



# Technology, subsistence, and mobility of Middle to Late Holocene hunter-gatherers in the southern Pampas: new archaeological data from Las Toscas shallow lake (Argentina)

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## Abstract

Despite a long history of hunter-gatherer occupation in the Pampas region starting at the end of the Pleistocene, the known archaeological record is still sparse for some periods, such as the Middle Holocene. Here, we present new archaeological data from Las Toscas shallow lake, located in the inland plains of the southern Pampas, where systematic fieldwork revealed an abundant and diverse archaeological record resulting from hunter-gatherer occupation. The aims of this study were to establish the chronology of the occupations; to evaluate the use of faunal and lithic resources; and to contribute to the understanding of hunter-gatherer land use patterns. Archaeological evidence indicates that procurement, domestic, and ritual activities were conducted around the shallow lake during the Middle and Late Holocene, including hunting of terrestrial game; tool manufacture and repair; storing and use of mineral pigments; and likely human burial practices. Evidence also suggests that the use of this locality was not continuous but redundant and that this shallow lake was a persistent place for hunter-gatherers. Faunal data agrees with regional models that propose that *Lama guanicoe* was the main food resource during the second half of the Middle Holocene, although a taphonomic bias in favor of larger vertebrates cannot be ruled out. The lithic assemblages suggest that artifacts entered the locality mostly as part of individual toolkits and indicate a strong preference for orthoquartzite. Finally, bone remains of extinct fauna were recovered at the locality; however, a functional association between these remains and cultural material could not be demonstrated.

**Keywords** Hunter-gatherers · Southern Pampas · Middle Holocene · Late Holocene · Subsistence · Lithic technology

## Introduction

Since the end of the Pleistocene (ca. 12,200 <sup>14</sup>C years BP; ca. 14,000 cal years BP) to the Late Holocene, the southern Pampas of Argentina was inhabited by mobile hunter-gatherers (Politis 2008). According to most authors, the evolution and historic trajectory of hunter-gatherers from

this region were a continuous process from the initial peopling of the region until the European conquest, although gradual changes in technology, subsistence, mobility, and land use were proposed (Politis 1986; Martínez 2002; Martínez et al. 2015; Mazzanti et al. 2015). However, other authors considered the peopling of this area as a discontinuous process, based on radiocarbon analysis and human craniofacial morphology (Barrientos 2001; Barrientos and Perez 2005; Barrientos et al. 2005). In particular, the occurrence of contraction or extinction processes in the local population has been proposed for the second half of the Middle Holocene<sup>1</sup>, based primarily in a gap in the

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<sup>1</sup> In this paper we follow the formal Holocene subdivision accepted by the International Union of Geological Sciences (Walker et al. 2018).

archaeological signal between ca. 5000 and ca. 4400 cal years BP<sup>2</sup> (Barrientos et al. 2005; Barrientos and Masse 2014).

The available archaeological information for the Middle Holocene suggests a high residential mobility based on short-term occupations of varied environmental settings, such as the inland plains, the hills, and the Atlantic coast (Martínez 2002; Mazzanti et al. 2015; Frontini and Bayón 2017). Current subsistence models propose that during the first half of the Middle Holocene (ca. 8200 to ca. 6200 cal years BP), hunter-gatherers exploited a broad spectrum of faunal resources, including terrestrial and marine species (Politis et al. 2009; Bonomo et al. 2013b; Álvarez 2014; Frontini and Bayón 2017). As for the second half (between ca. 6200 and ca. 4200 cal years BP), a stronger emphasis in terrestrial mammals has been proposed, and some researchers have suggested a specialization in ungulate hunting (Quintana and Mazzanti 2001; Martínez and Gutiérrez 2004; Álvarez 2014). Regarding the lithic technology, orthoquartzite was the preferred raw material for tool production (Martínez 2002; Barros et al. 2018; Donadei 2019). Medium-sized triangular projectile points and bola stones were the basic hunting tools, while unifacial tools, mainly side and end scrapers, were the more common processing tools (Politis 2008; Donadei 2019).

The number of archaeological sites notably increases for the Late Holocene, and most researchers relate this fact to an increase in population density (Mazzanti 2006; Politis 2008; Martínez et al. 2015). Also, a reduction in residential mobility, an increase in territoriality, and an intensification of supra-regional interaction social networks have been proposed (Bayón and Flegenheimer 2004; Mazzanti 2006; Politis 2008; Martínez et al. 2015). Regional models state that specialization in ungulate hunting continued during the first millennia of the Late Holocene but propose changes in subsistence after ca. 1000 years BP. These changes include a greater dependence on plant resources, a more intense processing of carcasses of ungulates, and an increase in small animal exploitation (Martínez and Gutiérrez 2004; Politis 2008; Quintana and Mazzanti 2014). Continuity in several aspects of the lithic technology is observed during the Late Holocene, such as raw material selection and tool manufacture techniques. Technological changes included the appearance of small triangular projectile points associated with bow and arrow technology; an increased number of grinding stones; and a more important role of strategies of provisioning places

with lithic artifacts and raw materials (Martínez and Mackie 2003; Bayón and Flegenheimer 2004). Other important technological innovation incorporated by hunter-gatherers during this period was pottery (Politis et al. 2001).

In this paper, we present and discuss new archaeological evidence dating to the Middle and Late Holocene recovered from Las Toscas shallow lake, a locality that revealed a rich record of hunter-gatherer occupations. The quantity and variety of surface materials and the preservation of buried remains make Las Toscas shallow lake a significant place for evaluating the land use patterns by hunter-gatherers from the southern Pampas during the second half of the Holocene. It also provides much needed Middle Holocene archaeological data for this region. Here, we present the first comprehensive study of the archaeological materials (i.e., lithic artifacts, mineral pigments, ceramic, and faunal remains) and three radiocarbon dates for the locality. The aims of this study were to establish the chronology of the hunter-gatherer occupations; to evaluate the use of faunal and lithic resources; and to contribute to the understanding of the land use patterns during the Middle and Late Holocene. Finally, archaeological data from Las Toscas shallow lake was used to evaluate previous models and hypotheses related to technology, subsistence, and mobility of Middle to Late Holocene hunter-gatherers from the southern Pampas.

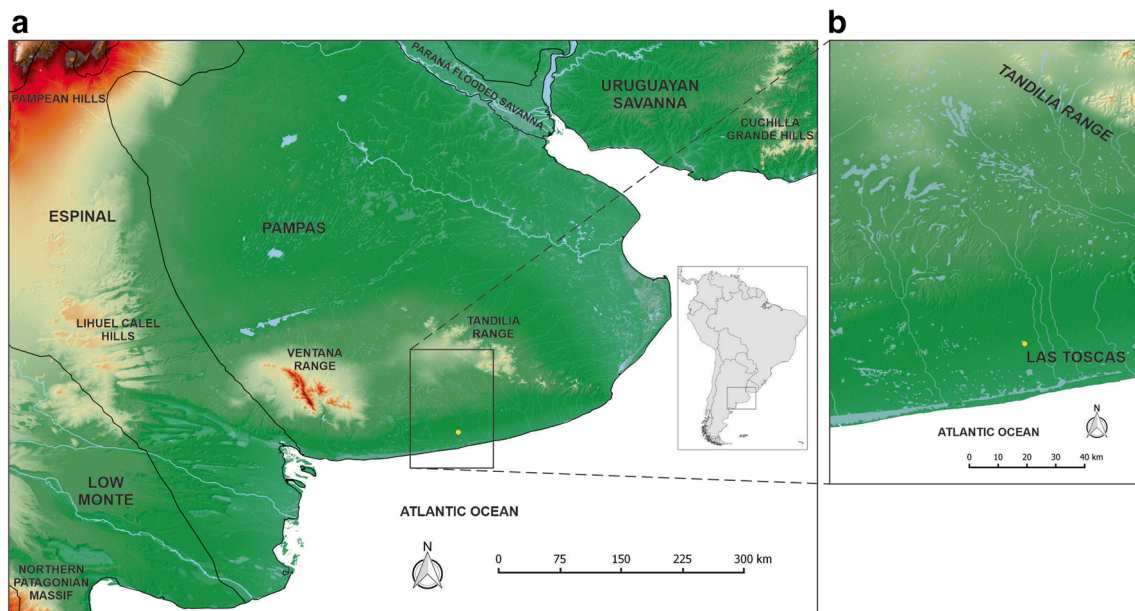
## Study area

Las Toscas shallow lake (TOSL) is located in the southern Pampas of Argentina ( $-38^{\circ}35'25''$ ,  $-59^{\circ}46'50''$ ; Tres Arroyos County, Buenos Aires province), in the portion of the plains that extends between the Tandilia and the Ventania mountain ranges, about 25 km from the Atlantic coast (Fig. 1). The present landscape is characterized by Late Quaternary loessic deposits (Pampiano Formation and La Postrera Formation; sensu Fidalgo et al. 1973) partially reworked by subsequent eolian and fluvial processes (Muhs and Zárate 2001).

Rivers, streams, and shallow lakes are the main surface water sources. Shallow lakes are abundant and they are either intermittent or perennial (Dangavs 2005; Diovisalvi et al. 2015). Due to their shallowness, they suffer strong fluctuations in their water levels caused mainly by seasonal or interannual variability in precipitation and evaporation (Bohn et al. 2011; Diovisalvi et al. 2015). In particular, Las Toscas shallow lake is circular in shape, with a surface area of approximately 0.45 km<sup>2</sup>—45 ha. It is classified as a perennial water body (Toresani et al. 1994); however, it can dry up completely during extended dry periods, as we observed in 2007 during our first visit to the locality.

In relation to the paleoenvironmental conditions in the southern Pampas, there is no general agreement among

<sup>2</sup> The chronology of this *hiatus* has varied in the different papers by Barrientos and colleagues. In the earliest papers, these authors proposed the existence of a significant gap between ca. 6000 and ca. 5000 <sup>14</sup>C years BP in the southeastern Pampas based on a smaller sample of uncalibrated radiocarbon dates (Barrientos 2001; Barrientos and Perez 2005). Here, the more recent proposal based on a larger dataset of calibrated ages was followed (Barrientos and Masse 2014).



**Fig. 1** Location of Las Toscas shallow lake. **a** Central-east Argentina, displaying the limits of the Pampas ecoregion (Matteucci 2012) and the main hills and mountain ranges. **b** Close-up view of a section of the southern Pampas and the location of Las Toscas shallow lake

researchers on the characteristics and chronology of the main climatic changes that occurred during the Middle and Late Holocene. While most agree that at the beginning of the Middle Holocene, there was an increase in temperature, correlated with the *hypsihermal*, there is still some discussion on whether this warmer climate produced an increase in humidity (Mancini et al. 2005; Quattrocchio et al. 2008; Iriondo et al. 2009) or dryness (Tonni et al. 1999; Stutz et al. 2014). Along the Atlantic coast of the southern Pampas, a rise in sea level took place between ca. 7500 and 6000 years BP, reaching a maximum of ca. 2 m above present mean sea level (Aguirre and Whatley 1995; Isla et al. 1996; Schnack et al. 2005). Middle Holocene sea level fluctuations ended around 5000 years BP, with the stabilization of the coastline at the current level (Isla 1998; Schnack et al. 2005). Toward the end of the Middle Holocene and the beginning of the Late Holocene (ca. 5000–4000 years AP), different paleoenvironmental evidence indicates drier climatic conditions, a drop in the groundwater level, and desiccation of small ponds and swampy areas of the floodplains (Zárate et al. 2000; Mancini et al. 2005; Quattrocchio et al. 2008; Iriondo et al. 2009). During the last 4000 years, a greater climatic variability has been recognized, including arid-semiarid periods interrupted by rapid changes in humidity (Muhs and Zárate 2001; Quattrocchio et al. 2008; Stutz et al. 2014).

In the southern Pampas, lithic resources are abundant but unequally distributed over the landscape. The two main areas that have been recognized as sources of toolstone are the Tandilia and the Ventania mountain ranges. In Tandilia, primary sources of several raw materials have been identified,

including orthoquartzite, chert, silicified dolomite, granitoids, and quartz (Bayón et al. 2006; Colombo 2011; Barros et al. 2015). The orthoquartzite from the Sierras Bayas Group (SBG), the highest-quality stone available for flaking within the region, outcrops in the central portion of Tandilia, where several prehistoric quarries and workshops were recognized (Bayón et al. 1999; Colombo 2011). Also, potential sources of mineral pigments were identified in this area (Porto López and Mazzanti 2009; Matarrese et al. 2011). In Ventania, as well as in water courses draining from this mountain range, metaquartzite, orthoquartzite, quartz, subarkose, and rhyolite have been identified in primary and secondary sources (Bayón et al. 1999; Catella et al. 2017). Other potential toolstone sources but of second order of importance for hunter-gatherers were the Atlantic coast and isolated and small rocky outcrops in the inland plains. Coastal lithic resources mainly include pebbles and cobbles with varied lithological composition (Bonomo and Prates 2014). Finally, the rocky outcrops in the inland plains correspond lithologically to the Ventania range and present different types of siltstones and sandstones among other rocks (Bayón et al. 1999; Rosello 2016).

