

RESEARCH ARTICLE

Perinatal guanacos (*Lama guanicoe*) exploited by hunter-gatherers from the Holocene of Argentine Pampas

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Abstract

The guanaco (*Lama guanicoe*) was the most relevant species in hunter-gatherer subsistence of the Argentine Pampas during the Quaternary. An early Late Holocene (3,184 ± 50 ¹⁴C years BP) guanaco assemblage with evidence of exploitation, coming from Cerro del Águila site, Buenos Aires Province, is analysed herein. The assemblage is composed by three perinatal individuals; the estimated age at the moment of death ranges from a few weeks before birth to a few weeks old. Cerro del Águila is interpreted as a site where activities of procurement and processing of perinatal individuals were performed. The available information allows raising a discussion on the hunting and exploitation strategies of guanaco in a regional context.

KEYWORDS

Argentine Pampas, Guanaco, hunter-gatherers, Late Holocene, perinatal individuals

1 | INTRODUCTION

Guanaco (*Lama guanicoe*) is the largest wild ungulate in South America; it inhabits arid or semi-arid regions from the north of Perú to the south of Argentina and Chile, mainly in the Andean mountain range (Franklin, 1983; Puig & Videla, 1995). This species has a complex social organisation that includes mixed groups, family groups, male groups, female groups, and lonely individuals, related to reproduction, breeding, and migration among other social behaviours (Franklin, 1983; Raedeke, 1978). A guanaco family group varies between 5 and 13 adult individuals, with an average of 2.9 young individuals (Puig & Videla, 1995). A female guanaco gives birth to a single offspring, its gestation period lasts 11.5 months, and the parturition timing varies with latitude (Franklin, 1983).

The guanaco was very abundant in the Argentine bonaerian Pampas during the Quaternary; however, it suffered a geographical retraction during the Late Holocene (Politis & Pedrotta, 2006; Politis, Prates, Merino, & Tognelli, 2011; Tonni & Politis, 1980). At present, it is restricted to native populations distributed in the Ventania range system and the islands of the Bahía Blanca estuary, Buenos Aires Province (Puig & Videla, 1995; Zapperi, 2009; Figure 1).

In the Argentine Pampas, the guanaco was one of the most important species in hunter-gatherer subsistence from the Late Pleistocene to

the Holocene (Martínez & Gutiérrez, 2004; Miotti & Salemme, 1999; Politis & Salemme, 1990, among others). Guanaco bone remains were recorded in most of the archaeological sites southern the Salado River (Figure 1). Most of the assemblages comprise mainly mature individuals, whereas unborn or neonate individuals are scarcely represented (e.g., Las Brusquillas 1 site, Massigoge, 2012; Calera site, Kaufmann & Álvarez, 2007).

The main goal of this contribution is to describe and analyse an archaeological assemblage of guanaco composed exclusively by perinatal individuals, with evidence of exploitation by hunter-gatherers, from the Late Holocene of Cerro del Águila site (Buenos Aires Province, Pampean Region, Argentina). Pre-burial and post-burial agents and processes involved in the formation of this assemblage are interpreted on the basis of a detailed taphonomic study. The results obtained herein are compared with the published information from other Late Holocene sites, in order to discuss and interpret the capture and exploitation strategies of this species in the region.

2 | MATERIALS AND METHODS

The specimens of guanaco studied herein are hosted in the Departamento de Humanidades, Universidad Nacional del Sur (Bahía

