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# BLANK EXTRACTION TECHNIQUES IN BONE TECHNOLOGY

Hunter-Gatherers  
from low Paraná Wetland (Argentina)

**Natacha BUC, Alejandro ACOSTA, Leonardo MUCCILO**

## **Abstract**

*The aim of this paper is to test the main extraction techniques used in the bone tool manufacturing sequences of hunter-gatherers in the Low Paraná wetland. For this purpose, we analyze archaeological assemblages, mainly based on their manufacturing waste-products, in light of the results of a previous experimental program.*

*The results of this work confirm that two main extraction techniques were used in the area: fracturing and perimetral sawing. At the regional level, homogeneous technical strategies are seen among different archaeological sites, suggesting that despite some functional variability, hunter-gatherer societies of the Low Paraná wetland shared manufacturing concepts during the Late Holocene.*

## **Keywords**

*Blank extraction techniques, bone tools, perimetral sawing marks, low Paraná wetland.*

## **Introduction**

Late Holocene hunter-gatherer sites in the Low Paraná wetland have yielded large and diverse bone and antler tool assemblages. In recent years, several papers focused mainly on functional aspects. Although experimentation was frequently involved (Buc, 2011), and though manufacturing techniques were necessarily included, no systematic analysis of this subject was conducted.

The aim of this paper is to address the subject of the extraction techniques used in the bone tool assemblages of the area. On a regional scale, we seek to determine whether similar extraction techniques were employed at different sites. In earlier papers, based on functional aspects, we supposed that despite particular cases of variability, the societies in this region shared a technological behavior (Buc, 2012), and we therefore expect this to be reflected in the manufacturing processes as well.

## 1 - Material and method

### A - Material

The Lower Paraná River runs from the Brazilian shield to the Río de la Plata in Argentina. Specifically, the low basin extends from the city of San Nicolás to its mouth in Buenos Aires, where it forms a delta (figure 1). This wetland environment, established nearly 2000 years ago, features a high ecological and ethological diversity in a subtropical climate. The landscape is formed by flood plains along the Paraná River and several islands in the delta sector. Fluvial banks, regularly deposited by periodic flooding, form the highest elevations in the area. These levees are found along streams, as well as in lagoon and marsh margins, and are typically colonized by grasses and many species of shrubs and trees (Loponte 2008).

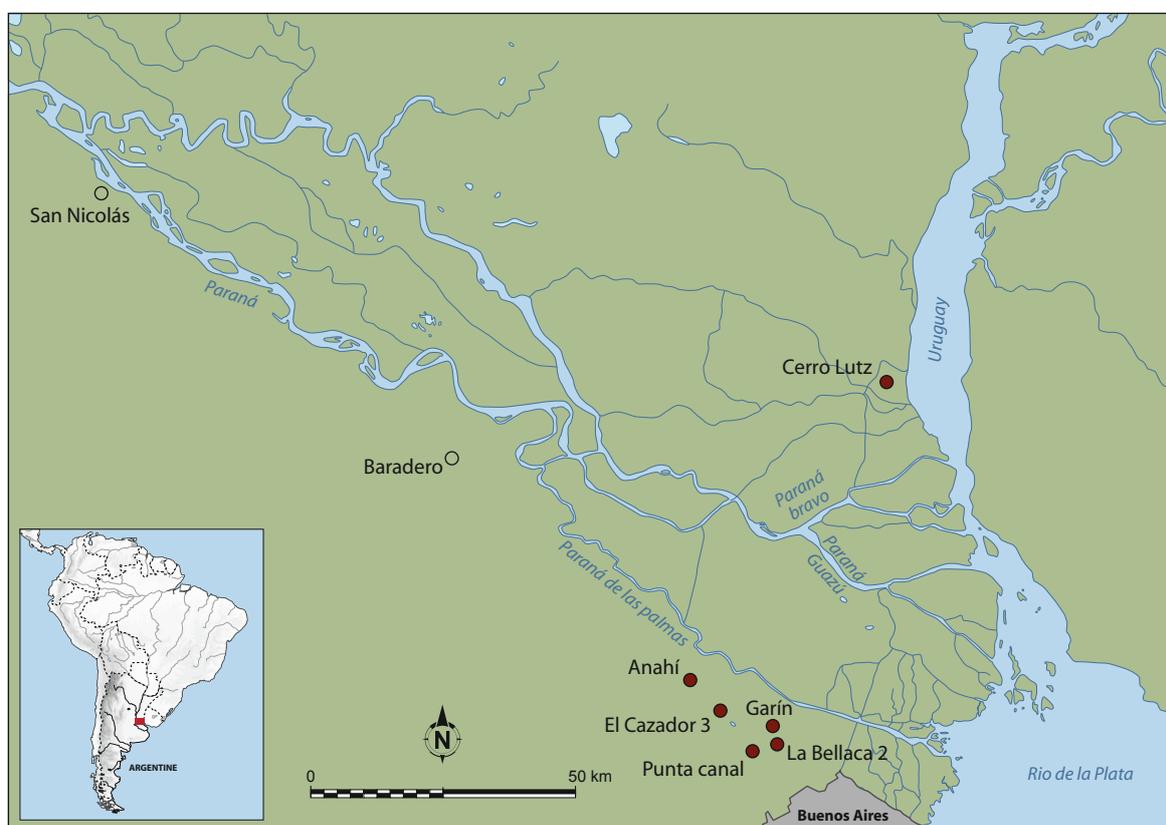


Figure 1 - Low Paraná wetland area and sites under analysis (CAD: F. Tessier).

