occasion—such as the Tohono O'odham annual cleansing ceremony (Underhill 1946)—a single deer played a central role in the ceremony.

After processing, some ethnographic groups disposed of artiodactyl bones in special areas, occasionally away from sites (Underhill 1946; Whitman 1940). Other deer bones were used to make awls, rattles, and musical instruments (Lange 1959; Parsons 1925, 1936), and artiodactyl skulls were often worn as headdresses during hunts (Spier 1928). Deer hunting was generally not a casual occurrence, and many rituals were often associated with deer hunts, including purification rites, dances, and the use of charms (Spier 1928, 1933; Stevenson 1904; Whitman 1940).

Interpreting the role of artiodactyl resources in an archaeological assemblage is complicated due to variables such as the location of the natural habitat of the animals, with relation to the location of the site, transportation issues, butchering practices, bone disposal practices, as well as the influence of other

Table 13.8. Artiodactyl and large mammal elements recovered from Cienega phase contexts at the Clearwater site, AZ BB:13:6 (ASM).

Element	*Odocoileus* sp. [*n* (%)]	Medium Artiodactyl [*n* (%)]	Large Mammal [*n* (%)]
Crania	–	1 (1.4)	–
Maxillae	1 (2.6)	–	–
Mandibles	–	3 (4.2)	–
Teeth	7 (18.4)	4 (5.6)	–
Antlers	3 (7.9)	–	–
Lumbar vertebrae	–	2 (2.8)	–
Unidentifiable vertebrae	–	–	2 (0.7)
Ribs	–	4 (5.6)	9 (3.2)
Costal cartilage	–	–	1 (0.4)
Scapulae	–	4 (5.6)	1 (0.4)
Humeri	3 (7.9)	2 (2.8)	–
Radii	–	2 (2.8)	–
Ulnae	1 (2.6)	1 (1.4)	–
Carpals	2 (5.3)	1 (1.4)	–
Innominates	5 (13.2)	8 (11.3)	–
Femora	4 (10.5)	24 (33.8)	–
Patellas	1 (2.6)	–	–
Tibiae	1 (2.6)	2 (2.8)	–
Astragali	2 (5.3)	–	–
Calcanea	2 (5.3)	–	–
Tarsals	2 (5.3)	–	–
Metatarsals III-IV	1 (2.6)	2 (2.8)	–
Sesamoids	–	–	–
Phalanges	–	–	–
Metapodials III-IV	–	–	–
Carpals/Tarsals	–	–	–
Shaft fragments	–	–	–
Indeterminate elements	–	–	–
Total	38	71	285

Note: Two thoracic vertebrae fragments, an unidentifiable vertebra fragment, and an intermediate carpal were identified as unsized artiodactyl, and three cheek tooth fragments were identified as Cervidae.

cultural behaviors. Additionally, the number of artiodactyl remains recovered is often small, making it difficult to assess some of these variables. However, some general assumptions about artiodactyl use during the Cienega phase can still be made. Femora and innominate fragments—elements that are often considered higher in utility and more likely to be transported longer distances—are the most common element type, suggesting long-distance hunting and differential transport of element types may have occurred. This pattern has been documented in other areas of south-central Arizona (Cameron 1998). The presence of small numbers of elements from other portions of the carcass, however, also indicate that, at least on occasion, some animals were butchered at the site. It is not clear if these animals were transported whole from a long-distance kill site, or if they were killed nearby.

The general distribution of the artiodactyl and large mammal bones in the Cienega phase contexts suggests this resource was not used for large-scale feasting. More than 25 features and intramural features yielded small numbers (generally less than five bones) of artiodactyl and large mammal remains. Feature 9357, the possible ceremonial structure, did yield a large number of these remains, but the proportion of these taxa in that feature is comparable with that noted in other features. Therefore, it is likely that the large number of artiodactyl and large mammal bones recovered from this feature is simply due to excavation volume. Further, none of the artiodactyl and large mammal remains could be directly associated with the original function of the feature because most were recovered from postabandonment fill and none were recovered from floor contexts. Both loci also yielded comparable proportions of these taxa (see Table 13.3). Although the artiodactyl and large mammal remains cannot be directly associated with the ceremonial structure, the possibility that some of the artiodactyl remains were consumed in other, small-scale communal activities, in addition to domestic use, cannot be ruled out.

Fifteen bone artifacts were recovered from a variety of Cienega phase features (see Table 13.2). Most of the bone artifacts were small awl or awl shaft fragments. The possibility that some of these artifacts may have been used as hairpins cannot be ruled out, although because none of the artifacts had any decoration, design, or other morphological features that clearly indicated a function as a hairpin, they are considered awls for this report. Most of the awls were manufactured from large mammal bones—probably artiodactyl elements that had been modified to such an extent they are no longer identifiable. All but one of the worked bones were recovered from the fill of the features. The artiodactyl metapodial recovered from Feature 15 was found on the floor. Environmental modification, primarily a coating of a hard sedimentary substance, on many of the awl fragments made observations of striations and polish difficult. Some light-to-moderate polish was observed on a few awls in unmodified areas. Awls are common bone artifacts recovered at many archaeological sites in southeastern Arizona.

A few elements of indeterminate function were also noted, including a large mammal shaft fragment with a beveled edge (Bag #6279). This specimen may represent a bead fragment. Two other fragments had shaped or flattened edges. It is not clear if these are small fragments of awls, fragments of pendants or gaming pieces, or if they had some other function.

Early Ceramic Period (A.D. 50-500)

More than 30 faunal remains recovered from contexts dating to the Early Ceramic period were analyzed, including 32 unworked bones (Table 13.9) and one worked bone (see also Table 13.2). These remains were collected from two pithouse features, Features 3014 and 3038, and an intramural pit feature, Feature 3038.02, located in the Mission Gardens locus. Similar to the pattern noted for the earlier time periods, the bones in the assemblage were highly fragmented, with the majority of the unworked remains less than one-quarter complete (n = 30, 93.8 percent). Half of the unworked bones exhibited a combination of past and recent breakage (n = 16, 50 percent), indicating recovery procedures and more recent bone handling had some impact on bone fragmentation in the assemblage. The remaining bones exhibited evidence of only past breakage.

Table 13.9. Unworked taxa recovered from Early Ceramic period contexts at the Clearwater site, AZ BB:13:6 (ASM).

Taxa	n (%)
Identifiable mammal (Mammalia)	
Rabbit or hare (Leporidae)	1 (3.1)
Cottontail (*Sylvilagus* sp.)	1 (3.1)
Medium artiodactyl (deer-sized)	3 (9.4)
Unidentifiable mammal	
Unsized mammal	9 (28.1)
Small mammal	5 (15.6)
Medium mammal	1 (3.1)
Large-medium mammal	3 (9.4)
Large mammal	9 (28.1)
Total	32 (100.0)

Environmental modification was noted on slightly more than one-quarter of the bones (n = 9, 28.1 percent). Most of the environmentally modified bones were covered, to varying degrees, by a hard unidentifiable sedimentary substance (n = 6, 66.7 percent). Two bones were root-etched, and one bone was eroded. Overall, the proportion of environmentally modified bones in this assemblage is much lower than the proportions noted for the earlier assemblages. While varying (and for three assemblages, small) sample sizes make it difficult to interpret the meaning of this difference, some of the difference may be related to the fact that the Early Ceramic assemblage was recovered from the Mission Gardens locus, while the assemblages from the other time periods were recovered from the San Agustín Mission, Brickyard, and Congress Street loci. This pattern suggests taphonomic conditions varied in this locus, compared with the other loci, impacting bone preservation in uncertain ways.

More than two-thirds of the bones were burned (n = 23, 71.9 percent), with equal numbers of partially charred (n = 11, 48 percent) and calcined (n = 11, 48 percent) bones. One bone was charred. The overall proportion of burned remains and the relatively high proportion of calcined bones in this assemblage differ markedly from the patterns observed in the earlier assemblages. Unfortunately, due to the small sample size of this and many of the earlier assemblages, it is not clear if these differences are due to behavioral differences, contextual differences, sample size, or a combination of these and other factors. Most of the burned remains were unidentifiable mammal (*n* = 8, 35 percent), small mammal (*n* = 4, 17 percent), and large-medium mammal (*n* = 3, 13 percent). Burned bones were recovered from all three Early Ceramic features, with most recovered from Feature 3014 (*n* = 15, 65 percent) and Feature 3038 (*n* = 7, 30 percent).

All of the remains analyzed from Early Ceramic period contexts were identified as mammals. Slightly more than 10 percent of these remains were identifiable below class, including a calcined indeterminate rabbit femur and an unburned cottontail femur recovered from Feature 3014. Both of these elements were less than half complete, and the cottontail femur was environmentally modified (root-etched). Due to the small number of rabbit bones, an assessment of rabbit use during this time period cannot be made.

Additional identifiable remains included a medium artiodactyl charred radius and a partially charred ulna recovered from Feature 3038; and an unburned medium artiodactyl radius found in Feature 3014. All of these elements were less than one-quarter complete, and the two elements from Feature 3038 were partially covered with a hard unidentifiable sedimentary substance. The radius from Feature 3014 was eroded, suggesting it had lain on the surface prior to burial.

Nine large mammal elements, which may represent artiodactyl remains too fragmented to identify, were also recovered from Features 3014 and 3038. These elements included an indeterminate vertebra fragment, two shaft fragments, and six indeterminate elements. All of these elements were less than one-quarter complete, and three of the elements were environmentally modified—two were partially covered with a hard sedimentary substance and another was root-etched. Some of the large mammal remains were partially charred, including the vertebra fragment, the two shaft fragments, and two of the indeterminate elements.

Overall, the proportion of artiodactyl and large mammal remains in this assemblage is much greater than that noted for the earlier assemblages. This pattern may reflect a difference in an emphasis on artiodactyl resources; however, given the small sample size of this and some of the other assemblages, any interpretation of behavioral differences is problematic.

One small worked bone (see Table 13.2) was recovered from Feature 3014. This is a possible awl fragment manufactured from a large-medium sized mammal element. Moderate polish was noted in a few areas along the edge of the artifact. The small size of the element precluded a more definitive identification of the tool type and any specific functions.

Hohokam Sequence (A.D. 750-1450)

Thirteen faunal remains recovered from contexts dating to Hohokam periods were analyzed, including 11 unworked elements (Table 13.10) and two worked bones (see also Table 13.2). These remains were collected from three pithouse or possible pithouse features in two areas: Feature 2 in RNA 2 and Features 3293 and 9376 in RNA 8. Similar to the pattern noted for the prior two time periods, the unworked bones in the Hohokam assemblage were highly fragmented, with most being less than one-quarter complete (*n* = 10, 90.9 percent). Slightly less than three-quarters of the unworked bones exhibited a combination of past and recent breakage (*n* = 8, 72.7 percent), which suggests recovery procedures and more recent bone handling had some impact on the degree of bone fragmentation in the assemblage. The remaining bones exhibited evidence of only past breakage (*n* = 3, 27.3 percent).

Table 13.10. Unworked taxa recovered from Hohokam period contexts at the Clearwater site, AZ BB:13:6 (ASM).

Taxa	*n* (%)
Identifiable mammal (Mammalia)	
Rabbit or hare (Leporidae)	1 (9.1)
Black-tailed jackrabbit (*Lepus californicus*)	3 (27.3)
Unidentifiable mammal	
Unsized mammal	5 (45.5)
Small mammal	1 (9.1)
Large mammal	1 (9.1)
Total	11 (100.0)

More than 80 percent of the unworked bones were environmentally modified (*n* = 9, 81.8 percent)—all covered to varying degrees by a hard unidentifiable sedimentary substance. The proportion of environmentally modified bones, as well the type of modification, are comparable to the patterns noted in the earlier assemblages. Similar to the strata 503/504 assemblage, no gnawed bones were noted, which suggests carnivores had relatively little impact on this assemblage.

Slightly less than half the unworked bones were burned (*n* = 5, 45.5 percent), with roughly equal numbers of partially charred (*n* = 3, 60 percent) and calcined (*n* = 2, 40 percent) bones. No charred bones were noted. The proportion of burned bones in this assemblage is comparable with the proportions of burned bones noted for the two earlier assemblages. Burned bones were recovered from all three Hohokam features. The absence of charred bones is probably related to the small size of the Hohokam assemblage.

All of the remains analyzed from Hohokam period contexts were identified as mammals. Slightly more than one-third of the unworked remains were identifiable below class, and all of these were rabbit (see Table 13.9). Rabbit elements included fragments of an unburned black-tailed jackrabbit scapula, a partially charred ulna, and a partially charred metatarsal collected from Features 3293 and 9376, as well as an indeterminate rabbit unburned tibia found in Feature 3293. All but one of the rabbit bones, a jackrabbit element, were less than half complete, with some of the breakage occurring recently. All of the black-tailed jackrabbit bones were also environmentally modified. The indeterminate rabbit remain was not modified. Overall, the proportion of rabbit remains in the Hohokam assemblage is slightly greater than the proportions noted for the two earlier assemblages (approximately 25 percent). However, due to varying and often small sample sizes, more detailed comparisons and observations about rabbit use cannot be made.

A partially charred large mammal indeterminate element, which may represent an artiodactyl remain too fragmented to identify, was recovered from Feature 2. This element was less than one-quarter complete and partially covered with a hard sedimentary substance. The recovery of only a single unworked large mammal element precludes any observations about artiodactyl or large mammal use.

Two worked bones—which may represent a single awl based on similar morphological and taphonomic features—were also analyzed (see Table 13.2). These artifacts were recovered from Feature 3293, but could not be refit. More specific functions of the worked bones could not be determined due to their small size and poor condition. Much of the surface area of the bones was covered with a hard sedimentary substance. Moderate polish was observed in some areas without environmental modification.

Tucson Presidio, AZ BB:13:13 (ASM)

A total of 69 faunal remains recovered from the Tucson Presidio site were analyzed (Table 13.11). All of these remains were recovered from four Hohokam features located in area RNA 12. These features included two pithouses (Features 406 and 417), a possible pithouse (Feature 380), and a small pit (Feature 350.02). The site is located in downtown Tucson, a few hundred meters east of the Santa Cruz River. A large historic-era component, including a Spanish period presidio, is present at the site and overlies the prehistoric contexts.

Similar to the assemblages at the Clearwater site, most of the bones in this assemblage were less than one-quarter complete (*n* = 63, 91.3 percent) and slightly more than half of the bones exhibited a combination of past and recent breakage (*n* = 37, 53.6 percent). Unlike the other assemblages, however, about one-quarter of the bones in this assemblage had only recent breakage (*n* = 16, 23.2 percent). This relatively high proportion suggests recovery procedures and more recent bone handling had greater impact on the degree of bone fragmentation in this assemblage. About one-fifth of the bones exhibited evidence of only past breakage (*n* = 14, 20.3 percent). Only two bones were unbroken.

Slightly more than one-third of the remains were environmentally modified (*n* = 24, 34.8 percent). The majority of the environmentally modified bones were eroded (*n* = 18, 75.0 percent) or root-etched (*n* = 4, 16.7 percent). One bone was sun bleached, and another exhibited a combination of environmental modifications. The relatively high percentage of eroded bones in this assemblage suggests the faunal remains may not have been buried as quickly at this site, or the contexts were disturbed, exposing previously buried bones to surface conditions. Either scenario would result in poorer preservation. This

Table 13.11. Unworked taxa recovered from Hohokam period contexts at the Tucson Presidio, AZ BB:13:13 (ASM).

Taxa	*n* (%)
Bird (Aves)	
Surface-feeding ducks (Anatinae)	1 (1.4)
Medium-small bird	1 (1.4)
Identifiable mammal (Mammalia)	
Small rodent	1 (1.4)
Medium artiodactyl (deer-sized)	2 (2.9)
Domestic cow (*Bos taurus*)[a]	4 (5.8)
Unidentifiable mammal	
Unsized mammal	29 (42.0)
Small mammal	1 (1.4)
Large-medium mammal	16 (23.2)
Large mammal	13 (18.8)
Indeterminate vertebrate	1 (1.4)
Total	69 (100.0)

[a]Site has a large historic-era component, and these elements undoubtedly originated from that occupation.

pattern could also account, at least in part, for the higher proportion of bones with only fresh breaks in the assemblage. Eroded bones are often more fragile, and therefore, more likely to break during excavation, or even in the specimen bags, than bones that have not been exposed to weathering processes. No gnawed bones were noted.

Less than one-fifth of the remains were burned (*n* = 10, 14.5 percent), with the majority of the burned remains being calcined (*n* = 8, 80 percent of the burned material). Only one charred and one partially charred bone were identified. The proportion of burned bones in this assemblage is much lower than that noted for the other assemblages. Unfortunately, it is unclear if these differences are related to behavioral differences, differences in the types of contexts from which the burned remains were recovered, taphonomic differences, sample size differences, or a combination of these and other factors. Most of the burned remains were unidentifiable mammal (*n* = 8, 80 percent) bones. Burned bones were recovered from three of the four features—most from Feature 406 (*n* = 6, 60 percent). Feature 380, which had a sample size of one, did not yield any burned bones.