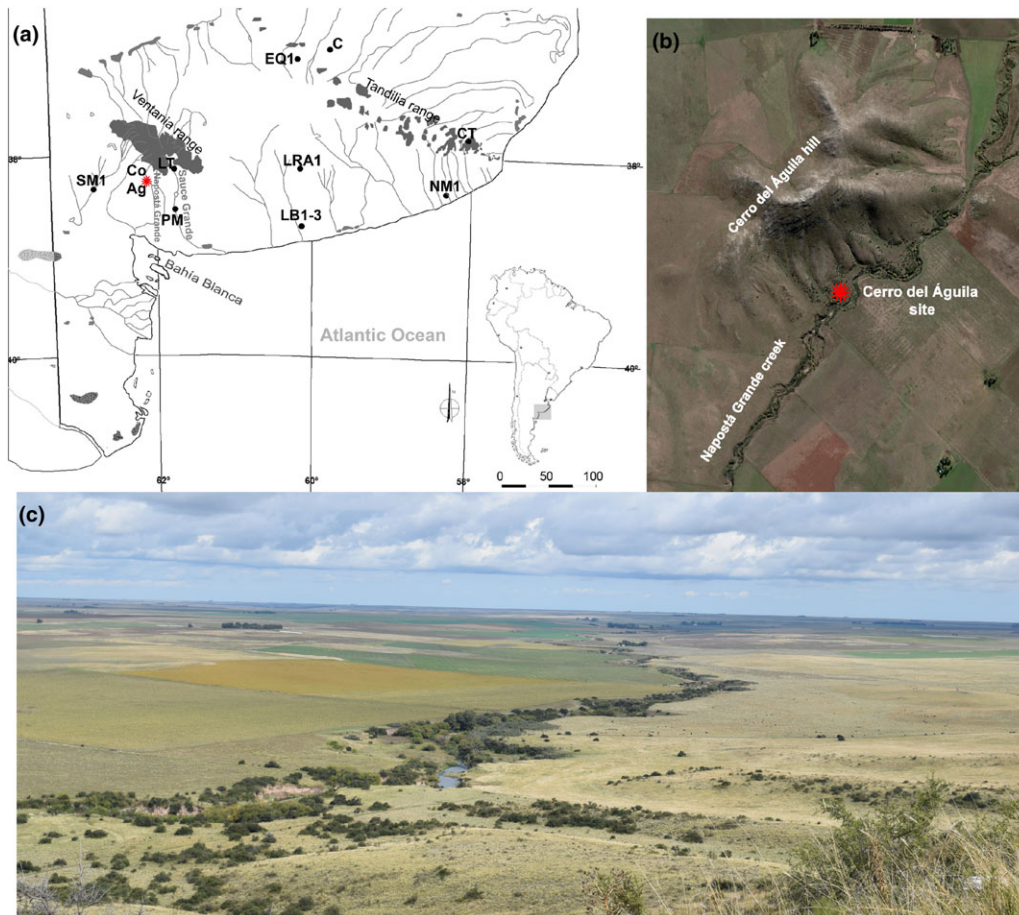


FIGURE 1 Location of study area. (a) Map showing Cerro del Águila site (Co Ag) and the other sites mentioned in the work. (b) View of the relationship between the archaeological site, Cerro del Águila hill, and Napostá Grande creek. (c) View of the Pampean plain from the top of Cerro del Águila hill. PM: Paso Mayor YI S1-2; LT: La Toma; NM1: Nutria Mansa 1; SM1: San Martín 1; C: Calera; EQ1: Empalme Querandíes 1; CT: Cueva Tixi; LRA1: La Represa Antigua 1; LB1-3: Las Brusquillas 1 and Las Brusquillas 3. [Color only in the online version] [Colour figure can be viewed at wileyonlinelibrary.com]

Blanca, Argentina), under the acronym AN CoAg/94. A radiocarbon dating was obtained using the Accelerator Mass Spectrometry method, at the National Science Foundation—Arizona Accelerator Mass Spectrometry Facility of the University of Arizona (Tucson, Arizona, United States); the sample selected was a first phalange corresponding to one of the perinatal guanaco individuals studied herein. The dating was calibrated using SHcal atmospheric curve with 95.4% of confidence (Hogg et al., 2013).

The taxonomical identification was made through anatomical comparisons with *L. guanicoe* reference collections hosted in the Museo de Ciencias Naturales de La Plata (La Plata, Argentina) and the Facultad de Ciencias Sociales, Universidad Nacional del Centro de la Provincia de Buenos Aires, INCUAPA—CONICET (Olavarría, Argentina; acronym FCS.CC), following Mengoni Goñalons (1999) and Kaufmann (2009). Some non-diagnostic skeletal elements (i.e., ribs and vertebrae) were also compared with *Ozotoceros bezoarticus* (Artiodactyla, Cervidae), species represented in the study area Pampas during the Holocene (Politis et al., 2011).

Anatomical representation was determined using different indexes: NISP (number of identified specimens per taxon; Payne, 1975), MNE (minimum number of elements; Bunn, 1982), MNI

(minimum number of individuals; White, 1953), MAU (minimum number of anatomical units; Binford, 1984), and %MAU.

The age of the individuals at death was estimated according to the fusion states of ossification centres, following the sequence and timing of fusion for *L. guanicoe* proposed by Kaufmann (2009). This analysis was performed using vertebrae, scapulae, humeri, radii, femora, tibiae, metapodials, and phalanges. Osteometrical measurements were obtained considering different variables and plotted against the graphical model of age estimation for *L. guanicoe* proposed by L'Heureux and Kaufmann (2012). This analysis was performed using metacarpals, radii, and the first and second phalanges. The archaeological specimens were also compared, from a morphometrical viewpoint, with bones of modern individuals that have known age at death, corresponding to the osteological collection of the Facultad de Ciencias Sociales, Universidad Nacional del Centro de la Provincia de Buenos Aires, INCUAPA—CONICET.

Anthropical activity was evaluated on the basis of the presence of butchering marks. The analysis considers features, location, and orientation of the marks (Binford, 1981; Mengoni Goñalons, 1999; Potts & Shipman, 1981). Functionality of marks was interpreted on

the basis of ethnographical, historical, and ethnoarchaeological information (Binford, 1981; Mengoni Goñalons, 1999).

The following taphonomic features were analysed in all the specimens (NISP = 148):

1. Articulation. Whether the specimens were articulated, disarticulated but associated, or disarticulated and isolated (Behrensmeyer, 1991).
2. Breakage. Whether the specimens were broken or not. The type of fracture was determined in long bones (humerus, radius, ulna, femur, tibia, metacarpal, and metatarsal), considering the proposal of Marshall (1989).
3. Predator/scavenger activity. Based on the presence of marks produced by carnivores (Binford, 1981; Fernández-Jalvo & Andrews, 2016; Lyman, 1994).
4. Weathering. Based on the stages defined by Behrensmeyer (1978), where Stage 0 represents specimens with no evidence of weathering and Stage 5 indicates an extreme degree of weathering.
5. Abrasion. Based on the categories proposed by Alcalá (1994), where Category 0 represents unaltered specimens, Category 1 represents specimens with rounding, and Category 2 represents specimens with polishing.
6. Impregnation, encrustation, and corrosion. Consider specimens with fossil-diagenetic modifications (Fernández-Jalvo & Andrews, 2016; Lyman, 1994).

