Bone tools at the Late Pre-Hispanic site Boyo Paso 2 (Sierras of Córdoba, Argentina)

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ABSTRACT – *The aim of the article is to assess the role played by bone tools at Boyo Paso 2 (Sierras of Córdoba, Argentina), an open-air site interpreted as a basecamp seasonally occupied by mobile mixed foraging and farming people* c. *900–700 years BP. The results suggest that diverse activities were carried out on-site, including hunting or warfare, tool production, food processing and rituals. Bone tool analysis may enable reconstruction of the technological level, social organization, and cultural attitude towards the environment among people neither wholly foragers nor wholly farmers, a category for which archaeology currently lacks sufficient archaeological understanding and that merits further research.*

KEY WORDS – *South America; Late Holocene; bone tool technology; raw material; mixed foraging and cultivation economies*

Koščena orodja na najdišču Boyo Paso 2 (gorovje Sierras de Córdoba, Argentina) iz poznega predšpanskega obdobja

IZVLEČEK – *V članku ocenjujemo vlogo koščenih orodij na najdišču Boyo Paso 2 (gorovje Sierras de Córdoba, Argentina), tj. najdišču na prostem, ki ga razlagajo kot bazni kamp, ki so ga v času ok. 900–700 pr. sed. sezonsko obiskovale mešane skupine nabiralcev in poljedelcev. Rezultati kažejo, da so se na tem najdišču odvijale različne aktivnosti, vključno z lovom ali bojevanjem, izdelava orodij, predelava hrane in rituali. S pomočjo analize koščenih orodij lahko rekonstruiramo tehnološko raven, družbeno organizacijo in odnos do okolja te skupine ljudi, ki niso ne povsem nabiralci, ne povsem kmetje, kar pa je kategorija, za katero arheologija trenutno še nima zadostnega arheološkega razumevanja in si zasluži nadaljnje raziskave.*

KLJUČNE BESEDE – *Južna Amerika; pozni holocen; tehnologija izdelave koščenih orodij; surovine; mešano nabiralniško in poljedelsko gospodarstvo*

Introduction

Bones are a common raw material for tool manufacturing in traditional societies partly because of working proprieties of bones and partly because of their abundance as a food by-product that provides an unending supply of pieces from which to choose (*Moore 1999; Stone 2011; Xie, Stiner 2018*). The Late Pre-Hispanic Period of Sierras of Córdoba (1500–360 years BP, Argentina) was no exception, and bone tools constitute the third most numerous artefact group-type collected on the archaeological record after pottery and lithic technology. The majority of bone tools were projectile points, spindle whorls, awls, pin-like tools, spatulas, knives, smoothers, needles, tubes, flakers and manufacturing by-products,

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showing that they played a key role in those societies where a broad-spectrum foraging and cultivation base took over daily subsistence and dominated the activities of adults (*Argüello de Dorsch 1983; Berberián 1984; González 1943; 1949; Laguens, Bonnin 2009; Marcellino* et al. *1967; Medina* et al. *2014; 2019; Medina, Balena 2020; Serrano 1945*).

However, to date studies of bone working have been relatively neglected due to the greater interest of archaeology regarding chronological questions focusing on lithic projectile technology or the adoption of crop farming. Manufacture debris was thus usually ignored and use-wear analyses were rare. Indeed, Late Pre-Hispanic bone tool assemblages were only exceptionally described or analysed from a typo-functional of sometimes chronological or comparative perspective, with the focus on unusual cases from which functional hypotheses or the activities carried out on-site were assessed (*Buc* et al. *2016; Laguens, Bonnin 2009; Medina* et al. *2014; 2018; 2019*).

The aim of the article is to identify the raw materials chosen and the working methods used for making bone tools at Boyo Paso 2, an open-air site interpreted as a base-camp seasonally occupied by mobile mixed foraging and farming people *c.* 900–700 years BP. Bone tool technology is compared here with the zooarchaeological record to link the economic life with the social life of Boyo Paso 2 people. Another related goal was to identify the possible activities carried out on-site and the role played by bone tools during the site's seasonal occupation. Briefly, the aim of this paper is to provide a full morphological, physical, and functional description of the bone tool assemblage recorded at Boyo Paso 2, exploring the nature of the activities performed and their relation to the socioeconomic intensification process observed at the end of the Holocene (*Buc* et al. *2016; Medina* et al. *2016; Rivero 2009*).

The site

Boyo Paso 2 is an open-air site located at 1160m a.s.l. in the eastern Salsacate valley (Fig. 1). Today, it might be considered one of the best archaeologically investigated sites from the Late Pre-Hispanic Period. In addition to four test-pit works over 2m^2, a specific section of the site was investigated, uncovering 55m^2. Horizontal excavation revealed two overlaying archaeological floors formed by packed sediments (see *Medina* et al. *2020.Figs. 3–4*). The living floors have post-moulds and abundant domestic refuse, including the bone tools analysed here.

The faunal remains found at Boyo Paso 2 were in several publications (*Medina* et al. *2019; 2019; Medina, Rivero 2020*). *Lama* sp. was the largest readily consumed faunal resource assigned to genus or species level. They were tentatively assigned to the wild camelid *Lama* cf. *L. guanicoe*. Two species of deer and diverse small vertebrates were the most consumed animals after *Lama* cf. *L. guanicoe*. *Rhea* sp. eggshells prevail among bird remains and, along with the identification of domesticated plant remains and wild fruits, support the site was occupied during the growing season – *i.e.* from October to April (*Medina* et al. *2019; 2020*). Lithic tool assemblages were dominated by expedient tools manufactured on local lithic raw material (*Balena, Medina 2020; Medina* et al. *2019*). Pottery vessels were dominated by medium-sized rounded morphologies with a versatile and transportable design, better able to withstand the stress of a mobile semi-sedentary lifestyle (*Medina* et al. *2016*). The existence of a wide range of subsistence and processing activities is evidenced by both artefacts and food refuse, including farming, foraging wild resources, storing, and grinding.

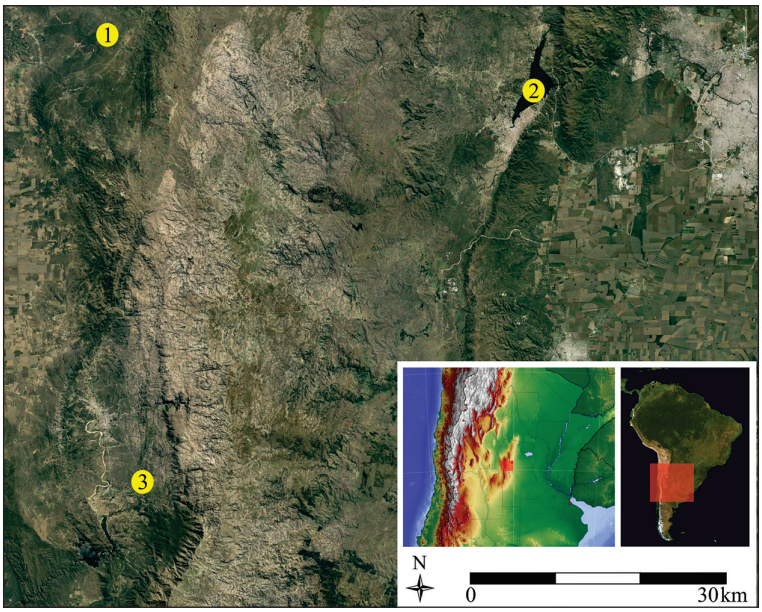

Fig. 1. Geographic locations of the archaeological sites referred to in the text:* 1 *Boyo Paso 2;* 2 *San Roque;* 3 *Carrupachina.

Signs of a full-sedentary farming economy at Boyo Paso 2 are question-

able, as this also occurred during the Late Pre-Hispanic Period, making it difficult to evaluate the reliance on crops over foraging due to the fragmentary nature of the archaeological record. The presence of habitational structures like pit-houses, huts or brush windbreaks was inferred by the detection of post-moulds. The absence of well-defined hearth features makes the identification of the shape and size of the structures more difficult, reinforcing the hypothesis that they were not durable habitational residences for long-term occupation. Artefacts left as abandonment stage refuse or as a site furniture were found on the living floors, including bone tools, suggesting that people planned to return to this location (*Medina* et al. *2014; 2016; 2018; 2020*). Seven radiocarbon dates have been obtained for the site (Tab. 1). The dates overlap roughly when two dates from the upper floor that are considered outliers – 1060±50 and 1500±80 years BP – are excluded, placing the archaeological floors between the range of 900–700 years BP, and confirming that they were formed over a relatively short period (*Medina* et al. *2016*).

Such evidence looks like a result of frequent seasonal reoccupation of the same site year after year or every few years, supporting the interpretation that Boyo Paso 2 was a seasonally reoccupied encampment where small groups of people with a mixed foraging and cultivation economy coalesced to do a wide range of activities. As such, the bone tool and manufacture debris assemblage of Boyo Paso 2 offers a viable match and an excellent opportunity to assess the process of bone raw material procurement, working method and tentative use of bone artefacts, where tactics, actions and decisions were repeated at an evolutionary scale resolution.

Materials and methods

The bone tool assemblage was formed by 87 items collected from fieldwork between 2011 and 2018. Although a few pieces were recovered during test-pit works, most of the bone tools were found on living surfaces or in the semi-subterranean feature of the upper archaeological floor, linking their use to the deposit in which they were found. Pieces were examined with a 20–10X hand lens. This approach was sufficient to confirm that the pieces were artificially modified by manufacture or use on at least one surface. Some of the bone tools discussed here were mentioned in Matías E. Medina *et al.* (*2018*) and Medina *et al.* (*2019*), but they were never studied from the whole worked bone assemblage perspective.

