

Bone industry management in the Upper Paleolithic occupations at El Cierro Cave (Ribadesella, Asturias, Spain)

L'industrie osseuse des occupations du Paléolithique supérieur de la grotte El Cierro (Ribadesella, Asturies, Espagne)

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Abstract: Although the production of artifacts from hard animal materials is considered an essential activity in subsistence strategies during the Upper Palaeolithic of SW Europe, the study of the bone industry of the El Cierro sequence shows an unequal proportion in the number of remains and in the complexity of the operational chains put into practice throughout the different periods. This study shows a turning point from the Lower Magdalenian, a period in which a clear increase is observed both in the number of elements and in the technical procedures carried out within the site. However, neither during the Lower Magdalenian nor during previous periods are there any planned operations aimed at the regular acquisition of bone raw materials, which leads us to reflect on the strategic nature of this technology throughout the Upper Palaeolithic sequence.

Keywords: Osseous industry, *chaîne opératoire*, technology, antler, Upper Palaeolithic, Magdalenian, Cantabrian Region.

Résumé : Bien que la production d'objets à partir de matériaux durs d'origine animale soit considérée comme une activité essentielle dans les stratégies de subsistance du Paléolithique supérieur du sud-ouest de l'Europe, l'étude de l'industrie osseuse de la séquence d'El Cierro (Asturies, Espagne) met en avant une proportion inégale entre nombre de vestiges et la complexité des chaînes opératoires mises en œuvre au cours des différentes périodes.

La grotte El Cierro, située au nord de la péninsule Ibérique, dans la moitié occidentale de la région cantabrique, est un site classique de la séquence régionale du Paléolithique supérieur. Elle contient une succession de couches du Solutréen et du Magdalénien inférieur, et forme un ensemble cohérent avec les sites proches, autour de l'embouchure du fleuve Sella, qui contiennent des occupations allant du Moustérien au Mésolithique.

Cette étude analyse les vestiges des niveaux attribués à l'Aurignacien, au Solutréen et au Magdalénien inférieur, et met en avant un tournant au cours de cette dernière période, pendant laquelle on observe une nette augmentation en nombre des vestiges et des procédés techniques mis en œuvre. Cependant, ni au Magdalénien inférieur ni au cours des périodes antérieures, il n'existe d'opérations planifiées visant l'acquisition régulière de matières premières osseuses, ce qui nous amène à réfléchir sur le caractère stratégique de cette industrie osseuse au long de la séquence du Paléolithique supérieur.

Pour l'évaluer, il est nécessaire de procéder à une analyse des séquences de production, afin de pouvoir établir : 1) si elles sont planifiées et comment elles sont exécutées – de manière concaténée ou hiérarchique – en relation avec d'autres tâches de subsistance, et 2) comment les activités s'organisent dans le temps et dans l'espace au sein des stratégies de mobilité de ces chasseurs-cueilleurs.

En plus d'être indispensable pour abattre les proies, le caractère stratégique de la production de projectiles en bois de cervidé pour la survie des groupes de chasseurs-cueilleurs est démontré par la récurrence, l'abondance et la variété des types et des spécimens. Cepen-

dant, la disponibilité et l'acquisition des matières premières nécessaires ne sont pas constantes, elles semblent variables dans le temps et dans l'espace, ce qui pourrait introduire un degré élevé d'incertitude lors de la planification de leur production. Dans le cas au Magdalénien inférieur d'El Cierro, les vestiges analysés suggèrent la présence de deux chaînes opératoires différentes, qui sont réalisées sur le site à la fois à partir de bois de cerf de massacre et à partir de supports préformés importés.

Nous considérons que cela pourrait traduire une anticipation des besoins en matières premières, compte tenu du caractère stratégique de ces productions. Dans le cas d'El Cierro, cela se matérialise dans la combinaison entre une production immédiate d'objets à la suite de l'acquisition des bois et la constitution d'une réserve de supports pour une transformation différée.

Mots-clés : industrie osseuse, chaîne opératoire, technologie, bois de cerf, Paléolithique supérieur, Magdalénien, région cantabrique.

INTRODUCTION

The production of objects and tools in hard materials of animal origin has been an essential aspect for the periodization of the Upper Palaeolithic in southwestern Europe, and its generalization is considered an adaptive advance typical of Anatomically Modern Humans (Blackwell and d'Errico, 2005; Tejero et al., 2011). This versatile and efficient technology allowed them to produce a varied range of utensils and weapons, as well as strengthen their social and symbolic cohesion through decorated objects, ornaments and sound instruments.

Although the production of artifacts in hard animal materials has been carried out systematically since the beginning of the Upper Palaeolithic, it is during the Magdalenian where a notable increase of bone industries occurs, which is evident by the abundance and variety of tools, by the diversity of raw materials and techniques used, and for its greater use as a support for decorative and artistic expressions (Aura et al. 2012; Langley et al., 2016).