3 | GEOGRAPHICAL AND ARCHEOLOGICAL SETTING

Cerro del Águila archaeological site (62°7'S, 38°12'W; 254 m.a.s.l.) is located in the upper valley of the Napostá Grande creek, near the Cerro del Águila hill, which represents the southern end of the Ventania range system (south-west of Buenos Aires Province, Pampean Region, Argentina; Figure 1). From a phytogeographical and zoogeographical viewpoint, the study area constitutes an ecotone very sensitive to the climatic changes since the Holocene (Cabrera, 1976; Deschamps, 2005; Quattrocchio, Borromei, Deschamps, Grill, & Zavala, 2008; Ringuelet, 1961).

The site was discovered in 1994 during geoarchaeological fieldworks in the Napostá Grande creek valley. Fieldworks included excavation by decapage and dry screening, using a mesh size of 2 mm. Several materials were recovered from surface up to 30-cm depth (Bayón, Frontini, & Tomassini, 2016), including a single stone tool and bone remains. The lithic artefact is a quartzite core, which raw material is available locally in the valley; no other material culture was recovered. Archaeofaunistic assemblage comprises 179 specimens; the 82.7% corresponds to guanaco, whereas the remaining are undetermined remains of large mammals. Guanaco was the only taxon recorded in this site.

4 | STRATIGRAPHICAL AND CHRONOLOGICAL SETTINGS

Specimens were recovered from a level of light brown to grayish brown silt and sandy silt. This deposit is generally massive, although

fine diffuse lamination can be distinguished in some sectors; root traces are common in the upper portion. Stratigraphical correlations with outcrops located in other sites of the Napostá Grande creek valley (e.g., Deschamps, 2005; Grill, 1995) allow assigning the bearing level to the Chacra La Blanqueada Formation (Rabassa, 1989). This unit represents a floodplain environment, originated from the deposition of sediments provided during flooding events (Deschamps, 2005; Tomassini, Frontini, & Bayón, 2014; and references therein). The radiocarbon dating yielded an age of $3,184 \pm 50$ ^{14}C years BP (1,521–1,264 years cal. BC; AA106110; $\delta^{13}\text{C}\text{‰} = -18.3$), corresponding to the early Late Holocene.

5 | RESULTS

5.1 | Anatomical representation

The NISP of the assemblage is 148, and the MNE is 103. The MNI is 3, on the basis of right radii, left ulnae, and left humeri. Ribs and vertebrae are the most abundant skeletal elements. The MAU and %MAU values show that humeri, radii, ulnae, metacarpals, and scapulae are the best represented elements. On the contrary, isolated teeth, axis, sternbrae, pelvis, and third phalanges are absent. It is worth highlighting that the cranial elements are represented only by one fragment of right hemimandible with p4-m1, one occipital, and one temporal bulla (Table 1).

5.2 | Age of the individuals

The fusion state of the ossification centres was evaluated only in 36 skeletal elements, due to the high breakage degree of the assemblage (Table 2). Most of the ossification centres ($n = 18$) are separated from their counterpart due to the decomposition of the epiphyseal plate, which was considered as evidence of an unfused stage (Table 2). In one ossification centre, a line can be seen in-between the centres, representing an incomplete fusing stage (Table 2). Fused ossification centres were not recorded.

According to Kaufmann (2009), VT1 and VL1 for thoracic and lumbar vertebrae, respectively, MC2 for III-IV metacarpals, and RC6 for ulnae, are ossification centres that merge at very early ontogenetical stages. VT1 appears unfused up to 3 months old, in a fusing stage between 15 days and 6 months old, and already fused from 3 to 6 months old. VL1 appears unfused up to 3 months old, in a fusing stage between 10 gestation months and 3 months old and reach a fused stage between 15 days and 3 months old. MC2 appears unfused up to 11 gestation months, in a fusing stage between 10 gestation months and 3 months old and reach a fused stage between 3 and 6 months old. RC6 appears unfused up to 6 months old, in a fusing or fused stage between 3 and 6 months. The other recorded centres fuse in later ontogenetical stages (Table 2; see Kaufmann, 2009). These results suggest that the assemblage is composed by immature individuals that died between 10 months of gestation and 3 months old approximately.

Osteometrical measurements were calculated only in 12 skeletal elements, due to the high breakage degree of the assemblage. The average ages obtained mostly correspond to negative values,

TABLE 1 Anatomical representation of guanaco from Cerro del Águila assemblage

Skeletal elements	NISP					MNE	MAU	% MAU
	R	L	NI	Axial	Total			
Occipital bone	1				1	1	1	33.33
Temporal bulla		1			1	1	0.5	16.67
Hemimandible	1				1	1	0.5	16.67
Atlas				1	1	1	1	33.33
Cervical vertebra				12	12	7	1.4	46.67
Thoracic vertebra				8	8	5	0.42	13.89
Lumbar vertebra				6	6	5	0.72	23.81
Thoracic or lumbar vertebra				5	5	5	—	—
Undetermined vertebra				1	1	1	—	—
Rib				59	59	30	1.25	41.67
Scapula	1	3			4	4	2	66.67
Humerus shaft	3	3			6	6	3	100
Humerus distal epiphysis		1			1			
Ulna	3	3			6	6	3	100
Radius shaft	3	3	1		7	6	3	100
Radius proximal epiphysis		1			1			
Scaphoid	1				1	1	0.5	16.67
Magnum	1				1	1	0.5	16.67
Pisiform			1		1	1	0.5	16.67
Metacarpal	2	2			4	4	2	66.67
Femur	1	1			2	2	1	33.33
Patella	1				1	1	0.5	20
Tibia	1	1			2	2	1	33.33
Metapodial shaft			5		5	4	—	—
Metapodial distal epiphysis			2		2			
First phalange (forelimb)			4		4	4	1	33.33
First phalange (hindlimb)			3		3	3	0.75	30
Second phalange (forelimb)			1		1	1	0.25	10
Second phalange (hindlimb)			1		1	1	0.25	10
					Total	148	103	