In order to organize the diverse set of objects, the assemblage was classified into morpho-functional groups based on visual inspection of the pieces following the French archaeological school (*Camps-Fabrer 1967*) adapted for South America prehistoric assemblages (*Buc 2012; Cahiza* et al. *2012; Capriles 2014; Medina* et al. *2014; Moore 1999; Pastor, Moschettoni 2018*). The anatomical and taxonomical identifications were based on the reference collections. The physical and metric data (maximum length, width and thickness), as well as the presence and orientation of polish and striae, were recorded to identify the manufacturing processes and tentative functionality of tools. Evidence from wear traces on active edges or ends, ethnographic analogy and archaeological context were used to link the tool type to the function and possible social significance of the objects (*cf. Berenguer, Acevedo 2015; Borella, Buc 2010; Buc 2012; Gates St-Pierre 2007; D'Errico* et al. *2012; Horta* et al. *2019; Legrand 2007; Legrand, Sidera 2007; Luik 2006; Nami, Scheinsohn 1997; Soressi* et al. *2013; Stone 2011*). Thus, the assignment functions of the bone tool assemblage are speculative until use-wear analysis are completed.

The use and performance of the projectile points as spears, arrows or darts were assessed based on the gross weight following Fenenga (*1953*), assuming that pieces with a weight lighter than 4g were used on arrows. The system of hafting projectile points

Stratigraphic unit	Material dated	^{14}C years	Sigma	Lab. code	Calibrated age
Upper archaeological floor (37–40cm)	Wood charcoal	750	70	LP-2932	549–744 BP
	Phaseolus vulgaris	866	39	AA110929	658–908 BP
	Zea mays	878	18	AA110928	716–774 BP
	Wood charcoal	1060	50	LP-3122	796–987 BP
	Wood charcoal	1500	80	LP-3107	1261–1538 BP
Lower archaeological floor (49–56cm)	Wood charcoal	870	50	LP-3577	666–808 BP
	Wood charcoal	970	40	LP-3567	757–924 BP

Tab. 1. Radiocarbon dates from Boyo Paso 2 taken from Medina* et al. *(2020). The calibration of ^{14}C ages was done using Calib Rev. 7.0.1 (*Reimer *et al.* 2013*).

and the size of the shaft were assessed by the morphology of the proximal end of the projectile point following Heidi Knetch (*1993.34*), mainly considering the characteristic of the stem (section, width-thickness, additional technological element associated, *etc.*). Traces of burning on artefacts were recorded using the same taphonomic scheme as that applied to zooarchaeological remains (see *Medina* et al. *2019*). Lastly, the zooarchaeological record described above was used as a baseline to evaluate the selection of raw materials for bone tool production.

Results

Raw materials chosen for making artefacts

The intense anthropic modification and post-depositional fragmentation of the assemblage made it difficult to identify the body parts and taxa selected to make most the bone tools. The species whose bones were most often used for making tools were *Lama* cf. *L. guanicoe* followed by Cervidae cf. *Ozotoceros* (Tabs. 2 and 3 (see Appendix)), readily available and in large quantities as kitchen waste (*Medina* et al. *2019*). Most of the bones identified as the body size classes Mammalia indent (medium-large size) or Macrovertebrate indet presumably also came from these Cetartiodactyla species. Cut marks on an artefact made of Camelidae scapula confirm that at least a portion of the bones used to fashion tools came from animals killed for food, probably those that remained on site after primary butchering. Cathartidae bones were also used for tool manufacturing. Although the meat of Cathartidae was not valuable for food (see *Kozák* et al. *1979*), a few bones of this species were probably sought for symbolic reasons, mainly for fashion specific tools for ritual paraphernalia.

The choice of raw material for manufacturing bone tools was rather standardized. Most often, splinters from macro vertebrate long bones were used to shape the tools, especially metapodials – judging from the pieces BP2-49, BP2-74 and BP2-82 – and perhaps also tibiae, because of their long and straight shape (Tabs. 2 and 3 (see Appendix)). Antler, rib, radius-ulna, scapula, carpals-tarsals, phalanges or axial bones were seldom used (Tab. 3). One particular type of bone tool – flakers – were made from antler, maybe because they required little alteration to produce a flaker. However, flakers were also made on long-bones. It is noteworthy that working traces on antler were ambiguous and could be assigned to a natural origin according to Alejandro Alberto Acosta *et al.* (*2020*). Thus, the functional assignation of antler flakers needs further exploration through use-wear analysis to determine whether they are expedient tools or simply pieces of raw material collected for later use.

In general terms, the raw materials selected to manufacture the worked bone at Boyo Paso 2 are similar to the osseous materials selected for making tools at other Late Pre-Hispanic Period sites (*Berberián 1984; González 1943; 1949; Medina* et al. *2014; Serrano 1945*). The subsistence strategies at all these Late Pre-Hispanic settlements were quite similar and this is also reflected in the exploitation of animal bones for making tools. Artefacts or manufacture debris made from bird bones are extremely scarce at Boyo Paso 2, and only three pieces were found (BP 2-1, BP2-70 and BP2-83). These are also rare at other Late Pre-Hispanic sites, even when bird long bones were used in neighbouring regions to produce bird bone tubes, tubular beads, pendants and pin-like tools (*Bonomo 2013; Del Papa* et al. *2019; Escoste-*

Tool type	Frequency (No.)	Burned (No.)
Projectile points		
Blade fragments	3	3
Serrated stems	2	–
Notched bone tool		
Notched bone tool	1	–
Flakers		
Antler-Flakers?	4	1
Long bone-Flakers	3	2
Smoothers and Scrapers		
Rib- Smoother	1	–
Long bone-Scrapers	4	1
Long bone-Longitudinal scraper	1	1
Pointed tools		
Pin-like tools	2	1
Awl	1	–
Spatulas		
Pin-shaped subtype spatula	1	1
Pin-shaped subtype spatulas?	4	2
Undecorated fragments of spatulas?	3	1
Indeterminate artefacts		
Artefacts on indeterminate taxa	45	23
Artefact on Cathartidae bone (mastic)	1	–
Artefacts on camelid bone	3	1
Artefacts on cervid bone	2	1
Unfinished items and waste by-products		
Pieces on Cathartidae bone	2	1
Pieces on camelid bone	3	–
Piece on cervid bone	1	1
Piece on macrovertebrate bone	1	1

Tab. 2. Summary of bone tool types from Boyo Paso 2.

guy et al. *2017; Horta Tricallotis* et al. *2019; Perez Jimeno, Del Papa 2016; Rusconi 1933*).

Tool types and tentative functions

The bone tool assemblage from Boyo Paso 2 shows different morpho-functional groups, including projectile points, awls, pin-like tools, spatulas, serrated edge tool and blunt points (Tabs. 2 and 3 (see Appendix)). Most tools showed clear signs of wear. Other items were considered manufacture debris by-products or artefacts with unknown functionality. The metric and physical data of the assemblage is presented in Table 3.

Five fragments of projectile points were found (Fig. 2). They were represented by three fragments of blades and two of stems assigned to a class of artefact relatively common in Late Pre-Hispanic Period assemblages characterized by the long triangular-shaped blade (*c.* 62.1mm), straight or slightly contracted stem with serrated edge and barber shoulders (*Medina, Balena 2020; Medina* et al. *2014; 2019; Pastor* et al. *2005*). Although abrasion makes bone identification difficult, nutrient foramida, an element-diagnostic feature, indicated that BP2-82 was fashioned on a metatarsal roughly assigned to Cetartiodactyla cf. Camelidae-Cervidae. The pieces BP2-39, BP2-64, BP2-75 and BP2-84, with a biplane cross-section, thickness of *c.* 3mm and diagonal manufacture traces or finally abraded surfaces, resemble the physical structure known for bone projectile points, which would thus increase the frequency of this tool-type in the assemblage. The gross weight of the nearly complete pieces suggests that these projectile points were hafted to a bow-and-arrow weapon delivery system, mainly because their light weight (*c.* 2–4g) needs speed to increase their effectiveness and penetration capacity (*Pastor* et al. *2005*). Moreover, they have a complex hafting system that involve shafts with a distal end being whittled down to match a stem with a serrated edge to reduce the slippage of the ligature and fasten the point firmly to the shaft (see *Medina* et al. *2019.Fig. 5*).

Hunting and warfare projectile points differ in that the former are produced to obtain meat, while the primarily intent of the latter is to kill or wound enemies. As a result, different constraints exist for these two tasks. Hunting points were made to kill as rapidly as possible to avoid the effort of tracking the prey (*Loendorf* et al. *2015*). In contrast, warfare points were designed to maximize the probability that injury or death resulted, regardless how long this might take (*Loendorf* et al. *2015; Luik 2006*). Nevertheless, such classification of warfare and hunting weapons is subjective, and if necessary warfare arrowheads could be used in hunting and vice versa (*Loendorf* et al. *2015; Luik 2006*). According to these assumptions, the bone arrow points from Boyo Paso 2 were interpreted as weapons designed for using against people in warfare, although the most abundant tiny lithic arrowheads could have been used with the same purpose. The capacity of bone tips to pierce the rib cage, the addition of barbed tangs that resist removal from the wound, and a securely hafted fastening method, all mean that if the projectile enters the body of an enemy then it is unlikely to be easily withdrawn, with the point being attached to an arrow creating a more serious internal haemorrhaging (*Christenson 1997; Loendorf* et al. *2015; Luik 2006*). The recent discovery of Late