In this way, the recurrence of this production highlights its importance among the subsistence tasks of the hunter-gatherer groups of the Upper Palaeolithic, and its continuous development shows a progressive transformation into a strategic aspect for their survival.

To evaluate the socioeconomic importance of these industries, it is necessary to carry out an analysis of the production sequences, so that we can establish: i) how they are planned and executed in a concatenated or hierarchical manner with other subsistence tasks, and ii) how the activities are organized over time and space within the mobility strategies of these hunter-gatherers.

In this article we present the study of the bone operational chains identified throughout the sequence of occupations recorded in the El Cierro cave (Asturias, Spain). The sample includes materials from the Aurignacian, Solutrean and Lower Magdalenian, and allows us to assess the importance of bone production and its degree of development in the context of each occupation.

The El Cierro cave is located in the north of the Iberian Peninsula, in the western half of the Cantabrian Region (fig. 1). It is a classic site in the regional Upper Palaeolithic sequence, particularly for housing a succession of layers from the Solutrean and Lower Magdalenian, and for forming a coherent group of nearby sites that host occupations from the Mousterian to the Mesolithic

around the mouth of the Sella River (Tito Bustillo, Les Pedroses, La Lloseta, El Cierro and Cova Rosa). El Cierro was excavated for the first time by F. Jordá Cerdá in 1959 and the materials from this site were studied by various specialists for their respective regional syntheses (Bernaldo de Quirós, Aurignacian; Strauss, Solutrean; Utrilla, Magdalenian; Clark, Mesolithic; Adán, bone industry). A later excavation was carried out between 1976 and 1979 by F. Jordá Cerdá and A. Gómez Fuentes, and between 2014 and 2019, E. Álvarez-Fernández and J. Jordá Pardo led new interventions to review the stratigraphic sequence of El Cierro, carry out a topographic record of the cavity and the profiles of the excavations (fig. 1), and study of all the archaeological materials recovered in the excavations of the 1970's.

As a result, 14 sedimentary units have been determined that span from the end of the Pleistocene to the beginning of the Holocene, and that host human occupations of variable intensity (Jordá-Pardo et al., 2024), from the Mousterian (Cierro N), Aurignacian (Cierro M and Cierro L), Gravettian (Cierro K, Cierro J2, Cierro J1, and Cierro I), Upper Solutrean (Cierro H1 and Cierro H2), Lower Magdalenian (Cierro G1, Cierro G, Cierro F, and Cierro E), Azilian (Cierro D and Cierro C) and Mesolithic (Cierro B).

1. MATERIALS AND METHODS

The remains of bone industry recovered in El Cierro come from the Aurignacian, Solutrean and Magdalenian occupations, and although they are characteristic materials of each period, the representativeness and abundance of the Aurignacian and Solutrean materials is too scarce to draw detailed technological conclusions (table 1). However, we consider that, at least for a general comparison, some aspects related to the phases of the operational chains and the types of raw materials represented in each case can be specified.

The sample studied here includes all remains identified as waste products, blanks and artifacts of bone, teeth or ivory and antler, which have been examined for technical traces with a 20× binocular lens (Leica EZ4 HD) and a PCE-MM200 USB microscope.

Technological traces have been interpreted as the basic mechanic actions performed on the osseous materials and then grouped in sequences of actions organized