Note. L: left; R: right; NI: nonidentifiable laterality.

except for one first phalange. The range of average ages varies from -3.77 to 0.47 months (Table 3). Thus, it can be estimated that the death of individuals would have occurred between the eighth month of gestation and 15 days old approximately (see L'Heureux & Kaufmann, 2012).

Skeletal elements from the assemblage of Cerro del Águila were compared with bones of modern guanacos with known age at death. All archaeological specimens displayed clear morphometrical similarities with individuals that died between the 10th month of gestation and 15 days old (Figure 2). This is coincident with the results obtained from the two age estimation methodologies analysed above.

In summary, the range age of death estimated through the three methods is coincident. This allows inferring that the death of individuals occurred between a few days before birth and few weeks after birth.

5.3 | Anthropical activity

Cut marks were recorded in four different skeletal elements; all of them present a single linear mark, with a V-shaped cross section.

The left scapula AN CoAg 23/94 has a superficial mark located in the subscapular fossa, transversal to the lateral border (Figure 3b). The left metacarpal AN CoAg 18/94 has a deep mark in the lateral face of the distal end, oblique to the long axis, with external striation (Figure 3d). The left humerus AN CoAg 12/94 has a deep mark oblique to the diaphysis in the distal section of the external epicondyle (Figure 3a). The first phalange AN CoAg 33/94 has a superficial mark in the palmar face of the proximal end, between the proximal articular surface and the sesamoid articular section, oblique to the long axis (Figure 3c).

5.4 | Other taphonomic features

All the specimens were disarticulated and isolated (*sensu* Behrensmeyer, 1991). Specimens without fractures were very scarce (8.33% of 148 total NISP), represented only by phalanges, radii, metacarpals, and ribs. Broken long bones showed spiral, sawtooth, and transverse fractures (*sensu* Marshall, 1989). Marks related with

TABLE 2 Fusion states of the ossification centres in different skeletal elements (following Kaufmann, 2009)

Skeletal elements	Ossification centres	Fusion states			Estimated age
		U	F	A	
Scapula (NISP = 1)	ESC1 (coracoid process–body)	1			<9 m
Humerus (NISP = 4)	HU2 (proximal epiphysis–diaphysis)	2		2	<30 m
	HU5 (distal epiphysis–diaphysis)	3		1	<6 m
Metacarpal (NISP = 4)	MC1 (diaphysis–distal condilae)	4			<30 m
	MC2 (third metacarpal–fourth metacarpal)		4		10 gm–3 m
Radius (NISP = 6)	RC5 (diaphysis proximal epiphysis)	2		4	<6 m
Ulna (NISP = 6)	RC3 (proximal epiphysis–diaphysis)	3		3	<30 m
	RC4 (ulna diaphysis–radius diaphysis)	6			<6 m
	RC6 (ulna diaphysis–radius epiphysis proximal)	6			<6 m
Tibia (NISP = 1)	TI2 (proximal epiphysis–tuberosity + diaphysis)	1			<30 m
Cervical vertebra (NISP = 1)	VC1 (anterior epiphysis–body)	1			<36 m
	VC2 (posterior epiphysis–body)	1			<48 m
Thoracic/lumbar vertebra (NISP = 4) ^a	VT1/VL1 (neural arch–body)	4			<3 m
	VT2/VL2 (anterior epiphysis–body)	4			<48 m
	VT3/VL3 (posterior epiphysis–body)	4			<48 m
First phalange hindlimb (NISP = 4)	FPD1 (proximal epiphysis–diaphysis)	4			<30 m
First phalange forelimb (NISP = 2)	FPT1 (proximal epiphysis–diaphysis)	2			<24 m
Second phalange hindlimb (NISP = 1)	FMD1 (proximal epiphysis–diaphysis)	1			<30 m
Second phalange forelimb (NISP = 2)	FMT1 (proximal epiphysis–diaphysis)	2			<30 m

Note. The presence of unfused lumbar/thoracic vertebrae and fusing metacarpals. U: unfused; F: fusing; A: absent; m: months; gm: gestation months; NISP: number of identified specimens per taxon.

^aIt was not possible to distinguish thoracic (VT) and lumbar (VL) vertebrae; however, according to Kaufmann (2009), both types of vertebrae present the same ossification centres.

