ERRATA

The nine footnotes of the final version of this essay that I submitted for publication were inserted into the main text during production, and I was not given the opportunity to check the final page proofs. Most of these changes were inconsequential to the intended meaning, but in two cases, they render the text nearly unintelligible. The correct versions of these two sections are as follows:

1. First page, second and third paragraphs (page 53 of the essay). These paragraphs should be:

Humans have lived in Chihuahua for perhaps as long as 12,000 years, but an analysis of their relationships with other mammals during this entire period is not yet possible. Of the hundreds of prehispanic settlements that have been identified in the state, few have been excavated and almost all of these date from after the introduction of maize agriculture from Mesoamerica to the region about 4000 years ago (Sayles, 1936; Brand, 1943; Phillips, 1989; Guevara Sánchez and Phillips, 1992; Phelps, 1998; Hard and Roney, 1998; Whalen and Minnis, 2001). Moreover, detailed faunal analyses have been published for only three archaeological sites, all located in the northwestern quadrant of the state.

[NOTE: A thorough analysis has also been completed of the faunal remains from the Villa Ahumada site in north-central Chihuahua, which dates from around A.D. 1200-1450. The results of this analysis are presented in the unpublished report of Polaco and Guzmán (n.d.) and summarized in Cruz Antillón and Maxwell (1999: 47-50). This site is remarkable for the extremely high relatively frequency of lagomorphs present, which represent over 98% of the total mammalian remains identified. Brief overviews of the faunal remains recovered from other archaeological sites in Chihuahua can be found in Lister (1958: 69), Ascher and Clune (1960: 271), Guevara Sánchez (1986: 174), and Whalen and Minnis (2001:71).]

Here we compare the results of these three faunal analyses to gain insights into the diversity and distribution of mammalian taxa that existed in the past within this area of northern Mexico and the range of human-mammal interactions, as well as changes in these interactions, that occurred there. Because of differences in the approaches followed in excavating these three sites and analyzing the faunal remains recovered from them, as well as the absence of faunal analyses from other areas of Chihuahua and earlier periods of its history, our conclusions regarding the relationships between humans and other mammals in prehispanic Chihuahua are necessarily tentative. We hope, however, that our interpretations of the data currently available on these relationships will provide a point of reference and stimulus for future studies on the topic.

2. Page 56 of the essay, second sentence of the third paragraph. This sentence should read:

The researchers who analyzed the deposits at Paquimé concluded that its residents emphasized artiodactyls over smaller mammals and proposed that bison provided them with their principal source of meat (Di Peso *et al.*, 1974).

[NOTE: The faunal analysis from Paquimé does not provide details of the body parts represented in the faunal assemblage, but in the case of bison, both “cranial material and post-cranial skeletal elements” are noted (Di Peso *et al.*, 1974).]

Humans and other mammals in Prehispanic Chihuahua

William L. Merrill[1] and Celia López González[2]

[1] Department of Anthropology, National Museum of Natural History, Smithsonian Institution.
[2] Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional - Unidad Durango, Instituto Politécnico Nacional

RESUMEN

Se compararon los resultados de los análisis faunísticos realizados en tres sitios arqueológicos en el noroeste de Chihuahua, México —Cerro Juanaqueña, El Zurdo, and Paquimé— con el fin de explorar la diversidad de mamíferos presentes en el área y sus relaciones con los humanos a partir del establecimiento de asentamientos agrícolas (alrededor de 1300 a.C.). En los depósitos de estos sitios fueron encontrados casi todos los taxa previstos; sin embargo, debido a las diferencias en la metodología utilizada para recuperar y analizar los restos de fauna, resultó difícil determinar variaciones entre los sitios en cuanto a las interacciones hombre-mamífero. Los resultados sugieren que en los sitios analizados los mamíferos pequeños constituyeron pieza clave en la estrategia de supervivencia; la aparente importancia del búfalo (*Bison bison*) y el berrendo (*Antilocapra americana*) en el sitio más complejo se interpreta como indicador del consumo de estos animales en contextos ceremoniales, más que en la dieta diaria de los pobladores.
Palabras clave: mamíferos, arqueozoología, Chihuahua, recursos alimentarios

ABSTRACT

Faunal analyses from three archaeological sites in northwestern Chihuahua, Mexico—Cerro Juanaqueña, El Zurdo, and Paquimé—are compared to gain insights into the diversity of mammals present in the area and their relationships with humans following the emergence, around 1300 B.C., of agricultural settlements there. Almost all expected mammalian taxa are encountered in the deposits of these sites, but evaluating intersite variation in human-mammal interactions is challenged by disparities in the methods used to recover and analyze the faunal remains from them. An emphasis on small mammals in the subsistence strategies of the residents of all three sites is suggested. The apparent prominence of buffalo (*Bison bison*) and pronghorn antelope (*Antilocapra americana*) at the most complex of these sites is interpreted as reflecting the special use of these large herbivores in periodic public feasts rather than in daily diet.
Keywords: mammals, archaeozoology, Chihuahua, diet resources

INTRODUCTION

The multifaceted adaptation of humans and other mammals to one another over the course of hundreds of thousands of years has been a key component of processes that have transformed the world's ecosystems and mammalian life within them. In this essay, we explore some aspects of this mutual adaptation by focusing on the interaction between human beings and other mammals during the three millennia that preceded the arrival of Europeans in what is today the northern Mexican state of Chihuahua.

Humans have lived in Chihuahua for perhaps as long as 12000 years, but an analysis of their relationships with other mammals during this entire period is not yet possible. Of the hundreds of prehispanic settlements that have been identified in the state, few have been excavated and almost all of these date from after the introduction of maize agriculture from Mesoamerica to the region about 4000 years ago (Sayles, 1936; Brand, 1943; Phillips, 1989; Guevara Sánchez and Phillips, 1992; Phelps, 1998; Hard and Roney, 1998; Whalen and Minnis, 2001). On faunal remains, a thorough analysis has also been completed from the Villa Ahumada site in north-central Chihuahua, which dates from around A.D. 1200-1450. The results of this analysis are presented in the unpublished report of Polaco and Guzmán (n.d.) and summarized in Cruz Antillón and Maxwell (1999). This site is remarkable for the extremely high relatively frequency of lagomorphs present, which represent over 98% of the total mammalian remains identified. Brief overviews of the faunal remains recovered from other archaeological sites in Chihuahua can be found in Lister (1958), Ascher and Clune (1960), Guevara Sánchez (1986), and Whalen and Minnis (2001).

Moreover, detailed faunal analyses have been published for only three archaeological sites, all located in the northwestern quadrant of the state. Here we compare the results of these three faunal analyses to gain insights into the diversity and distribution of mammalian taxa that existed in the past within this area of northern Mexico and the range of human-mammal interactions, as well as changes in these interactions, that occurred there. Because of differences in the approaches followed in excavating these three sites and analyzing the faunal remains recovered from them, as well as the absence of faunal analyses from other areas of Chihuahua and earlier periods of its history, our conclusions regarding the relationships between humans and other mammals in prehispanic Chihuahua are necessarily tentative. We hope, however, that our interpretations of the data currently available on these relationships will provide a point of reference and stimulus for future studies on the topic.

The Archaeological Sites. The three archaeological sites considered here –Cerro Juanaqueña, El Zurdo, and Paquimé – are all located within the semi-arid basin and

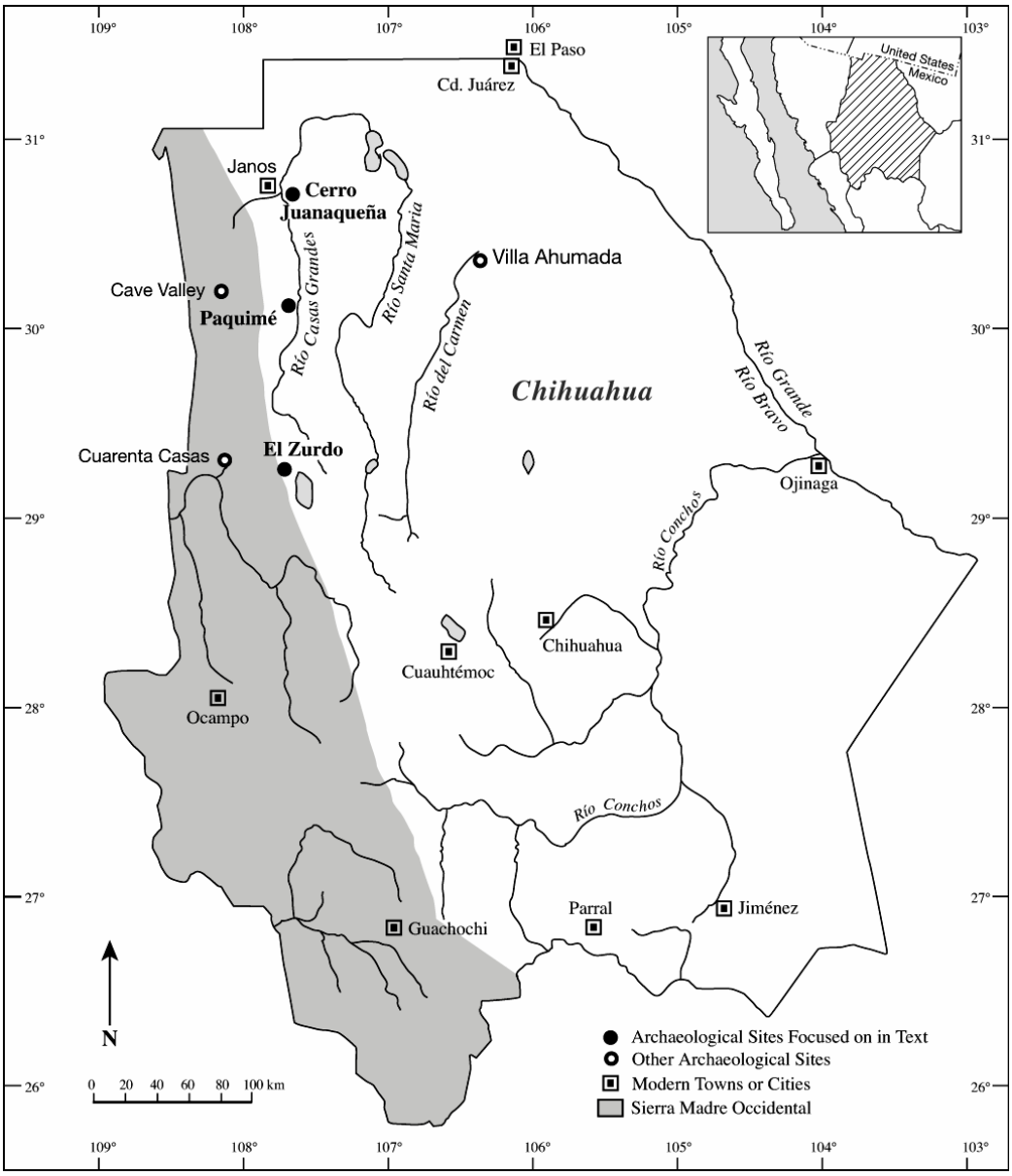

Figure 1. *Map of the analyzed area*

range country of northwestern Chihuahua, just east of the Sierra Madre Occidental mountain range (Figure 1). Cerro Juanaqueña and Paquimé are found in the valley of the northward-flowing Río Casas Grandes, at elevations of 1380 and 1480 masl respectively. Cerro Juanaqueña is 70 km north of Paquimé, which in turn is 90 km north of El Zurdo. El Zurdo is at a higher elevation than Cerro Juanaqueña and Paquimé, situated at 2200 masl in a narrow valley in the Babícora Basin, about 10 km northwest of the Laguna de Babícora.

Northwestern Chihuahua is characterized by considerable biodiversity (Schmidt, 1992; Brown, 1994). Three intergrading biotic communities, each associated with distinct but overlapping groups of plants and animals, are found in greater proximity to one another here than in any other part of the state: desertlands to the east, woodlands to the west, and grasslands in between. At the times these sites were occupied, grasslands dominated the immediate environs of Cerro Juanaqueña and Paquimé, with woodlands nearby and desertlands within 50 km of both sites. El Zurdo probably was situated in a woodland setting, separated by about 100 km from the desertlands but by only 25 km or so from the grasslands (Hodgetts, 1996; Whalen and Minnis, 2001; Hard and Roney, 2005).

