



Carnivore Taphonomy and the Early Human Occupations in the Andes

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Models of carnivore taphonomy in the Southern Andean Puna, based on actualistic studies and ecological information, are used to assess the incidence of these agents at two of the most significant early archaeological sites in the area: Inca Cueva—Cueva 4 (layer 2) and Quebrada Seca 3 (layer 2b14). Since the traces of local carnivores—which are mostly small ones—can be very faint and are potentially ambiguous, multiple lines of evidence are compared. They suggest that carnivores were involved in the formation of the archaeological faunal assemblages in only an unsubstantial way. These assemblages therefore may be confidently used for inferences on the early human populations in the region, such as their relatively wide food niche, and also allow some insight into the past carnivore community and the insertion of humans in the local predatory guild, one in which carnivores have not been effective competitors.

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Introduction

Mammalian carnivores have commonly attracted archaeologists' attention everywhere in the world, since they are often potentially important taphonomic agents which modify and destroy bones by gnawing (Binford, 1981), and also because bone accumulations at dens are the closest palaeontological parallel to zooarchaeological assemblages (Gifford, 1981).

Caves and other rock shelters in particular contain overlaps of both fossil records, since they are the final destination of food transport by both humans and carnivores (Stiner, 1991). When food debris is accumulated in rock shelters, these loci also may become scavengeable patches for carnivores, thus introducing ambiguity, in the sense that rock shelters can be both at the beginning and at the end of the trajectory of carnivore food procurement and transport. However, such sites can be expected to play the end role more systematically, since while they provide natural refuge for denning all the time—or, to be more precise, whenever unoccupied by humans—scavengeable food remains would not be continuously available within them.

Although research in some areas of the Southern Cone particularly has shed light on this issue for the last two decades, carnivore taphonomy in South America has not been as thoroughly studied as on other continents. This lack of information has led to

ambiguities in the interpretation of the zooarchaeological record. Such is the case of the Puna or Altiplano, a high plateau over 3500 masl W of the Andes (Figure 1), where only recently have the local attributes of carnivore taphonomic action been revealed.

Of concern here is the Southern Puna, where the issue of carnivore taphonomic action in rock shelters is particularly relevant to the early human occupation at the end of the Pleistocene and the Early Holocene. Although some sampling bias cannot be ruled out, early human populations seem to have occupied rock shelters relatively more frequently than in later times. However, they would have been fairly sparse, and there is evidence suggesting seasonal mobility (e.g., Elkin *et al.*, 1991). Hence, although these conditions imply a new actor competing for rock shelters in the landscape, such competition would not have been intense, and in fact it would have allowed the occupational alternation of humans and other predators in the same loci.

At the early stages of human settlement in the area, then, rock shelters can be expected to have been commonly at the end of the food-procurement-and-transport trajectories for carnivores. The attraction of the food debris left by this new member of the predator community, in the form of scavengeable sources, should not be disregarded, although it is thought to have become more important as a commensal relationship developed between humans and foxes during the Holocene (Mondini, 2000a).

In order to assess the signatures and archaeological implications of such scenario, actualistic studies aimed

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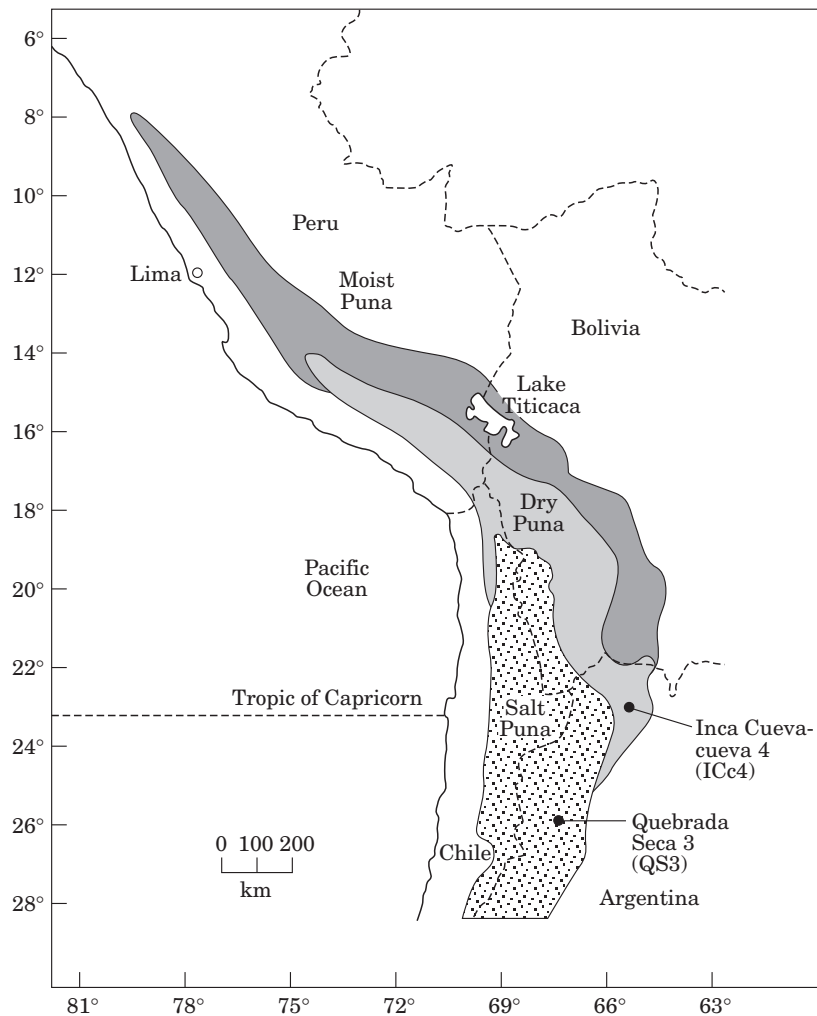


