TAPHONOMIC APPROACHES IN ARCHAEOLOGY: CURRENT TOPICS AND METHODS FROM SOUTHERN SOUTH AMERICA

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Analysis of zooarchaelogical and taphonomical variability from Maripe Cave site, Santa Cruz Province, Argentinian Patagonia

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ABSTRACT

This paper compares two zooarchaeological sub-samples, each of which comes from a different area (North chamber and South chamber) of Maripe Cave Site (Santa Cruz, Argentina). In previous papers, each chamber was interpreted as a particular microenvironment based on their specific environmental and geoarchaeological features. In both areas, hunting–gatherer society occupations were recorded since the Pleistocene–Holocene transition to late Holocene. This paper investigated and discussed the different agents and processes involved in the formation of each assemblage, with the aim of assessing the taphonomic variability between the two areas and discussing their integrity. Bone specimens of *Lama guanicoe* (guanaco), the most common species on the site, were analyzed. The bone surfaces of specimens were studied by naked eye observations and binocular magnifying to 10×, which allowed recognition of different patterns of modification. The representation of guanaco anatomical units was also discussed at each chamber according to economic utility and BMD values. The results indicate that while there was involvement of different natural agents and processes acted differently in each sector, the main accumulating agent in both sets was human.

Differences between both chambers are observed in the representation of anatomical units, in processing marks, in the conservation of specimens, and in the number and intensity performed by each natural agents and process in each sector. Each chamber indicates a different taphonomic history: the North Chamber records greater conservation and archaeological integrity, while the South Chamber shows a more complex taphonomy.

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1. Introduction

The interest of the Argentinean archaeologists in developing a taphonomic perspective in their investigations began during the second half of the 1980s (Borrero, 1987, 1988, 2001; Mengoni Goñalons, 1988; Politis and Madrid, 1988; Durán, 1991; Mondini, 2002; Gutiérrez, 2004). Nowadays, taphonomic studies have increased notably and have addressed a wide range of aspects, which has meant that the variety of the processes and studied agents has multiplied. In this sense, the contributions made by Borrero and his research team on different aspects from the taphonomy of Patagonia, and the development of a theoretical–methodological approach known as Regional Taphonomy (Borrero, 2001) has allowed the integration of both of Argentinean and Chilean archaeological and taphonomic information (Gutiérrez, 2004; Martin, 2007; Barberena, 2008; among others). Other taphonomic developments of importance in Argentina are those that have been carried out in the Pampean and north Patagonian regions by the group of researchers from INCUAPA-UNCPBA. They have generated an important corpus of practical and archaeological information based on the development of this perspective (Borella, 2000; Gutiérrez, 2004; Kaufmann and Gutierrez, 2004; Messineo, 2008; Kaufmann, 2009; Massigoge, 2009). There are also many remarkable works about taphonomy in other sectors of Patagonia (Muñoz, 2002; Cruz, 2003; Fernández, 2010; among others), the Argentine northwest (Mondini, 2002) and the centrewest (Gil and Neme, 1996; Giardina, 2010).

In spite of the unquestionable growth that the discipline has had, its establishment in Argentina is still developing and its integration with archaeology is incomplete. The taphonomic studies are often made after the sites have been excavated, and in many cases it is necessary to rearrange the interpretations (Borrero, 2007).

Zooarcheological studies have been present in the agenda of the researchers who worked in the Central Plateau area, Santa Cruz province, since the mid-1980s. However, the main emphasis was put on the study of patterns of subsistence of the hunter–gatherers societies that occupied the area during the Pleistocene transition and at the different moments of the Holocene (Miotti, 1998; Miotti et al., 1999; Aguerre and Pagano, 2003; Durán et al., 2003). Paleo-environmental topics (Miotti and Salemme, 1999; Horovitz, 2003), the anthropic use of Pleistocene fauna in early archaeological contexts and the discussions about their extinction were also addressed (Miotti, 1998, 2003; Miotti et al., 1999; Miotti and Salemme, 2005; Paunero et al., 2007a, 2007b; Marchionni and Vazquez, 2010).

Taphonomic studies made in archaeological sites in Central Plateau of Santa Cruz have been limited and non-systematic. Generally they consist of rather specific information as part of major works carried out in some sites of the area. The emphasis of these was mainly directed to the registration and quantification of human processing marks, weathering profiles, and rodent and carnivore marks (Durán, 1991; Miotti et al., 1995, 1999; Miotti, 1998, 2003; Aguerre and Pagano, 2003; Durán et al., 2003; Miotti and Salemme, 2005). The study of site formation processes that shaped particular taphonomic histories is a line of evidence that has recently started to be approached in a systematic way in the studied area (Miotti and Marchionni, 2009, 2011). From this perspective, the caves are presented as exceptional cases of sedimentary deposition. As stated by Waters (1992, p. 243), "The stratigraphic sequence in any rockshelter is unique because of differences in shelter lithology, weathering processes, hydrologic conditions, and types of depositional environments present outside the shelter". This, added to the intensity of human occupations, makes the stratigraphic correlation between sites of these characteristics even more complex. Moreover, in the same cave, environments showing sedimentary differences can be recognized (Farrand, 1985; Kornfeld et al., 2008). Because of the environmental and stratigraphic peculiarities inherent to the caves (Farrand, 1985),

very different situations exist to study intra- and intersite, so the understanding of the conditions and agents involved in the formation of archaeological sites is relevant.

The Maripe Cave site, located in the Central Plateau of Santa Cruz province (Argentina) (Fig. 1), is a large cave, divided into two chambers (North and South) by a rocky wall which in some sectors do not intersect the current floor of the cave. Each chamber was considered a distinct microenvironment (Miotti et al., 2007). The radiocarbon dating made for Maripe Cave allowed recognition of a broad occupational sequence in both chambers, which extends from the Pleistocene–Holocene transition (*ca.* 9500 BP) to historical times (Miotti et al., 2007).

