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Abstract

El Mirón Cave, located in northern Atlantic Iberia, has produced important evidence of human occupation during the Lower Magdalenian (19-17.5 cal kya). Among the finds dating to this period is that of a disturbed primary burial of an adult woman. The excavation of the small area around the burial yielded a considerable number of ornamental items (mainly shell beads), but the actual association of any of them with the interment is problematic. The results of our study of the perforated marine shells and mammal teeth suggest that the ornamental objects were not grave goods, but rather were simply artifacts present in the occupation layers in this part of the cave. The materials used to make ornaments were gathered by collecting shells along the Late Glacial shore and by hunting ungulates. The perforation techniques used were similar to those found at contemporary sites in the Franco-Cantabrian region and the appearance of various elements from the manufacturing operatory chain indicates that some of the ornaments were made at the site. It was also possible to determine that some of the shells were used—probably suspended or attached to other objects. From a functional standpoint, the ornaments probably played not only an aesthetic role, but also a symbolic one, facilitating communication and exchanges among human groups.

Keywords: Shell beads; perforated mammal teeth; Upper Paleolithic; ornaments; Magdalenian; human burial.

1. Introduction

In recent years, a new explanatory model has stressed the importance of marine resources among human populations of the Middle and Upper Paleolithic (Bailey and Flemming, 2008; Bicho and Haws, 2008; see also Straus and Clark, 1986). This model is derived from evidence that has been recovered from many sites (among other places) along the Atlantic and Mediterranean shores and contrasts with the traditional view that these resources had only become important in the Late Glacial (Colonese et al., 2011; Gutiérrez-Zugasti et al., 2011). Among the marine resources used by humans were mollusks that had various uses-- not only for food and tools (e.g. Bailey and Craighead, 2003; Cuenca-Solana et al. 2014), but also for symbolic and ideological purposes as ornaments (Álvarez-Fernández, 2006; Taborin, 1993).

Marine shells have been used as ornaments by humans since at least about 80 kya, as attested in Grotte des Pigeons (Morocco) (Bouzouggar et al., 2007) and Blombos Cave (South Africa) (d'Errico et al., 2005). The appearance of ornamental use of shells has been related with the development of greater capacity on the part of anatomically modern humans for expressive behavior relative to earlier hominins, and the evidence currently suggests that this first happened in Africa. This led to some scholars to defend the idea that the use of objects of symbolic character in Western Eurasia dated to the beginnings of the Upper Paleolithic (ca. 40 cal kya) (Álvarez-Fernández and Joris, 2008). However, current evidence is challenging this statement showing examples of possible symbolic behavior on the part of Neandertal populations in Europe (e.g. García-Díez et al., 2013; Morin and Laroulandie, 2012; Peresani et al., 2011, 2013; Rodríguez-Vidal et al., 2014; Zilhão et al., 2010), and contributing to the current debate on the relative capacities of Neandertals and *H. sapiens sapiens* (e.g., Caron et al., 2011; Mellars, 2010; Rendu et al., 2014; Soressi et al., 2013; Zilhão, 2007; Zilhão and d'Errico, 1999).

During the Upper Paleolithic shells, along with other materials—especially bones and teeth of animals (mammals, fish and birds), antler, ivory, and minerals were commonly used for the fabrication of ornaments (Álvarez-Fernández, 2006). The use of these elements was related to the symbolic world of hunter-gatherer groups. Shell beads in particular have been defined as objects that identified human groups (Kuhn et al., 2001; Stiner, 1999, 2003), social status (Vanhaeren and d'Errico, 2005), social and personal identities (White, 2007), and even ethno-linguistic groups (Vanhaeren and d'Errico, 2006).

El Mirón Cave, located in the northern Atlantic zone of the Iberian Peninsula, has produced significant evidence of human occupations during the Lower Magdalenian (19-17.5 cal kya). In addition to rich residential deposits, the excavations uncovered the disturbed, but substantially complete burial of an adult woman that is described in all its aspects in this special issue of *JAS* (Straus and González Morales, this issue). This find is the first of its kind on the Iberian Peninsula and one of the very few ever to be discovered in Western Europe (Orschiedt, 2013). The excavation of the area where the burial was located yielded a considerable number of ornamental elements (mostly shell beads), but their actual association with the interment is not clear. Generally, personal ornaments appear in differentiated contexts during the Upper Paleolithic: habitation areas and funerary areas. In the former they are usually dispersed and found together with remains of subsistence activities (e.g. Tatá et al., 2014) or in shell deposits that may or may not be associated with hearths (Álvarez-Fernández, 2006; Gutiérrez-Zugasti et al., 2013), while in funerary contexts they are found in close physical association with the human remains (e.g., in St.-Germain-la-Rivière [see Vanhaeren and d'Errico, 2005]).

It is fundamental to obtain information on the acquisition, transformation and use of ornaments by Upper Paleolithic forager groups in order to understand their symbolic world. Together with the technological activity related to ornament manufacture is their symbolic function, and the study of both aspects provides a more complete vision of the social relations that existed among such groups. The principal objectives of this article are to 1) determine whether the ornamental objects found in El Mirón Cave had any actual relationship with the Magdalenian burial or rather simply with the habitation layers into which the grave had been dug at the rear of the cave vestibule, and 2) establish the technical, functional and possible social characteristics of the identified ornaments. To do this, we analyzed the species represented in the whole shell assemblage and their characteristics, the taphonomic alterations that the shells had undergone, and the attributes of the perforated elements, their spatial distribution and morphometrics.

2 El Mirón Cave and the Magdalenian burial

El Mirón Cave is located at about 255 m above present sea level in the middle valley of the Asón River, in the central sector of the Cantabrian region of Spain (Fig. 1). The large cave mouth faces West and dominates the Asón valley at its confluence with the Calera and Gándara rivers from the steep side of Mount Pando. The site is about 20 km from the present shore of the Bay of Biscay at the mouth of the Asón, and would have been some 25-30 km from the shore during the Oldest Dryas, at the time of the Lower Magdalenian. The site was excavated by teams directed by Lawrence G. Straus and Manuel R. González Morales between 1996 and 2013. It contains a very long cultural sequence, with especially impressive occupation levels pertaining to the Cantabrian Lower Magdalenian. The excavations of these levels were conducted in the outer vestibule (Cabin area) and vestibule rear (Corral area), connected by the Mid-Vestibule Trench (González-Morales and Straus, 2009; Straus and González Morales, 2012).

The disturbed but primary human burial was excavated between 2010-2013 at the rear of the vestibule in a narrow area separated from the Corral area and the cave wall by a large engraved and ochre-stained block (Fig. 1). It is the first substantially complete Magdalenian burial to be found on the Iberian Peninsula. In this area, parts of meter-squares X5-7 and Y5-7 were dug (see Straus and González Morales, this issue, for a detailed discussion of the excavation, stratigraphy and radiocarbon chronology). Levels 501 and 502, although they yielded artifacts of clear Magdalenian attribution (including an antler harpoon barb in 502), were disturbed in recent times (probably by shepherds), as they contained modern artifacts such as shards of glass. The rest of the layers in the area were intact, beside the existence of the pit that had been dug in Lower Magdalenian times for the interment of the corpse. The human remains were mainly associated with intensely red ochre-stained Level 504 (dated to 18.9-18.7 cal kya) in square X7, subsquares B+D and adjacent subsquares. However, the rest of the area dug between the engraved block and the rear cave vestibule wall contained human habitation deposits that evidenced subsistence and flint-knapping activities (see articles respectively on mammalian fauna and artifacts by Marín-Arroyo and Geiling and by Fontes et al., in this issue). The skeleton, corresponding to an adult woman (see Carretero et al., this issue), was deposited during the formation of Level 504 in a pit that affected both that layer and underlying Level 505 (c. 18.9 cal kya). According to the taphonomic study of the human remains, the corpse would have been laid down in flexed, lateral position in a small pit dug into the sediments. After it had become skeletonized, it was slightly disturbed by a carnivore and finally certain large bones (including the cranium) were apparently removed by humans for transport to another (unknown) location, while the carnivore-gnawed tibia, mandible and several smaller bones were (re-)stained with ochre and reburied (Marín-Arroyo, this issue).

3. Materials and methods

The materials analyzed here were recovered during the excavation campaigns of 2010, 2011 and 2013 and come from levels 502, 503, 504, 505 and 506 in squares X5-7 and Y5-7. The marine mollusks and other aquatic organisms (e.g., sea urchins) were taxonomically identified using specialized manuals (Poppe and Goto 1991, 1993) and the comparative collection of one of the authors (IGZ). In terms of systematics, we used the nomenclature proposed by the World Register of Marine Species (WORMS) for marine mollusks (http://www.marinespecies.org/aphia.php?p=taxdetails&id=140293). The few perforated mammal teeth were anatomically and taxonomically identified with the help of the reference collection of the Bioarchaeology lab at the IIIPC (Cantabria, Spain). With respect to measures of abundance, we calculated absolute frequencies by Numbers of Identified Specimens (NISP) and Minimum Numbers of Individuals (MNI). To obtain the MNI for shells we used a method based on the creation of categories of levels of fragmentation, developed from patterns of mollusk disarticulation (Gutiérrez-Zugasti, 2011a; Moreno, 1994). Given the small number of ornamental objects that were piece-plotted with 3-dimensional coordinates during the excavation, the spatial distribution of the ornaments was analyzed using the subsquare (50x50 cm) information of each find.

