First results of the hunter-gatherer weapon system studies in the middle basin of the Salado creek (Pampas Region, Argentina)

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Abstract:

In this paper we present the results of the study of 32 projectile points from Hangar site, located in the Salado creek basin (centre of the province of Buenos Aires). Archaeological materials recovered from the site include some isolated human remains, several potsherds, faunal materials, and lithic artefacts. The presence of pottery and small triangular points, together with the radiocarbon dating results, indicate that the main occupations occurred during the end of the Late Holocene. Methodology used included the techno-typological study of the lithic assemblage. Results showed that the outcrops of some rocks present in the sample are found in the Humid Pampas (100-190 km distant from the site) and the Dry Pampas (400-530 km distant from the site). The projectile points show variability in design and size, attributes that have implications for distinguishing different weapon systems (*e.g.*, arrow and dart). In the Pampas region, the Late Holocene is a period characterized by an increasing complexity in hunter-gatherer societies, as it is indicated by long-distance exchange networks and different strategies of intensification and diversification on faunal resources. In accordance with this scenario, we propose that the variability that is observed in the lithic points is a reflex of an increase in the amount of the hunted species in relation with technological innovations such as the introduction of the bow and arrow.

Keywords: Pampas region; hunter-gatherers; weapon system; projectile points; Sierras Bayas Group orthoquartzite; chert

1. Introduction

In this article we present the results of different analyses conducted on the projectile points from Hangar, an archaeological site located in the basin of the Salado creek (Humid

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Pampas sub-region, province of Buenos Aires, Argentina). Along this basin and the nearby shallow lakes, several archaeological sites have been recorded, most of them dated to the Middle and Late Holocene (Barros *et al*. 2018; Crivelli Montero *et al*. 1987; 1997; Eugenio 1994; Kaufmann & González 2013). Archaeological evidences of Hangar site indicate that this context can be characterized as a residential or base camp, where hunter-gatherers conducted many different tasks. The objective of the present research was to characterize the projectile points, to determine the lithic raw materials, and to identify the knapping activities that were performed at the site. These data, together with the results of other lines of evidence, will allow us to discuss the hunting strategies used in Hangar during the Late Holocene.

Darts and arrows are related to distinct propulsion systems. For this reason, the projectiles should have some differences in shape and size, according to their necessity for velocity, precision, and impulse, among other variables. Darts are launched with a thrower while arrows are propelled by using a bow. Arrows are lighter than darts, thus being faster. On the other hand, darts are more penetrating than arrows (Hughes 1998; Martínez 2003; Okumura & Araujo 2015; Whittaker *et al*. 2017; among others). Different types of projectile points are recorded in the Pampas region. These items are assigned to different chronological periods, including the peopling of the Pampean plains during the Final Pleistocene (Politis 2000). Projectile points have been used as time markers (Nelson 1997) as well as indicators of interpersonal violence, tasks or hunting strategies performed at the sites (Berón 2015; Escola 2014; Mazzanti 2006; Politis *et al*. 2014; Valverde & Martucchi 2004; Vigna *et al*. 2014). The presence of small triangular points in the archaeological record is recurrent in contexts dated to the Late Holocene. These tools were recovered in the Tandilia system hill (*e.g*., Flegenheimer 1980; Mazzanti 2006; Valverde & Martucci 2004) and in the grassland plains (*e.g*., Barros & Messineo 2007; Crivelli *et al*. 1997; Escola 2014; Pedrotta 2005: 183-254; Politis 1984: 284-322). In general, most artefacts were manufactured on orthoquartzite SBG (Sierras Bayas Group), chert and, to a lesser extent, basalt, quartz, silicified siltstone, rhyolite, and silicified limestone, among other rocks. Raw materials from both the Dry and the Humid Pampas were used for the purpose of making projectile points. It is important to mention that in this article we refer to "chert" based on the definition given by Messineo and colleagues (Messineo *et al*. 2004: 306-307).

1.1. Background research in the basin of the Salado creek

Investigations in the study area began in 1970, led by Drs. Mario Silveira and Eduardo Crivelli. These authors recorded several archaeological sites in the basin of the Salado creek (*e.g*., Crivelli Montero *et al*. 1987-88; Eugenio 1994). Moreover, they excavated three of these sites: La Raquel 2, Escuela Agropecuaria, and Fortín Necochea. The latter is the most relevant to understanding the characteristics of the human occupations in the basin. Fortín Necochea is an open-air site located on the shore of a shallow lake, and it is multicomponent, with dates of about 6010 ± 400 years BP (lowest levels), 3630 ± 60 years BP, and the presence of post-contact materials. The lithic assemblage is dominated by orthoquartzite SBG and chert, followed by siliceous rocks, basalt, shale, and granite, in lower proportions. Raw materials were intensively used and most of them are the result of flake production techniques. Exploitation technique was mainly unipolar, but in some cases bipolar. It is important the presence of two projectile points, associated to post-contact materials. These tools are triangular and asymmetrical, with concave base. One of them was manufactured on orthoquartzite SBG and is medium-sized and the other was made on chert and is small. According to researchers, the latter could have been used as an arrow (Crivelli Montero *et al*. 1987). Finally, mineral pigments, potsherds, and faunal remains of different species were also

found at this site. The study of these materials indicated that Fortín Necochea functioned as a residential camp (Crivelli Montero *et al*. 1987).

Since last 10 years, our team has been working in the basin of the Salado creek and has generated new information (Barros *et al*. 2018; Kaufmann & González 2011). As part of this investigation, several sites were recorded: Laguna Muscar (sites 1 and 2), Laguna Seca (sites 1, 2, and 3), Laguna Redonda (site 1), El Trebolar (sites 1, 2, and 3), el Quince (sites 1 and 2), Arroyo Salado (sites 1 to 8), and Hangar. In some of these open-air sites, surface collections, test pits, and excavation were made. The materials that were recovered include faunal specimens (guanaco, Pampas deer, Greather rhea, and armadillos), human burials, potsherds, and mainly, lithic remains. The results obtained through lithic analyses of different sites allowed us to enhance our knowledge on the use of the rocks in the Salado basin. In the sites Laguna Seca 2, Laguna Redonda, and Escuela Agropecuaria, different raw materials were identified, but orthoquartzite SBG and chert were the most abundant (Table 1). Moreover, all the stages of the *chaîne opératoire* or operational sequence are represented for these two rocks. Core preparation could have taken place in the primary outcrops (the hills; between 188 and 107 km far from the sites, respectively), to be later transported to the interior plains. Raw materials were maximized, as it is evidenced by the advanced reduction stages, the sizes, and the use of the bipolar technique. Direct percussion technique was used for obtaining blanks of different modules. This is related to a variety of production objectives for the manufacturing of tools. There is a wide diversity in typological groups, which include scrapers, side scrapers, and multi-purpose tools (Barros 2013; 2018; Barros *et al*. 2018).

Table 1. Raw material frequencies in sites located in the basin of the Salado creek. Abbreviations = LS2 = Laguna Seca 2; LR = Laguna Redonda; LM2 = Laguna Muscar 2; FN = Fortín Necochea; UP = Upper levels; ML = Middle levels; LL = Lower levels; EA = Escuela Agropecuaria; H = Hangar; OSBG = Orthoquartzite SBG; Ch = chert; Sl = Silicified limestone; O = Other raw materials; C = Chronology; LH = Late Holocene; MH = Middle Holocene; fLH = final Late Holocene; PH = Post-Contact.