Figure 1. The study area.

at understanding the taphonomy of local carnivores and its variability were undertaken (Mondini, 1995, 2000a,b,c; 2001), and the taphonomic traces of carnivores in early archaeological assemblages were studied and are described here. They are from two of the most significant sites representing early human occupations in the area: Inca Cueva—cueva 4 (ICc4), and Quebrada Seca 3 (QS3) (Figure 1).

The Area and the Archaeological Assemblages

This study is focused in the Argentinean Puna, which comprises the SE segment of the plateau, and consists of a high-altitude desert. The NE portion of the study area is in the Dry Puna, and the SW portion is in the even drier Salt Puna; the Wet Puna is not represented here (Troll, 1958; Santoro & Núñez, 1987; see Figure 1).

The carnivore species living in the Argentinean Puna are described in Table 1. It should be emphasized that all of them but the puma (*Felis concolor*) are small body-sized. These species have remained basically the same since the early human peopling of the area. Here, unlike many other parts of the world, dogs (*Canis familiaris*) were introduced later in the Holocene (see Wing, 1989). Therefore, it is assumed that the carnivore activity in early archaeological deposits was incurred by wild species, of which foxes are the most likely to have utilized rock shelters.

Archaeological sites ICc4 and QS3 have been chosen for this study because they have rendered an important share of the available information about the early human occupations in the area. The archaeofaunas of both sites were in fact previously studied (Yacobaccio, 1991; Elkin, 1996), but with purposes different from mine. Both sites contain carnivore traces, the significance of which can be more thoroughly established now that these agents have been studied from a

Table 1. Wild carnivores in the area

Family	Scientific name	Common name	Average body size	Habitat	Diet	Feeding strategies	Comments
Canidae	<i>Pseudalopex culpaeus</i>	Culpeo, South American red fox	5 kg (females)–13.5 kg (males)	Mountains, steppe, and pampas, to at least 4500 masl	Broad, omnivorous, based mainly on small mammals, with a smaller component of scavenging (mainly of larger vertebrates)	Hunting (generally small animals)+scavenging (small and large animals)	Foxes are the local carnivores that most commonly use rockshelters
	<i>Pseudalopex griseus</i>	South American gray fox	More than 4 kg	Plains, pampas, deserts, and low mountains, although it can be found up to 4000 masl	Omnivorous, even broader, with a higher proportion of invertebrates and fruit, as well as a larger component of scavenging, compared to culpeos	Scavenging (small and large animals)+hunting (generally small animals)	Idem
Felidae	<i>Felis concolor</i>	Puma, mountain lion, cougar	More than 20 to 55 kg	Various habitats, to at least 4500 masl	Highly carnivorous	Hunting (small and large animals)	Pumas do not transport animal food to rockshelters as often as foxes do
	<i>Felis colocolo</i>	Pampas cat	About 3 kg	Various habitats, to more than 5000 masl	Highly carnivorous	Hunting (small animals)	Unlike pumas, not only are they much smaller, but also their population densities are very low in the area
Mustelidae	<i>Felis jacobita</i>	Mountain cat	About 4 kg	Arid and semiarid Andes, from ca. 3000–5000 masl	Highly carnivorous	Hunting (small animals)	Idem
	<i>Conepatus chinga</i>	Hog-nosed skunk	1.5 to almost 3 kg	Open and wooded areas, up to 4100 masl or more	Omnivorous, mainly invertebrates	Hunting (small animals)	Mustelids are most commonly found below 3500 masl
	<i>Galictis cuja</i>	Little grison	1 to 2.5 kg	Forests and open country, up to 4000 masl	Omnivorous, includes more small vertebrates	Hunting (small animals)	Idem

Based on Olrog & Lucero (1981), Berta (1987, 1988), Nowak (1991), Redford & Eisenberg (1992), Jaksic (1997), Brown & Diaz (1999), Diaz (2000), among others. For scientific names, Nowak (1991) was followed; it should be noticed that most genus names are debated. The "Feeding strategies" column includes a comment on the body size of prey/scavenging source. As to the Canidae, dogs (*Canis familiaris*) are present in the area, but were introduced later than the period considered here (see Wing, 1989, among others).