Cerro Juanaqueña, the oldest of the three sites, is the earliest agricultural settlement that has been excavated in all of northwestern Mexico, dating from 1300-1100 B.C., during the pre-ceramic, Late Archaic period (Hard and Roney, 2005). Overlooking a broad flood plain in the Río Casas Grandes valley, this site is known as a “cerro de trincheras” because it includes 550 trincheras, or terraces, constructed of stone and earth covering an area of 10 ha on a hill 140 m high. The archaeologists who excavated Cerro Juanaqueña have identified the terraces as house

platforms rather than fields, and they have interpreted their location on the hillside as evidence that the site's residents needed to defend themselves and presumably their fields and food stores either from local foragers or other farmers (Hard and Roney, 1998, 2005).

The other two sites also were agricultural settlements, but they were established over a thousand years later than Cerro Juanaqueña, after the appearance of ceramics in the region. El Zurdo was a small settlement about one hectare in size that was occupied primarily during the two hundred year period between A.D. 1200 and 1400 but includes an earlier occupation dating back to at least A.D. 700 (Hodgetts, 1996; Kelley, *et al.*, 1999). Paquimé was contemporaneous with El Zurdo but was radically different from it. It was the largest agricultural settlement in prehispanic northwestern Mexico and the center of development of the Casas Grandes culture, one of the most complex cultural traditions in the history of the region. The Casas Grandes cultural sequence began in the first millennium A.D. and concluded when Paquimé was abandoned, around A.D. 1450. This sequence is divided into two periods: the Viejo period, from around A.D. 700 to 1200, and the Medio period, from A.D. 1200 to 1450. A poorly documented period, known as the Plainware period because it is characterized by undecorated ceramics, is presumed to precede the Viejo period and to date from around A.D. 150 to 700 (Di Peso, 1974, vol. 1; Phillips, 1989; Dean and Ravesloot, 1993; Whalen and Minnis, 2001).

The beginning of the Medio period is marked by the appearance of a distinctive Casas Grandes style of polychrome pottery, which was soon followed by a series of major cultural developments associated with a more elaborate division of labor and the organization of the local population into some form of social hierarchy. Among these developments were the construction of multistoried buildings in Paquimé and canals to irrigate nearby flood plain fields, the latter indicating the intensification of agriculture. Paquimé residents also produced or acquired through trade a wide range of high-quality articles, including items made of copper, turquoise, and shell and textiles woven from wild plant fibers and possibly cotton (Di Peso *et al.*, 1974; Woosley and Ravesloot, 1993; Doolittle, 1993; Schaafsma and Riley, 1999; Whalen and Minnis, 2001; Vargas, 2001).

Paquimé clearly was part of a long-distance trade network that extended from the southwestern United States to Mesoamerica, but its main sphere of interaction appears to have been relatively constricted. It likely encompassed the area from far northwestern Chihuahua or adjacent portions of southwestern New Mexico in the north east to the Río del Carmen drainage, south to the Babícora Basin, and west and southwest into the Sierra Madre Occidental, where the well-known archaeological zones of Cave Valley and Cuarenta Casas are located (see Figure 1) (Lister, 1953, 1958; Guevara Sánchez, 1984, 1986; Cruz Antillón and Maxwell, 1999; Kelly *et al.*, 1999; Whalen and Minnis, 2001; MacWilliams and Kelley, 2004).

Within this 30,000 km^2 area, Paquimé's elite probably exerted significant political influence over only Paquimé itself and adjacent settlements within a radius of about 30 km (Whalen and Minnis, 1999; Whalen and Minnis, 2001. Also, although Paquimé was much larger than either El Zurdo or Cerro Juanaqueña, it was significantly smaller than major centers in Mesoamerica. Phillips (1989) notes that, while the maximum population proposed for Paquimé is 4700 people, who lived in an area of 36 ha, the earlier Postclassic Mesoamerican center of Tula (located in the State of Hidalgo) is estimated to have covered 12 km^2 and to have had a population of 60,000 people.

The subsistence strategies of the residents of all three of these sites combined collecting wild plants and animals with maize agriculture. A domesticated amaranth may also have been cultivated at Cerro Juanaqueña, and beans (*Phaseolus* sp.), squash (*Cucurbita pepo*), gourd (*Lagenaria siceraria*), cotton (*Gossypium hirsutum*), and possibly agave or mescal (*Agave* sp.) were grown at Paquimé (Adams and Hanselka, n.d.; Whalen and Minnis, 2001; Di Peso *et al.*, 1974).

Domesticated turkeys (*Meleagris gallopavo*) also were raised at Paquimé and the remains of macaws have been recovered there. Both military macaws *(Ara militaris*) and scarlet macaws (*Ara macao*) are reported from Paquimé (Di Peso *et al.*, 1974; Minnis *et al.* 1993). Scarlet macaws are native to the tropical lowlands of southern Mexico and Central and South America, in contrast to military macaws and turkeys, both of which occur naturally in northern Mexico. The identification of these macaws, their status as domesticated or wild, and many other aspects of their place in the lives of the residents of this area remain to be resolved. Also, the researchers concur that these birds were valued primarily for their feathers rather than their meat and probably were attributed important symbolic significance as suggested by evidence that they were used in sacrifices (Di Peso *et al.*, 1974; Breitburg, 1993; Minnis, 1988; Minnis *et al.*, 1993). Similar uses of turkeys are documented for El Zurdo, where macaws may also have been present, but no evidence of these fowl has been discovered at Cerro Juanaqueña (Hodgetts, 1996; K. Schmidt, n.d.).

The only domesticated mammal in the area was the dog (*Canis familiaris*). In addition to protecting local residents and their settlements, dogs probably served as hunting companions and pack animals and, at Paquimé at least, may have been a source of meat as well (Di Peso *et al.*, 1974). Dogs presumably were found at all three settlements, but *Canis familiaris* is reported only from Paquimé. Because of the similarities among dogs, coyotes, and wolves, the specialists who completed the faunal analyses for Cerro Juanaqueña and El Zurdo were reluctant to identify any of the *Canis* remains from these

sites as definitively those of domestic dogs (K. Schmidt, n.d.; Hodgetts, 1996).

The Faunal Analyses. A comparative analysis of the human-mammal relationships at these three sites is confronted by several challenges. The mammalian taxa present in the vicinity of these settlements would have been affected by the climatic conditions that prevailed at the times of their occupation, but the history of the climate of the region during the nearly three thousand years between the establishment of Cerro Juanaqueña and the abandonment of Paquimé is poorly known. Moreover, differences in the faunal repertoires reported for these sites undoubtedly reflect to some degree the different approaches that were followed in excavating these sites and recovering and analyzing the faunal remains from them.

With regard to the latter, the faunal analysis for Paquimé does not report the number of bone and bone fragments to which an identification could be assigned, a count known as the "Number of Identified Specimens" (NISP). Partial NISP counts for some mammalian taxa recovered at Paquimé are reported (Di Peso *et al.*, 1974). The only count given is the "Minimal Faunal Count," defined as "the smallest number of individuals of a species that can be demonstrated from a given provenience by age, sex, size, and duplication of elements" (Di Peso *et al.*, 1974). This "Minimal Faunal Count" is identical to that of "Minimum Number of Individuals" (MNI), the term used in most zooarchaeological studies today (Grayson, 1984; Marshall and Pilgram 1993; Reitz and Wing, 1999).

Both NISP and MNI counts are provided for the faunal remains excavated at Cerro Juanaqueña and El Zurdo (Hodgetts, 1996; K. Schmidt, n.d.). It is unfortunate that NISP counts are not also available for Paquimé because the two counts offer distinct perspectives on the relative prominence of different taxa recovered from archaeological sites and each compensates for the biases of the other (Grayson, 1984; Marshall and Pilgram 1993; Reitz and Wing, 1999). Because NISP counts are not reported and are impossible to reconstruct for Paquimé, our analysis of the human-mammal relationships at the three sites relies by necessity on a comparision of the MNI counts from them. We do, however, present in Table 1 both the NISP and MNI counts for mammalian orders recovered from Cerro Juanaqueña and El Zurdo.

The specialist who analyzed the faunal remains from Paquimé also assigned species and occasionally even subspecies identifications to taxa represented in the remains, based on her assumption that the fauna of the Paquimé area in the prehispanic period corresponded to the taxa known to occur there or in other areas of the region today. In contrast, the zooarchaeologists who produced the faunal analyses for Cerro Juanaqueña and El Zurdo often identified remains no lower than the level

MINIMUM NUMBER OF INDIVIDUALS (MNI)						
ORDER	MNI Cerro Juanaqueña	% MNI Cerro Juanaqueña	MNI El Zurdo	% MNI El Zurdo	MNI Paquimé	% MNI Paquimé
Indeterminate Mammalia	0	0.00%	8	9.64%	21	2.56%
Lagomorpha	99	52.38%	17	20.48%	162	19.73%
Rodentia	47	24.87%	37	44.58%	72	8.77%
Carnivora	8	4.23%	14	16.87%	109	13.28%
Artiodactyla	35	18.52%	7	8.43%	457	55.66%
Totals	189	100.00%	83	100.00%	821	100.00%
NUMBER OF IDENTIFIED SPECIMENS (NISP)						
ORDER	NISP Cerro Juanaqueña	% NISP Cerro Juanaqueña	NISP El Zurdo	% NISP El Zurdo		
Indeterminate Mammalia	0	0.00%	149	15.80%		
Lagomorpha	1958	80.71%	289	30.65%		
Rodentia	323	13.32%	208	22.06%		
Carnivora	11	0.45%	167	17.71%		
Artiodactyla	134	5.52%	130	13.78%		
Totals	2426	100.00%	943	100.00%		

Table 1. *NISP and MNI counts for mammalian orders. See text for details.*

of genus, adopting the more conservative and defensible position that the identification of faunal remains should be based primarily on the remains themselves (Hodgetts, 1996; K. Schmidt, n.d.).

The excavation of these sites also was approached differently. In the case of both Cerro Juanaqueña and El Zurdo, less than 1% of each site was excavated, with 52m^3 of material excavated at Cerro Juanaqueña and about 120m^3 at El Zurdo. The excavations at Paquimé were extensive by comparison, but the researchers who completed this work do not provide an indication of the amount of material excavated; a rough estimate would be at least 15,500 m^3 (Robert Hard, 2004: pers. comm.). Moreover, the selection of areas to excavate varied from site to site. At Cerro Juanaqueña partial excavations were completed throughout most of the site while at El Zurdo the excavations focused on a few areas (Hard and Roney, 1998; Robert Hard, 2004: pers. comm.; Hodgetts, 1996: 151, 155). At Paquimé, about a quarter of the western half of the site that existed during the Medio period —the period from which almost all (98%) of the identified faunal remains derive— was excavated and another quarter site was trenched, but none of the eastern half was either trenched or excavated. (Di Peso *et al.*, 1974; Wilcox, 1999).

Intra-site provenience data for faunal remains recovered at Paquimé and Cerro Juanaqueña demonstrate that different mammalian taxa were not distributed evenly across the sections of the sites that were excavated (Di Peso *et al.*, 1974; K. Schmidt, n.d.). Because none of the sites was completely excavated, certain taxa may have been missed altogether. In addition, because the frequency of occurrence of these taxa also varied among the excavated sections, further excavation might alter the relative frequency of the taxa presented in the faunal analyses, particularly if new kinds of features or temporal components were discovered.

A similar range of variation characterizes the techniques employed to recover faunal remains from these three sites. This variation reflects to some degree differences in the methodologies that were current at the time when the excavations and faunal analyses were undertaken: the late 1950s through the early 1970s for Paquimé, the early 1990s for El Zurdo, and 1997-2004 for Cerro Juanaqueña. At Paquimé faunal materials were simply picked out of the excavations while at El Zurdo they were recovered through screening using 1/4 inch mesh. At Cerro Juanaqueña, 1/8 inch mesh was used for screening in the field and additional materials were recovered through flotation, in which a small subsample of the deposits was screened through 1/8 inch and 1/16 inch mesh and then minute bones were picked out by hand from the remaining sediment.

