



Exploitation of faunal resources by hunter-gatherers in the center of the Pampa grasslands during the Holocene: The archaeofauna of the Laguna Cabeza de Buey 2 site (San Carlos de Bolivar, Buenos Aires, Argentina)



Nahuel A. Scheifler, Pablo G. Messineo*

INCUAPA-CONICET, Facultad de Ciencias Sociales, Universidad Nacional del Centro de la Provincia de Buenos Aires, Avenida del Valle 5737, B7400JWI, Olavarría, Buenos Aires, Argentina

ARTICLE INFO

Article history:

Available online 28 September 2015

Keywords:

Hunter-gatherers
Zooarchaeology
Subsistence
Pampa grasslands
Middle/Late Holocene

ABSTRACT

The purpose of this paper is to present a detailed zooarchaeological study conducted on the bone assemblage from the Laguna Cabeza de Buey 2 site, located on the margins of a small shallow lake in the center of the Pampa grasslands (province of Buenos Aires, Argentina). Taxonomic structure, taphonomic information, site formation processes, and subsistence strategies for different occupation events are described and discussed. At least three events of pre-Hispanic occupation (two in the Middle Holocene [6800 and 4150 14C years BP] and one in the Late Holocene) and one in Historical moments were identified. Human occupations are developed in relation to a shallow lake under a climate more arid during the Middle Holocene, which decreased up to the current environmental conditions; humid temperate. The camelid *Lama guanicoe* (guanaco) was always the most important economic resource during the three events of human occupation in the Holocene, followed by *Ozotoceros bezoarticus* (pampean deer) and, to a lesser extent, by three species of small armadillos (*Chaetophractus* sp., *Zaedyus pichiy*, and *Tolypeutes matacus*). In Historical times, modern domestic faunal remains (*Equus caballus* and *Bos taurus*) were exploited. A subsistence strategy focused on artiodactyls, mainly guanaco, allows suggesting certain specialization through time in the exploitation of animal resources by hunter-gatherer groups in the center of the Pampa grasslands, strategy that contrasts with what is recorded in other areas of the Pampean region.

© 2015 Elsevier Ltd and INQUA. All rights reserved.

1. Introduction

The current zooarchaeological record of the Pampa grasslands has a broad chronological and spatial distribution. Research of the economy of hunter-gatherers has made remarkable advances in some areas (e.g., Interserrana, Tandilia, North, South, and Salado Depression) of the Pampean region due to the increase in the number of sites investigated and the consequent generation of faunal data in the last three decades (e.g., Quintana and Mazzanti, 2001; Martínez and Gutiérrez, 2004; González, 2005;

Acosta et al., 2010; Stoessel, 2012; Frontini, 2013; Álvarez, 2014a). At the same time, zooarchaeological studies in some areas of this region (e.g., west) have had little development as a result of the lack of systematic research (see exceptions in Politis et al., 2012; Álvarez, 2014b). Recently, we conducted an excavation at the Laguna Cabeza de Buey 2, a multi-component archaeological site located in the western Pampean region of Argentina.

In this paper, we present the results of taxonomic and taphonomic analysis carried out on the skeletal faunal assemblage recovered for diverse events of human occupations at the Laguna Cabeza de Buey 2 site. The main objective is to evaluate the exploitation of faunal resources for understanding the subsistence strategies in the West area of the Pampa grasslands during the Holocene. To achieve this aim, we evaluated the taphonomic

* Corresponding author.

E-mail addresses: nscheifler@soc.unicen.edu.ar (N.A. Scheifler), pmessine@soc.unicen.edu.ar (P.G. Messineo).

processes and agents that modified the bone assemblage. Also, we conducted the paleoenvironmental study based on the taphonomic and taxonomic information of the site, together with different proxy data (pollen, sedimentology, and geomorphology) from diverse records, for understanding the environmental scenarios and their relationship with the adaptive strategies implemented by hunter-gatherers at the Laguna Cabeza de Buey 2 site. Finally, we compare the zooarchaeology information generated in this paper with other archaeological contexts located in different areas of the Pampa grasslands of Argentina in order to highlight geographical and chronological variation in the exploitation of faunal resources during the Holocene.

2. Regional setting

The Pampean region, an extensive flat to gently undulating landscape, is located in the eastern part of Argentina between 30° and 39° S. This vast plain is distinguished by a humid temperate prairie covered by grass (Soriano et al., 1992). This region is characterized by an east-west moisture gradient and increasing continentality towards the northwest. Average temperatures in the northeast are between 24 °C in summer (January–February) and 10 °C in winter (July–August), whereas in the southwest for the same months the average is between 20 °C and 7 °C. Precipitation is highly seasonal with two well-defined rainy seasons, spring and fall. The annual total rainfall increases towards the east from ca. 400 mm in the southwest to 1000 mm or more in the northeast (Burgos, 1968).

The most conspicuous terrestrial vertebrate (excluding the livestock) living in the open grasslands are micromammals

(<1 kg) and small mammals (between 1 kg and 20 kg). Among the former are the cricetid rodents (e.g., *Holochilus brasiliensis*, *Reithrodon auritus*, *Akodon azarae*, and *Calomys musculus*), the caviomorph rodents (e.g., *Galea leucoblephara*, *Microcavia australis*, *Cavia aperea*, and *Ctenomys* sp.), and the didelphid marsupials (Massoia et al., 2000; Gómez Villafaña et al., 2005; Pardiñas et al., 2010). With respect to small mammals are caviomorph rodents (e.g., *Lagostomus maximus* and *Myocastor coypus*), armadillos (e.g., *Chaetophractus villosus*, *Dasybus hybridus*, and *Zaedyus pichiy*), and carnivores (e.g., *Leopardus geoffroyi*, *Lycalopex gymnocercus*, and *Conepatus chinga*) (Redford and Eisenberg, 1992). Today, some medium and large native mammals (>20 kg), such as guanaco (*Lama guanicoe*), pampean deer (*Ozotoceros bezoarticus*), and puma (*Puma concolor*), are absent in most of the region, although they were common in the Holocene (see Martínez and Gutiérrez, 2004; Politis et al., 2011). Also, there is a large number of small birds (<20 kg), the major species belonging to the Tinamidae (tinamous), Anatidae (ducks and swans), Rallidae (coots, moorhens, and burritos), Podicipedidae (grebes), and Ardeidae (herons) Families (Darrieu and Camperi, 2001). In addition, there is a large flightless bird, the Greater rhea (*Rhea americana*).

Laguna Cabeza de Buey is located in the West area of the Humid Pampas sub-region (Politis and Barros, 2006; Fig. 1) and it is a semi-permanent shallow lake constituted by an elongated interdune depression, which is surrounded by fixed sand dunes. This shallow lake is situated on the eastern border of the aeolian unit called by Zárate and Tripaldi (2012) the Central Pampean Dunefield, which was characterized on the basis of its geomorphological features and the geological and structural settings. The main landforms in the

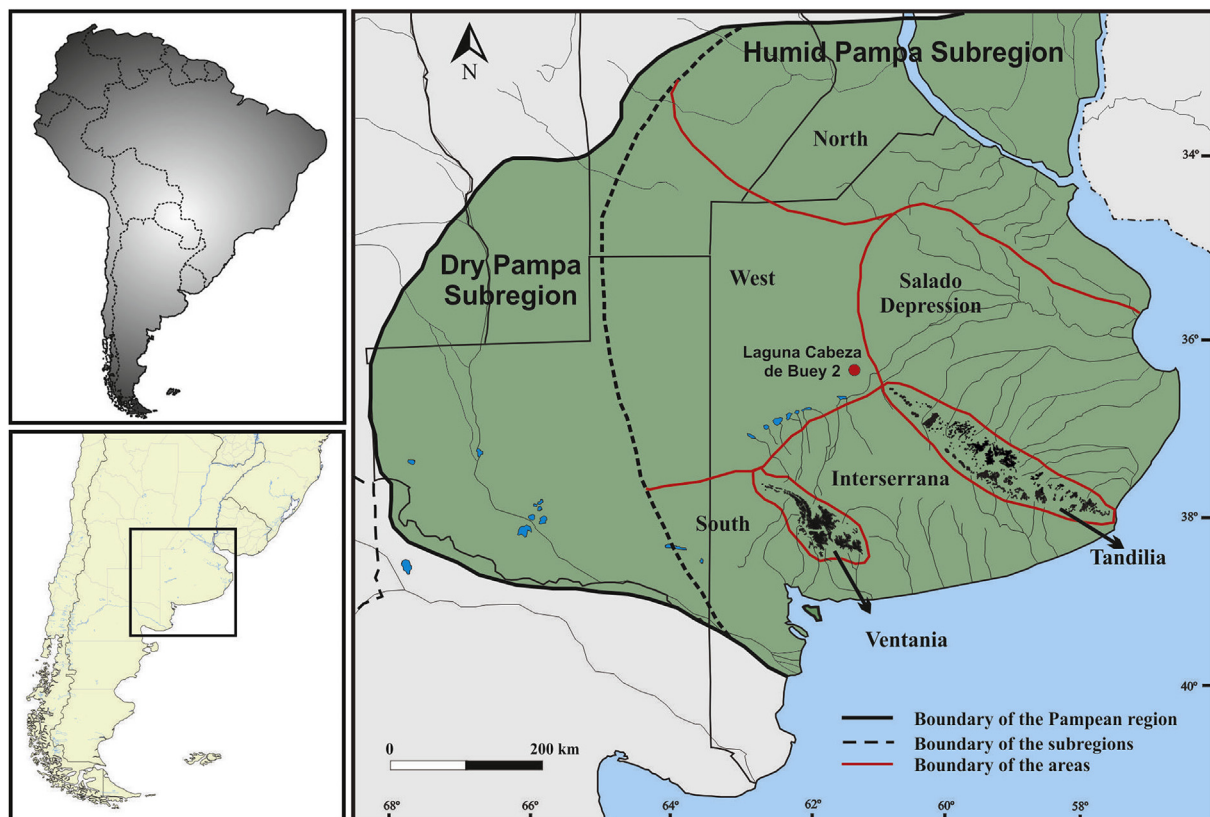


Fig. 1. Map showing the Pampean region and the location of the Laguna Cabeza de Buey 2 site in the West area (Argentina).

Central Pampean Dunefield are linear dunes, 100–130 km long and 2–3 km wide, with a general north-northeast trend and a relative relief of around 2 m. Dune orientations suggest paleowinds from the southwest quadrant (Iriondo, 1999; Zárate and Tripaldi, 2012) and the occurrence of megafauna fossil remains at the lower section of a dune in western of the Pampean dunefield was used to infer active aeolian accumulation during the Late Pleistocene (Montalvo et al., 2013). Kruck et al. (2011) used remote sensing data and physical age determinations (luminescence) of sands to reconstruct the climatic history of the Pampa plains. They concluded that the strength of the westerly winds was larger in the Pleistocene than in the Holocene. Also, dunes are markers for an intensification of aridity between 8500 and 3500 BP accompanied by occasional sporadic torrential rainfalls in the Middle Holocene.