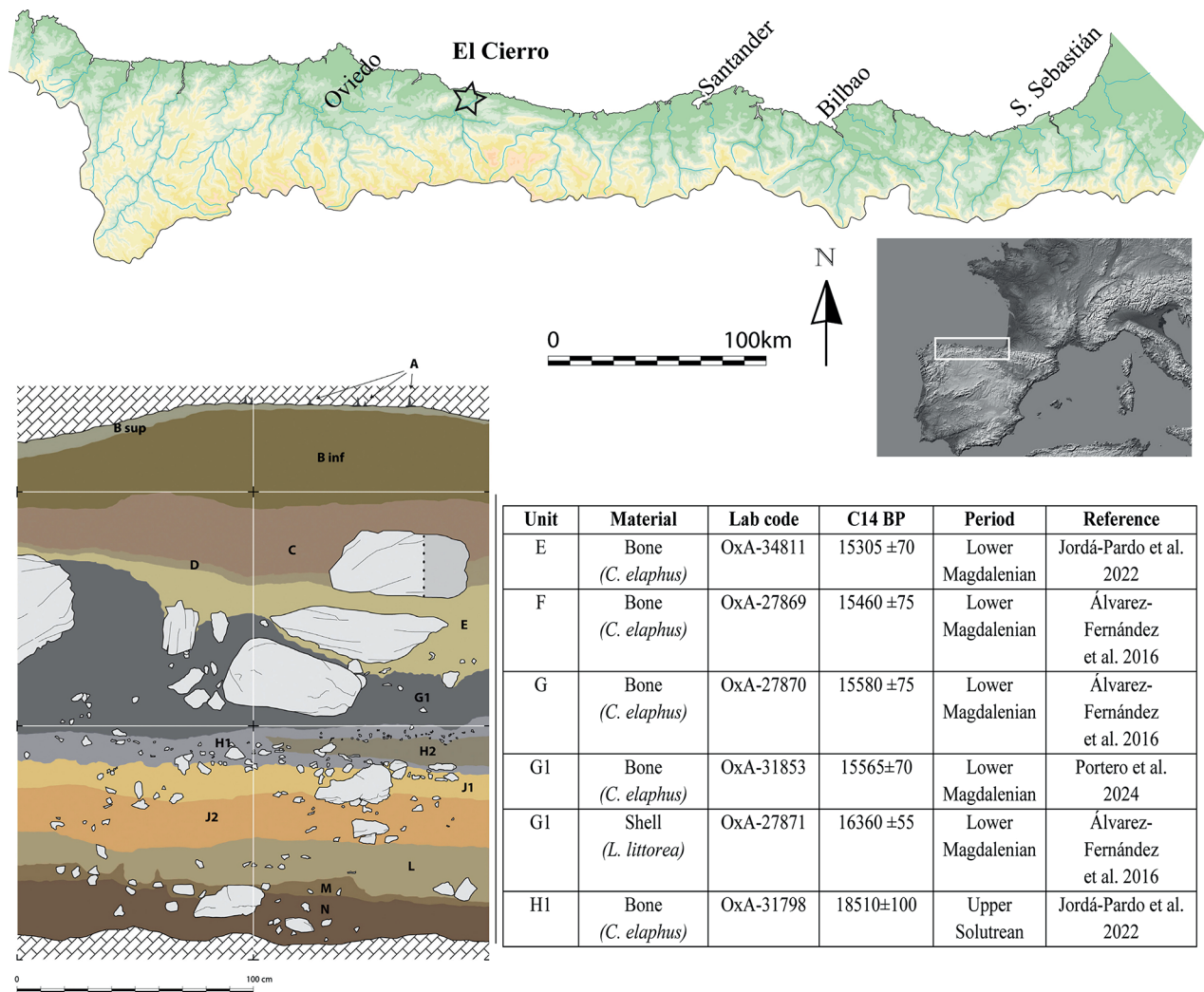


Fig. 1 – Location, stratigraphic sequence (northern section) and C14 dates of Solutrean and Lower Magdalenian layers of El Cierro cave (Álvarez-Fernández et al., 2016 and 2018).

Fig. 1 – Localisation, séquence stratigraphique (coupe nord) et dates C14 des couches du Solutréen et du Magdalénien inférieur de la grotte El Cierro (Álvarez-Fernández et al., 2016 et 2018).

according to their overlap and succession within the manufacturing process (Mujika, 1983 and 1990; Goutas, 2003 and 2009; Pétilion and Ducasse, 2012; Baumann and Maury, 2013; Averbough et al., 2016; Goutas and Tejero, 2016).

Conceptually, operations are organized into successive transformation phases, the results of which determine subsequent action possibilities. Therefore, analysing operation sequences makes it possible to determine production objectives and priorities (Inizan et al., 1999; Goutas and Tejero, 2016). As in the case of lithics, the order in which operations must occur is determined by their practical consequences on the dimensions and state of the materials, which also allows us to distinguish which are the priority objectives in complex operational chains (Soressi and Geneste, 2011).

Finally, although the transformation of the antler responds exclusively to technical objectives (Tejero et al., 2011), the operational chains carried out on bones and teeth may be conditioned by the way in which the animals

are processed for the food consumption, an issue that has been considered here to assess the strategic nature of these productions.

2. RESULTS AND DISCUSSION

2.1. Osseous industries from Lower Magdalenian layers (NR = 318)

The Lower Magdalenian occupations include levels Cierro F, Cierro G and Cierro G1, in addition to Cierro E, which has not provided remains of bone industry. Cierro G and Cierro G1 are two continuous sedimentary deposits with a similar texture, which were only differentiated by the intercalation between them of Cierro F, a sedimentary pocket of reduced extent that is not preserved in the current section. The C14 dating and the characteristics observed in the materials allowed us