Table 2. Radiocarbon dates (uncalibrated) for the archaeological layers analysed

Archaeological layer	Dates
ICc4-layer 2	10,620 ± 140 (LP-137)
	9900 ± 200 (AC-564)
	9650 ± 110 (LP-102)
	9230 ± 70 (CSIC-498)
QS3-layer 2b14	8670 ± 350 (AC-1118)
	7350 ± 80 (Beta 59928)

taphonomic perspective. Finally, they are located in different environmental settings: ICc4 in the Dry Puna, and QS3 in the Salt Puna. Hence, if this ecological variability has been systematically significant to carnivore taphonomic action in any sense, such as by inducing more stress on carnivore populations in the drier S area, it should be reflected in its traces.

Inca Cueva—cueva 4

ICc4 is a cave in Jujuy province, located in the Inca Cueva *quebrada* (gorge, ravine), in the NW portion of the Quebrada de Humahuaca area, at 3800 masl. The cave is 17·60 m wide at the entrance, and 6·50 m long. Two main natural stratigraphic units have been identified containing archaeological occupations (further descriptions of the site and the deposits in Aschero, 1984; Mengoni Goñalons, 1986; Yacobaccio, 1994). The upper unit dates to the Middle Holocene. Of interest here is layer 2, composed of fine sandy sediment and straw, which has been dated to *c.* 10,600–9200 BP (Table 2).

Palaeoclimate information from the Puna generally, although rather fragmentary, suggests that at the end of the Pleistocene and during the Early Holocene (*c.* 11,000–8000 BP), when this layer formed, the climate would have been cooler than present. However, data are inconsistent as to whether it was relatively wet (e.g., Markgraf, 1987; Baied & Wheeler, 1993; Lupo, 1993) or, after about 10,500–9000 BP, dry (e.g., Graf, 1981, 1992; Fernández *et al.*, 1991; Thompson *et al.*, 1998; Geyh *et al.*, 1999; Betancourt *et al.*, 2000). Since some palynological studies were done precisely at ICc4, as well as at the nearby location of El Aguilar, and both suggest a wetter climate than today (Markgraf, 1985, 1987; Lupo, 1993), it is assumed here that such was the local context at that time.

About 2500 faunal skeletal specimens—including bones, teeth, and a few nails—were recovered in layer 2 of ICc4, of which more than one thousand were identified (NISP, number of identified specimens=1045; Yacobaccio, 1991). More than 70% are of relatively large rodents belonging to the Chinchillidae family (Table 3). Of these, most correspond to mountain vizcacha (*Lagidium* sp.), of about 2 kg body weight, and only *c.* 12·5% have been inferred to be *Chinchilla* sp., of about 0·5 kg. Artiodactyls including

Table 3. Taxonomic structure of the faunal assemblages analysed

Taxa	NISP	
	ICc4 layer 2	QS3 layer 2b14
Camelids (<i>Lama</i> sp.)	107	233
Taruca (<i>Hippocamelus antisensis</i>)	15	—
Unidentified artiodactyls	127	—
Chinchillidae (<i>Lagidium</i> sp., <i>Chinchilla</i> sp.)	741	35
Other rodents	38	12
Armadillos	10	—
Canids	1	1
Birds	4	8
Batrachians	2	—
Total NISP	1045	289

After Yacobaccio (1991), Elkin (1996), and personal observations. Although the taxonomic representation of carnivores is not included as a diagnostic criteria here, the presence of a canid bone in each of the archaeological deposits is consistent with the participation, although meagre, of carnivores in their accumulation. As to QS3, camelids are also the most important taxon in the other Early Holocene layers (Elkin, 1996).

camelids and cervids, as well as smaller taxa such as rodents, armadillos, birds, batrachians (frogs/toads), and a canid have also been identified. As to the camelid specimens, both extant wild species in the Southern Andes are represented: the vicugna (*Lama vicugna*), of *c.* 45 kg, and the guanaco (*Lama guanicoe*), of *c.* 70 kg. Hair analyses are consistent with this. The local cervid (deer family) is the Andean huemul or taruca (*Hippocamelus antisensis*), of *c.* 50 kg. The canid bone must belong to a fox (*Pseudalopex* sp.). Other faunal remains include hide, hair, egg shell, feathers, pellets, and different scats, many of which are from carnivores.

The original study suggested that the cave might have been used by denning carnivores, most probably foxes, which would have introduced some prey bones, namely from Chinchillidae (Yacobaccio, 1991). This is one reason that led to the analyses presented here.

Quebrada Seca 3

QS3 is a rock shelter in Catamarca province, in the Quebrada Seca gorge, some 15 km E of Antofagasta de la Sierra village, and at approximately 4100 masl. It is *c.* 9 × 5 m in size. Three main stratigraphic units were identified, the densest of which, composed of sandy sediment and many anthropogenic remains, was in turn divided into many subunits based on the characteristics of the deposits (further descriptions of the site and the deposits in Aschero *et al.*, 1991; Pintar, 1996). The layers contain remains of human occupations during the whole Holocene. The earliest ones, corresponding to Early Holocene occupations, have been dated between *c.* 9000–7700 BP. Of these, layer 2b14, dated to *c.* 8700–7300 BP (Table 2), was originally chosen for a detailed faunal analysis (Elkin, 1996), and it was likewise selected for this study.