This site is located in the same hydrographic basin as the Piedra Museo rockshelter, in which were recorded some of the earliest occupations of South America (*ca.* 13,000 BP) associated with extinct fauna *i.e. Hippidion saldiassi*, *Lama gracilis* and *Mylodon* sp., with clear human processing marks (Miotti et al., 1999; Miotti, 2003; Miotti and Salemme, 2005; Marchionni and Vazquez, 2010). Piedra Museo is located 80 km east of Maripe Cave. At a similar distance to the north is Los Toldos locality, and southward are La María and El Ceibo localities. Archaeological contexts in all these sites involve occupations that correspond to the Pleistocene–Holocene Transition associated with extinguished Pleistocene fauna (Miotti, 1998; Paunero et al., 2007b; Frank, 2011). The sites, including Maripe Cave, are stratified contexts in caves and rockshelters with broad occupational sequences. Maripe Cave is situated within an important archaeological region for the study of the initial peopling of the continent and across the Holocene, and its particularities. In this sense, its study makes possible the approach to important issues of Patagonian archaeology and nearby regions, such as peopling of the continent and its different stages, the human use of megafauna, the adaptation to semi-arid climates, technological changes, mobility and subsistence strategies, among others, which characterize the hunter–gatherer societies life.

Since the beginning of Maripe Cave research, archaeological excavations were conducted on both sides of the cave, which
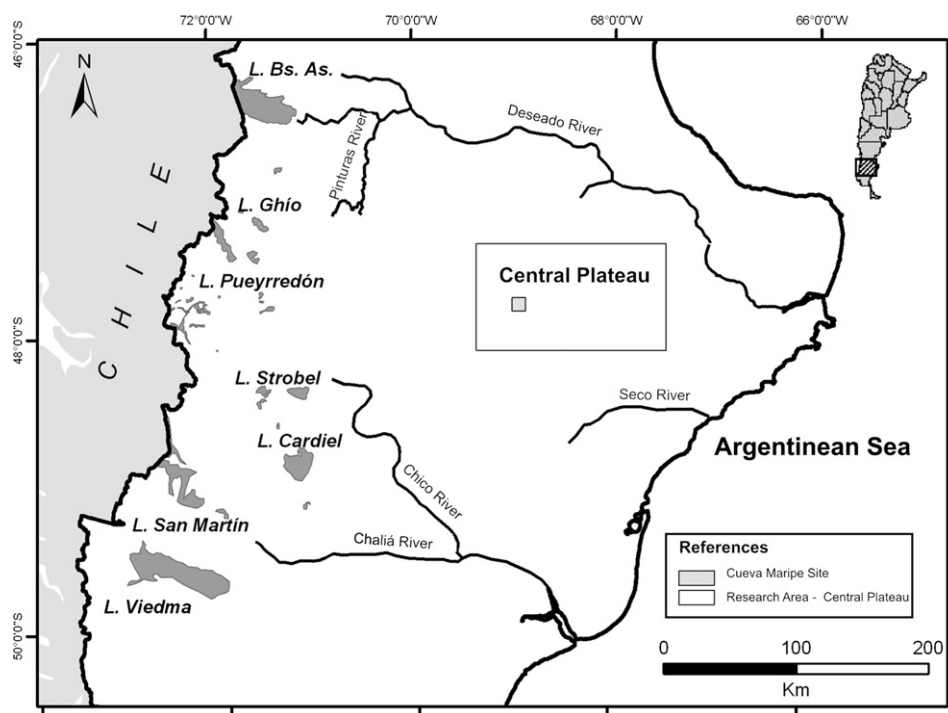

Fig. 1. Study area in Central Plateau (Santa Cruz Province) and Maripe Cave site (La Primavera locality).

allowed analysis and discussion whether the differences between the chambers could have played a significant role in the decisions taken by hunter—gatherer societies and the several biological agents that used the cave (Miotti et al., 2007; Miotti and Marchionni, 2009). This idea was also addressed as part of the research on rock art (Carden, 2009) and lithic technology (Hermo, 2008) that was developed in the context of two PhD theses, which presented evidence that supports the hypothesis of a differential use of space inside the cave.

The study of the arqueofauna is another line of evidence which tested this hypothesis. Therefore, this work is an effort in that direction. Analysis was conducted of bone surface modifications from Maripe Cave arqueofauna, and the taphonomic variability in each of the microenvironments of the site (North Chamber and South Chamber). Comparative analysis of bone modification allowed consideration of the various processes and agents (natural and cultural) involved in site formation, and evaluation of archaeological integrity in each of these chambers.

Many works performed in archaeological sites of Argentinean Patagonia analyzed and discussed several bone modifications (cultural and natural) from caves and rockshelters (Mengoni Goñalons, 1999; Aguerre and Pagano, 2003; Durán et al., 2003; De Nigris, 2004; Martin, 2007; Barberena, 2008; L'Heureux, 2008; Otaola and Franco, 2008; among others). Some research carried out in Santa Cruz province examined the horizontal and vertical distribution of materials in this kind of site (Aschero et al., 2007; Paunero et al., 2007a, 2007b; Barberena, 2008; Marchionni et al., 2010; among others). However, the taphonomic analyses that

contemplate the existence of different sectors or microenvironments in these shelters are scarce (Aguerre, 2003; Barberena, 2008; Borrero and Martin, 2011). Therefore, this paper provides new data regarding Maripe Cave, providing relevant information for taphonomic discussion of inter- and intra-site variability, the human—fauna relationship in the past, and the paleoenvironment on a regional and extra regional scale.

In this sense, the analysis of bone surface modification patterns is a valid methodological way for distinguishing the different processes and agents involved in the formation of an archaeological assemblage (Binford, 1981; Gifford-Gonzalez, 1991; Lyman, 1994; Marean, 1995). In this paper, the recorded bone modifications are discussed in terms of the geoarchaeological information known for the site (Miotti et al., 2007; Rabassa et al., 2007).