	Raw materials									
Archaeological	**OSGB**		**Ch**		**Sl**		**O**			
sites	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**C**	**References**
LS2	124	56.1	54	24.4	4	1.8	39	17.6	LH	Barros 2013
LR	115	59.9	58	30.2	-	-	19	9.9	LH	Barros *et al*. 2018
LM2	85	63.4	38	28.4	-	-	11	8.2	MH	Barros *et al*. 2018
FN: UP	524	68.5	221	28.9	-	-	20	2.6	PC	Crivelli Montero *et al*. 1987
FN: ML	38	59.4	25	39.1	-	-	1	1.6	LH	Crivelli Montero *et al*. 1987
FN: LL	17	60.7	11	39.3	-	-	-	-	MH	Crivelli Montero *et al*. 1987
EA	896	58.2	624	40.6	-	-	18	1.2	LH	Crivelli Montero *et al*. 1997
H	399	27.7	753	52.4	145	10.1	141	9.8	fLH	this publication

1.2. The regional lithic resource base

The Pampas region is divided into two sub-regions, the Humid Pampas (East) and the Dry Pampas (West), which are separated by the 600 mm isohyet (Figure 1). In both sub-regions, quarries, quarry-workshops, and potential sources of raw materials have been recorded. Studies on the structure of the regional lithic resource base (*sensu* Ericson 1984) were conducted in different areas of the Dry Pampas (Berón 2004: 8-32; 2013; Carrera Aizpitarte 2014: 267-308; Heider 2015; among others). The high variability of raw materials that were recorded includes: quartzite, granite, rhyolite, greywacke, siliceous rocks, andesite, and sandstone. In general, most of these rocks are more common towards the West, associated to the geological formations Cerro Azul and Paso de las Carretas (Heider 2015). Silicified limestone is the main raw material in the sites of the Dry Pampas, although it has also been identified in assemblages from the Humid Pampas (Barros 2013; Messineo & Scheifler 2016;

Messineo *et al*. 2018) and in Northern Patagonia (*e.g*., Santos Valero 2015). In the West, the sources of this rock are concentrated at Valle Daza (Charlín 2002), Laguna El Carancho (Berón 2006), and Meseta del Fresco (Berón 2006; Berón & Curtoni 2002; Curtoni *et al*. 2004).

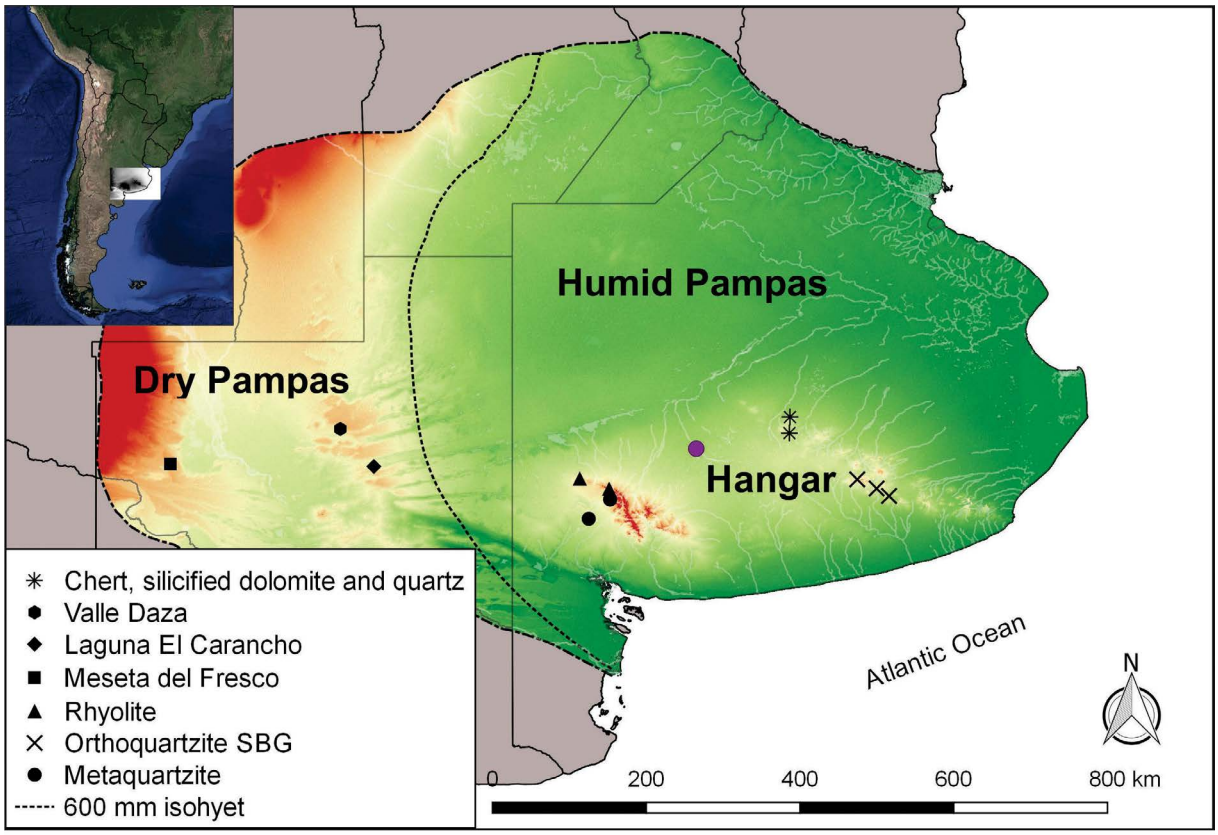

Figure 1. Location of Hangar site and the lithic raw material sources.

In the Humid Pampas, there are four main places where rocks suitable for knapping are available: Tandilia system hills, Ventania system hills, Atlantic littoral, and some isolated outcrops on the plains. Several rocks can be found along the Tandilia system hills. Quartzites of the Balcarce Formation outcrop on the South-eastern side (Mazzanti 1997; Valverde 2002). In the centre of these hills there are microcryptocrystalline silica, silicified dolomite, diabase, and the quarry-workshops of the Diamante creek, with orthoquartzite SBG (Colombo 2013: 144-233; Flegenheimer 1991; Flegenheimer & Bayón 2002; Flegenheimer *et al*. 1996; 1999). In the Northwest of the range, the main raw materials are: Granite, orthoquartzite SBG, limestone, silicified dolomite, chert, and quartz (Barros & Messineo 2004). On the other hand, several rocks have been recorded in the Ventania hills system, including rhyolite, granite, and primary and secondary sources of metaquartzite and orthoquartzite (Bayón & Zavala 1997; Catella 2014: 133-212; Oliva & Moirano 1997). On the plains, there are isolated outcrops of silicified limolite, quartzitic sandstone, and coarse-grained quartzite (Madrid & Salemme 1991; Politis 1984: 284-322). Finally, there is a wide variety of raw materials along the Atlantic littoral, which include siliceous rocks, basalt, and quartzite. These items occur in the form of coastal pebbles and cobbles (Bonomo 2005: 47-68).

2. Methods

Hangar was discovered when modern agriculture activities together with the action produced by burrowing animals, exposed materials from the A soil Horizon (0-30 cm depth).