## Fieldwork and lab methods

The first fieldwork in TOSL was undertaken in 2007 during a dry spell, when the lake was completely dry, exposing abundant archaeological material—mostly lithic—along the shorelines. During this fieldwork, archaeological materials were collected in three surface scatters [later named Las Toscas 1





**Fig. 2** Satellite image (Google Earth 2018) and photographs of Las Toscas shallow lake. Map on the left shows the density of artifacts in the surface scatters; the location of piece-plotted surface finds; test pits; and the archaeological sites Las Toscas 4 and Las Toscas 5. Images on the

right show two views of the shallow lake; the upper image was taken in 2007 during a dry spell, and the lower image was taken in 2012 during normal precipitation levels

(TO1), Las Toscas 2 (TO2), and Las Toscas 3 (TO3)] along the lake margins (Fig. 2). In each of these surface scatters, artifacts were collected along parallel linear transects spaced at 10-m intervals with variable lengths and 2-m widths. Each transect was subdivided into 10-m-long sampling units, which were later used to produce artifact density maps. Additionally, a few diagnostic or uncommon artifacts found outside the transects, whether in the surface scatters or in other sectors of the lake margin, were collected and recorded using a handheld GPS device. These materials are referred in this paper as piece-plotted surface finds.

In 2012, eleven test pits (50 × 50 cm) were excavated in loessic deposits adjacent to the shore of the lake where higher densities of surface materials were recorded in 2007. One of these test pits (test pit #11) revealed a deeply buried archaeological deposit containing lithic artifacts, mineral pigment fragments, and faunal remains [later named Las Toscas 5 (TO5) site]. Also, during this fieldwork season, two 1 × 1 m continuous units (2 m<sup>2</sup>) were excavated in the northern margin of the lake, where an accumulation of partially buried pigments was identified [this site was later named Las Toscas 4 (TO4)]. These last units were excavated in 5-cm spits, and sediment was wet-sieved through a 3-mm mesh.

The following year, four 1 × 1 m continuous units (4 m<sup>2</sup>) were excavated at the Las Toscas 5 site. These units were excavated to a sterile archaeological deposit, to a depth of 2 m below the ground surface. The upper stratigraphic unit was

excavated in 10-cm spits, while the lower ones were excavated in 5-cm spits. Sediment from the excavation was wet-sieved at the site through a 2-mm mesh. All objects with a maximum linear dimension >1 cm were piece-plotted using a total station. For elongated finds, both ends were plotted to calculate bearing and plunge following the methods described by McPherron (2005). A rose diagram and Rayleigh test of uniformity were used to describe the objects' orientations. Here, a statistically significant result ( $p \leq 0.05$ ) indicates that the orientations are non-uniformly distributed.

The geoarchaeological study of TO5 included the description and interpretation of the stratigraphic profile from the exposed south wall of the excavation. Additionally, an auger hole was drilled in the southeast corner of the excavation after reaching the 2-m depth excavation level, to a depth of 3.6 m below the ground surface. Soil color (dry) was classified according to Munsell soil color charts (Munsell Colour Company Inc. 1954). Texture (percentage of sand, silt, and clay) and geochemical analysis (percentage of organic matter, percentage of carbonates, and pH) were performed at the INCITAP-CONICET, Universidad Nacional de La Pampa. The texture analysis was attained using a laser diffraction particle size analyzer (Malvern Panalytical Mastersizer 2000). The percentage of organic matter was calculated by the Walkley-Black method (Walkley and Black 1934), the percentage of carbonate (CO<sub>3</sub><sup>2-</sup>) using a digital soil calcimeter, and the pH using the potentiometric method.



Chronological data from TO5 was obtained by AMS radiocarbon dates on bone collagen. Two samples were dated at the University of Arizona Accelerator Mass Spectrometry Lab (dates labeled as AA) and one at the LLNL Center for Accelerator Mass Spectrometry, California (date labeled as CAMS). Statistical analyses and calibration of radiocarbon dates were performed using Calib 8.2 (Stuiver and Reimer 1993; Stuiver et al. 2020) and the SHCal20 calibration curve (Hogg et al. 2020).

For all lithic artifacts, the following data was collected: artifact category (i.e., tool, core, and debitage), tool type, raw material type, presence of cortex, and weight. A more detailed morphological and technological analysis was conducted for the chipped stone artifacts recovered at TO3 and TO5 following the general guidelines described in Aschero (1975, 1983), Aschero and Hocsman (2004), and Bellelli et al. (1985). Raw materials were identified through macroscopic observation, using comparative samples from known sources.

A zooarchaeological and taphonomical analysis of the faunal assemblage from the TO5 site was conducted. Partial results of this analysis were presented in a previous paper (Rodríguez 2018). Attributes collected for all faunal specimens included taxon, body size (i.e., small vertebrate, < 15 kg live weight; large vertebrate, > 15 kg), skeletal element, side, and fusion state. Taxonomic abundance was quantified using the standard measurements NISP (number of identified specimens) and MNI (minimum numbers of individuals) (Lyman 2008). For guanaco (*Lama guanicoe*), the most abundant prey species, anatomical representation was quantified using MNE (minimum number of elements), MAU (minimum animal units), and the latter standardized value %MAU (Lyman 2008). For this species, the relationship between bone portion representation (%MAU) and bone mineral density (BMD) was evaluated, and Spearman's rho test, using the statistical software RStudio (RStudio Team 2020), was conducted to assess the degree of correlation between both variables. The BMD index for camelids proposed by Elkin (1995) was used.

Taphonomic analysis was performed on all the faunal remains identified to taxon—except on osteoderms and teeth—and on unidentified specimens larger than 2 cm. The recorded taphonomic variables included weathering (Behrensmeier 1978), geological abrasion (Behrensmeier et al. 1989; Fernández-Jalvo and Andrews 2003), chemical deterioration (Nicholson 1996), deposits of calcium carbonate and manganese oxide (Shahack-Gross et al. 1997; Marín Arroyo et al. 2008), burning (Buikstra and Swegle 1989; Costamagno et al. 2005; Frontini and Vecchi 2014; Carroll and Smith 2018), trampling marks (Dominguez-Rodrigo et al. 2009), dendritic etching (Behrensmeier 1978; Thompson 2005), cut marks (Fisher 1995; Dominguez-Rodrigo et al. 2009), percussion marks and notches (Blumenschine and Selvaggio 1988;

Capaldo and Blumenschine 1994; Galán et al. 2009), rodent marks (Binford 1981; Johnson 1985), carnivore tooth marks (Haynes 1980; Binford 1981; Blumenschine et al. 1996), and fracture. Punctures, pits, and scores were photographed using a Leica S6D stereo zoom microscope (0.63–4.0×) coupled with a digital camera Leica DMC4500 and measured using the software ImageJ v.1.5 (Schneider et al. 2015), following the methods described in Delaney-Rivera et al. (2009). For long bones and the first phalange, the fracture state was classified as fresh or dry following Johnson (1985). Although the osteoderms were not included in the detailed taphonomic analysis, these specimens were analyzed for the presence of thermal alteration or cut marks.

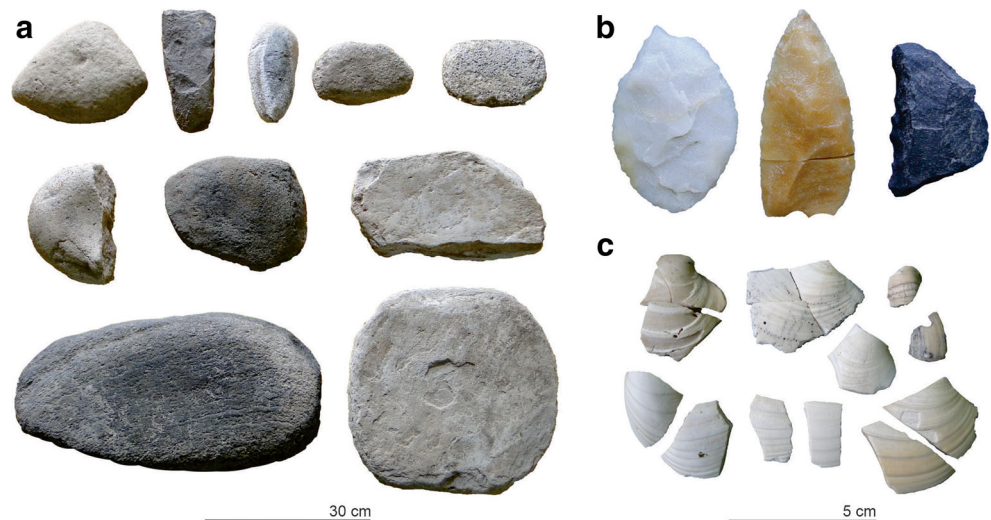
## Results

### Surface archaeological material

An outstanding characteristic of TOSL is the large quantity and variety of archaeological materials exposed along the shoreline (Fig. 3). Systematic surface collection produced abundant lithic artifacts, a small number of mineral pigment fragments and marine mollusk shells, and one ceramic fragment. Additionally, fragments of glass, stoneware, metal, and faunal remains were recovered but were not included in the present study; most of these materials were found in the surface scatter TO3 and were attributed to a rural post dating to the nineteenth century (Bagaloni 2018). Previous to our fieldwork, various lithic artifacts were unsystematically collected by amateur archaeologists and the farm owners. This collection includes two cores made on SBG orthoquartzite (one of them is a discoidal core weighing 3400 g), five bola stones, one possible bola stone, one mortar, one pestle, one stationary grinding stone, one anvil, and one hammerstone.

Seven transects (500 m long), covering a total area of 7000 m<sup>2</sup>, were performed along the northeast margin of the lake (surface scatter TO1). This surface assemblage is composed of 660 lithic artifacts, 13 lithic ecofacts, 10 mineral pigment fragments, and 2 small fragments of shell of unidentified marine mollusk. The archaeological material currently rests on an erosional surface with calcrete (locally known a *tosca*) outcrops covered by gravelly beach sediments, some of which were probably eroded by water from the loessic deposits adjacent to the shore of the lake. Preliminary observations of postdepositional modifications indicate that about 15% of the artifacts exhibit sedimentary abrasion. The lithic artifact assemblage is composed of debitage (67.7%), tools (28.9%), and cores (3.3%). Most tools are unifacial flake tools such as side scrapers, end scrapers, and combination tools. The predominant raw material type in all artifact categories is SBG orthoquartzite (80.5%), followed by chert from the Cerro Largo Formation (CLF) (8.3%) and beach cobbles (6.2%)

**Fig. 3** Sample of surface finds from Las Toscas shallow lake. **a** Ground stones. **b** SBG orthoquartzite and beach cobble tools. **c** Marine mollusk shell remains



(Table 1). Other materials occurring in very low frequency (< 2%) are silicified dolomite, green siltstone, granitoids, shale, and rhyolite. The remainder of the assemblage is made up of undetermined quartzite, siliceous rocks, and unidentified rocks. A low proportion of the artifacts exhibits cortex (8.6%); the majority of which are made from beach cobbles (Table 1).

Regarding the piece-plotted surface finds recovered at TO1, a total of 70 lithic artifacts, 1 mineral pigment fragment, and 1 ceramic sherd were recovered. The ceramic piece is a small and heavily abraded body fragment (< 1 cm) without decoration. The lithic artifacts consist of cores (7.1%), tools (45.7%), and debitage (47.1%). Cores were manufactured from CLF chert ( $n=3$ ), beach cobbles ( $n=1$ ), and green siltstone ( $n=1$ ). Tools include various types of unifacial flake tools (e.g., side and end scrapers) and several ground stone artifacts, including 4 bola stones, 2 multiple tools (stationary grinding stone/anvil), 1 stationary grinding stone, and 2 unidentified ground stone fragments. The stationary grinding stone is an exceptionally large piece weighing ca. 8 kg.

Four transects (600 m long), covering a total area of 4800 m<sup>2</sup>, were performed in the southeast margin of the shallow lake (surface scatter TO2). This surface assemblage rests on sandy sediments reworked from dune deposits and includes 552 lithic artifacts, 13 lithic ecofacts, and 5 marine mollusk remains. Preliminary observations indicate that about 20% of the artifacts exhibit sedimentary abrasion. The lithic artifact assemblage contains cores (6.5%), tools (22.8%), and debitage (70.6%). Most tools are unifacial flake tools such as side scrapers, end scrapers, combination tools, and retouched flakes. SBG orthoquartzite is the most abundant raw material (72.8%), followed by beach cobbles (9.8%) and CLF chert (6.3%) (Table 1). Raw materials occurring in very low frequency (< 2%) are green siltstone, granitoids, and quartz. Unidentified quartzite, siliceous rocks, and unidentified raw materials make up the remainder of the assemblage.

Cortex occurs in 10.5% of the artifacts, mainly on those made from beach cobbles (Table 1). The marine mollusk remains include four fragments of shell with no human modification and one artifact; this last piece is a sub-rectangular broken bead showing one perforation. Three of the unmodified shell remains were identified to family level (i.e., Veneridae), while the remaining unmodified remain and the artifact were classified as Mollusca indet. Other materials recovered in TO2 as piece-plotted surface finds include two lithic artifacts (one piece of debris and one core) and three marine mollusk shell remains identified as Veneridae.