All but two of the remains in the assemblage were identified as mammals (see Table 13.11). Non-mammalian remains included an unburned surface feeding duck (Anatinae) radius and an unburned medium-small bird vertebra collected from Feature 406. Both of these elements were complete, and the vertebra was not environmentally modified; the duck radius was sun bleached. The bones were generally in good condition, and they may represent more recent deposits. The recovery of historic cow bones in Feature 406 (see below) indicates this feature had been disturbed or contaminated with more recent deposits.

Identifiable mammal remains constituted approximately 10 percent of the assemblage. These remains included an unburned small rodent innominate recovered from Feature 380. Based on bone condition and color, this element is thought to represent a more recent, intrusive deposit. Additional identifiable mammal remains included two medium artiodactyl vertebrae fragments, one charred, recovered from Feature 406. Both of these elements were less than one-quarter complete, but only one exhibited evidence of recent breakage. Neither of the bones were environmentally modified.

Several large mammal indeterminate elements, as well as an atlas fragment, were recovered from Features 350.02, 406, and 417. All of the large mammal elements, which may represent artiodactyl remains too fragmented to identify, were less than one-quarter complete—many with a combination of past and recent damage. More than half of these elements were environmentally modified, primarily eroded (*n* = 6, 46.2 percent). Two bones were root-etched. A large mammal indeterminate element was calcined. Overall, the proportion of artiodactyl and large mammal remains in this assemblage is much greater than the proportions noted for the Hohokam and earlier assemblages at Clearwater. This pattern may reflect a difference in emphasis on artiodactyl resources; however, given the small sample size of many of the assemblages, as well as the possibility of disturbed contexts and poorer preservation at the Tucson Presidio, any interpretation of behavioral differences is problematic.

Four cow (*Bos taurus*) phalange fragments were also recovered from Feature 406, including the remains of two first phalanges and two third phalange fragments that may represent a single element. None of the cow bones were burned, and all but one have an eroded surface area. Three of the elements were less than half complete, and all had only fresh breaks. Given the nature of the contexts from which these bones were recovered, it is not clear if they represent an earlier or later Historic era use of the area.

Summary and Conclusions

The faunal assemblages from both sites were dominated by mammal remains. Except the Early Ceramic period contexts at Clearwater and the disturbed Hohokam contexts at the Tucson Presidio, the most common identifiable mammal was rabbits, particularly jackrabbits. This is typical for the assemblages of many prehistoric southeastern Arizona sites (Cameron 1998; Szuter 1991), although the Cienega phase contexts at Clearwater had a higher proportion of jackrabbits than expected, compared with later, larger Hohokam agricultural villages. Worked or unworked artiodactyl and large mammal bones were recovered for all temporal contexts.

Small sample sizes precluded interpretations about artiodactyl exploitation for many of the temporal phases. For the Cienega phase, the data suggested long-distance hunting and differential transport of elements may have occurred, although whole carcasses appear to have been butchered at the site on occasion. Although a possible communal structure dating to this phase was excavated, no evidence for utilizing artiodactyl resources in large-scale feasting activities was noted; nor could any of these remains be directly associated with any activities conducted in the structure. Artiodactyls may have been used for other communal activities and smaller-scale feasts, however. Communal activities may also account, in part, for the relatively high proportion of jackrabbits in this phase.

Burned rodent elements recovered from Cienega phase contexts provided some evidence that rodents may have been consumed occasionally, although many of the rodent remains appear to represent intrusive deposits. Many of the non-mammalian remains also appear to represent a combination of intrusive and cultural deposits, with the most likely cultural deposits being the turtle remains. Only one of the bird remains, a possible crow wing phalanx from the Cienega phase at Clearwater, appears to represent a cultural deposit. The paucity of bird remains in the assemblages is unusual. Ethnographic and archaeological evidence have indicated that ground-dwelling birds, such as quail, were used as meat resources (Cameron 1998; Henderson and Harrington 1914; Lange 1959). Raptors and several types of small birds were used to provide feathers for dance costumes and other ritual items (Henderson and Harrington 1914; Lange 1959; Underhill 1946). It is not clear why birds were not recovered in greater quantities, particularly for the Cienega phase contexts, which had a large sample size. No fish remains were noted, even though the sites are located relatively close to the Santa Cruz River. The absence of fish is not entirely surprising, however, as fish are not commonly recovered in archaeological sites in the region. Possible explanations for the absence of fish remains have included poorer preservation of fish bones, recovery procedures, and prehistoric dietary preferences.

VERTEBRATE FAUNAL REMAINS FROM THE SPANISH AND MEXICAN PERIOD FEATURES AT THE TUCSON PRESIDIO, AZ BB:13:13 (ASM)

Meat was an important part of the diet for the Spanish and Mexicans living in the Tucson Presidio. During the 2003 excavations at the site, 3,789 animal bone fragments were collected from six features dated primarily to the Spanish and Mexican periods (1694 to 1856). Two analyses of much smaller faunal assemblages from the Tucson Presidio that dated to the same periods were previously conducted (Diehl and Waters 2004; Thiel and Faught 1995). Based on the animal bones recovered, domestic taxa provided most of the meat consumed by presidio residents. Chickens, pigs, sheep or goats, and cattle were butchered inside the presidio walls, although beef comprised the largest portion of the meat diet. Traditional butchering methods using axes, cleavers, and knives were utilized to dismember carcasses and to divide body parts into edible portions. Comparisons with other Spanish and Mexican period faunal assemblages from the Tucson area show similarities in the types and proportions of animals used. Traditional butchering techniques gave way to the methods of the modern meat-packing industry by the turn of the nineteenth century.

Methods

All faunal material recovered from ¼-inch dry screening was analyzed to some degree. The NISP was tabulated for all identifiable taxa; identifiable includes all specimens identified at or below the order level. The identification of faunal specimens was assisted by the Western Archeological and Conservation Center (WACC) and Stanley J. Olsen comparative collections at the Arizona State Museum (ASM), as well as several references (Gilbert 1990; Gilbert et al. 1981; Hoffmeister 1986; Olsen 1964, 1968, 1979; Peterson 1990; Sisson 1953; Stebbins 1985). Fragments from recently broken identifiable specimens were refitted when possible and counted as one. Bone surface modifications resulting from both cultural and natural agents were recorded. The minimum number of individuals (MNI) was calculated for each discrete taxon based on the site total. Recorded variables for identifiable bone included provenience, taxon, element, element part and side, degree of fusion, amount present, degree of burning, and other surface modifications, including butchering marks.

Unidentifiable bone comprised 79 percent of the bone fragments. Unidentifiable large mammal (pig-/sheep-/cattle-sized) and very large mammal (horse-/cattle-sized) bone scrap was counted and weighed, but not otherwise analyzed unless it was identifiable to element, had butchering marks, or exhibited burning. These data were recorded for use in the butchering and body part representation tabulations. Other specimens were recorded by class and size; for example, medium bird (chicken-sized), small mammal (rabbit-/rodent-sized), and medium mammal (dog-/coyote-sized). Due to the small size of most bone fragments, refitting was not attempted for the unidentifiable bone; consequently, each fragment was counted as one.

The large proportion of unidentifiable bone is primarily the result of a combination of preservation problems and excavation techniques. Much of the bone exhibited traces of gypsum (calcium sulfate) crystals. This substance weakens the structure of the bone so that a single blow with a shovel reduces even complete elements into fragments. Most of the unidentifiable specimens are very large mammal long bone shaft pieces. Based on the distribution of taxa in the identifiable assemblage, these are probably cattle bone.

Identified Taxa

The majority (63 percent) of identifiable bone was from cattle (*Bos taurus*) (Table 13.12). Other domestic taxa comprised 19 percent of the identifiable assemblage, including chicken (*Gallus gallus*), possible chicken (cf. *Gallus gallus*), horse/mule/donkey (*Equus* sp.), pig (*Sus scrofa*), and sheep/goat (*Ovis aries/Capra hircus*). Wild taxa made up 12 percent of the assemblage, including one fish, an unspecified sucker (Catostomidae); two birds, dove (*Zenaida* sp.) and raven (*Corvus corax*); and four mammals, including jackrabbit (*Lepus* sp.), pocket gopher (*Thomomys* sp.), pocket mouse (*Perognathus* sp.), and deer (*Odocoileus* sp.). The remaining 6 percent are from either domestic or wild taxa. Dog/coyote/wolf (*Canis* sp.) may represent domestic dog (*Canis familiaris*), coyote (*Canis latrans*), or wolf (*Canis lupus*). Unidentified artiodactyl and medium artiodactyl (Artiodactyla) contain identifiable elements from artiodactyls of unknown size and pig/sheep/deer size, respectively.

The meat diet of the presidio residents was comprised almost entirely of domestic animals, with cattle being consumed most often. Very few wild food taxa are present in the assemblage. The sucker, dove, jackrabbit, and deer specimens are presumedly food remains. The remaining wild taxa, including pocket gopher and pocket mouse, probably represent recent, intrusive specimens, based on their unweathered bone surfaces. One unusual occurrence in the wild taxa is the raven from Features 420 and 423; the 34 total specimens belong to the same individual. All parts of the skeleton are represented, indicating the bird was relatively complete when buried. It may have been captured and treated as a pet. If the canid specimens belong to domestic dog, they were likely pets as well.

The MNIs for each discrete taxon are shown in the last column in Table 13.12. Most discrete taxa in the Tucson Presidio assemblage have a MNI of one. Exceptions include chicken, dog/coyote/wolf, pig, sheep/goat, and cattle. Multiple individuals were identified by differences in size, repetitions in element representation, and variations in bone development or estimated age. The ageing of domestic animals within animal husbandry has a long history. For example, the eruption of teeth occurs at regular intervals in pig, sheep, and cattle and provides a guide to the ages of the individuals represented (e.g., Silver 1970; Sisson 1953). Epiphyseal fusion rates for postcranial elements are also established and provide age range estimates for domestic taxa (e.g., Silver 1970).

Table 13.12. Taxa represented among identifiable bone (number of identified specimens) in features from the Tucson Presidio, AZ BB:13:13 (ASM).

	Features						
Taxon	373	409	420[a]	422	423[a]	441	Taxon Total[b]
Unspecified sucker (Catostomidae)	–	1	–	–	–	–	1/1 (<1)
Chicken (*Gallus gallus*/cf. *Gallus gallus*)	8	22	–	–	–	2	32/4 (8)
Dove (*Zenaida* sp.)	1	–	–	–	–	–	1/1 (<1)
Raven (*Corvus corax*)	–	–	31	–	3	–	34/1 (9)
Jackrabbit (*Lepus* sp.)	–	–	–	1	–	–	1/1 (<1)
Pocket gopher (*Thomomys* sp.)	2	–	4	–	–	–	6/1 (2)
Pocket mouse (*Perognathus* sp.)	–	–	–	–	1	–	1/1 (<1)
Dog/Coyote/Wolf (*Canis* sp.)	2	5	–	–	–	–	7/2 (2)
Horse/Mule/Donkey (*Equus* sp.)	–	10	–	–	–	2	16/1 (4)
Unidentified artiodactyl (Artiodactyla)	–	1	–	–	–	3	4 (1)
Medium artiodactyl (pig-/sheep-/deer-sized)	6	4	–	–	–	2	12 (3)
Pig (*Sus scrofa*)	–	9	–	–	–	1	10/2 (3)
Deer (*Odocoileus* sp.)	–	2	–	–	–	–	2/1 (1)
Sheep/Goat (*Ovis aries/Capra hircus*)	5	11	1	–	–	3	20/2 (5)
Cattle (*Bos taurus*)	36	152	26	10	1	22	247/5 (63)
Feature total	60	217	64	11	5	35	394/23 (101)

[a]Feature 420 cuts into Feature 423; looks as if there is some mixing of deposits and most of Feature 423 belongs with Feature 420?

[b]NISP/MNI; percentage of identifiable assemblage in parentheses.

Minimally, four chickens are present in the presidio assemblage, predicated on age and element representation. Based on modern comparative material, there is at least one individual aged 2-3 months at death and one individual aged approximately 6 months at death. At least two adults are present in the assemblage based on two left proximal radii.

The two dog/coyote/wolf individuals are differentiated by size. One specimen from Feature 409 is much larger than the others and is in the size range of a large dog or wolf, rather than a medium-large dog or coyote.

At least two pigs are represented in the assemblage and are differentiated by age. Two pig mandibles were recovered from Feature 409. One is an adult older than 20 months with all teeth erupted. The other is a juvenile aged between 4-12 months at death, based on the presence of a deciduous fourth premolar and permanent first molar (Silver 1970; Sisson 1953). One unfused long bone, a distal radius (which fuses at 3.5 years), was also identified. None of the other pig specimens could be aged.

At least two sheep/goat individuals are present in the Tucson Presidio assemblage, based on epiphyseal fusion rates (Table 13.13). One individual was less than 1.5-2 years of age at death, based on two unfused distal tibiae—one from each side of the body. The other individual was older than 3 years at death, based on one fused distal radius.

The standard MNI calculation for the cattle specimens in the presidio assemblage yields a minimum of five individuals. At least four adult or subadult individuals are represented by four right and four left proximal metacarpals and four right calcanei.

Table 13.13. Epiphyseal fusion rates for sheep/goat and cattle specimens from the Tucson Presidio, AZ BB:13:13 (ASM).

Element	Fused	Unfused	Age at Fusion[a]
Sheep/Goat			
Distal first phalanx	3	–	Before birth
Distal humerus	1	–	10 months
Proximal first phalanx	2	–	13-16 months
Distal tibia	–	2 (1 fusing)	1.5-2 years
Distal radius	1	–	3 years
Proximal humerus	–	1	3-3.5 years
Cattle			
Proximal metacarpal	8	–	Before birth
Proximal metatarsal	6	–	Before birth
Distal first or second phalanx	48	–	Before birth
Distal humerus	1	–	12-18 months
Proximal radius	2	–	12-18 months
Proximal first or second phalanx	43	2	1.5 years
Distal metacarpal	2	–	2-2.5 years
Distal tibia	2	1	2-2.5 years
Distal metapodial[b]	1	6	2-3 years
Distal metatarsal	3	–	2.5-3 years
Calcaneus	1	–	3-3.5 years
Proximal femur	–	3	3.5 years
Proximal humerus	–	1	3.5-4 years
Distal radius	1	3	3.5-4 years
Distal ulna	–	4	3.5-4 years
Distal femur	1	–	3.5-4 years
Proximal tibia	1	1	3.5-4 years
Innominate	3	–	4.5 years
Vertebral body	1	5	5 years

[a]Silver 1970.
[b]Combination of metacarpal and metatarsal fusion rates.

Based on comparison with modern skeletal material, one calf (less than 6 months old) is represented by a metatarsal shaft from Feature 420. The ages of the adult individuals range from less than 1.5 years to more than 5 years old (see Table 13.13). Additionally, two adult (older than 2-2.5 years) mandibles with all teeth erupted represent two of the individuals. This age profile, with individuals aged from less than 6 months to over 5 years, shows that animals of all ages except the very old were killed and that some of the cattle were used for purposes other than food. Most animals raised primarily for food are slaughtered before they are fully grown, although a small number are kept alive for breeding. The use of cattle for draft or dairying would result in more animals living to an older age (Landon 1996:96).

The following analyses include an additional 484 unidentifiable specimens, bringing the total to 876 analyzed specimens. These additional specimens were recorded in the database because they exhibit butchering marks or evidence of burning.

Bone Surface Modifications

Bone surface modifications resulting from both cultural and environmental processes were present on much of the faunal material from the Tucson Presidio. Cultural processes, such as burning and butchering, are biostrationomic, occurring before burial (Lyman 1994b:402). Modifications by environmental processes tend to occur after burial.

Environmental Modifications

The assemblage from the Tucson Presidio was in fair to poor condition. A total of 386 (44 percent) analyzed specimens exhibit postdepositional bone surface modifications from environmental factors. Erosion affected the largest number of modified specimens (*n* = 175). Erosion is most commonly associated with exposure to sunlight, moisture, and temperature fluctuations before bone is buried (Behrensmeyer 1978). Traces of gypsum were noted on 75 specimens. Gypsum forms in soil under different circumstances; for example, when, under the proper conditions, autotrophic sulfur bacteria produce sulfuric acid in the presence of calcium carbonate (caliche) or calcium phosphate (hydroxyapatite), the latter of which is the inorganic component comprising 70 percent of bone (Lyman 1994b:72; Waksman 1952:67). Further, substances such as gypsum may be formed from solutes carried through the soil by water. Gypsum crystals often co-occur with surface erosion on bones in the Tucson Presidio assemblage. This combination of environmental weathering led to the destruction of many bone surfaces and was responsible for much of the breakage leading to the large proportion of unidentifiable bone.