3. Previous studies on faunal exploitation in the Pampa grasslands

For the Pampean region of Argentina, a generalized regional economy based on a wide-ranging diet and a broad spectrum of resource exploitation has been proposed for the Late Pleistocene and Early Holocene period (ca. 12200–7000 ¹⁴C BP) (Miotti and Salemme, 1999; Quintana and Mazzanti, 2001; Martínez and Gutiérrez, 2004; Politis and Messineo, 2008). Previous research by Gutiérrez and Martínez (2008) suggested that the subsistence was mainly focused on artiodactyls (guanaco and deer), followed by small mammals and birds. Furthermore, the role of megamammals was marginal: they were not intensively and systematically hunted and/or scavenged.

At the end of the Early Holocene period (ca. 7000 ¹⁴C BP), pampean hunter-gatherers began to exploit marine vertebrate (e.g., fishes and pinnipeds) and to occupy, at least seasonally, the western Atlantic coast (Bonomo and León, 2010; Bayón et al., 2012; Blasi et al., 2013). Although the subsistence strategy changed from a generalist to specialist on artiodactyls animals during the Early Holocene, the archaeological records of the Pampas show some continuity in the consumption of a wide variety of species. The Middle Holocene (between 6500 and 3500 ¹⁴C BP) has been characterized by a specialized regional economy (Martínez and Gutiérrez, 2004) with an emphasis on guanaco hunting. New information indicates that this period was not homogenous. Some researchers suggest that during the first part of the Middle Holocene the subsistence strategy was similar to the Early Holocene, whereas in the last part of the Middle Holocene, the animal diet was focused on artiodactyls toward specialization in guanaco hunting strategy (Frontini, 2013; Álvarez, 2014a).

During the Late Holocene (last 3500 ¹⁴C BP), a diversification and intensification of areal economies was postulated (Martínez and Gutiérrez, 2004), with an increase in the use of small, medium, and large prey (Quintana and Mazzanti, 2001; González, 2005; Acosta et al., 2010; Stoessel and Martínez, 2014; Alcaráz, 2015). For this period, Politis and Barros (2006) proposed three main subsistence strategies among hunter-gatherers in the pampas: exploitation of the xerophitic forest in the Dry Pampas sub-region, exploitation of rivers and lagoons in the northeastern of the Humid Pampas sub-region (north and Salado Depression areas), and exploitation of the open grasslands in the Interserrana and Tandilia areas. In this last strategy, the guanaco was the main faunal resource (e.g., meat, leather, bone, and other products), but also pampean deer, armadillo, and rhea were consumed (Politis, 2008). Recent zooarchaeological investigations support this characterization (Frontini, 2013; Álvarez, 2014a).

4. Archaeology at the Cabeza de Buey site

4.1. Background

The only previous research in Cabeza de Buey shallow lake is the investigation carried out by Marcelo Bórmida in the late 1950s. First, he studied the archaeological collection that had been gathered from various lakes by the amateur Dr. Pedro Vignau, which was composed exclusively of lithic materials, mainly knapping tools. Under the Vienna culture historical school of ethnography, Bórmida defined two lithic industries (or *Kulturkreis*) called Blancagrandense and Bolivarense. In general, these industries are explained through the diffusion of materials as a result of the influence of different cultures that arrived at the central sector of the Pampa grasslands (Bórmida, 1960; Madrazo, 1973, 1979).

Subsequently, in 1960 this researcher visited the Cabeza de Buey shallow lake and identified two archaeological sites, one in the northwest and the other in the northeast sector (Fig. 2a). He conducted an excavation of 30 square meters at the edge of the dune in the site N° 2 (Fig. 2b). In the course of his excavations, Bórmida (1960) identified five geologic levels, although most of the findings (fragments of pottery, mineral pigments, lithic tools, and faunal bones) came from the top of Layer III. This deposit was associated with human occupation events in the last part of the Late Holocene and during the conquest.

Among the faunal bone remains recovered at the site, Bórmida (1960) identified different species, mainly bones of the native artiodactyls *Lama guanicoe* (Layers V and III), the rodent *Ctenomys* sp. (Layer III), and modern domestic animals such as cow and horse (Layers III, II, and I). However, in relation to the bone remains this researcher did not make any particular study, and only mentioned that some guanaco bones from the lower Layer V were mineralized (Bórmida, 1960, p. 221).

4.2. Recent investigations

From 2011 and during three field seasons, we conducted the excavation of an area of 8 square meters in the Laguna Cabeza de Buey 2 archaeological site (36°17'32.5"S and 61°11'20.1"W; Fig. 2b–c), which allowed us to recover diverse cultural elements, such as lithic materials (tools and debitage), pigments, charcoals, and few fragments of pottery (this last in the upper levels). Associated with these remains, bone and teeth fragments corresponding to several extant and extinct species were found (Messineo and Scheifler, in press).

Excavation revealed five major stratigraphic units (Fig. 3). The lower unit (SU-V) is culturally sterile and is possibly associated with Late Pleistocene and Early Holocene times. The textural analysis of this unit indicates a loamy sand deposit with the highest proportion of calcium carbonate (4.62%) compared to the rest of the units. The SU-IV (between 90 and 120 cm) is grayish brown and compact. The texture of the sediment is between a loamy sand and sandy loam. In this unit we recognized the earliest event of human occupation at the Laguna Cabeza de Buey 2 site. A radiocarbon date from a piece of charcoal yielded an age of 6801 ± 48 ¹⁴C BP (7560–7687 cal BP; AA-104106).

The stratigraphic Unit III (SU-III), between 50 and 90 cm, is grayish brown and has a low frequency of roots. The textural analysis shows a sandy loam deposit, with the lowest value of sand (~63%) and the highest silt (~33%) compared to the rest of the units. Clay is subordinate in all the stratigraphic units. From this unit, a *Lama guanicoe* bone with human modifications (cut-marks) gave an age of 4150 ± 42 ¹⁴C BP (4511–4729 cal BP; AA-100947), representing the second event of human occupation in the site.

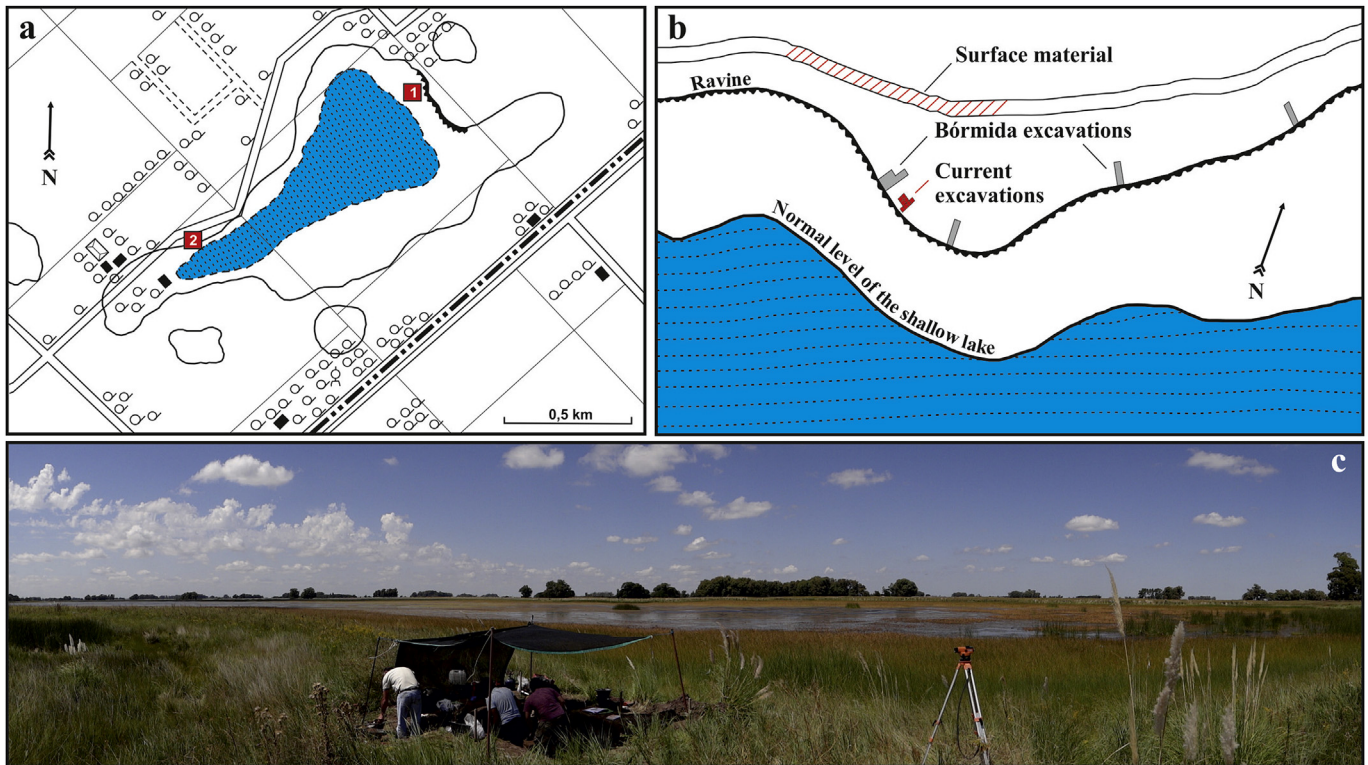


Fig. 2. Map showing the location of two archaeological sites identified by Bórmida in 1960 (a); location of the old and modern excavations at the Laguna Cabeza de Buey 2 (b); View of the modern excavation and the shallow lake environment (c).

Above, between 30 and 50 cm, we identified stratigraphic unit II (SU-II), which corresponds to an A horizon of a buried soil (Ab1). This unit is gray and less compact than SU-I. In the upper section of the sequence (from the surface up to 30 cm) we recognized stratigraphic unit I (SU-I), which is interpreted as an A horizon of soil of incipient formation (modern soil). This unit is dark gray and compact. The textural analysis shows that both units are formed by a loamy sand deposit which was modified by pedogenesis. The highest percentages of organic matter are recognized in the top of the profile (3.97% in SU-I and 2.46% in SU-II). No radiocarbon dates were obtained from these units. However, the presence of pottery in the SU-II locates this unit in the Late Holocene (last 3000 years), prior to the conquest. Finally, SU-I is linked to Historical times given the presence of introduced species, such as horse and cow, during the European conquest.

5. Materials and methods

The faunal assemblage is comprised of 86081 skeletal remains and 13 fragments of undetermined eggshell. From this sample, 222 specimens were recovered during the excavation (tridimensional record) and the remaining 85859 by water-screening (fine mash: 2 mm). The excavation was carried through artificial layers of 5 cm each with respect to the zero level.