In May 2017 we walked transects across 11,750 m^2, which had no plant cover, and therefore an excellent visibility. At that moment, we collected lithic artefacts, potsherds, faunal remains, and human bones from the surface. Posteriorly, we dug test pits and we found materials in stratigraphic position. In November 2017, we excavated 11m^2 and we recovered several materials, but these remains are still been studied. Two radiocarbon dates were conducted at the *Laboratoire des sciences du climat et de l'environnement* (France). Both of them were made on guanaco bones and indicated an age of 706±34 cal years BP (lab codes: GifA18041 and SacA5357) and 1226±54 cal years BP (lab codes: GifA18042 and SacA5357). In accordance with these dates, geomorphologic characteristics, the faunal association, and the presence of pottery indicate that the occupations took place during the end of the Late Holocene.

For this study, we analysed the surface lithic assemblage that we collected in May 2017. Stone artefacts were initially sorted into ground tools, knapped tools, cores, and knapping products. Typological analyses followed the guidelines by Aschero (1975:1-34; 1983:6-83). Moreover, basic statistical analyses were conducted. The chi-square goodness of fit test was used, considering the adjusted residuals with the Past program. The Monte Carlo method was used to estimate the probability.

In this work, we focus on projectile points; which were analysed from a techno-typological perspective (*sensu* Aschero 1975:1-34; 1983:6-83; Escola 2004; Martínez 2003). We considered different variables in the analysis: lithic raw material type, condition (broken or complete), relative dimension (length, width, thickness, and weight), width-thickness ratio, and technical series.

There are different models that enable to discuss the functional assignation of projectile points. These were made on the basis of experimental, ethnographic, and historic information (Hughes 1998; Ratto 2003: 45-91; Shott 1997; Thomas 1978; among others). These models consider metrical, morphological, and technical variables that make it possible to differentiate among points of different projectile propulsion systems (spear, javelin, dart, and arrow). In this article and as a first approximation to this topic, the function of projectile points was inferred following the proposal of Shott (1997) (see discussion in Martínez 2003; Ratto 2003: 45-91). This author states an equation with one variable (the width of the points) that can discriminate between darts and arrows in a given sample (Shott 1997). Many different techniques exist for estimating these proportions in a lithic assemblage (*e.g.*, Hildebrandt & King 2012; Hughes 1998). We use the Shott´s proposal (1997) because this is one of most accepted methods for discriminating between different projectile propulsion systems (Okumura & Araujo 2015: 2364). However, it is important to note that there is an overlapping between the measurements of darts and arrow (Shott 1997). Moreover, in some cases Shott's formulae was not successful for distinguishing both types of points (Railey 2010). For this reason, results must be carefully considered (Erlandson *et al*. 2014). However, this is a useful starting point for this discussion, considering that most of the projectile points of Hangar are broken and many of the previously mentioned variables cannot be recorded. Finally, contextual and chronological associations were also considered when interpreting the function of the projectile points (Martínez 2003).

3. Results

3.1. Lithic assemblage

The lithic assemblage (N=1438) is composed of eight ecofacts (pebbles and clasts) and 1430 artefacts. Of the latter, 149 are tools, four are ground stones, 17 are cores (chert n=16; orthoquartzite SBG n=1), 1226 are knapping products, and 34 are knapping products that could not be determined. The most common raw materials in the sample are chert (52.44%),

orthoquartzite SBG (27.79%), silicified limestone (10.08%), and metaquartzite (4.52%). The rocks that could not be identified represent 2% of the total sample. The rest of the raw materials (silica, chalcedony, *etc.*) have percentages lower than 1% (Table 2).

Table 2. Provenance of the lithic raw materials and assemblage composition of Hangar. Abbreviations: OSBG = Orthoquartzite SBG; CP = Complete Flake; BF = Broken Flake; FNP = flake with no platform; UKP = undetermined knapping product; UD = undetermined; Oqtzt.

			Artefacts									
					Knapping products							
	Lithic raw material sources	Raw material	Knapped tools	Cores	CF	BF	FNP	UKP	Ground stones	Ecofacts	Total	%
Humid Pampas	Tandilia-Northwest	chert	91	16	189	189	267	-	1	-	753	52.36
		silicified dolomite	-	-	1	7	2	-	-	-	10	0.70
		quartz	1	-	-	-	-	1	-	1	3	0.21
	Tandilia-Center	OSBG	38	1	65	109	179	7	-	-	399	27.75
		diabase	-	-	-	-	-	-	2		2	0.14
	Ventania	rhyolite	2	-	-	5	-	-	-	-	7	0.49
		metaquartzite	-	-	14	13	23	11	1	3	65	4.52
	Atlantic littoral	silica	1	-	5	2	1	-	-	2	11	0.76
Dry Pampas	Meseta del Fresco	silicified limestone	13	-	34	41	46	11	-	-	145	10.08
	UD	chalcedony	1	-	3	1	8	-	-	1	14	0.97
	UD	undetermined	2	-	8	1	13	4	-	1	29	2.02
		Total	**149**	**17**	**319**	**368**	**539**	**34**	**4**	**8**	**1438**	**100**

The analyses conducted on each raw material show notorious nominal variations between the predominant (orthoquartzite SBG and chert) and minority rocks. A higher number of typological groups was made on chert: Twelve of the 17 groups recorded in the total sample (Table 3). Nine typological groups were made on orthoquartzite SBG. Cores and utilized flakes are only recorded for orthoquartzite SBG and chert. In this sense, it is important to note that Franco (2004; 2014) mentions that these are the diagnostic elements to discuss access to lithic sources and production objectives.

The third more frequent rock is silicified limestone, with five typological groups. Only one group is represented in the rest of the raw materials. If we consider the raw materials by type of artefact, only four types of tools were made on the seven minority rocks. Seventy per cent are parts of weapon systems (three bola stones and four arrows), while the rest are scrapers and multi-purpose tools. It is important to note the presence of three drills in the sample (Table 3). These artefacts are very common in Patagonia but are scarcely represented in the Pampas region, where they are mainly related to occupations dated to the Late Holocene (Carrera Aizpitarte *et al*. 2013; Eugenio 1994; Pedrotta 2005: 183-254; Vecchi *et al*. 2013; Viani 1930: 39-41).

Preliminary statistical analyses were conducted on the predominant raw materials (orthoquartzite SBG and chert) and indicate that the differences previously mentioned are not statistically significant (Table 4). There is only one exception: Results obtained through the chi-square goodness of fit test indicate that scrapers and side scrapers present differences in relation with the selection of raw materials. In this sense, there are more scrapers made on chert than on orthoquartzite SBG in relation with what is randomly expected; and there are less side scrapers made on chert than on othoquartzite SBG in relation with what is randomly expected (Table 4).

Table 3. Types of tools and raw materials of Hangar. Abbreviations: orth = orthoquartzite; S = silicified; meta = metaquartzite; UN = undetermined.

Tool	Chert	Orth. SBG	S. limestone	Rhyolite	Silica	Meta.	Diabase	Chalcedony	Quartz	UN	Total	%
Scraper	45	12	4	-	-	-	-	-	1	1	63	41.45
Projectile point	17	7	4	2	1	-	-	1	-	-	32	21.05
Retouched flake	7	-	3	-	-	-	-	-	-	-	10	6.58
Multi-purpose tool	1	7	-	-	-	-	-	-	-	1	9	5.92
Utilized flake	6	2	-	-	-	-	-	-	-	-	8	5.26
Edge fragment	6	1	-	-	-	-	-	-	-	-	7	4.61
Side scraper	-	6	-	-	-	-	-	-	-	-	6	3.95
Drill	2	-	1	-	-	-	-	-	-	-	3	1.97
Bola stone	-	-	-	-	-	1	2	-	-	-	3	1.97
Splintered piece	2	-	-	-	-	-	-	-	-	-	2	1.32
Biface	1	-	1	-	-	-	-	-	-	-	2	1.32
Notch	2	-	-	-	-	-	-	-	-	-	2	1.32
Knife	1	-	-	-	-	-	-	-	-	-	1	0.66
Preform	-	1	-	-	-	-	-	-	-	-	1	0.66
Graver	-	1	-	-	-	-	-	-	-	-	1	0.66
Undetermined	-	1	-	-	-	-	-	-	-	-	1	0.66
Hammerstone	1	-	-	-	-	-	-	-	-	-	1	0.66
Total	**91**	**38**	**13**	**2**	**1**	**1**	**2**	**1**	**1**	**2**	**152**	**100**

Table 4. Results obtained through the chi-square goodness of fit test. Rows, columns=7, 2. Degrees freedom=6. Chi^2=32.747. Monte Carlo p=0.0001.