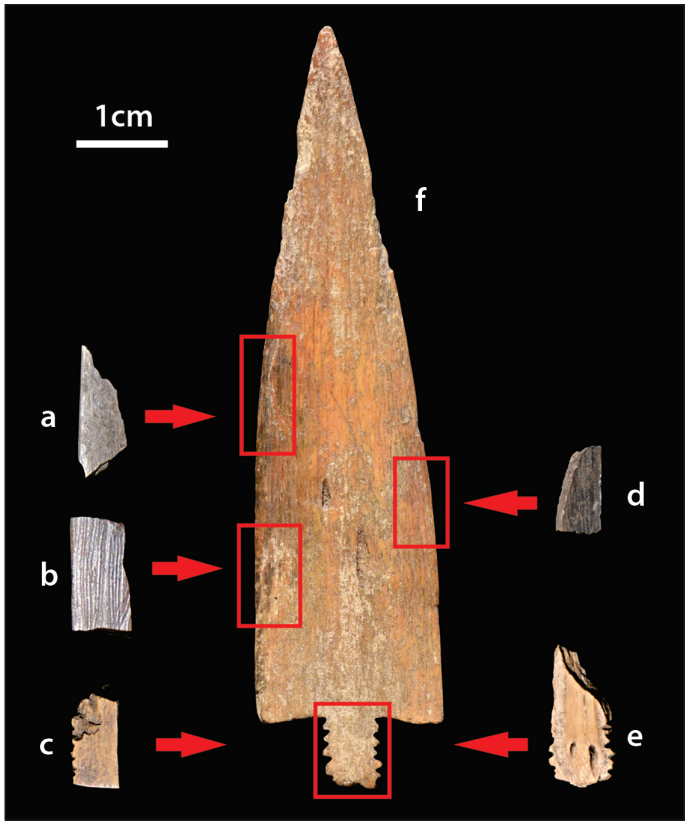

Fig. 2. Bone projectile points referred to in the text:* a, b *and* d *fragments of blades (BP2-29, BP2-56 and BP2-78, respectively);* c *and* e *fragments of stems (BP2-82 and BP2-81, respectively);* f *complete bone projectile point recovered at San Roque locality and housed in Museo Arqueológico Numba Charava (Villa Carlos Paz, Argentina).

Pre-Hispanic human skeletal remains with clear evidence of death caused by bone-tipped projectiles similar to the ones described here reinforce this functional hypothesis (*Fabra* et al. *2015; Pastor* et al. *2012*).

A notched bone tool was found on Boyo Paso 2 (BP2-58). The tool was manufactured on the posterior border of a *Lama* cf. *L. guanicoe* scapula, conserving the axillary border, the subscapular fossa and the posterior angle (Fig. 3.a). Fifteen closely spaced notches or denticulations were retouched on the infraspinatous fossa to create a serrated edge (Fig. 3.a). The notched use edge appears shiny to the naked eye. Starch grains recovered from the shiny area by sonication were identified as aff. *Oxalis* sp. tuber, although their taxonomic status as domestic or wild requires further investigation (*Medina* et al. *2018*). Based on this evidence, it is argued that the notched bone tool was used for peeling *Oxalis* sp. tubers, an activity with low archaeological visibility due to the poor preservation of underground plant organs.

Fig. 3. Different tool-types referred to in the text:* a *notched bone tool (BP2-58);* b *bone tool used for scraping hides in a transversal motion (BP2-79);* c *similar to BP2-79 nearly complete scraper recovered at Carrupachina (*Rivero *et al.* 2015*).

Most antler tines were tentatively identified as flakers. They have their natural tine tips presumably transformed into small, rounded surfaces, blunt and worn from use (Fig. 4.a). However, as it was mentioned above, such functions have not been verified so far through use-wear analysis and require further exploration. Fragments of blunt points made from elongated macrovertebrate long bone splinters slightly regularized were also identified as flakers (BP2-13, BP2-14 and BP2-45). They presented transversal and parallel striations on the apical end, inclusively visible under the naked eye, being short, deep and wide, similar to those observed in tools used as flakers (*D'errico* et al. *2012; Nami, Scheinsohn 1997; Borella, Buc 2009; Vitezović 2018*).

The greatest share of bone tools were connected to hide, leather or fibre processing. Presumably, the bone tool BP2-8, made from a macromammal rib, was used as a smoother for hides or similar, related activities (Fig. 4.b). The tool has been lightly shaped to blunt it into an pointed tip. The edges of the medial cortical side of the rib were scraped, exposing the spongy structure of bone for unknown function. Cortical bone at the very tip and around the edges was polished by use. Moreover, spongy bone is exposed and polished at and near the tip by use-wear. The anthropic modifications of the tip look like the result of abrasive pressure against a softer material, such a dry hide, with a repetition motion transverse to the active edge or longitudinally to the long axis of the bone. Rib smoothers are common in Late Pre-Hispanic contexts (*Medina* et al. *2014*) and are also related to pottery or basketry making (*Buc 2011; Medina* et al. *2014*). The small fragment of rib BP2-31 also has the edge of the cortical medial side scraped, but its fragmented characteristic impedes its secure classification as a rib smoother. Five fragments of macro mammal and Cervidae cf. *Ozotoceros* ribs with manufacturing traces can be linked to this type of tool or their manufacture by-products. On the other hand, the small fragments of long bone (BP2-6, BP2-48 and BP2-85) were identified as hide scrapers (*sensu Legrand, Sidera 2007*). They presented a flat side, bevelled and sharp-edged with polished spongy bone on the area affected by wearing and a set of parallel striations running longitudinally to the edge (Fig. 4.c). Something similar occurred with BP2-32 which, despite its small size and frag-

mented character, has a bevelled and polished by use edge. All these characteristics are consistent with their use against softer material such as a hide, producing a smoothly shifting pressure over a small area to result in a more impermeable and lustrous hide (*D'Errico* et al. *2012; Mozota Holgueras 2007; Soressi* et al. *2013; Vitezović 2011*). Finally, the long edge of a lengthwise split long bone of a large-medium size mammal (BP2-79) was classified as used for scraping or cleaning hides in a transversal motion (Fig. 3.b), as described by Heidi Luik and Giedrė Piličiauskienė (*2016*) for seal bone scrapers. As a result of this activity, the long edge of the diaphysis and trabecular bone of the epiphysis were polished and look shiny to the naked eye (Fig. 3.b). Similar tool-type scrapers were also common in the Late Pre-Hispanic context of the Carrupachina site (Fig. 3.c; *Rivero* et al. *2015*).

An awl and pin-like tools were probably multi-use items (*sensu Gates-St. Pierre 2006*), *e.g.*, for hide-working, corn husking and basketry making. In general terms, pointed tools were poorly standardized. They were not only made of long bones, and simple, opportunistically chosen ad hoc points with sharp tips were used with minimal modification as pointed tools, as exemplified by a sharp point tip fashioned on a camelid malleolus (BP2-54; Fig. 4.g). BP2-3, BP2-55 and BP2-80 are small indeterminate artefact fragments that can be classified as pin-like tools by their circular and fine cross-sections, but their apical areas were broken to verify this assignation. The sharp characteristics of the apical areas of BP2-19 (Fig. 4.f), BP2-20 (Fig. 4.e) and BP2-54 (Fig. 4.g), suggest drilling activities in soft materials such as hides or for making mats, nets and baskets, perishable tools crucial to many subsistence activities that are rarely preserved in today's archaeological record but comprise up to 95% of the material culture in ethnographically documented groups (*Stone 2011*). Ethnographic analogy is consistent with this functional assignation (*Moore 1999; Stone 2011*). The evidence of plant-based technologies impressed on the clay of Late Pre-Hispanic vessels reinforces these arguments. Moreover, the use of pointed tools to peel the husk of corn cob needs to be considered in horticultural groups, but this is never easy be recognize and only use-wear analysis can allow a valid identification of this activity (*Gates-St. Pierre 2006*).

There are few artefacts in Boyo Paso 2 that can be connected to cults, rituals or religions rather than a technological function. The most spectacular finding of this type is a fragment of pin-shaped subtype spatula (*sensu Pastor, Moschettoni 2018*) with decorative lateral fins (presumably shaped like animals). It is made of a long bone that is finely polished, smoothed and has incised decoration, mainly circles, triangles and dots, made in a positive relief (Fig. 5.a). Small fragments of artefacts with a dot-and-circle pattern (BP2-25, BP2-26, BP2-27 and BP2-28) and three distal ends of spatulas without incised decoration (BP2-18, BP2-42 and BP2-86) were assigned to the same ritual object, even when it is not clear if most of them were really spatulas, ornaments or other small personal objects related to clothing (Fig. 6). A few such decorated spatulas were also found at Sierras of Córdoba, but they are common at several sites in Norte Chico of Chile with similar chronologies, where they were imitated according to Pastor and Moschettoni (*2018*). They related pin-shaped subtype spatulas to the inhalant paraphernalia used in the consumption of hallucinogen substances such as cebil (*Anadenanthera colubrina*), and they are thought to have had important ritual functions. Tubes for *A. colubrina* consumption were not found,

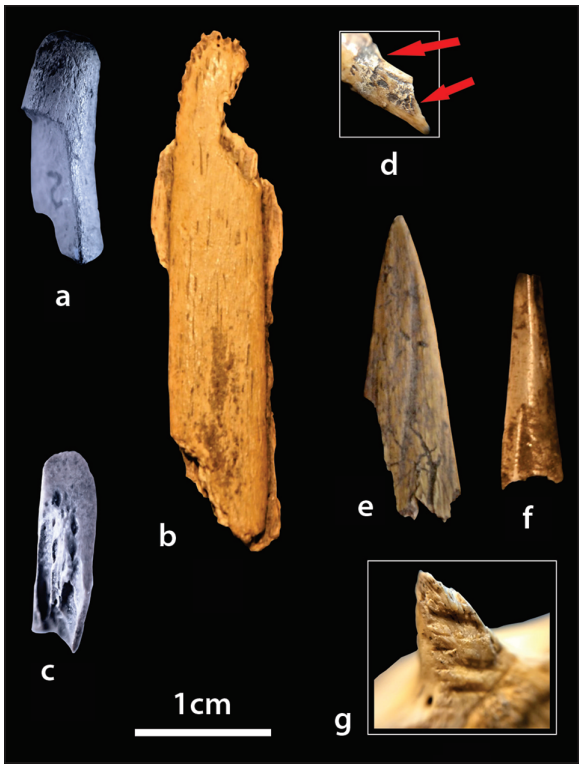

Fig. 4. Different tool-types referred to in the text:* a *antler tine tentatively identified as a flaker (BP2-2);* b *smoother made from a macromammal rib (BP2-8);* c *hide scraper (BP2-48);* d *Cathartidae cf.* Cathartes-Coragyps *distal radius splinter (BP2-70) with arrows showing the mastic residues;* e *pin-like tool (BP2-20);* f *pin-like tool (BP2-19);* g *awl (BP2-54).

but the by-products of its manufacture using Cathartidae long bones were recorded at Boyo Paso 2. The possible meaning of these tools in term of Pre-Hispanic networks and the significance of hallucinogens in the pre-Hispanic cultures and religions of the southern cone of South America have recently been discussed in several publications (*Berenguer, Acevedo 2015; Horta 2012; Horta* et al. *2019; Pastor, Moschettoni 2018; Perez Gollán 1994; Sprovieri 2008–2009*).