The faunal remains were classified according to different taxonomic and anatomical level categories. For this study we use reference material deposited in the Taxonomic Comparative Collection pertaining to the laboratory of Investigaciones Arqueológicas y Paleontológicas del Cuaternario Pampeano, Facultad de Ciencias Sociales (INCUAPA-CONICET/FACSO-UNICEN) and bibliographical inquiries (e.g., Vizcaíno et al., 1995; Hillson, 2005;

Kaufmann, 2009). Zooarchaeological quantitative analyses were applied to the assemblage for identifying the taxonomic and anatomical abundances, such as NISP (number of identifiable specimens), MNE (minimum number of elements), and MNI (minimum number of individuals) (Binford, 1978; Grayson, 1984; Klein and Cruz Uribe, 1984; Lyman, 2008). In this work we utilized five body-size categories for the faunal assemblage: micro vertebrates (<1 kg), small vertebrates (from 1 kg to 20 kg); medium vertebrates (from 20 kg to 100 kg), large vertebrates (from 100 kg to 1000 kg), and megamammal (>1000 kg).

Taphonomic analysis was conducted in order to study the agents and processes (natural and/or cultural) which acted in the formation of the site. Different taphonomic variables were used to assess bone modifications recorded on the specimens: cut marks, thermal alteration, carnivore marks, digestive corrosion, weathering, sedimentary abrasion, rodent marks, root marks, chemical dissolution, type of fracture, and deposition of manganese, iron oxide, and calcium carbonate (Behrensmeier, 1978; Binford, 1981; Johnson, 1985; Andrews, 1990; Fernández-Jalvo and Andrews, 1992; Lyman, 1994; Gutiérrez, 2004; Gutiérrez and Kaufmann, 2007; Frontini and Vecchi, 2014). On armadillo plates, we only evaluated the presence of anthropic modifications.

The taxonomic study allows achieving different levels of determination for 8131 remains (NISP), corresponding mostly to micro and small vertebrates (97.8%) and, to a lesser extent, medium, large, and megamammal (2.2%). Among the undetermined remains (N = 77,950), the highest frequency corresponds to fragments smaller than 4 cm in length (99.9%). In this paper, we present detailed taxonomic and taphonomic information obtained from the analysis of all the remains from the excavation and a sample of

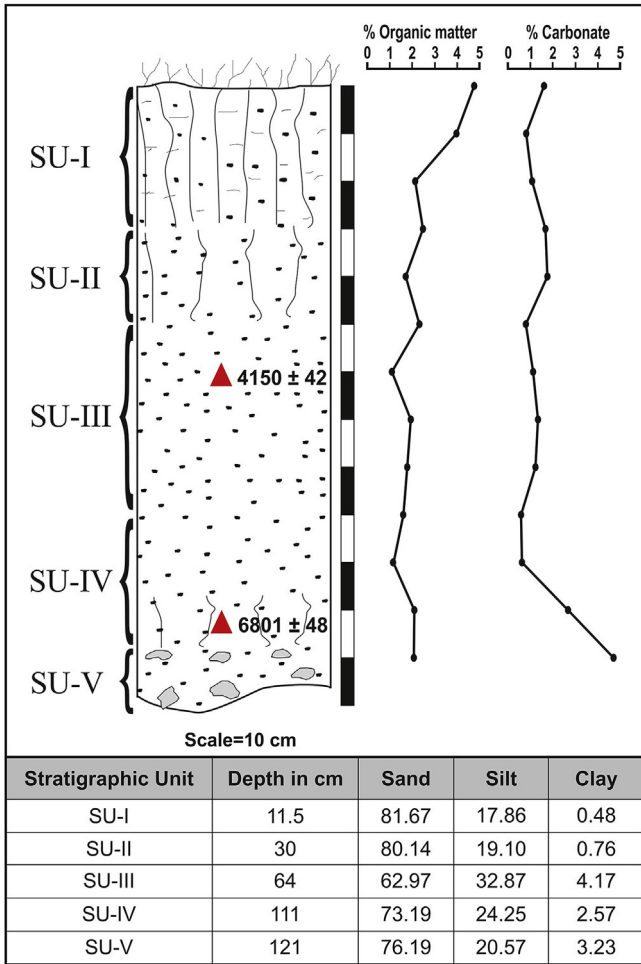


Fig. 3. Stratigraphic profile at the Laguna Cabeza de Buey 2 site and location of radiocarbon dates.

materials from water-screened, which include all the armadillo remains (N = 248) and rodent molars (*in situ* and isolated, N = 569).

6. Results

6.1. Taxonomic structure

The medium and large archaeofaunal assemblage in the three pre-Hispanic units (Middle and Late Holocene) is dominated by skeletal remains of two native artiodactyls, the camelid *Lama guanicoe* (SU-V = 1; SU-IV = 12; SU-III = 29; SU-II = 4) and the pampean deer *Ozotoceros bezoarticus* (SU-IV = 2; SU-III = 7; SU-II = 7). *Lama guanicoe* is recorded continuously from the middle part of the SU-IV up to SU-II, whereas *Ozotoceros bezoarticus* appears in the sequence intermittently from the top of SU-IV up to SU-II (Table 1). In a transitional zone between SU-V and SU-IV, two complete bone elements of an extinct megamammal were found, one of which corresponds to a second phalanx of *Toxodon* sp. (SU-IV), and the other to a sesamoid (SU-V) corresponding possibly to the same species. In SU-II, the only bone remains of *Rhea* sp., a shaft of femur, was recorded. SU-I (Historical times) shows remains of domestic megamammals *Equus caballus* (NISP = 7) and *Bos taurus* (NISP = 2).

Table 1

Stratigraphic unit (depth from level 0)	<i>Toxodon</i> sp.***	<i>Bos taurus</i> ***	<i>Equus caballus</i> ***	<i>Lama guanicoe</i> ****	<i>Ozotoceros bezoarticus</i> ***	<i>Chaetophracas pichiy</i> *	<i>Zaedyus hybridus</i> **	<i>Dasyus maximus</i> **	<i>Cenomyia azarae</i> **	<i>Alakodon auritus</i> **	<i>Rathiron</i> sp.***	<i>Holochilus brasiliensis</i> **	<i>Necromys simplex</i> **	<i>Pseudoryzomys rhea</i> sp.***	<i>Dendrocygna</i> sp.***			
SU-I	1	5	4	4	4	4	4	4	4	4	4	4	4	4	4			
SU-II	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
SU-III	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
SU-IV	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
SU-V	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Total	2	7	46	108	66	8	1	2	405	1	13	31	7	20	2	7	1	5

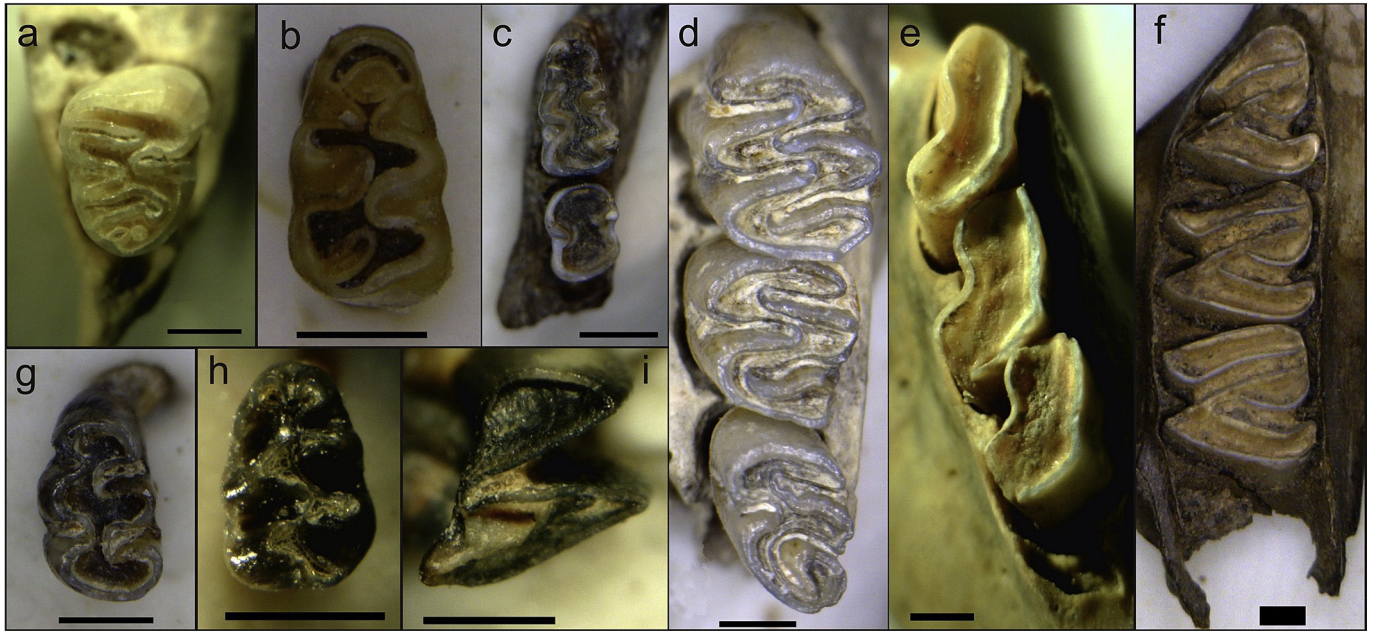


Fig. 4. Upper (M) and lower (m) molar series and isolated molars in occlusal views of rodent from the Laguna Cabeza de Buey 2 site: (a) *Holochilus brasiliensis*, right M3 *in situ* (B.LCB2.1014); (b) *Pseudoryzomys simplex*, right m1 (B.LCB2.1567); (c) *Akodon azarae*, left mandible (B.LCB2.1288); (d) *Reithrodon auritus*, left maxillary (B.LCB2.1015); (e) *Ctenomys* sp., right mandible (B.LCB2.1024); (f) *Cavia aperea*, left mandible (B.LCB2.72); (g) *Necomys* sp., left M1 (B.LCB2.1019); (h) *Calomys* sp., left m1 (B.LCB2.1032); (i) *Galea leucoblephara*, right M1 (B.LCB2.1186). Scale = 1 mm.