Fluvial banks are the primary locations where archaeological sites are found. At present, more than 20 sites have been recorded in the area, all of them defined as campsites (Binford 1980) with evidence of low residential mobility (Loponte 2008). Most of them were occupied by hunter-gatherer societies whose diet was based on local resources such as fish (mostly Silurid and Characiphorm species), mammals, such as marsh deer (*Blastocerus dichotomus*) and pampas deer (*Ozotoceros bezoarticus*), and rodents (*Myocastor coypus* and *Cavia aperea*). They also collected plants

and fresh water mollusks (mainly *Diplodon sp.*; Acosta, 2005; Loponte, 2008). A small number of sites show isotopic values compatible with a low scale horticulturalist economy, which also shares material properties different from those of hunter-gatherers, such as a typical corrugated and painted pottery known as “guaraní” (Loponte *et al.*, 2011). Focusing on hunter-gatherers, the complex process of peopling during the last 2000 years leads to the development of common but also variable features among societies. For example, high-quality stone is locally unavailable, hence it is always found in small quantities, represented mostly by natural flakes regularly used for cutting hard materials like bone and antler (Silvestre, 2011). Shells also formed part of the raw material used by hunter-gatherers; they were manufactured into ornaments (beads and *tembetás*) and it is highly possible that they were also used for their edges (Buc *et al.*, 2010; see also Orquera, Piana 1999; Lucero 2004 for other South American contexts). Moreover, technology was largely based on pottery and bone tools (Loponte, 2008; Buc, 2012). However, in the pottery assemblage, stylistic variability was detected among sites (Rodrigué, 2005). In the bone tool sample, although sites share generally similar technological concepts, variability appears in the occurrence of morphological types and, in some cases, in the functional identification of them (Buc, 2012). In this work we discuss the technical aspect of this situation through manufacture wasting, thus considering only sites where these remains were found: Anahí, Cerro Lutz El Cazador 3, Garín, La Bellaca 2 and Punta Canal (figure 1). Most sites are located in the riverside sector of the northern Buenos Aires province, but Cerro Lutz is in the floodplains of the southern Entre Ríos province. All of them were excavated by Acosta and Loponte between 1995 and 2010, with the exception of Anahí which was sampled by Lafon, Chiri and Orquera in 1969–1970 (Lafon, 1971, 1972). Radiocarbon datings from most sites are close to 1000 years BP, although La Bellaca 2 and Cerro Lutz show more recent samples (table 1).

Archaeological site	Date (C <sup>14</sup> AP)	Sample	Laboratory	Reference
Anahí	1020 ± 70	Bone – <i>Myocastor coypus</i>	Beta-177108	Loponte, 2008
Cerro Lutz	976 ± 42	Bone – <i>Homo sapiens</i>	AA77310	Acosta <i>et al.</i> , 2011
	916 ± 42	Bone – <i>Canis familiaris</i>	AA77312	
	796 ± 42	Bone – <i>Homo sapiens</i>	AA77311	
	730 ± 70	Bone – <i>Homo sapiens</i>	LP-1711	
El Cazador 3	1031 ± 36	Bone – <i>Homo sapiens</i>	AA97464	Loponte, Corriale, 2012
	921 ± 43	Bone – <i>Lama guanicoe</i>	AA97470	
Guazunambí	940 ± 60	Bone – mammal	Beta-147109	Loponte, 2008
La Bellaca 2	680 ± 80	Bone – mammal	LP-1263	Loponte, 2008
Punta Canal	900 ± 80	Bone – <i>Blastoceros dichotomus</i>	LP-1293	Arrizurieta <i>et al.</i> , 2010

**Table 1** - Radiocarbon dates of the sites studied.

## B - Methodology

The bone tool assemblages studied are morphologically very diverse, including tools such as awls, spearthrowers, stemmed points, hollowed points, harpoons, bipoints and smoothers (figure 2). Most of these tools were made from hard animal materials (bone and antler) from cervid species, along with some tools made from fish spines (table 2). In general, a strong selectivity of raw material is noted for each tool type, with a preference for antlers and cervid metapodials. In declining order, cervid ulnas and astragalii were also used. Other long bones such *O. bezoarticus* radius and tibia appear in lower proportions (table 2). Comparing metric structures from both technological and faunal assemblages, we suggested in an earlier paper that the bones used as raw materials were selected because of their geometry (Acosta *et al.*, 2010). Following Scheinsohn (2010), it is known that metric and geometrical properties are directly linked to mechanical ones. We therefore proposed that raw material selectivity was guided by these properties and that bones must have been set aside in the first steps of carcass processing (Acosta *et al.*, 2010).