The complete teeth and shells, as well as the substantial shell fragments used in the MNI calculations were examined for taphonomic alterations. The shells were observed with a Leica S8 APO binocular microscope. In order to evaluate the state of conservation, each shell was inspected using the method proposed by Yanes et al. (2012), with some modifications. The taphonomic descriptors used in the analysis were carbonate coating, manganese staining, biodegradation (loss of proteins), burning, color loss and ornamentation loss. The taphonomic study was conducted using three scoring variables as to the degree of weathering: 1=poor preservation; 0.5=intermediate preservation; 0=good preservation. The total taphonomic grade

(TTG) was scored for each shell and for the whole assemblage as the mean of all taphonomic features. Finally, the index of total fragmentation (FI) per level was calculated using the MNI/NISP ratio (Gutiérrez-Zugasti, 2011a).

The marine shells and teeth were measured with a digital caliper to the nearest 0.1 mm. Only the taxa that had complete or minimally fragmented shells were subjected to detailed biometric analysis. In the case of *Littorina obtusata* we measured the length, total width, width of the first whorl and the aperture width, while in the case of *Trivia* sp. we measured the length and width of the shell, following the conventions in the scientific literature (Gutiérrez-Zugasti, 2009; Rigaud et al., 2014). The ranges of measurements were compared with those from other assemblages, both modern and archeological, in order to evaluate any possible intentional selection of sizes of items to be used for ornaments.

All the items that could have been used as ornaments were also measured and inspected under the microscope at different magnifications. We did an even more exhaustive analysis of those shells and teeth that have perforations or evidence of having been used as personal ornaments. In these cases we measured the perforation holes, documented the presence of ochre and noted traces of use-wear on the shells. Then we compared any alterations with those published in several specialized works (d'Errico et al., 1993; Taborin, 1993; Vanhaeren and d'Errico, 2002; Vanhaeren et al., 2005) in order to infer the techniques that could have been used to make the holes and to establish the existence or not of wear-traces related to the use of the shells in question. In order to analyze the perforations we used macroscopic observation and microscopy with the same binocular instrument at 5/80X, as well as with a Leica DM 2500M metallographic microscope for possible wear-traces between 50/200X. To photograph the shells, we used a Canon digital camera mounted on the microscopes.

4. Results

4.1 Species representation

The analyzed excavation units produced a total of 157 remains of marine shells. Among them, 17 taxa were identified (Table 1). Four of them were identified at the species level (the bivalve *Solen marginatus* Pulteney, 1799; and the marine gastropods *Littorina littorea*

[Linnaeus, 1758], *Littorina obtusata* [Linnaeus, 1758] and *Nucella lapillus* [Linnaeus, 1758]), ten at genus level (the bivalves *Cerastoderma* sp., *Mytilus* sp., and *Pecten* sp.; and the marine gastropods *Cyclope* sp., *Littorina* sp., *Nassarius* sp., *Patella* sp., *Trivia* sp., *Turritella* sp.; the scaphopod *Antalis* sp.), one at order level (Camarodonta) and two at class level (Bivalvia and Gastropoda). Among the perforated mammal teeth we identified two taxa: red deer (*Cervus elaphus)* and goat (presumably ibex) (*Capra* cf. *pyrenaica*).

The collection of marine shells and mammal teeth is dominated by taxa that were generally utilized for ornaments in Western Europe during the Upper Paleolithic (Álvarez-Fernández, 2006), although it also includes mollusks that are usually exclusively used for food, such as the razor shell (*Solen marginatus*), mussel *Mytilus* sp., and sea urchins from the Camarodonta Order. The numbers of marine shells are similar in all the levels, though slightly greater in Levels 504 and 505. The gastropods are better represented than the bivalves in the whole sequence of levels. The identified taxa generally inhabit rocky zones or intertidal sand/mud zones, although some also inhabit the infratidal fringe (e.g., *Antalis* sp., *Pecten* sp.). Similarly, most of the taxa can be found both along the open shore and in estuaries, although there are some that live in exclusively one or the other of these habitats (e.g., *Antalis* sp. and *Turritella* sp. are mostly estuarine, while *Trivia* sp. and Camarodonta are usually found along open coasts).

4.1 Shell taphonomy

The TTG index reflects that the shells in all the levels display an intermediate state of preservation, with values centered around 0.5 (Fig. 2). However we did observe a pattern of progressive deterioration of the shells from the higher to the lower levels (from 0.47 in Level 502 to 0.64 in Level 506). Similarly the IF (fragmentation index) does not display extreme values in any level, but the pattern is slightly different than for the TTG, since Levels 502 (which is mixed) and 503 (which is intact) showed higher and lower indices of fragmentation respectively.

The most frequently observed taphonomic processes are manganese staining, biodegradation, color loss, and ornamentation loss (Fig. 3). The last three display the same trends throughout the stratigraphic sequence (the oldest levels display a higher grade of deterioration than the more recent ones), while manganese staining is less common on shells from Level

504—the burial deposit. This suggests that the presence of scarce decomposing organic matter during the formation of this level, in accordance with what has been observed on both the human and large mammal bones from Level 504 (Marín-Arroyo, this issue; Marín-Arroyo and Geiling, this issue). Other processes such as carbonate coating and burning are hardly attested among the shells.

The analysis of taphonomic alterations allowed us to identify some case of bioerosion, which indicates that some shells had been collected after the mollusks had died. Most of the shells display traces of ochre on both their external and internal surfaces. In some cases the ochre appears on breaks (both anthropic and natural), a fact which suggests that the shells were already broken when the ochre powder was deposited. The same is true for the manganese which habitually occurs on breaks. In addition, when the two kinds of mineral staining on the same shell, the manganese is always on top of the ochre, proving its antiquity.

4.3 Shell and tooth ornaments

Among the items that were transformed into ornaments, there are two types: shell beads and mammal teeth. From the 157 shell remains recorded in this study, a total of 47 whole and fragmentary shells belonging to nine taxa have been identified as ornamental objects (Table 2). Among the marine shells, 16 gastropods and bivalves display anthropic perforations (Fig. 4). Among the scaphopods we identified 31 whole or fragmentary manufactured beads with breaks that are either longitudinal or transversal to the long axis of the shell (Fig. 5). There are three terrestrial mammal teeth with perforations (one atrophied red deer canine, a juvenile ibex right incisor and an adult ibex right incisor with the perforation broken) (Fig 6). Apart from the shell beads, another 24 complete shells or smaller fragments belonging without traces of human manipulation (except for the presence of ochre in the surface of 12 of them) have been also identified as potential ornaments (Table 3; Fig. 7). They could have been collected to be transformed into beads and then discarded at the site or perhaps they are fragments of broken beads. Among the shells, 33 ornaments and 12 potential ornaments are stained with ochre. The presence of ochre in the surface of these shells suggests their use in symbolic activities.

The ornamental assemblage from post-burial Levels 503 and 502 is quite limited and is made up of marine and terrestrial species that are habitually found in Magdalenian deposits in

Western Europe (*Cyclope* in 503 and *Cerastoderma* and a red deer canine in 502). The level with the most ornaments is 505, followed by 504 and 506, and the most abundant shell beads belong to the taxa *L. obtusata, Trivia* sp., *Antalis* sp., *Nassarius* sp. and *N. lapillus* (Table 2). In general, the composition of the ornamental assemblages is quite homogeneous, with almost all the same species appearing in all three of these levels.

4.4 Morphometrics

Only two taxa had well preserved individuals, thus permitting detailed morphometric analysis: *L. obtusata* (n=10) and *Trivia* sp. (n=4). In both cases the average length of the perforated shells (*L. obtusata*=10.1 mm; *Trivia*=10.5 mm) is slightly greater than that of the non-perforated shells (*L.obtusata*=7.8 mm; *Trivia*=8.6 mm). The distributions of sizes of these two species were compared with those of reference collections from La Concha Beach in Santander for *L. obtusata* and from Cubelas (San Ciprián, Lugo, Galicia) for *Trivia* (data from Álvarez-Fernández, 2006). The results show that the specimens of *L.obtusata* from El Mirón cover most of the range of sizes among modern shells, with only one being clearly larger (Fig. 8A). As for *Trivia*, three individuals fall within the group of the largest modern specimens and one is of average size (Fig. 8B).