Type	Lower Magdalenian				Solutrean				Aurignacian			
	Antler	Bone	Tooth	Ivory	Antler	Bone	Tooth	Ivory	Antler	Bone	Tooth	Ivory
Point	38	-	-	-	4	-	-	-	1	2	-	-
Awl	3	3	-	-	-	2	-	-	-	-	-	-
Needle	-	3	-	-	-	-	-	-	-	-	-	-
Ch/W	1	4	-	-	-	-	-	-	-	-	-	-
HRR	1	-	-	-	-	-	-	-	-	-	-	-
Scraper	-	2	-	-	-	-	-	-	-	-	-	-
Compr.	-	1	-	-	-	-	-	-	-	-	-	-
Ornam	-	7	3	-	-	2	-	-	-	-	-	-
Waste	34	-	-	-	-	-	-	-	-	-	-	-
Matrix	-	2	-	-	-	-	-	-	-	-	-	-
Blank	8	-	-	-	1	-	-	-	-	-	-	-
No det.	208	-	-	-	8	-	-	-	-	-	-	1
TOTAL	293	22	3	0	13	4	-	-	1	2	-	1

Table 1 – Osseous remains from El Cierro. Abbreviations: Ch/W = chisels/wedges; HRR = half-round rods; Compr = pressure flakers; Ornam = ornaments (including decorated bones and personal adornments). Waste products include tines, beam fragments, and other discarded fragments.

Tabl. 1 – Restes osseux d'El Cierro. Abréviations : Ch/W = coins/ciseaux ; HRR = baguettes demi-rondes ; Compr = compresseurs ; Ornam = ornements (y compris les os décorés et les parures personnelles). Les déchets comprennent des andouillers, des fragments de merrain et d'autres fragments rejetés.

to examine the three levels as a coherent set in a previous study (Tapia et al., 2018).

Cierro F has provided 42 osseous remains, and Cierro G and Cierro G1, 276 remains, including artifacts and technological waste in bone and antler (fig. 2), and ornaments and mobile art in bone and teeth (fig. 3).

The archaeofaunal study conducted by Portero et al. (2024) places the red deer as the most hunted animal (91.2%) in the Magdalenian periods, and all age ranges are represented. However, the significant presence of infant and juvenile individuals suggests that the primary hunting target was herds of females with calves during the spring and summer. Although cranial fragments are represented at the site, only two bone pedicles are preserved, and no shed antlers have been found.

2.1.1. Antler (*C. elaphus*, $NR = 293$)

Most of the finished artifacts from layers Cierro F to Cierro G1 (fig. 2) correspond to fragments of spear points obtained from red deer antler (7 from Cierro F and 31 from Cierro G + Cierro G1), accompanied by a half-round rod and three pointed objects that, due to their small size, we interpret as awls. The other two artefacts are a beveled tool made from a tine and a hollowed-out beam fragment.

The presence of tines ($N = 15$) reveals that antlers were fractured and prepared as blocks of raw material at the site, and two pedicles with cut marks reveal that at least some of the antlers were acquired by hunting.

Although a high number of small antler fragments could not be determined ($N = 208$), among the production waste we found 18 fragments of rods that we relate

to the trimming of blanks during their configuration as points.

In the El Cierro sequence, supports ($N = 8$) were extracted using a combination of techniques (double-grooving procedure [DGP], percussion, splitting). However, the presence of wide supports is striking ($N = 3$), as their transformation into tools requires thinning by scraping or splitting by grooving from the ventral surface or in a bipolar manner. Some of the trimmed remains also show evidence of having been grooved bipolarly or from the ventral side, suggesting their origin from previously wider rods.

Thus, the extraction of these large rods is not directly followed by a phase of transformation into tools, but rather it is necessary to carry out a second extraction of blanks to make the artifacts. In a previous study (Tapia et al. 2018) we pointed out the possibility that these particular procedures were aimed at achieving blanks of adequate thickness to obtain thick square-section points. The average width of the largest points is 9 mm and the thickness is 8 mm, while these large rods have widths between 27 and 54 mm and thicknesses between 7 and 14 mm.

Although we continue to consider this hypothesis plausible, a review of the entire set now leads us to point in another direction. We suggest that these large supports may be blocks of raw material intended for deferred use, since between extraction and configuration an intermediate step is inserted.

In any case, in the Magdalenian layers of El Cierro all the steps of a production sequence are represented from the acquisition of raw material (through hunting), its fracturing, the extraction of blanks and their transformation into tools, and the final abandonment of these.

However, since these sequences are developed from antlers obtained from hunting male deer, it is not possible to foresee a constant and secure source of raw material supply, but this uncertainty can be resolved by prepar-

ing and storing materials in versatile and transportable formats. In this way, technological needs can be satisfied by combining both opportunistic and forward-looking strategies.