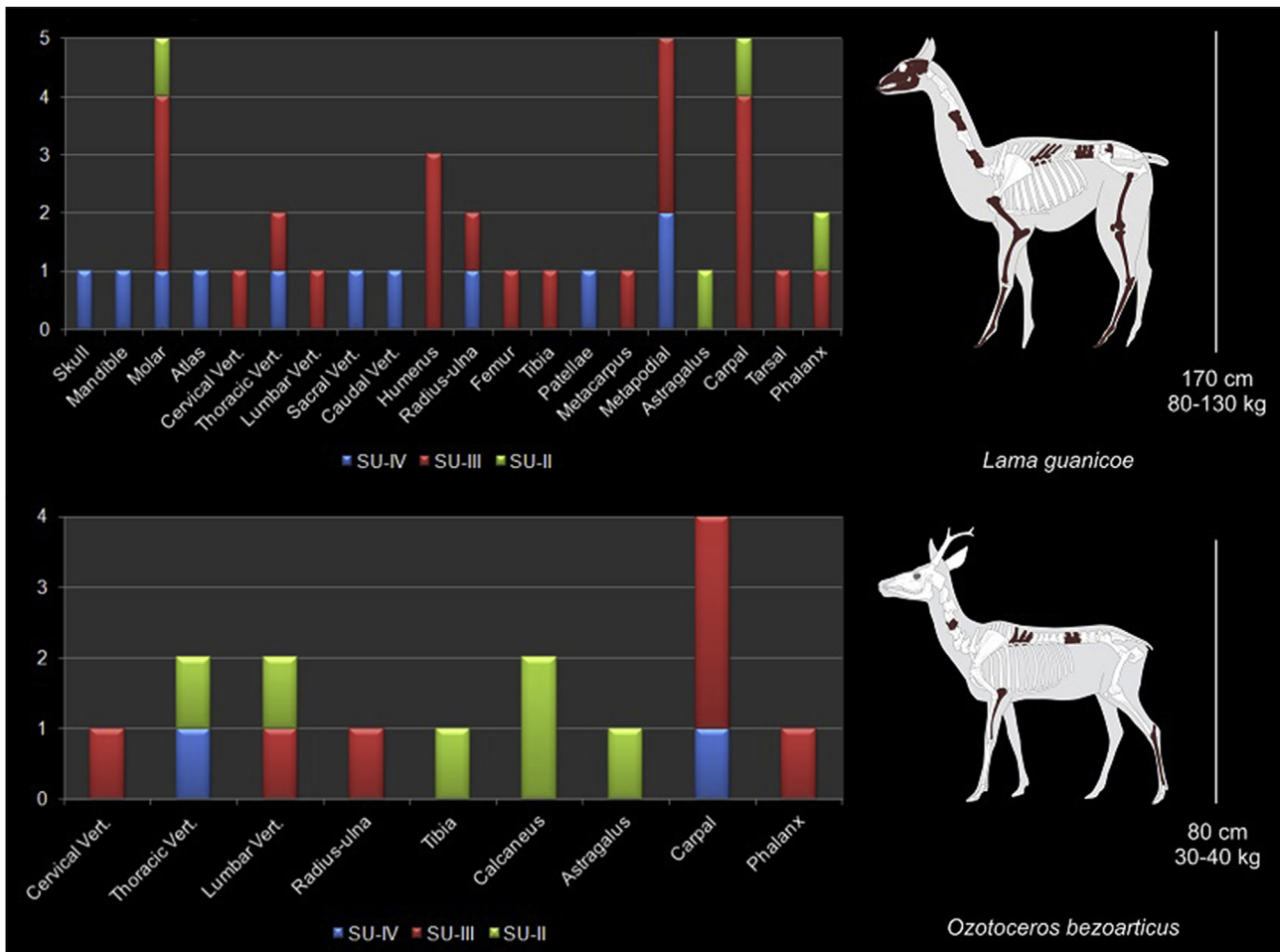


Fig. 5. Anatomical representation of *Lama guanicoe* (guanaco) and *Ozotoceros bezoarticus* (pampean deer) expressed in MNE for the three Holocene stratigraphic units (SU).

Among the small fauna, we identified 248 bones of Dasypodidae; a mandible, four vertebrae, eight podial, and 234 dermal plates. Through their plates, four taxa of armadillos such as *Chaetophractus* sp., *Zaedyus pichiy*, *Tolypeutes matacus*, and *Dasypus hybridus* were identified. The two first taxa, *Chaetophractus* sp. (UE-V/IV = 22; UE-III = 53; UE-II/I = 33) and *Zaedyus pichiy* (UE-V/IV = 16; UE-III = 32; UE-II/I = 18), are recorded continuously along the sequence, dominating the entire sample, while *Tolypeutes matacus* appears intermittently and secondarily in SU-IV and III, and *Dasypus hybridus* is restricted to SU-II (Table 1). SU-I (Historical times) has some bone remains (NISP = 5) of a small bird (*Dendrocygna* sp.).

Among the rodents, we identified a total of 10 taxa (Fig. 4; Table 1), with *Ctenomys* sp. the predominant taxa in all the stratigraphic units (UE-V/IV = 115; UE-III = 168; UE-II/I = 122).

aperea (NISP = 1). *Pseudoryzomys simplex*, *Lagostomus maximus*, and *Cavia aperea* were not recorded in SU-I (Table 1).

6.2. Frequency of skeletal parts

The medium and large faunal species, mainly guanaco and pampean deer, are represented by a small number of elements of the skeleton, whose degree of completeness is low in the majority of the units. In the Early and Middle Holocene transition (SU-IV), guanaco bone elements corresponding to the axial (NISP = 8) and appendicular (NISP = 5) skeleton were determined. For pampas deer only a vertebra and a carpal were registered. Both artiodactyls have a minimum number of individual (MNI) of one (Table 2; Fig. 5). In SU-IV, most of the elements (64.7%) have a degree of completeness less than 25%.

Table 2

Number of specimens for anatomical unit of the medium, large, and mega fauna at the Laguna Cabeza de Buey 2 site. *This specimen is from the top of the SU-V.

Anatomical unit	<i>Toxodon</i> sp.	<i>Lama guanicoe</i>			<i>Ozotoceros bezoarticus</i>			<i>Bos taurus</i>	<i>Equus caballus</i>		<i>Rhea</i> sp.
	SU-V/IV	SU-IV	SU-III	SU-II	SU-IV	SU-III	SU-II	SU-I	SU-II	SU-I	SU-II
Skull	–	1	–	–	–	–	–	–	–	–	–
Mandible	–	1*	–	–	–	–	–	–	–	–	–
Molar	–	1	3	1	–	–	–	–	–	–	–
Atlas	–	1	–	–	–	–	–	–	–	–	–
Cervical Vert.	–	–	1	–	–	1	–	–	1	–	–
Thoracic Vert.	–	2	1	–	1	–	2	–	–	–	–
Lumbar Vert.	–	–	3	–	–	1	1	–	–	–	–
Sacral Vert.	–	1	–	–	–	–	–	–	–	–	–
Caudal Vert.	–	1	–	–	–	–	–	–	–	–	–
Humerus	–	–	5	–	–	–	–	–	–	1	–
Radius-ulna	–	1	1	–	–	1	–	–	–	–	–
Femur	–	–	1	–	–	–	–	–	–	–	1
Tibia	–	–	2	–	–	–	1	–	–	–	–
Patellae	–	1	–	–	–	–	–	–	–	–	–
Metacarpus	–	–	1	–	–	–	–	–	–	–	–
Metapodial	–	3	5	–	–	–	–	–	4	–	–
Calcaneus	–	–	–	–	–	–	2	–	–	–	–
Astragalus	–	–	–	1	–	–	1	–	–	–	–
Carpal	–	–	4	1	1	3	–	1	1	–	–
Tarsal	–	–	1	–	–	–	–	–	–	–	–
Sesamoid	1	–	–	–	–	–	–	–	–	–	–
Phalanx	1	–	1	1	–	1	–	1	–	–	–
Total	2	13	29	4	2	7	7	2	6	1	1

Reithrodon auritus has a similar distribution, but with a lower abundance (NISP = 39) and an absence in some levels. The rest of the rodent taxa have a lower frequency of NISP and their distribution occurs discontinuously along the sequence (Table 1). In SU-IV, few remains of *Calomys* sp. (NISP = 2), *Galea leucoblephara* (NISP = 1), *Necromys* sp. (NISP = 1), and *Holochilus brasiliensis* (NISP = 1) are recorded. In SU-III, for the first time the species *Lagostomus maximus* (NISP = 1), *Pseudoryzomys simplex* (NISP = 3), and *Akodon azarae* (NISP = 16) are identified. This last species has a similar abundance as *Reithrodon auritus*, placing them both as the most important taxa after *Ctenomys* sp. (the most abundant rodent in the site). The increase of *Galea leucoblephara* (NISP = 5) and *Necromys* sp. (NISP = 6), the continuity of *Holochilus brasiliensis* (NISP = 1), and the disappearance of *Calomys* sp. is observed in this stratigraphic unit (Table 1). In SU-II, the most abundant rodent taxa after *Ctenomys* sp. are *Akodon azarae* (NISP = 12), *Necromys* sp. (NISP = 9), *Reithrodon auritus* (NISP = 7), *Galea leucoblephara* (NISP = 6), *Pseudoryzomys simplex* (NISP = 4), *Calomys* sp. (NISP = 2), *Lagostomus maximus* (NISP = 1), and *Cavia*

In the last part of the Middle Holocene (SU-III), guanaco bone elements, mainly from the appendicular (NISP = 21) and, to a lesser extent, the axial (NISP = 8) skeleton were determined (Table 2). The presence of two left proximal epiphysis of humerus, a fused and unfused, allows determination of a minimum number of two guanacos (a juvenile and an adult). Differential anatomical representation between both Middle Holocene units is recognized, with the axial skeleton predominating in SU-IV and the appendicular elements in SU-III. For pampas deer, specimens of a few anatomical units such as two vertebrae, one ulna, carpal/tarsal bones, and a phalanx were identified, which represent MNI = 1 (Fig. 5). In this stratigraphic unit, the level of fragmentation of the elements is lower than in SU-IV, with 43.3% of the specimens having a degree of completeness less than 25%, and 34.6% with a degree between 25% and 50%.