Lastly, six transects (transects 1 to 5= 500 m long; transect 6= 300 m long), covering a total area of 6600 m<sup>2</sup>, were performed along the northwest margin of the shallow lake (surface scatter TO3). Here, the archaeological material rests on an erosional surface covered by gravelly beach sediments and includes 1018 lithic artifacts, 37 lithic ecofacts, 13 faunal remains, 4 small fragments of shell of unidentified marine mollusk, and 4 mineral pigment fragments. The lithic artifact assemblage consists of tools (17.5%), cores (0.3%), and debitage (82.2%). Postdepositional modifications were identified in the lithic assemblage, including sedimentary abrasion and calcium carbonate coating recorded in 8.3% and 35.2% of the artifacts, respectively. A detailed description of this assemblage was presented in Torino (2020), and its main characteristics are summarized here. The most frequent raw material in the lithic assemblage from TO3 is SBG orthoquartzite (85.6%), followed by CLF chert (8.8%) (Table 1). Other rocks scarcely represented ( $\leq 2\%$ ) are beach cobbles, metaquartzite, silicified dolomite, green siltstone, and silicified limestone. Unidentified rocks make up the remaining of the assemblage. SBG orthoquartzite artifacts include 3 cores, 137 tools, and 731 pieces of debitage. Cortex remnants are only present in 1% of the artifacts. The two complete cores are small (< 15 g in weight) and exhausted, and one of them was reduced by

**Table 1** Raw material absolute frequencies by each artifact category in the lithic assemblages from Las Toscas shallow lake (piece-plotted surface finds are not included in the counts)

Assemblage	Raw material	Tool	Core	Debitage	Cortex
TO1	SBGO	142	11	378	12
	QUA	4		9	
	CHE	24	7	24	5
	DOL	1		1	
	SIL	2		5	
	GRA	1		2	
	SHA	1			
	RHY			1	
	BC	13	4	24	38
	SI	1			
	UN	2		3	
TO2	SBGO	83	25	294	5
	QUA	3	1	17	
	CHE	12	1	22	1
	SIL	1		9	
	GRA	1		2	
	BC	14	9	31	52
	QZ	1			
	SI	1			
	UN	10		15	
	TO3	SBGO	137	3	731
MET	2		9	1	
QUA			3		
CHE	30		60	1	
DOL	2		7		
SIL			2		
GRA			2		
BC	5		15	17	
LIM			1		
SAN	1		1		
SI	1		4		
UN			2	1	
TO4	SBGO	3		28	1
QUA			3		
CHE			2		
BC			2	2	
TO5-U1	SBGO	1		46	
QUA			1		
CHE			2		
BC			1	1	
SI			1		
TO5-U2	SBGO	19	1	809	1
MET			4		
QUA	2		13		
CHE	1		8		
SIL			15		
GRA			1		

**Table 1** (continued)

Assemblage	Raw material	Tool	Core	Debitage	Cortex
	BC	1		13	14
	SI	1		3	
	UN	1		11	

References: SBGO, Sierras Bayas Group orthoquartzite; MET, metaquartzite; QUA, unidentified quartzite; CHE, chert from the Cerro Largo Formation; DOL, silicified dolomite; SIL, siltstone; GRA, granitoid; SHA, shale; RHY, rhyolite; BC, beach cobble; QZ, quartz; LIM, silicified limestone; SAN, unidentified sandstone; SI, unidentified siliceous rock; UN, unidentified rock

bipolar knapping. Different types of tools were identified, most of them manufactured on flake blanks by unifacial marginal retouch. The most abundant types are the combination tools, the side and end scrapers, and the retouched flakes. Also, a small triangular projectile point (20.3 mm maximum length) was manufactured from SBG orthoquartzite; this piece is one of the few bifacial artifacts found in the locality. Most debitage from SBG orthoquartzite are broken flakes; the complete flakes ( $n=129$ ) vary in maximum length from 5.9 to 40.9 mm, and most of them are < 10 mm in maximum length (86%). Three bifacial thinning flake, two resharpening flakes, and 16 bipolar flakes were identified. Most debitage on this raw material resulted from late-stage core reduction and tool manufacture and maintenance. Artifacts made on CLF chert include 30 tools and 60 pieces of debitage. Only 1.1% of these artifacts present cortex. Slightly more than half of the tools manufactured from this raw material are end scrapers. Complete flakes ( $n=17$ ) vary in maximum length from 5.5 to 28.9 mm, the majority of which are < 10 mm (99%). Two bipolar flakes and one resharpening flake were identified. As was the case for SBG orthoquartzite, most debitage on CLF chert resulted from late-stage core reduction and tool manufacture and maintenance. Beach cobble artifacts include tools ( $n=5$ ) and debitage ( $n=15$ ). Most of them exhibit some remnant cortex (81%). This type of raw material was used mainly for the production of *pièce esquillée*. The blanks for these tools were mostly bipolar cores and bipolar flakes. Complete flakes ( $n=8$ ) vary in maximum length from 12.7 to 29.8 mm. Two bipolar flakes were identified. Bipolar reduction of beach cobbles for tool manufacture probably took place on the site. The remaining of the lithic assemblage from TO3 is made of different types of tools and debitage from a variety of raw materials. Tools include a combination tool and a fragmented side scraper made on metaquartzite, two end scrapers made on silicified dolomite, one possible handstone made on sandstone, and one fragmented end scraper made on an unidentified siliceous rock. Most debitage from these raw materials are small



flakes lacking cortex resulting from tool manufacture and maintenance. The piece-plotted surface finds collected in TO3 consist of one large SBG orthoquartzite core (1 kg), a piece of debris from a beach cobble, and three ground stone tools. These last tools include one grinding slab on unidentified quartzite, one handstone on sandstone, and one pestle on an unidentified raw material.

Piece-plotted surface finds recovered in other sectors of the lake comprise one small SBG orthoquartzite core and several tools. The tools include one end scraper made on a beach cobble, one bola stone on a calcrete, and several ground tools on unidentified rocks (i.e., one handstone, one grinding slab, one stationary grinding stone, and two unidentified tools). The grinding slab was another of the large tools found in the locality weighting ca. 7 kg.

### Mineral pigment accumulation: Las Toscas 4 site

An accumulation of partially buried mineral pigments was discovered along the northern margin of the lake (TO4 site) (Fig. 4a). A total of 1300 pieces of red mineral pigment—including blocks and small fragments—were recovered (Fig. 4d). Preliminary observation suggests that the mineral pigment is a rock containing iron oxides. Physical-chemical analyses to confirm the composition are currently underway. The overall weight of the pigment assemblage is 5.38 kg. The largest piece weights 0.82 kg. No traces of use or manufacture were observed in any of the pieces. Most of the material was concentrated in a small area of about 45 cm by 30 cm, although some pieces were found scattered around the main accumulation (Fig. 4b, c). The pigments did not extend past 10 cm below the surface. Besides the mineral pigments, other materials were recovered on the surface and during the

excavation, including 38 lithic artifacts (Table 1), 45 faunal remains, 7 pieces of metal, and 17 fragments of glass. With the exception of the lithic artifacts, the remaining materials seem of recent origin. The absence of datable materials in clear association with the pigments, as well as the high disturbance of the deposit by natural formation processes (e.g., cattle trampling and water flow from the lake), makes dating this feature extremely difficult.

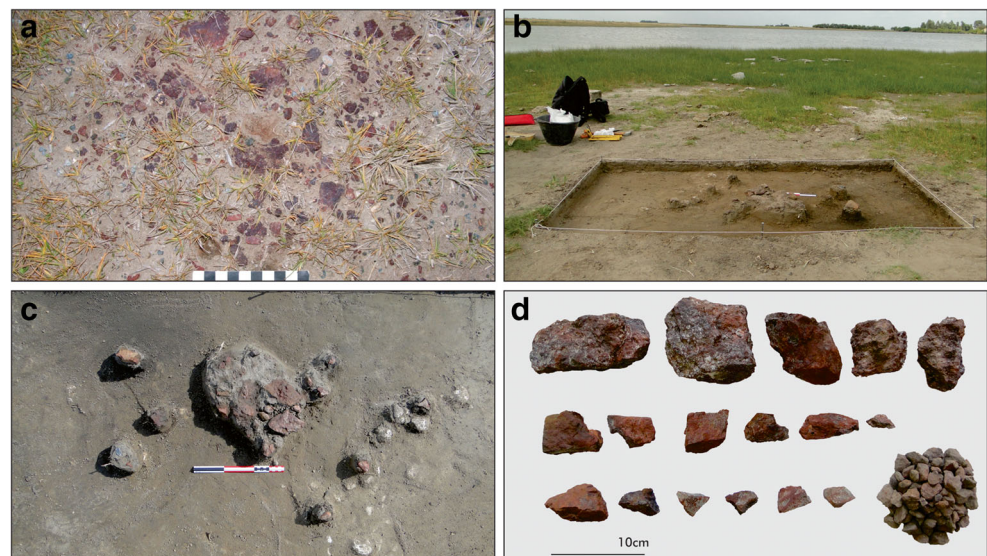
### Buried archaeological deposit: Las Toscas 5 site

The TO5 site is located on a transverse *lunette* dune which developed along the southeast margin of the shallow lake. Currently, it is a wooded area dominated by foreign species (e.g., *Tamarix* sp. and *Eucalyptus* sp.), close to an abandoned farmhouse and facilities. The excavation units were placed in the northern slope of the *lunette*, which faces the lake (Fig. 5). In these units, a total of 9045 faunal remains, 955 lithic artifacts, 166 mineral pigments, 5 lithic ecofacts, 1 shard of glass, and 3 isolated human bones were recovered. These human skeletal remains include a molar, an unfused epiphysis from an unidentified long bone, and a metatarsal. All of them are from a young individual.

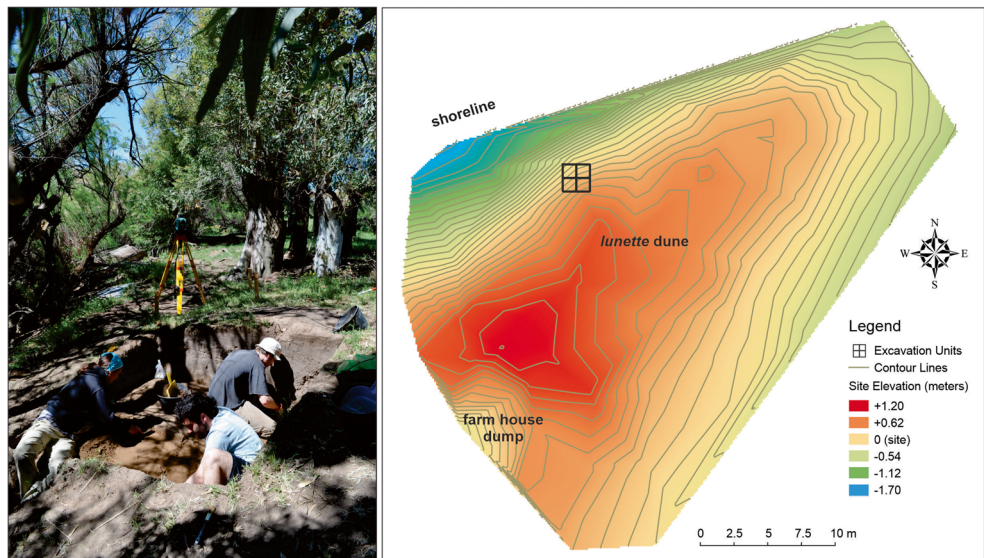
### Geoarchaeology

The eolian landform where the site is located originated from the deflation of the edges of the shallow lake, a process that probably started during the Late Pleistocene. Currently, the dune is being eroded by the lake when it is at its maximum level. The high concentration of surface archaeological materials found in the TO2 surface scatter seems to be related in

**Fig. 4** Accumulation of mineral pigments at Las Toscas 4. **a** Partially exposed mineral pigment accumulation as identified during the pedestrian survey; scale= 50 cm. **b** View of excavation units. **c** Top view of the excavated pigment concentration; scale= 30 cm. **d** Sample of pigment blocks and fragments recovered at TO4 site



**Fig. 5** The Las Toscas 5 site. Left image: photograph of site excavation in 2013. Right image: digital elevation model of the lunette and the location of the excavation grid

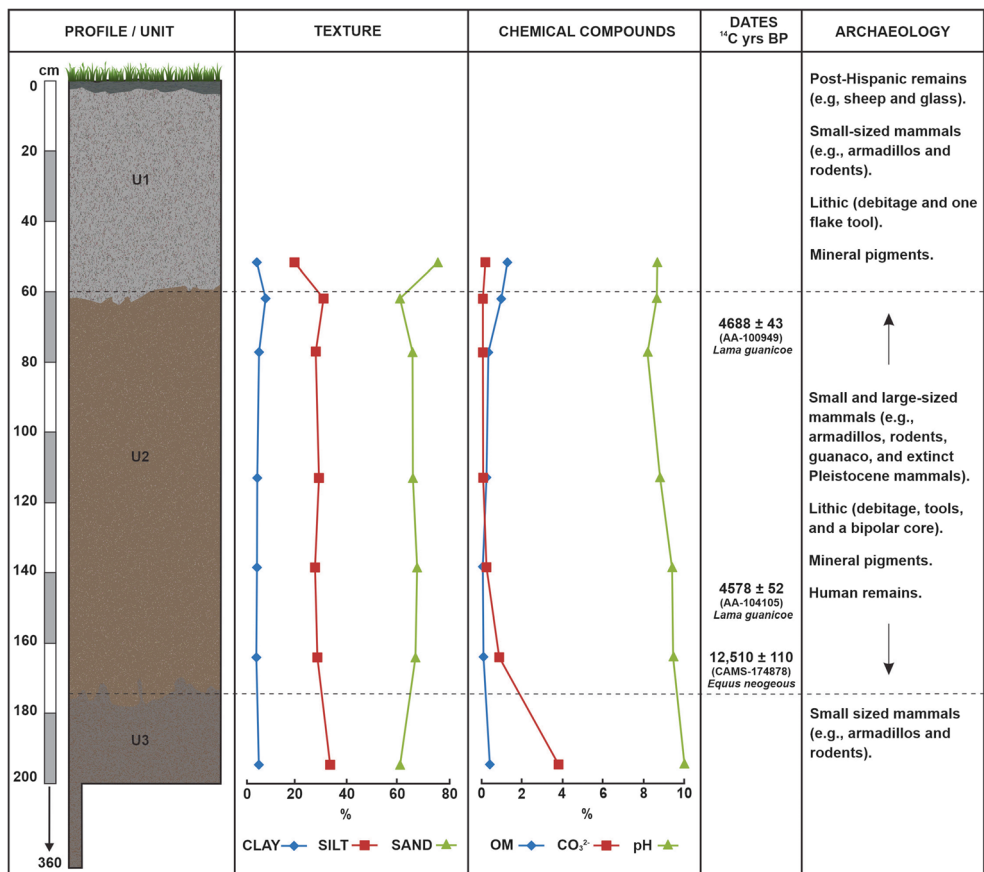


part to the erosion of the archaeological deposit at the TO5 site. Three main lithological units separated by clear erosional unconformities were identified in the TO5 site profile (Fig. 6):

Unit 1 (U1) is a dark grayish brown (10YR 4/2) silty sand affected by pedogenesis (A horizon). This unit is at the top of the sequence and extends to ~ 50 cm below modern ground surface. It is intensely disturbed by recent tree root growth and

burrowing by fossorial mammals. Both active and abandoned armadillo (*Cingulata*) burrows were observed during the excavation. Archaeological materials were found in this unit, although in low numbers. The geological characteristics of the deposit and the presence of sheep bones (*Ovis aries*) and a shard of glass suggest its formation during the Late Holocene/posthispanic times.