The impact of employing both screening and flotation and relying on finer-mesh screens is indicated by the fact that, even though the volume of earth excavated at El Zurdo was over twice that excavated at Cerro Juanaqueña, nearly ten times as many bones and bone fragments were recovered at Cerro Juanaqueña (33,165) than at El Zurdo (3,622) (K. Schmidt, n.d.; Hodgetts, 1996). For a controlled comparison of effect of different screen sizes on the recovery of the bones of small- and medium-sized mammals, see Shaffer and Sanchez (1994).

Of particular significance is the recovery at Cerro Juanaqueña of the bones of small fish through flotation. A total of 94 bones from small fish were recovered, 88 through flotation and only six through screening of dry soil; by comparison only 15 fish bone were recovered from El Zurdo. This difference may simply reflect the fact that Cerro Juanaqueña was located adjacent to a river while El Zurdo was not. However, the frequency of fish relative to other animal classes at these sites might also have been greater if both finer-mesh screening and flotation had been employed at El Zurdo and if all the excavated deposits at Cerro Juanaqueña had been subjected to flotation.

The enhanced recovery of small bones that are sufficiently large or intact to be identified also can compensate somewhat for the impact of the diverse factors that may affect the preservation of faunal remains in archaeological sites (see an overwiew in Reitz and Wing 1999). On the other hand, the recovery of significantly greater amounts of faunal material through the application of more sophisticated techniques does not automatically produce a comparable increase in identifiable specimens. The vast majority of the bone and bone fragments recovered from Cerro Juanaqueña was too small to be identified, so that the percentage of identified remains from this site (8.68%) was actually significantly lower than that from El Zurdo (50.11%).

The total count of bone and bone fragments recovered at Paquimé is not reported, but the lack of screening and flotation clearly limited the amount and kinds of faunal remain recovered there. The volume of excavated earth at Paquimé was approximately 300 times that excavated at Cerro Juanaqueña and 130 times that excavated at El Zurdo, but the "Minimum Number of Individuals" (MNI) identified from all classes of animals recovered at Paquimé was only about seven times that for Cerro Juanaqueña and eleven times that for El Zurdo; of these only 4 fish were identified, representing less than 1% of the total MNI count for Paquimé (see Table 2). Similarly, the bones of small mammals undoubtedly are underrepresented in the faunal materials recovered from both El Zurdo and Paquimé (Hodgetts, 1996). Over five times as many small mammal bones (rodents and lagomorphs) were recovered at Cerro Juanaqueña than at El Zurdo. The MNI count for small mammals identified at Cerro Juanaqueña is nearly three times that at El Zurdo and almost half that at Paquimé (see Table 3).

Given the fact that the techniques employed at El Zurdo were biased against the recovery of small bones, the high

CLASSES	MNI Cerro Juanaqueña	% MNI Cerro Juanaqueña	MNI El Zurdo	% MNI El Zurdo	MNI Paquimé	% MNI Paquimé
Fish	15	5.93%	2	1.19%	4	0.22%
Amphibians	4	1.58%	1	0.60%	0	0.00%
Reptiles	29	11.46%	2	1.19%	34	1.90%
Birds	16	6.32%	80	47.62%	932	52.04%
Mammals	189	74.70%	83	49.40%	821	45.84%
Totals	253	100.00%	168	100.00%	1791	100.00%
BIRDS						
Turkeys	0	0.00%	15	18.75%	344	36.91%
Macaws	0	0.00%	0	0.00%	503	53.97%
Aquatic Birds	1	6.25%	34	42.50%	24	2.58%
Other Birds	15	93.75%	31	38.75%	61	6.55%
Totals	16	100.00%	80	100.00%	932	100.00%
CLASSES WITHOUT TURKEYS & MACAWS						
Fish	15	5.93%	2	1.31%	4	0.42%
Amphibians	4	1.58%	1	0.65%	0	0.00%
Reptiles	29	11.46%	2	1.31%	34	3.60%
Birds	16	6.32%	65	42.48%	85	9.00%
Mammals	189	74.70%	83	54.25%	821	86.97%
Totals	253	100.00%	153	100.00%	944	100.00%

Table 2. *MNI counts for vertebrate classes, for bird groups and, vertebrate without the main bird group. See table explanation in text.*

COMMON NAME	MNI Cerro Juanaqueña	% MNI Cerro Juanaqueña	MNI El Zurdo	% MNI El Zurdo	MNI Paquimé	% MNI Paquimé
Small Mammals	146	77.25%	54	65.06%	234	28.50%
Deer or Antelope	17	8.99%	7	8.43%	407	49.57%
Bison	1	0.53%	0	0.00%	48	5.85%
Dogs or Coyotes	4	2.12%	4	4.82%	85	10.35%

Table 3. *MNI counts for mammal groups. See text for details.*

frequency (45%) of rodents relative to other mammalian taxa reported from this site suggests that rodents were a very important component in the local diet and possibly more significant than at Cerro Juanaqueña, where rodents represented about 25% of the total mammalian MNI counts (see Table 1). Some of the rodent remains at El Zurdo, as at Cerro Juanaqueña and Paquimé, undoubtedly are present because these small mammals entered the sites on their own. We do not believe, however, that the high relative frequency of rodents at El Zurdo can be accounted for solely as the result of their intrusion into the site. However, the converse argument cannot be adopted to account for the scarcity of rodents remains reported from Paquimé. The low relative frequency of rodents (about 9%) could reflect either a lower reliance on rodents compared to other mammalian taxa by the residents of this site or simply a lower level of recovery of rodent bones because excavated deposits were not screened.

THE TAXA PRESENT

Subphyla and Classes. The diverse kinds of animals represented in the faunal remains from these three sites come almost entirely from the subphylum Vertebrata. The only non-vertebrate taxa reported are 69 species of

marine mollusks recovered at Paquimé, which are associated with nearly four million shell ornaments. All these mollusks occur on Mexico's Pacific coast and presumably were imported to Paquimé from there (Di Peso *et al.*, 1974; Foster, 1992; Bradley, 1999; K. Schmidt, n.d.).

Five classes of Vertebrata are represented in the faunal repertoire associated with these sites: bony fishes, amphibians, reptiles, birds, and mammals. The MNI counts and relative frequency of these five classes are presented in Table 2. Fish, amphibians, and reptiles are insignificant at all three sites. Birds also represent a minor component (less than 7.0%) of the faunal remains recovered from Cerro Juanaqueña but not at El Zurdo and Paquimé, where the relative frequency of birds is comparable to that of mammals.

The prominence of birds at Paquimé reflects primarily the recovery of large quantities of turkey and macaw bones, which were identified as representing 344 and 503 individuals respectively. Turkeys and macaws were afforded special treatment as evidenced by intentional burials of entire or decapitated birds and kept in distinctive pens (Di Peso *et al.*, 1974; Minnis *et al.*, 1993). 15 turkeys, including five intentionally buried, were found at El Zurdo. Although no macaw remains were discovered, the site yielded one donut-shaped stone identified as part of the front of a macaw nesting box like those used at Paquimé (Hodgetts, 1996; Minnis, *et al.*, 1993).

Macaws represent over one-half and turkeys over one-third of the MNI counts for all birds recovered from Paquimé; together they constitute over 90% of the total bird MNI count. If macaws and turkeys are removed from consideration, the proportion of birds drops dramatically to 9% of the total MNI while that of mammals almost doubles to 87%. Excluding turkeys from the MNI counts for El Zurdo, however, has only a minor effect on the ratio between birds and mammals there: the percentage of birds in the total MNI for all vertebrate classes drops from 48% to 42% while the percentage of mammals rises from 49% to 54%.

The presence of significant numbers of waterfowl in the faunal remains from El Zurdo is the principal factor responsible for the prominence of birds at this site. Waterfowl, including species of grebes, herons, geese, swan, and ducks constituted 42% of the total bird MNI counts and 52% of these counts if turkeys are excluded. The high relative frequency of waterfowl at El Zurdo presumably reflects the proximity of this site to the Laguna de Babícora and would seem to indicate that these birds represented a significant component of local diet. Waterfowl also may have been of some significance at Paquimé, where they represented 28% of the total bird MNI counts after counts for turkeys and macaws are removed. In contrast, they appear to have been of negligible importance at Cerro Juanaqueña, where the remains of only one aquatic bird, a duck, was identified (K. Schmidt, n.d.).

Mammalian Taxa Present. With these adjustments for the presence of turkeys and macaws, mammals emerge as the dominant class of vertebrates at all three sites. Four mammalian orders are represented in the faunal remains from these sites (see Table 1): lagomorphs (jackrabbits and cottontails), rodents, carnivores, and artiodactyls (antelope and deer plus bison and bighorn sheep at Paquimé and possibly Cerro Juanaqueña).

There is considerable variation among the three sites in the relative frequency of these four orders. In the case of each site, these frequencies fall into three clusters: 1) around 50%, 2) around 20%, 3) around 10%. At Cerro Juanaqueña, lagomorphs constitute over 50% of the total mammalian MNI count, while rodents and artiodactyls fall around 20%, and carnivores represent less than 5%. At El Zurdo, rodents are the dominant order, followed by lagomorphs and carnivores at about 20%, and artiodactyls at less than 10%. At Paquimé, artiodactyls are by far the most prominent order present, perhaps reflecting the bias in favor of large bones of the methods used to recover faunal remains there. In any case, artiodactyls constituted over 50% of the total mammalian MNI count, with lagomorphs around 20%, and rodents and carnivores around 10%.

The MNI counts for the different mammalian taxa identified in the faunal analyses from these sites are presented in Table 4, along with the percentage that each taxon represents of the total mammalian MNI count from each site. A few aspects of this table require explanation.

1. The MNI counts for Paquimé are for faunal remains comprised of unworked hard tissue (bone or teeth) encountered primarily in trash deposits. However, two species not represented in these remains were found among the artifact assemblage recovered from the site: the beaver (*Castor canadensis*) and the puma (*Puma concolor*). Their presence in the mammalian repertoire of Paquimé is indicated in Table 4 with an "x."
2. Two mammalian taxa —pocket mice (*Perognathus* sp.) and one genus of bats (*Myotis* sp.)— were reported in a preliminary analysis of the faunal remains from Paquimé (Di Peso *et al.*, 1974). These genera were not included in the final faunal analysis from this site and are excluded from Table 4.
3. The single fox recovered from El Zurdo was identified as either *Urocyon* sp. or *Vulpes* sp. (Hodgetts, 1996). It is included in Table 4 as "*Urocyon* sp." based on modern distributions of these two genera. El Zurdo is located within the modern range of the gray fox (*Urocyon cinereoargentus*), while the kit fox (*Vulpes macrotis*) has been reported only from the desertlands of Chihuahua, to the north and east (Anderson, 1972).
4. The faunal analysis from El Zurdo also encountered