2. Maripe Cave site

The site is located in the canyon La Primavera, in the headwaters of Zanjón Blanco, Central Plateau of Santa Cruz province (47°51′05″S, 68°56′03″W; Fig. 1). This gully is oriented north—south and the cave is located at 560 m.a.s.l. on the east margin (Miotti et al., 2007). Maripe Cave has a 26 m by 24 m opening, and the total area excavated in the cave is 34 m^2 in squares of 2 m × 2 m.

The microenvironmental differences between the North Chamber (NC) and South Chamber (SC) were inferred in a previous work (Miotti et al., 2007) (Fig. 2A). These differences can be summarized in the following way: the NC is characterized by a higher incidence of winds, less sunlight, dry environment and the
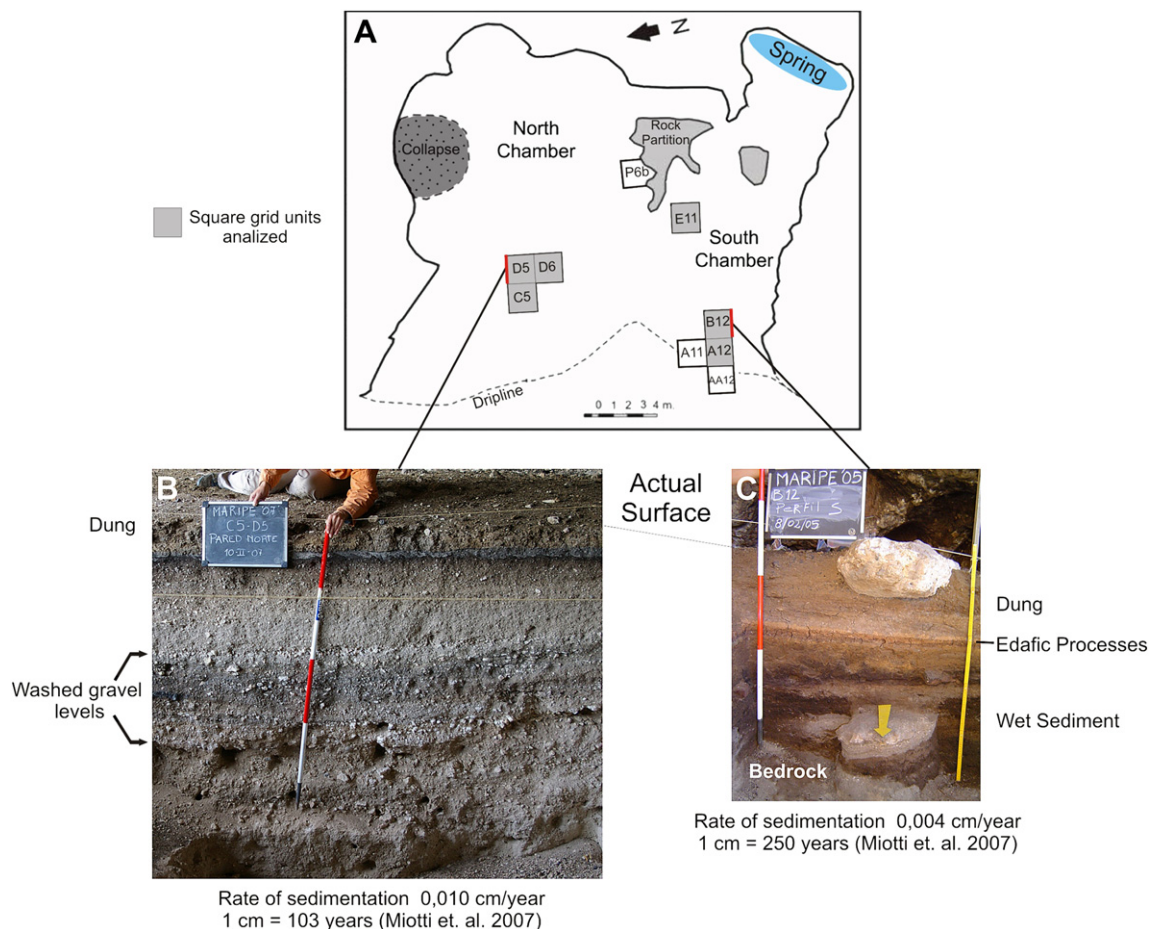

Fig. 2. A) Map site with North chamber and South chamber; B) North chamber Profile; C) South Chamber Profile.

sedimentation rate is higher (103 years/cm). The SC is more protected from the winds, and the incidence of sunlight is higher. This environment presents high humidity as a result of an active fresh water spring at the bottom of the cave, and the sedimentation rate is lower than in the NC (250 years/cm), resulting in a compressed sequence.

The stratigraphic sequence of both chambers presents particular geological and stratigraphic features (Fig. 2B and C). In the NC (Fig. 2B) layers with high proportions of gravel are present, the result of collapse or weathering of the ceiling of the cave (Rabassa et al., 2007). In this chamber, a collapse was recorded (Fig. 2A), which seems to be the result of an ancient, now inactive, spring (Fig. 2A). The SC profile (Fig. 2C) does not contain any sectors with marked presence of gravel, but leaching features show an incipient edaphic process. During the excavations carried out in this sector, the presence of roots at deep levels and close to the bedrock was registered.

Under these conditions of geoarchaeological and stratigraphic differentiation (Miotti et al., 2007), the physiognomy of both sectors is very different. This situation does not allow the correlation of layers of both chambers, with the exception of the aeolian sand resting on the bedrock of the site and the continuous manure layer which is the current floor of the cave (Fig. 2B and C).

Radiocarbon dating shows an occupational recurrence in which the first human occupations of the site correspond to the Pleistocene–Holocene transition. The earliest date was recorded on the SC, where the occupational sequence continues until the later stages of the Holocene (Table 1). The NC also recorded a large occupational sequence (Table 1). In spite of this, there is no overlap between radiocarbon dates in or between chambers. This fact led to the hypothesis of an alternate use of chambers at different times (Miotti and Marchionni, 2009).