Sixty specimens exhibited root-etching. Root-etching is thought to result from the acidic secretions of plant roots, although whether the acid is secreted by the roots themselves or by the fungi associated with decomposing roots is unknown (Grayson 1988:30; Lyman 1994b:375). Root-etching may have occurred either before or after burial. Caliche-coating, covering less than 50 percent of bone surfaces, was present on 52 specimens. Caliche-coating on bone results from the precipitation of calcium carbonate. In an arid environment with high rates of evapotranspiration, calcium carbonate is distributed throughout the soil horizon. The depth of dense accumulations of caliche depends on soil moisture and texture (McFadden and Tinsley 1985:30-32).

Twenty-one specimens were stained. Dark-colored staining on bone from the Tucson Presidio was likely caused by manganese oxide in the soil matrix (Brain and Sillen 1988:464, cited in Lyman 1994b:421). Only three specimens were abraded; abrasion is usually the result of "the tumbling of bones in a liquid that contains sediment" (Lyman 1994b:185). However, several processes other than fluvial transport can abrade bone, such as trampling and eolian activity (Lyman and references cited 1994b:187).

Evidence of animal damage was present on only 34 specimens. Carnivore gnawing was observed on 18 analyzed specimens; five occurrences were indeterminate gnawing. Two specimens show signs of carnivore digestion. Nine specimens from Feature 420 exhibited "bore holes," possibly from insects (cf. Lyman and references cited 1994b:393-394).

Bone Tools

Three very large (horse-/cattle-sized) mammal specimens were modified by Tucson Presidio residents into bone tools (Figure 13.1). One long bone

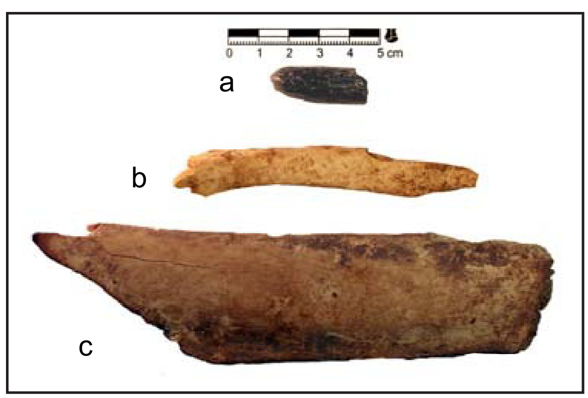

Figure 13.1. Bone tools from the Tucson Presidio, AZ BB:13:13 (ASM).

shaft from Feature 423 (FN 4217) exhibits scrapes where it was formed into a blunt point for an unknown use (see Figure 13.1a). This specimen is completely charred. One awl-like implement from Feature 441 (FN 4274) was fashioned out of a rib shaft (see Figure 13.1b). One distal rib from Feature 409 (FN 4240) was chopped diagonally through the shaft, ground to a point, and the point fire-hardened for use as an awl-like implement (see Figure 13.1c). One large mammal (pig-/sheep-/cattle-sized) mandible fragment was also ground down on one edge for an unknown use.

Prior to the 1850s, imported goods in Tucson were in short supply and those that were available were very expensive (Faught et al. 1995:42). People had to make do with what they brought with them and with what they could make on site. There were no shops selling manufactured goods until later in the Mexican period. Many residents reworked and reused their metal implements for as long as possible. The bone tools in the presidio assemblage are very crudely made and may represent quick substitutes for metal tools.

Burning

Twelve percent (*n* = 109) of the assemblage exhibits evidence of burning. The burned bone was grouped into four categories: partially charred, charred (black), charred/calcined, and calcined (blue/gray or white). Burning colors generally indicate the length of exposure to heat and/or the temperature of the fire. Higher temperatures and longer burning periods produce bone colors from brown to black to gray to white (Gilchrist and Mytum 1986:31). Most bones recovered from archaeological sites were probably not burned during cooking (Lyman 1994b:384). More often, bone was burned after being tossed into the cooking fire after consumption of the meat, through trash burning, as fuel for fires, or through the intentional burning of structures after abandonment (Haury 1976:115; Lyman 1994b:388).

Charred (*n* = 32), charred/calcined (*n* = 19), and calcined (*n* = 4) bone comprises 51 percent of the burned bone from the Tucson Presidio. Partially charred specimens (*n* = 54) comprised the remainder (49 percent) of the burned assemblage and may represent bone from meat that was roasted. However, the charred and calcined specimens were probably the result of incineration rather than food preparation, based on the intensity of burning (cf. Gilchrist and Mytum 1986:36). Individual pit features produced both burned and unburned specimens, indicating much of the bone was burned prior to its final deposition (cf. Stahl and Zeidler 1990, cited in Lyman 1994b:392).

Butchering Marks

Butchering marks were observed on 407 specimens, or 47 percent of the analyzed assemblage. Nearly all (*n* = 373, 92 percent) of the specimens with butchering marks exhibited chopmarks made by axes or cleavers. These marks indicate dismemberment and division of the carcass into edible portions. The large number (*n* = 226) of long bone shaft fragments with chopmarks may indicate breakage for marrow as well. Far fewer specimens exhibited cutmarks (*n* = 16, 4 percent) made by a thin blade, probably the result of skinning and defleshing. Seventeen specimens (4 percent) display both chopmarks and cutmarks. One specimen from Feature 441, a cattle lumbar vertebra, exhibits parallel sawmarks. Because it is the only recorded specimen with sawmarks, it may be an intrusion from later contexts at the site.

Element Representation and Butchering Practices

The element representation and incidence of butchering marks on pig, sheep/goat, and other identifiable artiodactyl specimens from the Tucson Presidio are shown in Table 13.14. Only 10 specimens were positively identified as pig; half are skull parts, including 1 squamous temporal, 2 mandibles, and 2 isolated teeth. Postcranial pig elements consist of 1 rib, 1 radius, and 3 fibulae. The sheep/goat skeleton was better represented, with 20 specimens. Identified elements include: 1 maxillary molar, 1 thoracic vertebra, 1 sacrum, 3 humeri, 1 radius, 1 ilium, 2 femora, 2 tibiae, 3 tarsals, 1 metapodial, and 4 phalanges. The six medium artiodactyl specimens identifiable to element are mostly axial elements, including 2 vertebrae, 2 ribs, and 1 innominate, and are probably either pig or sheep. One medium artiodactyl first phalanx from Feature 373 is either sheep or deer.

Butchering marks on pig specimens occur on postcranial elements only, and all of these butchering marks are chopmarks (*n* = 5). Sheep/goat specimens with butchering marks (*n* = 7) are mostly limb bones except one ilium; all are chopped. One medium artiodactyl rib has a cutmark, and one vertebra and one innominate display chopmarks. Due to the small sample sizes, it is not possible to interpret the sheep/goat and pig element representation and estimate the carcass apportionment for each taxon. However, because skull and foot elements are present and the butchering marks are almost exclusively chopmarks, complete animals appear to have been butchered within the presidio walls using traditional methods.

Table 13.14. Pig, sheep/goat, and identifiable artiodactyl elements from the Tucson Presidio, AZ BB:13:13 (ASM).

Taxon	Element	Butchering Marks	Number of Identifiable Specimens
Feature 373			
Medium artiodactyl	Thoracic vertebra	Chopmarks	1
	Rib	None	1
	Phalanx	None	1
Sheep/Goat	Sacrum	None	1
	Humerus	Chopmarks	1
	Ilium	Chopmarks	1
	Naviculo-cuboid	None	1
	Phalanx	None	1
Feature 409			
Pig	Mandible	None	2
	Rib	Chopmarks	1
	Radius	Chopmarks	1
	Fibula	Chopmarks	3
Sheep/Goat	Maxillary molar	None	1
	Thoracic vertebra	None	1
	Humerus	Chopmarks (1)	2
	Radius	Chopmarks	1
	Femur	None	1
	Tibia	Chopmarks	1
	Astragalus	None	1
	Metapodial	None	1
	Phalanx	None	2
Feature 441			
Medium artiodactyl	Unidentified vertebra	None	1
	Ischium/Acetabulum	Chopmarks	1
Pig	Squamous, temporal	None	1
Sheep/Goat	Femur	Chopmarks	1
	Tibia	Chopmarks	1
	Astragalus	None	1

Note: Feature 420 contained one sheep/goat first phalanx without butchering marks; Feature 423 had one medium artiodactyl rib with cutmarks.

To offset some of the effects of fragmentation on the NISP (Grayson 1984), the minimum number of elements (MNE) was calculated and then standardized for cattle anatomical portions after Stiner (1994:240). The MNE for selected portions of the cattle skeleton are shown in Table 13.15. Large mammal specimens identifiable to element are also included in Table 13.15 on the assumption that most are from cattle. The standardized MNEs are composed of the raw MNE counts collapsed into seven anatomical regions. The MNE for each region was calculated using the most common portion of each unpaired element and the sum of the rights and lefts of the most common portion, usually an articular end, of each type of paired element.

The seven regions include: the head (maxillae and mandibles), axial column (ribs, vertebrae, and innominates), upper front limbs (scapulae and humeri), lower front limbs (radii, ulnae, and metacarpals), upper hind limbs (femora), lower hind limbs (tibiae and metatarsals), and the feet (phalanges). The MNEs are summed for each anatomical region and then divided by the expected number of MNEs per anatomical region to obtain the standardized MNE. Each

Table 13.15. Body part representation (minimum number of elements, or MNE) of cattle and large mammal specimens identifiable to element from the Tucson Presidio, AZ BB:13:13 (ASM).

Body Part	Feature 373	Feature 409	Feature 420	Feature 422	Feature 441	rMNE[a]	sMNE[b]	sMNE/MNI[c]
Skull	2	4	1	0	7	14	3.50	1.00
Axial	11	33	6	4	5	59	1.20	0.34
Upper front	2	4	0	2	0	8	2.00	0.57
Lower front	3	12	2	2	1	20	3.33	0.95
Upper hind	2	3	1	0	1	7	3.50	1.00
Lower hind	2	12	4	0	2	21[d]	2.63	0.71
Feet	1	36	2	2	1	52	2.25	0.64

[a]Total raw MNE.
[b]Total standardized MNE.
[c]Anatomical completeness index.
[d]Includes one metatarsal from Feature 423.

standardized MNE represents a bone-based MNI estimate for each of the seven regions (Stiner 1994:241). The highest standardized MNE serves as the estimated number of carcasses represented. Figure 13.2 illustrates the MNI percentages based on the standardized MNEs from Table 13.15, using the standardized MNEs for the skull and upper hind regions (3.50) as 100 percent.

As shown in Figure 13.2, the skull, lower front, and upper hind were the best-represented portions of the cattle carcass. The upper front, lower hind, and feet were less well represented. However, only the axial skeleton is seriously underrepresented. The meatier and higher-quality portions are the axial, upper front, and upper hind. The lower front, lower hind, and particularly the skull and feet, contain less and lower-quality meat. The relatively good representation of all portions indicates the Tucson Presidio pit assemblages contain evidence for initial butchering, including the removal of the head and feet, as well as secondary butchering, or the subsequent partitioning of the carcass into edible portions. The low proportion of axial specimens may indicate these elements represent the most common end product of tertiary butchering for consumption and were disposed of elsewhere.

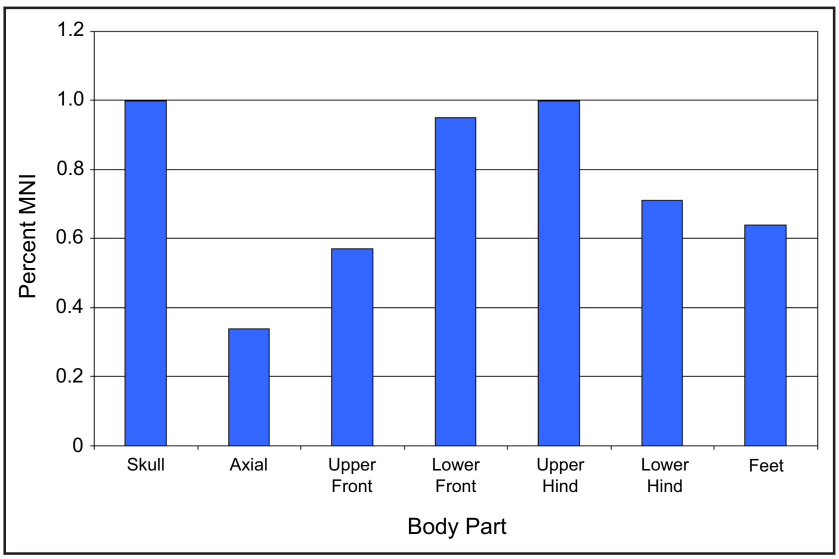

Figure 13.2. Tucson Presidio, AZ BB:13:13 (ASM), cattle body part representation.

The cattle and large mammal elements with butchering marks are listed in Table 13.16. Elements from the meatier portions of the cattle carcass are assumed to have had more butchering marks than elements from less meaty portions. With only a few exceptions, all portions confirm this assumption. The upper front and the upper hind portions have 67 percent and 65 percent, respectively, of the specimens displaying butchering marks. The axial portion is lower, with 54 percent showing butchering marks. Interestingly, thoracic vertebrae, ribs, and innominates all display butchering marks in higher proportions than the axial average. Most parts with little meat show few butchering marks. Skull parts have a

Table 13.16. Cattle and very large mammal elements with butchering marks from the Tucson Presidio, AZ BB:13:13 (ASM).

Element	Feature 373	Feature 409	Feature 420	Feature 422	Feature 423	Feature 441	Total[a]
Skull	1	2	–	–	–	–	3 (30)
Hyoid	–	1	–	–	–	–	1 (100)
Cervical vertebra	–	2	–	–	–	1	3 (33)
Thoracic vertebra	–	8	1	–	–	–	9 (64)
Lumbar vertebra	1	2	3	–	–	1	7 (44)
Rib	11	33	3	1	–	4	52 (60)
Scapula	1	3	–	–	–	–	4 (67)
Humerus	1	4	–	1	–	–	6 (67)
Radius	2	4	1	2	–	–	9 (89)
Ulna	1	5	1	–	–	–	7 (88)
Carpal (scaphoid)	–	1	–	–	–	–	1 (7)
Metacarpal	–	6	–	–	–	1	7 (54)
Innominate	2	2	–	–	–	–	4 (67)
Femur	2	2	5	–	–	2	11 (65)
Patella	–	–	–	–	–	1	1 (100)
Tibia	3	4	3	–	–	–	10 (77)
Astragalus	–	3	–	–	–	–	3 (75)
Calcaneus	–	5	–	–	–	–	5 (100)
Metatarsal	–	7	–	–	1	–	8 (80)
Metapodial	–	2	–	–	–	1	3 (23)
Long bone	29	116	46	–	5	23	219[b]
Unidentifiable element	1	4	1	–	1	–	7[b]
Total[a]	55 (49)	216 (56)	64 (76)	4 (33)	7 (47)	34 (60)	380 (58)

[a]Numbers in parentheses are percentage of the element total.
[b]Only fragments with butchering marks or burning were recorded.

low proportion (11 percent) of butchering marks, and foot elements show no butchering marks at all. However, the lower front and the lower hind portions have the highest proportions of butchering marks—73 percent and 81 percent, respectively. The elements in these portions are not surrounded by much meat, and the large proportions with butchering marks may reflect the use of these parts for the traditional Mexican dish of menudo (cf. Diehl et al. 2005:192).

Almost 90 percent of the cattle specimens with butchering marks exhibit only chopmarks. Chopmarks are primarily involved in initial butchering and secondary apportionment. Thirty-seven specimens display cutmarks, either alone or in combination with chopmarks, including one maxillary premolar with cutmarks along the gum line, eight ribs with cutmarks only, five ribs with chopmarks and cutmarks, and one proximal metatarsal with chopmarks and cutmarks. Twenty-two long bone shafts exhibit chopmarks and cutmarks. Cutmarks may be an indicator of skinning, a step of initial butchering, or of tertiary butchering, particularly deboning and meat removal for consumption.

Due to the heavy fragmentation of the assemblage, estimates of cattle carcass apportionment patterns were not attempted. However, some descriptive statements about initial and secondary butchering practices may be made. Chopmarks on the proximal and distal radius and ulna suggest separation from the humerus and carpus, although there are also lateral shaft chopmarks, possibly to apportion the radius into segments. Roughly parallel chopmarks through the acetabulum appear to be for apportioning the innominate into segments rather than disarticulating the femur. However, that disarticulation is indicated in a large percentage of proximal femur specimens where the femur head was chopped through. Horizontal chopmarks through the distal femur epiphyses likely indicate separation from the tibia. There are only two examples of intact femur shafts with chopmarks; one example is illustrated in Figure 13.3. This specimen represents the division of the element into portions. The distal tibia does not appear to be involved in the disarticulation of the lower hind leg. Instead, chopmarks through the calcaneus and astragalus indicate the removal of the lower hind leg.