Order y Family	Lowest Level of Identification	MNI Cerro Juanaqueña	% MNI Cerro Juanaqueña	MNI El Zurdo	% MNI El Zurdo	MNI Paquimé	% MNI Paquimé
	Mammalia	0	0.00%	8	9.64%	21	2.56%
Lagomorpha							
Leporidae	Leporidae	14	7.41%	1	1.20%	0	0.00%
	Sylvilagus sp.	26	13.76%	6	7.23%	25	3.05%
	Sylvilagus audubonii	0	0.00%	0	0.00%	18	2.19%
	Lepus sp.	59	31.22%	10	12.05%	108	13.15%
	Lepus californicus	0	0.00%	0	0.00%	11	1.34%
Rodentia							
	Rodentia	21	11.11%	9	10.84%	11	1.34%
Scuridae	Sciuridae	1	0.53%	3	3.61%	0	0.00%
	Tamias sp.	1	0.53%	0	0.00%	0	0.00%
	Spermophilus sp.	0	0.00%	3	3.61%	0	0.00%
	Cynomys sp.	0	0.00%	3	3.61%	0	0.00%
Geomyidae	Geomyidae	0	0.00%	2	2.41%	0	0.00%
	Thomomys sp.	2	1.06%	14	16.87%	4	0.49%
	Thomomys bottae	0	0.00%	0	0.00%	1	0.12%
Heteromyidae	Perognathus sp.	12	6.35%	0	0.00%	0	0.00%
	Dipodomys sp.	1	0.53%	0	0.00%	1	0.12%
	Dipodomys merriami	0	0.00%	0	0.00%	17	2.07%
	Dipodomys ordii	0	0.00%	0	0.00%	9	1.10%
	Dipodomys spectabilis	0	0.00%	0	0.00%	18	2.19%
Castoridae	Castor canadensis	0	0.00%	0	0.00%	x	n/a
Muridae	Muridae	0	0.00%	1	1.20%	0	0.00%
	Peromyscus sp.	3	1.59%	0	0.00%	0	0.00%
	Sigmodon sp.	5	2.65%	0	0.00%	0	0.00%
	Neotoma sp.	1	0.53%	1	1.20%	7	0.85%
	Neotoma albigula	0	0.00%	0	0.00%	3	0.37%
	Microtus sp.	0	0.00%	1	1.20%	0	0.00%
	Ondatra zibethicus	0	0.00%	0	0.00%	1	0.12%
Carnivora							
	Carnivora	0	0.00%	4	4.82%	5	0.61%
Canidae	Canidae	2	1.06%	0	0.00%	1	0.12%
	Canis sp.	0	0.00%	4	4.82%	8	0.97%
	Canis familiaris	0	0.00%	0	0.00%	51	6.21%
	Canis latrans	4	2.12%	0	0.00%	26	3.17%
	Urocyon sp.	0	0.00%	1	1.20%	0	0.00%
	Urocyon cinereoargenteus	0	0.00%	0	0.00%	1	0.12%
Ursidae	Ursus americanus	0	0.00%	1	1.20%	1	0.12%
	Ursus arctos	0	0.00%	0	0.00%	1	0.12%
	Procyon lotor	0	0.00%	0	0.00%	1	0.12%
Procyonidae	Mustela sp.	0	0.00%	1	1.20%	0	0.00%
Mustelidae	Taxidea taxus	2	1.06%	1	1.20%	0	0.00%
	Mephitis sp.	0	0.00%	0	0.00%	1	0.12%
	Mephitis mephitis	0	0.00%	0	0.00%	1	0.12%
Felidae	Felidae	0	0.00%	0	0.00%	4	0.49%
	Puma concolor	0	0.00%	1	1.20%	x	n/a
	Lynx rufus	0	0.00%	1	1.20%	8	0.97%
Artiodactyla							
	Artiodactyla	15	7.94%	5	6.02%	23	2.80%
Cervidae	Odocoileus sp.	7	3.70%	1	1.20%	14	1.71%
	Odocoileus hemionus	0	0.00%	0	0.00%	65	7.92%
	Odocoileus virginianus	0	0.00%	0	0.00%	29	3.53%
Antilocapridae	Antilocapra americana	10	5.29%	1	1.20%	276	33.62%
Bovidae	Bison bison	1	0.53%	0	0.00%	48	5.85%
	Ovis canadensis	2	1.06%	0	0.00%	2	0.24%
Totals		189	100.00%	83	100.00%	821	100.00%

Table 4. *MNI counts for mammalian taxa. See explanation in text.*

the remains of one "large ungulate" and one "pig" (Hodgetts, 1996). Because no further information on these two taxa was provided, they are excluded from Table 4.

5. Humans also are not listed in Table 4 even though 20 artifacts encountered at Paquimé were made of human bone (Di Peso *et al.*, 1974). Unworked human bone also was recovered at Cerro Juanaqueña and El Zurdo (Schmidt, n.d.; Hodgetts, 1996).

Lagomorpha. The Lagomorpha, represented by jackrabbits and cottontails (both of the Leporidae family), was the predominant mammalian order only at Cerro Juanaqueña, but it clearly was important at both El Zurdo and Paquimé as well. The majority of faunal remains associated with this order from all three sites could be identified at least to the level of genus, revealing that at Cerro Juanaqueña and El Zurdo jackrabbits occurred approximately twice as frequently as cottontails and at Paquimé almost three times as frequently as cottontails.

Rodentia. Although only about half of the rodent remains from Cerro Juanaqueña could be identified to the level of genus, these identifications combined with those from El Zurdo and Paquimé do reveal some patterns in the relative frequencies of the different kinds of rodents discovered at these sites. The overwhelming majority (over 80%) of identified rodents from Cerro Juanaqueña and Paquimé come from two families: the Heteromyidae (pocket mice and kangaroo rats) and the Muridae (deermice, cotton rats, woodrats or packrats, voles, and muskrats). In contrast, no Heteromyidae are reported from El Zurdo and the Muridae represent less than 10% of the rodents encountered there.

Pocket gophers (*Thomomys* sp.), of the Geomyidae family, were by far the most prominent rodent taxa found at El Zurdo, representing almost 40% of all rodents and about 17% of all mammals recovered from the site. Pocket gophers also were found at Cerro Juanaqueña and Paquimé but at a much lower level than at El Zurdo, constituting less than 10% of the rodents present.

No examples of Scuridae (squirrels) were reported from Paquimé, but the remains of one chipmunk (*Tamias* sp.) were encountered at Cerro Juanaqueña, and a ground squirrel (*Spermophilus* sp.) was found at El Zurdo. The two species of ground squirrel most likely to have been present at this site were the small spotted ground squirrel (*S. spilosoma*) and the much larger rock squirrel (*S. variegatus*). Another Scuridae species found at El Zurdo was the prairie dog (*Cynomys* sp.), presumably the black-tailed prairie dog *(C. ludovicianus*). Extensive prairie dog colonies are found today southwest of Cerro Juanaqueña and north of Paquimé, but the presence of this species was not documented at either of these sites.

The limited distribution of prairie dogs among these three sites is paralleled by that of muskrats (*Ondatra zibethicus*) and beavers (*Castor canadensis*), which were encountered only at Paquimé. One specimen of an immature muskrat was recovered from the trash deposits of a room at Paquimé, while the beaver was represented in the faunal remains by a single incisor stained by copper, discovered in deposits of another room with no special associations that would reveal its purpose (Di Peso *et al.*, 1974). Although the muskrat occurs in Chihuahua today primarily along the Río Bravo (Rio Grande) (Anderson, 1972), its range may have extended in the past to some of the other drainage systems in northern and eastern Chihuahua. The beaver also is found in Chihuahua today, along both the Río Bravo and the lower Río Conchos (Anderson, 1972), but the absence of any additional evidence of this large aquatic rodent at Paquimé or the other sites suggests that the beaver incisor may have entered Paquimé as a trade item from elsewhere.

Carnivora. Fifty percent or more of the identified carnivores present at all three sites were from the Canidae family, with the majority of these identified as species of *Canis*, including coyotes (*C. latrans*) and dogs (*C. familiaris*) but possibly not wolves (*C. lupus*). Foxes — probably the gray fox (*Urocyon cinereoargenteus*)— were reported in limited numbers from both El Zurdo and Paquimé but not Cerro Juanaqueña.

The other four families of carnivores found in Chihuahua today also were encountered in the faunal remains of least one of the three sites, but their presence varied considerably among the sites. Raccoons (*Procyon lotor*) and skunks (*Mephitis* sp.), from the Procyonidae and Mustelidae families respectively, were found only at Paquimé. Other genera from the Mustelidae were not encountered at Paquimé, like badgers (*Taxidea taxus*), which were reported from Cerro Juanaqueña and El Zurdo, and either weasels or ferrets (*Mustela* sp.), which occurred only at El Zurdo. It must be noted that the presence of badgers in the Paquimé area is indicated by the fact that they are depicted in the polychrome Casas Grandes effigy ceramics (Woolsey, 2001).

No members of the Felidae family appeared in the faunal remains of Cerro Juanaqueña, but both bobcats (*Lynx rufus*) and pumas (*Puma concolor*) were present at El Zurdo and Paquimé. At Paquimé, puma bones were documented only among the artifacts, most in association with the bones of several other large carnivores, including both the black bear (*Ursus americanus*) and the grizzly or brown bear (*Ursus arctos*), members of the Ursidae family. Both species of bear were also discovered in Paquimé's trash deposits, while at El Zurdo one black bear but no brown bears were encountered, and neither was identified in the faunal remains from Cerro Juanaqueña.

Artiodactyla. Over 70% of the artiodactyl remains recovered from El Zurdo and over 40% from Cerro Juanaqueña could not be identified beyond the level of the order. It is likely, however, that they were from either pronghorn antelopes (*Antilocapra americana*) or deer

(*Odocoileus* sp.), both of which were identified at these sites. At Paquimé large quantities of pronghorn antelopes were found, representing nearly 60% of the total artiodactyl MNI count. The ratio between pronghorn antelopes and deer at Paquimé was over 2:1, about the same as that between mule deer (*Odocoileus hemionus*) and white-tailed deer (*O. virginianus*).

The other family of artiodactyls found at Paquimé and probably at Cerro Juanaqueña was the Bovidae, which includes bighorn sheep (*Ovis canadensis*) and bison (*Bison bison*). This family was absent from El Zurdo, unless the single "large ungulate" reported among the faunal remains represented one of these species. At Cerro Juanaqueña, one bone was tentatively identified as bison and five others as possibly representing two bighorn sheep. Two bighorn sheep were also reported from Paquimé, but bison were prominent, constituting 10% of all the artiodactyls recovered from the site.

Mammalian Taxa Absent. Taken together, the faunal analyses from Cerro Juanaqueña, El Zurdo, and Paquimé present what appears to be a remarkably complete record of the mammals that lived in central and northwestern Chihuahua over nearly three millennia, between 1250 B.C. and A.D. 1450. Yet, the four mammalian orders documented from these sites constitute only half of the mammalian orders known to occur in the state of Chihuahua today. The four missing orders are Marsupialia, Insectivora, Chiroptera, and Edentata.

Both the Marsupialia and Edentata are represented today in Chihuahua by one species each: the Marsupialia by the opossum (*Didelphis virginiana*), the Edentata by the nine-banded armadillo (*Dasypus novemcinctus*). These species have been reported from southwestern Chihuahua but never northwestern Chihuahua, and both are known to have been expanding their ranges within the last century or so (Anderson, 1972; McManus, 1974; McBee and Baker, 1982).

Two species of Insectivora are known to occur in Chihuahua: *Sorex monticolus* (wandering shrew) and *Notiosorex crawfordii* (desert shrew). *Sorex monticolus* appears to be restricted to pine forests over 2000 meters and thus unlikely to occur in any of the sites considered here. *Notiosorex crawfordii* has a much broader distribution and possibly was found in the vicinity of these sites at the time of their occupation, even through it was not identified among the faunal remains (Anderson, 1972). The absence of this shrew may reflect the fact that even in areas where it occurs it is relatively rare.

The Chiroptera in Chihuahua include representatives of seven families of bats, and eight genera from three of these families have been documented in modern times in northwestern Chihuahua: *Antrozous* from the Antrozoidae family, *Tadarida* from the Molossidae family, and *Myotis*, *Pipistrellus*, *Eptesicus*, *Lasiurus*, *Corynorhinus*, and *Idionycteris* from the Vespertilionidae family (Anderson, 1972; Hall, 1981; López-Wilchis and López-Jardinez 1999). Even though it is likely that the diversity of bat species at the time these sites were occupied was comparable to that of today, no bats were identified in the faunal remains of these sites. Their absence suggests that, despite their undoubted importance in the operation of the local ecosystem, they were of little significance in the economies of the human inhabitants of the sites as a source of meat or raw materials, although bat guano could have been used to fertilize cultivated fields (Pennington, 1963).

The only other mammalian taxa not reported in these analyses that are expected to have existed in this area during the prehispanic period are three genera of small mice from the Muridae family (*Baiomys*, *Onychomys*, and *Reithrodontomys*) and the gray wolf (*Canis lupus*). Although zooarchaeologists can identify *Baiomys*, *Onychomys*, and *Reithrodontomys* on the basis of their teeth and long bones, these particular body parts perhaps were not preserved sufficiently to allow an identification to the level of genus. About 25% of the total MNI count for rodents recovered from all three sites could not be assigned an identification below the level of Rodentia, and mice constituted less than 7% of the taxa that could be identified to the level of genus. In addition, recognizing these three Muridae genera is particularly challenging. The pygmy mouse (*Baiomys* sp.) is the smallest rodent in North America, the harvest mouse (*Reithrodontomys* sp.) also is quite small, and the grasshopper mouse (*Onychomys* sp.) is easily confused with *Peromyscus*, a genus of small mice documented at Cerro Juanaqueña but not El Zurdo or Paquimé (Anderson, 1972).