A high number of worked or shaped pieces (n=51) were too fragmentary to permit any useful speculation as to the function of the tool, or even the orientation of the working edge. These pieces were classified as indeterminate artefacts. The category includes an unciform of *Lama* cf. *L. guanicoe* (BP2-11) and a cervical vertebrae of a deer (BP2-12) that presented abraded surfaces, but with an unknown function. It also includes a Cathartidae cf. *Cathartes-Coragyps* distal radius splinter with mastic residues (BP2-70; Fig. 4.d).

Bone working method

The presence of unfinished items and waste by-products suggests that at least a portion of the bone tools were manufactured on-site. The techniques used to manufacture bone tools at Boyo Paso 2 were simple and have much in common with those practiced through prehistory (*Álvarez 2014; del Papa* et al. *2019; Legrand 2007; Vitezović, Bulatović 2013*). One method used for splitting bones was grooving, where a transversal or longitudinal groove was cut into the diaphysis of long bone with a flint tool and then the bone was split to obtain a blank or a tube. As a result, a groove incised into the bone is visible at some split bones. The technique is exemplified by a proximal humerus of Cathartidae cf. *Cathartes-Coragyps* (BP2-1), a proximal metatarsal of *Lama* cf. *L. guanicoe* (BP2-49) and a proximal rib of Cervidae cf. *Ozotoceros* (BP2-5) with cut-and-break marks around the circumference of the diaphysis. More examples are available in Table 3 (see Appendix) and Figure 7, including a Cathartidae cf. *Vultur* proximal radius (BP2-83). Fracturing bone was also frequently used to produce blanks or preforms, *e.g.*, breaking by direct percussion. Moreover, some pieces could have been produced during cracking of bone to release marrow and not specifically for tool manufacturing.

After the blank was obtained, several bone working methods were observed. Many pieces have been so modified in finishing and use – *i.e.* projectile points – that the initial shaping trace has not been observed. Most common, though, was shaping by grinding against an abrasive surface, perhaps a ground stone, a common item found in Boyo Paso 2 layers (*Medina* et al. *2020*). Pieces were treated in this way to produce a uniform, smooth result. Conversely, many bone tools were identified by the traces of wear on a broken or natural surface, not by any deliberated shaping or cutting. Pointed tools show longitudinal coarse striations interpreted as manufacture traces made with abrasive coarse-grained material (Fig. 4.e). The pin-like tool BP2-19 suggests that the surface was more finally abraded (Fig. 4.f), whereas the awl BP2-54 shows manufacture traces as a scraped surface (Fig. 4.g). The fragments of bone projectile points presented longitudinal and oblique coarse striations suggesting that they were shaped by a combination of scraping and abrasion with a coarse-grain material. Blades were more finely abraded to increase the drag coefficient, reduce resistance and secure deeper penetration of the rib cage of the tar-

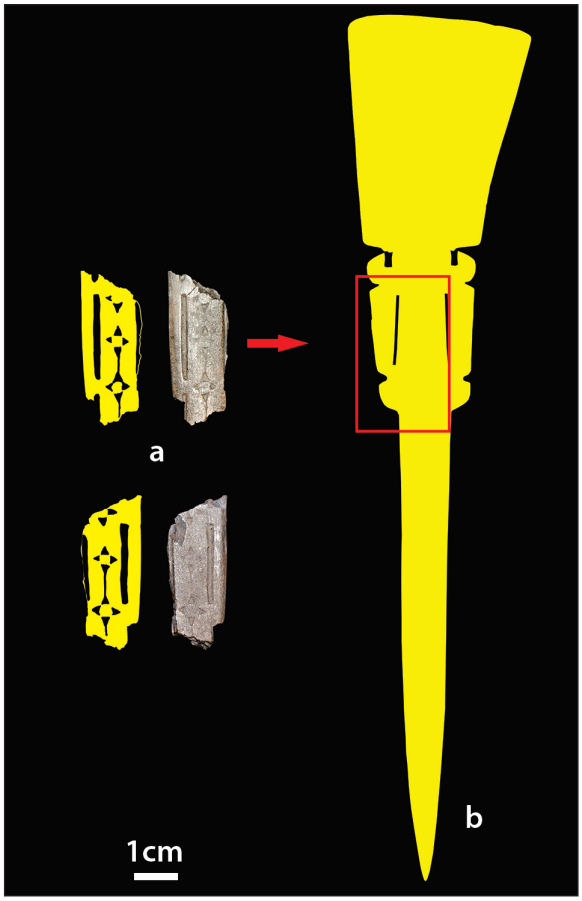

Fig. 5. Pin-shaped subtype spatulas referred to in the text:* a *and* b *fragment of pin-shaped subtype spatula recovered at Boyo Paso 2 (BP2-24);* c *outline of pin-shaped subtype spatula from the Norte Chico of Chile (modelled from* Pastor, Moschettoni 2018*).

get (Fig. 2.a,d). In decorated artefacts, a flint tool was used for carved circle, triangle and dot decorations and the surfaces were finely polished (Figs. 5 and 6). About 41 of the bone tools showed some sign of burning or heat treatment related to manufacturing or use, mostly when burning hardened the bone altering the crystal structures of the bone mineral (*Camps Fabrer 1967; Moore 1999; Vitezović 2018*). Burning also affected decorated tools (Figs. 5 and 6). It is thus open to question whether exposing the bone to fire was a deliberated practice, either to alter the appearance or working properties, or to finish its working life by discarding it in domestic fires. Burning damage could also be a response to accidental burning during the multiple occupation events that affected the deposit (see *Medina* et al. *2019*).

Discusion and conclusion

The bone tools of Boyo Paso 2 can be broadly divided into the group of artefacts made of suitable bone fragments – thus representing barely worked objects – and the group of artefacts skilfully or finally manufactured (*Choyke 1997*). The majority of bone tools belong to the first group, where the natural shape of bone or bone fragment has been exploited for making bone artefacts (pin-like tools, smoothers, notched bone tools, *etc.*). This tool-kit reflects that bone technology was related to short-term and low-risk activities (*Nelson 1991; Torrence 1983*), showing low-energy investment in manufacture and simple designs, without any features of curated technology. The raw materials for making bone tools were obtained from the by-product of faunal consumption and fashioned into tools by basic manufacture techniques such as cutting, fracturing and scraping. Moreover, the variability of pointed tools suggests that they were versatile tools that could perform different tasks with minimal labour investment (*Nelson 1991*). It seems likely that production took place in the household according to personal or domestic needs.

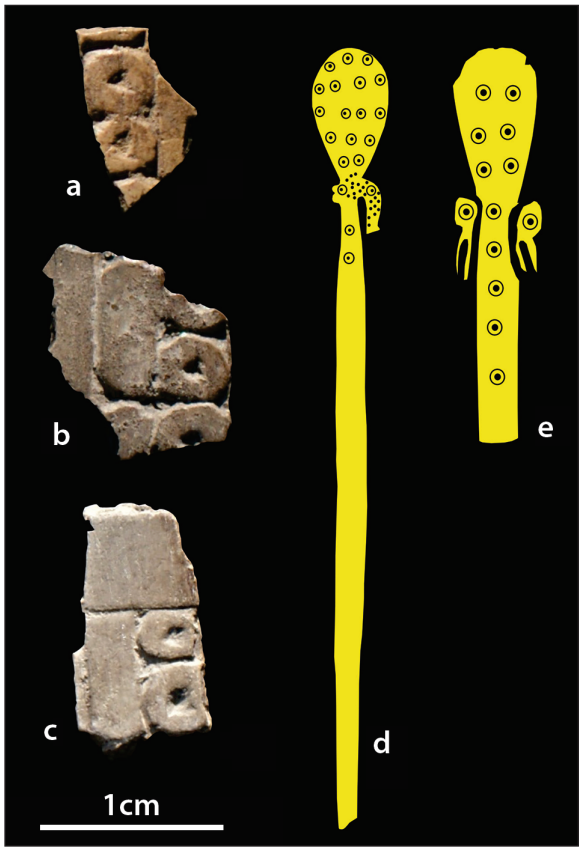

Fig. 6. Artefacts with dot-and-circle pattern referred to in the text:* a *BP2-26;* b *BP2-28;* c *BP2-25;* d *and* e *pin-shaped subtype spatulas from Caldera (Norte Chico, Chile) and Abaucán (Catamarca, Argentina) taken from Pastor and Moschettoni (*2018*).