4.5 Technology and use wear

The perforations of *L. obtusata* shells have a regular shape and flat surface on which one can see striations that are oblique to the axis of the shell (Fig. 9: #13, #14). This striated surface is the result of rubbing the shell against an abrasive object, probably a piece of sandstone. The same kinds of traces are found on the three broken specimens of *Nucella* (e.g. Fig. 9: #20), the two of *Nassarius* (one of them with three perforations, see Fig. 9: #17a, 17b and 17c), and one of *Cerastoderma* (Fig. 9: #1). The *Trivia* shells have regular, circular perforations whose edges are perpendicular to the surface of the shell (Fig. 9: #15a, #15b). Two shells have double perforations, with a hole at each end, while the third shell has only one small perforation (0.7 x 0.7 mm) at one end, but not exactly in the same position than the other two shells, which raise some doubts about its anthropogenic origin. Given the characteristics of *Trivia* shells, the holes must have been made from the exterior surface with a sharp object such as a stone borer or bone awl. Despite its poor state of preservation of the *Cyclope* shell, we were able to observe a hole of similar characteristics as those of the *Trivia* shells (Fig. 9: #3). In the case of the scaphopods, we found evidence of sawing of the shells to obtain tube-shaped beads (Fig. 10). Among the recovered fragments is one that has been sawed in its posterior portion (the thinnest part, usually discarded because of its small natural hole, see Figs. 5 and 10: #38) and two others that could be refitted (# 23 and 24). An irregular fracture on the edge of the anterior end has been identified in some individuals of *Antalis* (Fig. 5). This is probably related to the position of the shells with respect to one another in a composite ornament, with each successive bead being fitted into its neighbor along the string. This layout, together with twisting caused by suspension and movement of the ornament would have caused the breakage of this part of the shell.

The perforations on the red deer canine and on the juvenile ibex incisor are on the root and were made by scraping the root followed by rotary drilling with a lithic borer. In both cases we could see the scrape marks and many striations in several directions that were made in the process of preparation and drilling the holes (Fig. 6). The perforation of the adult ibex incisor is broken and the overall preservation of the piece is not good, but nevertheless we could see striations that the hole was also made by rotation with a small stone tool.

About 23% of the shell beads bear clear traces of wear in their holes, mainly in the form of smoothed edges at the perforations and/or polish traces (Table 2; Fig. 9). A considerable number (28%) also present polish traces that could be or not directly tied to shell use, since similar polishes appear on other zones of the shell surfaces. However, given the lack of experimental controls we were not able to distinguish if they are wear traces or post-depositional weathering. The rest of the whole and fragmentary shells (49%) show no traces of use. The perforated reed deer canine shows wear traces in the perimeter of the hole while the juvenile ibex incisor presents a thorough preparation of the hole (including a small platform perpendicular to the length axis of the tooth and a rounded groove longitudinal to that axis). In both cases these marks are probably related to the attachement/suspension of the teeth.

4.6 Spatial distribution

The analysis of the spatial distribution of the ornaments helped to determine their locations vis à vis the burial, which was centered on subsquares B and D of square /X7 (Fig. 11). Levels 502 (disturbed) and 503 (intact) were above the burial layer, so objects found in them were clearly not related to the burial. In Level 504 the ornaments were distributed among X6, X7, Y5 and Y6 (the latter squares being fairly remote from the burial). Only one item (the perforated ibex incisor from X7 subsquare D) was from the area occupied by the burial. In Level 505, the spatial distribution of perforated objects is very homogeneous throughout four squares: X7, Y7, Y6 and Y7, only the first two of which were in the immediate burial area. All the perforated items from Level 506 were from one subsquare (X7 C), but this level was only dug in a very small area in X7 (and did not exist in the northern part of X7 due to the presence of a sloping bedrock ledge there).

5. Discussion

5.1 The burial area shell and tooth ornaments: were they “grave goods”?

Levels 502-506 in El Mirón Cave, located in the area of the discovery of a Magdalenian-age human burial (Marín-Arroyo, this issue; Straus and González Morales, this issue) yielded a collection of ornamental elements made from marine shells and ungulate teeth. However, the spatial analysis of the items shows that only one element came from the burial layer (504) in the area of the burial pit in square X7 B+D. The rest of the objects came from areas outside the burial area, in zones clearly related to subsistence and flint knapping activities of the Lower Magdalenian inhabitants of the cave (see Marín-Arroyo and Geiling, this issue; and Fontes et al., this issue). This would seem to indicate that there was no (or almost no) relationship between the ornaments and the burial, which is the same conclusion that has been reached with regard to the faunal remains and the osseous and lithic artifacts from Level 504 (with the possible exception of a large quartz crystal). The presence of beads in this area of the cave was related to the conduct of normal, daily activities (and losses or discards), notably, we argue, as material remains of social relations among the living. Such objects were frequently found in the Lower (and other Magdalenian and Solutrean) levels throughout the other excavation areas of the cave in purely residential contexts (Straus et al., 2011). The presence of a perforated ibex incisor in the burial pit might not either be actually related to the interment, since it could have been originally in the Level 504 (or 505) fill that was dug into to make the narrow, shallow grave. In addition, the homogeneity of the ornamental assemblages from levels 504, 505 and 506 also supports the hypothesis that the beads were not related to the burial. The taphonomic alterations do not suggest the existence of different processes affecting the shells of Level 504 relative to the other levels, save perhaps for a higher incidence of manganese precipitation. Thus the presence of ornaments in this area of the site must be interpreted from a non-funerary perspective, just as in the case of other Lower Magdalenian living areas in the cave.

5.2 Acquisition of raw materials

The animal species that were used to make beads are all ones that are characteristic of the Cantabrian region, except the specimen of *Cyclope* sp. from Level 503, whose origin is Mediterranean. This species can be found today along the Cantabrian coast, but it is an allochthonous mollusk, having been introduced recently in association with the oyster-farming industry (Arias et al., 2012; Bachelet et al., 2004). The presence of Mediterranean species among the ornamental shell assemblages of the Upper Paleolithic in northern Atlantic Spain is sparse, but not insignificant. Various specimens of *Cyclope pellucida* were found in the Magdalenian of Tito Bustillo Cave (eastern Asturias), one of *Zonaria pyrum* in La Garma A (central Cantabria), and a specimen of *Homalopoma sanguineum* in El Mirón Level 17 (Lower Magdalenian—contemporaneous with the burial layer, 504) (Álvarez-Fernández, 2006). The presence of this species suggest the existence of networks of exchange among hunter-gatherer groups of the Mediterranean and Cantabrian regions (probably via the Ebro Valley, along which there are Magdalenian sites, see Utrilla et al., 2012) or exchange relationships with other groups in contact with Mediterranean bands.

As no fossil shells were identified, the acquisition of most of the shells used for ornaments was probably done along the Cantabrian shore, possibly around the paleo-mouth of the Asón River. At the time of the Lower Magdalenian the site would have been about 25-30 km from the early Late Glacial shore, proving that it was humans who transported the shells to the cave. Evidence from numerous Upper Paleolithic ornament assemblages indicates that the collection of dead shells (sometimes even fossil shells) to make beads was a habitual practice (e.g. Gutiérrez-Zugasti et al., 2013; Stiner et al., 2013; Taborin, 1993). Because of the bioerosion on the surfaces of some of the shells, they must have been collected dead, though we cannot determine whether they came from one or several kinds of thanatocenoses. In the case of perforated teeth, the two identified species (red deer and ibex) lived in the surroundings of El Mirón and were hunted by Lower Magdalenian people, as attested by the archeofaunal assemblage from Level 504 (see Marín-Arroyo and Geiling, this issue). Thus the teeth were probably obtained from carcasses that were killed and eaten by the inhabitants of the site at the time.

As regards the selection of shell sizes, among the specimens of *L. obtusata* only one has dimensions comparable to ones from Magdalenian assemblages like that of Urtiaga (Levels E+F) in Guipúzcoa, whose assemblage of shells displays a marked selection for the biggest specimens (Álvarez-Fernández, 2006; Rigaud et al., 2014). However, the rest of the individual unperforated shells in the El Mirón assemblage are smaller, though within the range of sizes that have been documented both in other Upper Paleolithic sites and along the present day Cantabrian coast (Álvarez-Fernández, 2006). On the other hand, comparison between the sizes of the perforated and non-perforated shells suggests a slight preference for larger shells with which to make beads. Generally the decrease in shell size through time has been explained either by sea-surface temperature rise or by the pressure of human exploitation (Bailey and Craighead, 2003; Gutiérrez-Zugasti, 2011b; Straus and Clark, 1986). As in many other sites in Western Europe, the species used for ornaments in El Mirón came from various kinds of thanatocenoses, so they were not subjected to the impact of human exploitation which, in any case was not especially intensive yet in the Magdalenian of Cantabria (Gutiérrez-Zugasti et al., 2011b). This means that human pressure does not seem to have played an important role in determining the sizes of shells that were available for selection. Furthermore, the climatic conditions of the Lower Magdalenian were too rigorous to suggest that there was any climatic reason for size decrease in *L. obtusata* at this time. In any case, although it is possible that variations in local ecological conditions along the Cantabrian coast could have played a role in the sizes of shells available to humans, the results of our study suggest that there was no preference for the largest shells in bead-making, since perforated and non-perforated *Littorina* shells are of the same sizes. On the other hand, in the case of *Trivia,* comparisons both with archeological shells and with modern collections (Álvarez-Fernández, 2006) of both El Mirón perforated and non-perforated shells suggest that the site's inhabitants selected the biggest shells for fabrication of ornaments. This distinction between the non-selection of large *Littorina* shells and the selection of large *Trivia* shells could be explained by the existence of more favorable ecological conditions for *Trivia* in the area where people were collecting shells at the time, which in turn would have permitted the formation of thanatocenoses with bigger individuals than in the case of *Littorina*. However, human choices and social practices can provide alternative explanations. Possible aesthetic choices of the artisans could have led them to associate large and small shells in the same beadwork, maybe organized according to a size gradient or a codified alternation of sizes. It can also be proposed that group composition included adult and children and that small shells were dedicated to children while larger shells were used for adults. Size reduction of personal ornaments crafted for children has already been proposed in the case of the Magdalenian burial in the type site of La Madeleine (Vanhaeren and d'Errico 2001). The Lower Magdalenian levels in El Mirón Cave evidence a wealth of materials of all types that have been interpreted as the products of repeated, multi-functional, residential occupations of the site. The complex composition of the groups represented would fit with the residential function of the site.