Metacarpals and metatarsals were chopped through the shaft, possibly to remove the feet (Figures 13.4-13.5). However, it is more expedient to separate the feet from the metapodials by chopping into the joint between the distal metapodial and the first phalanges rather than chopping through the shaft of the metapodial (Landon 1996:91). Only two distal metapodial specimens exhibited chopmarks. This suggests the metapodials were fractured for marrow. Only one proximal metatarsal (see Figure 13.5) exhibits the transverse cutmarks encircling the shaft that indicate skinning (Landon 1996:90).

There is little evidence for marrow processing in the presidio assemblage. Fourteen bone "flakes" and corresponding impact scars on large mammal long bone shafts show fracturing for possible marrow removal (see Figure 13.3). The use of bone marrow was probably more frequent than these examples suggest, however. Many of the limb bones were systematically partitioned through some portion of the shaft, ostensibly to divide the carcass into edible portions of meat. However, the partitioning of various long bones may have also been intended to retrieve bone marrow. This duality makes it difficult to determine the degree to which bone marrow was habitually used (cf. Landon 1996:78, 93).

As noted above, there is not much evidence for tertiary butchering in the Tucson Presidio assemblage. There are relatively few of the shallow cutmarks involved in deboning and meat removal. This suggests final butchering for consumption may have occurred elsewhere, although the pervasive erosion of bone surfaces in the assemblage could have obscured many of the shallower cuts.

Figure 13.3. Cattle femur from the Tucson Presidio, AZ BB:13:13 (ASM), showing chopmarks (top) and impact scar (bottom).

Figure 13.4. Cattle metacarpal from the Tucson Presidio, AZ BB:13:13 (ASM), with chopmarks.

Comparisons with Other Hispanic Assemblages in the Tucson Area

The Tucson Presidio faunal assemblage is compared with seven other faunal assemblages recovered from Hispanic features in the Tucson area dating to the Spanish, Mexican, and American Territorial periods (Table 13.17). The earliest assemblage in the comparison came from the Mission San Miguel de

Figure 13.5. Cattle metatarsal from the Tucson Presidio, AZ BB:13:13 (ASM), showing cutmarks (top) and chopmarks (bottom).

Table 13.17. Percentages of major domestic animal bone and butchering marks in Hispanic faunal assemblages from the Spanish, Mexican, and American Territorial periods.

Site	Cattle	Sheep	Pig	Chopmarks	Cutmarks	Sawmarks	Chopmarks and Sawmarks	Chopmarks and Cutmarks
Mission San Miguel de Guevavi[a] (1701-1773)	15	69	15	83	17	–	–	–
Mission San Agustín de Tucson[b] (1795-1820)	94	6	–	17	84	2	–	–
Tubac Presidio[c] (1775-1854)	35	64	1	Noted	Noted	Noted, rare	–	–
Tubac Presidio (1854-?)	40	59	1	Noted	Noted	Noted, rare	–	–
Tucson Presidio (1775-1854)	89	7	4	92	4	<1	–	4
Block 192[d] (circa 1780-1850)	77	19	3	62	12	17	–	10
León household[e] (1840s-1880s)	93	5	1	96	1	3	–	–
León household[e] (1880s-1890s)	87	11	1	74	1	23	2	–
León household[e] (1890s-1910s)	90	9	1	59	1	36	2	2
Mexican features at AZ BB:13:6 (ASM)[f] (1870-1890)	81	5	14	27	8	57	–	8
Block 180, Feature 26[g] (1870-1905)	78	18	4	34	2	63	–	–

[a]Gillespie 1992.
[b]This report.
[c]Hewitt 1975.
[d]Thiel and Faught 1995.
[e]Diehl et al. 2005.
[f]Diehl et al. 1997.
[g]Jones 1997.

Guevavi, AZ EE:9:1 (ASM), and dates from 1701-1773 (Gillespie 1992). Roughly contemporaneous to the Tucson Presidio assemblage are the assemblages from Mission San Agustín de Tucson (this volume), the Tubac Presidio (Hewitt 1975), and the Tucson Presidio occupation on Block 192 (Thiel and Faught 1995). The León household, AZ BB:13:505 (ASM), was occupied continuously from the 1840s through the 1910s (Diehl et al. 2005). The faunal assemblage from the Mexican features at the Clearwater site dates from 1870-1890 (Diehl et al. 1997). The final assemblage in the comparison, from Feature 26 in Block 180, dates from 1870-1905 (Jones 1997).

Beef was always the mainstay of the meat diet among Hispanic residents. Except the Mission San Miguel de Guevavi and the Tubac Presidio, cattle bone comprises from 78-94 percent of the bone from large domestic animals—including cattle, sheep, and pig—in the study group. Mutton and pork consumption was more variable, although pig specimens were generally recovered in lower quantities than sheep/goat specimens throughout the timespan.

Faunal assemblages dating to the Spanish and Mexican periods are dominated by chopped cattle bone. Hispanic butchers traditionally used cleavers, while handsaws were associated almost exclusively with Euro-American butchers of the American periods (Chapin-Pyritz and Mabry 1994:155). The early use of cleavers and axes to dismember and separate the carcass was very different from methods utilized later by the modern meat-packing industry. This trend is evident in the Hispanic faunal assemblages shown in Table 13.17. Through time, modern butchering methods were adopted by Hispanic butchers, and Hispanic shoppers patronized Euro-American butcher shops. This is seen in an increase in the proportion of sawn bone in Hispanic faunal assemblages from the Tucson area. Sawn bone ranges from 0-2 percent of the butchering marks in the Spanish period, while sawn bone comprises up to 63 percent of the butchered bone in the selected Hispanic assemblages by the turn of the nineteenth century. There is some variability in the proportions of sawn bone to chopped bone in the comparison. The León household assemblage still exhibits chopmarks on a majority of the identifiable assemblage into the 1910s. The León family owned several ranches outside of Tucson, and they likely butchered their own meat (Diehl et al. 2005:192).

Summary and Conclusions

The distribution of animal bone within the Tucson Presidio walls shows cattle as the primary source of meat, with chickens, sheep or goats, and pigs making smaller contributions. Wild mammals, birds, and fish were captured and eaten, but far less frequently. All domestic taxa were represented by both juveniles and adults. Chickens range in age from 2-3 months to adults. Pigs are represented by at least one juvenile and one adult older than 20 months. At least one subadult and one adult sheep or goats are present in the assemblage. The age profile for cattle specimens in the assemblage includes animals ranging in age from juveniles less than 1 year old to adults more than 5 years old. The range in ages at slaughter suggests not all animals were killed in their prime and that they were raised for more than meat.

Element representation among the domestic taxa indicates complete animals were butchered and processed by the Tucson Presidio residents. The relatively good representation of all portions of the cattle carcass suggests the Tucson Presidio pit assemblages are the result of initial and secondary butchering, including dismemberment and apportionment into segments. Nearly half of the assemblage exhibits butchering marks. Most are chopmarks made by an axe or a cleaver, further suggesting initial and secondary butchering. Little evidence for tertiary butchering, such as cutmarks from deboning and meat removal, is present. Cutmarks may also indicate skinning, part of the initial butchering process. However, except the cutmarks on the cattle maxillary premolar and proximal metatarsal from Feature 409, the position of the cutmarks and the elements they are on are not customary for skinning marks (Landon 1996).

Elements from the meatier portions of the cattle carcass display a higher proportion of butchering marks except the lower front and lower hind limb bones. These bones are consistently chopped through at various points on their shafts, indicating secondary apportionment, fracturing for marrow, or both. Because these bones have little and low-quality meat, marrow processing seems more likely. However, meat from the lower legs and feet were used in making menudo, a traditional Mexican dish. The chopmarks through shafts of the lower limb bones may be the result of marrow processing after the removal of the meat.

In the end,

> Butchery marks on bones reflect all stages of the butchery process, and it is not always possible to correlate specific marks, or even mark clusters, with a single step in the butchery process (Landon 1996:92).

However, based on element representation and butchering marks, complete animals were certainly being butchered within the presidio walls using traditional methods.

Comparisons with other Hispanic faunal assemblages through time show that domestic animals provided most of the meat for Hispanic residents of Tucson. Beef was by far the most popular, comprising the overwhelming majority of the meat consumed in the Spanish period and continuing through the early American Territorial period. Butchering was initially accomplished with axes and cleavers, and the finer work was done with knives. By the turn of the nineteenth century, sawmarks comprised the majority of butchering marks in most Hispanic faunal assemblages. This increase in sawmarks was probably the result of the gradual shift from a subsistence economy to a market economy where meat production is specialized and butchering methods are mechanized.

ZOOARCHAEOLOGY OF MISSION SAN AGUSTÍN DEL TUCSON, AZ BB:13:6 (ASM)

The adoption of animal husbandry as a subsistence strategy by southwestern Native American groups was an important goal of Spanish colonial missionaries. Documentary evidence suggests some Native Americans quickly adopted animal husbandry, but archaeological evidence indicates this strategy was not always successful in all regions. Current understanding of the responses of southwestern Native Americans to the introduction of domestic animals is hindered, however, by a dearth of evidence. Recent excavations at the site of the Franciscan mission of San Agustín in downtown Tucson, Arizona, provide an opportunity to examine Tohono O'odham subsistence practices at the turn of the nineteenth century. Analysis of faunal remains from the mission suggests missionary efforts to encourage Native Americans to adopt animal husbandry were, to some extent, successful. However, the hunting of wild resources continued to be an important part of missionized Tohono O'odham subsistence practices.

Introduction

The arrival of Europeans in North America beginning in the late fifteenth century A.D. had enormous implications for the lives of Native Americans. Some of the consequences of European contact and colonization were intentional and some were unintentional. Europeans introduced infectious diseases that devastated Native American populations and caused social and political upheaval. European trade goods such as cloth and metal knives were quickly incorporated into existing Native American trade networks, sometimes replacing, and sometimes adding to, traditional technologies. As part of a larger colonization strategy, Spanish missionaries were often the first Europeans to make contact with Native American groups. Missionization involved not only conversion to Catholicism but also the "civilizing" of the frontier in preparation for colonization by Spanish laypeople. Spanish missions were intended to become self-sustaining colonial enterprises that would support Spanish military efforts. Spanish military presidios (forts) were often placed near missions to take advantage of the latter's productivity, particularly during the initial days of military presence.

An important aspect of the Spanish missionization strategy was to introduce Eurasian crops and domestic animals and to convince Native American groups to adopt sedentary agriculture and animal husbandry. This strategy met with limited success at Spain's missions in what is now the southeastern United States (Reitz 1993). While Native American groups in Spain's eastern missions adopted some crops and domestic animals fairly early in the Historic era, the bulk of the Native American and Spanish diet was comprised of wild meats and indigenous domestic crops, such as maize and beans (Gremillion 1993; Reitz 1993).

Little is known about the introduction of domesticated animals in Spain's western missions. Ethnohistoric documents suggest southwestern Native Americans quickly adopted domestic animals such as cattle and sheep after their introduction by Father Eusebio Kino in the early eighteenth century (Sheridan 1988; Spicer 1962), but very little archaeological evidence exists to support or refute the written record. Only a handful of southwestern missions have been excavated. Faunal remains from the missions at Awatovi, San Marcos, and San Miguel de Guevavi suggest the introduction of domestic animals was more successful in the Southwest than it was in the Southeast (Chapin-Pyritz 2000; Gillespie 1992; Lucas et al. 2003; Olsen and Wheeler 1978).

Archaeological excavations at Mission San Agustín del Tucson provide a rare and important opportunity to examine the response of missionized Tohono O'odham to the introduction of Eurasian domestic animals.

Methods

Zooarchaeological remains from the San Agustín Mission were excavated from seven features dating between 1795 and 1820. Most of the materials from these features are thought to have been deposited as a result of subsistence activities by Tohono O'odham who resided at the mission. All zooarchaeological remains from San Agustín del Tucson were analyzed using standard zooarchaeological methods (Reitz and Wing 1999). Specimens were identified to the lowest taxonomic level possible using ASM's modern comparative skeletal collections on the campus of the University of Arizona, Tucson. The tables here use three common statistics in zooarchaeological analyses: (1) NISP; (2) MNI; and (3) biomass, an estimate of the amount of meat associated with a given weight of bone (Reitz et al. 1987). To depict overall subsistence strategies at the San Agustín Mission during the late eighteenth and early nineteenth centuries, all materials from the excavated seven features are combined here.

Results and Discussion

The San Agustín assemblage is relatively large, with over 9,000 specimens from an estimated MNI of 31 (Table 13.18). The assemblage includes a wide variety of wild and domestic animals, including reptiles and amphibians, birds, small mammals, and large wild and domestic mammals.

The San Agustín assemblage includes two unusual taxa: domestic cat (*Felis silvestris*) and collared peccary (*Tayassu tajacu)*, or javelina. Domestic cats, although introduced in the early Historic era by Europeans, are rare at isolated colonial sites. The cat specimens at San Agustín suggest the animal was intentionally brought to the area, perhaps by one of the friars, or soldiers at the nearby Spanish fort. The animal may have been brought as a pet, and/or to control pests. Javelina are indigenous to Central and South America and spread to present day northern Mexico and southern Arizona around the time of European colonization. The javelina specimen may be one of the earliest members of its kind in the region.

Domestic mammals, including cow and sheep or goat, predominate in the assemblage in terms of biomass (Table 13.19). However, wild mammals are more numerous in the assemblage than all domestic animals combined in terms of the estimated MNI.

Commensal taxa are animals found in close association with humans and their environment, and whose presence is not primarily attributable to their use as a food resource. In the San Agustín assemblage, the toad (cf. *Bufo alvarius*), the dog or coyote (*Canis* sp.), domestic cat, and horse or donkey (*Equus* spp.) are placed in the commensal category. The horse or donkey specimens are placed such to reflect their primary use as a pack animal and for transportation. However, the presence of cutmarks on one specimen suggests horse or donkey meat was at least occasionally consumed. No other commensal species identified in the assemblage exhibit modifications indicating they were used as a food resource.

The deer sample is small; however, the recovery of skeletal elements from across the skeleton suggests deer were acquired in relative close proximity to the mission (Table 13.20). The recovery of cattle and caprine (sheep or goat) remains from all parts of the carcass indicates these animals were slaughtered and butchered at the mission.

One mule deer (*Odocoileus hemionus*) was less than 29 months of age at death, as evidenced by an unfused calcaneus (Table 13.21). A fused proximal femur indicates a probable white-tailed deer (*Odocoileus* cf. *virginianus*) died at less than 32 months old. A cow (*Bos taurus*) individual was less than 10 months old at death, as evidenced by an unfused scapula (Table 13.22). Several unfused proximal tibia fragments indicate at least two cow individuals were over the age of 42 months at death. Two caprine (Caprinae) individuals were at least 3 months old at death (Table 13.23). The unfused distal metapodial fragment suggests at least one individual was less than 36 months at death, and the fused metapodial suggests an age of over 18 months.

Modification by heat, including burning and calcination, are the most common modification observed in the assemblage (Table 13.24). Gnawing by animals such as rodents and carnivores was also noted in the assemblage, suggesting scavenging and pest animals in the mission may have destroyed at least some osteological remains. The presence of only one sawn specimen and the preponderance of cutmarks and hackmarks are typical of carcass processing prior to the use of mechanical saws.

Conclusions

The San Agustín Mission provides an important opportunity to examine the role that animal husbandry played in the subsistence strategy of missionized Tohono O'odham. The overall pattern of subsistence here indicates a primary reliance on domestic animals for the meat-based portion of the diet. The Tohono O'odham who lived at the mission appear to have raised and butchered chickens, cattle, sheep or goat, and occasionally, horse or donkey, for meat, and likely for other animal products such as hide. The presence of large numbers of wild animals indicates domestic animals did not entirely replace traditional resources. The hunting of deer, rabbits, hares, and other small wild animals continued to be an important contributor to Native American diet even after the incorporation of animal husbandry.

The San Agustín assemblage is very different from mission assemblages from southeastern North America, although it is similar to assemblages from the few southwestern mission assemblages studied to date. These regional differences are likely attributable to a number of factors, including environmental differences, and, in the Southwest, previous experience with husbandry of the domestic turkey (Pavao-Zuckerman and Reitz 2004).

Table 13.18. Faunal species list from the San Agustín Mission locus, the Clearwater site, AZ BB:13:6 (ASM).