The apparent absence of the gray wolf from these sites is more puzzling, especially given its large size and the documented presence of all other large carnivores expected to have occurred in the area. It is possible that this wolf was represented in the canid remains that could not be identified below the level of family and genus. Because the three *Canis* species (dogs, coyotes, and wolves) can interbreed, distinguishing among them can be difficult. Schmidt (n.d.), who analyzed the faunal remains from Cerro Juanaqueña, identified the canid bones recovered from this site as either coyote (*Canis latrans*) or as simply *Canis*, concluding that they were less robust than would be expected if they were from the Mexican wolf (*Canis lupus baileyi*). Hodgetts (1996), who completed the faunal analysis for El Zurdo, gives "Dog, Wolf, Coyote" as the common names for "*Canis* sp." in the summary table of her results, but in her discussion she implies that these *Canis* remains represented either dogs or coyotes. In the faunal analysis for Paquimé, canid bones are identified as either coyotes or dogs. The possibility that some of these bones could have come from wolves is not mentioned at all (Di Peso *et al.*, 1974).

Except for dogs and coyotes, the MNI counts for large carnivores are very low at all three sites (see Table 4). This suggests that the residents of these sites seldom consumed these carnivores, either avoiding them or driving them away from their settlements and fields rather than killing them. In the case of gray wolves specifically, they perhaps were not hunted at all. Because they travel in packs and can move quite rapidly across considerable distances, hunting them is more difficult than other carnivores and also more dangerous: the hunter can quickly become the hunted (Mech 1974).

We also suspect that gray wolves did not venture close to the human settlements in prehispanic northwestern Chihuahua. We base this conclusion primarily on the evidence that coyotes were prominent in the vicinity of all three sites from this area considered here. The relationship between coyotes and wolves is antagonistic, and coyote populations tend to be significant only in areas where wolves are absent. Also, the preferred wild prey of wolves —primarily deer and other artiodactyls but rabbits and rodents as well— would have been readily available away from human settlements and, in the case of artiodactyls, probably more abundant there (Mech 1974; Bekoff 1977).

This situation changed radically during the Spanish colonial period with the introduction of Old World livestock, which drew wolves much closer to the human sphere and supported the dramatic growth of local wolf populations. Wolves became the dominant large carnivore across Chihuahua and much of western North America, maintaining this position until the nineteenth and early twentieth centuries, when the expansion of human settlement fragmented their habitats and campaigns of extermination eliminated them from most of the region (Leopold, 1959; Steffel, 1809; Mech, 1974). In contrast to wolves, which are strictly carnivorous and run in packs, coyotes are omnivorous and are solitary most of the time. They adapt readily to the increased proximity of humans, whose trash and domesticated animals provide them with additional sources of food. The negative impact of human expansion on the wolf population thus favored the expansion of coyotes into their former range.

The distribution of mammalian taxa. The absence of wolves, bats, the three genera of small mice, and the shrew confirms the obvious point that faunal remains recovered from archaeological sites reflect primarily human-animal interactions and only secondarily the diversity of animal taxa that occurred in the area of these sites. At the same time, these remains can provide important insights into the distribution of the taxa that are recovered, for time periods that precede by centuries or millennia written descriptions and biological collections of them.

Most of the mammalian taxa identified at Cerro Juanaqueña, El Zurdo, and Paquimé are still found in these areas today, but the faunal analyses from these sites include some unexpected data on distributions. For example, the discovery of a muskrat at Paquimé suggests that the range of this species included river drainages other than the Río Bravo, the only place in Chihuahua where they are found today. Similarly, although it is generally accepted that bison occurred in northwestern Chihuahua in the prehispanic period, this conclusion is reinforced by the significant representation of bison in the faunal record from Paquimé (Di Peso *et al.*, 1974). This record confirms the presence of bison in northwestern Chihuahua back at least a thousand years. If additional bone that can be definitely identified as bison is recovered at Cerro Juanaqueña or other sites in the area of comparable antiquity, this presence will be extended to three millennia.

Of even greater interest is the recovery of prairie dog bones from El Zurdo but not from Cerro Juanaqueña or Paquimé. Today prairie dog colonies are found in the vicinity of both Cerro Juanaqueña and Paquimé but not farther south, in the Babícora Basin where El Zurdo is located or elsewhere in Chihuahua (Anderson, 1972). However, the antiquity of these colonies in more southerly locations within the state is indicated by Late Pleistocene records of prairie dogs in both the Babícora Basin and in southeastern Chihuahua, near Jiménez (Alvarez, 1983; Messing, 1986). The first report of prairie dogs in far northwestern Chihuahua comes from the 18th century (Estolano de Escudero, 1777), suggesting a northward shift in prairie dog colonies after the arrival of Europeans to the region. We suspect that the principal factor responsible for this presumed shift was the introduction of large quantities of cattle, horses, and other livestock into the Babícora Basin during the early Spanish colonial period, in contrast to the Cerro Juanaqueña-Paquimé area, where livestock grazing was much less intensive (Almada, 1987; Griffen, 1979).

The apparent existence of prairie dog populations around El Zurdo may be linked to presence of the *Mustela* species reported there but not at Cerro Juanaqueña or Paquimé (Hodgetts, 1996). This presence is documented by a single mandible fragment, which could not be identified to the species level (Jonathan Driver, 2004: pers. comm.). One candidate is the long-tailed weasel (*Mustela frenata*), remains of which have been recovered from the deposits of the Villa Ahumada site, located in far northern Chihuahua about 180 km northeast of El Zurdo (Cruz Antillón and Maxwell, 1999; Polaco and Guzmán, n.d.). This site was occupied from around A.D. 1200-1450, coinciding with the final period of the El Zurdo occupation, and during this period both it and El Zurdo were situated near major lakes, where the long-tailed weasel often occurs (Sheffield and Thomas, 1997). In addition, it is the only *Mustela* species reported today from Chihuahua. Despite the assumption that it is widely distributed, however, only one specimen of it has been collected in modern times in the state, at Guachochi in the mountains of southwestern Chihuahua over 300 km south

of El Zurdo (see Figure 1; Anderson, 1972; Sheffield and Thomas, 1997).

The only other possible identification for this *Mustela* species is the black-footed ferret (*Mustela nigripes*). This ferret has not been encountered in Chihuahua in modern times, and it has disappeared from all of its former range in western North America, avoiding extinction only by being maintained in captivity. However, its presence in prehispanic Chihuahua is documented from the Pleistocene deposits of Cueva de Jiménez in southeastern Chihuahua (Messing, 1986). Because prairie dogs were a preferred prey of the black-footed ferret, the co-occurrence of a *Mustela* species and prairie dogs at El Zurdo and the absence of both at Cerro Juanaqueña and Paquimé raises the possibility that the *Mustela* species from El Zurdo could have been *Mustela nigripes* (cf. Owen *et al.*, 2000).

HUMAN-MAMMAL INTERACTION

Formation of the Faunal Record. Understanding the interaction between humans and other mammals that took place at Cerro Juanaqueña, El Zurdo, and Paquimé requires as a first step a consideration of the circumstances under which the mammals would have come to form part of the faunal remains recovered from the sites. There are two main alternatives: 1) the mammals were attracted to the sites and either died on their own or were killed by the human inhabitants there; or 2) these residents intentionally introduced the mammals into the sites.

Three features of these settlements can be identified as potential attractions to wild mammals: cultivated fields, organic trash, and potential prey. Cultivated fields and trash deposits offered the kinds of disturbed environments and food sources attractive to a wide range of mammals. In fact, the existence of cultivated fields alone would have attracted many of the mammals documented from these sites because they are either herbivores or omnivores and often thrive in these kinds of environments (Linares, 1976; Neusius, 1996; Hodgetts, 1996; Reitz and Wing, 1999). Small mammals, like rabbits and many rodents, are frequently found in or around cultivated fields, and a wide range of larger mammals also are known to raid these fields, especially for maize, including coyotes, foxes, raccoons, deer, and bears. Large herbivores reported from these sites that were unlikely to have been encountered in and around these cultivated fields were pronghorn antelopes, bison, and bighorn sheep, which tend to range in open plains or rugged areas that would not have been ideal sites for cultivating crops.

The diversity of small mammals that presumably would have been associated with cultivated fields or trash deposits would have served to attract both omnivores and the few mammals in the area that are predominantly or exclusively carnivorous, including badgers and bobcats primarily but also wolves. In addition, pumas may have approached the sites in search of deer or even bobcats, the remains of which frequently are encountered in the stomachs of pumas (Leopold, 1959). The captive fowl maintained at El Zurdo and Paquimé probably represented potential prey for some of these predators, for example, skunks, weasels, raccoons, foxes, and coyotes. Coyotes are notoriously adept at circumventing the devices that humans create to protect such fowl, and the presence of foxes at El Zurdo and Paquimé but not Cerro Juanaqueña, where no turkeys or macaws were recovered, suggests that foxes may have been motivated to enter these sites in part by the prospect of capturing these fowl. Domestic dogs also would have been vulnerable to some of the larger predators, but their ability to defend themselves probably precluded their falling victim with any frequency.

Although most of the mammals that appear in the faunal analyses considered here could have entered or approached the sites on their own, we can assume that at least some were brought into the settlements by their human residents. At the same time, the presence of a particular species of mammal in the faunal records of these sites does not necessarily indicate that it was used by the people who lived there. Rodent intrusion into archaeological deposits is the best known example of "non-cultural" mammalian presence. Such intrusion often can be recognized by the location of faunal remains in contexts that were clearly nesting areas or by the recovery of intact, non-charred bone or complete skeletons, which would suggest that the animal died *in situ*. In the absence of such evidence, however, the possibility that small rodents were an important component of local diet should not be discounted (Szuter, 1991a; Shaffer, 1992).

Site Catchment Areas. The faunal assemblages from Cerro Juanaqueña, El Zurdo, and Paquimé suggest that the residents of these sites collected the vast majority of mammals in areas quite close to their settlements, venturing farther a field only to hunt a very limited number of species (Hodgetts, 1996; Kelley *et al.*, 1999; Whalen and Minnis, 2001; Hard and Roney, 2005; K. Schmidt, n.d.). These species would have included those animals documented in the deposits of these sites that preferred habitats distinct from those that characterized the immediate environs of these settlements, for example, pronghorn antelopes in the case of El Zurdo and bighorn sheep in the case of Cerro Juanaqueña and Paquimé. Other mammals found relatively close to Cerro Juanaqueña and El Zurdo may have avoided Paquimé because of the density of settlements and human populations there. The residents of Paquimé may have organized hunting trips to acquire them or, alternatively, the residents of outlying areas may have brought some of these, especially larger game, to Paquimé to exchange for the exotic and luxury goods like shell ornaments that were produced or distributed there (Whalen and Minnis, 2001; cf. Di Peso *et al.*, 1974).

The size of the areas within which the residents of these three sites hunted and trapped mammals cannot be defined with precision, but it is possible that these areas did not extend much beyond a 30 km radius of these settlements. All of the mammalian taxa recovered from each of these sites are associated with ecological zones found within such a radius of them, and most of these taxa would have been attracted even closer to the settlements by their cultivated fields, trash deposits, or concentrations of potential prey. Even bison and bighorn sheep may have been available in the general vicinity of Paquimé and perhaps Cerro Juanaqueña. Di Peso *et al.* (1974) present historical evidence from the 16th to the 20th century that bison herds ranged into the Río Casas Grandes drainage, where both of these settlements are located, and the bison remains recovered from Paquimé include bones from animals of all ages and both sexes, suggesting year-round hunting. Similarly, bighorn sheep were reported in high desert ranges across much of northern and eastern Chihuahua until the 20th century (Leopold, 1959; Anderson, 1972).

The relatively restricted catchment's areas of these sites is also suggested by the fact that their faunal remains included no taxa associated with other, more distant ecological zones, even though at least some of these taxa presumably would have been highly valued as a source of meat. The most obvious examples of the latter are bison and bighorn sheep, which are entirely absent from El Zurdo even though they definitely were present in northwestern Chihuahua at the time that El Zurdo was occupied but in the area of Paquimé, 90 km to the north. Similarly, smaller mammals like tree squirrels (e.g., *Sciurus nayaritensis*) do not appear in the faunal remains from Cerro Juanaqueña and Paquimé but presumably were found in the mountains about 40 km to the south and west of these settlements, where they are known to occur today (Anderson, 1972). Of course, it would not be expected that special trips would have been undertaken to hunt such small mammals exclusively and if they were killed, the hunters may have consumed them away from the settlements.