5.3 Technology and use

The perforation techniques used to make the shell beads at El Mirón (abrasion and percussion/pressure) are very habitual for the manufacture of ornamental shells throughout Western Europe in the Upper Paleolithic (Álvarez-Fernández, 2006; Taborin, 1993). The presence of manufacturing debris (principally fragments of *Antalis*) and several shell beads without wear traces, indicate that at least some of the ornaments could have been made at the site. The manufacture of shell (and tooth) beads—symbolic artifacts-- here would fit in very well with the overall picture of the site multifaceted occupations.

Only some pieces have clear wear-traces, probably related to the suspension/attachment of the shells. Several other shells display traces of wear around the hole that are similar to wear traces on other zones of shell surfaces. We cannot rule out the possibility that taphonomic alterations that occurred during biostratinomic or diagenenic phases of the shells' existence were responsible for these wear traces. The presence of traces on various parts of the shells could be related to tying the beads in different ways. White (2007) has pointed out that these materials are usually associated with body ornaments from a traditional typo-morphological perspective, while ethnographic examples suggest that they could have been used as non-body-ornament objects adapted for suspension or attachment on baskets, bags, blankets, dwellings, etc. Experimental studies have demonstrated that different kinds of use-wear are produced when different systems for stringing the shells together are used, and that some of those systems produce wear traces in various parts of the shells (Vanhaeren et al., 2013). However, considering the limited number and quality of the use-wear recorded on El Mirón shells, and the previously published experimental data, it is not possible to make any accurate assumption on the function of the shells.

5.4 Social implications

Currently available ethnographic evidence supports the idea that the ethnic dimension of human groups can be recognized through the use of different bead types and by their combination and arrangement on the body and on other objects such as clothing. Thus understanding the meaning of the ornaments could be shared by one or more neighboring groups. This would allow or facilitate the communication of social identity of people bearing the ornaments as members of the same group, gender or other grouping related to age, marital status, role in society, etc. (Kuhn et al., 2001, 2009; Vanhaeren and d'Errico, 2006).

In El Mirón, both the species used to make ornaments and the manufacturing processes are similar to those that are documented at Upper Paleolithic sites throughout Western Europe, especially in the Franco-Cantabrian region (Álvarez-Fernández, 2006). This fact suggests that the Magdalenian human groups shared the same technological tradition for the manufacture of ornaments and that those ornaments may have had the same general sorts of social meanings as is documented in the ethnographic record of recent forager societies. The presence of Mediterranean species in Cantabrian sites including El Mirón suggests the existence of a network of contacts among Magdalenian bands (see Schwendler, 2004). These contacts could have occurred during travels related to the subsistence strategies but also during social get-togethers ("aggregations"), as has been argued for the Lower Magdalenian site of Altamira (Conkey, 1980), which is linked to El Mirón by the presence of striation-engraved red deer scapulae

(González Morales and Straus, 2009). The ornamental objects could have served to facilitate communication among members of different bands, and thus social relations and exchanges.

6. Conclusions

The results of this study of the marine shells and perforated ungulate teeth in El Mirón Cave suggest that the beads (with the remotely possible exception of a perforated ibex incisor) were not grave goods deposited with the Magdalenian burial. On the contrary, they were no doubt objects lost during residential occupations of this area at the rear of the cave vestibule before and after the time of the burial. The raw materials for making the beads were all easily obtainable by the Lower Magdalenian inhabitants of the site (with the exception of a shell of Mediterranean origin) either by collection along the Bay of Biscay shore or by hunting normal game animals near the cave. The perforation techniques used are like those found at other contemporary sites in the Franco-Cantabrian region, suggesting the existence of a widespread, well-established technological tradition across a very large area. The discovery of several remains of the manufacturing operatory chain and shells without wear traces suggests that some of the beads were made on-site, a fact that supports the hypothesis that El Mirón was used as a multi-purpose site during the Lower Magdalenian. We were also able to determine the presence of wear-traces on some of the shells, confirming that they were utilized as personal ornaments. From a functional standpoint, the ornaments probably played not only an aesthetic role, but also a social one in the facilitation of communication among different groups, including interpersonal relationships and exchanges of all sorts—from trade, to information-sharing, to intermarriage.

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Figure captions

Fig. 1: Location of El Mirón Cave (above). The plan of the site (below) shows excavation areas, including the burial area and the burial pit (Marín-Arroyo and Geiling, this issue).

Fig. 2: Total Taphonomic Grade (TTG) and Fragmentation Index (FI) of marine shells from levels 502-506. Note the progressive decrease of the TTG from older to younger levels, while the FI is higher (better preservation) in Level 503 and similar for the rest of levels.

Fig. 3: Recorded taphonomic alterations in marine taxa from levels 502-506. Biodegradation, manganese staining, color loss and ornamentation loss present the higher TTG (Total Taphonomic Grade) (poorer shell preservation), while carbonate coating and burning are scarcely represented.

Fig. 4: Complete and fragmentary shell beads from levels 502-506 showing perforations: 1: *Cerastoderma* sp.; 3: *Cyclope* sp.; 4, 12, 13, 14, 47: *Littorina obtusata*; 5, 15, 16: *Trivia* sp.; 6, 19, 20: *Nucella lapillus*; 17, 18, 48: *Nassarius* sp. Numbers referred to Table 2.

Fig. 5: Shell beads made on *Antalis* sp. and manufacturing debris. Numbers referred to Table 2.

Fig. 6: General and detailed views of perforated teeth: Left) atrophied red deer canine; Right) juvenile ibex right incisor; and Center) adult ibex right incisor with the perforation broken. Numbers referred to Table 2.

Fig. 7: Additional shells identified as potential ornaments. 51, 52, 53, 57, 62, 70, 71, 72, 73: *Littorina obtusata*; 54: *Littorin*a sp.; 55: Gastropoda sp.; 56: *Cyclope* sp.; 58, 59, 63, 64: *Trivia* sp.; 60, 65: *Nassarius* sp.; 61: Bivalvia sp; 66, 74: *Turritella* sp.; 67, 68, 69: *Pecten* sp. Numbers referred to Table 3.

Fig. 8: Morphometric data from archaeological specimens of *Littorina obtusata* (A) and *Trivia* sp. (B) of El Mirón compared to modern reference collections from La Concha beach (Santander) and Cubelas beach (Galicia) respectively. Black triangles: perforated shells; Black circles: non perforated shells; Grey and white circles: modern reference collection (after Álvarez-Fernández, 2006).

Fig. 9: Detailed view of perforations made by abrasion on *L. obtusata* (#13, 14), *N. lapillus* (#20), *Nassarius* sp. (#17a, 17b, 17c) and *Cerastoderma* sp. (#1); and percussion/pression on *Trivia* sp. (#15a, 15b) and *Cyclope* sp (#3). White rectangles are showing use wear traces in the perforations.

Fig. 10: Examples of *Antalis* sp. (#25, 36, 38) with evidence of sawing. Top: view of the whole shells; Bottom: detailed view of the areas with traces of sawing.

Fig. 11: Spatial distribution by subsquares of shell and tooth ornaments from levels 502-506.

Table captions

Table 1: Marine taxa from levels 502-506 at the burial area in El Mirón Cave and abundance in terms of Number of Identified Specimens (NISP) and Minimum Number of Individuals (MNI).

Table 2: Morphometric data (mm), presence/absence of ochre stains, perforation metrics (mm), modification type and presence/absence of use wear of shell and tooth ornaments from levels 502-506. Black circles in the use column refer to clearly identified use wear traces, while the asterisk represent the occurrence of polishing of ambiguous origin (either anthropogenic or natural).