Taxa	Element	Bones with perimetral sawing marks							Bone tools								
		A	CL	EC3	G	LBII	PC	Total	%	A	CL	EC3	G	LBII	PC	Total	%
<i>Cervidae</i>	Antler	1	0	2	1	0	2	6	6	2	10	8	2	20	1	43	7
<i>Blastocerus dichotomus</i>	Antler	3	1	2	1	1	0	8	8	27	5	31	6	2	6	77	13
	Metapodial	0	0	1	0	0	0	1	1	0	0	4	1	0	5	10	2
	Tibia	0	0	0	0	1	0	1	1	0	1	0	0	0	0	1	0
	Ulna	4	0	0	0	0	0	4	4	2	0	2	0	1	1	6	1
	Astragalus	0	0	0	0	0	0	0	0	4	1	3	2	0	0	10	2
	Calcaneum	2	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0
<i>Ozotoceros bezoarticus</i>	Metapodial	12	18	1	2	20	6	59	60	15	6	39	8	11	15	94	16
	Radius	0	1	0	0	0	0	1	1	3	3	3	0	1	0	10	2
	Tibia	0	0	0	0	1	0	1	1	0	1	4	0	1	1	7	1
<i>Lama guanicoe</i>	Metapodial	0	0	0	0	0	0	0	0	1	0	14	0	0	1	16	3
<i>Crhysocyon Brachyurus</i>	Femur	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
<i>Rhea Americana</i>	Tarsal-Metatarsal	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
<i>Hydrochoeris hydrochaeris</i>	Femur	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0
	Radius	0	1	0	0	0	0	1	1	0	1	0	0	0	0	1	0
<i>Homo sapiens</i>	Humerus	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0
	Ulna	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Fish bones	Spines	0	0	0	0	0	0	0	0	13	17	23	9	7	8	77	13
Non determined	Various	5	4	0	0	0	0	9	9	30	22	83	5	73	12	225	39
<b>Total</b>		<b>28</b>	<b>28</b>	<b>7</b>	<b>4</b>	<b>23</b>	<b>8</b>	<b>98</b>	<b>100</b>	<b>97</b>	<b>67</b>	<b>214</b>	<b>33</b>	<b>116</b>	<b>50</b>	<b>577</b>	<b>100</b>

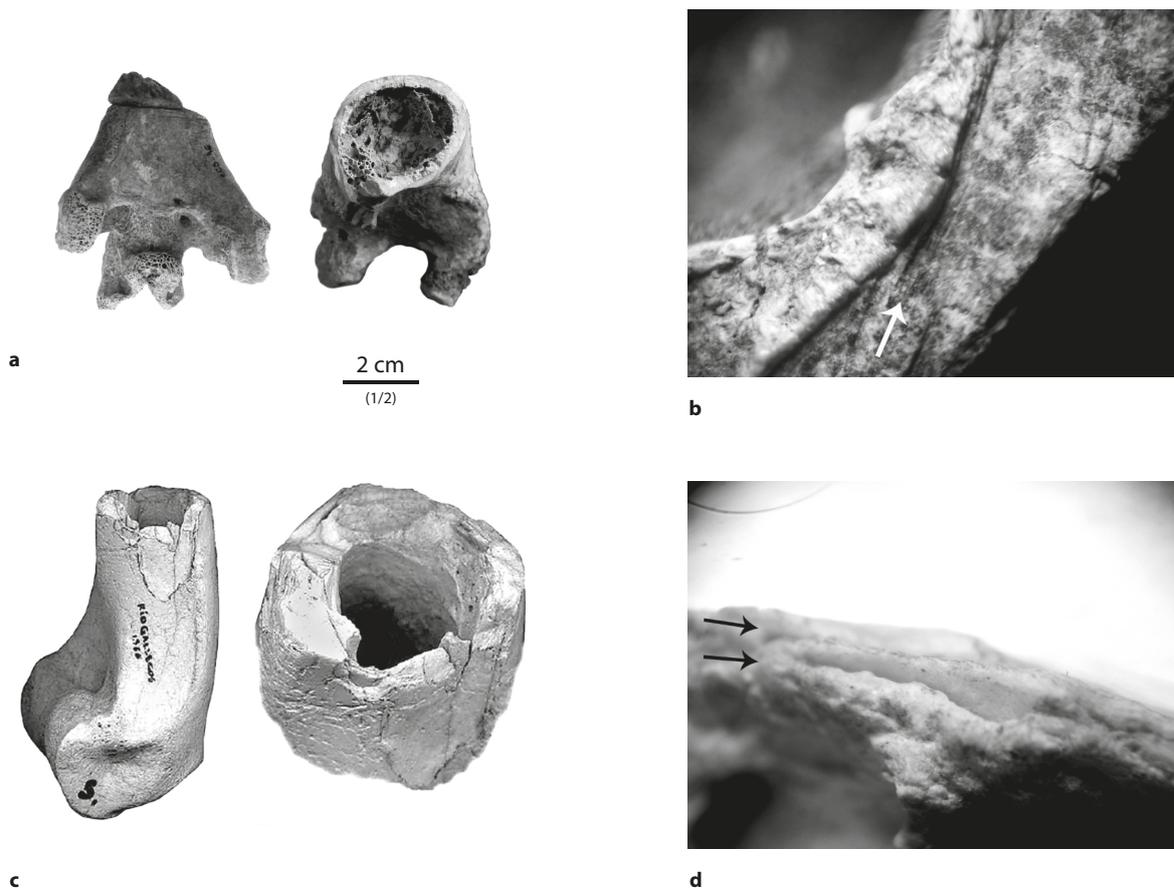
Table 2 - Taxonomic identification of bone remains with sawing marks, and bone tools.