Conversely, bone arrowheads and spatulas are outstanding among the Late Pre-Hispanic bone tools for their careful finishing, high energy investment and standardization, reflecting the importance of the task they were used for in the society as a whole. Pin-shaped subtype spatulas are particularly meticulously made, with very high skill, time and labour investment. They were produced through several stages of abrasion, cutting, carving, scraping and polishing. Even though they were probably used for special occasions, in Boyo Paso 2 they were found on living floors and in a semi-subterranean feature that looks likely to have been used for multiple functions, including trash disposal. Something similar occurs with projectile points: hours of work were needed to fashion one projectile point. In earlier archaic occupations, no similarly finished artefact types were formed (see *Rivero 2009*). Thus, these are culturally and chronologically specific artefacts. This means that arrow points and decorated spatulas were new types introduced to deal with the socioeconomic changes that occurred when crop plant cultivation was adopted *c.* 1500 years BP. They thus shed light on a time of high social dynamism during the Late Pre-Hispanic Period, which involved the intensification of social relations through prestigious technologies and inter-personal violence.

Some degree of standardization in the choice of raw materials is characteristic of the bone tools from the Late Pre-Hispanic. The long bones of macro vertebrates, probably *Lama* cf. *L. guanicoe* and deer, were used more often. Camelids and cervids were gene-

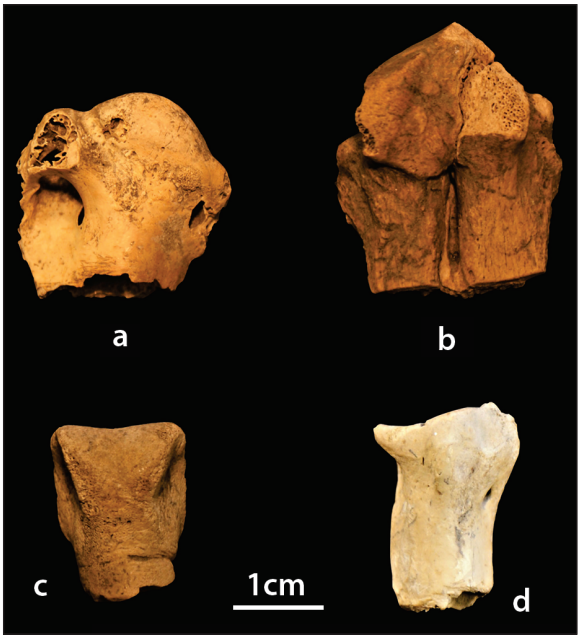

Fig. 7. Examples of waste by-products recovered at Boyo Paso 2:* a *proximal humerus of Cathartidae cf.* Cathartes-Coragyps *(BP2-1);* b *proximal metatarsal of* Lama *cf.* L. guanicoe *(BP2-49);* c *distal first phalanx of* Lama *cf.* L. guanicoe *(BP2-22);* d *Cathartidae cf.* Vultur *proximal radio (BP2-83).

rally the animals that were mostly hunted at Boyo Paso 2 (see *Medina* et al. *2019*), indicating that the acquisition of bone was embedded within subsistence activities. In other words, the prevalence of wild ungulate species in the raw material choices certainly points to cultural attitudes to hunting prey, which were included in all segment of life and in diverse aspects of consumption.

The study of the worked-bone assemblage of Boyo Paso 2 provides several insights regarding the daily use of bone tools by people with a mixed foraging and cultivation economy. The diversity of bone tools suggests that multiple activities were carried out at Boyo Paso 2, mainly related to hunting or warfare, food processing, hide-working, net or basketry-making, ritual activities, and lithic tool production. Bone arrow points were used for defence or attack, but also occasionally for hunting ungulate prey. The adoption of an effective weapon for individual defence probably increased the political self-sufficiency of families and encouraged the development of a more independent family-based political system, as the described by early colonial records (*Gonzalez Navarro 2009*). Pointed tool types were used in basketry or drilling activities when working with soft organic materials such as skins, whereas the smoother and scraper were used to smooth animal hides, technologies associated with the labour of woman that are frequently invisible in the archaeological record (*Stone 2011*). The notched bone tool was used for peeling *Oxalis* sp. tubers, highlighting the role of tubers, whether wild or domestic, in the daily seasonal life. Similar notched bone tools only occurred in Late Pre-Hispanic sites, suggesting that the adoption of a broad-scale foraging and cultivation base was accompanied by the development of new types of bone tool for processing the plant foods that were now included into subsistence. On the other hand, blunt points presented traces that were compatible with lithic flakers, reinforcing the hypothesis of Imanol Balena and Matías E. Medina (*2020*) that the manufacture and maintenance of lithic artefacts for hunting or food processing were common activities at Boyo Paso 2. Artefacts connected with cults, religions or expressing social identities are also represented among the bone objects from Boyo Paso 2, probably imitating foreign bone tool objects (*Pastor, Moschettoni 2018*). These objects comprised decorated incised pin-shaped subtype spatulas used in ritual paraphernalia along the southern cone of South America, and/or small fragments of probable ornaments related to clothing. It is particularly interesting that these tools and decoration patterns show an important South-Central Andean influence, although (and again) in a somewhat modified way, reflecting the wide distribution of ideologies or symbolic meanings across regions and the existence of social ranks whose status requirements these artefacts met. Residues of vulture and condor bones resulting from the manufacture of bird bone tubes, artefacts commonly used for the consumption of hallucinogens (*Horta-Tricallotis* et al. *2019*) or ritual paraphernalia (*Potter 1997*), may be conceived in the same way, even when such tubes have not been found yet at Boyo Paso 2. It is thus concluded that the analysis of bone technology makes it possible to explore a component of the subsistence and material culture that has to date been neglected, directly or indirectly, by its low visibility in the record. As a result, bone tools may enable reconstruction not only of the methods of subsistence, but also of technological levels, social organization, and cultural attitudes towards the environment.

While the analysis presented here must be considered a starting point toward resolving more complex problems that await further formal functional research, this should not be an impediment to communicating the results to the archaeological community interested in how neither wholly foragers nor wholly farmers dealt with technological prob-

lems using bone as a raw material. At the very least it contributes with a set of first conclusions, mostly to be viewed as hypotheses until use-wear studies have been established, providing data to improve the knowledge of the material culture associated with mixed foraging and cultivation economies, a category for which archaeology currently lacks sufficient archaeological understanding and which thus merits further research.

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References

Acosta A., Buc N., and Loponte D. 2020. Tecnología ósea de los grupos cazadores-recolectores de la Pampa Ondulada (provincia de Buenos Aires). *Revista del Museo de Antropología 13(2): 79–92*. https://doi.org/10.31048/1852.4826.v13.n2.25387

Álvarez M. C. 2014. Tecnología ósea en el Oeste de la Región Pampeana: Identificación de las técnicas de manufactura a partir de evidencias arqueológicas y experimentales. *Chungara 46(2): 193–210*.

Argüello de Dorsch E. 1983. Investigaciones arqueológicas en el Departamento de Punilla (Provincia de Córdoba-Rep. Argentina). Sitio C.Pun.39. *Comechingonia 1: 41–60*.

Balena I., Medina M. 2020. Horticultura, Movilidad y Tecnología Lítica: Una Mirada desde Boyo Paso 2 (900–700 AP, Sierras de Córdoba, Argentina). *Estudios Atacameños, in press*.

Berberián E. 1984. Potrero de Garay: Una entidad sociocultural tardía de la región serrana de la Provincia de Córdoba (Rep. Argentina). *Comechingonia 4: 71–138*.

Berenguer J., Acevedo N. 2015. Tubos de hueso de ave como implementos chamánicos en el Desierto de Atacama, siglos XI-XV. *Boletín del Museo Chileno de Arte Precolombino 20(1): 51–72*.

Bonomo M. 2013. Reanálisis de la Colección de Samuel Lothrop procedente del Delta del Paraná. *Relaciones de la Sociedad Argentina de Antropología XXXVIII(1): 169–198*.

Borella F., Buc N. 2009. Ópticas y ópticos. Una aproximación a la tecnología ósea en la Bahía de San Antonio (Río Negro), Argentina. In M. Salemme, F. Santiago, M. Álvarez, E. Piana, M. Vázquez, and M. Mansur (eds.), *Arqueología de Patagonia: Una Mirada desde el Último Confín*. Editorial Utopías. Ushuaia: 421–433.

Buc N. 2011. Experimental series and use-wear in bone tools. *Journal of Archaeological Science 38: 546–557*. https://doi.org/10.1016/j.jas.2010.10.009

2012. *Tecnología Ósea de Cazadores-Recolectores del Humedal del Paraná Inferior. Bajíos Ribereños Meridionales*. Instituto Nacional de Antropología y Pensamiento Latinoamericano. Buenos Aires.

Buc N., Rivero D., and Medina M. 2016. The Late Holocene bone tools from Quebrada del Real 1 (Sierras of Córdoba, Argentina). In S. Vitezović (ed.), *Close to the Bone: Current Studies in Bone Technologies*. Institute of Archaeology. Beograd: 80–85.

Cahiza P., Aguilar J., and García Llorca J. 2012. Tecnología ósea del alero Las Tumanas (LT1), Valle Fértil, San Juan. *Comechingonia 16(2): 75–91*.

Camps-Fabrer H. 1967. *Matièreet Art Mobilierdans la Préhistoire Nord-Africaine et Saharienne*. Mémoires du Centre de Recherches Anthropologiques, Préhistoriques et Ethnographiques. Paris.

Capriles J. 2014. *The economic organization of early camelid pastoralism in the Andean Highlands of Bolivia*. BAR International Series 2587. Archaeopress. Oxford.