The catchment areas of these sites can be divided into three general zones: 1) the settlements themselves, composed of both residential areas and cultivated fields; 2) uncultivated areas immediately adjacent to the settlements, where the residents gathered firewood, collected wild plants, and completed other kinds of activities; and 3) the grass- and scrublands beyond this intermediate area, where the level of human activity was relatively low. Small rodents and cottontail rabbits would have been encountered mainly in the first zone. The cultivated fields in this zone would have attracted deer, which along with jackrabbits would have been found primarily outside the settlements, in both disturbed areas closeby the settlements and in less disturbed areas farther away. Pronghorn antelopes, bison, and bighorn sheep would have remained farther from the settlements, in the semidesert grasslands and desert scrublands which offered the kinds of vegetation and spaces that they prefer (Leopold, 1959; Anderson, 1972; Brown, 1994).

Mammal Procurement Strategies. The broad range of mammalian taxa recovered from these three sites suggests that their residents hunted or trapped almost any kind of mammal that they encountered, killing them to acquire food or raw materials, to defend their crops, or in the case of Paquimé and El Zurdo, to protect their captive fowl from predators. It also is possible that some of these mammals were either killed by other animals or died on their own and then brought into the sites by their residents. The importance of such scavenging in prehispanic Chihuahua is difficult to evaluate, but one case is documented from the late 18th century, in which Indigenous people in southwestern Chihuahua took a deer that had been recently killed and hidden by a puma (Steffel 1809).

Within this general procurement strategy, the residents of each of these sites may have developed more specific procurement strategies focused on different kinds of mammals. At Cerro Juanaqueña, the emphasis clearly was on rabbits, especially jackrabbits which occurred over twice as frequently as cottontails in the faunal assemblage of this site (see Table 4). Together these lagomorphs represent 52% of the total mammalian MNI count for Cerro Juanaqueña and exceeded by nearly 10% the combined MNI counts for rodents and artiodactyls. Their dominance is even more evident when the NISP counts for these three taxa are compared: lagomorphs constitute over 80% of the total NISP count for the site compared to less than 20% for rodents and artiodactyls together (see Table 1).

A comparable focus on one order may not have characterized the mammalian procurement strategies of the residents of El Zurdo and Paquimé. In the MNI counts for El Zurdo, the predominant mammalian order is rodents, with one family of rodents —Geomyidae, or pocket gophers— occurring with about the same frequency as all lagomorphs and over five times more frequently than artiodactyls (see Tables 1 and 4). The dominance of rodents fades, however, when the NISP counts for these taxa are taken into consideration. Rodents represent 22% of the total mammalian NISP count compared to 31% for lagomorphs.

The higher NISP count for lagomorphs can be attributed in part to the fact that their bones are larger than those of rodents and thus more likely to have been recovered by the techniques employed in the excavations at El Zurdo. This bias may be offset by the likelihood that a larger percentage of rodents than lagomorphs entered the site on their own, but it would be a mistake to dismiss the high relative frequency of rodents as simply the result of intrusion or to underestimate the importance of these rodents in the local diet. All of the rodent taxa encountered —pocket gophers primarily but also ground squirrels, prairie dogs, mice, rats, and voles— are edible

and most are eaten by the Rarámuri, the principal Indigenous society in Chihuahua today (Bennett and Zingg, 1935; Pennington, 1963). In fact, even if half of the rodents recovered from El Zurdo were eliminated as intrusive, rodents would still represent over 25% of the total MNI count for the site.

In this regard, the prominence of pocket gophers is particularly intriguing. These small rodents make up almost 20% of the total mammalian MNI count at El Zurdo, in contrast to both Cerro Juanaqueña and Paquimé, where they constitute 1% or less of the MNI counts. Today pocket gophers are a common pest in the maize fields of the Rarámuri, who trap and eat them (Bennett and Zingg, 1935; Pennington, 1963). Shaffer (1992) reports a similar high frequency of these gophers at an agricultural settlement in southwestern New Mexico that was occupied between A.D. 600 and A.D. 1150, at about the same time as El Zurdo. He proposes that the presence of more cranial than postcranial skeletal elements of gophers can be interpreted as indicating that these rodents were processed by humans and thus introduced into the site by them, possibly as a source of food. Unfortunately, this possibility cannot be evaluated for El Zurdo because comparable data on the skeletal elements associated with gophers there are not available.

In light of these considerations, we can suggest that the residents of El Zurdo relied about equally on both rodents and lagomorphs and that these small mammals were much more significant in their diet than artiodactyls and other larger mammals. This focus is clearly indicated in Table 3, where the MNI counts for rodents and lagomorphs have been collapsed to form the category of "small mammals." Small mammals constitute about 65% of the total mammalian MNI count for El Zurdo and over 75% for Cerro Juanaqueña.

The evaluation of the relative significance of small versus large mammals at Paquimé is complicated by the fact that the bones of larger mammals were more likely to be recovered by the methods used there. The researchers who analyzed the deposits at Paquimé concluded that its residents emphasized artiodactyls over smaller mammals and proposed that bison provided them with their principal source of meat, however, the faunal analysis from Paquimé does not provide details of the body parts represented in the faunal assemblage, but in the case of bison, both "cranial material and post-cranial skeletal elements" are noted (Di Peso *et al.*, 1974). They estimated that the carcass of one adult male bison was equivalent to that of 18 adult male pronghorns or 300 jackrabbits. If these equivalences are correct, then the adult male bison recovered from the site (around 15 of the total of 48 bison) would have been equivalent to 270 adult male pronghorns and 4500 jackrabbits. This figure for pronghorns is about the same as the total MNI count of 276 for pronghorns of all ages and both sexes actually recovered at Paquimé during the Medio period and is almost 40 times that for jackrabbits (MNI = 119).

No bison remains are reported from El Zurdo but one bone, a broken and charred mid-section of a left rib, was recovered at Cerro Juanaqueña that has been tentatively identified as bison (K. Schmidt, n.d; Robert Hard, 2005: pers. comm.). Given the quantity of meat that bison could have provided, it would be expected that the residents of Cerro Juanaqueña would also have hunted bison. The absence of additional bison remains suggests that these herbivores were rare in the Cerro Juanaqueña area when the site was occupied around three thousand years ago, in contrast to their apparent abundance two thousand years later in the vicinity of Paquimé, located seventy km south of Cerro Juanaqueña (Di Peso *et al.*, 1974).

Researchers have demonstrated for other areas of western North America that the population sizes of bison and other artiodactyls vary significantly under different climatic regimes, with populations increasing during cooler, wetter periods, when grasses are more abundant, and declining during hotter, drier periods (Byers and Broughton, 2004; Speth, 2004; Adams and Van West, 2004). Perhaps the marked differences in the frequencies of bison reported from Cerro Juanaqueña and Paquimé reflect such climatic variations, but this hypothesis cannot be evaluated until the climatic history of northwestern Chihuahua is better known.

Assuming that the identification as bison of the rib fragment at Cerro Juanaqueña is correct, several alternative hypotheses can be offered for its presence. The residents of this settlement could have organized bison hunts away from the site, returning to Cerro Juanaqueña with only a few bones but with quantities of dried meat or hides, which would not have been preserved. They also could have acquired it through trade, but there are no other exotic items at the site that would indicate that such trade took place. It is also possible that the quantities of rabbits and rodents available either within the settlement or in nearby areas were sufficient to meet the needs of Cerro Juanaqueña's relatively small population, who hunted or scavenged for larger mammals like bison only occasionally to supplement the meat and raw materials provided by these more readily accessible small mammals. Determining whether one or another or some combination of these alternatives is preferable is impossible at this point because the data currently available are too limited.

With regard to Paquimé, Di Peso *et al.* (1974) argue that the need to provide meat for an expanding population motivated the residents of this settlement to increase their reliance on pronghorns and bison and that local hunters "ranged farther afield, leaving the grasslands and extending their hunting trips into the foothills and uplands for deer." That Paquimé experienced significant population growth during the time of its occupation is not in question, due perhaps to an influx of people from outlying settlements rather than a general population increase across the area (Paul Minnis, 2004: pers. comm.). However, whether its residents responded to the

dietary needs of its growing population by modifying both the focus and range of their hunting activities requires further evaluation.

The point of reference that these researchers used to gauge long-term changes in the Paquimé procurement strategy was the obviously incomplete faunal record from the pre-A.D. 1200 Viejo period. Only 15 mammal individuals were identified for this period: two jackrabbits, three dogs, four antelope, five bison, and one "unknown bovine," presumably a bison (Di Peso *et al.*, 1974). These extremely low MNI counts and the complete absence of deer and most other mammalian taxa indicate that this record is not a credible reflection of the Viejo period procurement strategy for Paquimé.

Whether changes in Paquimé's mammal procurement strategy occurred through time can be better evaluated by considering the more complete faunal record from the Medio period alone (Di Peso *et al.* 1974). Although the chronological relationships among the various components of the Paquimé site are not entirely clear (Whalen and Minnis, 2001), we will assume for the purposes of this essay that the faunal remains assigned to the Medio period by Di Peso *et al.* derive from this period. The division of this period into phases also is the subject of debate, but we use the chronology that distinguishes an earlier Buena Fe phase (A.D. 1200-1300) from a later Paquimé/Diablo phase (A.D. 1300-1450) (Phillips, 1989; Dean and Ravesloot, 1993).

The MNI counts for the deer, pronghorn, bison, and rabbit remains that could be dated to these two phases are presented in Table 5, along with the relative frequencies of these taxa. These data indicate that, despite significant growth in the human population in the area during the Medio period, the relative frequency of all four taxa remained more or less constant between the earlier and later phases. Moreover, although increasing population growth would be expected to have depleted the populations of mammals in the vicinity of Paquimé, there is no clear evidence that such depletion actually occurred. This fact is suggested by the paucity of mammal bone recovered from smaller settlements near of Paquimé (Paul Minnis, 2004: pers. comm.; Michael Whalen, 2005: pers. comm.). The factors responsible for the contrast between these sites and Paquimé in the quantity of faunal materials encountered are unclear.

For example, over 70% of the rabbits recovered from the site were adults (Di Peso *et al.*, 1974), perhaps reflecting their rapid maturation rate but also suggesting that local residents were not forced to rely on immature animals. The high reproductive capacity of both rabbits and rodents make them highly resistant to overhunting and, despite the fact that the techniques employed at Paquimé to recover faunal materials favored the recovery of the bones of larger mammals like artiodactyls over those of smaller mammals, rabbits and rodents together represent almost 30% of the total mammalian MNI count for Paquimé (see Table 1).

Although neither a significant decline in local mammal populations due to human population growth nor an increasing reliance on pronghorns, bison, and deer can be demonstrated for Paquimé, artiodactyls do appear to have been more significant in the mammal procurement strategy at this settlement than at either Cerro Juanaqueña and El Zurdo. We suspect that this inter-site variation reflects to some degree the impact of socio-political factors that operated at Paquimé but not at these other settlements.

Paquimé's size, elaborate architecture, extensive water-management systems, and many other characteristics indicate that the political organization there was more complex than that found at most other contemporaneous settlements north of Mesoamerica. However, Whalen and Minnis (2001) make a convincing argument that the political power of Paquimé's leaders was relatively limited and that they were able to organize and integrate the local population primarily by controlling the distribution of a variety of luxury goods and by staging major religious ceremonies and other public events, including large-scale feasts (cf. Dietler and Hayden, 2001).