Taxa	Number of Identifiable Species	Minimum Number of Individuals		Weight (gm)	Biomass	
		No.	%		kg	%
cf. *Bufo alvarius* (probable Colorado River toad)	10	2	6.5	2.27	N/A	N/A
cf. *Gopherus agassizii* (probable desert tortoise)	3	–	–	4.68	0.089	0.0
Gopherus agassizii (desert tortoise)	1	1	3.2	2.06	0.051	0.0
Serpentes (indeterminate snake)	1	–	–	0.11	0.001	0.0
cf. Colubridae (probable nonpoisonous snake)	2	1	3.2	0.24	0.003	0.0
Aves (indeterminate bird)	4	–	–	0.68	0.014	0.0
cf. *Branta canadensis* (probable Canada geese)	1	1	3.2	0.62	0.013	0.0
cf. *Gallus gallus* (probable chicken)	3	–	–	2.73	0.051	0.0
Gallus gallus (chicken)	4	1	3.2	2.99	0.055	0.0
Mammalia (indeterminate mammal)	7,385	–	–	10,769.40	111.940	58.7
Leporidae (rabbit/hare family)	3	–	–	0.51	0.014	0.0
Lepus sp. (hare)	66	5	16.1	36.57	0.671	0.4
Lepus cf. *alleni* (probable antelope jackrabbit)	16	–	–	16.98	0.336	0.2
Lepus californicus (black-tailed jackrabbit)	5	–	–	4.87	0.109	0.1
Sylvilagus sp. (rabbit)	7	2	6.5	1.71	0.043	0.0
Rodentia (indeterminate rodent)	5	–	–	1.21	0.031	0.0
cf. *Spermophilus variegatus* (probable rock squirrel)	1	1	3.2	0.47	0.013	0.0
cf. *Thomomys* sp. (probable pocket gopher)	2	–	–	0.44	0.013	0.0
Thomomys sp. (pocket gopher)	5	2	6.5	1.05	0.027	0.0
Carnivora (indeterminate carnivore)	1	–	–	0.17	0.005	0.0
Canis sp. (dog or coyote)	4	1	3.2	12.54	0.256	0.1
Vulpes macrotis (kit fox)	1	1	3.2	0.34	0.010	0.0
Felis silvestris (domestic cat)	9	1	3.2	6.83	0.148	0.1
Equus sp. (horse or donkey)	1	–	–	6.48	0.141	0.1
Equus cf. *caballus* (probable horse)	2	–	–	23.20	0.446	0.2
Equus caballus (horse)	2	1	3.2	36.79	0.675	0.4
Artiodactyla (even-toed ungulate)	6	–	–	16.25	0.323	0.2
Tayassu tajacu (collared peccary)	1	1	3.2	2.26	0.055	0.0
Cervidae (deer family)	2	–	–	8.04	0.172	0.1
cf. *Odocoileus* sp. (probable deer)	1	–	–	1.35	0.034	0.0
Odocoileus sp. (deer)	6	–	–	33.81	0.625	0.3
Odocoileus cf. *hemionus* (probable mule deer)	2	–	–	11.20	0.231	0.1
Odocoileus hemionus (mule deer)	2	1	3.2	27.57	0.520	0.3
Odocoileus cf. *virginianus* (probable white-tailed deer)	2	1	3.2	5.76	0.127	0.1
cf. *Bos taurus* (probable cow)	39	–	–	378.17	5.495	2.9
Bos taurus (cow)	305	6	19.4	5,866.37	64.796	34.0
Caprinae (domestic sheep or goat)	23	2	6.5	196.52	3.048	1.6
Vertebrata (indeterminate vertebrate)	1,091	–	–	237.94	–	–
Total	9,024	31	100.0	17,721.18	190.587	100.0

Table 13.19. Faunal remains from the San Agustín Mission locus, the Clearwater site, AZ BB:13:6 (ASM), summary table.

	Minimum Number of Individuals		Biomass	
	No.	%	kg	%
Domestic mammals	8	25.8	73.339	91.1
Domestic birds	1	3.2	0.055	0.1
Wild mammals	14	45.2	3.000	3.7
Wild birds	1	3.2	0.013	0.0
Snakes/Turtles	2	6.5	0.144	0.2
Commensals	5	16.1	3.936	4.9
Total	31	100.0	80.487	100.0

Note: Includes all taxa identified beyond the taxonomic level of order. Anurans are included in the MNI calculation, but are not included in the biomass calculation because allometric values are not currently available for the Anurans.

Analysis of the San Agustín zooarchaeological assemblage provides a clearer picture of missionized Native American subsistence than possible using only historical documents. The data support ethnohistoric reports of the early adoption of animal husbandry by southwestern Native Americans. However, the data also indicate traditional hunting continued to be practiced at the missions—an aspect of Native American life that is not often recorded in colonial documents.

Table 13.20. San Agustín Mission locus, the Clearwater site, AZ BB:13:6 (ASM), faunal body part distribution.

	Deer	Cow	Sheep/Goat
Head	2	68	5
Vertebra/Rib	1	66	2
Forequarter	0	28	6
Hindquarter	3	47	4
Forefoot	3	40	1
Hindfoot	2	36	2
Foot	2	59	3
Total	13	344	23

Note: Includes all specimens with cf. and sp. identifications.

Table 13.21. Epiphyseal fusion for all deer *(Odocoileus* sp.) at the San Agustín Mission locus, the Clearwater site, AZ BB:13:6 (ASM).

	Unfused	Fused	Total
Early fusing			
Metapodials, proximal	–	1	1
1st/2nd phalanx, proximal	–	1	1
Middle fusing			
Calcaneus, proximal	1	–	1
Late fusing			
Femur, proximal	–	1	1
Total	1	3	4

Note: Includes all specimens with cf. or sp. identifications.

FAUNAL BONE FROM THE CHINESE WELL, SAN AGUSTÍN MISSION LOCUS, THE CLEARWATER SITE, AZ BB:13:6 (ASM)

The Chinese residents at the former site of the Mission de San Agustín are represented by artifacts recovered from a trash-filled well, Feature 4. The fill from this feature was deposited between 1893 and 1900. The men were gardeners by trade, but evidently also raised livestock and fruits and vegetables. Their meat diet was comprised primarily of, but not limited to, pork. Other domestic animals—including cattle, turkey, chicken, sheep or goat, dog, and cat—were also included in their meals. They ate a wide variety of wild animals as well, including fish, turtle, birds, leporids, and rodents. Many fish taxa were identified and are described in a separate section of this chapter.

Methods

An abbreviated analysis of the total assemblage was completed; the analyzed assemblage is comprised of 9,215 fragments of non-fish bone. All specimens assigned to the order level or below were considered identifiable and were quantified using NISP. Only specimens from the large domestic taxa, including horse/mule/donkey (*Equus* sp.), medium artiodactyl (pig-/sheep-/goat-sized), pig (*Sus scrofa*), sheep/goat (*Ovis aries*/*Capra hircus*), and cattle (*Bos*

Table 13.22. Epiphyseal fusion for cow (cf. *Bos taurus* and *Bos taurus*) at the San Agustín Mission locus, the Clearwater site, AZ BB:13:6 (ASM).

	Unfused	Fused	Total
Early fusing			
Humerus, distal	–	4	4
Scapula, distal	1	5	6
Radius, proximal	–	1	1
Metapodials, proximal	–	7	7
1st/2nd phalanx, proximal	1	23	24
Middle fusing			
Tibia, distal	2	–	2
Calcaneus, proximal	2	2	4
Metapodials, distal	4	7	11
Late fusing			
Humerus, proximal	1	–	1
Ulna, proximal	1	1	2
Femur, proximal	5	–	5
Femur, distal	2	–	2
Tibia, proximal	3	4	7
Total	22	54	76

Table 13.23. Epiphyseal fusion for sheep/goat (Caprinae) at the San Agustín Mission locus, the Clearwater site, AZ BB:13:6 (ASM).

	Unfused	Fused	Total
Early fusing			
Radius, proximal	–	2	2
Metapodials, proximal	–	1	1
1st/2nd phalanx, proximal	–	2	2
Middle fusing			
Tibia, distal	–	1	1
Calcaneus, proximal	–	1	1
Metapodials, distal	1	1	2
Total	1	8	9

taurus) were entered into the computer database. Recorded variables for these specimens included provenience, taxon, element, element part, fusion, and butchering marks. All specimens—including 139 fragments of unidentified bird bone, 4,643 fragments of unidentified mammal bone, and 240 fragments of cuttlefish (*Sepia* sp.)—were counted and weighed. The cuttlefish is a member of the invertebrate Class Cephalopoda (nautiluses, squids, cuttlefishes, and octopods) (Dorit et al. 1991:682). These animals also are found in other faunal assemblages deposited by Chinese immigrants in the western United States (e.g., Gust 1993; Waters 2005).

Assemblage Description

Domestic taxa comprised 72 percent of the identifiable assemblage, with the largest proportion (40 percent) from pigs (*Sus scrofa*) (Table 13.25). Other domestic animals include chicken (*Gallus gallus*) and possible chicken (cf. *Gallus gallus*), with 13 percent; cattle (*Bos taurus*), with 12 percent; domestic cat (*Felis silvestris*), with 5 percent; dog (*Canis familiaris*) and sheep/goat (*Ovis aries/Capra hircus*), with 1 percent each; and horse/mule/donkey (*Equus* sp.), with less than 1 percent. Wild taxa made up 13 percent of the assemblage, including bony fishes (Osteichthyes), frog/toad (Anura), turtle/tortoise (Testudines), two birds, woodpecker (Picidae), and small passerine (Passeriformes), as well as five mammals including cottontail (*Sylvilagus* sp.), jackrabbit (*Lepus* sp.), pocket gopher (*Thomomys* sp.), cotton rat (*Sigmodon* sp.), and deer (*Odocoileus* sp.). Two percent are from either domestic or wild taxa, including duck (Anatidae), turkey (*Meleagris gallopavo*), and pigeon (cf. *Columba livia*). Unidentified artiodactyl and medium artiodactyl (Artiodactyla) contain identifiable elements from artiodactyls of unknown size and pig-/sheep-/deer-sized. A sizable portion (13 percent) of the identifiable assemblage is comprised of medium artiodactyls. Based on the distribution of taxa, most of these are likely pig, although they cannot be positively identified as such.

The element representation of the large ungulates—including cattle, pig, and sheep/goat—was examined to determine if animals were butchered on the premises. Similarly, the slaughtering ages were estimated for each taxon to look for indications of animal husbandry. Finally, butchering marks were examined per level for evidence of changes in butchering practices through time and the use of purchased meat.

Element Representation of Large Domestic Ungulates

The ungulate carcass may be divided into seven regions, including the head (maxillae and mandibles), axial column (ribs, vertebrae, and innominates), the upper front limbs (scapulae and humeri), lower front limbs (radii, ulnae, and metacarpals), upper hind limbs (femora), lower hind limbs (tibiae and metatarsals), and feet (phalanges). The axial, upper front, and upper hind portions are the best-

Table 13.24. Bone modifications, the San Agustín Mission locus, the Clearwater site, AZ BB:13:6 (ASM).

Taxon	Rodent Gnawed	Carnivore Gnawed	Burned	Calcined	Cut	Hacked	Clean Cut	Sawed	Weathered
Probable Colorado River toad	–	1	–	–	–	–	–	–	–
Indeterminate mammal	3	13	498	167	72	8	–	–	6
Jackrabbit	3	2	9	1	–	–	–	–	–
Probable antelope jackrabbit	1	–	–	–	1	–	–	–	–
Black-tailed jackrabbit	1	–	–	–	–	–	–	–	–
Rabbit	–	–	1	–	–	–	–	–	–
Dog or coyote	1	–	–	–	–	–	–	–	–
Kit fox	1	–	–	–	–	–	–	–	–
Probable horse	–	–	–	–	1	–	–	–	–
Even-toed ungulate	–	–	1	–	4	–	–	–	–
Collared peccary	–	–	–	1	–	–	–	–	–
Deer	–	1	3	–	4	1	–	–	1
Mule deer	–	1	1	–	1	1	–	–	–
Probable white-tailed deer	–	–	–	–	1	–	–	–	
Probable cow	–	–	2	1	2	–	–	–	2
Cow	1	6	19	1	24	9	2	1	14
Caprinae	–	1	–	–	2	–	–	–	1
Indeterminate vertebrate	–	–	76	45	–	–	–	–	–
Total	11	25	610	216	112	19	2	1	24

represented sections of the carcasses of all three taxa (Table 13.26). Not surprisingly, these are the parts with the most and best-quality meat. However, because the axial skeleton contains the largest number of elements, the element distribution may be biased toward those elements.

The skull, lower front, lower hind, and feet were less well-represented. The lower front, lower hind, and, particularly, the skull and feet contain less and lower-quality meat. However, the presence of head and foot bones at archaeological sites is cited as evidence for animal husbandry or on-site butchering, because the "cranial and foot bones of cows and sheep are commonly discarded in the butchering process due to low food value" (Lyman 1977:69). Cattle skull and foot bones comprise only 1 percent each of the total cattle specimens. In contrast, the pig subassemblage contains 6 percent skull parts and 9 percent foot bones. Likewise, 13 percent of the sheep/goat subassemblage are cranial parts and 6 percent are foot bones. This suggests beef was purchased rather than raised and butchered on-site, while the opposite appears true for sheep/goat and pig. The slaughtering ages of the respective ungulate taxa also imply this.

Slaughtering Ages of Large Domestic Ungulates

The aging of domestic animals within animal husbandry has a long history. For example, the eruption of teeth occurs at regular intervals in pig, sheep, and cattle, and provides a guide to the ages of the individuals represented (e.g., Silver 1970; Sisson 1953). Epiphyseal fusion rates for postcranial elements are also established and provide age range estimates for domestic taxa (e.g., Silver 1970).

The tooth eruption sequence for domestic ungulates begins with deciduous incisors and premolars at, or within weeks after birth. Deciduous molars are absent. The permanent premolars and the molars erupt in a regular sequence, allowing rough age estimates for maxillae and mandibles. Eruption dates also depend on management and nutrition. "The better the housing and feeding and the more highly bred, the earlier the eruption of teeth" (Silver 1970:295). However, domestic ungulates consist of many breeds whose rates of maturation vary considerably. The dates used in the current study are nineteenth century figures for cattle, median dates between modern figures and 1790 figures from semi-wild, hill sheep for sheep/goats, and the median

Table 13.25. Faunal taxa represented in Feature 4 at the Clearwater site, AZ BB:13:6 (ASM).

Taxon	Quantity[a]
Cuttlefish (*Sepia* sp.)	240
Bony fish (Osteichthyes)	518[b]
Unidentified frog/toad (Anura)	1
Unidentified turtle/tortoise (Testudines)	1
Unidentified duck (Anatidae)	46
Chicken (*Gallus gallus*)	546
Turkey (*Meleagris gallopavo*)	5
Pigeon (cf. *Columba livia*)	21
Woodpecker (Picidae)	2
Small passerine (Passeriformes)	10
Cottontail (*Sylvilagus* sp.)	10
Jackrabbit (*Lepus* sp.)	8
Medium rodent (Rodentia)	3
Pocket gopher (*Thomomys* sp.)	4
Cotton rat (*Sigmodon* sp.)	1
Dog (*Canis* sp.)	28
Domestic cat (*Felis silvestris*)	215
Horse/Mule/Donkey (*Equus* sp.)	1
Pig (*Sus scrofa*)	1,723
Pig/Sheep/Goat (*Sus/Ovis/Capra*)	566
Sheep/Goat (*Ovis aries/Capra hircus*)	52
Deer (*Odocoileus* sp.)	1[c]
Cattle (*Bos taurus*)	534
Identifiable total	4,536

[a]Number of identified specimens, except cuttlefish, which is number of fragments.
[b]Fish taxa are described in Table 13.34.
[c]Antler tool handle.

Table 13.26. Cattle, pig, and sheep/goat elements (number of identified specimens) from Feature 4 at the Clearwater site, AZ BB:13:6 (ASM).

Element	Cattle	Pig	Sheep/Goat
Skull	4	102[a]	8
Cervical vertebra	32	103	1
Thoracic vertebra	14	114	4
Lumbar vertebra	21	114	3
Sacrum	9	9	–
Caudal vertebra	24	24	–
Unspecified vertebra	26	137	–
Rib	85	328	9
Innominate	58	38	2
Scapula	36	95	3
Humerus	19	68	3
Radius	8	40	2
Ulna	6	46	5
Femur	139	74	3
Patella	–	3	–
Tibia	5	31	3
Fibula	–	16	–
Astragalus	1	7	–
Calcaneus	2	17	5
Carpal/Tarsal	5	30	1
Metapodial	–	149	–
Sesamoid	1	–	–
Phalanx	2	159	3
Long bone	33	1	–
Unidentifiable element	2	–	–
Total	532	1,705	55

[a]Does not include isolated teeth.

between late eighteenth century figures and modern figures for pigs (Silver 1970:296-299). In all cases, eruption dates can only be used as a rough estimate for the indication of age.

Only four skull parts from cattle were identified in the assemblage from Feature 4; three of those are isolated teeth. One adult mandible with the first through the third molars (FN 5295) was recovered. The third molar was erupted but unworn, indicating an age of approximately 48 months. Seven sheep/goat skull parts were recovered, including one frontal and one indeterminate skull fragment, two maxillae with teeth, and three mandibles with teeth. At least three different-aged and different-sized individuals are represented (Table 13.27). The left and right maxillae (FN 5129) each contain a newly erupted third molar and are aged at approximately 30 months (Silver 1970:297); they are probably from the same individual. One left mandible (FN 5129) contains a deciduous fourth premolar with the second molar erupting, indicating an age of 6-14 months. One right mandible (FN 5158) contains all teeth except the unerupted third molar; all premolars are deciduous. This mandible was from an individual aged between 14 months and 26 months at death. The unsided mandible (FN 5114) contains only a deciduous fourth premolar and permanent first molar. This mandible belonged to an individual between 6 months and 26 months at death.