Choyke A. 1997. The bone manufacturing continuum. *Anthropozoologica 25–25: 65–72*.

Christenson A. 1997. Side-notched and unnotched arrowpoints. Asssesing functional differences. In H. Knetch (ed.), *Projectile Technology*. Plenum Press. New York: 131–142.

del Papa L., Lamenza G., Salceda S., and Calandra H. 2019. Un núcleo óseo: nuevos aportes a la comprensión de la tecnología ósea en el Gran Chaco sudamericano (Argentina). *Latin American Antiquity 30(2): 429–436*. https://doi.org/10.1017/laq.2019.2

D'Errico F., Backwell L., and Wadley L. 2012. Identifying regional variability in Middle Stone Age bone technology: The case of Sibudu Cave. *Journal of Archaeological Science 39: 2479–2495*.
https://doi.org/10.1016/j.jas.2012.01.040

Escosteguy P., Salemme M., and González M. 2017. Tecnología ósea en la Depresión del Río Salado (provincia de Buenos Aires). *Arqueología 23(3): 65–90*.

Fabra M., González C., and Robin S. 2015. Evidencias de violencia interpersonal en poblaciones del piedemonte y las llanuras de Córdoba (Argentina) a finales del Holoceno tardío. *Runa 36: 5–27*.

Fenenga F. 1953. The weights of chipped stone points: A clue to their functions. *Southwestern Journal of Anthropology 9(3): 309–323*.

Gates St.-Pierre C. 2007. Bone awls of the St. Lawrence Iroquoians: A microwear analysis. In C. Gates St-Pierre, R. Walker (eds.), *Bones as Tools: Current Methods and Interpretations in Worked Bone Studies*. BAR International Series 1622. Archaeopress. Oxford: 107–118.

González A. 1943. Arqueología del yacimiento indígena de Villa Rumipal (Pcia. de Córdoba). *Publicaciones del Instituto de Arqueología, Lingüística y Folklore "Dr. Pablo Cabrera" IV*. Universidad Nacional de Córdoba, Córdoba.

1949. Nota sobre la arqueología de Pampa de Olaen (Córdoba). *Notas del Museo de La Plata, tomo XIV, Antropología 56: 463–503*.

González Navarro C. 2009. Autoridades étnicas en un contexto de desestructuración: Córdoba entre la fundación y la visita de Antonio Martines Luxan de Vargas. In B. Bixio, C. González Navarro, R. Grana, and V. Iarza (eds.), *Visita a las Encomiendas de Indios de Córdoba 1692–1693*. Editorial Brujas. Córdoba: 63–114.

Horta H. 2012. El estilo circumpuneño en el arte de la parafernalia alucinógena prehispánica (Atacama y Noroeste Argentino). *Estudios Atacameños 43: 5–34*.

Horta-Tricallotis H., Echeverría J., Lema V., Quirgas A., and Vidal A. 2019. Enema syringes in South Andean hallucinogenic paraphernalia: evidence of their use in funerary contexts of the Atacama and neighboring zones (ca. AD 500–1500). *Archaeological and Anthropological Sciences 11: 6197–6219*.
https://doi.org/10.1007/s12520-019-00913-5

Knecht H. 1993. Early Upper Paleolithic approaches to bone and antler projectile technology. In G. Peterkin, H. Bricker, and P. Mellars (eds.), *Hunting and Animal Exploitation in the Later Paleolithic and Mesolithic of Eurasia*. Archaeological Papers of the American Anthropological Association. New York: 33–47.

Kozák V., Baxter D., Willamson L., and Carneiro R. 1979. The Héta Indians: Fish in a Dry Pond. *Anthropological Papers of the American Museum of Natural History 55(6): 349–434*.

Laguens A., Bonnín M. 2009. *Sociedades indígenas de las Sierras Centrales. Arqueología de Córdoba y San Luis*. Editorial de la Universidad Nacional de Córdoba. Córdoba.

Legrand A. 2007. *Fabrication et Utilisation de L'outillage en Matières Osseuses du Néolithique de Chypre: Khirokitia et Cap Andreas-Kastros*. Oxbow Books. Oxford.

Legrand A., Sidéra I. 2007. Methods, means, and results when studying European bone industry. In C. Gates St-Pierre, R. Walker (eds.), *Bones as Tools: Current Methods and Interpretations in Worked Bone Studies*. BAR International Series 1622. Archaeopress. Oxford: 291–304.

Loendorf C., Simon L., Dybowski D., Woodson M., Plumlee R., Tiedens S., and Withrow M. 2015. Warfare and big game hunting: flaked-stone projectile points along the middle Gila River in Arizona. *Antiquity 89(346): 940–952*. https://doi.org/10.15184/aqy.2015.28

Luik H. 2006. For hunting or warfare? Bone arrowheads from the Late Bronze Age fortified settlements in Eastern Baltic. *Estonian Journal of Archaeology 10(2): 132–149*.

Luik H., Piličiauskienė G. 2016. Bone tools at the Neolithic sites of Šventoji, Lithuania: raw materials and working methods. In S. Vitezović (ed.), *Close to the Bone: Current Studies in Bone Technologies*. Institute of Archaeology. Beograd: 188–200.

Marcellino A., Berberián E., and Pérez J. 1967. El yacimiento arqueológico de Los Molinos (Dpto. Calamuchita, Córdoba). *Publicaciones del Instituto de Antropología XXVI: 1–68*.

Medina M., Balena I. 2021. Tiny arrowpoints, bone-tipped projectiles and foraging during the Late Prehispanic Period (Sierras of Córdoba, Argentina). In J. Belardi, D. Bozzuto, P. Fernández, E. Moreno, and G. Neme (eds.), *Ancient Hunting Strategies in Southern South America*. The Latin American Studies Book Series. Springer. Nueva York: 33–58.

Medina M., López L., Campos M., Saur Palmieri V., and Pastor S. 2020. Pit-houses, seasonality and subsistence resources: an essay from Boyo Paso 2 (ca. 900–700 BP, Sierras of Córdoba, Argentina). *Archaeological and Anthropological Sciences 12(6): 119*.
https://doi.org/10.1007/s12520-020-01066-6.

Medina M., Rivero D. 2020. Hunting and skeletal element abundance of guanaco during the Holocene of Sierras of Córdoba, Argentina. *Journal of Archaeological Science: Reports 29: 102074*.
https://doi.org/10.1016/j.jasrep.2019.102074.

Medina M., Balena I., and Rivero D. 2019. Proyectiles y procesos de intensificación: una aproximación desde Boyo Paso 2, 1500–750 AP (Sierras de Córdoba, Argentina). *Chungara 51(4): 517–529*.
http://dx.doi.org/10.4067/S0717-73562019005002202

Medina M., Campos M, Ávila N., Soibelzon E., and Fernandez F. 2019. Animal food during the Late Prehispanic Period at Sierras of Córdoba (Argentina). A zooarchaeological view from Boyo Paso 2. *Anthropozoologica 54(10): 83–95*.
https://doi.org/10.5252/anthropozoologica2019v54a10

Medina M., Picasso M., Campos M., and Ávila N. 2019. Tarsometatarsus, eggshells and the species level identification of large-sized flightless birds from Boyo Paso 2 (Sierras of Córdoba, Argentina). *International Journal of Osteoarchaeology 29(4): 584–594*.
https://doi.org/10.1002/oa.2754

Medina E., López L., and Buc N. 2018. Bone tool and tuber processing: a multi-proxy approach at Boyo Paso 2, Argentina. *Antiquity 92(364): 1040–1055*.
https://doi.org/10.15184/aqy.2018.93

Medina M., Pastor S., and Recalde A. 2016. The archaeological landscape of late prehispanic mixed foraging and cultivation economy (Sierras of Córdoba, Argentina). *Journal of Anthropological Archaeology 42: 88–104*.
https://doi.org/10.1016/j.jaa.2016.04.003

Medina M., Buc N., and Pastor S. 2014. Intensificación y dinámica ocupacional en el Periodo Prehispánico Tardío de las Sierras de Córdoba (Argentina): Una aproximación desde el registro artefactual óseo. *Chungara 46(1): 73–90*.

Moore K. 1999. Chiripa worked bone and bone tools. In C. A. Hastorf (ed.), *Early Settlement at Chiripa Bolivia: Research of the Taraco Archaeological Project*. Archaeological Research Facility. University of California. Berkeley: 73–93.

Mozota Holgueras M. 2007. Industrias óseas musteriense en el Cantábrico Oriental: los "alisadores" en hueso de los niveles B, C y D de Axlor (Dima, Bizkaia). *Cuadernos de Arqueología 15: 31–42*.

Nami H., Scheinsohn V. 1997. Use-wear patterns on bone exerimental flakers: a preliminary report. In A. Hannus, L. Rossum, and R. P. Winhan (eds.), *Proceedings of the 1993 Bone Modification Conference. Hot Springs, South Dakota*. Archaeology Laboratory. Agusana College. Sioux Falls. South Dakota: 256–264.

Nelson M. 1991. The study of technological organization. *Advances in Archaeological Method and Theory 3: 57–100*.

Pastor S., Moschettoni L. 2018. Practicas inhalatorias y redes de de interacción. Análisis de espátulas óseas del Centro de Argentina. *Boletín del Museo Chileno de Arte Precolombino 23(1): 101–115*.

Pastor S., Medina M., Recalde A., López L., and Berberián E. 2012. Arqueología de la región montañosa central de Argentina. Avances en el conocimiento de la historia prehispánica tardía. *Relaciones de la Sociedad Argentina de Antropología 37: 89–112*.

Pastor S., Rivero D., and Pautassi E. 2005. Los sistemas de armas de las comunidades agroalfareras de Córdoba: una aproximación arqueológica y experimental. In *Actas del XIII Congreso Nacional de Arqueología Argentina. Tomo IV*. Córdoba: 253–266.