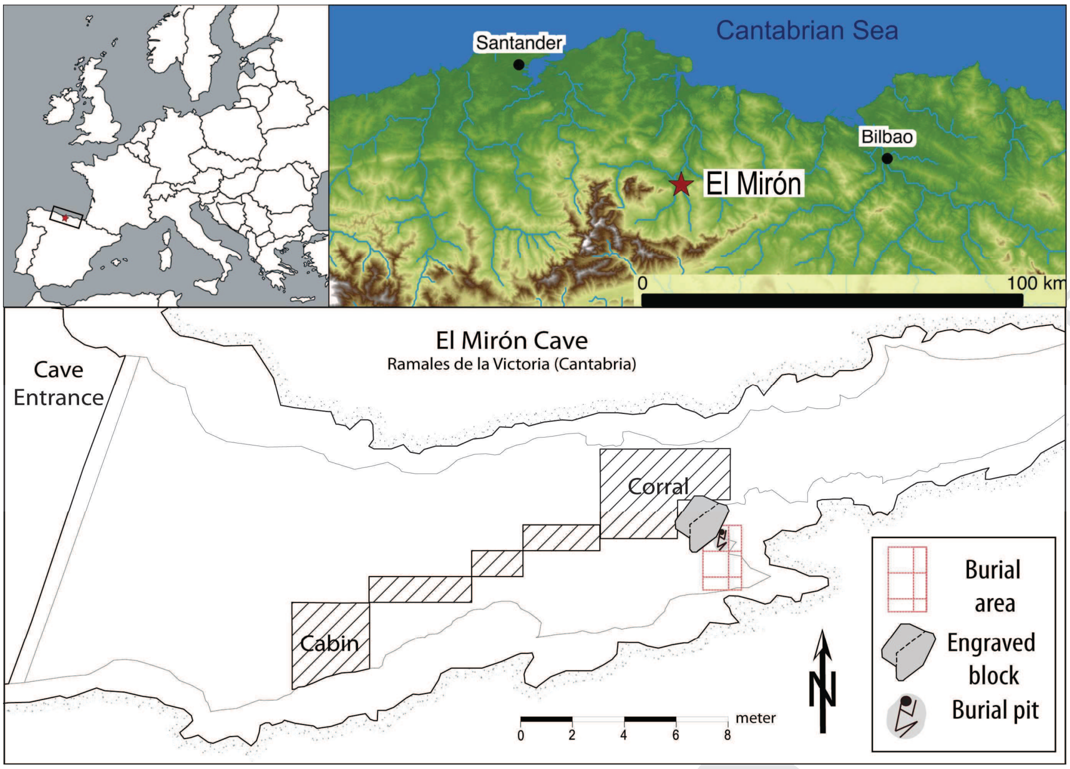
Table 3: Morphometric data (mm) and presence/absence of ochre stains in whole and fragmentary shells from levels 502-506 considered potential ornaments.

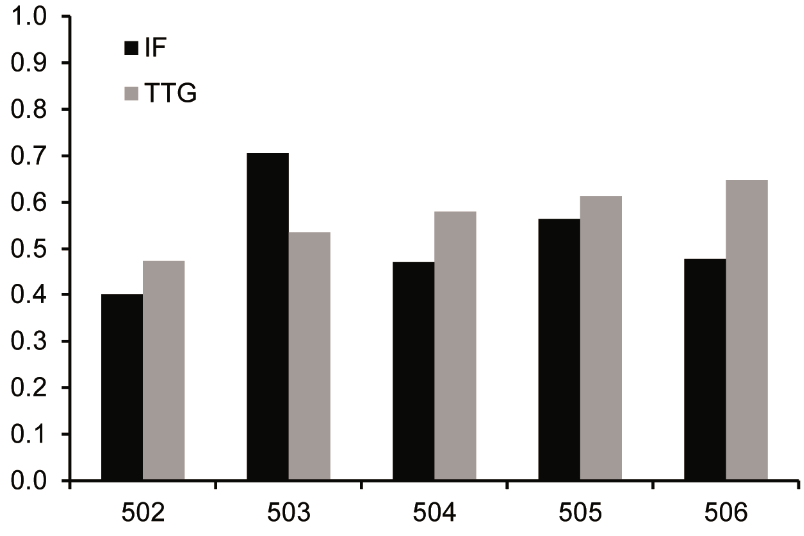
	502		503		504		505		506	
Marine bivalves	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Bivalvia sp.					3	2	1	1		
Cerastoderma sp.	2	1			1	1				
Mytilus sp.	5	1			1	1				
Pecten sp.							4	1		
Solen marginatus			1	1						
Total Bivalves	**7**	**2**	**1**	**1**	**5**	**4**	**5**	**2**		
Gastropods										
Cyclope sp.			2	2						
Gastropoda sp.			1	1						
Littorina littorea	2	1	4	3	8	2	1	1	1	1
Littorina obtusata	1	1	6	2	7	2	7	6	17	5
Littorina sp.	3	1	1	1			1	1	1	1
Nassarius sp.					1	1	3	2	1	1
Nucella lapillus	1	1			2	1	2	2		
Patella sp.			1	1	3	2				
Trivia sp.					3	2	4	3		
Turritella sp.							1	1	1	1
Total gastropods	**7**	**4**	**14**	**9**	**24**	**10**	**19**	**16**	**21**	**9**
Scaphopods										
Antalis sp.					4	2	29	14	1	1
Echinoderms										
Camarodonta					2	1	2	1		
Unidentifiable	6	2	1	1	1	1	7	2	1	1
TOTAL	**20**	**8**	**16**	**11**	**36**	**18**	**62**	**35**	**23**	**11**

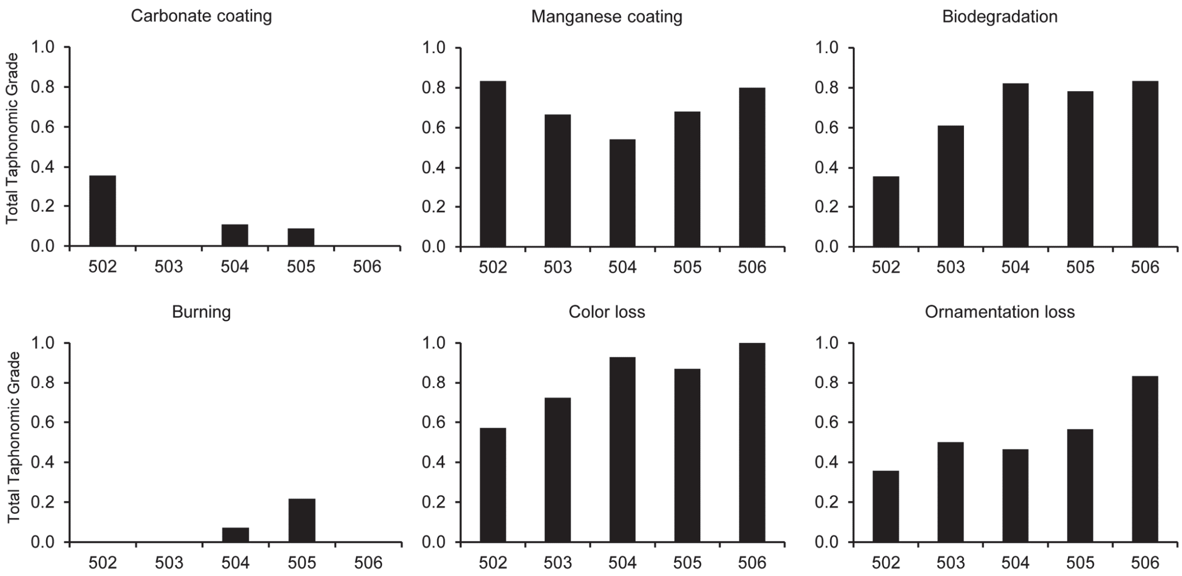
			Shells and teeth					Perforation			
Sample ID	Species	Level	Length	Width	Spire width	Aperture width	Ochre	Lmax	Lmin	Modification type	Use wear
1	*Cerastoderma* sp.	502	28	26			●	2,3	1,4	Abrasion	●
2	*Cervus elaphus*	502	19,2	11,6			●	2,9	1,9	Rotation	●
3	*Cyclope* sp.	503	4,9	6,4			●	4,8	2,7	Percussion	*
4	*Littorina obtusata*	504	8,5	8	4,3	4,6	●	4	2,7	Abrasion	●
5	*Trivia* sp.	504	7,3	5,8			●	0,7	0,7	Percussion	
6	*Nucella lapillus*	504					●			Abrasion	
7	*Antalis* sp.	504	11,9	2,9			●			Serrated	
8	*Antalis* sp.	504	8	3,1			●			Serrated	*
9	*Antalis* sp.	504	8,3	3			●				*
10	*Antalis* sp.	504	3.2	3.3			●				
11	*Capra pyrenaica*	504	23,8	7						Rotation	
12	*Littorina obtusata*	505	11,4	9,2	6,8	5,6				Percussion	
13	*Littorina obtusata*	505	10	10,8	5,6	6	●	3,7	3,3	Abrasion	●
14	*Littorina obtusata*	505	6,5	6,5	3,4	3,8		3.2	1.9	Abrasion	●
15	*Trivia* sp.	505	10,6	7,9			●	3,5/3,4	2,2/2,6	Percussion	●
16	*Trivia* sp.	505	10,4	7,3				3,2/3,3	2,7/2,8	Percussion	●
17	*Nassarius* sp.	505	8	4,9		3,1	●	2,2/2/3,4	2/1,4/2,9	Abrasion	●
18	*Nassarius* sp.	505	10,4	5		3,8	●	3,8	2,7	Percussion	
19	*Nucella lapillus*	505								Abrasion	*
20	*Nucella lapillus*	505					●			Abrasion	●
21	*Antalis* sp.	505	3,1	2,3			●				
22	*Antalis* sp.	505	4,9	3,6			●			Serrated	*
23	*Antalis* sp.	505	10,3	3,3						Serrated	*
24	*Antalis* sp.	505	3,1	2,6			●			Serrated	*
25	*Antalis* sp.	505	7,4	2.8							
26	*Antalis* sp.	505	5,1	3,3			●			Serrated	*
27	*Antalis* sp.	505	6,5	3.5							
28	*Antalis* sp.	505	3,6	2.5			●				
29	*Antalis* sp.	505	3,3	3.2			●				
30	*Antalis* sp.	505	6,6	3,6			●			Serrated?	*
31	*Antalis* sp.	505	2.6	3.3			●				
32	*Antalis* sp.	505	3.1	3.4			●				
33	*Antalis* sp.	505	7,5	2,6							
34	*Antalis* sp.	505	3,3	2,8							
35	*Antalis* sp.	505	5,2	3,8			●			Serrated	●
36	*Antalis* sp.	505	3,1	2,3			●			Serrated	*