**Fig. 6** Schematic stratigraphic profile of the Las Toscas 5 site (the sampled profile corresponds to the south wall of the excavation unit 1997/997)



Unit 2 (U2) extends from ~50 to 175 cm and is composed of brown (10YR 5/3) silty sand with a low percentage of organic matter, abundant calcium carbonate mottles, and a slightly hard consistence. At a regional level, it correlates to the eolian La Postrera Formation. This unit is also affected by bioturbation by tree root growth and mammal burrowing. Most of the archaeological material comes from this unit.

Unit 3 (U3) is a light brownish gray (10YR 6/2) silty sand with higher proportion of carbonates and a harder consistence. Only a few faunal remains were recovered in this deposit and lithic artifacts were absent. The auger test drilled in the southeast corner of the excavation revealed the continuity of this deposit from the lower excavation level at 2 m to a depth of 3.6 m below ground surface. In other sectors of the shallow lake, such as its northeast margin, there is evidence of a Pleistocene calcrete (Pampiano Formation), which likely constitutes the base of the stratigraphic sequence at the TO5 site.

### Radiocarbon dates

Three AMS radiocarbon dates were obtained from bone specimens recovered from U2 (Table 2; Fig. 6). The first date ( $4688 \pm 43$   $^{14}\text{C}$  years BP; AA-100949) is from a proximal phalanx of guanaco with a fresh fracture recovered during the excavation of the test pit, at approximately 75 cm below the surface. The second date ( $4578 \pm 52$   $^{14}\text{C}$  years BP; AA-104105) was obtained from a fragment of a cut-marked lumbar vertebra of guanaco, recovered in excavation unit 1997/997 and at 145 cm below the surface. These two radiocarbon dates are statistically the same at 95% level, with a mean pooled radiocarbon age of  $4643 \pm 33$   $^{14}\text{C}$  years BP ( $t=2.66$ ;  $\chi^2=3.84$ ;  $df=1$ ). Finally, a distal phalanx from an extinct horse (*Equus* cf. *E. neogeous*) found in excavation unit 1998/996 and at 175 cm below surface returned a date of  $12,510 \pm 110$   $^{14}\text{C}$  years BP (CAMS-174878; XAD-2 purification method). This bone showed no evidence of human modification.

### Lithic material

A total of 955 lithic artifacts were recovered, most of them from U2. The lithic assemblage from U1 consists of 1 tool fragment and 51 pieces of debitage. The predominant raw material is SBG orthoquartzite (90.4%), followed by CLF chert (3.8%), unidentified quartzite (1.9%), unidentified siliceous rock (1.9%), and beach cobbles (1.9%) (Table 1). Artifacts manufactured from SBG orthoquartzite include a small fragment of an unidentified flake tool (< 1 cm) and several pieces of debitage, including complete flakes ( $n=9$ ), fragmented flakes ( $n=20$ ), and debris ( $n=17$ ). None of these artifacts exhibit cortex. One resharpening flake and one bipolar flake were recovered. Complete SBG orthoquartzite flakes are small (< 10 mm in maximum length). Other raw materials are present only in the form of debitage. This includes two complete flakes on CLF chert (including a bipolar flake), one complete primary flake on a beach cobble, and one fragmented flake on an unidentified siliceous rock. All complete flakes are < 10 mm in maximum length.

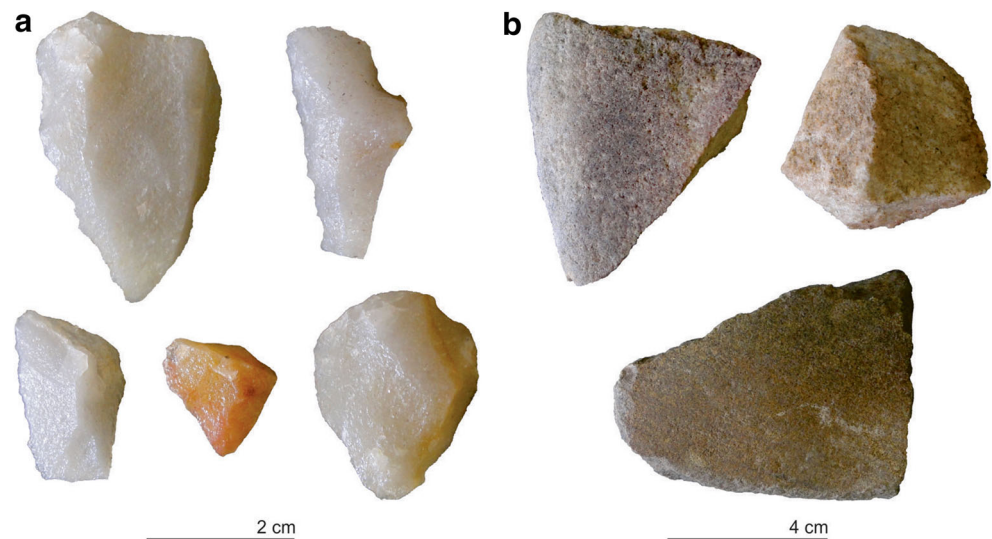
The lithic assemblage recovered from U2 consists of 877 pieces of debitage, 25 tools, and 1 core. The majority of the lithic artifacts from this unit correspond to SBG orthoquartzite (91.8%) (Table 1). Other identified raw materials are green siltstone (1.7%), beach cobbles (1.6%), CLF chert (1%), and metaquartzite (0.4%). The remainder of the U2 assemblage is made up of unidentified quartzite, siliceous rocks, and unidentified rocks. SBG orthoquartzite artifacts from U2 include one core, tools ( $n=19$ ), and debitage ( $n=809$ ). Cortex occurs only on a partially cortical flake. The core is small (20 mm maximum length; 3.2 g in weight) and was reduced by bipolar technique. Most of the tools are unifacial flake tools with marginal retouch (Fig. 7). The only complete pieces are one retouched flake (17-mm maximum length) and one notched flake (22 mm). The broken pieces include two side scrapers, one graver, one denticulate, two combination tools, one bifacial tool (a fragment of a possible projectile point), seven retouched flakes, and three retouched pieces that are too fragmented to categorize. Although most of the tools were

**Table 2** Radiocarbon and calibrated dates from the Las Toscas 5 site

Inventory Number	Lab. code	$^{14}\text{C}$ years BP	$\delta^{13}\text{C}$	Cal years BP (one sigma range)	Cal years BP (two sigma range)	Specimen details
FCS.TO5.390	AA-100949	$4688 \pm 43$	-19.5	5316-5461	5294-5572	Bone; <i>Lama guanicoe</i>
FCS.TO5.301	AA-104105	$4578 \pm 52$	-21	5053-5316	4977-5443	Bone; <i>Lama guanicoe</i>
FCS.TO5.349	CAMS-174878	$12510 \pm 110$	-19	14,349-14,960	14,181-15,108	Bone; <i>Equus</i> cf. <i>E. neogeous</i>



**Fig. 7** Sample of lithic materials recovered from unit 2 of the Las Toscas 5 site. **a** SBG orthoquartzite tools. **b** Fragments of ground stone tools



made on flakes, two small bipolar cores (< 30 mm maximum length) were recycled and used as blanks. The debitage on SBG orthoquartzite includes 163 complete flakes, 417 fragmented flakes, and 229 pieces of debris. Complete flakes vary in maximum length from 3.3 to 43.5 mm, the majority of which are < 10 mm (63%). One bifacial thinning flake, 19 resharpening flakes, and 20 bipolar flakes were identified.

Siltstone artifacts from U2 include six complete flakes, six fragmented flakes, and three pieces of debris. No remnant cortex was identified. Complete flakes vary in maximum length from 6.2 to 14.2 mm. Two resharpening flakes were identified. Artifacts on beach cobbles include a fragment of a *pièce esquillée* and 13 pieces of debitage, comprising three complete flakes, seven fragmented flakes, and three pieces of debris. The three complete flakes are < 20 mm in maximum length. Flakes are fully ( $n=6$ ) or partially cortical ( $n=4$ ). Three flakes and one piece of debris were produced by bipolar technique. Regarding the CLF chert, one fragmented notch and eight pieces of debitage were recovered, all of them lacking cortex. Three complete flakes, three fragmented flakes, and two pieces of debris were present. The complete flakes vary in maximum length from 5.4 to 16.5 mm. One bipolar flake and one resharpening flake were identified.

Artifacts on metaquartzite are scarce; they include two complete flakes and two pieces of debris, all lacking cortex. The two complete flakes vary in size: the larger flake is 35.1 mm in maximum length and 52.9 mm in maximum width; and the smaller is 8.1 mm in maximum length and 16.7 mm in maximum width. The remaining lithic artifacts include 1 fragment of a grinding tool (Fig. 7), 1 fragment of an unidentified ground stone tool, and 13 pieces of debitage on unidentified quartzite; 1 fragmented end scraper and 4 pieces of debitage on unidentified siliceous rocks; and 1 fragment of a grinding tool and 11 pieces of debitage on

unidentified raw materials. Complete flakes are in all cases < 25 mm in maximum length. Macroscopic red residues, possible mineral pigments, were observed on the surface of the two fragmented grinding artifacts.

### Mineral pigments

Small fragments of red mineral pigments were found in U1 and U2 (Fig. 6). Compositional analysis was not performed yet, but a preliminary observation suggests that most fragments are similar to the mineral pigments recovered from TO4. Nine pieces of mineral pigments with an overall weight of 2.63 g were recovered from U1; the largest piece in this sample is 13.25 mm. A larger sample of mineral pigment fragments was recovered from U2 ( $n=157$ ) with an overall weight of 30.51 g. About 90% of the fragments are < 10 mm and the largest piece is 25.24 mm. One fragment exhibits striations, possibly produced by use, whereas no trace of use or manufacture was observed in the remaining pieces.

### Zooarchaeology

A total of 9045 faunal remains were recovered in TO5, most of which are unidentifiable small fragments (81.9%). Specimens were found in all stratigraphic units (Table 3), but the majority comes from U2, coinciding with the distribution of lithic artifacts.

The faunal assemblage recovered from U1 comprises 180 identified specimens, the majority of which correspond to small-sized mammals (Table 3). Sixty five percent of identified specimens are rodents, mainly the small subterranean rodent tuco-tuco (*Ctenomys* spp.). Armadillos (Cingulata) are also abundant (31.7%). The remaining 3.5% are unidentified bird and sheep bones (*Ovis aries*).