TABLE 3 Metacarpals, radii, and phalanges measures (mm) and estimated ages (months; following L'Heureux & Kaufmann, 2012)

Long bones	GL		GBpxD		GDpxD		BdsE		Average ages
	mm	Age	mm	Age	mm	Age	mm	Age	
Metacarpal (AN CoAg 19/94)	178.60	-2.5			20.26	0.16			-1.17
Metacarpal (AN CoAg 20/94)	175.44	-4.28			19.88	-0.4			-2.34
Metacarpal (AN CoAg 18/94)	175.96	-3.03			19.28	-2			-2.5
Radius (AN CoAg 52/94)	159.34	-3.1	30.46	1.5	18.76	-1.1			-0.9
Radius (AN CoAg 49/94)	165.15	-1.5							-1.5
Radius (AN CoAg 65a/94)							31.37	-2	-2
Phalanges	GL		Bp		Dp		Bd		Average ages
	mm	Age	mm	Age	mm	Age	mm	Age	
First phalange forelimb (AN CoAg 34/94)	53.18	-2	13.38	-2					-2
First phalange forelimb (AN CoAg 33/94)	54.61	0.5	13.83	-2					-0.75
First phalange forelimb (AN CoAg 38/94)			13.33	-2					-2
First phalange hindlimb (AN CoAg 35/94)	49.57	2.3	13.8	-0.5	13.38	-2			-0.66
Second phalange forelimb (AN CoAg 41/94)	22.93	2.9	11.81	0.8	10.95	-0.2	9.4	-1.6	0.47
Second phalange hindlimb (AN CoAg 40/94)	19.38	-4	11.02	-3.3	10.33	-4			-3.77

Note. GL: greatest length; GBpxD: greatest proximal breadth; GDpxD: greatest proximal depth; BdsE: breadth of the unfused distal epiphysis; Bp: breadth of the proximal end; Dp: depth of the proximal end; Bd: bread of the distal end.

the activity of carnivores (e.g., punctures) were recorded in a few specimens (9.46%), including vertebrae, scapulae, and limb elements. Specimens with evidence of weathering included scapulae, vertebrae, ribs, and limb elements (radii, ulnae, humeri, tibiae, metapodials, and phalanges); some of them (9.85%) showed slight splitting parallel to the fibre structure (Stage 1, *sensu* Behrensmeyer, 1978), whereas others (1.52%) presented flaking and deeper splitting (Stage 2, *sensu*

Behrensmeyer, 1978). None of the specimens displayed signs of abrasion (Category 1, *sensu* Alcalá, 1994).

All specimens showed encrustation, represented by calcareous coatings. Impregnation with manganese oxides was observed in several specimens (40.74%), represented by dark spots with dendritic habit. Specimens with root traces assigned to the *Corrosichnia* ethological category were abundant (45.93%).

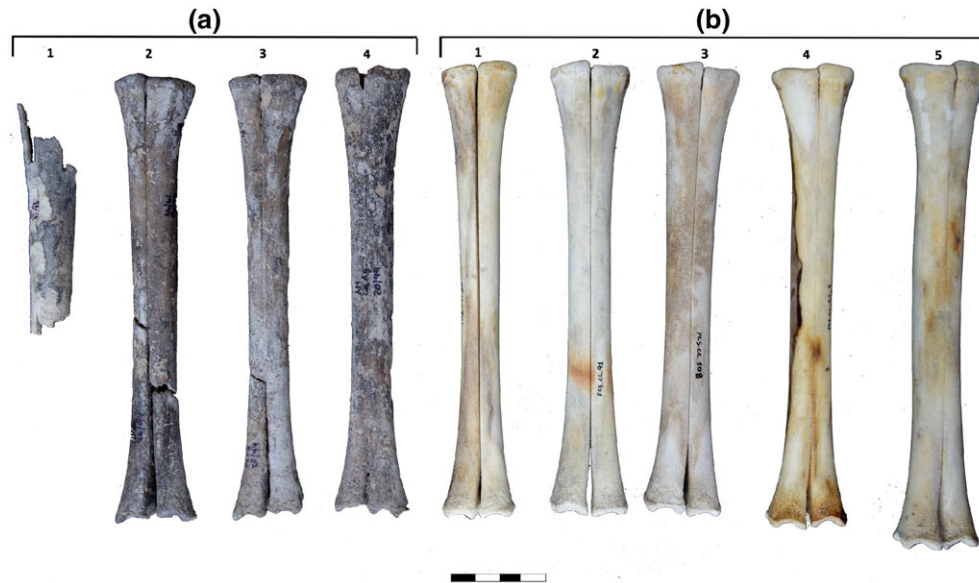


FIGURE 2 Fusing metacarpals corresponding to (a) Cerro del Águila assemblage and (b) modern populations from Río Negro Province. (a1) AN CoAg 71/94; (a2) AN CoAg 19/94; (a3) AN CoAg 18/94; (a4) AN CoAg 20/94; (b1) FCS CC 86, 10–11 gestation months; (b2) FCS CC 91, 10–11 gestation months; (b3) FCS CC 108, 0–0.5 months old; (b4) FCS CC 25.3, 0–0.5 months old; (b5) FCS CC 17, 0.5–3 months old. Bar scale = 4 cm. [Color only in the online version] [Colour figure can be viewed at wileyonlinelibrary.com]