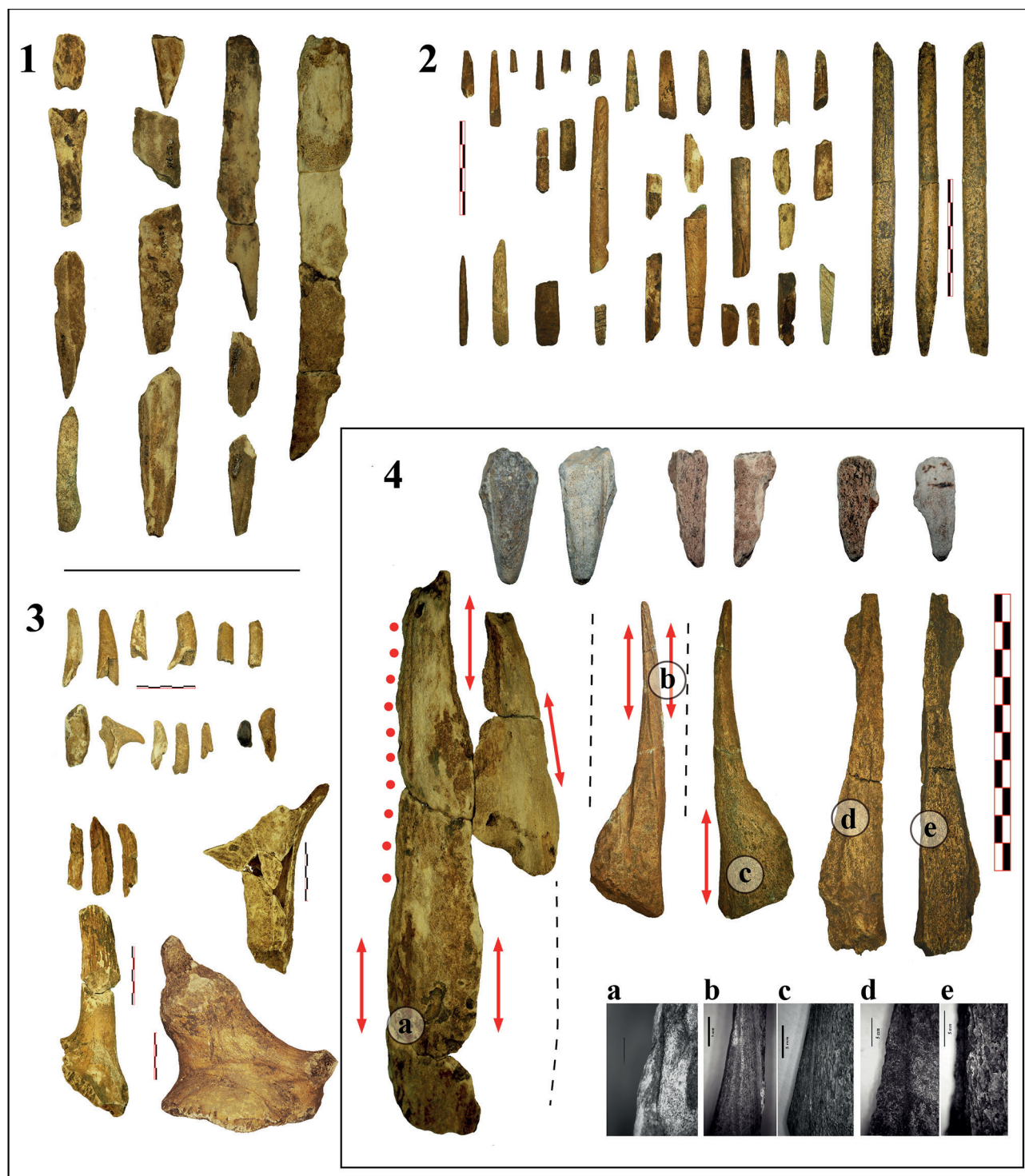


Fig. 2 – Red deer antler remains from Lower Magdalenian layers of El Cierro: 1) Rods and offcuts; 2) Proximal, medial and distal fragments of red deer antler points; 3) Pedicles, beam fragments and tines; (4) Wide rods and offcuts worked on both sides or from the spongy side. Arrows indicate grooving and dots indicate percussions.

Fig. 2 – Restes de bois de cerf provenant des couches du Magdalénien inférieur d'El Cierro : 1) baguettes et fragments travaillés ; 2) fragments proximaux, médiaux et distaux de pointes en bois de cerf ; 3) pédicules, fragments de merrain et andouillers ; 4) baguettes larges et déchets travaillés des deux côtés ou du côté spongieux. Les flèches indiquent du rainurage, et les points indiquent des percussions.

2.1.2. Bone and teeth (NR = 25)

Bone and teeth artifacts from the Lower Magdalenian in El Cierro (fig. 3) are scarce and show relatively short or poorly developed transformation processes. Despite the set includes ornaments and portable art the most developed productions relate to functional artefacts as awls and needles. Needles are represented by three fragments and two matrices, and in the case of the awls, three fragments and another broken in the process of being made have been recovered.