**Figure 2** - Bone tool types discussed in this paper: a) hollowed point made from an *O. bezoarticus* metapodial; b) hollow point made from a cervid antler; c) awl from *O. bezoarticus* metapodial; d) harpoon made from a cervid antler; e) bi-point made from a mammal bone; f) smoother made from a fish spine; g) stemmed point made from a mammal bone; h) spearthrower made from a *B. dichotomus* astragalus.

One experiment was recently conducted to test certain extraction techniques for blank acquisition (Buc *et al.*, 2013). According to the general literature, bone technology extraction techniques can be divided into those involving: a) fracturing: either by direct or indirect percussion, flexion, direct or indirect cutting percussion (Averbouh, Provenzano 1998-1999); and b) pressure activities, such as sawing and grooving, usually followed by fracturing (Clark, Thompson, 1978; Yesner, Bonnischen, 1979; Averbouh, Provenzano 1998-1999). These activities leave different types of marks on the bone material, such as: fractured faces with impact notches when indirect percussion is involved; sawing marks with a V shaped-profile; and long and deep groove marks with more U-shaped profiles (see Averbouh, Provenzano 1998-1999).

In Argentina, it is important to distinguish bones with perimetral sawing marks (Acosta, 2000) from those with perimetral marking (Muñoz, Belardi, 1998; Hadjuk, Lezcano, 2005; Bourlot *et al.*, 2010). Though no bones with perimetral marking were recovered in the study area, these terms are used interchangeably by many authors. The latter type is often found in the southern Patagonia area and is defined as a “transverse fracture which in section view, shows the perfect outline of the medullar channel and negative flakes oriented along the epiphyseal axis” (Muñoz, Belardi, 1998: 108, our translation). Both elements are indeed distinguishable when viewed from above under a microscope: while PSM appears as a clear V-shaped cut; marks on the perimeter are seen as contiguous flakes or compacted layers of cortical bone (figure 3).



**Figure 3** - Sawed bones: a) ventral and zenithal view; b) zenithal view with an incidental microscope, 15x: the white arrow shows sawing marks; marked bones: c) lateral and zenithal view after Hajduk, Lezcano, 2005: figure 3; d) zenithal view with an incidental microscope, 15x, after Buc, Cruz, 2012: the black arrows show layers of compacted cortical bone.

In the literature, both techniques are also associated with different functional hypothesis. PSM are linked across the world to manufacturing by-products (e.g. Semenov, 1964; Chauvière, 2003; David, 2008; Byrd, 2011), usually supported by experimental assemblages (Nami, Borella, 1999; David, 2008). The function of perimetral marks, on the other hand, has been widely discussed in Patagonian sites. In general, perimetral marking is considered a technique used to fracture diaphyses transversally: a grooving technique which leads or limits the fracture (Mengoni Goñalons, 1982: 90). Miotti (1990-1992) proposes that the straight transversal fracture was made by retouching via friction or pitting all around the diaphyses (other variants are detailed in Hajduk, Lezcano, 2005). As far as their significance, the first reference was made by Bird in 1993 [1936], linking these bones with the manufacturing procedure of lithic spheres. More recently, in various Patagonian contexts bones with perimetral marking are interpreted as product of a standardized fracturing method linked to faunal processing. Specifically, it would be involved either in the acquisition of medulla (e.g. Mengoni Goñalons, Silveira 1976; Muñoz, Belardi, 1998; Bourlot *et al.*, 2009, Miotti, 1990-1992) and/or in the processing and transport of frozen carcasses (e.g. Muñoz, Belardi, 1998). Alternatively, Hajduk and Lezcano (2005) start from Bird's functional hypothesis and, based on experimental programs, state that fish-scaled or stepped micro-flaking patterns seen on marked bones result from their use as hammers (*machacadores*). Authors with intermediary positions suggest that bones could be marked in order to transform them into tools (e.g. Silveira, 1979; Miotti, 1990-1992), and also that they could have served as hafts (Miotti, 1990-1992).

Outside Patagonia, bones with similar marks are linked to bone technology. For example, Stordeur (1980) defines them as hafts and also as artifacts *per se*, where flaking was intentionally done to regularize the active edge. Other researchers suggest that, as in Hajduk and Lezcano's (2005) hypothesis, flaking results from using bones as tools. In this case, Watson (1983) proposes they were fleshers, and Sidéra (2010) suggests they were adzes used in wood-working. This last position is supported by use-wear patterns found in the archaeological sample which are similar to those of experimental tools used in wood-working (Sidéra, 2010).