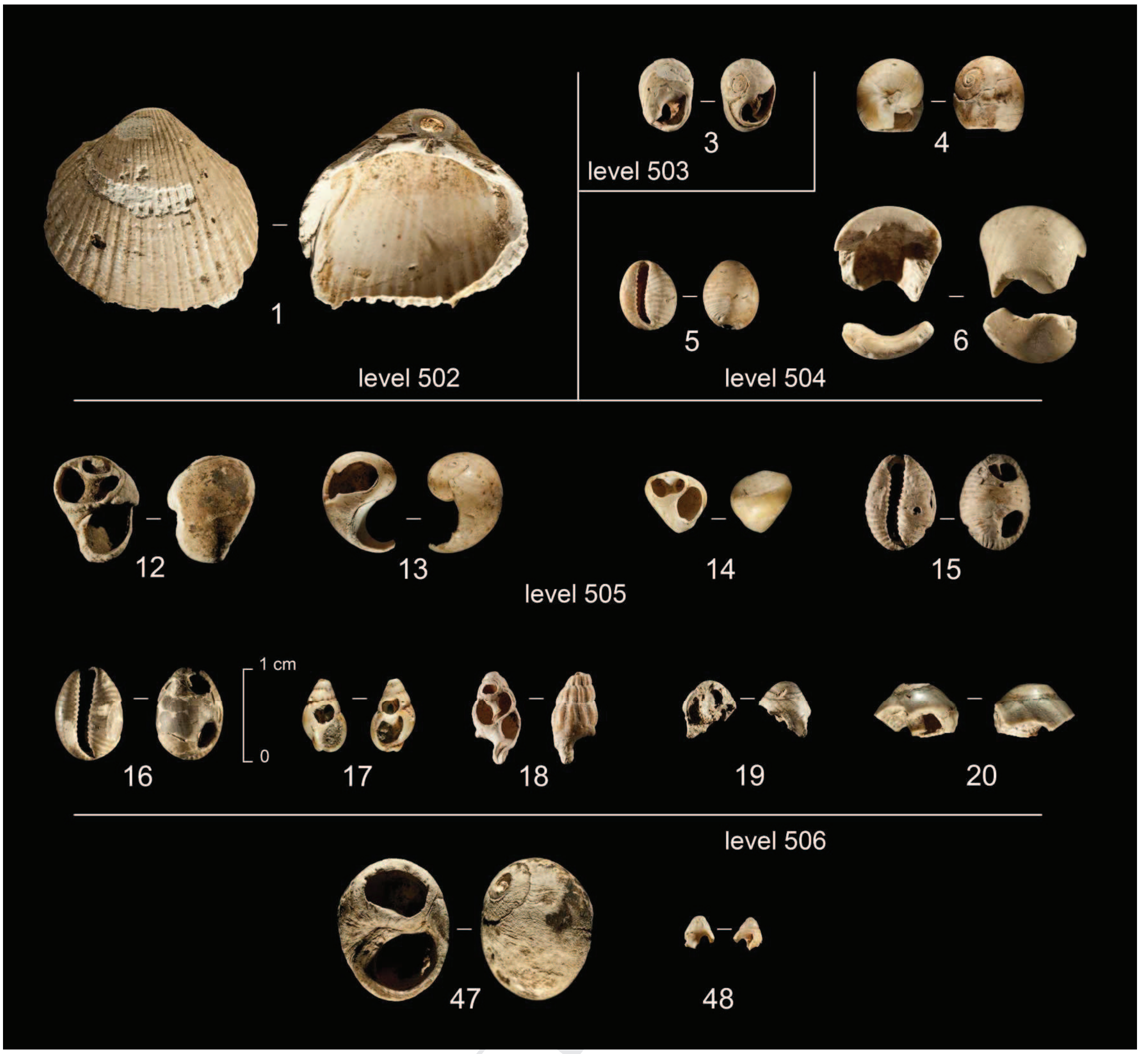
37	*Antalis* sp.	505	4,9	2,5			•				*
38	*Antalis* sp.	505	4	2,1						Serrated	
39	*Antalis* sp.	505	3,8	3,7			•				
40	*Antalis* sp.	505	3,4	3,6							
41	*Antalis* sp.	505	5,7	3,5			•				
42	*Antalis* sp.	505	10,2	2,9							
43	*Antalis* sp.	505	8,1	3,1			•				*
44	*Antalis* sp.	505	3	3			•			Serrated	*
45	*Antalis* sp.	505	2,3	3,7							
46	*Antalis* sp.	505	1,9	2,5			•			Serrated	
47	*Littorina obtusata*	506	14,3	13,6	8,2	7,7		6.6	4.3	Abrasion	•
48	*Nassarius* sp.	506	3,7	3,4			•			Abrasion?	
49	*Antalis* sp.	506	5,9	2,8							
50	*Capra pyrenaica*	506	16,9	4,4				1,4	1,1	Rotation	

Sample ID	Species	Level	Length	Width	Spire width	Aperture width	Ochre
51	*Littorina obtusata*	502	6,8	5,5	2,5	3	●
52	*Littorina obtusata*	503	6,6	7,2	3,5	3,9	●
53	*Littorina obtusata*	503					●
54	*Littorina* sp.	503					
55	Gastropoda sp.	503					
56	*Cyclope* sp.	503					●
57	*Littorina obtusata*	504	10,2	9	5,2	5,2	●
58	*Trivia* sp.	504					●
59	*Trivia* sp.	504					
60	*Nassarius* sp.	504					●
61	Bivalvia sp.	504					
62	*Littorina obtusata*	505					
63	*Trivia* sp.	505					●
64	*Trivia* sp.	505	10	8			●
65	*Nassarius* sp.	505					
66	*Turritella* sp.	505					●
67	*Pecten* sp.	505					●
68	*Pecten* sp.	505					
69	*Pecten* sp.	505					●
70	*Littorina obtusata*	506	7,6	7	3,7	3,9	
71	*Littorina obtusata*	506	8	7,1	3,6	3,9	
72	*Littorina obtusata*	506					
73	*Littorina obtusata*	506					
74	*Turritella* sp.	506					