The stratigraphic complexity, coupled with the homogeneous vertical distribution of specimens, the transitional limits of natural layers and the lack of hiatus, seals, or volcanic ash levels, does not allow temporal separation of the assemblages of each chamber. Geoarchaeology, taphonomy and other lines of evidence such as lithic technology, phytoliths, diatoms and GIS studies are being used to refine the degree of temporal resolution of the occupations. On this basis, the sub-samples are considered as time averaged sets (Behrensmeyer, 1982; Lyman, 1994). The focus is on the spatial taphonomic differences within the cave to recognize patterns and trends.

3. Materials and methods

The recognition of different patterns of bone surface modifications allows inferring, in some cases, the taphonomic agents and processes responsible (Johnson, 1985; Gifford-Gonzalez, 1991). This type of study contributes to understanding of the taphonomic history of a site and its archaeological integrity (Lyman, 1994).

Taphonomic research is understood as the study of the preservation processes and how they affect the information contained in the register (Behrensmeyer and Kidwell, 1985). This is a necessary requirement that allows understanding of the zooarchaeological record before attempting interpretations about the subsistence strategies of human groups in the past (Lyman, 1982). The comparative method (Marean, 1995) is a valid procedure that allows inference, from the traces or marks registered on the surface of bone specimens, of the actor or process responsible for them.

The faunal structure of each sub-sample (Miotti and Marchionni, 2009) shows a clear dominance of *Lama guanicoe* (guanaco). The trend obtained is consistent with the tendency recorded in other sites in the interior of Patagonia, where guanacos were the main economic resource of hunter–gatherer societies (Miotti, 1998; Mengoni Goñalons, 1999; Miotti et al., 1999; De Nigris, 2004; De Nigris and Mengoni Goñalons, 2004; Otaola and Franco, 2008; Rindel, 2008; Marchionni et al., 2010; Miotti and Marchionni, 2011; among others). Therefore, both quantitative and bone surface modification analyses were made, focusing on the representation of anatomical parts and recording of different traces (natural and cultural) on this taxon's specimens.

Bone specimens were studied comparatively with three-dimensional allocation. These specimens come from 6 squares of excavation; 3 squares correspond to the NC (C5, D5 and D6 = 12 m^2) and 3 to the SC (A12, B12 and E11 = 12 m^2) (Fig. 2A).

The agents and taphonomic processes affect taxa differently. The evaluation of the modifications produced only on *L. guanicoe* specimens allowed better control over the variability introduced by that situation. The materials recovered by means of sieves are in process of analysis, and thus have not been included in this work.

The representation of the guanaco anatomical units allowed evaluation of the probable processes or agents responsible. Both anthropic origin, which refers to human decisions about transport or consumption of anatomical parts, and natural origin which produces the destruction of anatomical parts with less bone mineral density (BMD) were taken into account. For this purpose, it was necessary to correlate the meat utility index (Borrero, 1990; Lyman, 1992) and the bone density values (Elkin, 1995) with the % MAU (Binford, 1984). This analysis allowed evaluation of whether the frequency of registered anatomical parts correspond to human decisions, whether it was the result of destruction processes mediated by differential density of each specimen, or whether it was a combination of both alternatives (Lyman, 1994). In any case, this result leads to an assessment of the degree of integrity of both sets. The record of bone surface modifications was performed both by means of naked eye and binocular microscope, with a magnification of 10×, on all specimens assigned to guanaco, both the axial skeleton and the appendicular skeleton.

The comparison of weathering profiles (Behrensmeyer, 1978) allowed an indirect assessment of the preservation of the sub-samples. Weathering measures the potential bone loss by action of physico-chemical factors among which the sun and exposure time to atmospheric conditions play a primary role. Depending on the microenvironmental features described for Maripe Cave, the expectation was to find greater weathering in bone specimens from the SC.

Table 1
Radiocarbon dates of Maripe Cave site (taken from Miotti and Marchionni, 2009 and modified).

Period	North chamber			South chamber		
	Square	Code	^{14}C age BP	Square	Code	^{14}C age BP
Pleistocene/ Holocene transition	D5	AA 65179	8992 ± 65	A12	AA 65175	9518 ± 64
	C5	AA 65178	8762 ± 50			
Early Holocene				A12	AA 65174	8333 ± 63
Middle Holocene	D6	AA 65173	5084 ± 49	B12	AA 65177	7703 ± 47
	C5	LP 1497	3210 ± 60	A12	AA 65181	4113 ± 39
Late Holocene				B12	AA 65176	1078 ± 40

The analysis of weathering was performed in those specimens corresponding to the shaft of guanaco long bones. This minimizes the error introduced by evaluating this feature in specimens corresponding to different species and/or different anatomical units (Behrensmeyer, 1978). Weathering profiles grouped stages 0 and 1 (low weathering), stages 2 and 3 (middle weathering), and stages 4 and 5 (high weathering).

Other natural modifications considered in this work are those produced by the action of carnivores (Binford, 1981; Capaldo and Blumenschine, 1994; Mondini, 1995; Cleghorn and Marean, 2007; Martin, 2007) and rodents (Binford, 1981; Bocek, 1992; Lyman, 1994), etching by roots (Lyman, 1994; Montalvo, 2002); deposits of CaCO₃ (Courty et al., 1989; Lyman, 1994; Gutiérrez, 2004) and staining by oxides of manganese (Karkanas et al., 2000; Gutiérrez, 2004; Lopez-Gonzalez et al., 2006). The category "dark indeterminate" was used for those bone specimens that showed darkened surfaces and whose causal agent (fire, manganese, or other) could not be identified. This difficulty to more precisely distinguish thermal alteration or stains produced by diagenesis processes has been addressed by several authors (Lopez-Gonzalez et al., 2006). The frequency of natural modifications was considered in relationship to particularly features (microenvironmental and stratigraphic) that were recognized in each chamber.