This layer would have been partly formed during the cool period described above. In this case, given the ambiguity of evidence and the unavailability of local information, I would rather leave the question of locally wet vs. dry conditions open for the moment. In any case, at about 8000–7000 BP, when layer 2b14 was apparently still forming, some further changes were triggered. Most studies suggest that the climate began to turn drier, although there is not much agreement as to whether temperatures were higher or lower than at present (e.g. Ybert & Miranda, 1984; Markgraf, 1987; Baied & Wheeler, 1993; Fernández *et al.*, 1991). This greater aridity relates to the Altithermal, inferred to begin *c.* 7500–4000 BP in the area, although it might have started as early as 8500 BP (Markgraf, 1985; Baied & Wheeler, 1993). One recent study in the Chilean Atacama desert, however, suggests that at about 8000–7000 BP a wetter period began (Betancourt *et al.*, 2000). Since most of the sites studied, mainly E of the Andes, suggest a change towards drier conditions, it may be assumed that such was the case in Quebrada Seca. Furthermore, it has been suggested that in the Salt Puna, where QS3 is located, *pajonal* grassland vegetation would have retreated to even higher altitudes than in the slightly moister Dry Puna (Pintar, 1996).

Nearly 1500 bone/tooth specimens were recovered in layer 2b14 of QS3, of which approximately one fifth was identified (NISP=289; Elkin, 1996; pers. observations). Unlike in ICc4—layer 2, camelids dominate this assemblage, making up more than 80% of the sample (Table 3). In the early layers generally, they are represented by vicuñas, guanacos, and another large camelid—one whose hair is more similar to that of domestic llamas (*Lama glama*), rather than guanacos and vicuñas (Reigadas, 1992). Rodents, birds, and one canid bone also have been identified. The canid bone—the only one in the early layers—must be considered, as in ICc4, as from a fox. Hide, hair, feathers, and scats were also recovered. Some of the scats, as in most layers, are from carnivores.

As the site was excavated, the presence of carnivore traces, along with the location of the shelter, led the archaeologists to suspect carnivore use. Later, zooarchaeological analyses suggested that, according to gnawing damage, these taphonomic agents—most probably foxes—would not have played a very important part in site formation (Elkin, 1996). These preliminary conclusions were subjected to further analyses, and those concerning the earliest occupations of the site are next presented.

Humans vs. Carnivores as Agents of Faunal Accumulation

As mentioned, one of the strongest implications of the potential involvement of carnivores in the formation of the deposits would be that they alternated with humans, using the rock shelters as dens, and producing

their own faunal accumulations. To assess this possibility, I have modelled the signatures of both agents, based namely on my actualistic studies of Puna carnivore taphonomy, along with behavioural and ecological information.

A first, general assessment can be made by focusing on the topographic properties of the rock shelters themselves. Shelters that are close to prey and water are generally preferred by both denning carnivores and humans. But, if available, carnivores—which are mostly small ones in the area—tend to choose shelters that are smaller than the ones used by humans (Mondini, 2001). The ICc4 and QS3 shelters were fairly large early in the Holocene, and they are both in rocky *quebradas* where several small shelters were also available. Under these conditions, and assuming that competition for rock shelters was not particularly intense in earliest times, we should not expect much occupational overlap in these particular loci. A somewhat generic redundancy in the occupations of carnivores and those of humans, i.e., a spatial overlap in the same areas but not the same specific loci, was probably more common.

As to the fossil record, particularly the bone assemblages, several studies have developed criteria for determining whether the accumulating agents were humans or carnivores, but they have dealt primarily with large carnivores (among the few exceptions are Andrews & Evans, 1983; Andrews, 1990; Stallibrass, 1984, 1990). Several differences emerge when dealing with smaller ones and, especially, when the ones most prone to use rock shelters are small scavengers.

Blumenshine (1988), for example, compared the properties of three different kinds of bone assemblages: “carnivore only” (bones from bovids killed or scavenged and consumed by large African carnivores), “hammerstone only” (bovid bones broken with a hammerstone), and “simulated site” (some of these hammerstone-opened, marrowless bones further subjected to carnivore scavenging). One of the most significant differences reported is between “carnivore only” and “simulated site” assemblages regarding the proportion of gnawing marks, which is higher in the former. Besides, “simulated site” bones have percussion marks in mid-shafts, where tooth marks are least abundant. However, as Lyman (1994) and others have noticed, gnawing marks are not always proportional to carnivore involvement, and hence this line of evidence must be used in conjunction with other ones to help discriminate both agents.

Stiner (1994), in her study of Mousterian sites in Italy, used three sets of variables to distinguish the relative roles of hominids vs. carnivores in bone accumulations: bone modifications, species frequencies, and behavioural information. She divided them into eleven criteria, which she laid out in a matrix (Stiner, 1994: Table 5.23). Of these, some criteria are not relevant to the Puna, partly because they refer to large carnivores. The presence of carnivore bones is disregarded here, since none has been identified in the modern dens

Table 4. Criteria for distinguishing carnivore vs. human involvement in the accumulation of bone assemblages in the Southern Andes

Attributes	Carnivores	Humans
<i>Bone modifications</i>		
% gnawing damage	0–100	0–10 (e.g., a few bones gnawed by humans, or left by carnivores during an occasional visit)
% digestive corrosion	0–100	0–10 (e.g., a few bones ingested by humans, or left by carnivores during an occasional visit)
% tool damage	0–25 (when scavenging from human food debris)	0–100
% burnt bone	0–25 (when scavenging from human food debris)	0–100
<i>Context</i>		
Association with carnivore scats	0–100 (i.e., mostly scats, almost no transported bones)	0–10 (e.g., a few accidentally introduced scats, or left by carnivores during an occasional visit)
Association with artefacts	0–10 (e.g., a few accidentally introduced artefacts)	0–100 (i.e., mostly artefacts, almost no bones)

It should be emphasized that local carnivores are mainly small body-sized.