To summarize, different interpretations of the so-called "marked bones" clearly reflect their equifinality. Nevertheless, we think that it is most plausible to link them to bone technology, and particularly, as tools. Hadjuk and Lezcano (2005) experimentally demonstrated that transversal fractures made by different techniques do not lead to patterns like those observed on marked bones. In fact, in the general literature, no experiments on manufacturing techniques described such a finding (*cf.* Averbouh, Provenzano 1998-1999; David 2008). Conversely, Hadjuk and Lezcano saw similarities between these bones and those used in pressure activities. Moreover, even though Sidéra (2010) does not have an experimental database with marked bones, she clearly demonstrated that use-wear on archaeological marked bones could be interpreted as intentional use.

## 2 - Results

### A - The experimental sample

The experimental program presented here constitutes a first approach in the exploration of different extraction techniques in local bone technology. Our aim was to test the different technical options presented in bibliographical data (Averbouh, Provenzano 1998-1999; David, 2008), their limitations, material results, and relative importance to the archaeological model. Details are published in Buc *et al.* 2013, while in this paper, we present a synthesis of the experiments used as reference base for archaeological analysis.

For our raw materials, we used antlers and *Ovis aries* metapodials<sup>1</sup>, which are morphologically and metrically similar to *O. bezoarticus* (now a protected species). As cutting edges, we used materials represented in the archaeological record: natural flakes of local chalcedony and quartzite, and shells. To fracture bones, local rocks were used as hammers.

### Fracturing

Sixteen metapodials were fractured by direct percussion on an anvil. Bones were fractured in their longitudinal, and sometimes diagonal, axis, resulting in pointed blanks (figure 4) which could be instantly shaped into a tool by scraping with sandstone. Bone resistance to fracture is proportionally related to its humidity (see also Byrd, 2011): bones with higher water content were more resistant, being torn instead of fractured.



Figure 4 - Experimental bones: pointed and irregular blanks obtained by direct fracture.

### Sawing

Eight elements (three antlers and five metapodials) were sawed perpendicularly all around the antler or bone cylinder, near the proximal or distal metapodial end in this latter case (figure 5). The final segmentation was made by flexion.

Sawing both antler and bones took an average of 40 minutes (Buc *et al.*, 2013). For antler, less time was necessary when it was soaked while sawing (see Guthrie, 1983). For bones, no activity took less than 25 minutes and a minimum of three shell/lithic edges. A similar result was obtained by Nami and Borella (1999) when sawing cetacean bone. In any case, perpendicular splitting by flexion (or percussion, as Nami and Borella also did), does not occur until sawing reaches the cancellous bone.

1. Although *O. bezoarticus* is often represented in the archaeological record in the form of adult individuals, mostly young *O. aries* individuals were used in the experiment due to their availability at the market. In any case, *O. aries* is more robust as a domesticated species, thus young individuals meet the metrical standards of adult *O. bezoarticus*.



**Figure 5** - Experimental bones, perimetral sawing marks. Circled images were digitally enlarged 100%.

In our case, no difference in time or energy was noted in the same activities when they were realized with lithic or shell edges. Differences were noted only in the quantity of items needed to perform the task: as shells are more brittle than stone, more edges are needed to complete the work. However, this brittle nature makes shells extremely efficient in sawing activities, since the powder acts as an abrasive that enhances the action. Considering the scarcity of high quality rocks in the study area, and the ubiquity and abundance of fresh water bivalves, shells would have been an option for cutting or sawing hard materials.

In another paper, in which we describe bones being cut using lithic and shell edges, we noted differences in the marks observed under high magnifications (Buc *et al.*, 2010). Cut-marks made with lithic edges are coarse, deep, have sharp walls and a narrow V-shaped profile (see also Greenfield 1999; Liesau von Lettow-Vorbeck 1998; D’Errico 1993; Olsen 1988; Walker, Long 1977). In contrast, marks made with shells are smooth, with staggered walls and wide V-shaped profiles (see also Choi, Driwantoro 2007). However, in the case presented here, no significant differences could be noted with the naked eye.

### Grooving

Based on the archaeological record, two *O. aries* metapodials items were grooved in an X-shaped pattern. Grooving could be done only on the flat surface of metapodials, that is, on their internal face, and took 5 minutes. The bones were then struck on a wooden anvil. As in the fracturing activity, the action was easier when the bone was less moist. In this case, one item was completely wet during the experiment and did not fracture, but just shred. We tried to split the parts using a lithic wedge, but it did not work. Finally, the bone was easily fractured, hitting it from the face opposite of the groove. As result, the X-shaped groove guided the fracture to obtain two fragments with acute points (figure 6).