Tool	Chert	Orthoquartzite SBG
Scraper	2.0405	-2.0405
Projectile point	0.089748	-0.089748
Retouched flake	1.7827	-1.7827
Multi-purpose tool	-3.6854	3.6854
Utilized flake	0.31452	-0.31452
Edge fragment	0.93136	-0.93136
Side scraper	-3.8493	3.8493

3.2. Projectile points

Thirty-two projectile points were recovered in Hangar. Seventeen were manufactured on chert, all of which are stemless and triangular. Six of them are complete and small. Five of the points are bifacial and one is partially bifacial and has a notch. From this group, four of the blanks that were used are flakes and two could not be determined. In three of the points that were made from flakes, the platform is still present, and located on the left side of the proximal limb (Figure 2a). Symmetry and regularity are attributes observed in the pieces, especially in the longitudinal and cross sections. However, there are some differences in the selected thickness (Table 5). In general terms, the pressure technique was used for making the points and regular and parallel retouch are observed in the pieces. Only one specimen presents

denticulated edges (FCS.H.27). The technical treatment of the bases shows that five of them were thinned by retouch. In the rest of the cases, the flake´s plane was used. The contours of the bases are convex, concave, and rectilinear.

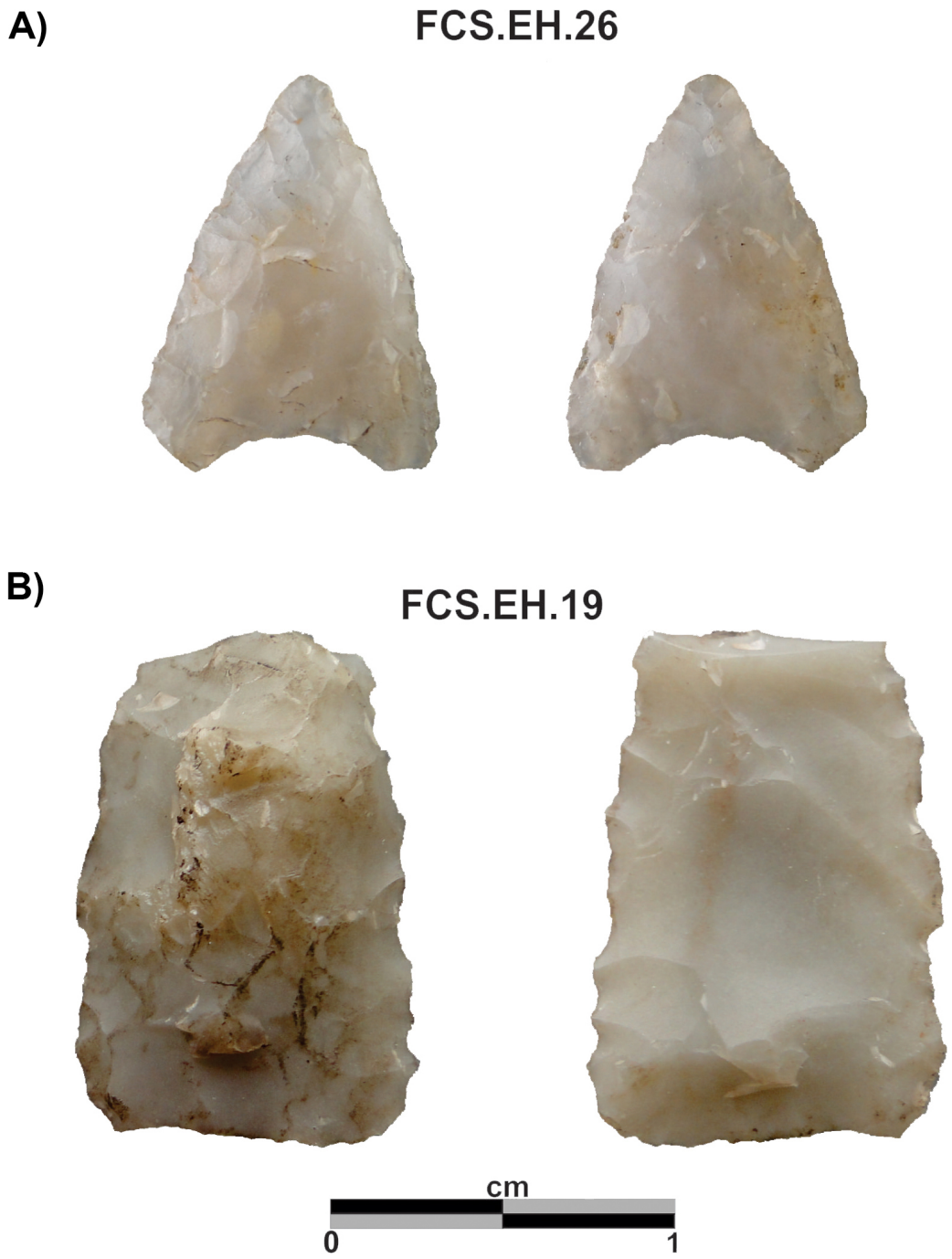

Figure 2. Arrows manufactured on chert.

Table 5. Variables measured for the projectile points of Hangar. References: Orth = orthoquartzite; L = length; W = width; T = thickness; Wg = weight; WTR = width-thickness ratio; Th = thick; VT = very thick; LT = little thick; UF = undifferentiated because of the fracture; UN = undetermined; * = according to Shott (1997) equation.