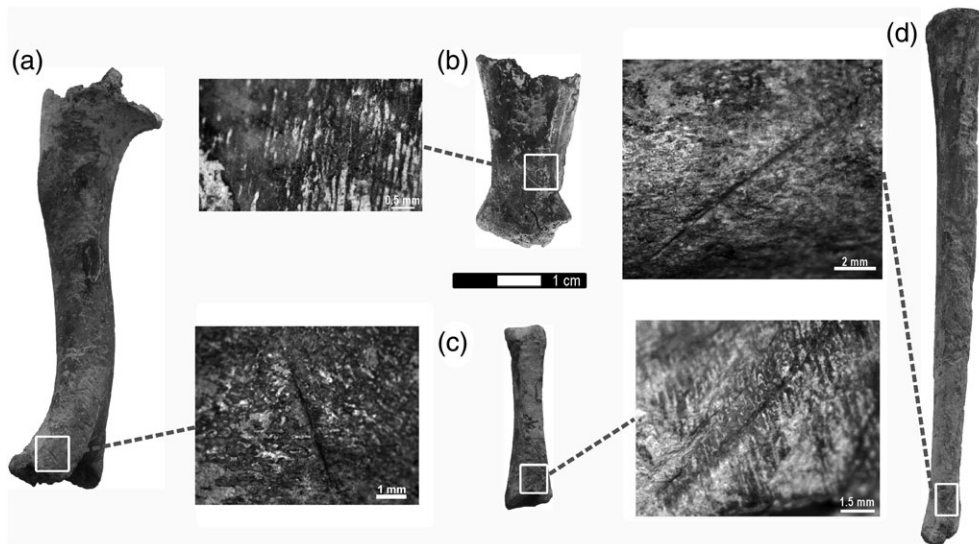


FIGURE 3 Butchering marks: (a) left humerus AN CoAg 12/94, (b) left scapula AN CoAg 23/94, (c) first phalange AN CoAg 33/94, and (d) left metacarpal AN CoAg 18/94

6 | DISCUSSION

The assemblage recovered in Cerro del Águila site comprises several specimens belonging to three individuals of guanaco. Radiocarbon dating ($3,184 \pm 50$ ^{14}C years BP) reflects that this assemblage corresponds to the early Late Holocene. Guanaco is recorded in several sites of the Argentine Pampas with similar chronology (Table 4); particularly for the Napostá Grande creek valley, this species was mentioned in García del Río, Arroyo Napostá Grande, and Paso Vanoli sites (Deschamps, 2005; Deschamps & Tomassini, 2016; Tomassini et al., 2014; Vecchi, Frontini, & Bayón, 2013). It is worth highlighting that the studied assemblage is composed

exclusively by perinatal individuals; in this regard, the three methods used herein suggest that the age at death of the three individuals ranges from a few weeks before birth to a few weeks old.

The knowledge of the ethology of animals is relevant in the design of hunting strategies (e.g., Aschero & Martínez, 2001; Churchill, 1993; Ratto, 2003; Santiago & Salemmé, 2016). In the population structure of living guanacos, family groups are variable in size (Raedeke, 1978); they are in average formed by seven or eight guanacos, including one adult male, four adult females, a young female, and one or two neonates (Puig & Videla, 1995; Raedeke, 1978). The neonates can stand up as early as 5–76 min post-partum and are closely linked with their mothers until about a year old

TABLE 4 Information on the ontogenetical stages of guanaco individuals recorded in archaeological sites of the Late Holocene Argentine Pampas

Site	Functionality/observations	¹⁴ C years BP	MNI	Ontogenetical stages (MNI)						References
				U/N	Ca	J	Sub	A	Se	
LT, lower level	Multiple activities. Neonate based on the fusing state of the long bones ossification centres	3,523 ± 32	6	1					5	Álvarez and Salemme (2015)
	Occupations during November and December									
LRA1	Multiple activities	3,430 ± 40	4			1			3	March et al. (2011)
	No information about seasonality	3,180 ± 40 3,053 ± 40								
C	Ritual site. Ontogenetical stages based on the development and wear of teeth	3,390 ± 170 3,005 ± 66	55	8	4	5	11	21	6	Kaufmann and Álvarez (2007)
	Occupations during late spring and early summer									
LB1	Multiple activities	3,334 ± 43	5	1		2			2	Massigoge (2012)
	Occupations during mid spring and late summer									
CT—Occupation 3)	Short-term occupation. Site of processing	3,255 ± 75	2	1 ^a					1	Mazzanti and Quintana (2001)
	No information about seasonality									
CAG	Special activities	3,184 ± 50	3	3						This work
Equation 1	Multiple activities. Ontogenetical stages based on the development and wear of teeth	3,095 ± 50 (Bone Pile 2) 2,816 ± 49	3 9	1 3		4	2		2	Álvarez, Messineo, and Kaufmann (2017)
	Occupation during different periods of the year									
NM1	Multiple activities. Primary and secondary butchery	3,080 ± 10 2,920 ± 110 2,705 ± 66	Bone pile: 8 Out of bone pile: 26	2 ^a 4 ^a					6 22	Bonomo (2005)
	Occupations during late spring and early summer									
SM1	Multiple activities	2,890 ± 80	5			2			3	Oliva, Catella, and Morales (2010)
	No information about seasonality									
LB3	Multiple activities	2,830 ± 110	6		2	1			3	Massigoge et al. (2018)
	No information about seasonality									
PM	Multiple activities	2,774 ± 45	3			1			2	Bayón, Pupio, Frontini, Vecchi, and Scabuzzo (2010)
	Spring occupations (based on the presence of Rheidae eggs)									

Note. LT: La Toma; LRA1: La Represa Antigua 1; C: Calera; LB1: Las Brusquillas 1; CT: Cueva Tixi; CAG: Cerro del Águila; Equation 1: Empalme Querandíes 1; NM1: Nutria Mansa 1; SM1: San Martín 1; LB3: Las Brusquillas 3; PM: Paso Mayor YI S1-2; MNI: minimum number of individuals; U/N: unborn/neonate: last gestation months to 15 days old; C: calf: 15 days old to 1 year old; J: juvenile: 12 to 24 months old; Sub: subadult: 24 to 30 months old; A: adult: 3 to 10 years old; Se: senile: +10 years old.