TAXA	MNI Buena Fe Phase A.D.1200-1300	% MNI Buena Fe Phase	MNI Paquimé/Diablo Phase A.D. 1300-1450	% MNI Paquimé/ Diablo Phase	Difference
Leporidae	31	22.79%	67	22.26%	-0.53%
Odocoileus spp.	23	16.91%	47	15.61%	-1.30%
Antilocapra americana	56	41.18%	106	35.22%	-5.96%
Bison bison	7	5.15%	15	4.98%	-0.16%
Canis familiaris	2	1.47%	25	8.31%	+6.84%
Other Mammals	17	12.50%	41	13.62%	+1.12%
Totals	136	100.00%	301	100.00%	

Table 5. *MNI counts for some mammal remains that could be dated. See text for details.*

We suggest that these artiodactyls served as the principal source of meat prepared for such public feasts. These animals would have provided meat for significant numbers of people, and special hunts may have been organized to acquire them specifically for these events. Whalen and Minnis (2001) propose that the food distributed at these feasts included "large quantities of the heads of succulent plants such as agave and maguey" that were cooked in stone-lined earth ovens constructed of an outer ring of large stones 8-12 meters in diameter, surrounding a fire pit that ranged from 2-5 meters across. Meat could have been roasted in similar earth ovens, a practice well-known across much of Mexico today and documented in Chihuahua during the Spanish colonial period for both beef and agave (Steffel, 1809).

Such special-purpose use of bison and pronghorns would account for the prominence of these animals in Paquimé's faunal record. Although the residents of Paquimé probably consumed bison and pronghorns in other contexts as well, we expect that, as at Cerro Juanaqueña and El Zurdo, smaller mammals like rabbits and rodents were more important in their everyday diet than artiodactyls, with the possible exception of deer. Unlike pronghorns and bisons, however, hunting deer probably would not have inevitably required trips "into the foothills and uplands" or other areas away from the site. At least some deer would have been attracted to Paquimé's cultivated fields and also available in areas of less intensive human activity near the settlement.

In contrast to Cerro Juanaqueña and perhaps El Zurdo, dogs also appear to have been consumed with some frequency at Paquimé. The relative frequency of *Canis* spp. at Cerro Juanaqueña is quite low, in terms of both MNI (about 2%) and NISP counts (less than 1%). While the MNI relative frequency of *Canis* spp. at El Zurdo also is low (5%), the NISP count (123) is quite high, exceeded only by the NISP count for jackrabbits (196) and representing about 13% of the total mammalian NISP count for the site (Hodgetts, 1996). These figures suggest that the residents of El Zurdo but not Cerro Juanaqueña may have consumed canids. Of the potential mammalian meat sources considered in Table 5, only dogs shows a significant increase in relative frequency during the Medio period, and the remains of *Canis* sp. (which includes both dogs and coyotes) represented 10% of the total mammalian assemblage from the site (see Table 4). The fact that pups constituted over 30% of the total MNI count for *Canis* sp. possibly supports this conclusion; they may have been preferred as a meat source because their meat is tenderer than that of adults (Di Peso *et al.*, 1974). If dogs were consumed, they would have provided a more reliable and readily accessible source of meat than artiodactyls for Paquimé's growing human population, whose dietary needs may also have been met in part by increased agricultural production.

Although we have focused thus far on the contribution of mammals to the diet of the residents of Cerro Juanaqueña, El Zurdo, and Paquimé, the importance of many of these mammals as a source of raw materials should be noted. Evidence of this role at Cerro Juanaqueña and El Zurdo is minimal. A total of only 14 specimens of worked mammal bone, including awls, a needle, and ornaments, were recovered from both sites, suggesting that the residents of these settlements produced their tools and other artifacts primarily from other materials, such as wood or stone (K. Schmidt, n.d.; Hodgetts, 1996). In contrast, the extensive assemblage of over 800 bone artifacts recovered from Paquimé indicates that the residents there relied on mammalian bone to create a wide range of items.

The researchers who initially excavated this site divided these artifacts into two general categories: utilitarian and non-utilitarian, with the latter subdivided into personal ornaments and "socio-religious paraphernalia" (Di Peso *et al.*, 1974). Over 95% of these artifacts were made of non-human mammalian bone, including all of the utilitarian objects and 90% of the non-utilitarian items; the remainder were made of bird bone. The utilitarian items consisted of such things as awls and stone-tool flakers. The personal ornaments included hair ornaments, pins, and beads while items like musical instruments and carved effigies were classified as socio-religious paraphernalia. Raw materials also would have been derived from the soft tissue of a wide range of mammals, but such materials are rarely preserved in open archaeological sites. However, items like sinew and rabbit fur, the latter apparently used in blankets, have been recovered from rockshelters in southwestern Chihuahua (Lister, 1958; Zingg, 1940).

The Paquimé bone artifacts also provide some indirect evidence for specialized hunting. Over 40% of the artifacts interpreted as having special ritual significance were made from bone from three large mammalian species: the black bear, the brown bear, and the puma (Di Peso *et al.*, 1974). Although the black bear and puma could have been killed by a single hunter with a bow-and-arrow or lance, the brown bear likely was hunted in groups. Spanish colonial period reports from northwestern and central Chihuahua indicate that brown bears were normally hunted by groups of men and killed with lances because bullets could not penetrate their thick fur (Estolano de Escudero, 1777; Rubio, 1778).

Given the notoriety of both black and brown bears as raiders of maize fields and the presence in these fields of mammals preyed upon by pumas, these animals might have been hunted relatively near Paquimé as well as El Zurdo, where remains of both black bear and puma were recovered. These large mammals may have also been the focus of expeditions undertaken farther from the settlements, and the residents of all three sites probably organized communal hunts of jackrabbits and artiodactyls to complement the hunting, trapping, and scavenging activities of individuals (Kent 1989; Szuter 1991b).

CONCLUSIONS

Understanding the relationship between humans and mammals in the history of prehispanic Chihuahua requires detailed faunal data from a much broader range of archaeological sites than are currently available. Nonetheless, the faunal analyses for Cerro Juanaqueña, El Zurdo, and Paquimé offer the opportunity to begin discerning the outlines of this relationship during a crucial time in this history: the 3000 year period between the introduction of agriculture to the region and the arrival of Europeans there.

By far the most significant development that affected this relationship was the introduction of agriculture itself. The modifications to the local environment that were the consequence of agricultural practices, especially cultivated fields, created new ecological niches that attracted and probably promoted the population growth of a wide range of mammal species, including herbivores, omnivores, and carnivores. In addition to their impact on predator-prey dynamics in the area, these changes would have fostered the redistribution of mammalian species across the landscape, with greater concentrations of certain species in closer proximity to human settlements than ever before. As a result, a more localized strategy for procuring meat and raw materials could be sustained.

A comparison of the faunal remains from these three sites suggests that lagomorphs, especially jackrabbits, were the most important mammalian taxon in local diet. Other species –for example, rodents at El Zurdo and perhaps dogs at Paquimé– were prominent at one site but not the others, reflecting perhaps variations in the abundance and accessibility of these species or in the food preferences of the residents of the different settlements. Deer were relatively insignificant at all three sites, and the high frequency of pronghorns at Paquimé possibly reflected not their importance in everyday diet but rather their use, along with bison, as a source of meat for public feasts. This proposed specialized use of large herbivores at Paquimé, if accurate, is paralleled by the symbolic significance that its residents appear to have attributed to large carnivores, as evidenced in the bone artifacts discovered at this site.

Mammals were the principal source of meat at all three sites, but the importance of meat to their residents is difficult to assess. For example, Hard and Roney (2005) propose that Cerro Juanaqueña was occupied for 200 years and that the human population during this period averaged 200 people. Because about 0.2% of the site was excavated, a rough estimate of the quantities of fauna that might be recovered if the site was completely excavated can be obtained by multiplying the MNI counts for each taxa by a factor of 500. The most prominent mammalian order in the faunal remains recovered from this site were rabbits, the MNI count for which was about 100 individuals. Multiplied by 500, the estimated MNI count for rabbits from the entire site would be 50,000 rabbits or about 1.25 rabbits per person per year, a figure that clearly is much too low. Applying the same formula to the MNI count for artiodactyls (35) from Cerro Juanaqueña produces a figure of 0.44 artiodactyls per person per year, which is more reasonable but probably also too low.

Such MNI counts are obviously of limited value in estimating the quantities of animals that were acquired by the residents of this and the other two northwestern Chihuahua settlements considered here, but the faunal analyses from these sites do offer important insights into the animal species with which they interacted and to a more limited extent the relative importance of different species to them. This information has already contributed to the formulation of initial reconstructions of the diet and subsistence strategies of the prehispanic populations of the region (Di Peso *et al.*, 1974; Hodgetts, 1996; Whalen and Minnis, 2001; Hard and Roney, 2005; Schmidt, n.d.).

These models undoubtedly will be refined and elaborated as additional data accumulate from a variety of other sources, like analyses of floral remains, coprolites, and human bone. Historical and ethnographic information from the Spanish colonial and post-colonial periods can also be useful as long as it is recognized that the majority of this information was recorded after local ecological relations were significantly disrupted. Future reconstructions presumably will revise current understandings but also confirm what already seems evident: that the prehispanic farming societies of northwestern Chihuahua relied on a broad range of animals and plants for their survival and that their ability to engage in agricultural activities depended at least in part on their continued use of the mammals and other wild resources that had sustained for millennia the non-agricultural foraging societies that preceded them.

ACKNOWLEDGMENTS

We would like to express our appreciation to the following individuals who provided data, commentaries, or other assistance crucial to the completion of this essay: Karen Adams, Joaquín Arroyo, Marcia Bakry, Greta de León, Jonathan Driver, Diego García, Robert Hard, Arthur MacWilliams, Paul Minnis, Oscar Polaco, John Roney, Kari Schmidt, Maria Sprehn, Carla Van West, and Michael Whalen. The map is a slightly modified version of one prepared by Arthur MacWilliams. We are grateful to him for granting us permission to use it and to Greta de León and Marcia Bakry for adapting it for this essay. The research presented here was supported by the Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (Project X011), the Smithsonian Institution, and the Instituto Politécnico Nacional.

LITERATURE CITED

Adams, K. R., and J. K. Hanselka. n.d. Plant Use in the Late Archaic Period, in: *Early Farming and Warfare*

in Northwest Mexico (R. J. Hard and J. R. Roney, eds.). Volume in preparation.

Adams, K. R. and C. R. Van West. 2004. Subsistence through Time in West-Central New Mexico and East-Central Arizona. Pp. 10.1-10.52, *in: Archaeological Data Recovery in the New Mexico Transportation Corridor and First Five-Year Permit Area, Fence Lake Coal Mine Project, Catron, County, New Mexico* (C.R. Van West and E. K. Huber, eds.). Volume 2, Part II: Synthetic Studies. Draft Technical Series. Statistical Research, Tucson.

Almada, F. R. 1987. *Diccionario de Historia, Geografía y Biografía Chihuahuenses.* Gobierno del Estado de Chihuahua, Chihuahua.

Álvarez Solórzano, T. 1983. Notas sobre algunos Roedores Fósiles del Pleistoceno de México. *Anales de la Escuela Nacional de Ciencias Biológicas, México*, 27:149-163.

Anderson, S. 1972. Mammals of Chihuahua: Taxonomy and Distribution. *Bulletin of the American Museum of Natural History,* 148:149-410.

Ascher, R., and F. J. Clune, Jr. 1960. Waterfall Cave, Southern Chihuahua, Mexico. *American Antiquity*, 26:270-274.

Bekoff, M. 1977. *Canis latrans*. *Mammalian Species*, 79: 1-9.

Bennett, W. C., and R. M. Zingg. 1935. *The Tarahumara: An Indian Tribe of Northern Mexico*. University of Chicago Press, Chicago.

Bradley, R. J. 1999. Shell Exchange with the Southwest: The Casas Grandes Interaction Sphere. Pp. 213-228, *in: The Casas Grandes World* (C. F. Schaafsma and C. F. Riley, eds.). University of Utah Press, Salt Lake City.

Brand, D. D. 1943. The Chihuahua Culture Area. *New Mexico Anthropologist*, 7:115-158.

Breitburg, E. 1993. The Evolution of Turkey Domestication in the Greater Southwest and Mesoamerica. Pp. 153-172, *in: Culture and Contact: Charles C. Di Peso's Gran Chichimeca* (A. I. Woosley and J. C. Ravesloot, eds.). Amerind Foundation and the University of New Mexico Press, Dragoon and Albuquerque.

Brown, D. E., (ed.). 1994. *Biotic Communities: Southwestern United States and Northwestern Mexico.* University of Utah Press, Salt Lake City.

Byers, D. A., and J. M. Broughton. 2004. Holocene Environmental Change, Artiodactyl Abundances, and Human Hunting Strategies in the Great Basin. *American Antiquity*, 69:235-255.