Not surprisingly, there were many more skull parts from pigs than from sheep/goats or cattle. The specimens were also more complete than the cattle and sheep/goat cranial parts. At least 114 pig skull parts were recorded in the assemblage from Feature 4. However, two-thirds (67 percent) are not ageable, including 12 isolated teeth, 48 indeterminate cranial fragments, and 16 fragments without teeth.

Of the remainder, 35 specimens, representing at least 12 individuals, are ageable (Table 13.28). One individual, represented by a right maxilla (FN 6423), was aged to approximately 12 months. At least three individuals, represented by three left mandibles (FN 5114, 5445, 6423), were aged to approximately 16 months. Three right maxillae (FN 6423, 6350) represent at least three individuals and were aged to

Table 13.27. Age ranges for sheep/goat cranial material with teeth from Feature 4 at the Clearwater site, AZ BB:13:6 (ASM).

Field Number	Element	Teeth	Age	Age Criteria
5129	Left mandible with teeth	Fourth premolar through second molar	6-14 months	Deciduous premolar, second molar erupting
5114	Mandible with teeth	Fourth premolar, first molar	6-26 months	Deciduous premolar, permanent molar
5158	Right mandible with teeth	All teeth except third molar (missing)	14-26 months	Deciduous premolars, permanent second molar
5129	Left maxilla with teeth	Second premolar to third molar	circa 30 months	Permanent premolars, third molar newly erupted
5129	Right maxilla with teeth	Second and third molars	circa 30 months	Third molar newly erupted

Table 13.28. Ages of pig cranial material with teeth from Feature 4 at the Clearwater site, AZ BB:13:6 (ASM).

Field Number	Element	Age (months)	Age Criteria
6423	Right maxilla	circa 12	Canine erupting, permanent first molar (M1)
6423	Right mandible	Less than 16	Deciduous premolars, permanent M1, second molar (M2) unerupted
5092	Left mandible	Less than 18	Deciduous premolars
5114	Right mandible, left maxilla	Less than 18	Deciduous premolars
5114, 5445	Left mandible (*n* = 2)	circa 16	Deciduous premolars, M2 erupting
6391, 6423	Right maxilla, left partial skull	circa 16	M2 newly erupted, third molar (M3) unerupted
6423	Left and right mandibles	circa 16	Permanent M1, M2 (unworn), M3 unerupted
5173	Right maxilla	16-18	Newly erupted P3, deciduous P4, unworn M2
5326	Right and left mandibles	16 -18	Deciduous premolars, M3 unerupted
6423	Left maxilla, right maxilla (*n* = 2)	circa 18	Premolars erupting, M3 unerupted
6350, 6391	Right maxilla, right mandible	circa 18	Premolars erupting, M3 unerupted
6391	Right mandible	18-26	Permanent M2, M3 unerupted
6391, 6419	Left partial skull, left mandible	18-26	Permanent premolars, M3 unerupted
6350, 6423	Right maxilla, left maxilla	18-26	Permanent premolars, M3 unerupted
5092	Right maxilla	circa 26	Permanent M2, M3 erupting
6391	Left maxilla, left and right mandibles	circa 26	Permanent premolars, M3 erupting
6494	Left and right mandibles	circa 26	Permanent premolars, M3 erupting
6499	Unsided mandible	circa 26	M3 newly erupted
5404, 6391	Unsided mandible, right mandibles (*n* = 2)	More than 18	Permanent premolars
6423	Left maxilla	More than 18	Permanent premolars

around 18 months. At least two individuals, represented by two left maxillae (FN 6391, 6423), were aged to between 18 months and 26 months, and at least three individuals, represented by three left or right mandibles (FN 6391, 6494, 6499), were aged to approximately 26 months at death. Four specimens could only be aged as less than 16-18 months. Three specimens were aged to more than 18 months. Due to missing teeth, these specimens cannot be placed in a bracketed age category.

Epiphyseal fusion of specimens further established an age range for the three main domestic taxa. Very few of the cattle postcranial specimens are unfused (Table 13.29). Only six of 142 specimens with epiphyses were from immature individuals, and all were from relatively late-fusing elements. One proximal ulna and one distal ulna were unfused. These epiphyses do not fuse in cattle until 3.5-4 years of age. The other four unfused specimens are vertebral pads that do not fuse until 5 years of age. The age at fusion distribution of sheep/goat postcranial specimens is more dispersed than for cattle (see Table 13.29). Specimens with unfused epiphyses range in age at fusion from 3-6 months to 3.5 years. The proportion of unfused to fused specimens is much more even than among the cattle specimens.

Nearly half (48 percent, n = 15) the sheep/goat specimens with epiphyses are unfused or fusing. An examination of pig epiphyseal fusion rates shows that many young specimens were present in the assemblage (Table 13.30). Nearly one-third (32 percent, n = 242) of pig specimens with epiphyses were unfused or fusing. The youngest specimens are not shown in Table 13.30. One nearly complete humerus and three phalanges are from at least one fetal/neonate individual. More mature animals range in age from less than 3-6 months to more than 3.5 years at death. Most of the unfused specimens are from elements that fuse at less than 3.5 years old. Only 14 (2 percent) of the 733 specimens with fused epiphyses are from elements that fuse at more than 3.5 years.

The postcranial material from the three main domestic taxa fits fairly well with the cranial material in terms of relative age. Cattle postcranial specimens

Table 13.29. Epiphyseal fusion rates for sheep/goat and cattle specimens from Feature 4 at the Clearwater site, AZ BB:13:6 (ASM).

Element	Fused	Unfused	Fusing	Age at Fusion[a]
Sheep				
Distal first or second phalanx	1	–	–	Before birth
Vertebral body with arch	8	2	–	3-6 months
Scapula	3	1	–	6-8 months
Proximal radius	1	1	–	10 months
Proximal first phalanx	–	1	–	13-16 months
Proximal ulna	1	2	–	2.5 years
Calcaneus	2	3	–	2.5-3 years
Proximal femur	–	–	1	2.5-3 years
Proximal humerus	–	1	–	3-3.5 years
Distal femur	–	1	–	3-3.5 years
Proximal tibia	–	2	–	3.5 years
Innominate	1	1	–	3.5 years
Cattle				
Proximal radius	3	–	–	12-18 months
Distal tibia	2	–	–	2-2.5 years
Proximal humerus	2	–	–	3.5-4 years
Proximal ulna	1	1	–	3.5-4 years
Distal ulna	1	1	–	3.5-4 years
Distal femur	1	–	–	3.5-4 years
Innominate	51	–	–	4.5 years
Vertebral body with pad	82	4	–	5 years

[a]Silver 1970.

range from at least 1 year to more than 5 years at death. The mandible with teeth was aged to 4 years. The sheep/goat postcranial elements appear to be slightly younger than the cranial elements; the youngest specimen was less than 3-6 months at death, compared with 6-14 months at death. However, the oldest specimens, two calcanei, are more than 2.5 years old, which compares favorably with the oldest cranial part aged to 30 months at death. The tooth eruption data for pigs fit fairly well with the postcranial fusion rates, except they do not include the youngest or the oldest individuals.

This age profile shows that mostly older cattle were present in the assemblage. Most animals raised primarily for food are slaughtered before they are fully grown, although a small number are kept alive for breeding. The use of cattle for draft or dairying would result in more animals living to an older age (Landon 1996:96). In contrast, sheep appear to have a more normal slaughtering distribution, with mostly young animals; none of the specimens were older than 3.5 years at death. The pig age profile, with individuals aged from fetal/neonate to more than 3.5 years, shows that animals of all ages were killed. The presence of older pigs may by an indication the Chinese gardeners kept some in reserve for breeding purposes.

Butchering Marks

Seventy-one percent (*n* = 2,068) of the large domestic ungulates exhibit butchering marks. This total includes 1,206 pig specimens, 437 cattle specimens, 396 medium artiodactyl (pig-/sheep-/goat-sized) specimens, and 29 sheep/goat specimens. Butchered specimens comprise 70 percent of the pig bone, 82 percent of cattle bone, 70 percent of medium artiodactyl bone, and 56 percent of sheep/goat bone. In addition to the large ungulates, bones from ducks, chickens, turkeys, dogs, and domestic cats also displayed butchering marks. Although the smaller mammals, such as rabbits and rodents, did not exhibit butchering marks, they may also have been used for food.

Butchering marks include chopmarks, sawmarks, cutmarks, and various combinations of the three. Chopmarks made with an axe or a cleaver are primarily involved in initial butchering and secondary apportionment, and indicate butchering as traditionally practiced by the Chinese (Gust 1982:109). Sawmarks are reflective of the Euro-American style of butchering, in which the carcass is apportioned into specific cuts. Far fewer specimens exhibit cutmarks made by a thin blade, probably the result of skinning and defleshing.

Table 13.30. Epiphyseal fusion rates for pig specimens from Feature 4 at the Clearwater site, AZ BB:13:6 (ASM).

Element	Fused	Unfused	Fusing	Age at Fusion[a]
Proximal metapodial	41	–	–	Before birth
Distal first or second phalanx	8	–	–	Before birth
Vertebral body with arch	410	88	–	3-6 months
Scapula	87	2	–	1 year
Distal humerus	12	14	2	1 year
Proximal radius	14	5	–	1 year
Proximal second phalanx	–	6	1	1 year
Distal tibia	7	6	–	2 years
Proximal first phalanx	3	13	–	2 years
Distal metapodial[b]	4	90	1	2-2.25 years
Calcaneus	9	5	–	2-2.5 years
Proximal ulna	3	6	–	3-3.5 years
Distal ulna	2	3	–	3-3.5 years
Proximal humerus	6	24	2	3.5 years
Distal radius	–	9	–	3.5 years
Proximal femur	1	27	–	3.5 years
Distal femur	2	28	1	3.5 years
Proximal tibia	–	12	1	3.5 years

[a]Silver 1970.
[b]Combination of metacarpal and metatarsal fusion rates.

Pig specimens with butchering marks exhibit chopmarks more frequently than sawmarks, by an almost 10-to-1 margin, or 1,045 with chopmarks and 111 with sawcuts. Conversely, cattle specimens with butchering marks exhibit over twice as many sawmarks (n = 296), as opposed to chopmarks (n = 129). The overwhelming majority (n = 25) of butchered sheep/goat specimens contain chopmarks. Medium artiodactyls, presumably comprised of mostly pig specimens, with butchering marks contain 382 specimens with chopmarks, as opposed to only 14 with sawcuts. All the smaller animals with butchering marks exhibit only chopmarks, including a domesticated cat (Figure 13.6). Only small, nondomesticated animals appear to have been captured for food. The lone deer bone identified in the assemblage is an antler tine tool handle, probably purchased or traded for rather than hunted. Several deer specimens were recovered from previous excavations (Diehl et al. 1997).

Diachronic Trends in Feature 4

The frequencies of butchering marks by excavation level are shown in Table 13.31. The proportion of chopmarks decreases from a clear majority in the lower, or earlier, levels to about half of the butchering marks at the top, or later, levels. The feature can be divided into roughly three groups based on the proportion of chopmarks. The first group includes Level 11 through Level 15, where chopmarks make up between 80 percent and 93 percent of the butchering marks. Levels 5-10 contain between 62-83 percent of butchered specimens with chopmarks. The third group, representing the later part of the deposition, consists of Level 1 through Level 4, with 40 percent to 55 percent chopped specimens.

The NISP of cattle versus pig by excavation level is provided in Table 13.32. An index was derived from the ratio of the pig NISP divided by the sum of the cattle NISP and pig NISP. The index decreases through time, indicating a reduction in the proportion of pig specimens relative to cattle specimens. Again, the levels can be divided into three groups based on the index value. Levels 10-15 comprise the earliest group, with index values between 0.90 and 0.93; the middle group values range from 0.82-0.83 in Levels 6-9. The latest levels, Levels 1-5, have index values between 0.28 and 0.58. Pig specimens barely outnumber cattle specimens in these later levels, even falling below cattle specimens in Levels 3 and 4. These groups follow the butchering groups fairly closely, although the index values are more consistent within each group than the butchering mark percentages.

Both the proportion of chopmarks and pig specimens relative to cattle specimens decrease through time, indicating an increase in sawcuts and cattle specimens relative to pig specimens. These trends indicate a change in diet and animal husbandry practices. If pigs were no longer raised by the Chinese gardeners, purchased meat, particularly beef, may have replaced the pork from their own animals. They would not butcher their own animals and

Figure 13.6. Chopmarks on domestic cat (*Felis silvestris*) bones from Feature 4 at the Clearwater site, AZ BB:13:6 (ASM).

would purchase standard retail meat cuts from butcher shops.

Previous excavations of features associated with Chinese gardeners at the Clearwater site revealed a meat diet high in beef, with little pork or mutton evident (Diehl et al. 1997, 1998; Thiel 1997). The assemblage was dated from 1892 to 1905, extending five years later than the assemblage from Feature 4. It is hard to imagine that their diet could change so radically within five years. However, that trend

Table 13.31. Butchering marks on identifiable bone from Feature 4 at the Clearwater site, AZ BB:13:6 (ASM), by level. (Quantities are number of identified specimens [NISP] with butchering marks.)

Level	Chopmarks	Sawmarks	Other Marks	Feature Total
1	40	36	1	77
2	29	36	0	65
3	50	72	2	124
4	84	62	6	152
5	89	29	1	119
6	220	35	4	259
7	59	29	3	91
8	58	14	2	74
9	53	20	6	79
10	54	22	11	87
11	488	22	15	525
12	195	19	3	217
13	100	15	4	119
14/15	62	14	2	78
Feature total	1,581	425	60	2,066 (71)

Table 13.32. The number of identified specimens (NISP) of cattle versus pig in Feature 4 at the Clearwater site, AZ BB:13:6 (ASM), by level.

Level	Total NISP	Cattle NISP	Pig NISP	Index Value[a]
1	102	47	48	0.51
2	124	50	69	0.58
3	169	83	80	0.49
4	219	96	35	0.28
5	194	68	78	0.53
6	353	54	268	0.83
7	169	27	119	0.82
8	108	16	80	0.83
9	122	10	49	0.83
10	107	10	92	0.90
11	658	26	326	0.93
12	280	25	248	0.91
13	194	13	138	0.91
14/15[b]	108	6	80	0.93

[a]Pig NISP/Cattle + Pig NISP.
[b]Level 15 contained fewer than 20 cattle and pig specimens.

was already obvious in the level data from Feature 4, with fewer pigs relative to cows (see Table 13.32). The butchering data in the assemblage recovered from previous excavations showed more sawcuts (86 percent) than chopmarks (9 percent) (Diehl et al. 1997). This is in contrast to the assemblage from Feature 4, where chopmarks outnumbered sawcuts. Nonetheless, as noted above, the trend toward sawcuts outnumbering chopmarks was starting in the upper levels of Feature 4.

It is uncertain if the difference between the two samples is due to sampling error, or if it reflects a change in behavior. Based on the age profiles of the assemblage from Feature 4, the Chinese gardeners at Clearwater appear to have been raising pigs for food, and possibly for sale to other Tucson residents. The proportion of pig specimens in the assemblage could have been drastically reduced if they had quit raising pigs by 1900. One explanation is that they no longer raised pigs and that they turned to beef to fulfill most of their protein needs. This may signal a change in economic status as well. On the other hand, the features are far enough apart spatially that they may represent two different households of Chinese gardeners.

Comparisons with Contemporaneous Assemblages

How does the Chinese gardeners' meat diet compare with that of their contemporaries in Tucson? The assemblage from Feature 4 was compared with two Chinese faunal assemblages, as well as several Mexican and Euro-American assemblages (Table 13.33). Most of the assemblages date to between 1880 and 1910, although the starting date of the earliest Mexican assemblage is circa 1840, while the latest ending date is 1929. The time depth in the Mexican assemblages allows for the charting of some change through time. The Tucson Chinatown was excavated as part of the Tucson Urban Renewal project (Lister and Lister 1989a). Feature 21 in Block 136 was a borrow pit filled with refuse from the local Chinese grocer in the Barrio Libre (Thiel 2002). Feature 26 in Block 180 was a small borrow pit and trash deposit filled with trash from a Mexican household (Ciolek-Torrello and Swanson 1997). Bone refuse from the other features in Block 180 were deposited by Anglo families on the block (Ciolek-Torrello and Swanson 1997). The León household assemblage came from a farmstead occupied by a Mexican-American family

Table 13.33. Comparisons among the faunal assemblage from Feature 4, the Clearwater site, AZ BB:13:6 (ASM), and contemporaneous assemblages in Tucson.