^aImmature in the original paper.

(Raedeke, 1978); then, the adult male expels them from the group (Franklin, 1983). Considering this ethological characteristic, it is proposed that the capture of guanacos in Cerro del Águila site could have been oriented towards family groups. It can be stated that the assemblage is biased from an ontogenetical viewpoint and only represents a small part of a family group. The MNI obtained is coincident with the number of neonate individuals present in the family groups of modern populations.

The parturition timing for this species varies with the latitude (Franklin, 1983). Zapperi (2009) studied the guanaco populations

that currently inhabit in the Parque Provincial Ernesto Tornquist, a natural reserve located in the context of Ventania range system (~40 km north-eastern Cerro del Águila site; Figure 4). This author determined that the parturition timing in this zone ranges from November to January. On the basis of the range of ages represented in the studied assemblage (few weeks before birth to a few weeks old), it can be inferred that the capture event occurred in late spring/early summer.

The evidence of processing activities was represented by specimens with butchering marks. The mark in the first phalange is



FIGURE 4 Part of a guanaco family group in the Parque Provincial Ernesto Tornquist (Buenos Aires Province; September 29, 2007). Left to right: fawn, fawn, adult female, fawn, adult female, and adult female. [Color only in the online version] [Colour figure can be viewed at wileyonlinelibrary.com]

interpreted as derived from skinning procedures (Binford, 1981, p. 126). The marks in the distal humerus and the metacarpal represent primary dismemberment (Binford, 1981; Mengoni Goñalons, 1999). The mark in the scapula evidences filleting activities (Binford, 1981; Mengoni Goñalons, 1999). Although the cut marks are scarce, according to the available ethnoarchaeological information for ungulates, different activities could be recognised in the assemblage. Thus, it can be proposed that the preys were used integrally, for extracting both leather and meat. On the basis of the evidence, Cerro del Águila could be interpreted as a site where activities of procurement and processing of perinatal guanaco individuals were performed by hunter-gatherers.

The deliberate procurement of unborn and newborn individuals was mentioned for different species of ungulates in historical and ethnographical records (Binford, 1978, pp. 53, 86–87, 150). Particularly for guanaco, the 19th-century voyagers (Hatcher, 1903; Claraz, 1988, pp. 60, 73; Moreno, 1969, p. 35) reported the hunting of pregnant female and newborn individuals by natives for the extraction of meat and leather, this latter for manufacture of fur cloak (*quillango*) and other soft clothes (see Caviglia, 2002, and references therein). With respect to this, Hatcher (1903, p. 268) mentioned “(...) while the coverings of the tent or *toldos* of these Indians are made of the skins of the adult guanaco carefully and strongly sewed together, their clothing and bedding are for, the most part, made of skins of the young animals. For such purposes only the skins of such as are less than two months old are employed and the very choicest of these fur mantles are manufactured from the skin of the still unborn young. These are obtained by killing the mother few days before the birth of the young guanaco.”

The landscape is a relevant aspect considered in the determination of hunting strategies (e.g., Aschero & Martínez, 2001; Churchill, 1993; Miotti, 2003; Ratto, 2003). The topographical features that allow to visually dominate the landscape and control the natural resources are useful to anticipate the place where animals could head for, to ambush them, and to predict and control the trajectory of the escaping preys (see Mazzanti & Bonnat, 2013; Santiago & Salemme, 2016). Cerro del Águila site is located near a low hill (Cerro del Águila, ~400 m.a.s.l.), from the top of which it can be seen much of the plain

(Figure 1b,c); this topographical characteristic would have represented a strategical point used by hunter-gatherers for observing and intercepting the guanaco groups when they went to the Napostá Grande creek for water and food.

The anatomical representation of the Cerro del Águila assemblage showed some peculiarities. The low representation of skulls, mandibles, and the absence of isolated teeth is noteworthy. This situation raises an unsolved equifinality: (a) the high destruction of cranial elements as consequence of weathering. Actualistic studies on weathering of guanaco bones showed that the skeletal elements corresponding to immature individuals reached more advanced weathering stages faster than those skeletal elements corresponding to adult individuals; this is particularly noticeable in skulls, mandibles, and teeth (Massigoge, González, Kaufmann, & Gutiérrez, 2010). This situation could also have been favoured by the combination with other pre-burial and post-burial destructive processes (e.g., activity of scavengers, trampling, and activity of roots). (b) The skull could have been selected by hunter-gatherers and transported to other place for consuming the brain, due to its nutritional value. Ethnographical studies mention the use of the head for food extraction (Binford, 1978, p. 86).

There are also differences between the representation of the scapular girdle/elements of the forelimb and the pelvic girdle/elements of the hindlimb. However, the small size of the assemblage does not allow making conclusive interpretations about this aspect.

On the basis of the diverse taphonomic features of the assemblage (absence of articulated specimens, representation of different weathering stages, presence of carnivore marks, and high predominance of broken specimens with fractures typical of the biostratigraphic stage), it is estimated that the remains were exposed during a time on the surface, in the area of the floodplain of the Napostá Grande creek. The absence of signs of abrasion suggests that the time of interaction between bones and sedimentary particles was not long or that the intensity was very low; this hypothesis is consistent with the low energy interpreted for the bearing level and allows inferring that the specimens were preserved in the place of death or very near.