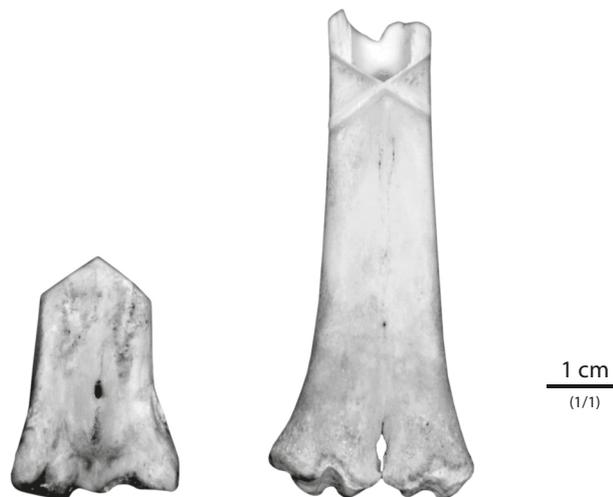


Figure 6 - Experimental bone: X-shaped groove.

## B - The archeological sample

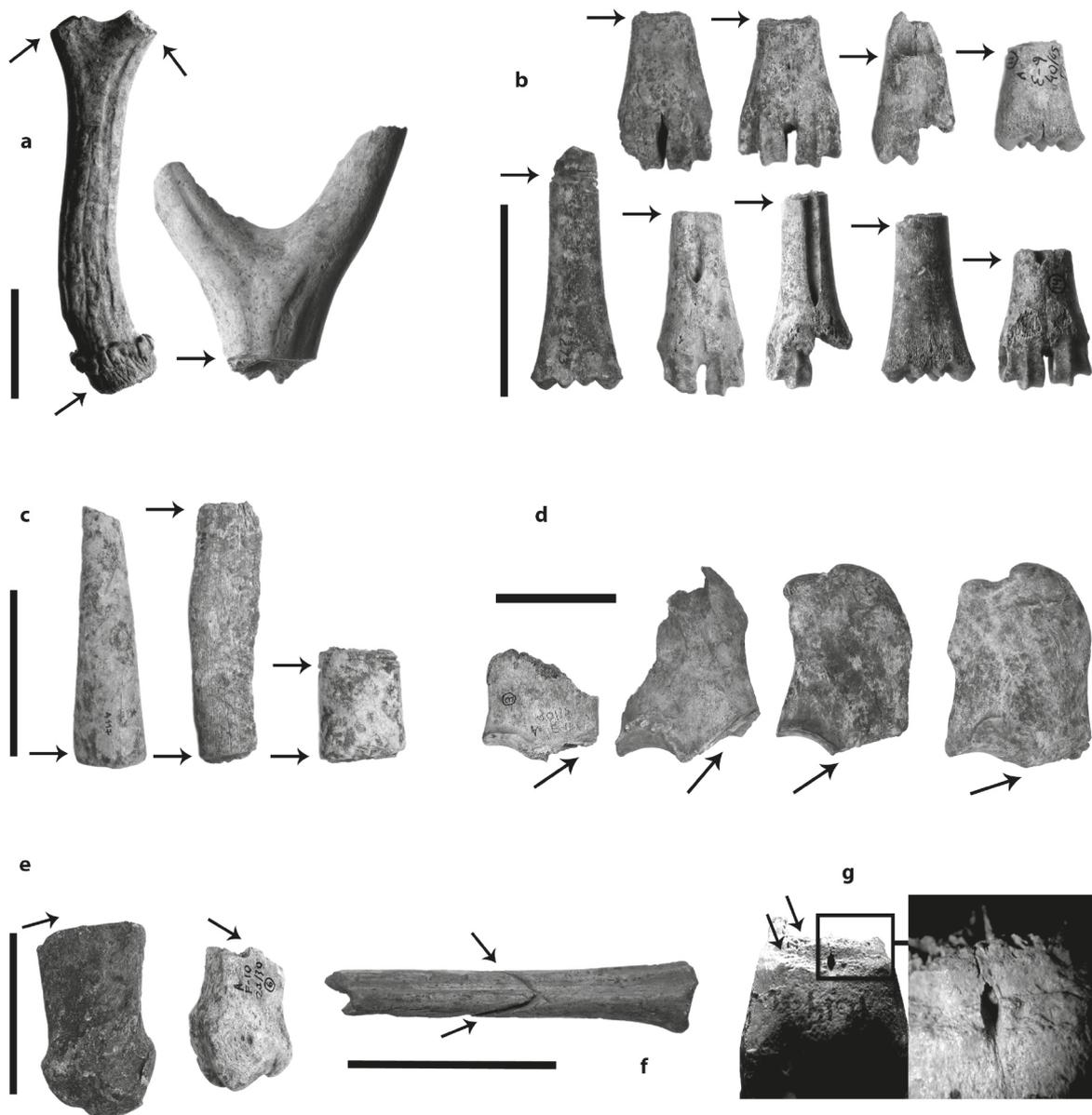
In our research domain, fracturing, sawing and grooving are found in most bone tool assemblages. Following the experimental pattern, direct fracturing is indicated by the fractured faces preserved on most points, such as awls and hollowed points (figure 2<sup>a,c</sup>). The fractured faces suggest in particular that this activity was realized with fresh but not wet bones, supporting our idea that they were selected in the first steps of carcass processing. Remnant flakes are not frequently found in the archaeological record: not only is it difficult to distinguish them from other archaeofaunal remains due to their high fragmentation, but they may also have been used as tool blanks (Loponte, Buc, 2012). Grooving is indicated by marks found on only one *O. bezoarticus* metapodial from El Cazador 3<sup>2</sup> (figure 7<sup>f</sup>). This grooving mark, however, does not resemble those created by the “groove and splinter” technique known in the international literature (Clark, Thompson 1978; Yesner, Bonnischen 1979), but it forms a V or X form. This technique was not identified on finished tools, though we must remember that manufacturing and use processes modify the original artifactual surface. Sawing is frequently identified in the archaeological record by the presence of bone tools with sawed ends (figure 2<sup>b</sup>), and by bone elements with perimetral sawing marks (figure 7<sup>a-e</sup>). Finally, we found three distal metapodials in Punta Canal and El Cazador with marks different than those made through experimentation, which can be defined as roughing (figure 7<sup>g</sup>; cf. David 2008).