NISP has been used as the total on which all percentages are based, since it is more common in archaeological reports than total number of specimens.

As to the gnawing damage, it should be noticed that variation should be expected according to the taxa represented (in the case of small vertebrates, the proportion of gnawed specimens can be more important, even in the case of humans—the Hadza, for example, can gnaw nearly 80% bones of size I animals; see [Oliver, 1993](#)—although this tendency may reverse if prey are small enough to process or swallow without much tooth damage). Anatomical representation also plays a role, since some elements are more prone to record gnawing damage than others. Another exception to the pattern modelled here would be the case in which humans scavenge carcasses previously accessed by carnivores. These potential sources of variation should be taken into account in every particular case, and also in the case of other bone modifications. In modern dens, light tooth marks, especially scoring, are the most common gnawing damage ([Mondini, 2000b](#)).

Burnt specimens should not be considered if they are suspected to relate to natural fires.

The values in the “Context” section are expressed as % scats of total scats+bones, and % artefacts of total artefacts+bones, respectively. “Artefacts” include all human traces, e.g., not only lithic tools but also debris.

surveyed in the region, and only a few have been found, with insignificant statistical representation, in archaeological deposits. Also not relevant is the criterion of relatively low fragmentation levels—as expressed by mean fragment length—since Puna carnivores can accumulate very comminuted bone, especially in the case of scatological assemblages ([Mondini, 2000a](#)). Interior space use is not as relevant either, since the caves and rock shelters under study are not as large as the Italian ones.

[Lyman \(1994\)](#) has summarized several models such as these, and suggested that human-generated bone assemblages would be characterized by a combination of burning, comminution, homogeneous weathering, tool marks, and the association with human traces such as artefacts. In the context analysed here, however, fragmentation would be a very ambiguous criterion, as mentioned above. Weathering can also be equivocal, since it is conditioned by many processes independent of the accumulating agent.

Based on these and other related models and, especially, on the actualistic studies carried out in the Puna ([Mondini, 1995, 2000a,b,c, 2001](#)), a model has been developed which considers the specifics of the

local carnivores, summarized in [Table 4](#). It considers two sets of attributes: bone modifications and contextual variables. Not all of these criteria will be informative in all cases, due to the fact that even in cases where an attribute can be expected to have a 100% frequency, it can also be absent. The use of multiple, independent lines of evidence is then essential.

Assessing Who Accumulated What

In [Table 5](#) and [Figure 2](#), the values for the model’s variables are shown both for Puna modern dens and the archaeological deposits, along with information on assemblage size. The den assemblages are from the Antofagasta de la Sierra area ([Mondini, 1995, 2001](#)), where QS3 is also located. For comparative purposes, it should be kept in mind that while the ICc4 assemblage is dominated by small taxa, the QS3 one is dominated by large taxa, almost in a mirror-like fashion. This may influence how damage and other attributes are distributed.

The archaeological deposits differ from the carnivore ones in many respects, and in fact fit the theoretical

Table 5. Criteria for distinguishing human vs. carnivore bone accumulations in modern carnivore dens and archaeological deposits

Attributes	Modern assemblages						Average modern assembl.	Archaeological a.		
	ANSm2	ANSm4	ANSm5	ANSm6	ANSm7	ANSm8		ICc4-layer 2	QS3-layer 2b14	
<i>Assemblage size</i>										
NSP	61	20	100	16	30	21	41	2515	1459	
NISP	49	20	76	7	23	17	32	1045	289	
<i>Bone modifications</i>										
% gnawing damage	NISP	25	2	7	2	11	9	9	18	8
	%NISP	51	10	9	29	48	53	33	2	3
% digestive corrosion	NISP	0	0	0	0	0	0	0	4	1
	%NISP	0	0	0	0	0	0	0	1	1
% tool damage	NISP	2	0	0	0	0	0	0	>204	91
	%NISP	4	0	0	0	0	0	1	>20	31
% burnt bone	NISP	5	0	0	0	0	0	1	>22	6
	%NISP	10	0	0	0	0	0	2	>2	2
<i>Context</i>										
Association with carnivore scats	N scats	0	0	6	0	122	9	23	121	>3
	%NISP	0	0	7	0	84	35	21	10	>1
Association with artefacts	N artef.	0	0	0	1	3	0	1	>982	>3360
	%NISP	0	0	0	13	12	0	4	>48	>92

Assemblage size is only given as background information, not as a diagnostic criterion.