ID #	Raw material	State	L (mm)	W (mm)	T (mm)	Wg (gr)	WTR	Section	Function*
FCS.H.1	rhyolite	broken	14	19	4	1	Th	base	dart
FCS.H.2	rhyolite	broken	42	23	7	7.3	Th	base	dart
FCS.H.4	orth. SBG	broken	33	20	9	7.2	VT	base	dart
FCS.H.5	orth. SBG	complete	39	31	8	8.1	Th	UN	dart
FCS.H.6	orth. SBG	complete	27	17	5	2	Th	UN	arrow
FCS.H.7	orth. SBG	complete	21	15	2	0.9	LT	UN	arrow
FCS.H.8	orth. SBG	broken	30	27	5	5.3	LT	base	dart
FCS.H.9	orth. SBG	broken	13	16	3	0.7	LT	base	arrow
FCS.H.10	orth. SBG	broken	23	15	4	1.6	Th	base	arrow
FCS.H.11	silica	broken	10	11	2	0.3	LT	blade	arrow
FCS.H.12	silicified limestone	broken	10	9	2	0.3	Th	base	arrow
FCS.H.13	silicified limestone	broken	24	21	4.5	2.4	Th	base	dart
FCS.H.15	silicified limestone	broken	16	14	3	0.8	Th	base	arrow
FCS.H.39	silicified limestone	broken	18	13	3	0.7	Th	mesial base	arrow
FCS.H.25	chalcedony	broken	20	16	4	1.5	UF	base	un
FCS.H.14	chert	complete	24	15	4	1.1	Th	UN	arrow
FCS.H.16	chert	broken	9	9.5	2.5	0.3	Th	base	arrow
FCS.H.18	chert	broken	8	17	2	0.4	LT	base	arrow
FCS.H.19	chert	broken	30	19	6	4.1	Th	base	arrow
FCS.H.20	chert	broken	14	10	2	0.4	LT	base	arrow
FCS.H.21	chert	broken	19	16	3	1.2	LT	base	arrow
FCS.H.22	chert	broken	20	16	3	1	LT	base	arrow
FCS.H.23	chert	broken	12	14	2.5	0.5	LT	base	arrow
FCS.H.24	chert	complete	17	13	2.5	0.5	LT	UN	arrow
FCS.H.26	chert	complete	23	17	5	1.6	Th	UN	arrow
FCS.H.27	chert	complete	17	12	2	0.5	LT	UN	arrow
FCS.H.28	chert	complete	22	12	2	0.8	LT	UN	arrow
FCS.H.29	chert	broken	12	8	1	0.1	LT	blade	arrow
FCS.H.30	chert	broken	10	13	2	0.4	LT	base	arrow
FCS.H.33	chert	broken	11	12	2	0.4	LT	base	arrow
FCS.H.34	chert	complete	12	11	2	0.5	LT	UN	arrow
FCS.H.40	chert	broken	11	11.21	1.8	0.3	LT	base	arrow

The dimensions of the pieces, as well as the raw materials and possible weapon systems are presented in Table 5. In the case of the broken points, several types of fractures were recorded: impact (n=4), perverse (*sensu* Crabtree 1972; n=2), stepped (n=2), and undetermined (n=5). Four fragments of basal limbs were identified: three of them were made of flakes while in the fourth specimen, the blank could not be determined. The technical treatment shows short bifacial (n=2) and short unifacial (n=2) retouch, as well as scarce bifacial flaking. One of the specimens (FCS.H.20) presents a notch in the right side of the limb. The contours of the bases are rectilinear and attenuated concave. The piece FCS.H.19 was made of a flake with pronounced curvature and a thickness of 6 mm. This tool could have been broken while it was being manufactured (Figure 2b). Three of the six basal fragments were made of flakes and the other three of undetermined blanks. In five pieces, bifacial flaking, laminar retouch, and short retouch are observed. The other projectile is unifacial with denticulated and parallel flaking on the right side and on the base (FCS.H.33). The treatment of the bases indicates that five pieces were thinned by short and parallel retouch while only one was manufactured from a fracture. This fracture could have been already present before the artefact was done, or could have been produced while making the tool. The contours of the bases are rectilinear, concave, and convex. Differences are also observed among the thickness of the items (Table 5). These data could indicate that the projectiles were reactivated when they were hafted. Finally, there is a tip fragment with evidences of the bifacial technique; one side presents laminar retouch and the edges are denticulated. The results obtained on the weapon system indicate that, in the case of chert, all the projectile points correspond to arrows, although there are differences in the technical treatments (Table 5).

With regards to orthoquartzite SBG, the pieces correspond to a preform, two complete points, one slightly fractured, and four broken items. All of these specimens are stemless. The blank that was used for the preform is a flake and it has long and short unifacial retouch (FCS.H.3) (Figure 3a). The three complete projectiles were made of flakes, with short retouch and bifacial microretouch, and have asymmetrical biconvex transverse cross sections. The first one has a convex shape, thinned by retouch (FCS.H.5). The second has a medium to small size, and a fracture in the proximal section of the limb, with a concave shape (FCS.H.6; Figure 3b). The third point is medium-sized, and is scarcely manufactured, with marginal microretouch. This point was reused to make a notch on the right side of the limb. In the case of the broken pieces, there are two perverse fractures, one impact fracture, and one undetermined. There are three fragments of basal limb and one of a base. In two cases the blanks are flakes, while in the rest of the specimens it could not be determined. Two fragments of the basal limb show similarities in the elongated module. One of them (FCS.H.4) has a cross section asymmetrical convex, with bifacial retouch, and the base was thinned by fluting. The second (FCS.H.10) has unifacial retouch and microretouch, and the base was thinned by retouch. The third point (FCS.H.8) has parallel retouch and microretouch and the base was thinned by retouch too. The basal fragment has retouch and microretouch and the base is concave and thinned by retouch. In this case, the analyses related to the weapon system indicate the presence of darts (n=3) and arrows (n=4).

Four items were identified that were manufactured on silicified limestone. All of them are broken, two are fragments of basal limbs, one is a piece lacking the tip, and one is a fragment of the distal section of the limb. The blanks could not be identified because the specimens were highly modified. The fragments of basal limbs correspond to two pieces of different width. One of the pieces (FCS.H.13; Figure 4a) presents signs of maintenance and reactivation, with an attenuated convex base, while FCS.H.39 is more laminar and the base is concave and thinned by retouch. In the case of the point lacking the tip, it has bifacial retouch and a notch on the right side of the limb, with a convex to normal base. The fragment of the distal section of the limb (FCS. H.12) has bifacial microretouch. In the case of the fractures,

one is perverse, two are related to the maintenance, and one was undetermined. In relation to the weapon system, there are three arrows and one dart.