After burial, the specimens were modified by different processes that reflect a direct interaction with the substrate where they were preserved. Precipitation of manganese oxides reflects alkaline and oxidising conditions of the preservation environment during dry periods (López-González, Grandal-d'Anglade, & Vidal-Romani, 2006; Marín Arroyo et al., 2008; Tomassini et al., 2014). Calcareous encrustations indicate alkaline conditions of the preservation environment during dry periods (Fernández López, 2000; Lyman, 1994). Root traces suggest a temporary shallow burial in a substrate supporting vegetation (see Mikuláš, 1999; Montalvo, 2002). The record of transversal fractures, typical of the fossil-diagenetic stage, suggests that the specimens were probably affected by lithostatic load of the overlying sediments (Alcalá & Escorza, 1998).

In order to analyse the possible prey selection according to the ontogenetical stage of the guanaco individuals among regional hunter-gatherers, a synthesis of the published information from the Pampean Region of Argentina, for the interval ranging from 3,500 to 2,500 ¹⁴C years BP, is presented herein (Table 4 and Figure 5). Only archaeological sites with radiocarbon dating and with information of the age structure of the assemblage were considered

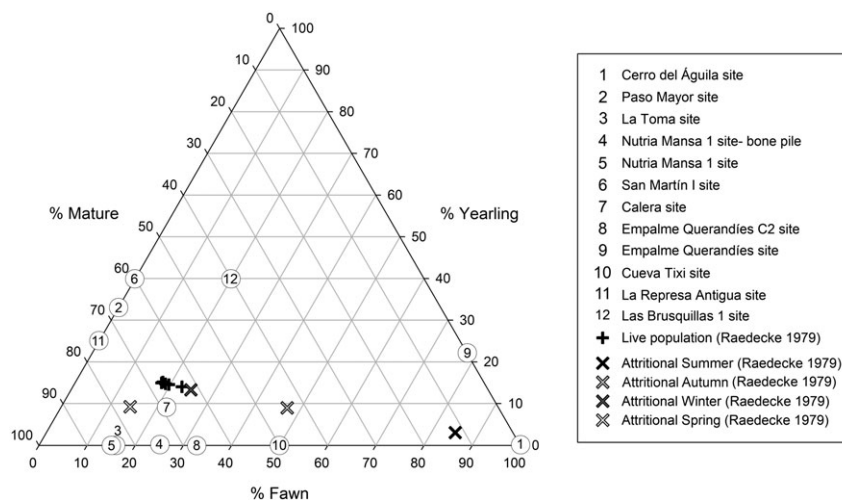


FIGURE 5 Fawn–juvenile–mature plot system (following Lubinski, 2000) showing ages distribution of archaeological guanaco assemblages, modern live guanaco population, and attritional death

($n = 11$). Individuals with different ontogenetical stages were mentioned in most of the sites, mainly corresponding to juveniles and adults, except in Cerro del Águila site that includes only perinatal individuals (Table 4). In four of these sites (La Toma, Calera, Empalme Querandíes 1, and Las Brusquillas 1), the presence of unborn or neonate individuals were also indicated, and in three other sites (Nutria Mansa 1, Cueva Tixi, and Las Brusquillas 3), immature individuals were reported; nevertheless, in all cases, these ontogenetical stages represent a small proportion of the total MNI of each assemblage. When we plot the archaeological records against live populations and attritional dead information, following Lubinski (2000), most of the sites are within or near the cluster of live populations; only Cerro del Águila site is near the cluster of summer attritional dead (Figure 5).

The absence of unborn or neonate guanacos in the remaining sites could be explained by different factors. Among natural factors, destructive taphonomic processes (e.g., weathering, trampling, and activity of predators/scavengers) could produce biased assemblages, because bones belonging to immature individual are destroyed quickly (see Massigoge et al., 2010; Munson, 2000). Regarding anthropical factors, hunting strategies, landscape use, site functionality, and seasonality of occupations, among others, influence the representation of the different ontogenetical stages.

The structure of the live populations of guanaco varies throughout the year (Kaufmann, 2009), and the presence of neonate/newborn individuals is restricted to the end of spring and early summer. In this frame, the record of specimens belonging to these ontogenetical stages is an important proxy to infer the period of occupation of the archaeological sites.

In this context, it is also important to highlight that in several archeological sites, the age structure of the assemblage was not informed because the specific frames of reference to evaluate the representation of different ontogenetical stages of guanaco specimens were only considered in recent years (see Kaufmann, 2009).

7 | CONCLUSIONS

The analysis performed in the assemblage of Cerro del Águila site contributes to the interpretation of guanaco exploitation strategies

by Pampean hunter-gatherers during the Late Holocene. It is an exceptional assemblage that could represent a short-term episode, exclusively composed by perinatal individuals—with an estimated age from a few weeks before birth to a few weeks old; the three different methods used herein for determining the age at death of individuals resulted coincident.

Cerro del Águila could be interpreted as a site of special activities oriented to the procurement of leather and meat. The exclusive exploitation of perinatal individuals could have been included in a regional hunting strategy that emphasises mature individuals of this species, as it was recorded in other Late Holocene sites located in the south-west of Buenos Aires Province, Argentina, including Paso Mayor Y I-II (Bayón et al., 2010), and García del Río (Tomassini et al., 2014). The available evidences suggest that the hunter-gatherers possibly used the topographical features of the area in the determination of hunting strategies.

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