Bones contained within scats are not considered in the "Digestive corrosion" column; for information on modern scatological bone assemblages, see Mondini (2000a,c).

"Context" values are expressed as %scats of total scats+bones, and %artefacts of total artefacts+bones, respectively. It should be noted that while each carnivore den assemblage has been interpreted as the result of probably single occupational events, layer 2 of ICc4 has been interpreted as the result of multiple events (Yacobaccio, 1991), and layer 2b14 of QS3 is also most probably so, which could account for the relatively high raw frequencies of tools, bones, and scats.

In general, most scats are fragmented, so that many specimens might come from fewer scats; also, apart from these modern dens, two latrines were recorded containing only scats ($N=6$ and $N=4$, respectively), but no bones. If we took them into account, the average proportion of scats in modern assemblages would equal 37%, which would be a more realistic average.

In the "Archaeological assemblages" column, data are from Yacobaccio (1991), Elkin (1996), and my own observations. Whenever minimum numbers are provided, they are preceded by the symbol ">"; in all cases, though, only a few bones/artefacts/scats would not be included (Yacobaccio, pers. com. 2001; Aschero, pers. com. 2001).

model of human-generated assemblages. Most remarkably, the proportion of gnawing damage in archaeological assemblages significantly diverges from the average in modern assemblages, and it does not even approach the lowest values in those. In QS3, the proportions are also low in the other Early Holocene layers (Elkin, 1996). In ICc4—layer 2, even if we only considered the artiodactyls (large taxa), the percentage of gnawed NISP would be 4%, which is lower than in all modern dens.

The levels of digestive corrosion are very similar across all assemblages, approaching zero. A reason why no scatological bones were recovered from modern dens—apart from the ones contained within scats—in spite of being considered as diagnostic, would partly have to do with time-dependent factors: not enough time would have elapsed for scats to break apart, as it certainly has in the archaeological sites. Hence, the relative abundance of scats in many modern dens would compensate for the absence of derived scatological bone. Both variables should generally be considered together.

As to the attributes that characterize human-generated assemblages, tool damage is quite diagnostic, even in ICc4, where it could be somewhat

underestimated. Burnt bone is, as digestive corrosion, very similar across all assemblages, and very scarce generally; it should be considered in conjunction with other attributes denoting food preparation.

Regarding the contextual variables, they seem to be very informative of agency in these cases: while the association with carnivore scats can be important in modern dens, it is artefacts that become definitely common in archaeological deposits. This last criterion is in fact more diagnostic in these cases, since the proportion of scats in the dens is highly variable and the archaeological deposits do in fact fall within the range of modern reference samples.

To sum up, even when ICc4 and QS3 assemblages are very different, the role of carnivores in their accumulation, although it cannot be ruled out, seems to account for only a small proportion of each sample. This suggests that humans were the prime accumulators of these assemblages.

Finally, the palaeoecological conditions under which these processes occurred should be considered. As mentioned, the climate would have been cooler and wetter at the time when layer 2 of ICc4 was formed, at least in the Inca Cueva area. According to my actualistic studies in El Bolsón valley (Catamarca),