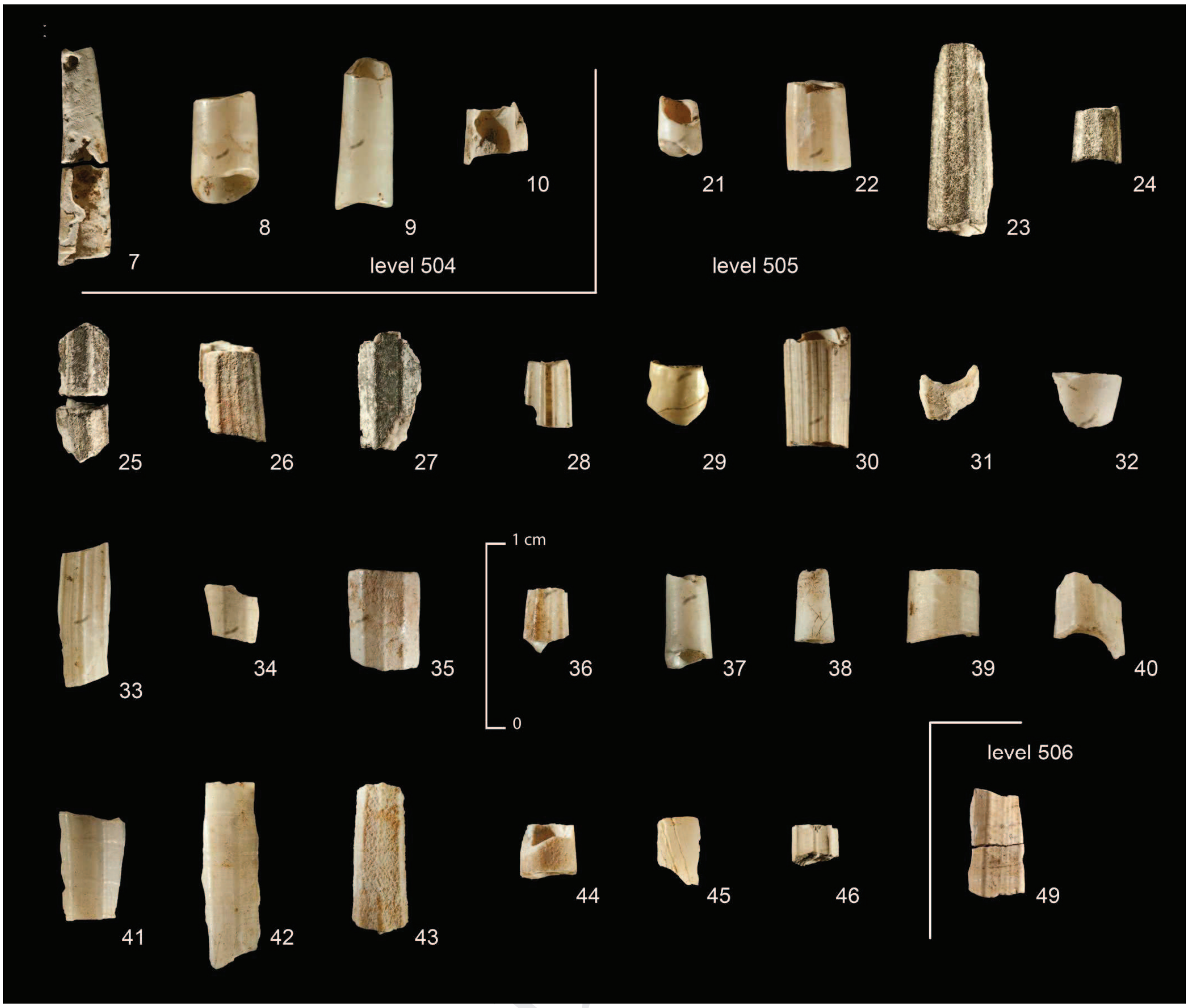

Cantabrian Sea
Santander
Bilbao
El Mirón
0
100 km
El Mirón Cave
Ramales de la Victoria (Cantabria)
Cave Entrance
Corral
Cabin
Burial area
Engraved block
Burial pit
meter
0
2
4
6
8
N

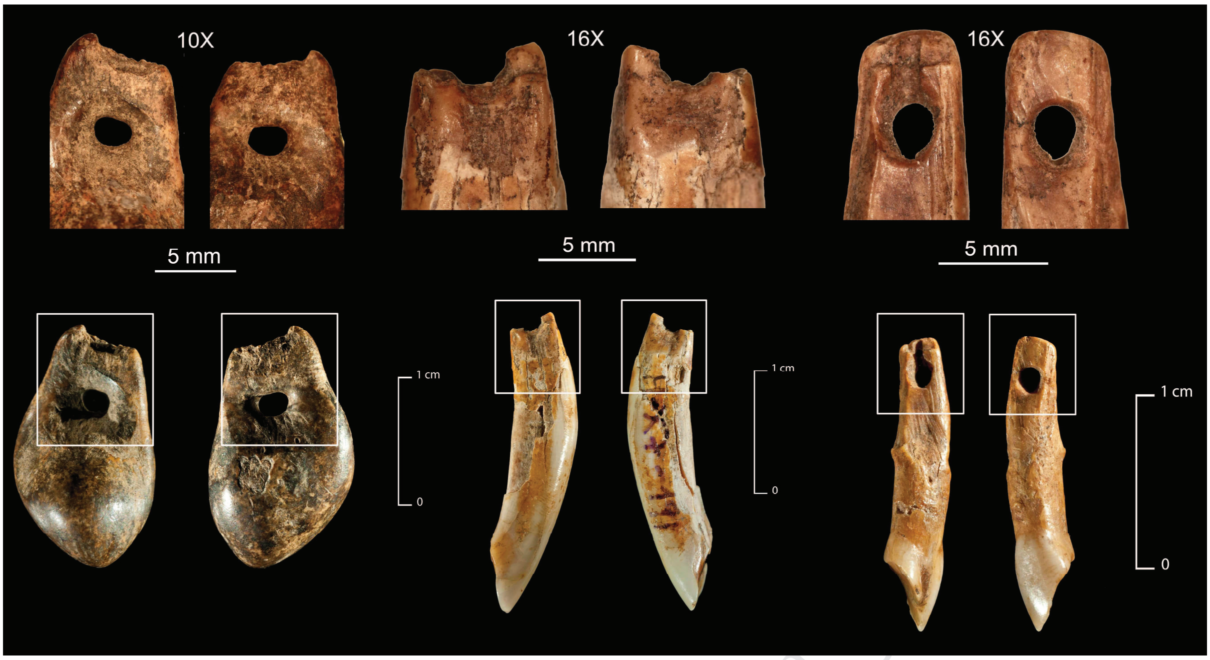

1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
IF
TTG
502
503
504
505
506


Carbonate coating
Manganese coating
Biodegradation
Burning
Color loss
Ornamentation loss
Total Taphonomic Grade
1.0
0.8
0.6
0.4
0.2
0.0
502
503
504
505
506