Site	Dates	Sample Size	Cattle NISP	Pig NISP	Chopmarks	Sawmarks	Ethnicity
Tucson Chinatown	1880-1910	2,090	1,179	573	NA[a]	NA[a]	Chinese
Block 136, Feature 21	1890-1910	1,965	572	49	NA[b]	NA[b]	Chinese
AZ BB:13:6 (ASM), Feature 4	1893-1900	4,296	534	1,723	1,581	425	Chinese
Block 180, Feature 26	1870-1905	1,084	565	28	149	275	Mexican
León Household	1840-1860	1,169	233	4	107	1	Mexican
León Household	1870-1880	221	44	0	22	3	Mexican
León Household	1880-1890	2,540	474	7	175	54	Mexican
León Household	1890-1910	3,783	520	7	119	121	Mexican
Block 139, Features 1, 19	1891-1900	1,250	373	4	31[c]	360[c]	Mexican
Block 139, Feature 6	1905-1929	1,018	488	23	51[c]	225[c]	Mexican
Block 180 (all except Feature 26)	1880-1920	1,522	456	228	196	1,395	Euro-American
Block 83, Feature 14 (Levels 5-6)	1886-1893	951	360	0	0	63	Euro-American
Block 83, Feature 18 (Levels 9-12)	1893-1902	347	246	0	0	54	Euro-American

Note: NISP = Number of identifiable specimens.
[a]Gust (1993:193) notes that there were mostly handsaw marks.
[b]Not recorded.
[c]Butchering marks on cattle and very large mammal bone only.

from the mid-to-late 1800s (Thiel 2005). The assemblage was separated into four intervals based on associated artifacts (Diehl et al. 2005). The features in Block 139 contained trash from three different Mexican-American families in the Barrio Libre (Diehl and Thiel 2003). Feature 14 (Levels 5-6) and Feature 18 (Levels 9-12) in Block 83 consisted of trash deposited by Euro-American families on the block (Mabry et al. 1994).

Ethnic affiliation appears to play a role in meat selection. Pork was the preferred meat in China, and the eating of pork has a long tradition among the Chinese (Gust 1993:185). Pig bones found in archaeological sites in China date to perhaps as early as 9300-7000 B.C. (Simoons 1991:295). Cattle bones were recovered from later (5000-1700 B.C.) sites, but the consumption of beef in China declined by the T'ang Dynasty (618-907 A.D.) under the influence of Buddhism (Chang 1977:29). The taboo against beef consumption continued into the nineteenth century, when laws prohibited the slaughter of cattle and water buffalo for food (Simoons 1991:303). Consequently, beef consumption was not common among Chinese at that time, including those immigrating to the United States. The Chinese are also known for the diversity of their diet. They traditionally used a wider range of animals for food. There are several species found in the Chinese features that are not usually found in urban Mexican or Euro-American features, including fish, duck, dog, cat, and deer. The inclusion of these more unusual meats in their meals suggests the Chinese immigrants were trying to recreate the diet of their homeland.

Excavations in urban Chinatowns outside Arizona show that pork was the main meat consumed in Sacramento, Woodland, and Ventura, California, and in Lovelock, Nevada (Gust 1993). However, as shown in Table 13.33, the assemblage from the Tucson Chinatown had cattle specimens comprising 56 percent of the assemblage, compared with 27 percent for pig specimens (Gust 1993). Cattle specimens from the borrow pit filled by the Chinese grocer in Block 136 comprise 29 percent of the assemblage, compared with only 3 percent for pig specimens (Diehl et al. 2002). The Mexican assemblages contain even lower proportions of pig specimens, ranging from 0-3 percent of the assemblage (Cameron 2003b; Diehl et al. 2005; Jones 1997). The Euro-American assemblages range from 0 percent in the assemblages from Block 83, to 15 percent in the assemblages from Block 180 (Jones 1997; Mabry et al. 1994).

Butchering techniques are also related to ethnicity. The presence of chopmarks in greater numbers than sawmarks in historic faunal assemblages from Tucson can be a good indicator of ethnicity (Thiel and Faught 1995:209). Greater proportions of chopmarks versus sawmarks are associated with early Chinese and Mexican assemblages. Traditionally, Mexican butchers used axes and cleavers to divide the carcass into portions (Diehl et al. 2005:192); traditional Chinese butchering used cleavers as well (Gust 1982:109). Handsaws were associated almost exclusively with Euro-American butchers (Chapin-Pyritz and Mabry 1994:155).

Comparisons of chopmarks to sawmarks among the assemblages in Table 13.33 show some interesting patterns. Only Feature 4 from the Clearwater site and the León household contained more specimens that exhibited chopmarks than sawmarks. Unfortunately, the butchering marks for the two other Chinese assemblages were not published, although Gust (1993:193) notes that most of the marks were made by handsaws, which is very different than the assemblage from Feature 4. There were some differences in degree among the assemblages with more sawmarks than chopmarks. Two of the three Euro-American assemblages did not have any butchered specimens with chopmarks. The Mexican assemblages from Block 139 contained relatively fewer specimens with chopmarks than the Mexican assemblage from Block 180. Tenants in Block 139 may have patronized Euro-American butchers, while the family on Block 180 either butchered their own meat, or patronized a Mexican butcher.

Discussion

The arrival of the railroad to Tucson in 1880 "opened the floodgates of Anglo-American settlement" (Thiel 2002:6), which created a market for individual meat cuts. This was "in contrast with the slaughter and consumption of the entire animal in one location" (Clonts 1983:351) and ushered in the systematic techniques used by the modern meatpacking industry. Rather than being chopped into pieces with cleavers and hatchets, carcasses were divided into specific wholesale and retail cuts using handsaws and, after the advent of electricity, band saws.

As shown in Table 13.33, the archaeological evidence from many urban Tucson residences at the turn of the nineteenth century reflects meat purchases in a market economy rather than home butchering. After the introduction of American butchering methods, Mexicans living in Tucson appear to have either adopted the same butchering methods as, or patronized, Euro-American butchers. This is evident in the León household assemblage, where chopmarks outnumbered sawmarks until around 1890, when the frequency of both marks was nearly equal. Likewise, Gust (1993:193) notes that cleaver marks declined and sawmarks increased through time on faunal bone from selected Chinese sites in the western United States. This was evident in Feature 4 where chopmarks became less prevalent through time (see Table 13.31). Therefore, Chinese and Mexican assemblages dating to 1880 and later are difficult to distinguish from Euro-American assemblages based on butchering marks alone.

Summary and Conclusions

A large and diverse faunal assemblage was recovered at the Clearwater site from Feature 4, a trash-filled well associated with Chinese gardeners, dating to the turn of the nineteenth century. Domestic animals include duck, turkey, chicken, pigeon, horse/mule/donkey, pig, cattle, sheep/goat, dog, and cat. Wild animals include fish—both freshwater and marine—frog/toad, turtle/tortoise, woodpecker, small passerine, cottontail, jackrabbit, pocket gopher, cotton rat, and deer. All the domestic taxa, except horse/mule/donkey, probably represent food items, as they contain at least one specimen with butchering marks. However, the wild small animal specimens, such as rodents and wild birds, did not exhibit butchering marks and may or may not represent food items. Pork was the preferred meat, with pig specimens comprising at least 40 percent of the identifiable assemblage.

The presence of head and foot bones at archaeological sites is cited as evidence for animal husbandry and on-site butchering. These bones were usually discarded during the butchering process due to low food value (Lyman 1977:69). This does not necessarily apply to pigs' feet, which were, and still are today, sold in butcher shops. The small proportion (2 percent) of cattle cranial and foot bones suggests a low occurrence of primary home butchering. This contrasts with the pig and sheep/goat element representation, where skull and foot specimens comprise 15 percent and 20 percent, respectively, of the element representation.

Slaughtering ages of the large domestic taxa also indicate animal husbandry, or the lack of it, in the Chinese gardeners' assemblage. Cattle fusion rates show the age at fusion range from less than 3.5 years to over 5 years. None of the sheep specimens were older than 3.5 years at death. Similarly, the pig specimens consist of mostly young individuals, ranging in age from fetal/neonate to more than 3.5 years at death. Because most animals raised primarily for food are slaughtered before they are fully grown, this age profile suggests the older cattle in the assemblage were used for draft or dairying, or they represent purchased beef. In contrast, sheep and pigs appear to have a more normal slaughtering distribution, with primarily young animals. Additionally, the full range of elements, in conjunction with the age spread, suggests on-site butchering, and therefore, animal husbandry, in the sheep/goat and, particularly, the pig subassemblages.

Butchering marks imply that some meat cuts were purchased, while others represent home butchering. Sixty-eight percent of cattle butchering marks were sawcuts. Most of the specimens were standard retail cuts, indicating most beef was purchased from outside sources. For example, a quarter of the cattle specimens represent round steaks; that is, femur shafts exhibiting parallel sawcuts. In contrast, 88 percent of pig specimens with butchering marks were chopped into varying cuts that did not necessarily correspond with standard retail cuts. All the sheep specimens that exhibited butchering marks were chopped. In comparison, the Tucson Chinatown assemblage exhibited mostly handsaw cuts, and cleaver marks account for roughly 20-40 percent of the butchering marks on pig and sheep bones, compared with only 10 percent on cattle bone (Gust 1993:193). The trend in butchering marks exhibited by specimens from Feature 4 tends to be one in which sawcuts increase in relation to chopmarks in the upper levels. The few sources documenting late nineteenth century butchering by Chinese in the United States indicate they eventually adopted American methods and tools (Gust 1993:207). Likewise, the traditional butchering strategies used by the Chinese gardeners at Clearwater gradually gave way to the techniques of the modern meat-packing industry.

Although beef rivaled pork as the main meat consumed at the end of the sequence in Feature 4 at the Clearwater site, this trend was already apparent in the other Chinese assemblages from Tucson during the late 1800s, including those recovered from the Tucson Chinatown, the Chinese-associated borrow pit from Block 136, and previous excavations into the Chinese gardeners' features at Clearwater (Diehl et al. 1997; Diehl et al. 2002; Gust 1993). All these assemblages showed a definite preference for beef over pork.

Comparisons with other late nineteenth century assemblages from Tucson suggest the determination of ethnicity using only faunal remains is not advisable. Nonetheless, several characteristics emerge that are useful in identifying Chinese faunal assemblages in Tucson. The best indicators include a diversity of animals used for food and a large proportion of chopmarks, particularly on smaller animals such as chicken, rabbits, cat, and dog. Chopmarks on the larger domestic ungulate bone alone may be difficult to distinguish from early Mexican assemblages. The proportion of cattle to pig specimens is still unreliable, because it seems to depend on whether animal husbandry was practiced and also if the assemblage predates the introduction of the railroad.

LATE NINETEENTH CENTURY FISH REMAINS FROM A *HUÁQIÁO* SITE NEAR TUCSON, ARIZONA

In the last half of the nineteenth century, overseas Chinese (*Huáqiáo*) immigrants played a crucial role in the settlement and industrialization of the far west, providing both the abundant cheap labor source demanded by capitalists and also—in spite of legal and extralegal impediments—a large number of innovative entrepreneurs. While the role of these immigrants in urban centers and various major industries is well known, their activities in the Southwest has not been extensively studied (Fong 1980; Lister and Lister 1989a, 1989b).

A previous archaeological study of Chinese gardeners in Tucson has provided information regarding the dietary adaptations of these immigrants. Popular images of the southwestern frontier picture it as an area of isolation, remote from urban sources of supply—a region where settlers lived off the land and produced their own food. In fact, the gardeners arrived after the railroad reached Tucson in 1880, and the real mediating factor in dietary decisions—as in many other aspects of the local economy—was probably the high transportation cost of imported goods:

> Evidence recovered from the Chinese gardeners' household in Tucson suggests that these individuals maintained a traditional diet by using missing items with innovative ingredients and analogues. Despite the apparent low economic status of the gardeners, they mitigated the constraints imposed by the local dominance of nontraditional foods by preparing and serving these foods in a traditional manner. Moreover, the maintenance of a diverse diet was promoted through the use of locally-available wild and animal foods (Diehl et al. 1998:30).

Recent excavation of a second assemblage from contemporary local gardeners provides an opportunity to expand those studies and to assess the relevance of fish remains to the perspective provided by the earlier study.

Provenience, Materials, and Methods

Archaeological investigations at San Agustín Mission, conducted by Desert Archaeology in 2001, involved excavation of a well that was backfilled between 1893 and 1900. During that time, the property was leased to a group of unidentified Chinese gardeners. The well was almost 3 m deep and was filled rapidly, based upon ceramic crossmends that span several feet of fill.

The fish remains were examined under light magnification and identified to the most specific taxonomic level that could be confidently assigned. Identification of native Pacific Coast species was relatively routine, with comparative material being available at the California State Archeological Laboratory, the California Academy of Sciences and the Museum of Anthropology, University of California, Davis. Additional comparative material was made available by the Natural History Museum of Los Angeles County, the University of Michigan Zoology Museum, and by Kenneth Gobalet, Steve James, and Mark Roeder. Identification of Chinese species relied on comparative material collected by the author—salt fish specimens obtained during two trips to Hong Kong, Guangzhou, and Macao, as well as salt, frozen, and fresh specimens collected over several years in Asian markets in California. The availability of this material allowed secure identification of the majority of the submitted elements. Fuller diagnostic notes on the Chinese specimens have been provided in a report on a California site in that included the species found here (Schulz 2002). Most of the material that remains unidentified is too fragmentary for definitive identification. The collection does, however, contain several distinctive elements that remain unidentified for lack of appropriate comparative material.

Wet weight estimations for salmon are derived either from bone-dimension or live-weight regressions provided by Casteel (1972). Similar estimations for pikeminnows, chubs, and suckers are derived from the same source, using, in each case, regressions for California species of the same genus. Regressions for cod are from Kenchington and Kenchington (1993) and sources therein. Wet weight of other species is extrapolated from known-weight museum specimens.

Salt-dried weights of imported species were based on the foregoing figures, using weight loss percentages from the literature. A salt-dried weight of 20.5 percent of round weight used by Kenchington and Kenchington (1993) for cod is in rough accord with figures in earlier sources and indicates that the dried product fish had been gutted, headed, and trimmed before salt processing. Absent independent figures for salt salmon, the same figure was used, because these large fish were treated in a somewhat similar manner. The other, smaller species were sometimes gutted and sometimes split, but generally retained the heads and most of the skeleton—as amply demonstrated by the present collection. For these fishes, various ratios were used, following Tanikawa (1971) and Yean et al. (1998). Sciaenid (croaker and corvina) weights were estimated at 50 percent of round weight, shad at 34 percent (using ratios from other clupeids), and other fishes at 50 percent. White herring were estimated directly from known-weight salt-dried specimens.

Results

The 517 specimens in the present collection include 60 scales. These derive from teleost fishes, although no attempt was made at identification. Of the remaining 457 bones and fragments, 292 were identified at least to family. These materials represent at least 18 species. The collection can be grouped into three associations: fishes caught locally, those imported from the Pacific Coast, and those imported from China (Table 13.34).

Arizona Species

Colorado Pikeminnow. The Colorado pikeminnow (*Ptychocheilus lucius*), the largest freshwater fish in the Colorado River drainage, is identified from 25 specimens representing at least three individuals. An inhabitant of larger flowing streams throughout the Colorado Basin, this species probably approached a length of 2 m and a weight of 45 kg, although most individuals were much smaller. Known vernacularly as "salmon" or "white salmon," these fish were quite abundant in some localities and were common enough in the Salt River to support a commercial fishery in the very early twentieth century. Populations declined during the last century, however, and the species was extirpated in the Gila Basin by the late 1950s (Minckley 1973:120-121).

Live weight of these fish was from vertebral diameters, using calculations provided by Casteel (1972) for *Ptychocheilus grandis*, a related California species. Caution is merited here, however, because the calculated size of these specimens exceeds the modern comparative sample range available for computation of Casteel's formulae.

Chub. Six specimens from the collection clearly represent chubs (*Gila* sp.). The Gila chub (*G. intermedia*) is the only species of this genus reported from the Santa Cruz River (Minckley and DeMarais 2000), and no comparative specimens were available for this study. The presumption that they represent this species is strengthened by the fact that the remains do not compare favorably with osteological specimens of bonytail chub (*G. elegans*) or roundtail chub (*G. robusta*)—large chubs that were common in other parts of Arizona.

Table 13.34. Chinese fish remains (San Agustín Mission species) from other *Huáqiáo* sites.

Species	Common Name	IJ56 Block, Sacramento, CA, 1850s[a]	HI56 Block, Sacramento, CA, 1850s[b]	IJFront2 Block, Sacramento, CA, 1880s[c]	Second Street Laundry, Woodland, CA, 1880s[d]	Yema-Po Construction Camp, Alameda County, CA, 1874-1875[e]	Point San Pedro Fishing Camp, Marin County, CA, 1870-1910[f]	Woolen Mills Chinatown, San Jose, CA, 1887-1902[g]	Los Angeles Chinatown, 1880-1930?[h]	Wong Ho Leun, Riverside, CA[i]	Tucson, AZ, Chinatown, 1880-1900?[j]
Ilisha elongata	White herring	–	P	–	–	–	–	P	–	–	–
Nemipterus spp.	Threadfin breams	–	P	–	–	–	–	P	–	–	–
Larimichthys crocea	Yellow croaker	P	–	–	–	–	–	P	P	P	–
Tetraodontidae	Puffers	–	–	P	P	P	P	P	P	P	P

[a]Schulz 1982.
[b]Schulz 1997.
[c]Personal observation.
[d]Schulz 1984.
[e]Gill 1985.
[f]Personal observation.
[g]Schulz 2002.
[h]Roeder 1996.
[i]Collins 1987.
[j]Gust 1993.