The record of antrophic modifications allowed assessment of the role of the human agent in the formation of each sub-sample. Different traces related to the processing and reduction of carcasses were identified. Among these traces were cut marks (Binford, 1981; Potts and Shipman, 1981; Johnson, 1985; Lyman, 1994; De Nigris, 2004), impact points (Johnson, 1985; Lyman, 1994), intentional fractures (Johnson, 1985; Capaldo and Blumenschine, 1994; Lyman, 1994), scraping marks (Binford, 1981; Potts and Shipman, 1981; Olsen, 1988) and percussion marks (Blumenschine and Selvaggio, 1988; Blumenschine et al., 2006). Another variable that we analyzed was the presence of thermal alteration (Buikstra and Swegle, 1989; Lyman, 1994; De Nigris, 2004). PAST v.2.08 software was used to statistically evaluate the consistency of results (http://www.nhm.uio.no/norgest/past/download.html).

4. Results

Of all the specimens analyzed in both chambers (NSP = 1747), 95.5% could be identified at some anatomical or taxonomical level (NISP = 1669). From total NISP, 61.5% corresponded to the NC (NISP = 1026) and 38.5% to the SC (NISP = 6430). Miotti and Marchionni (2009) presented the taxonomic relative abundance trends for each chamber from a smaller sample universe (NSP = 1007). This shows that in both sectors the most represented species is *L. guanicoe* (over 50% of NISP) followed by large mammals, and that the frequency of specimens in the NC is higher than in the SC. The results found by expanding the sample validate the previously obtained trends, showing that guanacos are the most represented species in the NC (54.1% NISP) and the SC (53.6% NISP). The absolute frequency of guanaco specimens in the NC (NISP = 555) is higher than in the SC (NISP = 345) (Table 2).

The MNI obtained for *L. guanicoe* in Maripe Cave is 9, calculated from tibia shafts with nutrition foramen (Table 2). The representation of anatomical parts shows that in the NC the most represented units (MAU = 100%) are elements from the rear legs: tibia shaft and proximal metatarsal (Table 2). In second place, also showing a high representation (MAU = 83.3%), are elements from the front legs: distal humerus and radius/ulna shafts, and elements from the axial skeleton such as skulls (Table 2). From these units, the tibia shaft and radio/ulna shaft recorded the highest values of BMD (Elkin, 1995).

The most represented anatomical parts (MAU = 100%) in the SC are distal elements from rear legs: proximal metatarsal and astragalus; and scapula from the front legs (Table 2). In second place (MAU = 83.3%), are the tibia shafts from the rear legs and distal elements from front legs as proximal metacarpal and unciform (Table 2). High (distal tibia, proximal metatarsal and metacarpal), middle (astragalus and unciform) and low (scapula) BMD values were recorded (Elkin, 1995).

The frequency of guanaco anatomical parts in both chambers shows the presence of units from axial and appendicular skeletons. The highest frequency in both sectors corresponds to specimens from the appendicular skeleton, which in the SC (83.31% of the NISP) shows a higher percentage than in the NC (68.46% of the NISP). The difference in frequencies between axial and appendicular skeletons observed in the two chambers was analyzed using both a chi-square test and a G-test (see Table A.1). These tests were based on the MNE values obtained for each chamber for the appendicular and axial regions. The results obtained from both the chi-square test ($p = 0.054 > 0.05$) and G-test ($p = 0.048 < 0.05$) are similar. Although the first result indicates independence between these variables, the second result shows the possibility of some dependence. Given that both values are very close to the level of significance (< 0.05), the anatomic parts representation is not considered to be different between chambers. The unequal representation of elements from axial/appendicular skeletons is not considered statistically significant.

The results obtained in the different calculated correlations are presented in Table 3. In both chambers, there is a moderate and positive correlation between %MAU and BMD. This means that these sets could be interpreted as a result of destruction processes mediated by density, because those parts with higher chances of survival are the most represented. However, specimens with very low BMD, which should have disappeared, were recognized in both chambers: sacrum parts and vertebrae (Table 2). The lack of correlation between %MAU and Utility Index does not reflect a particular utility or transport strategy. Based on the results of the correlations, both sets correspond to class 4 proposed by Lyman (1994, p. 264).

The weathering trend observed in long guanaco bones (NC $n = 160$ and SC $n = 51$) indicates that specimens from the NC have higher frequencies in low weathering stages than in the SC (Fig. 3). Estimation of the significance of this variability between the chambers used a two-by-two chi-square test and a G-test because specimens with high weathering stages were not registered (see Table A.2 in Appendix). The results of both the chi-square test ($p = 0.00024 < 0.05$) and the G-test ($p = 0.00041 < 0.005$) shows that there is a dependence between the weathering stages and each sector. The weathering observed, at least in part, could indicate that the assemblage of the SC had a longer time of exposure to atmospheric conditions than the assemblage of the NC, and in consequence, the number of agents that acted during deposition and post-deposition was greater than in the NC.

In reference to bone surface modifications, in both chambers patterns that resulted from of natural and cultural agents and processes were identified. In some bone specimens, the action of more than one of these processes was registered (Fig. 4a and b).

With regard to natural modifications, manganese staining in specimens from the NC (10.9%) is the most frequent occurrence. These are registered on bone cortical and marrow cavity surfaces, usually as spots or stains that partially cover the specimens. This modification has a low frequency in the SC (8.9%) but in this sector manganese covers almost the complete surface of the bone (Fig. 4a).

Root traces were identified in both chambers and at low percentages, although in the SC (2.8%) the frequency is higher than in the NC (1.7%). These marks are presented as thin channels with

Table 2
Representation of anatomical units of guanaco in NC and SC, Maripe Cave site.