Other tools for common use are two side-scrapers, four wedges and a hammer, all of them made on bone splinters using percussion. In all cases, the phases of acquiring raw materials, obtaining supports and configuring them as tools are represented within the site. Due to their degree of transformation and their size, it is not possible to determine what species of fauna or what type of bone they come from, but they are compatible with the main species represented at the site, especially the red deer.

The ornaments are three pierced ibex and deer teeth, and the art or decorated elements are two bone splinters with engraved oblique lines, a deer metapodia with incised grooves on one of the condyles, and four deer scapula fragments with striated motifs.

In summary, the selection of certain anatomical parts is only observed for the elaboration of ornamental elements characteristic of this period in the region, such as scapulae with striated engravings and ornaments on herbivore teeth (Álvarez-Fernández et al., 2016; Straus et al., 2019). Both the production of instruments that can be related to everyday tasks and that of objects endowed with symbolic meaning are carried out using poorly developed procedures, they adapt to the available material formats, and they do not interfere with the processing of animals for food consumption, since they do not require variations in the usual butchery procedures.

2.2. Osseous industries from the Solutrean layer (NR = 17)

The Solutrean layer Cierro H1 has provided a small set of 17 remains, which include four tools, one production waste and eight indeterminable remains on antler, and two tools and two decorated elements on bone (fig. 4).

The antler instruments are four medial and distal fragments of spear points, uncharacteristic from a typological point of view, accompanied by a rod with traces of grooves on the sides, and eight antler fragments of small indeterminate size. On bone, two fragments of flat awls, and two splinters decorated with lines have been recovered.

Despite the scarcity of remains, a preference for antlers is observed in El Cierro to make projectile points, relegating the bone to the production of everyday utensils and as a support for decorations. As in the Magdalenian assemblage, bone products do not interfere with food processing, while antler products seem to correspond to previously prepared tools and a small reserve of raw materials carried into the site.

2.3. Osseous industries from Aurignacian layers (NR = 4)

The osseous materials from the Aurignacian layers of El Cierro are only four elements, which however concentrate very characteristic features of this period (fig. 5). On the one hand, among the raw materials we find deer antler, bone and ivory, and on the other hand, among the projectiles we find two of the characteristic types of this period: a possible fragment of flattened spear point made of antler, and a split-based point in bone. A double-pointed object made of bone has also been found. The ivory object consists only of a fragment without technological traces, which only attests to the acquisition of this variety of raw material.

In the case of the split-based point made of bone, two grooves have been made on its sides to guide the split on its base. Tejero et al. (2011) have pointed out that the split base points are commonly made from thick antler blanks, so that the split can be made avoiding the risk of fracture. In this case, the lateral grooves carved on both side in the proximal end may be due to the need to guide the split on a more rigid and thinner blank of bone.

Finally, with regard to the operational chains, we see that in this case only finished objects are incorporated and there is no evidence of production at the site.

2.4. A comparison of the operational sequences

As we have indicated previously, the approach of this work is to reconstruct the osseous productions of the different layers and assess their strategic role by examining their degree of planning, the complexity of their organization and their articulation with other fundamental tasks for subsistence throughout the time.

The production chains of tools and decorated or ornamental objects in bone and teeth show an increase in the Magdalenian, but can be traced earlier throughout the sequence, adapting to the formats and anatomical portions resulting from food processing. Despite the increase in the production of bone objects for everyday use, the technical procedures are simple and a greater technical effort is only observed in the application of the grooving technique to produce needles and awls, while projectile points are no longer made in bone.

Considering hunting as the main subsistence task among hunter-gatherers, the use of projectile points on hard materials of animal origin appears as an essential aspect in all layers, even during the Solutrean, a period in which stone flat-retouched points predominate (Sonneville-Bordes, 1966; Straus, 2012; Álvarez-Fernández et al., 2019).

We see that during the Aurignacian these points were made of various types of material and that they were imported as finished tools, without evidence of having been produced at the site.

In the case of the split-based point, it is observed that the techniques for its production are adapted to the nature