**Table 3** Taxonomic representation at Las Toscas 5 site

Taxon		U1		U2		U3		MNI
		N	%	N	%	N	%	
<b>Small vertebrates</b>								
Amphibians	Bufonidae			1	0.2			1
Reptiles	Reptilia indet.			1	0.2			
	Ophidia			11	1.9			
	Colubridae			2	0.3			1
Birds	Ave indet.	3	2.1	11	1.9			
	Anatidae			1	0.2			1
	Tinamidae			1	0.2			1
Mammals	Mammalia indet.			65	11.0			
	Rodentia indet.	60	42.3	113	19.1	4	100	
	Cricetidae	1	0.7					
	<i>Reithrodon auritus</i>	1	0.7	5	0.8			1
	<i>Ctenomys</i> spp.	30	21.1	135	22.8			4
	<i>Dolichotis patagonum</i>			1	0.2			1
	<i>Lagostomus maximus</i>			5	0.8			1
	Cingulata	31 (26)	21.8	38 (578)	6.4	(3)		
	<i>Chaetophractus villosus</i>	14 (12)	9.9	18 (173)	3.0			2
	<i>Dasyus hybridus</i>			(3)				1
	<i>Zaedyus pichiyi</i>			(67)				1
	<i>Lycalopex gymnocercus</i>			4	0.7			1
	<b>Large vertebrates</b>							
Birds	<i>Rhea americana</i>			2	0.3			1
Mammals	Mammalia indet.			103	17.4			
	Pilosa			(36)				1
	<i>Ovis aries</i>	2	1.4					1
	<i>Equus</i> cf. <i>E. neogeus</i>			2	0.3			1
	<i>Lama guanicoe</i>			72	12.2			3
	<i>Ozotoceros bezoarticus</i>			1	0.2			1
<b>Total NISP</b>		142 (38)		592 (857)		4(3)		
<b>Unidentified specimens (small vertebrates)</b>				153		297		
<b>Unidentified specimens (large vertebrates)</b>				16		200		
<b>Unidentified specimens</b>				283		6413	47	
<b>NSP</b>				632		8359	54	

**Note:** NSP, total number of specimens, including those identified to taxon (NISP) and those not identifiable. Numbers in parentheses refer to osteoderms. Percentages were calculated for each taxonomic category at the class level or below, excluding osteoderms

A total of 1449 specimens from U2 were identified; however, a high proportion of these specimens correspond to osteoderms (59%). In this unit, taxonomic representation is also weighted in favor of small mammals, but larger mammals are more abundant in comparison to U1 (Table 3). Rodents predominate, mainly the tuco-tuco. Less well-represented rodents are coney rats (*Reithrodon auritus*), plains vizcacha (*Lagostomus maximus*), and Patagonian hare (*Dolichotis patagonum*) (Table 3). Armadillos are the second most abundant small mammals; three species were identified: hairy

armadillo (*Chaetophractus villosus*), pichi (*Zaedyus pichiyi*), and mulita (*Dasyus hybridus*); these last two were determined exclusively by the presence of osteoderms. The only one carnivore identified in very low proportion was the pampas fox (*Lycalopex gymnocercus*). The remaining small-sized vertebrates from U2 correspond to amphibians (Bufonidae); reptiles, mostly ophidians; and birds (Tinamidae and Anatidae).

Large-sized vertebrates from U2 are mainly mammals. Guanaco (*Lama guanicoe*) is the most abundant species

(Table 3). Different skeletal elements of this camelid were identified (see below). Two other ungulates were identified in low proportions: Pampas deer (*Ozotoceros bezoarticus*; one escaphoid) and extinct American horse (*Equus* cf. *E. neogeus*; one distal phalanx and one magnum) (Table 3). The remaining identified specimens from large-sized vertebrates are several osteoderms from an extinct ground sloth (*Pilosoa*) and one vertebra and one tibiotarsus shaft fragment from greater rhea (*Rhea americana*).

Finally, a total of 54 faunal remains were recovered in U3 but only seven were identified. All of the faunal remains from this unit correspond to small-sized vertebrates, including small rodents and armadillos (Table 3).

As previously mentioned, guanaco is the most abundant large vertebrate (NISP= 72). The total MNI estimated for this species is three: two immature individuals < 10 months old at death (based on two unfused distal humerus) and one mature individual  $\geq$  36 months old (based on a fused proximal and distal femur and a fused proximal tibia). A total of 41 elements (MNE) were estimated for this species. All types of skeletal elements were identified, except for sternebrae, ribs, scapula, and mandible (Online Resource 1). Appendicular elements are more abundant than axial elements. There is a moderate, but significant correlation between anatomical representation (%MAU) and bone mineral density (BMD) ( $S = 2137.5$ ,  $p$  value = 0.002928,  $\rho = 0.524468$ ) (Online Resource 2, Online Resource 3, Online Resource 4). This result suggests that the guanaco skeletal element profile could in part be conditioned by density-mediated attrition, a possibility that will be examined in the following section through taphonomic analyses.

### Taphonomy

A taphonomic study of the faunal remains from U1 and U2 was performed in order to detect any potential bias caused by differential preservation and to identify the agents and processes of bone accumulation/modification. Because of small sample size, the percentages of taphonomic attributes for large vertebrates from U1 should be considered with caution.

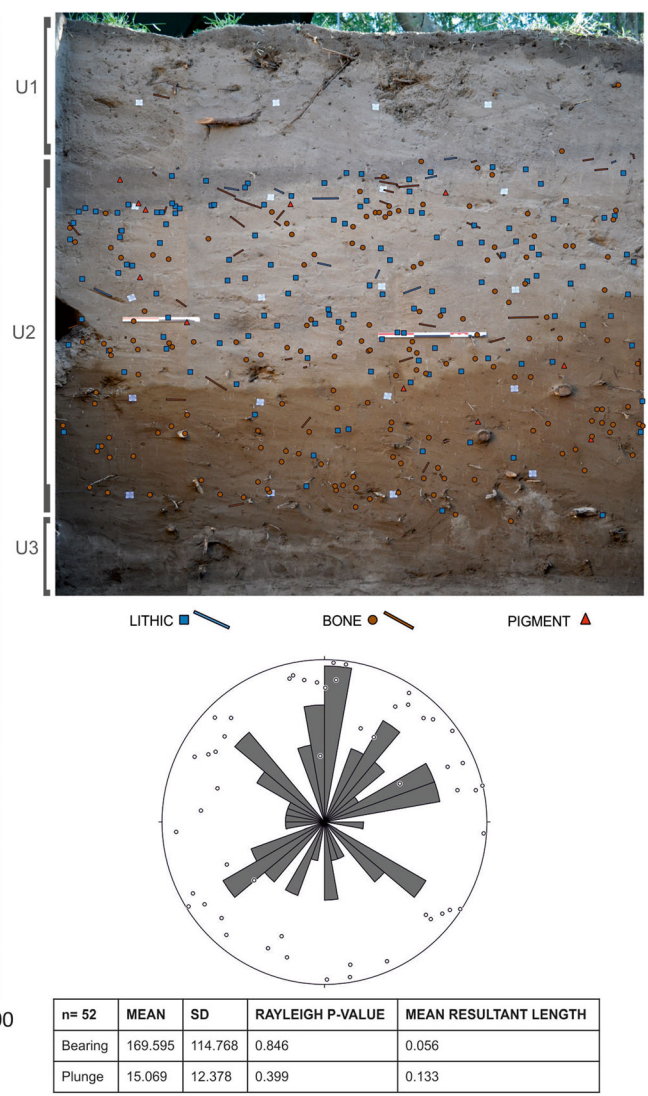
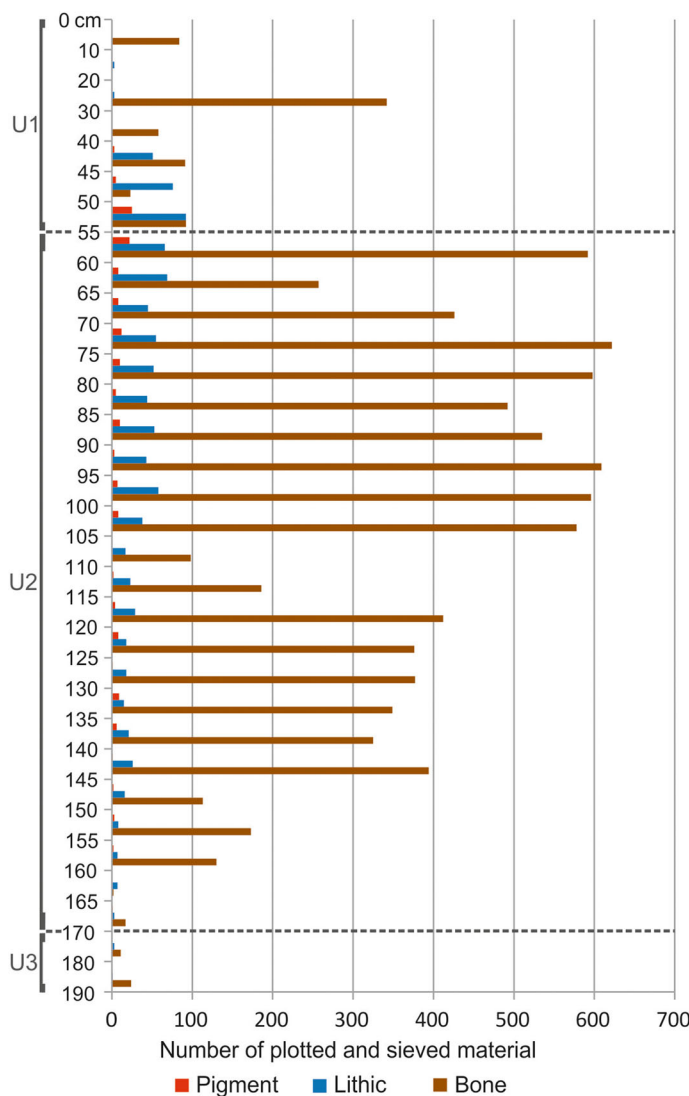
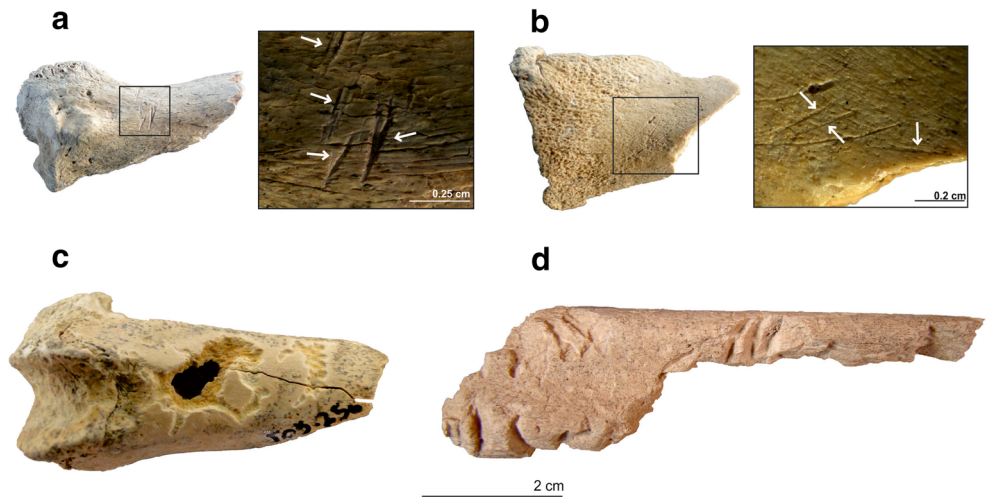
A high degree of bone fragmentation (> 95%) was recorded for small and large vertebrates from both sedimentary units (Online Resource 5). Complete elements are mostly short and compact bones, such as phalanges, carpals, and tarsals. For long bones, dry fractures prevail, but fresh fractures were also identified. The high percentage of dry fractures is indicative of the importance of postdepositional processes acting on the faunal samples from both units. One such process is weathering, which impacted differentially on the specimens according to provenience and size class. Weathering affected less than 35% of the specimens from U1, and none reached beyond stage 2, whereas the proportion of weathered specimens from U2 is > 85%, with weathering stages from 0 to 4

(Online Resource 5). Large vertebrates from both units exhibit a higher frequency of weathered bones and more advanced weathering stages in comparison to small vertebrates. Dendritic etching is another common surface modification (Fig. 8c), affecting more than 50% of the specimens from both sedimentary units (Online Resource 5). Root activity is certainly the main cause for this type of modification, as evidenced by the abundance of roots from modern trees penetrating the deposit. Manganese oxide and calcium carbonate coatings are also frequent in both units; the percentage of specimens showing the first type of surface modification is > 60%, whereas the percentage showing the second is > 25% (Online Resource 5). Rodent gnawing was identified in about 5.5% of the specimens from U1 and 8% of the specimens from U2 (Online Resource 5; Fig. 8d). Carnivore tooth marks were observed in almost 8% of the small vertebrate specimens from U1 and in less than 2% of the small and large vertebrate specimens from U2 (Online Resource 5). This type of modification was identified in different skeletal elements of rodents (e.g., *Ctenomys* spp., Cricetidae) and on a distal femur of guanaco. Carnivore modifications observed on specimens of small vertebrates include 15 punctures (maximum length, mean= 0.9 mm, maximum value= 2.1 mm, minimum value= 0.1 mm); 44 pits (mean= 0.3 mm, maximum value= 0.8 mm, minimum value= 0.1 mm), 19 scores (maximum breath, mean= 0.2 mm, maximum value= 0.3 mm, minimum value= 0.1 mm), and 5 specimens with crenulated edges. Preliminary observations of tooth marked rodent bones also show that most have a degree of digestive corrosion (Andrews 1990). Tooth marks identified on the guanaco specimen include crenulated edge and two scores (1.1 mm and 0.1 mm in maximum breath).