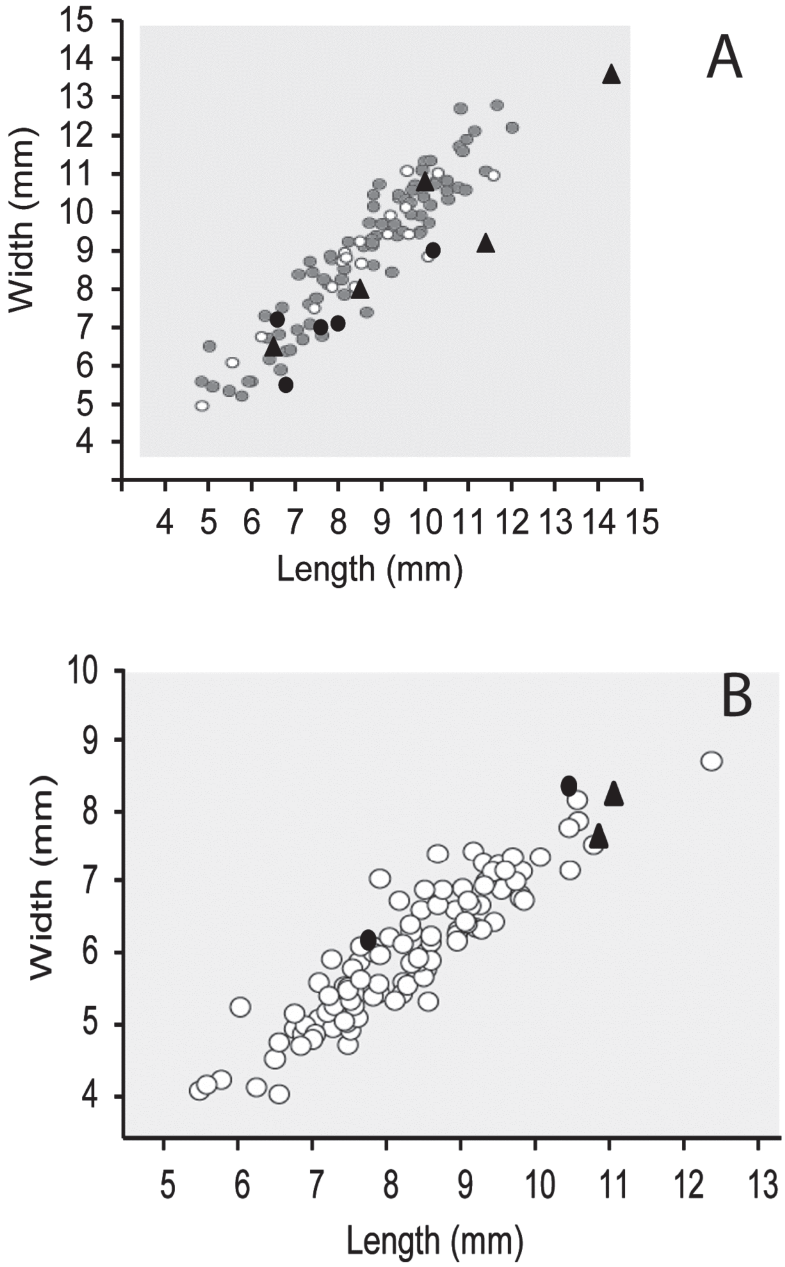


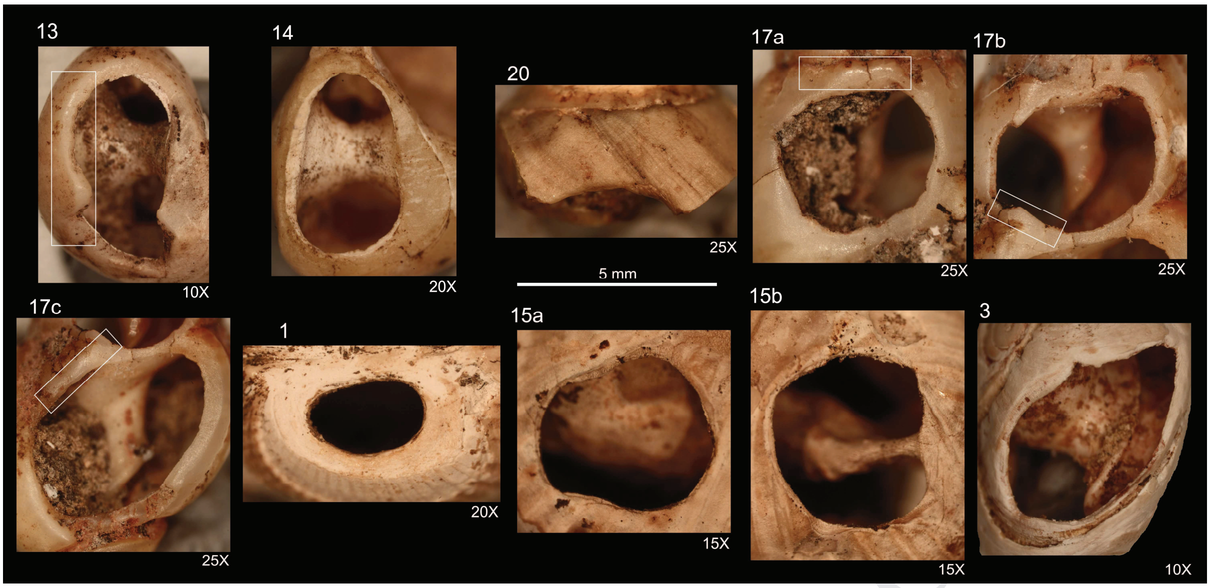
1
level 502
3
level 503
4
5
6
level 504
12
13
14
15
level 505
1 cm
0
16
17
18
19
20
level 506
47
48

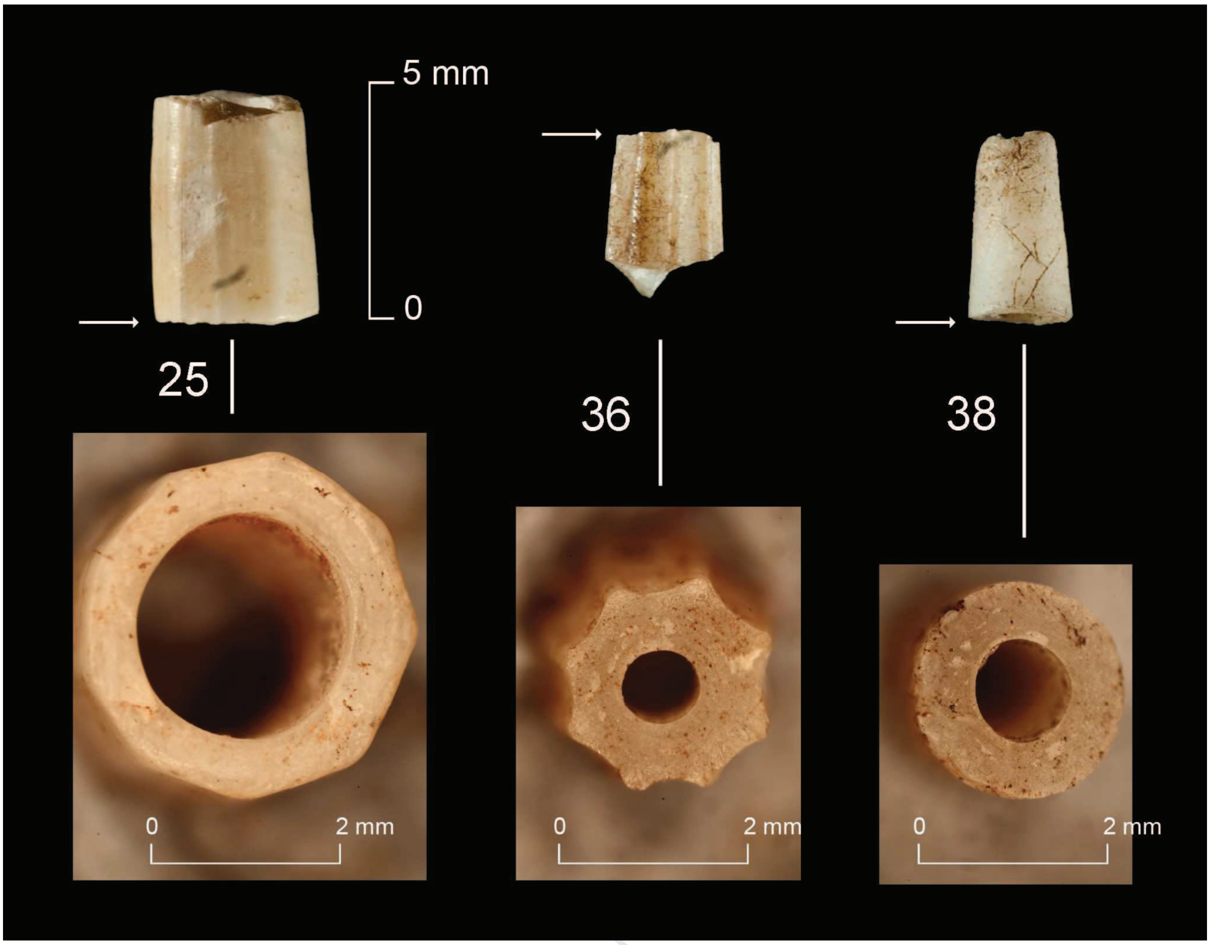

7
8
9
10
level 504
21
22
23
24
level 505
25
26
27
28
29
30
31
32
33
34
35
1 cm
0
36
37
38
39
40
level 506
41
42
43
44
45
46
49

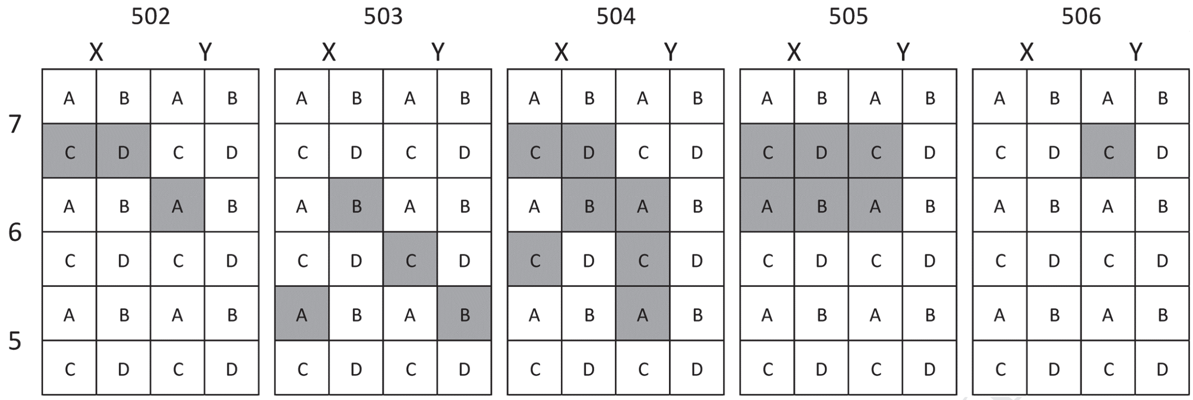

10X
5 mm
16X
5 mm
16X
5 mm
1 cm
0
1 cm
0
1 cm
0


51
level 502
52
level 503
53
54
55
56
57
level 504
58
59
60
61
62
63
64
level 505
65
66
level 506
1 cm
0
67
68
69
70
71
72
73
74


A
Width (mm)
Length (mm)
B
Width (mm)
Length (mm)


13
10X
14
20X
20
25X
5 mm
17a
25X
17b
25X
17c
25X
1
20X
15a
15X
15b
15X
3
10X


5 mm
0
25
36
38
0
2 mm
0
2 mm
0
2 mm


502
503
504
505
506
X
Y
7
6
5
A
B
C
D

Highlights

- A Lower Magdalenian burial of an adult woman was excavated at El Mirón Cave.
- Perforated shells and teeth from the Magdalenian burial area were not grave goods.
- Ornamental objects were related to habitation levels.
- Ornaments played a social role facilitating communication and exchanges among humans.