Pérez Gollán J. 1994. El proceso de integración en el Valle de Ambato: complejidad social y sistemas simbólicos. *Rumitacama 1: 33–41*.

Perez Jimeno J., del Papa L. 2016. Presencia del grupo morfológico definido como tubo-ave e hipótesis de uso. El humedal del Paraná medio y el Chaco seco como caso de estudio. *Revista de Antropología del Museo de Entre Ríos 2(1): 100–118*.

Potter J. 1997. Communal ritual and faunal remains: an example from the Dolores Anasazi. *Journal of Field Archaeology 24(3): 353–364*.
https://doi.org/10.1179/009346997792208140

Reimer P., Bard E., Bayliss A., +27 authors, and van der Plicht J. 2013. INTCAL13 and MARINE13 radiocarbon age calibration curves 0–50,000 years cal BP. *Radiocarbon 55: 1859–1887*.
https://doi.org/10.2458/azu_js_rc.55.16947

Rivero D. 2009. *Ecología de Cazadores-Recolectores del Sector Central de las Sierras de Córdoba (Rep. Argentina)*. BAR International Series 2007. Archaeopress. Oxford.

Rivero D., Pastor S., Truyol G, Medina M., and Agüero M. 2015. Investigaciones Arqueológicas en el Sitio Carrupachina (Dpto. San Alberto, Pcia de Córdoba). Primeros Resultados. *Precirculados de las XI Jornadas de Arqueología y Etnohistoria del Centro-Oeste del País*. Universidad Nacional de Río Cuarto. Río Cuarto.

Rusconi C. 1933. Instrumentos óseos trabajados por indígenas prehispánicos de Santiago del Estero. *Revista de la Sociedad Amigos de la Arqueología VII: 229–250*.

Serrano A. 1945. *Los Comechingones. Serie Aborígenes Argentinos I*. Instituto de Arqueología, Lingüística y Folklore de la Universidad Nacional de Córdoba. Córdoba.

Soressi M., McPherron S., Lenoir M., +11 authors, and Texier J. 2013. Neandertals made the first specialized bone tools in Europe. *Proceedings of the National Academy of Sciences of USA 110 (35): 14186–14190*. https://doi.org/10.1073/pnas.1302730110

Sprovieri M. 2008–2009. Alucinaciones en circulación. Una mirada a la interacción surandina tardía desde las tabletas y tubos de La Paya (valle Calchaquí, Salta). *Anales de Arqueología y Etnología 63–64: 81–105*.

Stone E. 2011. The role of ethnographic museum collections in understanding bone tool use. In J. Baron, B. Kufel-Diakowska (eds.), *Written in Bones. Studies on Technological and Social Contexts of Past Faunal Skeletal Remains*. Uniwersytet Wrocławski. Wrocław: 25–37.

Torrence R. 1983. Time, budgeting and hunter-gatherer technology. In G. Bailey (ed.), *Hunter-Gatherer Economy in Prehistory*. Cambridge University Press. Cambridge: 11–22.

Xie L., Stiner M. 2018. Raw material preferences for scapular tools: evaluating water buffalo age bias in the early Hemudu culture, China. *International Journal of Osteoarchaeology 28(6): 645–655*. https://doi.org/10.1002/oa.2677

Vitezović S. 2011. The Mesolithic bone industry from Kula, eastern Serbia. *Before Farming 3(2): 1–21*. https://doi.org/10.3828/bfarm.2011.3.2

2018. Retouching tools from the post-Palaeolithic period in southeast Europe. In J. Hutson, A. García-Moreno, E. Noack, E. Turner, A. Villanuenga, and S. Gaudzinski-Windheuser (eds.), *The Origins of Bone Tool Technologies*. Römisch-Germanisches Zentralmuseum Leibniz-Forschungsinstitut für Archäologie. Mainz: 297–315.

Vitezović S., Bulatović J. 2013. Managing raw materials in Vinča culture: A case study of osseous raw materials from Vitkovo. *Documenta Praehistorica 40: 279–289*. https://doi.org/10.4312/dp.40.22

Appendix

Tab. 3. Catalogue of the bone tools from Boyo Paso 2.

Bone tool (No.)	Tool type	Context	Max. width (mm)	Max. thick (mm)	Skeletal element	Taxa	Description	Cross-section
BP2-1	waste by-product	Upper floor	33.3	14.2	Proximal humerus	Cathartidae cf. *Cathartes-Coragyps*	End with cut-and-break marks around the circumference of the proximal diaphysis.	
BP2-2	flaker?	Upper floor	13.1	4.5	antler	Cervidae cf. *O. bezoarticus*	Burned tine with the natural tine tip presumably transformed into small. rounded surface, blunt and worn from use.	circular
BP2-3	indeterminate artefact	Upper floor	13.4	3.5	long bone splinter	Macrovertebrate indet	Burned fragment with manufacture traces.	circular
BP2-4	Indeterminate artefact	Upper floor	12.8	1.4	long bone splinter	Macrovertebrate indet.	Burned fragment with manufacture traces.	biplane
BP2-5	waste by-product	Upper floor	15.5	6.5	proximal rib	Cervidae cf. *O. bezoarticus*	Burned fragment of a long-bone cylinder with cut-and-break marks around or near the neck.	
BP2-6	scraper	Lower floor	20	4.5	long bone splinter	Mammalia indet. (medium-large size)	Fragment with a flat-side, beveled, sharp-edged with polished spongy bone on the area affected by wearing and a set of parallel striations running longitudinally to the edge.	
BP2-7	waste by-product	Upper floor	19.1	5.7	long bone	Mammalia indet. (medium-large size)	Burned fragment with cut-and-break and manufacture traces.	plane-convex
BP2-8	smoother	Test-pit 3	38.3	10	rib	Mammalia indet. (medium-large size)	Fragment with an ojival-shaped tip and with the edges of the medial cortical face of the rib scraped. The tip and around the edges were polished by use.	biplane
BP2-9	flaker?	Upper floor	46.9	9.4	antler	Cervidae cf. *O. bezoarticus*	Longitudinal fragment of a tine with the natural tine tip presumably transformed into small, rounded surface, blunt and worn from use.	
BP2-10	flaker?	Upper floor	14	4.5	antler	Cervidae	Longitudinal fragment of a tine with the natural tine tip presumably transformed into small, rounded surface, blunt and worn from use.	
BP2-11	indeterminate artefact	Upper floor	22.5	11.6	unciform	*Lama* sp.	Bone with manufacture or wear traces on one surface.	
BP2-12	indeterminate artefact	Feature of upper floor	19.2	7	cervical	Cervidae	Burned fragment with manufacture or wear traces.	
BP2-13	flaker	Upper floor	18.6	2.2	long bone splinter	Macrovertebrate indet.	Burned fragment of a blunt point with manufacture and wear traces on active end.	
BP2-14	flaker	Upper floor	20.7	4.2	long bone splinter	Macrovertebrate indet.	Burned fragment of a blunt point with manufacture and wear traces on active end.	
BP2-15	indeterminate artefact	Upper floor	10.7	1.8	long bone splinter	Vertebrate indet.	Burned fragment with manufacture trace.	
BP2-16	″	Upper floor	10.8	1.9	long bone splinter	Mammalia indet.	Burned fragment with manufacture traces.	
BP2-17	″	Upper floor	17.6	3	long bone splinter	Macrovertebrate indet.	Fragment with oblique manufacture traces.	

BP2-18	spatula	Upper floor	20.4	2.3	long bone splinter	Macrovertebrate indet.	Burned distal-lateral active end fragment with polished surface.	biplane
BP2-19	Pin-like tool	Test-pit 4	16	2.8	long bone splinter	Macrovertebrate indet.	Burned fragment of tip with use-wear traces.	circular
BP2-20	Pin-like tool	Test-pit 4	23	1.5	long bone splinter	Vertebrate indet.	Fragment of tip with manufacture and use-wear traces.	plane-concave
BP2-21	indeterminate artefact	Test-pit 3	8.8	3	long bone splinter	Macrovertebrate indet.	Burned fragment with manufacture traces.	
BP2-22	waste by-product	Test-pit 3	19.2	13.3	distal first phalanx	*Lama* sp.	End with cut-and-break marks around the circumference of the distal diaphysis.	
BP2-23	indeterminate artefact	Test-pit 3	75.5	6.5	radius-ulna	*Lama* sp.	Diaphysis splinter with manufacture traces.	
BP2-24	pin-shaped subtype spatula	Feature of upper floor	35.3	3.9	long bone splinter	Macrovertebrate indet.	Burned fragment finely polished with decorative lateral fins (presumably shaped like animals) and incised decoration, mainly circles, triangles and dots made on a positive relief.	biplane
BP2-25	pin-shaped subtype spatula?	Test-pit 3	14.3	1.8	long bone splinter	Mammalia indet. (medium-large size)	Burned fragment with incised decoration, mainly circles and dots made on a positive relief.	
BP2-26	″	Upper floor	10.5	1.6	long bone splinter	Mammalia indet. (medium-large size)	Fragment with incised decoration, mainly circles and dots made on a positive relief.	
BP2-27	″	Upper floor	13.4	2	long bone splinter	Mammalia indet.	Fragment with incised decoration, mainly circles and dots made. on a positive relief.	
BP2-28	″	Upper floor	14.2	1.9	long bone splinter	Mammalia indet. (medium-large size)	Burned fragment with incised decoration, mainly circles and dots made on a positive relief.	
BP2-29	projectile point	Feature of the upper floor	15	1.5	long bone splinter	Macrovertebrate indet.	Burned fragment of the edge of the blade with manufacture traces.	plane-concave
BP2-30	indeterminate artefact	Feature of the upper floor	19.4	1.9	long bone splinter	Mammalia indet. (medium-large size)	Burned fragment with manufacture traces.	
BP2-31	indeterminate artefact	Feature of the upper floor	28.1	2.7	rib	Mammalia indet. (medium-large size)	Fragment with manufacture and use-wear traces.	
BP2-32	scraper	Upper floor	12.1	2.5	long bone splinter	Vertebrate indet.	Fragment with a beveled and polished by use edge.	plane-concave
BP2-33	indeterminate artefact	Upper floor	9	2.3	long bone splinter	Mammalia indet.	Burned fragment with manufacture and use-wear traces.	biplane
BP2-34	″	Upper floor	7.3	4	axial bone	Mammalia indet.	Fragment with manufacture and use-wear traces.	
BP2-35	″	Upper floor	13.2	2.1	long bone splinter	Mammalia indet	Burned fragment with manufacture and use-wear traces.	
BP2-36	″	Lower floor	18.2	3.3	long bone splinter	Macrovertebrate indet.	Fragment with manufacture traces.	biplane
BP2-37	flaker?	Feature of the upper floor	34.3	10	antler	Cervidae cf. *O. bezoarticus*	Fragment of a tine with the natural tine tip presumably transformed into small, rounded surface, blunt and worn from use.	
BP2-38	indeterminate artefact	Feature of the upper floor	14.3	1.1	long bone splinter	Vertebrate indet.	Fragment with manufacture traces.	
BP2-39	″	Upper floor	17.7	2.9	long bone splinter	Macrovertebrate indet.	Burned fragment with oblique manufacture traces.	biplane