No clear evidence of human accumulation or modification of bones from U1 was identified. Evidence of burning is present in both small and large vertebrate specimens (9.6% and 5.5%, respectively) (Online Resource 5); however, the random distribution of this alteration through the skeleton and the presence of different burning stages from partial carbonization to calcination suggest that most of the burning is related to postdepositional processes. A different situation was observed for U2, where evidence for the human accumulation and modification of bones from large and small vertebrates was identified. Cut marks were documented in 1.9% of the sample of large vertebrates, including four specimens of guanaco (i.e., lumbar vertebra, humerus, femur, and tibia; Fig. 8b), one specimen of greater rhea (i.e., vertebra), and one specimen of indeterminate large mammal (i.e., long bone shaft fragment). Also, percussion notches on two fresh fractured guanaco bones (i.e., femur and tibia) and three fresh fractured large mammal long bone shaft fragments suggest marrow extraction. Burning was identified on guanaco ( $n = 4$ ) and indeterminate large mammals ( $n =$



**Fig. 8** Example of taphonomic modifications from the Las Toscas 5 site. **a** Cut marks on a humerus distal shaft of pampas fox (*Lycalopex gymnocercus*). **b** Cut marks on a tibia proximal shaft of guanaco (*Lama guanicoe*). **c** Distal femur of pampas fox with manganese staining and dendritic etching. **d** Indeterminate long bone shaft fragment from large-sized mammal with extensive rodent marks



**Fig. 9** Spatial analysis at the Las Toscas 5 site. Left bar graph: Vertical distribution of plotted and sieved material. Upper right image: Georectified photography of the south wall of the excavation units and a schematic representation of artifacts with plunge data for elongated

finds. The sharp color change in the unit 2 is the result of differences in humidity. Lower right image and table: Rose diagram showing bearing and plunge data and artifact orientation results

13). The burning pattern does not allow attributing this modification to cultural practices; cooking, discard of bones in hearths, and postdepositional burning could all be accountable for the damage (Rodríguez 2018). In regard to the small vertebrates recovered from U2, cut marks were identified on four specimens, including a cervical vertebra and two dermal plates of Cingulata and a distal humerus of pampas fox (Fig. 8a). Evidence of burning was also observed on several specimens of indeterminate small mammals, rodents, and armadillos; only for the last *taxa* the burning pattern seems to indicate a cultural origin (Rodríguez 2018).

### Spatial analysis

Taking into consideration all the lithic, pigment, and faunal materials, their vertical frequency co-varies positively (Fig. 9), except in the first levels of U1, which contain mostly fauna. After these initial levels, the frequencies of lithic and pigments gradually increase, with maximum frequencies at the top of U2, and then decrease toward the bottom of this unit. The faunal specimens increase substantially in U2, with higher frequencies in the upper levels and lower frequencies toward the bottom. An abrupt decrease in the amount of faunal remains was recorded in the middle section of U2. However, this discontinuity in the vertical frequency of faunal material was not accompanied by changes in the taxonomic representation, lithic technology, stratigraphy, or chronology that suggest the presence of two separate archaeological components. Regarding the orientation of elongated finds, both bearing (Rayleigh  $p=0.846$ ) and plunge (Rayleigh  $p=0.399$ ) are randomly distributed, with no preferred angles (Fig. 9).

## Discussion

### Middle Holocene occupation

The earliest evidence of human occupation at the Las Toscas shallow lake comes from the lithological unit 2 at the Las Toscas 5 site. Two radiocarbon dates obtained from guanaco bones place the human occupation of this landform around 4600 years BP (ca. 5320 cal years BP), during the regional arid phase that followed the *hypsihermal*. Several cut- and percussion-marked bones from this unit, including the dated ones, provide clear evidence of a functional association of bones and stone artifacts. A third radiocarbon date on a bone from an extinct horse produced an age of ca. 12,500 years BP (ca. 14,650 cal years BP). This date is consistent with the first arrival of hunter-gatherers into the region (Politis et al. 2016). Although this evidence is not enough to propose a Late Pleistocene human occupation; it does provide valuable paleontological data for reconstructing the local environment.

The taphonomic study indicates that both cultural and natural processes were involved in the accumulation and modification of the bone assemblage from TO5. Bone surface modification data indicates that hunter-gatherers preyed on guanaco, greater rhea, pampas fox, and armadillos and discarded their bones at the site. The presence of carnivore tooth marks on one guanaco bone suggests that discarded food waste probably attracted scavengers after human occupation; however, the sample size of tooth marks is too small to evaluate the type of carnivore involved or degree of destruction of bones discarded by humans. The high percentage of weathered bones from U2, some of them showing weathering stages 3 and 4, suggests a slow burial rate. Carnivore action and subaerial weathering probably contributed to bone fragmentation and loss; as a consequence, the taxonomic, anatomical, and age representation at TO5 may be conditioned not only by human consumption strategies but also by density-mediated destruction (Lyman 1984).

The presence of manganese oxide and calcium carbonate precipitates on the bones indicates changes in the redox conditions of the deposit produced by fluctuations of the groundwater level. This fluctuating humidity conditions probably contributed to the chemical, physical, and biological diagenetic alteration of bones (Kendall et al. 2018). Fortunately, the oxidative and alkaline geochemical conditions prevailing in the matrix have been favorable for bone preservation and radiocarbon dating. Disturbance by plants and burrowing mammals further increased bone fragmentation and deterioration of cortical surfaces, especially when acting on bones previously weakened by subaerial weathering and diagenesis. As a consequence, proportions of diagnostic human modifications and carnivore marks were probably lowered. Bioturbation was also responsible for the random orientation of the elongated finds, especially in relation to plunge, and of the wide vertical distribution of the materials, an issue that will be discussed below.

In regard to the accumulation of rodent bones, which are abundant in the deposit, it seems to be mainly the consequence of natural causes. This is surely the case for tuco-tuco, the most abundant *taxa* in the site. Tuco-tucos are small subterranean rodents of the genus *Ctenomys*, similar to pocket gophers (Geomyidae) in ecology and morphological adaptations (Reig et al. 1990). Remains of tuco-tucos were not identified to a species level, but they probably correspond to *Ctenomys talarum* (Talas tuco-tuco; mean body weight 130 g), which currently does not inhabit the site area but is present in some restricted eolian deposits in the inland plains (Mora et al. 2013). Considering the geological context of the site, the ecological characteristics of the species, and the taphonomic modifications of the bone remains, the high abundance of *Ctenomys* spp. likely resulted from the natural death and predation of individuals inside or near the vicinity of their burrows. The size of the carnivore tooth marks measured on the

specimens of small vertebrates suggests that they probably were accumulated by a small-sized carnivore (see Delaney-Rivera et al. 2009; Andrés et al. 2012), while the presence of digestive corrosion on most of them indicates that they entered the site contained in scats.

Natural deaths may also help to explain the high representation of armadillos. The dune where TO5 is located constitutes a favorable habitat for armadillos, particularly for the hairy armadillo (*Chaetophractus villosus*), the most common species of armadillo in the Pampas (Abba et al. 2005). The identification of several burrows in the sedimentary deposit suggests that natural intrusion of armadillo remains probably occurred at the site. As a consequence, a mixed origin—anthropic and natural—for the armadillo sample at TO5 is the best hypothesis.

Burrowing activities by rodents and armadillos not only contributed to the fragmentation of archaeological bones and to the incorporation of natural bones but also to the spatial configuration of the archaeological record. Studies on the action of tuco-tucos and armadillos in archaeological sites from Argentina indicate that during the course of burrowing activities, these mammals bring to the surface archaeological materials from different depths (Frontini and Escosteguy 2012; Álvarez et al. 2020). As a result, vertical and horizontal movements of materials, preferably those of smaller size, are produced (García 2005; Frontini and Escosteguy 2012). This process may have produced the extended vertical distribution of archaeological remains in TO5, where fauna remains, lithic artifacts, and mineral pigments occur almost continuously, albeit at varying densities, through a 2-m-deep deposit. In particular, postdepositional vertical migration can help to explain (1) the presence of a few lithic artifacts and mineral pigment fragments in U1 in association with posthispanic materials; (2) the vertical separation by almost 75 cm of the two guanaco samples dated ca. 4600 years BP; and (3) the occurrence of several Late Pleistocene faunal remains at the same levels as the Middle Holocene materials. On the other hand, the presence of the human skeletal remains could be a result of its lateral displacement by burrowing animals from a nearby human burial. The high disturbance of the deposit suggests that the archaeological assemblage recovered from U2 might represent different time-averaged human occupation events. In the present state of knowledge, it is not possible to determine whether this assemblage corresponds to a single occupation event or to multiple superimposed brief occupations.

The faunal assemblage indicates that humans transported carcasses or portions of several prey species. The greater abundance of guanaco suggests that this ungulate was the main prey. At least three individuals are represented in the assemblage, including two newborns and one adult. The presence of newborns indicates that hunters targeted family groups, although the capture of solitary individuals or individuals from other social groups cannot be dismissed. The

territorial behavior of the guanaco family groups makes them spatially predictable and facilitates pre-hunt planning (Kaufmann et al. 2021). The presence of elements from all anatomical regions of the guanaco skeleton, including both high (e.g., femur) and low utility portions (e.g., metapodials, carpals, tarsals), suggests a non-selective transport of carcass parts to the site (Rodríguez 2018). The transport of complete or nearly complete carcasses suggests that procurement may have taken place within a short distance from this site. The low MNI and the non-selective transport of carcass parts suggest small-scale hunting events in the surroundings of the shallow lake, which was probably frequently visited by guanacos (see Sect. 5.3 Las Toscas shallow lake: a persistent place in the inland plains). The presence of bola stones in the surface record of the locality suggests local hunting with this weapon. Bola stones are an effective weapon in the open environments that characterize the inland plains and have been associated with hunting guanaco in other archaeological sites (Kaufmann et al. 2021). However, the fact that the bone assemblage from TO5 may be time-averaged and that the skeletal representation seems to be conditioned by density-mediated attrition precludes further discussion on the differential transport of guanaco and hunting strategies. Cut marks on guanaco bones are consistent with both disarticulation and defleshing activities (Costamagno et al. 2019), while fresh fractured long bones exhibiting percussion notches indicate that bone marrow was exploited at TO5, although not intensively.

Greater rhea and pampas fox are represented by just a few specimens, accounting for one individual each. The poor preservation state of the bone assemblage suggests that taxonomic and size biasing should be considered as a contributing factor to the low representation of birds and smaller mammals because they are more prone to postdepositional destruction (Behrensmeier et al. 1979; Cruz 2015). Cut marks in greater rhea are indicative of evisceration or defleshing while in pampas fox are consistent with disarticulation or defleshing (Costamagno et al. 2019). The sample size limits further interpretation of the procurement and processing strategies of these animals. Evidence of human processing of armadillos includes cut marks on a cervical vertebra and two osteoderms, which may be indicative of the separation of the carapace from the endoskeleton. Burning damage is consistent with the cooking of the armadillos under direct fire in their carapace (Frontini and Vecchi 2014).

Abundant lithic artifacts were recovered in association with the faunal remains at TO5. Due to the absence of sources of flakeable stone in the locality and neighboring areas, all lithic material had to be transported to this site. A clear preference for SBG orthoquartzite is observed, with more than 90% of the artifacts made on this raw material. This rock was probably obtained in the central portion of the Tandilia range, more than 100 km from TOSL. The SBG orthoquartzite was probably carried to the site in the form of cores in late stages of



reduction, flake blanks, preforms, and finished tools. A minor proportion of the lithic assemblage is made up of raw materials coming from a variety of regional sources, including CLF chert, also from the Tandilia range; green siltstone, probably from the isolated rocky outcrops in the inland plains (> 60 km from TO5); beach cobbles, from the Atlantic coast; and metaquartzite, from the Ventania range (> 200 km). The beach cobbles were probably transported to the site in the form of nodules and tools, and the remaining raw materials mainly as finished tools. All the raw material probably entered the site as part of transported toolkits that individuals carried with them.

Technological activities carried out at TO5 included the reduction of cores to produce flakes and the manufacturing and resharpening of tools. Tools were mainly manufactured on flakes by marginal unifacial retouch. However, bifacial knapping and pecking and grinding were also used for tool manufacture. A bipolar technique was used for the reduction of beach cobbles and SBG orthoquartzite cores. Extensive reduction of SBG orthoquartzite cores by bipolar knapping, recycling of cores for tool production, and tool resharpening were alternative ways to extend the utility of largely depleted toolkits in this environmental setting lacking raw materials.

A diverse array of tools indicative of a broad range of processing activities were identified at TO5, including side and end scrapers, combination tools, notches, retouched flakes, and grinding tools, among others. These tools were probably used in the processing of animal prey, mineral pigments, and perhaps other resources that were not discarded or preserved at the site. The presence of a possible projectile point suggests hunting activities as well. Regarding the mineral pigment fragments, the absence of clear traces of use or manufacture on them suggests that they are the remnants of processing this material at the site.

Current chronological data constrain human occupation of TO5 to the Middle Holocene. This is further supported by the lack of temporally diagnostic artifacts from other time periods, such as small projectile points and ceramics from the Late Holocene. However, hunter-gatherers' use of the site during other chronological periods cannot be completely ruled out. Taken together, the archaeological evidence from TO5 indicates that multiple activities took place along the margins of the shallow lake during the second half of the Middle Holocene, including hunting, processing, cooking, and consumption of different animal prey; manufacture, maintenance, and use of lithic artifacts; and processing of mineral pigments. All these activities seem to be related to residential occupations; however, further excavation and analysis are needed to corroborate this functional hypothesis. On the other hand, the presence of human bones suggests that burial practices probably took place here. Nevertheless, the scant evidence available and the lack of radiocarbon dating of these finds do not allow us to interpret the mortuary practices or to associate them with the Middle Holocene occupations at this time.

The findings from TO5 contribute to a growing database of archaeological evidence dated to the Middle Holocene in the southern Pampas. The archaeological information from TO5 is particularly relevant considering that it has been directly dated during the second half of the Middle Holocene (ca. 6200 to ca. 4200 cal years BP), when changes in subsistence and population dynamics have been proposed. Currently, human occupations dating to this time interval are recorded in the Tandilia range (Colombo 2013; Mazzanti et al. 2015) and in the inland plains (Crivelli Montero et al. 1997; Politis et al. 2014b; Barros et al. 2018)<sup>3</sup>.