Anatomical unit	DMO	North chamber					South chamber				
		NISP	MNE	MNI	MAU	%MAU	NISP	MNE	MNI	MAU	%MAU
Skull	(no data)	42	5	5	5.00	83.33	12	2	2	2.00	66.66
Mandible	(no data)	22	6	4	3.00	50	9	4	2	2.00	66.66
Atlas	0.82	4	3	3	3.00	50	3	2	2	2.00	66.66
Axis	0.67	4	3	3	3.00	50	–	–	–	–	–
Cervical V.	0.56	23	8	2	1.60	26.66	8	3	1	0.60	20
Thoracic V.	0.64	13	5	2	0.42	7	4	4	1	0.33	11
Lumbar V.	0.42	5	2	1	0.29	4.83	9	3	2	0.43	14.33
Sacrum	0.35	7	3	3	0.60	10	4	2	2	0.40	13.33
Caudal V.	(no data)	–	–	–	–	–	–	–	–	–	–
Rib	0.71	26	22	1	0.92	15.33	3	3	1	0.13	4.33
Sternebrae	0.2	3	3	1	0.50	8.33	–	–	–	–	–
Scapula	0.60	8	6	4	3.00	50	6	6	3	3.00	100
Px. Humerus	0.42	1	2	1	1.00	16.66	–	–	–	–	–
Humerus shaft	1.24	18	7	5	3.50	58.33	8	3	2	1.50	50
Ds. Humerus	0.79	12	10	5	5.00	83.33	5	4	3	2.00	66.66
Px. Radius/ulna	0.81	16	8	7	4.00	66.66	6	4	3	2.00	66.66
Radius/ulna shaft	1.3	38	10	5	5.00	83.33	12	3	2	1.50	50
Ds. Radius/ulna	0.72	11	6	5	3.00	50	4	3	2	1.50	50
Cuneiform	0.71	–	–	–	–	–	–	–	–	–	–
Scafoid	0.71	1	1	1	0.50	8.33	2	2	1	1.00	33.33
Lunar	0.71	3	3	2	1.50	25	2	2	1	1.00	33.33
Magnum	0.71	–	–	–	–	–	1	1	1	0.50	16.66
Pisiform	0.71	–	–	–	–	–	–	–	–	–	–
Trapezoid	0.71	–	–	–	–	–	–	–	–	–	–
Unciform	0.71	2	2	2	1.00	16.66	5	5	4	2.50	83.33
Px. metacarpal	0.98	11	7	2	3.50	58.33	6	5	4	2.50	83.33
Pelvis	(no data)	1	1	1	0.50	8.33	6	3	2	1.50	50
Px. femur	0.62	7	4	3	2.00	33.33	3	3	2	1.50	50
Femur shaft	1.15	22	9	6	4.50	75	13	2	1	1.0	33.33
Ds. Femur	0.48	1	1	1	0.50	8.33	3	3	2	1.50	50
Patella	0.58	1	1	1	0.50	8.33	1	1	1	0.50	16.66
Px. tibia	0.55	17	8	4	4.00	66.66	8	3	2	1.50	50
Tibia shaft	1.3	44	12	9	6.00	100	37	5	3	2.50	83.33
Ds. tibia	0.82	4	3	2	1.50	25	2	2	2	1.00	33.33
Astragalus	0.79	4	4	3	2.00	33.33	6	6	3	3.00	100
Calcaneus	0.85	5	4	2	2.00	33.33	3	3	2	1.50	50
1° Tarsal	(no data)	–	–	–	–	–	–	–	–	–	–
Cuboid	(no data)	3	3	2	1.50	25	4	4	3	2.00	66.66
Ento cuneiform	(no data)	4	4	3	2.00	33.33	3	3	2	1.50	50
Navicular	(no data)	5	5	4	2.50	41.66	1	1	1	0.50	16.66
Fibulare	(no data)	1	1	1	0.50	8.33	3	3	2	1.50	50
Sesamoid	(no data)	4	4	1	0.25	4.16	–	–	–	–	–
Px. Metatarsal	0.93	15	12	5	6.00	100	6	6	3	3.00	100
Px. Metapodial	0.955	1	1	1	0.25	4.16	–	–	–	_	–
Metapodial shaft	1.275	62	8	4	2.00	33.33	82	9	3	2.25	75
Ds. Metapodial	0.8	16	7	4	1.75	29.16	23	7	3	1.75	58.33
1° Phalange	0.95	29	14	3	1.75	29.16	15	8	2	1.00	33.33
2° Phalange	0.56	12	12	3	1.50	25	6	6	1	0.75	25
3° Phalange	(no data)	–	–	–	–	–	1	1	1	0.13	4.33
Phalange indet.	–	1	–	–	–	–	1	–	–	–	–
Back Tooth indet.	–	15	–	–	–	–	7	–	–	–	–
Incisor/canine tooth	–	11	–	–	–	–	1	–	–	–	–
Vertebra indet.	–	–	–	–	–	–	1	–	–	–	–

zigzag forms over the bone surface, with dendrite designs and heterogeneous coloration in the channels (Fig. 4a).

Rodent action was recorded in specimens from both chambers, more frequent in the NC (4.5%) than in the SC (3.1%) (Fig. 4a). Carnivore marks show very low frequencies (<1%) in both chambers

Table 3
Results of correlations among Meat Utility Index, Bone Mineral Density, and %MAU for *L. guanicoe* in NC and SC (Maripe Cave site).

	NC	SC
%MAU–Meat Utility Index (Borrero, 1990)	rs = 0.221; p > 0.05	rs = 0.036; p > 0.05
%MAU–Utility Index (Lyman, 1992)	rs = 0.195; p > 0.05	rs = 0.036; p > 0.05
%MAU–BMD (Elkin, 1995)	rs = 0.515; p < 0.05	rs = 0.466; p < 0.05

(Fig. 4a). Carbonate deposits were identified in 3.2% of the specimens of the SC, and in the NC it does not reach 1% of NISP (Fig. 4a). Generally, they cover small areas of specimen surfaces and appear in cortical and marrow cavity surfaces. In both chambers, some bones were assigned to the "dark indeterminate" category, with a percentage of about 6.5% of NISP in the NC and 30.2% in the SC.