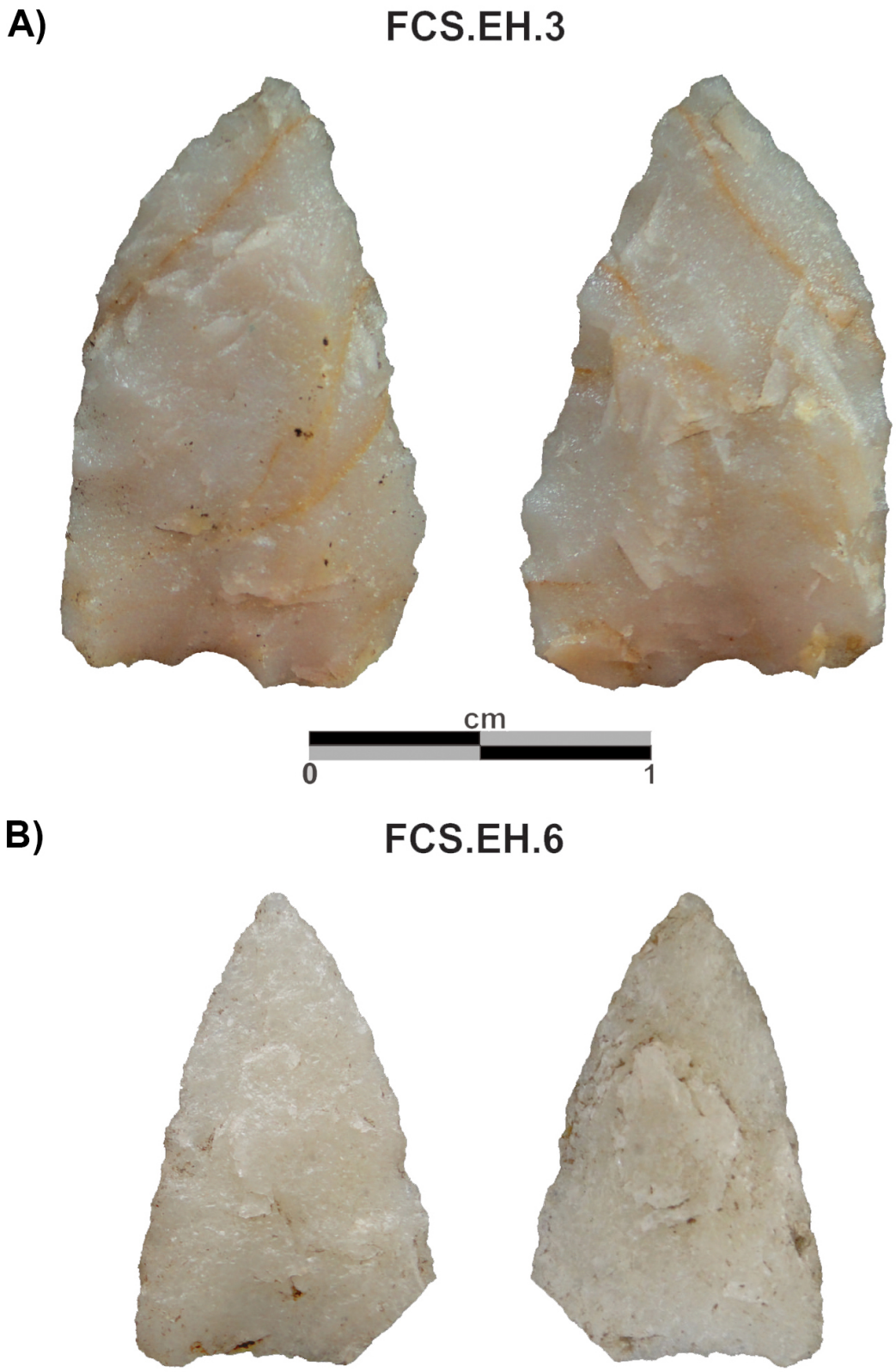

Figure 3. Preform and arrow manufactured on orthoquartzite SBG.

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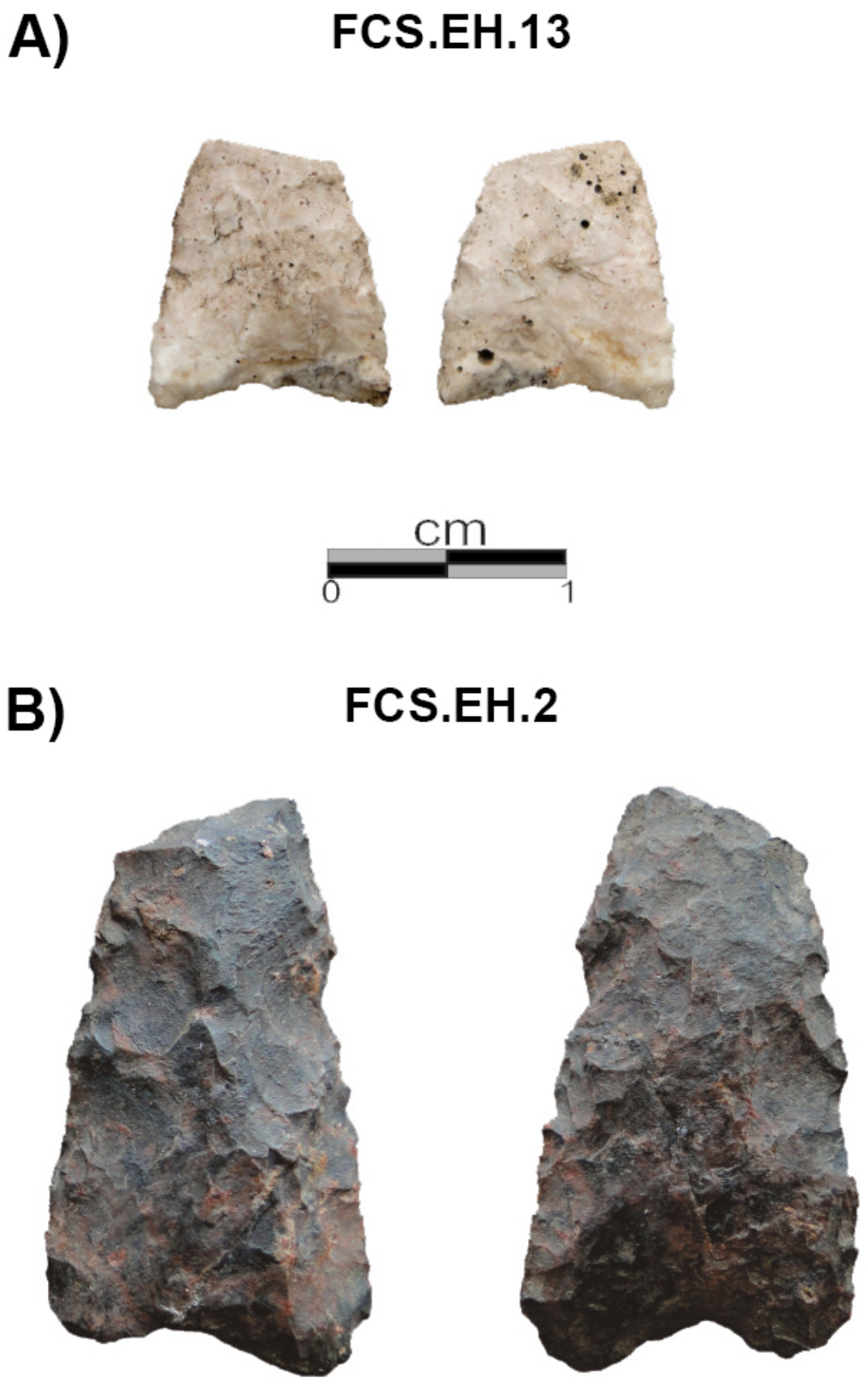

Figure 4. Darts manufactured on silicified limestone and rhyiolite.

In the case of rhyolite, there are two specimens, one is broken at the tip and the other is a base. The first one (FCS.H.2) presents retouch and irregular microretouch and it has been modified on the left side of the limb to make a notch. The base is deep concave, thinned by retouch and the type of fracture could not be determined. The second has marginal retouch and the base is attenuated concave. It has been thinned by retouch and the fracture is perverse. (FCS.H.3; Figure 4b). Both points could have been used as darts.

Regarding silica and chalcedony, two fragments of points were recovered that were made on these rocks. The silica item is a fragment of limb with an impact fracture and has been thinned by retouch. The second is a fragment that is the result of a radial fracture, it has unifacial microretouch and the base is concave, and it was thinned by bifacial retouch.

Finally, there is another weapon system that was complementary to the projectile points: The stone balls called *bolas* or *boleadoras*. This is a throwing weapon made of stones and interconnected cords, used to hunt animals by entangling their legs. Three bola stones were recovered in Hangar. They have not been analysed in detail yet, but some observations were conducted on these materials. Two of the bola stones were made of diabase and one of metaquartzite. The sizes are big and the modules are medium to normal, and short and width. In the case of the typological groups, one of the bola stones presents an encircling groove, one is biconical, and the other one is spheroid.

3.3. Observations on faunal materials

The faunal remains recovered in Hangar correspond to guanaco (*Lama guanicoe*), Greater rhea (*Rhea Americana*), Plains viscacha (*Lagostomus maximus*), Pampas deer (*Ozotoceros bezoarticus*), Canidae, and some bones of modern domestic cattle. Butchery evidences, such as cut marks and anthropic fractures, were recorded for the first three species (Figure 5). However, guanaco specimens (n=86) are the most abundant.