Bone tool (No.)	Tool type	Context	Max. width (mm)	Max. thick (mm)	Skeletal element	Taxa	Description	Cross-section
BP2-40	indeterminate artefact	Upper floor	12.6	3.7	long bone splinter	Macrovertebrate indet.	Burned fragment with manufacture traces.	plane-concave
BP2-41	indeterminate artefact	Upper floor	84.2	4.5	rib	Cervidae cf. *O. bezoarticus*	Fragment with manufacture traces.	
BP2-42	indeterminate artefact	Upper floor	14.4	3.1	long bone splinter	Mammalia indet. (medium-large size)	Fragment with manufacture and use-wear traces.	
BP2-43	spatula	Upper floor	16.4	2.3	long bone splinter	Macrovertebrate indet.	Fragment of a distal active end with manufacture traces.	plane-concave
BP2-44	indeterminate artefact	Upper floor	13.4	1.7	long bone splinter	Mammalia indet.	Fragment with manufacture traces.	
BP2-45	flaker	Upper floor	18.7	4	long bone splinter	Macrovertebrate indet.	Fragment of a blunt tip with manufacture and use-wear traces.	
BP2-46	indeterminate artefact	Upper floor	9.6	3.9	long bone splinter	Macrovertebrate indet.	Fragment with manufacture traces.	plane-convex
BP2-47	indeterminate artefact	Feature of the upper floor	20	1.4	long bone splinter	Vertebrate indet.	Fragment with manufacture and use-wear traces.	
BP2-48	scraper	Upper floor	14.5	5.4	long bone splinter	Mamifero indet.	Fragment with a flat-side, beveled, sharp-edged with polished spongy bone on the area affected by wearing and a set of parallel striations running longitudinally to the edge.	convex-concave
BP2-49	waste by-product	Upper floor	28.9	24.6	proximal metatarsal	*Lama* sp.	Longitudinal fragment of a proximal end and diaphysis (caudal side) with longitudinal-transverse grooves and manufacture traces.	
BP2-50	indeterminate artefact	Upper floor	11.6	1.6	long bone splinter	Vertebrate indet.	Burned fragment with manufacture traces.	
BP2-51	waste by-product	Upper floor	41.5	14.8	First phalanx	*Lama* sp.	Nearly complete diaphysis with cut-and-break marks around the circumference of the distal epiphysis.	
BP2-52	indeterminate artefact	Feature of the upper floor	28.4	3	long bone splinter	Macrovertebrate indet.	Fragment with manufacture traces.	
BP2-53	indeterminate artefact	Feature of the upper floor	9	4.2	long bone splinter	Macrovertebrate indet.	Burned fragment with rounded contour and polished surfaces.	biplane
BP2-54	awl	Upper floor	24.6	13	malleolus	*Lama* sp.	Fragment with manufacture traces (scraped marks).	
BP2-55	indeterminate artefact	Upper floor	13	4.7	long bone splinter	Macrovertebrate indet	Burned fragment with manufacture traces.	plane-convex
BP2-56	projectile point	Upper floor	13	2.7	long bone splinter	Macrovertebrate indet.	Burned fragment of a blade with manufacture traces.	biplane
BP2-57	indeterminate artefact	Upper floor	12.2	3.7	long bone splinter	Macrovertebrate indet.	Burned fragment with oblique manufacture traces.	
BP2-58	notched bone tool	Upper floor	140.1	49.2	scapula	*Lama* cf. *L. Guanicoe*	Fragment of the posterior border with cut-marks and fifteen closely spaced notches incised on the infraspinatous fossa.	
BP2-59	indeterminate artefact	Upper floor	11.2	2.8	long bone splinter	Macrovertebrate indet.	Polished fragment with manufacture traces.	

BP2-60	indeterminate artefact	Upper floor	25.9	11.9	long bone splinter	Mammalia (medium-large size)	Polished fragment with manufacture traces.	
BP2-61	indeterminate artefact	Upper floor	16.3	11.3	long bone splinter	Mammalia indet. (medium-large size)	Polished fragment with manufacture traces.	biplane
BP2-62	″	Upper floor	22.2	10.5	hueso axial	″	Polished fragment with manufacture traces.	
BP2-63	indeterminate artefact	Upper floor	15.5	4.5	long bone splinter	Mammalia indet. (medium-large size)	Fragment with manufacture and use-wear traces.	plane-convex
BP2-64	″	Upper floor	6.1	1.5	long bone splinter	″	Burned fragment with manufacture traces.	biplane
BP2-65	″	Upper floor	5.3	1.1	long bone splinter	Vertebrate indet.	Burned fragment with manufacture traces.	
BP2-66	″	Test-pit 4	28.3	7.7	long bone splinter	Macrovertebrate indet.	Fragment with manufacture traces.	
BP2-67	″	Test-pit 4	19.5	4.8	long bone splinter	Macrovertebrate indet.	Fragment with manufacture and use-wear traces.	
BP2-68	″	Test-pit 4	8	1.8	long bone splinter	Mammalia indet.	Burned fragment with manufacture traces.	
BP2-69	″	Test-pit 4	17.3	6.4	long bone splinter	Mammalia indet.	Fragment with manufacture and use-wear traces.	
BP2-70	indeterminate artefact (mastic)	Upper floor	23.8	6	Distal radius	Cathartidae cf. Cathartes-Coragyps	Diaphysis splinter with mastic residues.	
BP2-71	indeterminate artefact	Upper floor	22.4	11.8	Apendicular bone	Mammalia indet. (medium-large size)	Fragment with manufacture traces.	
BP2-72	indeterminate artefact	Test-pit 3	18.2	9.3	long bone splinter	Macrovertebrate indet.	Burned fragment of a blunt tip with oblique manufacture traces and shiny surface.	
BP2-73	″	Upper floor	16	4.3	long bone splinter	Mammalia indet.	Fragment with manufacture and use-wear traces.	
BP2-74	″	Upper floor	29.8	19.6	metacarpal	*Lama* sp.	Burned longitudinal end fragment with manufacture traces.	
BP2-75	indeterminate artefact	Upper floor	9	3	long bone splinter	Mammalia indet. (medium-large size)	Fragment with transversal grooves and manufacture traces.	biplane
BP2-76	″	Upper floor	14.4	2	long bone splinter	Mammalia indet.	Fragment with manufacture and use-wear traces on the spongy bone.	
BP2-77	″	Upper floor	9	1.9	long bone splinter	Vertebrate indet.	Burned fragment with manufacture traces.	
BP2-78	projectile point	Upper floor	9.9	2.6	long bone splinter	Macrovertebrate indet.	Burned mesial-lateral fragment of the blade with manufacture traces.	
BP2-79	scraper	Upper floor	42.6	15	long bone	Mammalia indet. (medium-large size)	Burned fragment with use-wear traces along the edge of the diaphysis and trabecular bone.	
BP2-80	indeterminate artefact	Upper floor	11	5.2	long bone splinter	Macrovertebrate indet.	Burned fragment with manufacture traces.	circular
BP2-81	projectile point	Lower floor	11.4	2.1	long bone splinter	Macrovertebrate indet.	Fragment of a straight stem with a serrated edge.	
BP2-82	projectile point	Upper floor	15.8	2.3	metapodium	Cetartiodactyla cf. Camelidae-Cervidae	Fragment of a straight stem with a serrated edge and manufacture traces.	
BP2-83	waste by-product	Upper floor	24.3	15.4	Proximal radius	Cathartidae cf. *Vultur*	End with cut-and-break marks around the circumference of the proximal diaphysis.	
BP2-84	indeterminate artefact	Upper floor	33.8	4	long bone splinter	Macrovertebrate indet.	Burned fragment with manufacture traces.	
BP2-85	scraper	Upper floor	13.4	1.7	long bone splinter	Mammalia indet.	Burned fragment with a slightly beveled edge affected by wearing.	
BP2-86	spatula	Lower floor	60	3.7	long bone splinter	Macrovertebrate indet.	Distal active end fragment with manufacture and use-wear traces.	
BP2-87	indeterminate artefact	Upper floor	23	5	long bone splinter	Macrovertebrate indet.	Burned fragment with manufacture traces.	