The modifications attributable to human action included different marks related to the butchering and reduction of carcasses. Cutmarks are the most plentiful in both chambers, 19.8% of NISP in the NC and 8.9% of NISP in the SC. Also recorded were 10.5% of specimens which exhibit a longitudinal mark patterns associated with fracture edges in long bones, which are concordant with scraping marks. In the NC, impact points show high frequencies (7.9%) and percussion marks were identified in 3.5% of NISP. In the SC, impact point frequency occur in 7.6%, scraping
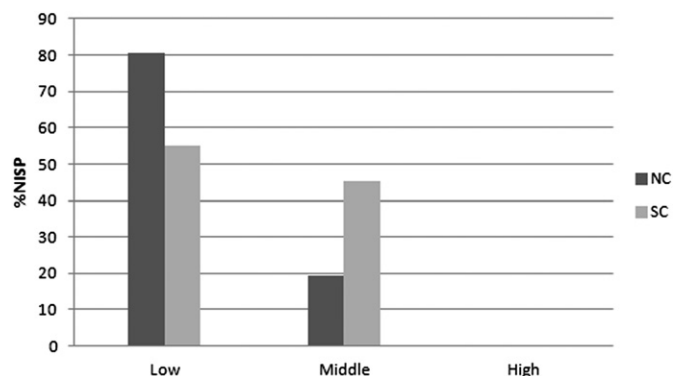
Fig. 3. Weathering profile in the NC and the SC in Maripe Cave site. Frequency of shaft long bones is expressed in %NISP.

marks 5.7% and percussion marks 1.5% of the specimens. The analysis of intentional fractures shows very high frequencies in the NC (68.1%) and in the SC (66.8%) (Fig. 4b).

Thermal alteration is less dependably attributed to human agency. Bone fragments from both chambers have different levels of burning that affected them partial or totally. The trend shows a higher frequency of heat-modified specimens in the SC (40.7%) than in the NC (20.27%) (Fig. 4b).

A chi-square test evaluated the existence of a differential record of natural/cultural traces between chambers. The contingency table (Table A.3) was built considering the two areas of the site and the frequency of specimens with traces of natural (rodent, carnivores,
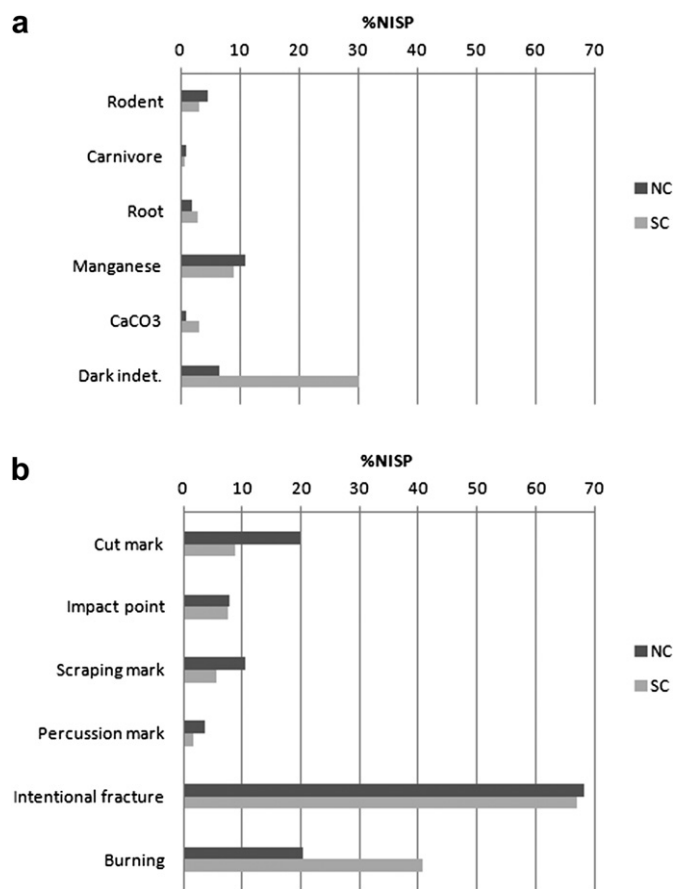

Fig. 4. Natural (a) and cultural (b) modifications in bone specimen in Maripe Cave. Frequency expressed in %NISP.

roots, manganese oxides and carbonates) and cultural processes (cut marks, impact points, scraping and percussion marks). The result ($p = 0.00859 < 0.05$) indicates that the difference of natural and cultural modifications frequencies between chambers is statistically significant.

5. Discussion and conclusions

The studies presented here allowed recognition of a set of differences between the assemblages from both chambers. The taxonomic abundance analysis made in Maripe Cave Site shows that, although early chronologies were registered, the presence of extinct fauna was not recorded. This situation differs from other studied sites of the region with similar chronologies and associated extinct fauna (Miotti et al., 1999; Miotti, 2003; Miotti and Salemme, 2005; Paunero et al., 2007a, 2007b; Marchionni and Vázquez, 2010).

The importance of *L. guanicoe* as an economic resource for hunter−gatherer groups that occupied Argentine Patagonia since Pleistocene−Holocene transition to late Holocene was widely tested in most archaeological sites (Miotti, 1998; Mengoni Goñalons, 1999; Miotti et al., 1999; Aguerre and Pagano, 2003; Durán et al., 2003; De Nigris, 2004; Paunero et al., 2007a; Rindel, 2008; Miotti and Marchionni, 2009; Frank, 2011; among others). The high frequency of *L. guanicoe* specimens in Maripe Cave site seems to indicate that this resource was very important for the human groups that occupied the site. However, this situation should be tested in the future when the temporal resolution of both chambers is established. The bone elements corresponding to both axial and appendicular skeletons of guanaco are represented in both chambers and their frequencies did not record significant statistical differences between the two areas.

Results from correlations made between %MAU, BMD (Elkin, 1995) and utility indexes (Borrero, 1990; Lyman, 1992) indicate both sets are lag deposits (Lyman, 1994). The assemblages do not reflect human decisions in the selection of parts with high economic values. Both assemblages seem to be result of density-mediated destruction processes. However, considering the results of weathering trends and bone modification analysis, another possible interpretation exists.