F. M. Chamberlain, who conducted a fish survey of Arizona waters in 1904, reported that Gila chubs then being taken on hook and line in the San Pedro Basin and were "more or less esteemed for food" (Minckley 1999:201). The chub was popularly known as *lisa*, accurately enough reported by Chamberlain as "meaning smooth." While this may have been a local folk etymology, the term is actually the most frequent Spanish word for mullet, and is commonly used for those marine fish (*Mugil* spp.) from the Gulf of California. The general similarity of western chubs to mullets in shape, size, and coloration undoubtedly facilitated the transfer of coastal nomenclature to the unrelated inland fish.

Live weight of the minnows represented here is estimated from a large series of known-weight material of *Gila bicolor,* a related species from the Great Basin.

Suckers. Four species of suckers occurred in southeastern Arizona prior to the environmental disruptions of the last century: *Xyrauchen texanus*, *Catostomus latipinnis*, *C. insignis,* and *C. (Pantosteus) clarki*. The present specimens clearly represent one or more species of the genus *Catostomus.* However, it was not possible to assign the material definitively to any of the three species.

Carp. The common carp (*Cyprinus carpio*) accounted for 19 bones from at least five fish. This fish was introduced to Arizona in the early 1880s (and much of the rest of the country) from the national piscicultural ponds in Washington, D.C. By 1885, at least 65 Arizona applicants had been supplied with fish (Anonymous 1886; Smiley 1886); one of these carp ponds, Warner Lake, was located 0.25 miles southwest of the present site. In 1889, it was leased by Chan Tin Wo, a Chinese immigrant, who intended "to furnish Tucson with fresh carp at all times" (*Arizona Daily Star* 1889).

Pacific Coast Species

American Shad. American shad (*Alosa sapidissima*) is represented in the present collection by 14 elements—representing two fish.

This species is a common food fish on the Atlantic coast. In the nineteenth century, it provided an abundant, inexpensive, and highly valued contribution to the diet of America's eastern cities. A favored species of early fish culturists, it became the first exotic fish species formally introduced into California when, in 1871, 10,000 young shad from the Hudson River were deposited in the Sacramento River. Taking of the species was prohibited prior to December 1877, by which time it seems to have become fairly well established (Dill and Cordone 1997:15, 31-33). Lockington (1879a:58) reports it as scarce but repeatedly present in the San Francisco market, and it appears intermittently in the retail market listings from 1880 onward.

Although the hopes of its advocates were fulfilled in that the species became well established, gastronomic enthusiasm among potential consumers seems to have waned over the years. By the second and third decades of the new century, shad had come to be viewed—in spite of promotion from the fish commission and anglers' journals—as a "common" fish, and one difficult to prepare for the table. It eventually became one of the cheapest and least-desired fish in the market (California Fish and Game 1922; California Fish and Game Commission 1916; Hedderly 1912; Nidever 1916).

A specialized and well-known fishery for salt shad existed in the Sacramento-San Joaquin Delta for a few years following 1912:

> From the time shad became abundant in our waters up to 1912 they were utilized almost entirely by fresh markets. But in the spring of 1912 several salting stations for shad were established on the San Joaquin River by Chinese companies… These continued for only two seasons, for they did not seem to pay. Later a salt shad market was established for China and practically all the California fish were shipped there. Several local salmon packers have now taken up the dry-salting of shad and have packed many tons during the last two or three years, which they have sold through Chinese brokers in San Francisco (Nidever 1916:62).

Although this report emphasizes the fresh market for shad prior to 1912, it can be assumed that the fish were at least occasionally salted for market. Documentation is scarce, but at least one report survives:

> During the past two weeks shad have been coming up the American river in great numbers, but there is a useless destruction of them by Chinese and Portuguese miners by placing nets across the entire river and catching the fish in great quantities. At the mouth of Alder creek and Mississippi bar nets have been stretched across the river for a week or more, and fish are being caught and salted down by the barrel (*San Francisco Post* 1890:4).

Short-term, localized operations such as this undoubtedly account for the present specimens.

Cod. Cod (*Gadus* sp.) are represented by only a single bone. Recent taxonomic summaries generally classify the world's cod populations into three species, at least two of which were available as salt fish on western markets during the last century. Atlantic cod (*G. morhua*) have been commercially important in Europe and North America for hundreds of years, while the large populations of Pacific cod (*G. macrocephalus*) began to be exploited by the San Francisco fishing fleet in the 1860s. Species of the present specimen cannot be determined.

Certainly the paucity of cod remains here is a contrast from Euro-American assemblages, where such bones are generally among the most common of fish remains. Such remains are almost ubiquitous in late nineteenth century California assemblages, reflecting the status of salt cod as the most important fish on the North American market. It seldom appears in Pacific Coast fish market retail price lists, but only because it stocked the shelves of almost every grocer in the west and was available in confusing variety. A sense of the ubiquity of salt cod in western settlements can be gained from a sardonic commentary from a Wyoming newspaper, reprinted in a San Francisco contemporary:

> The Wyoming codfish is generally dead. Death in most cases is the result of exposure and loss of appetite. No one can look at the codfish of commerce and not shed a tear. Far from home with his system filled with salt, while his internal economy is gone, there is an air of sadness and homesickness and briny hopelessness about him that no one can see unmoved.
>
> It is in our home life, however, that the codfish makes himself felt and remembered. When he enters our household, we feel his all prevading [sic] presence, like the perfume of wooden violets, or the seductive odor of a dead mouse in the piano.
>
> Friends may visit and go away to be forgotten with the advent of a new face, but the cold, calm, silent corpse of the codfish cannot be forgotten. Its chastened influence permeates the entire ranch. It steals into the parlor like an unbidden guest and flavors the costly curtains and high-priced lambiquins. It enters the dark closet and dallies lovingly with our swallow-tailed coat. It goes into your sleeping apartment and makes its home in your glove box and handkerchief case.
>
> That is why we say it is a solemn thing to take the life of a codfish. We would not do it. We would pass him by a thousand times, no matter how ferocious he might be, rather than take his life, and have our happy home haunted by his unholy presence (*San Francisco Journal of Commerce* 1882:1).

Chinook Salmon. This species (*Oncorhynchus tshawytscha*) was the most important food fish of the Pacific Coast in the latter half of the nineteenth century, although it is represented here by only three bone—a caudal vertebra and two hypurals (tail bones).

Salt salmon was always a significant by-product of the fishery, because it allowed fishermen (most of whom processed their own fish) to preserve part of their catch for later sale if the market was oversupplied with fresh product. This practice also provided an outlet for salmon taken illegally during the closed season (Jordan 1887:614, 618; Jordan and Gilbert 1887:732-735). The process, in anatomical terms, is worth noting:

> In dressing salmon for pickling on the Pacific coast, the heads are removed and the fish split along the belly, the cut ending with a downward curve on the tail. The viscera and two-thirds of the backbone are removed, and the blood, gurry, and black stomach membrane scraped away (Stevenson 1899:455-456).

Staghorn Sculpin. Only one specimen of the staghorn sculpin (*Leptocottus armatus*) was recovered. This fish is a common in-shore species throughout much of the Pacific Coast and is readily taken in line and net fisheries. The bones are extremely common among the fish remains recovered from a late nineteenth century Chinese fishing camp on San Francisco Bay (personal observation). One scientific observer in the 1880s referred to them as "catfish" and likewise noted them as an abundant component of the by-catch of the San Francisco Bay shrimp fishery:

> These fishes are not taken to market, but are soaked in brine and spread on mats to dry in the sun. When dried they sell at less than 2 cents per pound, the *Leptocottus* being nearly all head. The catch on hand during my visit must have contained fully half a ton of these small fish (Jordan 1887:612-613).

Rockfish. Numerous bones represent rockfish (*Sebastes* spp.). More than 50 species of this genus occur along the Pacific Coast. Specific identification from isolated bones is usually difficult. Because comparative specimens were available for only about 30 species, no attempt at specific identification is offered here. It is suspected that the remains derive from one or more species not represented in the comparative collections utilized.

Fishes of this genus—vernacularly known as rock cod—are quite common along the Pacific Coast, where they have contributed significantly to commercial landings since the early 1850s. Dried rockfish were a common product of fisheries operated by Chinese immigrants (Collins 1892:60; Lockington 1881:37) and probably account for most of the "cod" noted in the San Francisco custom house records as a common export to China.

California Corbina. The California corbina (*Menticirrhus undulatus*) was recognized from only a few bones. This croaker reaches a length of at least 71 cm and a weight of at least 3 kg. The species—known in the late nineteenth century as bagre, sucker bass, or sucker—was reported as abundant along the

California coast from Santa Barbara southward. It was reported as a food fish of fair quality, taken in seines and gill nets (Jordan 1884:379; Lockington 1881:45). No reports of salt-drying have been found, although given that the other species of this family were the subject of focused salt-drying industries, it is not surprising. The corbina is a common constituent of southern California middens and has been previously recovered from Chinatown deposits in San Diego and San Jose (Schulz 2002).

Surfperch. The collection yielded two bones identifiable as surfperch (Family Embiotocidae). Nineteen species of this family occur along the coast of California—most of them common food fishes. They were salted in quantity by Chinese fishermen in Monterey and on San Francisco Bay (Collins 1892:60; Jordan 1887:612-613), and undoubtedly in other localities as well.

Ocean Whitefish. The ocean whitefish (*Caulolatilus princeps*) is identified from four specimens. This was a common commercial fish of the southern California coast. They were commonly salted, by both Chinese and American fishermen, and were among the best salt fish on the market (Jordan and Gilbert 1882:46, 53).

Sheephead. The second-most abundantly represented fish in the sample is identified from 45 specimens from at least four individual fish. Formally ascribable only to the wrass family (Labridae), these bones are almost certainly those of California sheephead (*Semicossyphus pulcher*). Some caution in making this ascription is warranted given the numerous species of this family found in the Gulf of California and along the southern Chinese coast, where, it must be noted, at least some species are salted for market. However, the present remains all appear to be from a single relatively large species. All the specimens are osteologically compatible with *S. pulcher* and differ from the limited number of Chinese and Mexican comparative specimens available.

California sheephead—then vernacularly known as blackfish or redfish—were once abundant along the coast south of Point Conception. They were taken in immense numbers by Chinese fishermen and were salted and dried. The flesh was reputed by Euro-American observers as "rather coarse, but the fat forehead is esteemed for chowder" (Lockington 1881:42). Drying method was evidently specific to this fish:

> The redfish (Trochopus pulcher) are dressed by opening the abdomen and removing the viscera, and Chinamen exhibit much ingenuity in giving a picturesque appearance to the head and teeth of this species. According to Dr. D. S. Jordan: "A 'junk' with the deck covered with drying redfish seems at a little distance to be full of frogs about to leap" (Stevenson 1899:417).

Flatfishes. Although the excavation yielded 15 bones of flatfishes (Pleuronectiformes), only two could be identified to species. The latter bones are from the starry flounder (*Platichthys stellatus*), one of the most common flatfishes of the central California coast. Lockington (1879b:93) reported it as "the most abundant of all the flat-fishes brought to our markets," noting that it "is sold under the name of 'Flounder,' which here [San Francisco] appears limited strictly to this species." The terminology is confirmed by Jordan (1884), who reported that the name "Flounder" was rarely used in a generic sense in San Francisco.

Chinese Species

The excavations yielded remains of at least four species imported from China—all of them as salt fish.

White Herring. The white herring (*Ilisha elongata*) is identified from several specimens, representing at least two individuals. It may be noted that comparative specimens were available for only one species of the genus, *I. elongata*. Although two additional species occur along the coast of Guangdong, neither attains sufficient size to be responsible for the archaeological specimens.

Superficially, the species resembles a large herring—hence the English name—but it is generally classified in a separate family. Maximum standard length is 40.5 cm. This species is reported by Anderson (1972:110) as "a mainstay of the [Hong Kong] salt fish industry, and … the most highly valued salt fish." Yang and Chen (1971:8) note that it is caught only in small quantities in Taiwan, but that it is "highly esteemed when salted Cantonese style." Salt specimens were readily obtainable in Hong Kong and Macao markets in 1986 and 1989. In spite of this popularity in southeastern China, the species is not at all common on the overseas salt-fish market in California and has never been observed here by the author.

Threadfin Breams. The threadfin breams (*Nimipterus* spp.) are schooling perciform fishes, easily recognized by their reddish bodies with multiple luminous yellow pin-striping. They are among the most common fishes in the South China Sea and a traditional mainstay of Guangdong marine fisheries (Anderson 1972; Hong Kong Agricultural and Fisheries Department 1972). They are marketed mainly fresh, but were also widely dried and are readily available frozen in overseas markets today. Although at least five individuals were represented in the present collection, only one could be identified to species.

The identified species was the golden threadfin (*N. virgatus*), a benthic species that reaches a maximum size of 35 cm. This fish is widely known in Cantonese as *hung sam* ("red jacket") (Anderson 1972:125), although it is marketed in English most commonly as "golden thread" or "golden threadfin." Probably the most common nemipterid in southern Chinese landings, it is certainly the most common found in Pacific Coast markets today.

Yellow Croaker. The yellow croaker (*Larimichthys crocea*) is represented by 17 bones from at least two individuals. One of the most popular food fishes of southern China, the yellow croaker (or yellow flower fish) is also probably the most frequently exported. Remains of this species, recovered from gold rush-era deposits in Sacramento, indicate it was being imported into California by the 1850s (see Table 13.34). It is still readily available in Asian markets here, although now frozen and canned as well as salted.

Puffer. The collection includes three puffer bones (Family Tetraodontidae). These are from a relatively large fish, but are insufficient for identification of species. Such remains are quite commonly found in deposits associated with overseas Chinese communities (see Table 13.34). In only one case have such bones been identified to species—the remains of kanafugu (*Lagocephalus inermis*) from the Woolen Mills Chinatown in San Jose, California (Schulz 2002). Many species of puffers are found in the South China Sea. Whether the nineteenth century fishery targeted kanafugu in particular, is unknown.

The evident popularity of these fish in the overseas communities calls for some explanation, given their well-justified reputation for being poisonous. Various species of puffers are certainly in great demand as sashimi among Japanese epicures, but this enthusiasm is generally thought to be lacking in China. Read (1939:80) notes that in traditional Chinese pharmaceutical practice, puffer flesh was considered "sweet, warming and poisonous" and was used as "a tonic for weak people, dehydrotic, good for the loins and feet, for piles, antihelmintic."

Salt processing is unreliable in completely removing the poison (tetraodotoxin) from puffer flesh. However, cooking the processed product is effective to this end (Deng-fu Hwang, personal communication 2005; Ozawa 1983; Tsubone et al. 1986), and salt-dried puffer are still sold in China and Taiwan. Therefore, although consumption in nineteenth century North America may have been influenced by traditional medicinal beliefs, the archaeological remains represent salt fish consumed primarily as food.

Discussion

This study demonstrates that salt fish from China contributed to the diet of *Huáqiáo* residents of Tucson by the 1880s. The species identified were common market items recovered from many nineteenth century urban Chinatowns on the Pacific Coast (see Table 13.34). It is clear, however, that local fresh fish were more important in the diet, and that imported salt fish from the Pacific Coast vastly more so.

It is noteworthy that even the non-Chinese fishes represented in this assemblage reflect a dietary adaptation found among Chinese immigrants on the Pacific Coast, and one that differed substantially from Euro-American residents. Archaeological remains from the latter group often include bones of local freshwater or marine fishes, but salt fish is usually restricted to the traditional products of the North Atlantic and North Pacific: salt cod, and sometimes herrings or mackerels. Salt cod is—perhaps with the exception of salmon in areas where it could be obtained fresh or smoked—the most common food fish by far.

Chinese assemblages show a different pattern. Salt cod, although it occasionally (as in this case) is present, is uncommon. The same is true of salmon, even in areas where it was readily available. Instead, the diet was dominated by local marine and freshwater species, the products of primarily Chinese fisheries.

In the case of the present gardeners' assemblage, the carp consumed were the same species found in their homeland, and the other freshwater fishes were similar to species readily obtained there. Except cod and salmon, all the imported fishes were at least potentially products of *Landsmann* enterprises, processed in traditional ways. Because many of the Pacific Coast species (sheephead, whitefish, corbina, flatfish) were closely related to fishes common in Chinese markets, the gardeners who consumed them may have been unaware of their origin. The fish remains from the present assemblage thus seem to argue strongly for the maintenance of dietary traditions, even though those traditions drew upon new geographical sources of supply.

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