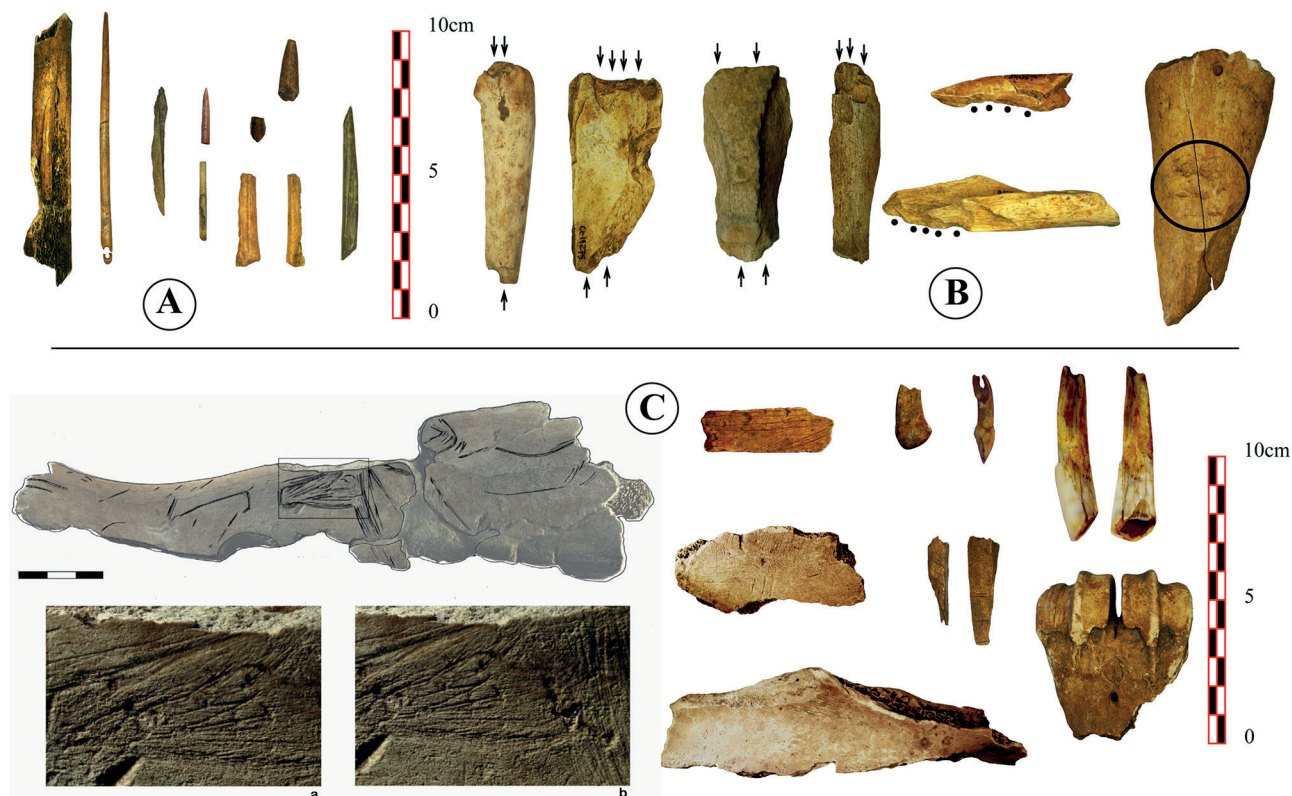


Fig. 3 – Bone and teeth objects from Lower Magdalenian layers of El Cierro: A) Needles, matrices and awls; B) Unworked bones used as intermediate tools, side-scrapers and hammer/pressure flaker (active parts are respectively indicated by arrows, dots and a circle); C) Engraved scapula fragments, decorated bone splinters, grooved metapodia, teeth ornaments (engraved hind from Álvarez-Fernández et al., 2016).

Fig. 3 – Objets sur os et dents provenant des strates du Magdalénien inférieur d'El Cierro : A) aiguilles, matrices et poinçons ; B) fragments d'os bruts utilisés comme outils intermédiaires, racloirs et percuteur et/ou compresseur (les parties actives sont respectivement indiquées par des flèches, des points et un cercle) ; C) fragments d'omoplate gravés, fragments d'os décorés, métapode rainuré, dents percées (biche gravée d'après Álvarez-Fernández et al., 2016).



Fig. 4 – Antler and bone objects from Upper Solutrean layer of El Cierro: A) Fragments of antler points and red deer antler rod; B) Distal fragments of bone awls; C) Bone splinters with engravings.

Fig. 4 – Objets en bois et en os de la couche du Solutrén supérieur d'El Cierro : A) fragments de pointes de sagaies et baguette en bois de cerf ; B) extrémités distales de poinçons en os ; C) éclats d'os avec traits de gravure.



Fig. 5 – Bone, antler and ivory fragment from Aurignacian layers of El Cierro: A) Possible flat-section spear point in antler; B) Ivory fragment; C) Fragment of a split based point in bone; D) Double point in bone.

Fig. 5 – Objets en os et en bois de cerf, et fragment d'ivoire provenant des couches aurignaciennes d'El Cierro : A) possible pointe de sagaie à section ovale en bois de cerf ; B) fragment d'ivoire ; C) fragment de pointe à base fendue en os ; D) outil à pointe double en os.

and characteristics of the material used, which suggests a lower investment of effort in the selection and formal preparation of blanks than in their shaping as tools.