For the Late Holocene (SU-II), few guanaco bone elements (two carpal/tarsal bones, a phalanx, and a molar) were determined; while for pampas deer, three vertebrae, a tibia, and three carpal/tarsal bones were identified. Both artiodactyls are represented by a

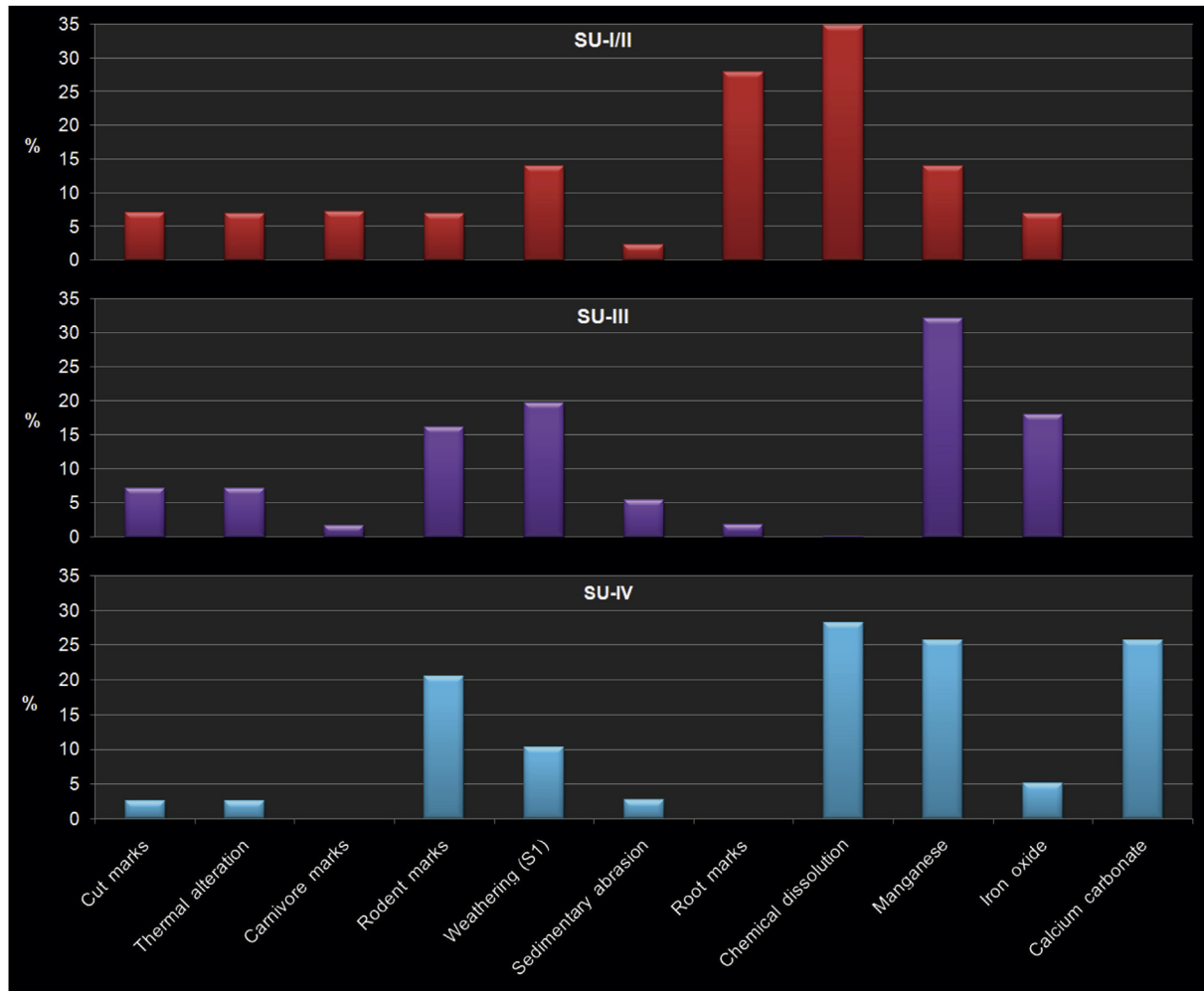


Fig. 6. Taphonomic variables for the different stratigraphic units (SU) at the Laguna Cabeza de Buey 2 site.

MNI = 1. In this stratigraphic unit the only bone element (femur) of *Rhea* sp. was recovered. In Historical times (SU-I), for one of the introduced species (horse) a cervical vertebra, a carpal, a humerus and a metapodial were identified, while for the other species (cow) only a phalanx and carpal/tarsal bone were found (Table 2). In both stratigraphic units (II and I) most of the specimens of medium, large, and megamammal (67.6%) have a degree of completeness greater than 25%.

6.3. Taphonomic analysis

The taphonomic analysis on the assemblage shows that some variables are present with different frequencies in each of the stratigraphic units (rodent marks, weathering, sedimentary abrasion, manganese, and iron oxide), while others are only restricted to certain units (carnivore and root marks, chemical dissolution, and calcium carbonate; Fig. 6). In SU-IV, the more important variables are chemical dissolution (28.2%), manganese (25.6%), and calcium carbonate (25.6%), following by rodent marks (20.5%) and weathering in stage 1 (10.2%). In SU-III, manganese has the highest percentage (32.1%), following by weathering (19.6%), rodent marks (16.1%), iron oxide (17.9%), and sedimentary abrasion (5.4%). The most recent stratigraphic units (II/I) show that the most frequent variables are chemical dissolution (34.8%) and root marks (27.9%), followed by weathering and manganese (13.9% each), carnivore

marks (7.2%), and iron oxide and rodent marks (6.9% each). Carnivore marks registered in SU-II/I were identified on three long bones of *Dendrocygna* sp., a mandible of *Cavia aperea*, and a humerus of *Lama guanicoe*.

The analysis of fossil bone fragmentation reveals that in all the stratigraphic units, post-depositional fractures dominate (SU-IV = 54.6%; SU-III = 57.1%; SU-II/I = 40.6%), following by anthropic (SU-IV = 31.8%; SU-III = 18.4%; SU-II/I = 34.4%) and undetermined fractures (SU-IV = 13.6%; SU III = 24.5%; SU-II/I = 21.9%). Furthermore, a humerus of *Dendrocygna* sp. from the SU-I shows a fracture that was possibly caused by a carnivore.

The analysis of rodent molars recorded that the most important traces in all the stratigraphic units are manganese (SU-V = 62.5%; SU-IV = 49.2%; SU-III = 70%; SU-II/I = 37.8%), iron oxide (SU-V = 55.5%; SU-IV = 59%; SU-III = 56.7%; SU-II/I = 40.5%), and calcium carbonate (SU-V = 62.9%; SU-IV = 45.1%; SU-III = 67.1%; SU-II/I = 56.4%). Chemical dissolution has a higher percentage in SU-III and II/I (43.8% and 45.9%, respectively) than in SU-IV and V (13.1% and 11.1%, respectively). Weathering is present in very low percentages only in SU-V (3.7%) and SU-IV (0.8%). A few molars show corrosion by gastric juices of predators (SU-II/I = 8.5%; SU-IV = 7.3%; SU-III = 6.2%; SU-V = 3.7%), which correspond to different rodent taxa including *Ctenomys* sp., *Reithrodon auritus*, *Akodon azarae*, *Galea leucoblephara*, *Pseudoryzomys simplex*, *Calomys* sp., *Necromys* sp., and Caviidae (Table 3).

Table 3Digestive patterns of corrosion on rodent molars (*in situ* and isolate) by stratigraphic units at the Laguna Cabeza de Buey 2 site.

	Taxa	Absent		Light		Moderate		Heavy		Extreme	
		N	%	N	%	N	%	N	%	N	%
SU-II/I	<i>Ctenomys</i> sp.	127	97.7	3	2.3	–	–	–	–	–	–
	<i>Cavia aperea</i>	3	100	–	–	–	–	–	–	–	–
	<i>Galea leucoblephara</i>	6	85.7	–	–	–	–	1	14.3	–	–
	Cricetidae	2	100	–	–	–	–	–	–	–	–
	<i>Reithrodon auritus</i>	6	66.6	3	33.4	–	–	–	–	–	–
	<i>Akodon azarae</i>	10	62.5	4	25	2	12.5	–	–	–	–
	<i>Calomys</i> sp.	4	80	–	–	–	–	1	20	–	–
	<i>Pseudoryzomys simplex</i>	3	75	–	–	1	25	–	–	–	–
	<i>Necomys</i> sp.	12	80	3	20	–	–	–	–	–	–
	Total	173	90.6	13	6.8	3	1.6	2	1	–	–
SU-III	<i>Ctenomys</i> sp.	196	96.5	1	0.5	1	0.5	4	2	1	0.5
	Caviidae	7	87.5	–	–	–	–	1	2.5	–	–
	<i>Galea leucoblephara</i>	5	83.3	1	6.7	–	–	–	–	–	–
	<i>Reithrodon auritus</i>	13	76.5	1	5.9	3	17.6	–	–	–	–
	<i>Akodon azarae</i>	15	93.7	1	6.3	–	–	–	–	–	–
	<i>Necomys</i> sp.	6	85.7	1	14.3	–	–	–	–	–	–
	<i>Holochilus brasiliensis</i>	1	100	–	–	–	–	–	–	–	–
	<i>Pseudoryzomys simplex</i>	2	66.7	1	33.3	–	–	–	–	–	–
	Total	245	93.9	6	2.3	4	1.5	5	1.9	1	0.3
	SU-V/IV	<i>Ctenomys</i> sp.	89	92.7	3	3.2	1	1	2	2.1	1
Caviidae		1	100	–	–	–	–	–	–	–	–
<i>Reithrodon auritus</i>		12	85.7	2	14.3	–	–	–	–	–	–
<i>Calomys</i> sp.		1	50	1	50	–	–	–	–	–	–
<i>Holochilus brasiliensis</i>		1	100	–	–	–	–	–	–	–	–
Total		104	91.2	6	5.3	1	0.9	2	1.7	1	0.9

In regard to human modifications, we recognized cut marks, anthropic fractures to access the bone marrow, and thermal alteration on different bones of all stratigraphic units. Among the identified species, both artiodactyls, *Lama guanicoe* and *Ozotoceros bezoarticus*, present cut marks, helical fracture debris, and thermal alteration. This last modification was also recorded on the plates of three taxa of armadillos (*Chaetophractus* sp., *Tolypeutes matacus*, and *Zaedyus pichiy*). Regarding this thermal alteration, this is a typical pattern of the archaeofaunal record in the Pampa grasslands, which has been associated with forms of cooking with ethnographic sustenance, wherein the animal is roasted on the breastplate (Frontini and Vecchi, 2014). The two livestock species (*Equus caballus* and *Bos taurus*) and the greater bird (*Rhea* sp.) have evidence of human utilization such as cut marks and anthropic fractures.

In the Early and Middle Holocene transition (SU-IV), cut marks were identified on the shaft of a long bone of undetermined medium mammal (likely guanaco), which indicate filleting activities. Helical fractures occurred in three specimens of guanaco (two metapodials and one radius-ulna) and four long bone of unidentified medium mammal (possibly guanaco). Specimens with thermal alteration were recognized in guanaco bones (6.8%) and on the plates of the three species of armadillos (18.9%). One of the unidentified medium mammal long bones had cut marks associated with helical fracture and thermal alteration.

In the last part of the Middle Holocene (SU-III), cutting traces were identified on the shaft of a long bone of unidentified medium mammal (likely guanaco; Fig. 7a) and on three specimens of guanaco: distal diaphysis of radius (skinning), distal epiphysis of metacarpal (skinning), and diaphysis of humerus (filleting). Anthropic fractures occurred in six long bones of guanaco (three humerus, one tibia, one radius-ulna, and one metacarpal) and in three long bone unidentified, probably of guanaco. Thermal alteration was determined in both species of artiodactyls (7.1%) and on the plates of the three armadillos (18.1%).