Cruz Antillón, R., and T. D. Maxwell. 1999. The Villa Ahumada Site: Archaeological Investigations East of Paquimé. Pp. 43-53, *in: The Casas Grandes World* (C. F. Schaafsma and C. F. Riley, eds.). University of Utah Press, Salt Lake City.

Dean, J. S., and J. C. Ravesloot. 1993. The Chronology of Cultural Interaction in the Gran Chichimeca. Pp. 83-103, *in: Culture and Contact: Charles C. Di Peso's Gran Chichimeca* (A. I. Woosley and J. C. Ravesloot, eds.). Amerind Foundation and the University of New Mexico Press, Dragoon and Albuquerque.

Dietler, M., and B. Hayden (eds.). 2001. *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power.* Smithsonian Institution Press, Washington.

Di Peso, C. C. 1974. *Casas Grandes, A Fallen Trading Center of the Gran Chichimeca.* Volumes 1-3. Amerind Foundation, Dragoon.

Di Peso, C. C., J. B. Rinaldo, and G. J. Fenner. 1974. *Casas Grandes, A Fallen Trading Center of the Gran Chichimeca*. Volume 8: Bone-Economy-Burials. Amerind Foundation, Dragoon.

Doolittle, W. E. 1993. Canal Irrigation at Casas Grandes: A Technological and Developmental Assessment of Its Origins. Pp. 133-151, *in: Culture and Contact: Charles C. Di Peso's Gran Chichimeca* (A. I. Woosley and J. C. Ravesloot, eds.). Amerind Foundation and the University of New Mexico Press, Dragoon and Albuquerque.

Estolano de Escudero, M. 1777. *Relación Geográfica del Valle y Presidio Reformado de San Buenaventura.* Unpublished manuscript, Biblioteca Nacional, Madrid, Manuscrito 2449, ff. 7, 74-79; Manuscrito 2450, ff. 235-236.

Foster, M. S. 1992. Arqueología del Valle de Casas Grandes: Sitio Paquimé. Pp. 229-282, *in: Historia General de Chihuahua I: Geología, Geografía y Arqueología* (A. Márquez-Alameda, ed.). Universidad Autónoma de Ciudad Juárez y Gobierno del Estado de Chihuahua, Ciudad Juárez.

Grayson, D. K. 1984. *Quantitative Zooarchaeology: Topics in the Analysis of Archaeological Faunas.* Academic Press, New York.

Griffen, W. B. 1979. *Indian Assimilation in the Franciscan Area of Nueva Vizcaya.* Anthropological Papers of the University of Arizona No. 33. University of Arizona Press, Tucson.

Guevara Sánchez, A. 1984. *Las Cuarenta Casas: Un Sitio Arqueológico del Estado de Chihuahua.* Cuadernos de Trabajo 27, Departamento de Prehistoria, Instituto Nacional de Antropología e Historia, México.

Guevara Sánchez, A. 1986. *Arqueología del área de las Cuarenta Casas, Chihuahua.* Colección Científica 151, Instituto Nacional de Antropología e Historia, México.

Guevara Sánchez, A., and D. A. Phillips, Jr. 1992. Arqueología de la Sierra Madre Occidental en Chihuahua. Pages 187-213, *in: Historia General de Chihuahua I: Geología, Geografía y Arqueología* (A. Márquez-Alameda, ed.). Universidad Autónoma de Ciudad Juárez y Gobierno del Estado de Chihuahua, Ciudad Juárez.

Hall, E. R. 1981. *The Mammals of North America*. 2 volumes. 2d. edition. John Wiley & Sons, New York,

Hard, R. J., and J. R. Roney. 1998. A Massive Terraced Village Complex in Chihuahua, Mexico, 3000 Years Before Present. *Science*, 279:1661-1664.

Hard, R. J., and J. R. Roney. 2005. The Transition to Farming on the Rio Casas Grandes and in the Southern Jornada Mogollon in the North American Southwest. *In: Current Research on the Late Archaic Across the Borderlands* (B. J. Vierra, ed.). University of Texas Press, Austin, in press.

Hodgetts, L. M. 1996. Faunal Evidence from El Zurdo. *The Kiva*, 62:149-170.

Kelley, J. H., J. D. Stewart, A. C. MacWilliams, and L. C. Neff. 1999. A West Central Chihuahuan Perspective on Chihuahuan Culture. Pp. 63-77 in *in: The Casas Grandes World* (C. F. Schaafsma and C. F. Riley, eds.). University of Utah Press, Salt Lake City.

Kent, S., ed. 1989. *Farmers as Hunters: The Implications of Sedentism*. Cambridge University Press, Cambridge.

Leopold, A. S. 1959. *Wildlife of Mexico*. University of California Press, Berkeley.

Linares, O. F. 1976. "Garden Hunting" in the American Tropics. *Human Ecology*, 4: 331-349.

Lister, R. H. 1953. Excavations in Cave Valley, Chihuahua, Mexico. *American Antiquity,* 19:166-169.

Lister, R. H. 1958. *Archaeological Excavations in the Northern Sierra Madre Occidental, Chihuahua and Sonora, Mexico*. Series in Anthropology 7, University of Colorado Press, Boulder.

López-Wilchis, R. and J. López-Jardínez. 1999. *Los Mamíferos de México Depositados en Colecciones de Estados Unidos y Canadá.* Vol. 2., Universidad Autónoma Metropolitana Unidad Iztapalapa, México.

MacWilliams, A. C., and J. H. Kelley. 2004. A Ceramic Period Boundary in Central Chihuahua. Pp: 247-264, *in: Surveying the Archaeology of Northwest Mexico* (G. E. Newell and E. Gallage, eds.). University of Utah Press, Salt Lake City.

Marshall, F., and T. Pilgram. 1993. NISP vs. MNI in Quantification of Body-Part Representation. *American Antiquity*, 58:261-269.

McBee, K. and R. J. Baker. 1982. *Dasypus novemcinctus*. *Mammalian Species*, 162:1-9

McManus, J. J. 1974. *Didelphis virginiana*. *Mammalian Species*, 40:1-6

Mech, L. D. 1974. *Canis lupus*. *Mammalian Species*, 37:1-6.

Messing, H. J. 1986. A Late Pleistocene-Holocene Fauna from Chihuahua, Mexico. *Southwestern Naturalist*, 31:277-288

Minnis, P. E. 1988. Four Examples of Specialized Production at Casas Grandes, Northwestern Chihuahua. *The Kiva*, 53:181-194.

Minnis, P. E., M. E. Whalen, J. H. Kelley, and J. D. Stewart. 1993. Prehistoric Macaw Breeding in the North American Southwest. *American Antiquity*, 58:270-276.

Neusius, S.W. 1996. Game Procurement among Temperate Horticulturalists: The Case for Garden Hunting by the Dolores Anasazi. Pp. 273-288, in: *Case Studies in Environmental Archaeology* (E. J. Reitz, L. A. Newsome, and S. J. Scudder, eds.). Plenum Press, New York.

Owen, P. R., C. J. Bell, and E. M. Mead. 2000. Fossils, Diet, and Conservation of Black-footed Ferrets (*Mustela nigripes*). *Journal of Mammalogy*, 81:422-433.

Pennington, C. W. 1963. *The Tarahumar of Mexico: Their Environment and Material Culture.* University of Utah Press, Salt Lake City.

Phelps, A. L. 1998. An Inventory of Prehistoric Native American Sites in Northwestern Chihuahua. *The Artifact*, 36:1-175.

Phillips, D. A., Jr. 1989. Prehistory of Chihuahua and Sonora, México. *Journal of World Prehistory*, 3:373-401.

Polaco, O. J., and Guzmán, A. F. n.d. *Restos de Fauna del Sitio Arqueológico de "Los Moctezumas", Municipio de Villa Ahumada, Chihuahua.* Unpublished report, No. Z-484, Laboratorio de Arqueozoología "M. en C. Ticul Álvarez Solórzano," Instituto Nacional de Antropología e Historia, Mexico City, September 7, 1996.

Reitz, E. J., and E. S. Wing. 1999. *Zooarchaeology.* Cambridge University Press, Cambridge.

Rubio, J. F. 1778. *Compendio de las Noticias que Su Majestad ordena se puntualicen para el Conocimiento de la Geografía de la Misión de Coyachic y de el Real de Santa Rosa Cucihuriachic*. Unpublished manuscript, Biblioteca Nacional, Madrid, Manuscrito 2449, ff. 173-179.

Sayles, E. B. 1936. *An Archaeological Survey of Chihuahua, Mexico.* Medallion Papers 22. Gila Pueblo Foundation, Globe.

Shaffer, B. S. 1992. Interpretation of Gopher Remains from Southwestern Archaeological Assemblages. *American Antiquity*, 57: 683-691.

Shaffer, B. S., and J. L. J. Sanchez. 1994. Comparisons of 1/8"- and 1/4"-Mesh Recovery of Controlled Samples of Small-to-Medium Sized Mammals. *American Antiquity*, 59: 525-530.

Sheffield, S. R. and H. H. Thomas. 1997. *Mustela frenata*. *Mammalian Species*, 570:1-9

Schaafsma, C. F., and C. F. Riley, (eds.). 1999. *The Casas Grandes World.* University of Utah Press, Salt Lake City.

Schmidt, R. H. 1992. Chihuahua: Tierra de Contrastes Geográficos. Pp 45-101, *in: Historia General de Chihuahua I: Geología, Geografía y Arqueología* (A. Márquez-Alameda, ed.). Universidad Autónoma de Ciudad Juárez y Gobierno del Estado de Chihuahua, Ciudad Juárez.

Schmidt, K. M. n.d. Faunal Remains. *In: Early Farming and Warfare in Northwest Mexico* (R. J. Hard and J. R. Roney, eds.). Volume in preparation.

Steffel, M. 1809. Tarahumarisches Wörterbuch, nebst einigen Nachrichten von den Sitten und Gebräuchen der Tarahumaren, in Neu-Biscaya, in der Audiencia Guadalaxara im Vice-Königreiche Alt-Mexico, oder Neu-Spanien. Pp. 293-374, *in: Nachrichten von verschiedenen Ländern des Spanischen Amerika, aus eigenhändigen Aufsätzen einiger Missionare der*

Gesellschaft Jesu. Johannes Christian Hendel (C. G. von Murr, ed.). Halle.

Szuter, C. R. 1991a. Hunting by Hohokam Desert Farmers. *Kiva*, 56: 277-291.

Szuter, C. R. 1991b. *Hunting by Prehistoric Horticulturalists in the American Southwest*. Garland, New York.

Vargas, V. D. 2001. Mesoamerican Copper Bells in the Pre-Hispanic Southwestern United States and Northwestern Mexico. Pp. 196-211, *in: The Road to Aztlan: Art from a Mythic Homeland* (V. M. Fields and V. Zamudio-Taylor, eds.). Los Angeles County Museum of Art, Los Angeles.

Whalen, M. E., and P. E. Minnis. 1999. Investigating the Paquimé Regional System. Pp. 54-62, *in: The Casas Grandes World* (C. F. Schaafsma and C. F. Riley, eds.). University of Utah Press, Salt Lake City.

Whalen, M. E., and P. E. Minnis. 2001. *Casas Grandes and its Hinterland: Prehistoric Regional Organization in Northwest Mexico*. University of Arizona Press, Tucson.

Wilcox, D. R. 1999. A Preliminary Graph-Theoretic Analysis of Access Relationships at Casas Grandes. Pp. 93-104, *in: The Casas Grandes World* (C. F. Schaafsma and C. F. Riley, eds.). University of Utah Press, Salt Lake City.

Woosley, A. I. 2001. Shadows on a Silent Landscape: Art and Symbol at Prehistoric Casas Grandes. Pages 164-183, *in: The Road to Aztlan: Art from a Mythic Homeland* (V. M. Fields and V. Zamudio-Taylor, eds.). Los Angeles County Museum of Art, Los Angeles.

Woosley, A. I., and J. C. Ravesloot, (eds.). 1993. *Culture and Contact: Charles C. Di Peso's Gran Chichimeca.* Amerind Foundation and the University of New Mexico Press, Dragoon and Albuquerque.

Zingg, R. M. 1940. Report on the Archeology of Southern Chihuahua. Center of Latin American Studies l, Contributions of the University of Denver III. Denver.