For the Solutrean, the phases of acquisition, fracturing and extraction of blanks are not present in the deposit. The projectile points seem to arrive at the site previously finished and accompanied by a small reserve of raw material, which, together with the few indeterminate remains, suggests that replacement and perhaps configuration of new points took place at the site. Although a certain degree of foresight may be suggested, the production of antler points still seems poorly systematized, taking into account the formal characteristics of the tools and the rod.

Finally, for the Magdalenian, a full exploitation of antlers for the production of projectile points is observed, with well-established procedures that include the use of waste products in other secondary production sequences. The evidence from El Cierro shows at least the presence of a complete sequence that begins with the acquisition of antlers through hunting, to which another sequence is probably added from the exploitation of reserves of raw material in the form of large rods.

The dimensions of most Magdalenian rods from El Cierro are compatible with the extraction and sub-

sequent shaping of points at the site. Some rods and trimmed fragments exhibit a regularized spongy portion, which may represent a prior preparation of the supports or correspond to the beginning of the shaping phase of the tools. However, the main effort in this shaping phase is the reduction and adjustment of the compact portion of the shaft, which is mechanically stronger than the spongy portion and occupies three of the four sides of the supports.

In contrast to this model compatible with continuous production at site, some of the remains suggest the coexistence of an alternative model, which we interpret as corresponding to a deferred exploitation of blanks.

Three of the rods are much wider than the expected final products, making it necessary to split or trim them longitudinally before shaping them into points. This implies that the tool width is not predetermined during the extraction phase. Furthermore, two of these rods and some offcuts have a regularized spongy portion, and there is evidence of subsequent scraping and grooving from the upper and lower faces, demonstrating that the extraction and preparation of blanks is separated in time from the shaping process.

All of this suggests that these wide rods do not correspond to a continuous extraction and shaping project car-

ried out at the deposit, but rather to a segmented one, in which the extraction was probably carried out elsewhere.

A final observation is that the extraction of these large supports in El Cierro is carried out by combining different techniques (Tapia et al., 2018), and not exclusively using DGP, which implies less predetermination during the extraction of the rods (Goutas, 2009; Averbouh et al., 2016). The persistence of fracturing techniques other than DGP has been described in later Magdalenian contexts (Lefebvre and Pétilon, 2018) and their combination with the grooving technique in the Cantabrian has been previously mentioned (Adán, 1997). Additionally, materials under study from Langatxo and Iruroin in the Basque Country, point in the same direction (Tapia et al., 2025). In this regard, we point to the possibility that this combination is due both to the structure of the deer antler (Currey et al., 2009), less hard and demanding than that of the reindeer, and to cases where more expeditious extractions may be required. Although this procedure requires subsequent regularization of the edges and sections of the blanks, it allows the antlers to be quickly processed and reduced to lighter and more transportable modules.

Regarding the strategic nature of the production of projectile points, we see that it acquires independence from food processing by specializing in the exploitation of antlers, and also that increasingly complex and standardized procedures are developed. However, with regard to production planning, the acquisition of raw material is still linked to the success in (seasonal) capturing male specimens or the (random) finding of shed antlers, which implies a high degree of uncertainty for the performance of strategic tasks.

For this reason, in the Lower Magdalenian, when the opportunity to acquire antlers arises, the entire chain is carried out, but including the preparation of material reserves for deferred processing. This means that the operational sequences can be distributed variably among sites over time, depending on whether reserve stocks are available or new raw materials are acquired.

Among mobile hunter-gatherers, the essential feature that denotes a planned strategy is the design of suitable and versatile formats for transport, that allow stock to be transformed into a wide range of tools, including large-caliber tips. In this way, the randomness in the acquisition of raw materials is solved, allowing a change from opportunistic production to a systematic and far-sighted one.

CONCLUSIONS

Throughout the Upper Paleolithic, an evolution is observed in the design and production of projectile points for hunting in hard materials of animal origin, which progressively tended to specialize in the use of deer antlers (Adán, 1997; Aura et al., 2012; Langley et al. 2016). In addition to being essential for shooting down prey, the strategic nature of the production of antler projectiles for the survival of hunter-gatherer groups is demonstrated by the recurrence, abundance and variety of types and specimens.

However, the availability and acquisition conditions of the necessary raw materials are not constant, but variable in time and space, which introduces a high degree of uncertainty when planning their production.

In this article we have presented a study of the operational chains in hard materials of animal origin from the El Cierro Cave (Asturias, Spain), which allows us to confirm the general trend towards a progressive specialization in the production of antler projectile points.

In the case of the Lower Magdalenian of El Cierro, production takes place in two different chains, which are carried out at the site both from antlers from hunted deer and from previously prepared imported blanks. We consider that it is the forecasting of raw material needs that gives strategic character to these productions, which in the case of El Cierro materializes in the combination between a production of artifacts immediately after the acquisition of antlers, and a preparation of blanks for their deferred transformation.

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