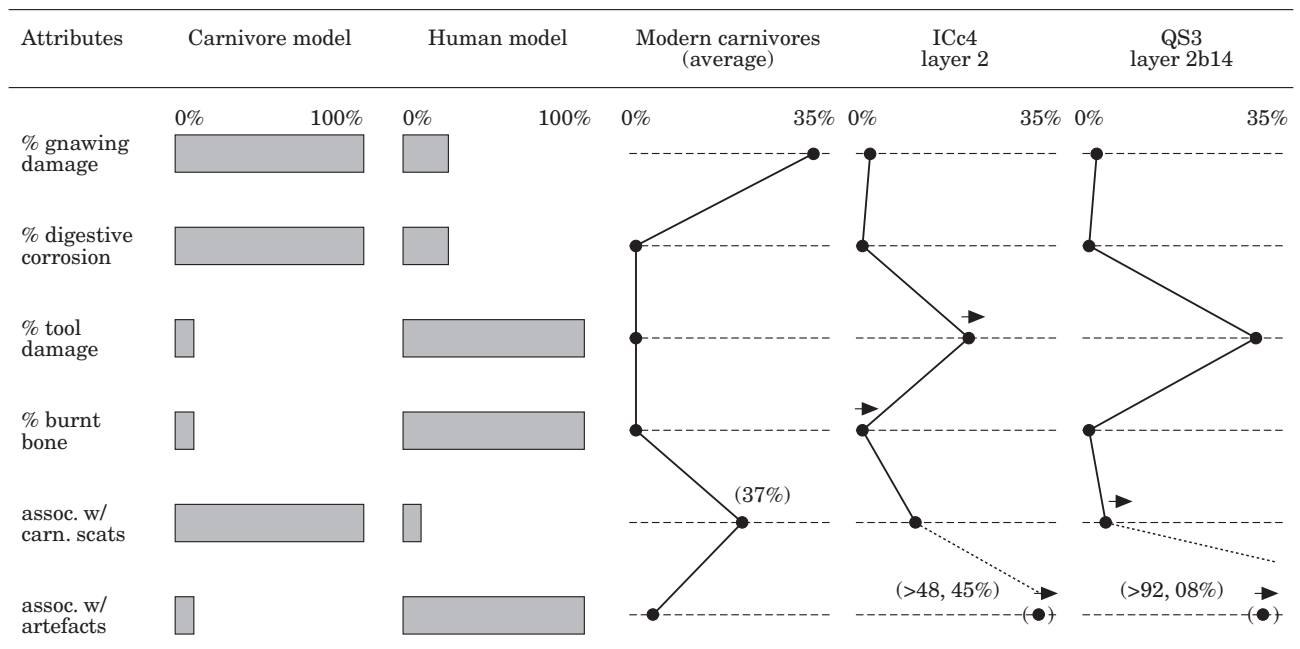


Figure 2. Human vs. carnivore attributes in modern carnivore dens and archaeological deposits. Graphical design adapted from Behrensmeyer (1991). Data after Tables 4 and 5. →=Incomplete data; point should be considered as a minimal percentage. In all cases, only a few bones/artefacts/scats would not be included in the countings (Yacobaccio, pers. com. 2001; Aschero, pers. com. 2001).

immediately below the Puna plateau, in a wetter setting carnivores tend to eat more small vertebrates and also more invertebrates and plants (Mondini, 2000c). As a consequence, scat-derived assemblages are more common in rock shelters than transported bones, as compared to the Puna. This may have been the case in ICc4. Even when tooth damage is far less common there than in even the least damaged modern assemblage, the percentage of scats, although lower than the modern average, falls within the range of the modern dens, and in fact slightly exceeded the model expectation—even when time has provided more chances for them to break apart. Also there are some bones bearing digestive corrosion, which is more than in the modern cases (where there are none).

QS3, on the other hand, is located in an area which is presently drier. Furthermore, aridification seems to have been occurring while layer 2b14 was forming. Evidence of scatological assemblages is scarcer than at ICc4, but evidence of transported assemblages, namely gnawing damage, is nearly as insignificant. If some stress was occurring on the local carnivore community, as suggested above, it does not seem to have affected the levels of bone damage, at least in this site. Perhaps it did affect the carnivores by making them enlarge their home ranges, or by reducing their numbers, but such interpretations are beyond the scope of this paper.

In situ Attrition and Scavenging

In situ bone modification and destruction is difficult to identify, and hence it is difficult to weigh its

significance. The same can be said about the deletion of skeletal parts due to transport elsewhere, if these rock shelters were used as scavenging sources. However, the levels of bone modification by carnivores and the integrity of anatomical profiles relative to bone structural density can be used together to assess the potential importance of these processes. In any case, we should not expect strong attrition by these mostly small carnivores (Mondini, 2000b), and if the deletion of parts occurred, it would most probably be due to transport.

The unimportance of gnawing damage in both archaeological cases shown above, along with some indications of anatomical integrity, suggest that attrition was not intense.

For ICc4—layer 2, Yacobaccio (1991) reports that the correlation between camelid MAU (minimum animal units, after Binford, 1984) and density values (after Lyman, 1985) is very low: r (Spearman)=0.375 ($P=0.431$). As to the Chinchillidae, which comprise most of the assemblage, unpublished data recorded by Yacobaccio suggests a somewhat more ambiguous situation, although on the whole structural density does not seem to account for the patterns inferred. On comparing proximal:distal MNEs (minimum number of elements, after Binford, 1984), humerus (5:17), radius (11:1), and femur (15:4) frequencies might be explained by density-mediated attrition. On the other hand, proximal:distal ends of other long bones are fairly even. Finally, those elements most closely approaching the minimum number of individuals inferred for the assemblage (MNI=27) are axial ones:

skull, scapula, and innominate, suggesting that the overall pattern cannot be wholly accounted for by density-mediated attrition.

For QS3—layer 2b14, Elkin (1996) also reports low correlation levels between camelid MAU and volume density values (after Elkin, 1995): r (Spearman)=0.293 ($P=0.432$) for juveniles/adults, and r (Spearman)=0.272 ($P=0.432$) for bones of immature individuals. Again, density-mediated attrition can be safely ruled out as the main process shaping assemblage structure.

No correlations were made with food utility indexes, but if carnivores scavenged away parts previously processed by humans, they would aim at those richer in within-bone nutrients such as long bone ends, which are generally structurally weaker. This in fact is the case of camelid bones in modern carnivore dens, many of which would have been scavenged from human middens (Mondini, 1995, 2001). According to the correlations with bone density, however, this is not the case in the archaeological assemblages.

Some Conclusions

This study has shown evidence suggesting that carnivores did not have an important role in the accumulation of layer 2 of ICc4 and layer 2b14 of QS3, or in scavenging from them. This does not mean that carnivores did not have a role in the formation of these assemblages at all, but that their incidence has not significantly affected the zooarchaeological record in terms of integrity—neither through modification and attrition, nor through addition.

Overall, this is in agreement with the original zooarchaeological analyses (Yacobaccio, 1991; Elkin, 1996). What is most relevant is the fact that the study reported here has provided new support, one that is based on relevant information on the agents involved, and one that is independent from such inferences. In fact, it suggests an even higher integrity of these deposits as regards carnivores.