For the Late Holocene (SU-II) and in Historical times (SU-I), we identified modification with anthropic origin in specimens of

guanaco, pampas deer, rhea, cow, and horse. Cut marks were identified in a thoracic vertebra of pampean deer (filleting), in the shaft of a first phalanx of guanaco (skinning; Fig. 7b), and the proximal epiphysis of a second phalanx of cow (skinning). Helical fractures were determined in the aforementioned specimen of guanaco, in a tibia of pampean deer, in a femur of rhea, and in a humerus and two metapodial of horse, and in five specimens of undetermined medium and large mammals (four are possibly guanaco and one is horse). Thermal alteration was determined in a 6.25% of the medium fauna (only recorded in pampean deer and undetermined mammal) and in a 13.9% of the plates of two armadillos (*Chaetophractus* sp. and *Zaedyus pichiy*).

7. Discussion

7.1. Taphonomic agents and processes

Considering the taphonomic analysis, we can identify some patterns that allow us to assess the history of the bone assemblage in Laguna Cabeza de Buey 2 site. The presence of anthropic modifications (e.g., cut marks, helical fracture debris, and thermal alteration) on guanaco, pampean deer, rhea, hairy armadillo, pichi, and southern three-banded armadillo bones indicates human exploitation. The low frequency of specimens with natural predation (a guanaco bone with carnivore marks) and post-depositional traces (e.g., abrasion), and its association with cultural artifact (e.g., lithic tools and ceramics potsherds) suggest that these species were deposited as result of the human activity.

The rodent assemblage does not present evidence of human exploitation. The skeletal elements analyzed in this paper (i.e., molars) are not susceptible of burning (Medina et al., 2012). However, preliminary analysis of post-cranial and cranial bones of rodents does not have evidence of thermal alteration. Corrosive effects of gastric digestion are present in a low frequency of the specimens (8.7%) which correspond to most of the rodent species (Table 3). The low percentage of digestion and the predominance of the lowest degree (i.e., light) in all stratigraphic units, suggest that

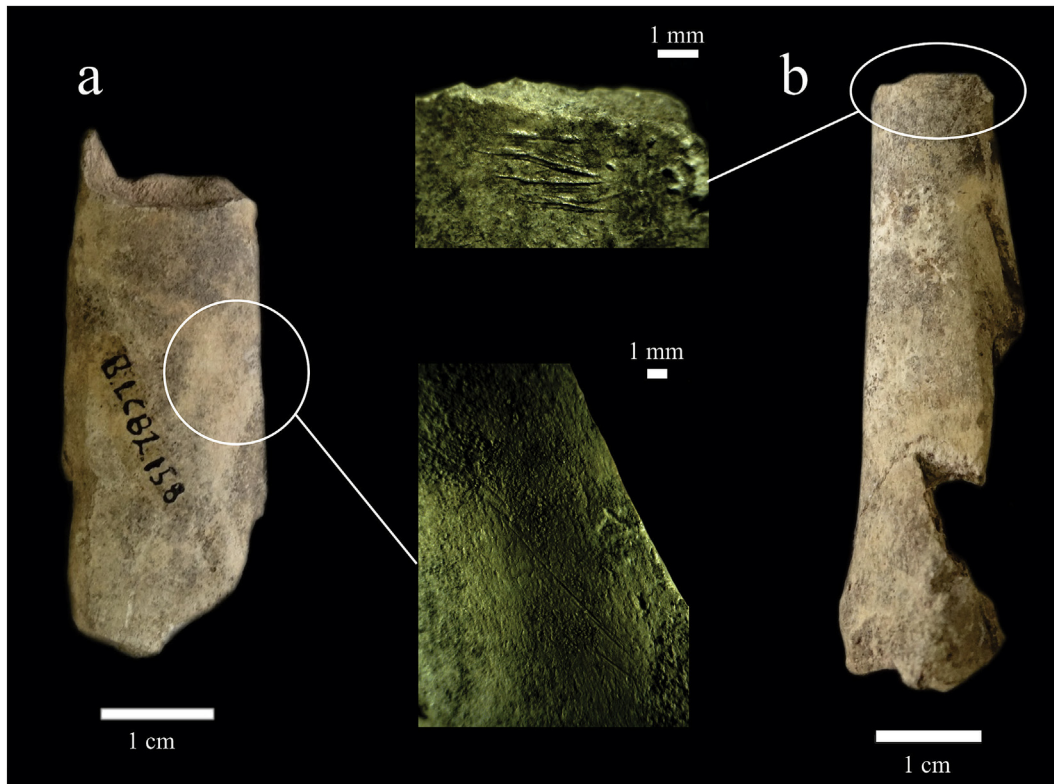


Fig. 7. Cut marks (filleting) on the shaft of a long bone of unknown medium mammal (a) and cut marks (skinning) on the shaft of first phalanx of *Lama guanicoe* (b).

digestion on the rodent bone assemblage was produced mainly by strigiforms (Andrews, 1990; Fernández-Jalvo and Andrews, 1992; Pardiñas, 2000).

Moreover, the predominance of *Ctenomys* sp., a genus with fossorial habits, and *Reithrodon auritus*, a species that usually lives in burrows made by the latter, support the importance of eto-ecological processes (i.e., natural death) in the incorporation of some rodent species in the deposit (Pardiñas, 2000). A large number of burrow systems, probably of *Ctenomys* sp., as they contained skeletal remains of this genus, were recorded during field works. The presence of these burrows and rodent marks on bones allows us to suggest that vertical and horizontal displacement of small materials likely occurred within and among the stratigraphic units.

The high frequency of post-depositional fragmentation of skeletal remains and the low identification of medium and large fauna specimens could be linked with the dynamic of erosion and deposition of sediment in dune environments. However, the low percentage of weathering suggests that the erosion and deposition process was not as high as in other environments dunes (Conard et al., 2008; Belardi et al., 2012). In this sense, this pattern also may be associated with changes in environmental conditions of the burial of specimens produced by flooding situations. Diagenetic processes could have weakened the structure of the skeletal specimens (shown by the lack of protein content of three samples sent for radiocarbon dating), favoring the process of destroying them. In addition, diagenetic processes could have been responsible for other patterns registered on bone assemblage, such as the presence of specimens stained by minerals (manganese and iron oxides) and with calcium carbonate (Lyman, 1994; Gutiérrez, 2004). The variation in the proportion of specimens with traces of chemical dissolution between stratigraphic units may be linked

with the increase in vegetation and rooting, suggesting variations in moisture and environmental stability (Goldberg and Macphail, 2006).

7.2. Paleoenvironment evolution

Taphonomic history establishes that the faunal assemblage of Laguna Cabeza de Buey 2 site is informative of the environment to different scales. Ethnoarchaeological studies show that small animals (<20 kg) are generally obtained during daily foraging trips, in a radius <10 km, while procurement of large fauna may exceed this distance (Binford, 1978; Kelly, 1995). Strigiforms, generalists, and opportunistic predators of cricetid rodents, acquire their prey in a range of action whose diameter does not usually exceed 5 km, so they are considered good indicators of local natural communities (Andrews, 1990; Taylor, 1994; Leveau et al., 2006).

The taxonomic diversity of rodents indicates the presence of an environmental mosaic probably composed of open grasslands (e.g., *Calomys* sp., *Akodon azarae*, and *Necromys* sp.), shrubs (e.g., *Reithrodon auritus*), sandy soils (e.g., *Ctenomys* sp.), and flooded terrains and lotic water bodies (e.g., *Holochilus brasiliensis* and *Pseudoryzomys simplex*). The small, medium, and large fauna that were hunted by human groups may be understood within this environmental framework, extending the range of this scenario on a regional scale. This environmental scenario could have begun to develop during the Middle Holocene, when some specimens of small vertebrates (e.g., *Holochilus brasiliensis*) are recorded in SU-IV and III, while their main features were reached in the Late Holocene, when most of the small vertebrates are recorded in large proportions. Although it is not possible to ensure that the presence of *Holochilus* is not due to vertical migration, it is remarkable that after its occurrence in the sequence, the evidence of the human

occupations begin to be registered in the site, possibly linked with the availability of water in this areal environment. In this context, the emergence of *Pseudoryzomys simplex* in SU-III, a rodent that requires hydric habitats, reinforces the hypothesis proposed.

The taxonomic assemblage suggests that the weather conditions were more arid in the Middle Holocene and similar to the current climate (temperate/humid) in the Late Holocene. This climatic evolution model is based on the presence during the Middle Holocene (SU-IV and SU-III) of species that currently are restricted to arid/semiarid environments (e.g., *Tolypeutes matacus* and *Zaedyus pichiy*), which subsequently giving rise to other species of tropical lineage (e.g., *Dasyopus hybridus* and *Cavia aparea*) during the Late Holocene. The gradual process of climatic change would have enabled the convergence of species that currently have divergent distributions (e.g., *Pseudoryzomys simplex* and *Zaedyus pichiy*).

The environmental conditions inferred, based on the faunal assemblage of Laguna Cabeza de Buey 2 site, coincide with the results generated by Kruck et al. (2011), and by Tonello and Prieto (2010) in the central Pampa grasslands. Similarly, Pardiñas (1991) registered different species of micro and small mammal of tropical lineage (e.g., *Monodelphis dimidiata* and *Holochilus brasiliensis*) and arid/semiarid environments (e.g., *Dolichotis patagonum*) in a stratigraphic unit of the Middle Holocene at the Fortín Necochea archaeological site (~110 km to the south). However, this researcher concludes that these elements may reflect different climatic conditions, warm and humid (relative to the Hypsithermal, see Pardiñas, 1999) versus dry periods during the beginning and the end of the Middle Holocene, respectively. The presence of *Dasyopus hybridus* and *Myocastor coypus* in the Ceramic Late Holocene suggest a climatic condition similar to today (Pardiñas, 1991). In relation to the Hypsithermal, it is difficult to assess the relationship of certain rodent species (e.g., *Holochilus brasiliensis*) with climate, as they are represented in the Pampean region from the Middle/Late Pleistocene, through the Holocene and to the present (Pardiñas et al., 2010; Pardiñas and Teta, 2011; Scheifler et al., 2012). Recent paleoenvironmental studies on skeletal assemblages of micro and small mammals (Rodentia, Didelphidae, and Dasypodidae) from other archaeological sites located in the center of the Pampa grasslands (~100 km to the southeast), indicate similar trends to those raised in this work; paleoclimatic conditions more arid than today during the last part of the Early Holocene and similar to the current climate during the Late Holocene (Scheifler et al., 2012, 2015; Messineo et al., 2013).

7.3. Subsistence strategies

The first event of occupation occurred during the transition between the Early and Middle Holocene (SU-IV; ca. 6800 ¹⁴C BP). The guanaco was the most important economic resource, supplemented by three taxa of armadillos (*Chaetophractus* sp., *Zaedyus pichiy*, and *Tolypeutes matacus*). The presence of two pampean deer bones at the top of this unit could suggest the migration of these elements from the overlying SU-III by post-depositional processes; however, it cannot be ruled out that their presence in this stratigraphic unit is the result of the beginning of exploitation during the Middle Holocene. The pampean deer is an animal that lives in places with the presence of water (Jackson, 1987) and its emergence in the sequence is related to the occurrence of the amphibian rodent *Holochilus brasiliensis*.