One of the bone specimens from the site corresponds to the proximal end and metaphysis of the humerus of a newborn guanaco that is less than three months old (Figure 6). This item presents striations generated by the penetration of a lithic artefact that is embedded in the metaphysis section. This injury could have been produced with a throwing weapon and has a quartering-away shot angle. The chip is located at the potential killing zone, usually the target of the hunters. The lungs and the hearth are situated in this area; these are vital organs that produce a rapid death, avoiding the escape of the prey. Nevertheless, more studies are still needed in order to determine the type of artefact inside the bone.

4. Interpretations of the data

Hangar was a base camp where a wide range of activities was carried out. In this site, the production objectives guided the raw material selection, based on their quality and functional characteristics for making tools. For this reason, the discussion will be based on the types of raw materials that are present in the site.

Chert is the most prevalent rock and it was mainly used for making scrapers and projectile points. Flakes, some of them retouched, were also used as lithic supports. Other types of tools are drills, splintered pieces, notches, and a biface. We consider that a large part of these tools were made *in situ*. We are currently conducting detailed studies that indicate the presence of bifacial and unifacial thinning flakes. While most of the chert could have entered the site in the form of cores, the transport of natural nodules cannot be discarded. This is evidenced by the presence of cortex in the flakes. As it was previously noted in quarry studies, the lithic supports are short-width and laminar, with different thicknesses (Barros *et al*. 2015). In the case of projectile points, they could have been made locally. Some of them could have been entered broken to be replaced at the site, as it is evidenced by the presence of

fractured basal fragments that were reactivated while they were hafted. In four of the projectile points, the platform is on the left side of the limb and reduction and thinning were made from it. The presence of platform can be related to the techniques that were used by the knappers or to the type of hafting. This situation will be evaluated by experimental studies. Projectile points are small; in general the thickness is thin and to a lesser extent, thick. Results on the weapon system indicate that these tools were related to the use of bow and arrow. Different types of projectiles are represented, which could be related to the size of the hunted animals. It is also relevant that four of the points were reused to make notches. Some authors have proposed that notches are tools that were used for working wood, specifically for repairing arrow shafts (Franco 2004).

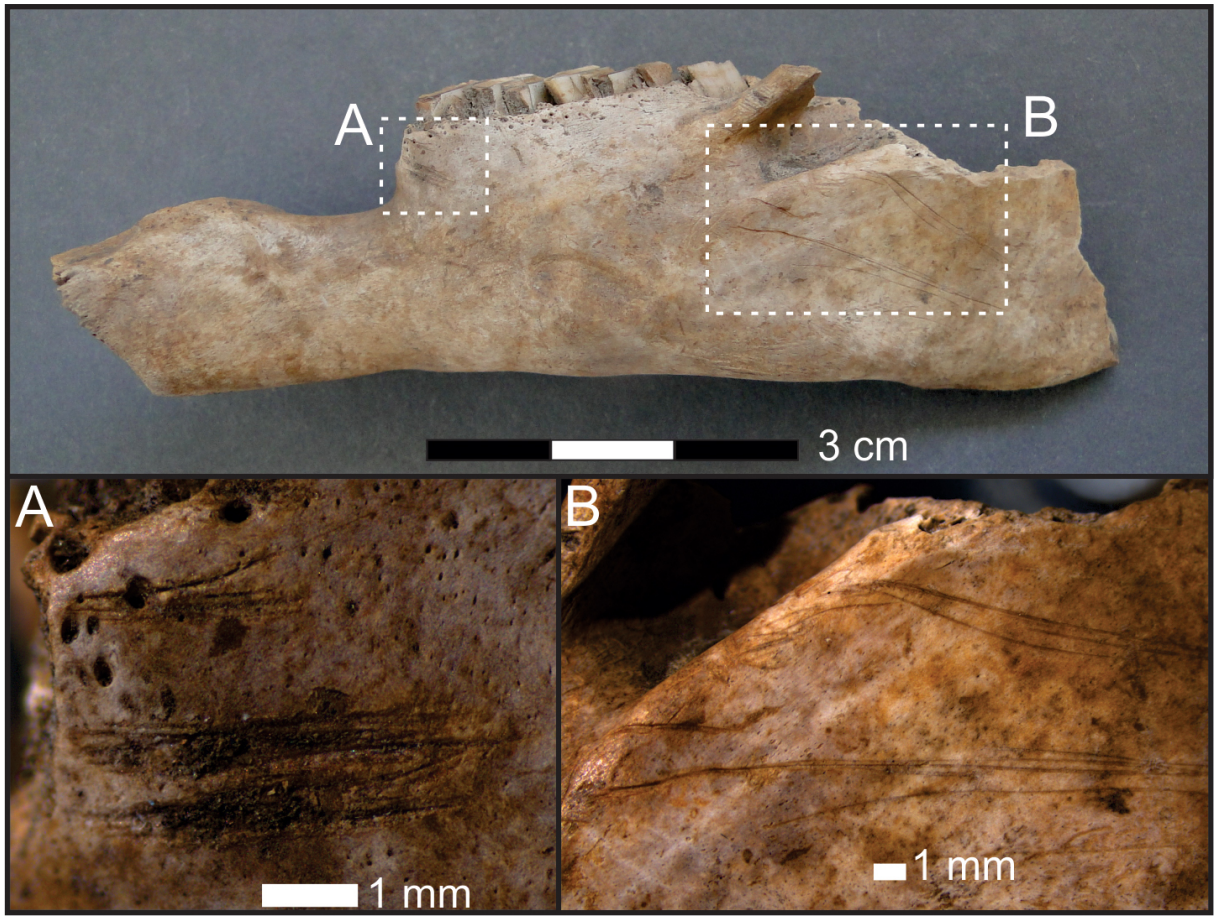

Figure 5. Cut marks recorded in Plains viscacha mandible.

Orthoquartzite SBG was second in terms of frequency. This is a particular situation because in most of the sites of the Humid Pampas, orthoquartzite SBG is the prevalent rock, aspect previously discussed in the study area as well as in the Pampas region in general (Barros *et al*. 2018; Crivelli Montero *et al*. 1997; Leipus & Mansur 2007; Pal 2015). In Hangar, this raw material was used for making scrapers and projectile points and, to a lesser degree, multi-purpose tools and side scrapers. Utilized flakes and a graver were other tool types recorded. The operational sequences for making these points are represented in Hangar. However, as in the case of chert, it is not discarded that some of them could have been transported either inside the hunted animals or to be replaced or discarded at the site. Some of the points are big and where made on thick supports. Others are small and have variable thickness. In this sense, standardization in the production is not observed in this sample. This

indicates that diverse types of hafting could have been used, which are associated to darts and arrows, two different weapon systems. Finally, one of the points was reused to make a notch.