Most sites in the Tandilia range are located in caves and rockshelters in the eastern portion (i.e., Abrigo Los Pinos, Alero El Mirador, Cueva Tixi, Lobería I site 1, and Rincón Grande site 1). Small lithic assemblages were recovered in these sites, which were interpreted as logistical camps (Mazzanti et al. 2015; Donadei 2019). Bone preservation is rare; only Cueva Tixi contains faunal remains (Mazzanti et al. 2015). Two other sites were identified in the east-central portion of the Tandilia range: the small rockshelter site of Alero La Esperanza and the open-air site El Picadero. The first one was interpreted as a lithic workshop located nearby SBG orthoquartzite quarries (Weitzel et al. 2020), while the second has been characterized as a quarry where pits were dug to exploit primary outcrops of high-quality SBG orthoquartzite during the Middle and Late Holocene (Colombo 2013).

In regard to the inland plains, evidence of human occupation dated within the second half of the Middle Holocene comes from four open air sites: Arroyo Seco 2, Fortín Necochea 2, Laguna Muscar 2, and Paso Mayor YI S1. All of these sites are stratified multi-component sites with long occupation sequences extending beyond the Middle Holocene. The abundance and diversity of archaeological materials suggest that multiple activities were carried out in these sites, which were interpreted in most cases as residential camps (Crivelli Montero et al. 1997; Bayón et al. 2010; Politis et al. 2014b; Barros et al. 2018). As a consequence of human reoccupations and the action of postdepositional processes, all these sites present low chronological resolution.

When comparing the results from Las Toscas 5 with data from the other archaeological assemblages dated to the second half of the Middle Holocene, some shared features as well as differences emerge. All the sites identified in the inland plains are located in slightly elevated landforms, close to water sources, and most are interpreted as residential camps. The selection of this type of location for residential occupations may have been influenced in part by practical considerations, such as availability of a dry and ample space with good

<sup>3</sup> Sites dated exclusively through organic material from sediments and soils were not considered in the discussion because these dates only provide minimal ages of the sedimentary unit containing the archaeological materials, but they do not directly date the human occupation.

visibility of the surrounding areas, combined with an easy access to water and food resources. Evidence from the Arroyo Seco 2 site also reveals the use of this type of setting for inhumations during this time period (Politis et al. 2014b). On the other hand, difference in location and content of contemporaneous archaeological assemblages from the Tandilia range seems to be the result of functional differences in comparison to the inland plain sites. In this sense, as was previously mentioned, most assemblages in this mountain range are interpreted as the result of more specific activities.

Regarding subsistence, faunal data from TO5 suggests that the guanaco was the main prey species, which is in agreement with the results from the other inland sites (Crivelli Montero et al. 1997; Frontini 2013; Barros et al. 2018). According to the regional archaeological record, this ungulate played an important role in the subsistence of hunter-gatherer groups, especially in the plains, where it seems to have been the main resource at least since the Early Holocene and until the Late Holocene (Crivelli Montero et al. 1997; Miotti and Salemme 1999; Martínez and Gutiérrez 2004; Frontini 2013; Álvarez 2014; Rafuse 2017). At the regional level, researchers have proposed a process of specialization in ungulate hunting starting toward the end of the Middle Holocene (Quintana and Mazzanti 2001; Martínez and Gutiérrez 2004; Álvarez 2014). The faunal data from TO5 is in agreement with the subsistence specialization model; however, the possibility of a taphonomic bias in favor of the larger vertebrates in this assemblage suggests that it does not provide strong evidence to test this proposal.

Regarding technology, the lithic assemblage from TO5 shares many similarities with collections from the previously mentioned Middle Holocene sites. Although the hunter-gatherers of the southern Pampas used a variety of raw material types, there was a strong preference for SBG orthoquartzite, which is present in all the sites and in most cases represents more than 60% of the total raw materials (Crivelli Montero et al. 1997; Barros et al. 2018; Donadei 2019). This rock was only used as a secondary resource in locations where alternative raw material sources were readily available (Bayón et al. 2010; Donadei 2019). As was pointed out by other researchers, the selection of SBG orthoquartzite was probably influenced by its quality for tool knapping as well as for the abundance, size, and shape in which it occurs in the outcrops (Barros et al. 2018; Donadei 2019). With the exception of the Alero La Esperanza and El Picadero sites, the remaining sites are located more than 100 km away from the known sources of this raw material. The characteristics of the lithic assemblages from all these sites suggest that the earlier stages of core reduction and tool production took place at the quarries and nearby workshops and that this raw material arrived at the plain sites more often in the form of prepared cores, blanks, preforms, and/or finished tools (Bayón et al. 2010; Colombo 2011; Donadei 2019; Weitzel et al. 2020).

The way in which raw materials entered the sites suggests that they were mostly transported from source to place of use as part of toolkits carried by individuals. According to Kuhn (1995), this provisioning strategy could be more advantageous under conditions of high residential mobility. Due to the highly localized nature of the raw material sources in the southern Pampas, Middle Holocene hunter-gatherers had to keep themselves supplied with transportable toolkits during their frequent movements to exploit resources in a landscape largely depleted of raw materials, especially in the inland plains. During this time, lithic resources were probably acquired through both specific lithic procurement trips and during the process of completing other tasks (embedded procurement, sensu Binford 1979, p. 259). The first strategy probably played a more important role—though not exclusive—in the procurement of SBG orthoquartzite, while the acquisition of secondary raw materials, such as CLF chert or beach cobbles, was probably most often embedded in other activities during daily or logistical foraging trips.

A common characteristic of all sites dated to the second half of the Middle Holocene is that most tools, regardless of raw material type, were manufactured on flakes by unifacial marginal retouch (Crivelli Montero et al. 1997; Bayón et al. 2010; Barros et al. 2018; Donadei 2019). Also, bipolar reduction was identified in the form of bipolar cores and flakes. This technique was used to exploit cobbles from the Atlantic coast and to conserve good quality raw materials, especially SBG orthoquartzite (Crivelli Montero et al. 1997; Bayón et al. 2010; Donadei 2019). On the other hand, the presence of a few bifacial tools and debitage in some of the sites indicates that this type of reduction was part of the technological repertoire of hunter-gatherers, but it was probably limited to the production of a few tool types, such as projectile points. The same can be said of pecking and grinding, which was identified at TO5 and other sites through the presence of ground stone tools or waste from its manufacture or maintenance.

In agreement with previous proposals, evidence from TO5 and the other sites discussed above suggests a pattern of high residential mobility during the second half of the Middle Holocene based on short-term occupations of varied environments. According to Martínez (2002), through a strategy of high mobility, hunter-gatherers might have coped with environmental patchiness and resource fluctuations that characterized the Middle Holocene. Current archaeological data on the functionality of the sites suggests that residential movements by hunter-gatherers were mainly made within the inland plains, where they established residential sites close to shallow lakes or fluvial valleys. The abundance of large game, especially guanaco, and the presence of permanent sources of water, probably favored the occupation of this type of environmental setting. On the other hand, archaeological data from the Tandilia range shows ephemeral occupations resulting

from logistical mobility to exploit local resources, including a variety of raw materials and fauna (Mazzanti et al. 2015; Donadei 2019). The importance of raw materials from the Tandilia range at the regional level, especially SBG orthoquartzite, suggests that raw material procurement in this area was an important factor in the organization of the annual cycle of mobility and settlement for hunter-gatherers of the southern Pampas.

So far, no evidence of human occupation has been identified on the Atlantic coast for the period between 6200 and 4200 cal years BP, contrasting with the high abundance of coastal sites dated at the end of the Early Holocene and the beginning of the Middle Holocene (Politis and Bonomo 2011; Bayón et al. 2012; Bonomo et al. 2013a; Bayón and Politis 2014). This abrupt change in the archaeological record may be related to the transformations of the coastal environment and the establishment of the current coastal conditions following the sea level fluctuations associated with the *hypsihermal*. These changes in the coastal environment probably caused a reduction in the local availability of marine resource and might have led to changes in the use of this area by hunter-gatherers toward the end of the Middle Holocene, including a decrease in the exploitation of marine food and a consequent adjustment in the type and intensity of human activities carried out along the seashore. However, the possibility of geoarchaeological biases in the archaeological record should also be considered as an alternative or complementary explanation for the lack of coastal archaeological sites dated to the second half of the Middle Holocene. In this sense, the dynamic environmental conditions already mentioned may have precluded the formation of buried archaeological deposits along the coast. Taking this problem into consideration, Bonomo (2005) suggested that some of the surface archaeological coastal sites, which are abundant in the sand dunes, might correspond to the Middle Holocene, after the sea level maximum. These surface sites were interpreted as workshops where beach cobbles were exploited by bipolar reduction during brief occupational events by small groups of people (Bonomo 2005). Despite its low frequency, the presence of beach cobbles in TO5 confirms that the hunter-gatherers visited the Atlantic coast at this time where they obtained lithic raw materials and likely other resources, such as food resources and/or mollusk shells (see below).

### Middle to Late Holocene occupations

As was previously mentioned, an outstanding feature of TOSL is the abundance and variety of surface archaeological materials. Three main surface scatters were recorded on the northeast, southeast, and northwest margins of the lake (TO1, TO2, and TO3, respectively); these comprise mainly lithic artifacts and few fragments of mineral pigment, shell of marine mollusk, and ceramic. Also, a partially exposed

accumulation of mineral pigments, which constitutes a rare finding for the region, was found in the northern margin of the lake. Artifacts found on the surface scatters exhibit sedimentary abrasion suggesting that they were exposed to water flows; many of them were probably reworked by water from their original depositional context and redeposited in the present lake beach.

Currently, chronological controls of the surface archaeological record are limited. Some of the material from the surface scatter TO2 seems to be reworked from the eolian landform where TO5 is located. This suggests that at least part of this surface scatter dates to the Middle Holocene. However, until a systematic subsurface testing is carried out on this landform to determine the existence of other archaeological deposits, this entire assemblage cannot be assigned to this period.

On the other hand, two Late Holocene diagnostic artifacts were recorded in other sectors of the lake, including a ceramic piece found at TO1 and a small projectile point found at TO3. Less direct evidence of hunter-gatherer occupation dating to this time period is the ground stone tools recorded on the surface record. This type of artifacts is present in archaeological contexts from the southern Pampas dating back to the Pleistocene/Holocene transition (Flegenheimer et al. 2015), but they are more abundant in Late Holocene assemblages (Martínez and Mackie 2003; Bayón and Flegenheimer 2004; Bonomo 2005). However, most of the Late Holocene assemblages derive from surface deposits heavily affected by post-depositional processes and lacking strong chronological control, which might constitute cumulative palimpsests (sensu Bailey 2007, p. 204). This may also be the case for TOSL. Here, the co-occurrence of temporally diagnostic artifacts and relatively abundant ground stones is suggestive of a Late Holocene date for the surface scatters TO1 and TO3. However, considering the evidence of postdepositional disturbance and the limited number of diagnostic artifacts, it is safer to assume that they are time-averaged accumulations of archaeological materials at least partially deposited during this time period.

Taking into consideration the chronological information discussed above, it is reasonable to assume that most archaeological surface material recorded at TOSL corresponds broadly to the Middle to Late Holocene. Until geoarchaeological studies and detailed lithic analyses of surface assemblages are carried out, all the surface material will be considered as a single dataset.

The surface scatters exhibit raw material distributions and technological features similar to the TO5 site. SBG orthoquartzite is the dominant raw material, followed by CLF chert and beach cobbles. Other types of raw material present but rarer in the surface record are green siltstone, metaquartzite, silicified dolomite, shale, rhyolite, quartz, sandstone, and calcrete. This wide array of raw materials indicates



the use of different regional sources, mainly from the Tandilia range and secondarily from the Atlantic coast, the isolated rocky outcrops in the inland plains, and the Ventania range. The identification of a bola stone made on calcrete is an important finding, because it may be showing the exploitation of a lithic resource that outcrops in the locality. Although this raw material is not common in the regional archaeological record, its use has been demonstrated for the manufacture of ground stone tools, in particular bolas (Matarrese and Poiré 2009; Vecchi 2016). On the other hand, while only represented by a single artifact, the identification of silicified limestone suggests the acquisition of raw material from an extra-regional source; the nearest known sources of this type of rock are located in the province of La Pampa (i.e., Meseta del Fresco and Laguna El Carancho), more than 450 km to the west from TOSL (Berón and Carrera Aizpitarte 2019). Most raw materials were probably acquired by hunter-gatherers through both residential and logistical movements, while a small percentage of them, especially those from La Pampa province, were probably obtained indirectly through long-distance social networks.

The characteristics of the lithic surface assemblages suggest that the SBG orthoquartzite, the CLF chert, and the green siltstone were transported to this locality in various states of manufacture, from cores in advanced stage of reduction to finished tools; the beach cobbles in the form of nodules and tools; and the remaining raw materials mainly as finished tools. Like the TO5 site, most cores from the surface record made on SBG orthoquartzite are small and exhausted, and some of them were reduced by bipolar knapping, probably as a means to maximize this raw material. Raw materials were probably transported over long distance before arriving to the locality, mainly as part of individually transported toolkits. However, the presence of a few large grinding tools and cores suggests that a strategy of provisioning places (*sensu* Kuhn 1995) could also be under operation at the locality, an idea that will be further discussed below.