The low diversity of fauna resources exploited in the SU-IV of Laguna Cabeza de Buey 2 is similar to that recorded in other nearby archaeological sites, such as Fortín Necochea (base of stratigraphic unit II, ca. 6000 ¹⁴C BP, Crivelli Montero et al., 1997) and El Puente (lower component, ca. 5700 ¹⁴C BP, Messineo et al., 2014), in which

the guanaco was the predominant species as a food resource. However, the information for the center of the Pampa grasslands contrasts with what is observed for other areas of the Pampean region (e.g., Interserrana), where the subsistence strategy was focused on the diversification of the diet during this period of time (Álvarez, 2014a). This difference may be the result of the functionality of the earliest occupation in Laguna Cabeza de Buey 2 site (a locus of specific activity associated with the processing of animals and the last stages of lithic reduction), post-depositional processes, and different social and environmental scenarios, among other factors. (Messineo and Scheifler, in press)

The second event of occupation occurred during the last part of the Middle Holocene (4150 ¹⁴C BP). The guanaco remained the most important economic resource, complemented with pampean deer and, to a lesser extent, by the three taxa of armadillos (*Chaetophractus* sp., *Zaedyus pichiy*, and *Tolypeutes matacus*). This scenario is similar to other areas (e.g., Southwest and Interserrana) from the Pampean region, where the diet was strongly focused on the exploitation of both artiodactyls (Frontini, 2013; Álvarez, 2014a). The higher frequency of the appendicular skeleton relative to the previous SU-IV and the variability in processing tasks (skinning and filleting) suggest changes in the activities undertaken at the site (Messineo and Scheifler, in press).

In the Late Holocene, the NISP indicates a similar importance of guanaco and pampean deer in the human subsistence. However, the guanaco has a body mass three times higher than the pampean deer (80–130 kg versus 30–40 kg), so the potential resource offered by the first is more abundant. In addition, two taxa of armadillos were consumed (*Chaetophractus* sp. and *Zaedyus pichiy*) and other species, including the flightless bird (rhea), is incorporated. At the Laguna Cabeza de Buey 2 site, a change in the subsistence strategy towards intensification and/or diversification in the diet has not been registered, as has been proposed for other areas of the Pampean region, in relation with the variety of animals exploited and the increase in vegetable consumption (Martínez and Gutiérrez, 2004). In this case, a similar trend was observed in nearby sectors, such as the upper basin of the Tapalqué creek, 100 km to the southeast (Messineo, 2011), where it was suggested that the guanaco was the main faunal resource in the subsistence of hunter-gatherers who occupied the central Pampa grasslands. In Historical times and as result of European colonization, the faunal assemblage represents the change from one type of milenary economy based on hunting and gathering of native species to another based on the management of domestic livestock.

8. Conclusions

The information presented in this paper suggests a specialized subsistence strategy, which was focused on artiodactyls. In this strategy, the guanaco was the main food resource for hunter-gatherer groups during the Middle and Late Holocene in the center of Pampa grasslands. During the different times of human occupation of the site, the pampean deer was a complementary resource in the diet, while the armadillos were occasional species. The gradual evolution of the Holocene environment conditions in the center of Pampa grasslands may be important factors in the subsistence strategies identified at the Laguna Cabeza de Buey 2 site. The lack of dramatic climate changes allowed the hunter-gatherer groups to develop rearrangements within the framework of the general characteristics of their adaptation strategies at the heart of the Pampas grasslands. Finally, future work will be oriented to deepen this line of research using other methodological tools and studying new archaeological contexts, allowing us to generate a more detailed model about the subsistence strategies

implemented by hunter-gatherer groups who occupied the center of the Pampa grasslands.

Acknowledgements

The Agencia Nacional de Investigaciones Científicas y Técnicas (ANPCyT) supports this research (PICT 2008-0430 and PICT 2010-1415). We would like to thank the editors, Fernando Fernandez and Luis del Papa, for the invitation to write in the Special Volume *South American Zooarchaeology*. We also want to thank to Marcela Tonello, Silvina Stutz, and Diego Navarro (IIMyC-CONICET, Universidad de Mar del Plata) who made the geochemical analysis of the sediment. Ana Paula Alcaráz and two anonymous reviewers made important comments to improve the paper. This work is part of our ongoing research carried out in the INCUAPA-CONICET (Facultad de Ciencias Sociales, Universidad Nacional del Centro de la Provincia de Buenos Aires). However, the content and interpretations are full responsibility of the authors.

References

- Acosta, A., Loponte, D., Mucciolo, L., 2010. Comparando estrategias de explotación faunística en el humedal del Paraná Inferior: cazadores-recolectores versus horticultores amazónicos. In: Gutiérrez, M.A., de Nigris, M., Fernández, P.M., Giardina, M., Gil, A., Izeta, A., Neme, G., Yacobaccio, H. (Eds.), *Zooarqueología a Principios del Siglo XX: Aportes Teóricos, Metodológicos y Casos de Estudio*. Libros del Espinillo, Ayacucho, pp. 177–188.
- Alcaráz, A.P., 2015. Aprovechamiento antrópico de fauna menor en el curso inferior del río Colorado (transición pampeano-patagónica oriental): el sitio El Tigre como caso de estudio. *Intersecciones en Antropología* 16, 115–129.
- Álvarez, M.C., 2014a. Subsistence patterns during the Holocene in the Interserrana area (Pampean region, Argentina): evaluating intensification in resource exploitation. *Journal of Anthropological Archaeology* 34, 54–65.
- Álvarez, M.C., 2014b. Tecnología ósea en el oeste de la región pampeana: identificación de las técnicas de manufactura a partir de evidencias arqueológicas y experimentales. *Chungara, Revista de Antropología Chilena* 46 (2), 193–210.
- Andrews, P., 1990. *Owls, Caves and Fossils*. Natural History Museum Publications, London.
- Bayón, C., Frontini, R., Vecchi, R., 2012. Middle Holocene settlements on coastal dunes, southwest Buenos Aires Province, Argentina. *Quaternary International* 256, 54–61.
- Behrensmeier, A.K., 1978. Taphonomic and ecologic information from bone weathering. *Paleobiology* 4 (2), 150–162.
- Belardi, J.B., Rindel, D., Bourliot, T., 2012. Much more than it was expected: preservational differences of diaphysis and epiphyseal ends of guanaco (*Lama guanicoe*) long bones in Southern Patagonia (Argentina). *Journal of Taphonomy* 10 (1), 45–65.
- Binford, L., 1978. *Nunamiut Ethnoarchaeology*. Academic Press, New York.
- Binford, L., 1981. *Bones: Ancient Men and Modern Myths*. Academic Press, New York.
- Blasi, A., Politis, G.G., Bayón, C., 2013. Palaeoenvironmental reconstruction of La Olla, a Holocene archaeological site in the Pampean coast (Argentina). *Journal of Archaeological Science* 40, 1554–1567.
- Bonomo, M., León, D.C., 2010. Un contexto arqueológico en posición estratigráfica en los médanos litorales. El sitio Alfár (Pdo. de General Pueyrredón, Pcia. de Buenos Aires). In: Berón, M., Luna, L., Bonomo, M., Montalvo, C., Aranda, C., Carrera Aizpitarte, M. (Eds.), *Mamul Mapü: Pasado y Presente desde la Arqueología Pampeana*, Tomo 2. Libros del Espinillo, Ayacucho, pp. 29–45.
- Bórmida, M., 1960. Investigaciones paleontológicas en la región de Bolívar, Provincia de Buenos Aires. *Anales de la Comisión de Investigaciones Científicas de la Provincia de Buenos Aires* 1, La Plata, pp. 190–283.
- Burgos, J.J., 1968. El clima de la provincia de Buenos Aires en relación con la vegetación natural y el suelo. In: Cabrera, A.L. (Ed.), *Flora de la Provincia de Buenos Aires*, Parte 1. Colección Científica del INTA, Buenos Aires, pp. 33–99.
- Conard, N.J., Walker, S.J., Kandel, A.W., 2008. How heating and cooling and wetting and drying can destroy dense faunal elements and lead to differential preservation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 266, 236–245.
- Crivelli Montero, E.A., Eugenio, E.O., Pardiñas, U.F.J., Silveira, M.J., 1997. Archaeological investigation in the plains of the Province of Buenos Aires, Llanura Interserrana Bonaerense. In: Rabassa, J., Salemme, M. (Eds.), *Quaternary of South America & Antarctic Peninsula*, vol. 10 (1994). A. A. Balkema, Rotterdam, Brookfield, pp. 167–209.
- Darrieu, C.A., Camperi, A.R., 2001. Nueva lista de las Aves de la Provincia de Buenos Aires. *ProBiota* 2, Cobiobo 3. Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, La Plata.
- Fernández-Jalvo, Y., Andrews, P., 1992. Small mammal taphonomy of Gran Dolina, Atapuerca (Burgos), Spain. *Journal of Archaeological Science* 19 (4), 407–428.
- Frontini, R., 2013. Aprovechamiento faunístico en entornos acuáticos del sudoeste bonaerense durante el Holoceno. *Relaciones de la Sociedad Argentina de Antropología* 38, 493–519.
- Frontini, R., Vecchi, R., 2014. Thermal alteration of small mammal from El Guanaco 2 site (Argentina): an experimental approach on armadillo bone remains (*Cingulata*, *Dasyopodidae*). *Journal of Archaeological Science* 44, 22–29.
- Goldberg, P., Macphail, R., 2006. *Practical and Theoretical Geoarchaeology*. Blackwell Publishing, Oxford.
- Gómez Villafaña, I.E., Miño, M., Cavia, R., Hodara, K., Courtalón, P., Suárez, O., Busch, M., 2005. *Roedores*. Guía de la Provincia de Buenos Aires. *Literature of Latin America*, Buenos Aires.
- González, M.I., 2005. *Arqueología de Alfareros, Cazadores y Pescadores Pampeanos*. Colección Tesis Doctorales. Sociedad Argentina de Antropología, Buenos Aires.
- Grayson, D.K., 1984. *Quantitative Zooarchaeology: Topics in the Analysis of Archaeological Faunas*. Academic Press, Orlando.
- Gutiérrez, M.A., 2004. *Análisis tafonómicos en el Área Interserrana (Provincia de Buenos Aires)* (Ph.D. thesis). Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, La Plata.
- Gutiérrez, M.A., Kaufmann, C.A., 2007. Methodological criteria for the identification of formation processes in guanaco (*Lama guanicoe*) bone assemblages in fluvial-lacustrine environments. *Journal of Taphonomy* 5 (4), 151–176.
- Gutiérrez, M.A., Martínez, G.A., 2008. Trends in the faunal human exploitation during the Late Pleistocene and Early Holocene in the Pampean region (Argentina). *Quaternary International* 191, 53–68.
- Hillson, S., 2005. *Teeth*. *Cambridge Manuals in Archaeology*. Cambridge University Press, Cambridge.
- Iriondo, M., 1999. Climatic changes in the South American plains: records of a continent-scale oscillation. *Quaternary International* 57/58, 93–112.
- Jackson, J.E., 1987. *Ozotoceros bezoarticus*. *Mammalian Species* 295, 1–5.
- Johnson, E., 1985. Current developments in bone technology. In: Schiffer, M.B. (Ed.), *Advances in Archaeological Method and Theory*, vol. 8. Academic Press, New York, pp. 157–235.
- Kaufmann, C.A., 2009. *Metodologías para la Construcción de Perfiles de Mortalidad y Determinación de la Estacionalidad en Restos Óseos de Guanacos (Lama guanicoe)*. Su Aplicación a Sitios Arqueológicos de la Región Pampeana. Colección Tesis Doctorales. Sociedad Argentina de Antropología, Buenos Aires.
- Kelly, R.L., 1995. *The Foraging Spectrum: Diversity in Hunter-Gatherers Lifeways*. Smithsonian Institution Press, Washington DC.
- Klein, R., Cruz-Urbe, K., 1984. *The Analysis of Animal Bones from Archaeological Sites*. Chicago University Press, Chicago.
- Kruck, W., Helms, F., Geyh, M.A., Suriano, J.M., Marengo, H.G., Pereyra, F., 2011. Late Pleistocene-Holocene history of Chaco-Pampean sediments in Argentina and Paraguay. *Quaternary Science Journal* 60 (1), 188–202.
- Leveau, L., Teta, P., Bogdaschew, R., Pardiñas, U.F.J., 2006. Feeding habits of the Barn Owl (*Tyto alba*) along a longitudinal-latitude gradient in Central Argentina. *Ornitología Neotropical* 17, 353–362.
- Lyman, R., 1994. *Vertebrate Taphonomy*. Cambridge Manuals in Archaeology. Cambridge University Press, Cambridge.
- Lyman, R., 2008. *Quantitative Paleozoology*. Cambridge Manuals in Archaeology. Cambridge University Press, Cambridge.
- Madrazo, G.B., 1973. *Síntesis de arqueología Pampeana*. Etnia 17, 13–25.
- Madrazo, G.B., 1979. *Los cazadores de larga distancia de la Región Pampeana*. Prehistoria Bonaerense. Olavarría 13–67.
- Martínez, G.A., Gutiérrez, M.A., 2004. Tendencias en la explotación humana de la fauna durante el Pleistoceno final-Holoceno en la Región Pampeana (Argentina). In: Mengoni Goñalons, G.L. (Ed.), *Zooarchaeology of South America*, British Archaeological Reports, International Series 1298. Oxford, pp. 81–98.
- Massoia, E., Forasiepi, A., Teta, P., 2000. *Los Marsupiales de la Argentina*. Editorial Lola, Buenos Aires.
- Medina, M.E., Teta, P., Rivero, D., 2012. Burning damage and small-mammal human consumption in Quebrada del Real 1 (Cordoba, Argentina): an experimental approach. *Journal of Archaeological Science* 39 (3), 737–743.
- Messineo, P.G., 2011. Investigaciones arqueológicas en la cuenca superior del Arroyo Tapalqué. Un modelo de ocupación humana para el centro de la subregión Pampa Húmeda durante el Holoceno tardío. *Intersecciones en Antropología* 12, 275–291.
- Messineo, P.G., Scheifler, N.A., 2015. Investigaciones arqueológicas de cazadores-recolectores en el sitio Laguna Cabeza de Buey 2 (centro de los pastizales pampeanos, Buenos Aires). Cincuenta años después de las Industrias Culturales definidas por Bórmida. *Intersecciones en Antropología* (in press).
- Messineo, P.G., Álvarez, M.C., Favier Dubois, C., Steffan, P., Colantonio, M.J., 2013. Estado de avance de las investigaciones arqueológicas en el sitio Empalme Querandíes 1 (centro de la subregión Pampa Húmeda, provincia de Buenos Aires). *Comechingonia, Revista de Arqueología* 17, 123–148.
- Messineo, P.G., Kaufmann, C.A., Steffan, P.G., Favier Dubois, C., Pal, N., 2014. Ocupaciones humanas en un valle intraserrano del sector noroccidental de Tandilia: sitio El Puente (partido de Olavarría, Buenos Aires). *Relaciones de la Sociedad Argentina de Antropología XXXIX* (2), 435–462.
- Miotti, L.L., Salemme, M., 1999. Biodiversity, taxonomic richness and specialists-generalists during late Pleistocene/Early Holocene times in Pampa and Patagonia (Argentina, Southern South America). *Quaternary International* 53/54, 53–68.
- Montalvo, C.I., Zárate, M.A., Bargo, M.S., Mehl, A., 2013. Registro faunístico y paleoambientes del Cuaternario tardío, provincia de La Pampa, Argentina. *Ameghiniana* 50 (6), 554–570.