The weathering trend in NC show that most specimens exhibit low weathering stages (0 and 1). Weathering in the SC is higher and shows a trend with similar specimen percentages in low and middle stages. The differences observed between weathered specimens from both chambers agree with the expectations of higher weathering in the SC and less exposure time in the NC. The incidence of meteorological factors (higher exposure to the sun and higher moisture) is greater in the SC than in the NC. Furthermore, the differences registered in sedimentation rates (lower in the SC that in the NC) suggest a faster burial of materials in the NC than in the SC.

Considering the weathering trends, NC should have better assemblage preservation than SC. The presence in NC of elements as sternebrae, vertebrae and sacrum indicates that, if the destruction processes mediated by density had been intense, these elements would not have survived. The representation of anatomical units with high BMD and low economic value in the NC would be the result of past human choices related with transport, processing and consumption of carcasses.

The Drying Utility Index (Indice de Secado de Carne) proposed by De Nigris and Mengoni Goñalons (2004), allows interpretation of the absence in the archaeological record of some parts that could be dried for deferred consumption: ribs, sternebrae, and vertebrae. On the other hand, the high frequency of low economic value parts can be interpreted as the result of additions associated with high

economic value parts (Perkins and Daly, 1968). These frequencies can also be explained by the importance of tendons, cartilaginous tissue and the use of bone to make tools (Lyman, 1994, p. 225). Morín (2007) emphasizes the importance of these units in relation to high oleic acid content, which makes their fats easier to digest.

The number of agents and processes that could act over the assemblage to deteriorate the bone surfaces is related with the time of exposure to atmospheric conditions. The large amount of human modifications quantified on cortical surfaces of specimens, mainly those related to the processing and reduction of carcasses, should have disappeared if these processes (weathering, carnivore gnawing) acted strongly on the assemblage. The same could have happened if the processes that act mainly post-depositionally (roots, rodents) were strong.

Among natural modifications, staining by manganese oxides seems to have mostly affected specimens in both sets. In the SC, its frequency could be explained by the contribution of water from the still active spring at the bottom of this sector, which is also responsible for the constant moisture of sediments. However, the frequency of specimens with manganese stains in the NC is higher than in the SC, although the NC is currently the driest area of the cave. In this chamber, a collapse of the roof was recorded which could be result of the erosion caused by ancient spring activity, and in the stratigraphic section were layers of gravels with washed fine matrix (Rabassa et al., 2007). This evidence could indicate the possibility that spring water has affected the NC bone assemblage in the past. The high frequency in which these modifications occur leads to questions as to when the spring could have been active and whether its activity was continuous or intermittent, which will be investigated in the future.

Other modifications produced by natural agents or processes were identified in lower proportions. Carbonate deposits on bone surfaces indicates precipitation of soluble salts. Their greater frequency in the SC could be related to the incipient pedogenetic process which favours the dissolution of carbonates. The highest frequency of root traces in the SC could also be explained by this process. Carnivore action is very low in both sectors, so its role as an accumulator/disperser agent would not have been significant in the assemblage configuration. Furthermore, although the action of rodents has been recorded in higher percentages than carnivores, it occurs in very low frequencies.

The high frequency of human processing marks would indicate that the assemblages from both areas have been, in the first place, results of human action. The action of others agents and processes may play a secondary role in their configuration. In this sense, modification produced by heat in the SC is double the frequency registered in the NC, which could reflect different uses of space inside the cave. Considering these statements and according to the evidence presented, the two sub-samples of the Maripe Cave site were affected by different natural and cultural processes.

In addition to the characteristics and features described in the stratigraphic sequence of SC, the differential record of natural and cultural modifications in this sector shows a more complex depositional and post-depositional history than in the NC. This is mainly related with the existence of a compressed sequence, where the exposure times of materials (>weathering, <sedimentation rate) were higher than in NC. The high percentage of darkened specimens whose causal agent could not be inferred is another of the features which demonstrate the complexity of this sector.

Water could have been another important agent in the formation of both sets. However, the information presented about different trends of weathering, the representation of anatomical units, sedimentation rates and the high frequency of butchering marks, indicate that the set from NC shows higher integrity than that of SC.

On an extra-regional level, the literature on taphonomic analysis of intrasite variability in cave environments is scarce and, in Argentinean Patagonia, refers to the work done by Barberena (2008). This author made comparative analyses between two zooarchaeological sets from Condor 1 cave (Pali Aike volcanic area, Santa Cruz), each recovered in a different sector of the cave (opening and bottom). The interior set has more integrity than the one from the opening of the cave. Borrero and Martin (2011) addressed this problem in the Milodon Cave site (Chile). The preservation of the material decreases from south to north in the interior of the site.

The environmental and stratigraphic peculiarities inherent to the caves (Farrand, 1985) result in very different study situations at intra- and intersite scales, so the understanding of conditions and agents that intervene in the formation of the archaeological sets is of relevance. The evaluation of accumulation factors and bone modifications of archaeofaunistic sets allows the assessment of potential preservation of sets and, based on this, deduction of living conditions and differential use of space at different scales.

Appendix

Table A.1

Contingency table used in the statistical analysis of differential representation of anatomical parts of axial and appendicular skeletons of guanaco, based on the sum of MNE values (Table 2) obtained for each anatomical element of the skeleton where they are located (axial and appendicular).

MNE	North chamber	South chamber
Axial	60	23
Appendicular	180	117

Table A.2

Contingency table used for the statistical analysis of weathering. Guanaco long bone specimens (NISP of long bones) exhibit different weathering stages.

Weathering	North chamber	South chamber
Low	129	28
Middle	31	23

Table A.3

Contingency table to compare frequencies of natural (rodents, carnivores, roots, manganese oxides and carbonates) and cultural (cut marks, impact point, scraping and percussion marks) modifications between chambers. These values result from the addition of times in which some of those modifications were registered on guanaco specimen surfaces.

Modification	North chamber	South chamber
Natural	95	59
Cultural	211	75

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