Besides similarities in raw material management, the surface material shares other important technological features with the TO5 site. These include predominance of tools manufactured on flakes by unifacial marginal retouch; similar inventories of flake tools; occasional use of pecking and grinding for tool manufacture; limited use of bifacial reduction; and frequent use of bipolar reduction to conserve good quality raw materials and to exploit beach cobbles. Overall, the similarities between the lithic assemblage from TO5 and the surface record suggest that there was continuity in the main manufacturing techniques and technological strategies from the second half of the Middle Holocene to the Late Holocene. Although the low chronological resolution of the surface record may potentially obscure temporal patterns, the remarkable consistencies suggest that if changes occurred over time, they

were not so marked to be detected with the current approach.

A distinctive feature of the surface archaeological record is the presence of a variety of ground stone tools. Unlike what was observed in TO5 (Fig. 7), most of the surface ground stones were unbroken (Fig. 3). The absence of preforms and production debris of this type of tool suggests that most of them were manufactured elsewhere and later transported to this locality. The few flakes from ground implements that were identified point to maintenance activities carried out at the locality. The only potential evidence of *in situ* manufacture is the presence of the bola stone made in calcrete, which might represent a case of opportunistic exploitation of a readily available raw material.

The various types of ground stone tools recorded in TOSL provide useful information about different activities carried out by hunter-gatherers at this locality. The presence of several bola stones (most of them complete) suggests that hunting of terrestrial large game probably was carried out in the vicinity of the shallow lake. The use of this hunting weapon by hunter-gatherers is well documented in the ethnohistorical record of the posthispanic period from the Pampa and Patagonia regions. This record documents its use to capture different prey through different hunting strategies (Vecchi 2006). On the other hand, the identification of several grinding tools adds new evidence about resource processing at the locality. Residue analysis performed on grinding tools recovered at other archaeological sites from the southern Pampas dating to the Middle and Late Holocene indicates that they were used to process a variety of products, including pigments, plants, and, probably, animal resources (Babot et al. 2007; Bonomo and Matarrese 2012). The abundance of mineral pigments in TOSL suggests that some of the grinding tools may have been used to process this colorant material. However, functional interpretations remain to be corroborated through residue analysis on the tools.

Beyond the evaluation of potential uses, the presence and design of grinding tools have also been used to assess the occupational history of particular places and to discuss settlement organization by past populations (e.g., Schlanger 1991; Nelson and Lippmeier 1993; Martínez and Mackie 2003). In these approaches, large grinding stones are generally considered site furniture, a particular type of insurance gear (*sensu* Binford 1979, p. 257). In the southern Pampas in particular, the abundance of grinding stones and large quartzite cores in some archaeological localities assigned to the Late Holocene was interpreted as the result of stockpiling of raw materials and artifacts to address anticipated needs in frequently used locations (Martínez and Mackie 2003; Bayón and Flegenheimer 2004; Bonomo 2005). Regional scholars proposed that provisioning places with artifacts and raw materials became a more important strategy for hunter-gatherers during the Late Holocene; and they linked this change in

technological organization to the social and economic transformation occurring during this period, such as reduction in residential mobility, resource intensification, and increase in territoriality. In the present study, the finding of some large grinding tools and cores at TOSL is also interpreted as the result of a place provisioning strategy, although due to the low temporal resolution of the surface record, it is not possible to determine when this strategy started to be implemented. Regardless of the specific date of these artifacts, its presence is indicative of long residential occupation and/or regular and anticipated returns to this locality.

The idea of extended stays and/or anticipated returns is further supported by the accumulation of red mineral pigment blocks with no traces of use or manufacture in the northern margin of the lake (TO4 site). The total amount of material (more than 5 kg) and its spatial arrangement suggest that this feature may correspond to a cache of raw material, probably placed there for future use. The stockpiling of mineral pigments adds further evidence in support of the place provisioning strategy mentioned above. Macroscopic observation suggests that the mineral pigment may be a type of rock naturally available in the Tandilia range close to the SBG orthoquartzite outcrops (Matarrese et al. 2011). The volume of transported material and the planning involved in its storage suggest that it was probably procured through specific trips. A seemingly comparable accumulation of mineral pigments was reported from the Laguna del Trompa site, also located in the inland plains (Crivelli Montero 1994). At this site, three surface features were interpreted as caches of lithic artifacts, one of them consisting of pieces of “ochre.” A different type of accumulation of coloring substances was found in Amalia site 2, a rockshelter located in the eastern portion of the Tandilia range (Mazzanti 2002). At this site, two concentrations of archaeological materials containing coloring substances were found in an archaeological level dating to the first half of the Middle Holocene. One of these included more than 20 pieces of mineral pigments, most of them showing use-wear traces, positioned around and above a grinding instrument. The other concentration contained five pieces of pigments showing use-wear traces, one fragment of unmodified mineral pigment, and several flaked artifacts. These features were interpreted as caches of special artifacts, perhaps of symbolic value due its functional specialization (Mazzanti 2002).

Besides the mineral pigments found in the TO4 site, numerous small and dispersed fragments of mineral pigment—mostly red—were found in the surface scatters. As in TO4, no traces of use or manufacture were identified in the majority of these pieces which probably are the remains of mineral pigment processing. As was previously mentioned, some of the ground stone tools found at the locality could have been used for grinding pigmentary rocks, as was recorded in other archaeological sites in the region (Matarrese et al. 2011; Bonomo and Matarrese 2012). Evidence from TO5 indicates

that activities involving the use of pigments were performed at TOSL from the earlier occupations. Archaeologically documented uses in the southern Pampas include funerary treatment of the dead, ceramic decoration, and rock painting (Bonomo 2006; Pedrotta 2010; Matarrese et al. 2011; Politis et al. 2014a). Other potential uses mentioned in the chronicles of the eighteenth and nineteenth centuries from Pampa and Patagonia include hide processing and/or painting, decoration of objects other than ceramic, and corporal painting (Bonomo 2006; Prates 2009). In addition, these chronicles remark the utilitarian and also symbolic value of coloring substances for indigenous groups and describe the different ways in which these resources were obtained, which included special trips to the procurement areas, the central portion of the Tandilia range in particular, as well as exchanges with other groups. The large amount of pigmentary raw material at TOSL and its storage in anticipation of future use suggest that activities that required an abundant use of red coloring substances were carried out in this locality, perhaps frequently.

Finally, another important finding from TOSL is the presence of marine mollusk in all three surface scatters. Most of them are shell fragments with no human modification; however, a single perforated bead was found in surface scatter TO2. Different lines of evidence discussed by Bonomo (2007) indicate that hunter-gatherers from this region used marine mollusk for both technological and ornamental purposes, and not as a food source. According to this author, marine mollusks probably held strong symbolic meaning for hunter-gatherers and circulated in the region as exchange goods. In the particular case of hunter-gatherers which occupied TOSL, a direct acquisition can be proposed due to the proximity of the Atlantic coast and the presence of other coastal resources (i.e., beach cobbles). In agreement with the regional record, the shell specimens from this locality do not appear to be the remains of subsistence-related activities, but rather the result of its ornamental and symbolic use. The presence of several shells without human modification suggests that they could have been brought to this locality as raw material and that the beads could be manufactured here.

In summary, the surface record from TOSL indicates that multiple activities were performed around the shallow lake during the Middle and Late Holocene, including hunting of terrestrial game; tool manufacture and repair; manufacture and/or use of shell beads; and storing and use of mineral pigments. Also, the diverse lithic assemblage suggests that a range of processing tasks was undertaken, including animal butchering, pigment grinding, and perhaps plant processing and hide working. Due to the fact that this surface record is time-averaged, it is not possible to determine whether this diversity of activities is the result of long-term residential occupations, frequent

short-term visits for different specific activities, or a combination of both.

### Las Toscas shallow lake: a persistent place in the inland plains

All the evidence discussed so far strongly suggests that TOSL was an important place for hunter-gatherers who inhabited the southern Pampas. Hunter-gatherers were clearly present at this locality during the Middle Holocene and continued visiting this place until the Late Holocene. The use of this locality was not continuous, but it was redundant and planned. Occupations may have become more intense toward the Late Holocene, but this idea needs to be further evaluated in the future. Evidence for repeated use during the long-term occupation of the southern Pampas suggests that Las Toscas shallow lake was a persistent place (*sensu* Schlanger 1992, p. 92) for hunter-gatherers.

In agreement with what has been proposed for other archaeological sites from this region associated with shallow lakes (Mazzia 2013), the exploitation of lacustrine resources does not seem to have been one of the main factors that attracted hunter-gatherers to this locality. Instead, the presence of water might have been of great importance, especially during the drier phases at the end of the Middle Holocene and the beginning of the Late Holocene, when the desiccation of small ponds and swampy areas caused a regional decrease in the availability of surface water. However, as previously suggested by other regional researchers (Curtoni 2011; Mazzia 2013), the significance of water for hunter-gatherers of the Pampas probably went beyond its role as a vital resource and also involved important symbolic connotations. The visitation of TOSL for ritual practices seems to be supported by the abundance of mineral pigments as well as for the presence of human skeletal remains.

Another factor that may have drawn people to this place was the presence of terrestrial game and perhaps plant resources. The guanaco, the main prey species in the inland plains during this time, is a periodic drinker, requiring at least occasional free or vegetational water (Franklin 1982). In consequence, it is likely that guanacos tended to gather around the shallow lake, especially during the drier periods. Hunting of guanaco in the vicinity of the shallow lake is supported by the faunal assemblage at the TO5 site and by the presence of several bola stones in the surface assemblages.

In addition to these natural features, the accumulation of cultural material around the shallow lake, especially lithic resources deposited intentionally or unintentionally during previous occupations, probably further increased the attractiveness of this place. The scarcity of naturally available lithic raw materials in the inland plains suggests that the presence of these cultural materials may have been especially important in promoting re-occupations of this locality.

TOSL is not an exception in the regional archaeological record. On the contrary, many other localities in the inland plains associated with water sources show evidence of repeated and frequent use, and some of them (e.g., Arroyo Seco 2, Paso Mayor) have been also interpreted as persistent places for hunter-gatherers (Bayón et al. 2010; Politis et al. 2014b). Most of these localities were used for both residential and ritual purposes, and the presence of secondary burials in some of them gives further support to the idea that beyond the availability of natural resources and cultural materials, hunter-gatherers' occupations were also motivated by the symbolic meanings of these places.

### Conclusions

The study of the archaeological record from Las Toscas shallow lake, despite of its mixed origin, low chronological resolution, and selective destruction of organic remains, has revealed a long-term land use pattern by hunter-gatherers from the Middle Holocene (ca. 4600 <sup>14</sup>C yrs BP; ca. 5300 cal yrs BP) to the Late Holocene. The findings from the stratified deposit at TO5 are of particular relevance because they provide much needed information for the second half of the Middle Holocene, a period of time scarcely represented in the regional archaeological record. Faunal data from this site are in agreement with regional models for the southern Pampas that propose that the guanaco was the main food resource during this time period. However, since the possibility of a taphonomic bias in the faunal assemblage from TO5 cannot be ruled out, the hypothesis of specialized hunting of ungulates cannot be supported. It is worth pointing out that this problem does not downplay the importance of the faunal data from this site; on the contrary, it alerts about potential taphonomic biases in other archaeofaunal assemblages from similar geomorphological contexts that were used to build this specialized hunting model. Regarding technology, in agreement with evidence from other regional sites dated to the second half of the Middle Holocene, the lithic study of TO5 showed a strong preference for SBG orthoquartzite. The presence of this rock as well as other lithic raw materials suggests that hunter-gatherers that occupied the inland plains exploited resources from other environmental contexts, such as the Tandilia range, the Atlantic coast, and the Ventania range. Morphological and technological characteristics of the lithic assemblage indicate that artifacts probably entered the site mostly as part of toolkits carried by individuals. As in other regional lithic assemblages with similar chronologies, most of the tools were manufactured on flakes by unifacial marginal retouch. Bipolar and bifacial reduction and pecking and grinding were also part of the technological repertoire of hunter-gatherers.



The surface archaeological record from TOSL has also proven to be extremely informative. This record provides useful information about long-term trends in technological strategies and land use by hunter-gatherers during Middle to Late Holocene times. Comparison among the lithics from the surface scatters and those of TO5 points to continuity in raw material selection, manufacturing techniques, and provisioning strategies through the second half of the Middle Holocene and the Late Holocene. Only a slight difference in provisioning strategies was identified in the surface record as some of the large cores and grinding tools seem to have entered the locality as a result of place provisioning, a strategy that probably became more important during the Late Holocene according to the regional archaeological record. This evidence, as well as the discovery of a cache of mineral pigment, indicates that this locality was supplied with raw materials and tools according to anticipated needs, which suggests frequent visits or long residential occupation.

In general, archaeological evidence from TOSL indicates that procurement, domestic, and ritual activities were conducted around the shallow lake. The use of this locality was not continuous but redundant. This evidence suggests that this shallow lake was a persistent place for hunter-gatherers. The presence of water was probably one of the main features that motivated long-term visitation, not only for its importance as a vital resource but also for its symbolic meanings for hunter-gatherers who inhabited the southern Pampas. Also, the location of TOSL in the inland plains where game animal was abundant and the close proximity to the Tandilia range and the Atlantic coast probably contributed to its attractiveness for hunter-gatherer occupation. The pattern of human occupation at TOSL appears to have varied slightly over time: the Middle Holocene record from TO5 suggests a short-term residential occupation or a series of brief occupation events, while the surface record, which includes a Late Holocene component, point to more intense occupation. However, changes in subsistence, technology, and mobility do not seem to be abrupt, which agrees with the model of local cultural evolution as a continuous process.

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## Declarations

**Competing interests** The authors declare no competing interests.

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