Such an integrity, along with evidence that the assemblages did not suffer significant attrition otherwise (Yacobaccio, 1991; Elkin, 1996), in turn provides strong support to further archaeological inferences. That is, the zooarchaeological record can be considered as being informative of past human behaviour in a fairly straightforward and complete way. This is of utmost importance, since these archaeological sites are considered to be key sources for understanding the early human population of the Puna.

One of the inferences which is now safely warranted is that concerning species representation in these records (Yacobaccio, 1991; Elkin, 1996), the variations of which can be interpreted in terms of a shift in food niche. According to these and other sites (e.g., Elkin & Rosenfeld, 2001), the ending of the Pleistocene/beginning of the Holocene was a time when animal resources were exploited in a very opportunistic way.

Diet was more generalized at this time, as indicated by the high proportion of taxa other than camelids. This is particularly clear in the case of small taxa, the importance of which is evidenced not only by the frequency of their bones, but also by direct evidence of human processing—such as butchering marks and burning—in some cases and, importantly, by evidence suggesting that carnivores were not important agents of accumulation. It was only later that camelids became the main staple, as part of an increasingly tighter coevolutionary relationship with humans, which eventually led to their domestication.

The ecological and evolutionary implications of such changes in dietary niche are beyond the scope of this paper, but they are certainly very informative, among other things, of the way this Andean region was peopled by the human species.

The information presented also sheds light on the way *Homo sapiens* entered and became part of the local predatory guild. One dimension of this is the trajectory of the coevolutionary relationship between human and carnivore populations through time, which is best seen in historical perspective. While commensalism would have developed between foxes and humans over the Holocene (Mondini, 2000a), it is worth noting that carnivore–human competition would not have been important. This is evident from the characteristics of the carnivores themselves and, although more early sites should be examined before we reach definite conclusions, it is further supported by the study reported here. Unlike many other regions, especially in other continents, the Puna supports a mammal predator community dominated by small carnivores, which would not be effective competitors to humans. In fact, the early archaeological deposits reported here evidence very little shared interest for food resources. Just as carnivores appear to compete little among themselves they also appear to compete little with humans, one of the most recent newcomers to the predator community. In any case, as human diet narrowed its focus on camelids, it overlapped less with small carnivores, and more with the puma, the only carnivore to hunt large ungulates in the region.

This study also has palaeoecological implications as to the carnivore community in the past. In the present Puna setting, two sets of factors seem to condition most of the variability in animal food procurement, transport, and attrition by carnivores: the body size relationship between them and their prey or source-carcasses, and ecological conditions such as the apparently low levels of competition between themselves (Mondini, 1995, 2001). Both result in the patterns described here for modern dens, such as the lack of intense attrition. As far as this study is concerned, there is no reason to believe that these conditions were significantly different at the end of the Pleistocene and Early Holocene, although more local palaeoecological information is required if we are to reach stronger

conclusions. Nevertheless, since relevant Quaternary palaeontological information is extremely scarce, reports based on archaeological sites are of substantial importance for learning on the natural history of the region.

Methodological implications of this study are quite significant as well, namely the fact that it is the use of different, independent lines of evidence which has allowed a controlled inference of the integrity of these deposits regarding carnivores. This is the only way to provide a grounded account of the effects of taphonomic processes (Gifford-González, 1991). It becomes particularly relevant when some of the lines of evidence, by themselves, are rather ambiguous about agency. Even the presence of gnawing damage can be so, since humans and carnivores—which in this context are mainly small, and most commonly inflict light damage to the bones—can potentially leave analogous traces (Elkin & Mondini, 2001). The only way to unravel such equifinality, and the logical difficulties it implies, is an approach that addresses several independent variables in parallel.

This is also the case when some key indicators can be faint. It is noteworthy, for example, that while the proportion of gnawing damage generally discriminates carnivore vs. archaeological assemblages in the samples analysed, in the largest den assemblage (ANSm5) this percentage is very low. This is very significant, since one of the main conclusions of the actualistic studies is that active bone accumulation is taphonomically more important than bone modification by these carnivores—except for the smallest prey, which can be analytically absent due to total ingestion. Under these conditions, if we relied heavily or exclusively on the proportion of gnawed bones to assess the incidence of carnivores in an archaeological assemblage, as has often been the case in zoo-archaeological studies, we could wrongly infer a high integrity where in fact carnivores have played an important role (Mondini, 2000b). Again, multiple, independent lines of evidence are the only way to avoid misinterpretations.

To sum up, this study has helped understand carnivore taphonomy in the context of the early human occupations in the Andes in many ways. One aspect relates to the fact that carnivore taphonomic traces can be very faint and ambiguous in this part of the world. Once we disentangled this problem with the methodological resource of multiple lines of evidence, some palaeoecological implications of carnivore traces could be assessed. This is an issue on which more information is required, although the archaeological record is considered to be a unique source in many respects. Also, and most importantly, we were able to provide support to the notion that the integrity of ICc4—layer 2 and QS3—layer 2b14, two of the most relevant earliest archaeological assemblages, is high enough as to allow a major insight into the first human adaptations in the Southern Puna.

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