The sample of bones with PSM consists of 98 items. Most of them are *O. bezoarticus* metapodials (60%) and cervid antler (cervid + *B. dichotomus* antlers = 14%). Undetermined bones follow in frequency (9%), followed by *B. dichotomus* ulna (4%) and calcaneus (2%). The remaining materials are represented by one element (table 2).

The raw materials identified in tool assemblages are mainly antler (20 %) and *O. bezoarticus* metapodials (16%). We should remember, however, that in most cases it is not possible to identify anatomical and taxonomical raw materials due to the extensive modification of tool blanks (40%; table 2).

2. Recently, items with X grooving were found in Isla Lechiguanas 1 archaeological site (see also Buc *et al.* 2013 for other near contexts).

As mentioned above, there is a strong regularity in the bones selected as raw materials and in the tool-types (Acosta *et al.*, 2010). We can note the selection of antlers to make harpoons, hollowed points, and, less frequently, bi-points. Metapodials, on the other hand, were transformed into awls, hollowed points, bi-points and other points (concave-convex, flat-convex points). Except for awls, made from metapodials in their natural shape, to make the remaining types it was necessary to split the diaphysis from the epiphysis. If we compare this data with that of bones with PSM, a recurrence between both samples is undeniable so we suggest that the latter are manufacturing waste products (*cf.* Acosta, 2000).



**Figure 7** - Bone materials with technical marks: a) perimetral sawing mark on an antler base; b) perimetral sawing marks on *O. bezoarticus* distal metapodials; c) perimetral sawing marks on antler tines; d) perimetral sawing marks on a *B. dichotomus* ulna; e) PMS in *B. dichotomus* astragalii; f) V grooving marks in *O. bezoarticus* metapodial, g) roughing marks in *O. bezoarticus* metapodial. The arrows show sawing, grooving and preparation marks. Scale = 5 cm.

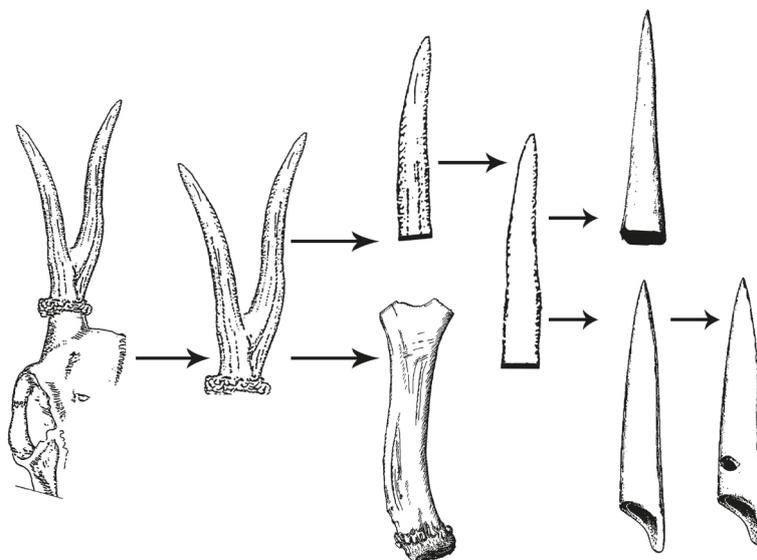
### 3 - Discussion

Based on the experimental results, we were able to identify different extraction techniques in the archaeological assemblages of our study area, fracturing and sawing being the most widespread. In addition, though this experimental program is preliminary, some elements are useful for the interpretation of local archaeological evidence. First, we recognized that these techniques are linked to different options in bone technology. We observed that fracturing bones without sigmoid torsion, such as metapodials, permits the fast and easy removal of pointed segments (see also Sadek Kooros, 1972; Yesner, Bonnischen 1979), and is therefore a time efficient and economic method. This could explain why it was the technique most used to manufacture different tool types, either alone or in combination with other methods. More control in the defined shape and length of blanks, however, is gained if bone is previously grooved. Through perimetral sawing, the shape is totally controlled, not at the pointed end, but at the opposite one. It also enables the extraction of the longest possible blanks from different hard animal materials.