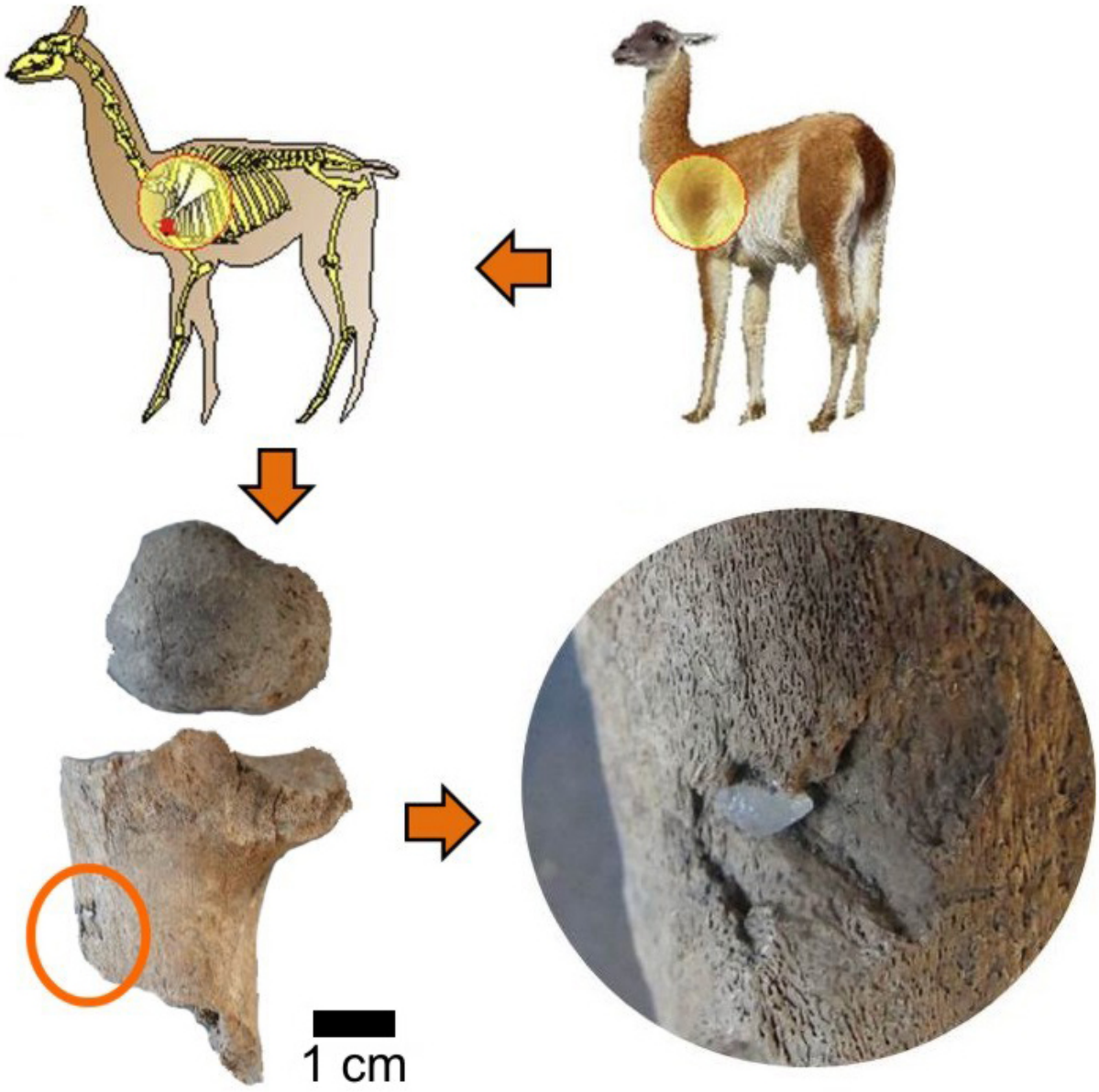

Figure 6. Bone specimen of new-born guanaco with embedded artefact.

Differential use of chert and orthoquartzite SBG is related to the lithological characteristics of each rock, as well as to the way in which they outcrop in the landscape. Outcrops are located 110 km (chert) and 190 km (orthoquartzite SBG) distant from Hangar. Orthoquartzite SBG is versatile; different cutting edges can be produced in the same tool to be used in diverse tasks (Leipus & Mansur 2007). On the contrary, chert presents functional integrity, which results in its use for tools associated with a single activity (Pal 2015). These differences between the raw materials are reflected in the lithic assemblage of Hangar. On the other hand, projectile points manufactured on chert and orthoquartzite SBG present technological differences with other ones from sites located in the Pampas hills such as Cueva El Abra and Lobería 1 (Mazzanti 2006; Valverde & Martucci 2004) where there is standardization in the production of these items. This situation is not so marked in Hangar, where certain standardization is observed for the points made of chert only. This difference

between Hangar and other sites could be related to traditional ways of doing things, landscape characteristics where hunting activities took place, type of prey, and hunting strategies, among other options. We think that one possibility is that there was a differential use of the projectile points made on distinct raw materials. Points made on orthoquartzite SBG (darts and arrows) could have been used for hunting big and medium-sized animals such as guanaco, Pampas deer, and Greater rhea. Points made of chert could have more oriented to the obtaining of small prey species.

Silicified limestone was the third rock in frequency. According to macroscopic characteristics, this raw material is very similar to the one from Meseta del Fresco, distant 530 km from Hangar. The tools that were made of silicified limestone include scrapers and projectile points, followed by retouched flakes, a drill, and a biface. Some knapping products were identified for this rock. However, stages of the operational sequence related to the manufacturing of the projectile points were not recorded in Hangar. For this reason, we propose that the points were already finished when entered the site. In the case of the weapon system, three items correspond to arrows and one to a dart. Silicified limestone, as chert and orthoquartzite SBG, was mainly used for the production of scrapers and projectile points. These artefacts are related to the tasks performed at the site, which can be characterized as a base camp where the manufacture, replacement, and conditioning of the weapons took place, together with the butchery of different prey. The presence of silicified limestone also shows that the lithic procurement strategies, direct or indirect, included the transport of this rock over long distances.

Projectile points manufactured of rhyolite, chalcedony, and silica are scarce and it is possible that these items would have entered the site as finished products. Rhyolite comes from the Ventania system hill, distant 100 km from Hangar. Chalcedony and silica items were small fragments and we were not able to conduct detailed analyses or evaluating the origin of these raw materials.

In general, the results of the width-thickness ratio show the predominance of modules that are little thick, followed by thick, and very thick in only one case. In this sense, there is an association among raw materials, width-thickness ratio, and weapon system. For example, in the case of chert, all the projectile points were characterized as arrows, and the little thick artefacts are predominant. On the contrary, all the points made on rhyolite are thick and were related to the use of darts. There is an intermediate situation for silicified limestone because the artefacts are thick but both arrows and darts were identified. In the case of orthoquartzite SBG, arrows and darts were equally observed with different thicknesses.

In addition to darts and arrows, bola stones were used as a weapon system. *Bolas* were complementary to projectile points and expands the variability of weapons that were recorded at Hangar.

5. Conclusions

In summary, some of the activities performed at Hangar include the manufacture of projectile points, mainly on chert and orthoquartzite. In general terms, different stages can be recognized at the site, including initial manufacture, reactivation, re-functionalization of the broken points, recycling, and replacement. On the contrary, the points made on the rest of the raw materials could have been already finished when entered the site. Moreover, the presence of a bone with an embedded lithic chip could indicate that some of the points entered to the site within the prey.

The analyses of the raw materials of the total lithic assemblage show the presence of multiple vectors, coming from different sectors of the Pampas region. We believe that this indicates a circuit of mobility or interaction that is constantly related with the Southwest. The

presence of items from the West support the model proposed by Berón (2006) of circulation of goods from long-distances during the Late Holocene in the South of the Dry Pampas.

Finally, this is a preliminary work and the conclusions obtained in this study can be used as hypotheses for upcoming analyses. In this sense, experimentation and traceological analysis of archaeological material will be conducted in future research.

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