- Pardiñas, U.F.J., 1991. Roedores, marsupiales y edentados en la secuencia de Fortín Necochea, General La Madrid, Buenos Aires. Implicancias paleoambientales. *Boletín del Centro* 2, 139–153.
- Pardiñas, U.F.J., 1999. Fossil murids: taxonomy, paleoecology, and paleoenvironments. In: Rabassa, J., Salemme, M. (Eds.), *Quaternary of South America and Antarctic Peninsula*, vol. 13. A. A. Balkema, Rotterdam, Brookfield, pp. 225–254.
- Pardiñas, U.F.J., 2000. Tafonomía de microvertebrados en yacimientos arqueológicos de Patagonia (Argentina). *Arqueología* 9, 265–340.
- Pardiñas, U.F.J., Teta, P., 2011. Fossil history of the marsh rats of the genus *Holochilus* and *Lundomys* (Cricetidae, Sigmodontinae) in southern South America. *Estudios Geológicos* 67, 111–129.
- Pardiñas, U.F.J., Teta, P., Bilencia, D., 2010. Roedores Sigmodontinos de la región Pampeana: una introducción zoogeográfica. In: Polop, J.J., Busch, M. (Eds.), *Biología y Ecología de Pequeños Roedores en la Región Pampeana de Argentina. Enfoques y Perspectivas*. Editorial Universidad de Córdoba, Córdoba, pp. 9–36.
- Politis, G.G., 2008. The Pampas and Campos of South America. In: Silverman, H., Isbell, W. (Eds.), *Handbook of South American Archaeology*. Springer, New York, pp. 235–260.
- Politis, G.G., Barros, M.P., 2006. La región pampeana como unidad espacial de análisis en la arqueología contemporánea. *Folia Histórica del Nordeste* 16, 51–73.
- Politis, G.G., Messineo, P.G., 2008. The Campo Laborde site: new evidence for the Holocene survival of Pleistocene megafauna in the Argentine Pampas. *Quaternary International* 191, 98–114.
- Politis, G.G., Prates, L., Merino, L.M., Tognelli, M.F., 2011. Distribution parameters of guanaco (*Lama guanicoe*), pampas deer (*Ozotoceros bezoarticus*) and marsh deer (*Blastoceros dichotomus*) in Central Argentina: archaeological and paleoenvironmental implications. *Journal of Archaeological Science* 38, 1405–1416.
- Politis, G.G., Messineo, P.G., González, M.E., Álvarez, M.C., Favier Dubois, C., 2012. Primeros resultados de las investigaciones en el sitio Laguna de los Pampas (partido de Lincoln, provincia de Buenos Aires). *Relaciones de la Sociedad Argentina de Antropología XXXVII*, 463–472.
- Quintana, C.A., Mazzanti, D., 2001. Selección y aprovechamiento de recursos faunísticos. In: Mazzanti, D., Quintana, C.A. (Eds.), *Cueva Tixi: Cazadores y Recolectores de las Sierras de Tandilia Oriental*. Geología, Paleontología y Zooloarquología. Laboratorio de Arqueología. Universidad Nacional de Mar del Plata, Publicación Especial 1, Mar del Plata, pp. 181–209.
- Redford, K.H., Eisenberg, J.F., 1992. *Mammals of the Neotropics*. In: *The Southern Cone*, vol. 2. The University of Chicago Press, Chicago.
- Scheifler, N.A., Teta, P., Pardiñas, U.F.J., 2012. Small mammals (*Didelphimorphia* and *Rodentia*) of the archaeological site Calera (Pampean region, Buenos Aires Province, Argentina): Taphonomic history and Late Holocene environments. *Quaternary International* 278, 32–44.
- Scheifler, N.A., Messineo, P.G., Pardiñas, U.F.J., 2015. Implicancias tafonómicas y paleoambientales de los pequeños vertebrados del sitio arqueológico Campo Laborde (centro de los pastizales pampeanos, Buenos Aires, Argentina). *Archaeofauna: International Journal of Archaeozoology* 24, 187–208.
- Soriano, A., León, R.J.C., Sala, O.E., Lavado, R.S., Deregiibus, V.A., Cauhépé, M.A., Scaglia, O.A., Velázquez, C.A., Lemcoff, J., 1992. Río de la Plata Grasslands. In: Coupland, R.T. (Ed.), *Ecosystems of the World 8A. Natural Grasslands. Introduction and Western Hemisphere*. Elsevier, New York, pp. 367–407.
- Stoessel, L., 2012. Análisis zooarqueológico en el curso inferior del río Colorado (provincia de Buenos Aires). Aportes para el conocimiento de la subsistencia de cazadores-recolectores durante el Holoceno tardío (Ph.D. thesis). Facultad de Ciencias Sociales, Universidad Nacional del Centro de la Provincia de Buenos Aires, Olavarría.
- Stoessel, L., Martínez, G., 2014. El proceso de intensificación en la transición pampeano-patagónica oriental. Discusión y perspectivas comparativas con regiones aledañas. *Comechingonia. Revista de Arqueología* 18, 65–94.
- Taylor, I., 1994. *Barn Owls*. Cambridge University Press, Cambridge.
- Tonello, M.S., Prieto, A.R., 2010. Tendencias climáticas para los pastizales pampeanos durante el Pleistoceno tardío-Holoceno: Estimaciones cuantitativas basadas en secuencias polínicas fósiles. *Ameghiniana* 47 (4), 501–514.
- Vizcaíno, S.F., Pardiñas, U.F.J., Bargo, M.S., 1995. Distribución de los armadillos (*Mammalia*, *Dasyproctidae*) en la región Pampeana (República Argentina) durante el Holoceno. Interpretación paleoambiental. *Mastozoología Neotropical* 2, 149–165.
- Zárata, M.A., Tripaldi, A., 2012. The aeolian system of central Argentina. *Aeolian Research* 3, 401–417.