#### A - Antlers

It is well known that antler is the preferred raw material in various archaeological contexts due to its material properties (Guthrie, 1983; Knecht, 1997). In the Low Paraná wetland, its high plasticity minimized the risk of failure in critical tools used under high mechanical stress, such as harpoons or hollowed points. Both of these tool types also display metrical standardization, suggesting that metrical standards were considered (Buc, 2012). This explains the high numbers of antler found with PSM on their bases and tines: this technique was employed to split antlers from the cranium and then to obtain tines (figure 8).

Hollowed points display PSM on their basal ends. For harpoons, on the other hand, the hook was obtained by an oblique fracturation after perimetral sawing (figure 8). Some pieces from both assemblages retain manufacturing use-wear marks suggesting that antlers were scraped with a coarse-grained material, such as sandstone (Buc, 2012).

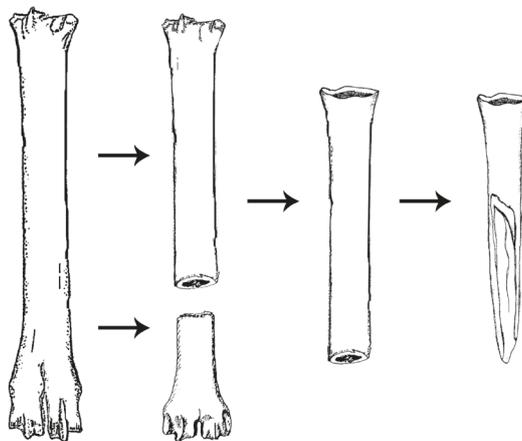


**Figure 8** - Hypothesis of a manufacturing process using antler to make hollowed points and harpoons.

## B - Metapodials

Metapodials show a more complex panorama. The tools most frequently made with this bone are awls, which do not display sawing marks, since the distal epiphyses are retained (Acosta *et al.*, 2010). Pointed ends were obtained by direct fracturing.

Most of the remaining tools are hollowed points. In this case, however, the proximal end is hollowed (see David, 2008 for examples of this technique). By first sectioning distal epiphyses through sawing, the longest possible blank was obtained. This blank was then fractured to obtain a pointed end (see also David, 2008; Byrd, 2011). If this were not the case, the distal condyles would have interfered in the fracturing. Metrical data support this idea. The medial lengths of modern *O. bezoarticus* metatarsals and metacarpals are 170 mm and 150 mm, respectively (Loponte 2004). If we consider that the medial length of hollowed points made from *O. bezoarticus* metapodials is 121 mm and the medial length of these epiphyses with PSM is 42 mm (Buc, 2012), we can conclude that almost all of the bone cylinder was used for hollowed points, discarding only the dense distal epiphyses. Moreover, Byrd (2011) suggests that sawing at approximately 40 mm from the distal epiphyses also allows the extraction of medulla. According to Byrd, leaving marrow inside the bone would not only imply losing it as food, but the fat would also make tool manufacturing or manipulation difficult. Based on these ideas, a new experimental program has been oriented toward manufacturing hollowed points by the sequence proposed in the [figure 9](#). According to our experiments, fracturing made with a hammer on an anvil results in pointed and longitudinal fragments, but which are very irregular in their length (Buc *et al.*, 2013). The final shape would have been obtained by scraping bones with a coarse-grained material such as sandstone, as is observed in the archaeological bone tool assemblage (Buc, 2012).



**Figure 9** - Hypothesis of a manufacturing process using a metapodial to make hollowed points.

## Conclusion

These first results suggest that Late Holocene hunter-gatherer societies in the study area shared, in addition to general technological properties and some functional particularities, similar bone tool blank acquisition techniques. If we consider that local bone technology entailed a careful selection of bone raw materials, we can assume that it was also related to extraction techniques. Based on our experiments, we were able to identify four extraction techniques in the archaeological record, mainly in the manufacturing by-product assemblages. Future research will focus on a detailed analysis of manufacturing techniques in the bone tool samples.

Among these, fracturing would have been the most common and economic option. Secondly, the widespread use of perimetral sawing is explained by its material benefit: it was selected when a long bone blank or a certain perimeter range was needed, either to make long tools such as hollowed points, or to obtain standardized hafts, such as harpoons. Both tool types were made to resist high stress levels and PSM ensured very homogeneous forms (Buc, 2012).

All of these features suggest the existence of a shared technological *baüplan* in this densely populated area: even if there was internal variability, the hunter-gatherers inhabiting this area by the Late Holocene shared common technological strategies with bone raw materials. Further work will test the social implication underlying the variability confirmed in this case by the occasional presence of techniques such as grooving and roughing: do these represent a spatial segregation, chronological differences, or were they associated with the production of certain tool types? Technological options are selected in space and time (Sackett, 1977) and therefore technical variants could reflect the existence of novelties and/or differences in the route along which technological information was transmitted.

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