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ABSTRACT: Coastal adaptations of Palaeolithic foragers along the north Atlantic seaboard have received renewed attention in the last decade and include growing evidence for exploitation of whale bone by Late Glacial Magdalenian groups to the north of the Pyrenees. Here we present a systematic revision of Magdalenian osseous industries from the Cantabrian region designed to explore whether this phenomenon was more widely shared by hunter-gatherer groups along the Atlantic coast of the northern Iberian Peninsula. Fifty-four whale bone objects were identified from 12 of the 64 sampled sites. Essentially represented by large, finished weapon elements (projectile points), these objects are primarily associated with the middle phase of the Cantabrian Magdalenian, and overlap slightly with the beginning its upper and probably the end of its lower phases. More broadly, the circulation of these objects evinces regular, long-distance (ca. 600 km) communication networks operating on both sides of the current French and Spanish Basque Country between 17.8 and 15 cal ka BP. The structure of this network poses interesting questions concerning potential social and/or economic interactions between Magdalenian groups from the Pyrenees and neighbouring Cantabrian region. We suggest that the use of whale bone by these particularly mobile hunter-gatherer groups for the production of hunting weapons was connected to the longer use-life afforded by the large size of this particular raw material. This choice potentially reflects attempts to offset raw material transport costs by privileging their regular maintenance rather than the replacement of hunting weaponry. This growing body of evidence for the exploitation of marine resources during the Magdalenian further reinforces the Bay of Biscay being the backdrop to the emergence of the first regular, diversified and organized coastal economies at the end of the Last Glaciation.

KEYWORDS: North Atlantic, osseous technology, southwestern Europe, Late Upper Palaeolithic, coastal adaptations, communication networks

1. Introduction

Hunter-gatherer adaptations to coastal environments remain a key issue in European prehistoric research, especially along the northern Atlantic coast of the Iberian Peninsula. The emergence of these subsistence practices is reflected in the discovery of marine shells from Palaeolithic and Mesolithic assemblages, as well as depictions on rock art, which were recognised relatively early on in the history of the region's archaeological research (e.g., Alcalde del Río, 1906; Vega del Sella, 1914, 1916, 1930; Obermaier, 1916; Hernández-Pacheco, 1919, 1923; Aranzadi y Barandiarán, 1935; Breuil and Obermaier, 1935). Evidence for the exploitation of coastal resources at European Palaeolithic sites has grown progressively, leading to a critical reassessment of their importance for both the subsistence needs and symbolic practices of Palaeolithic hunter-gatherer groups (see for example Madariaga, 1963, 1966; Altuna, 1976, 1986; Straus et al., 1980; Straus, 1981; Balbín and Moure, 1981; Poplin, 1983; Sonneville-Bordes and Laurent, 1983; Cleyet-Merle, 1990; Cleyet-Merle and Madelaine, 1995; Bailey and Craighead, 2003; González Morales et al., 2004; Álvarez-Fernández, 2006, 2011; Roselló and Morales, 2014; Gutiérrez-Zugasti, 2009; Gutiérrez-Zugasti and Cuenca-Solana, 2015; Gutiérrez-Zugasti et al., 2015). New finds and studies over the past decade have pushed the earliest exploitation of coastal resources into the European Middle Palaeolithic (Colonese et al., 2011; Álvarez-Fernández, 2015; Zilhão et al., 2020), and led to a reassessment of the role of coastal environments in human evolution and dispersal events (Erlandson, 2001; Álvarez-Fernández, 2011; Marín-Arroyo, 2013; Pétillon, 2016; Will et al., 2019; Zilhão et al., 2020).

Reconstructing Pleistocene coastal environments is complicated by the highly fragmentary nature of the archaeological record (Bailey and Flemming, 2008; Bicho and Haws, 2008). Large portions of previously accessible coastal areas are now submerged depending on both marine transgressions and coastal geography (Deschamps et al., 2012; Benjamin et al., 2017). Nevertheless, a handful of well-preserved Iberian sites, which were close to the paleoshore, provide evidence for the exploitation of these areas from the Middle (Figueira Brava, Arrábida, Portugal; Zilhão et al., 2020) to the Late Upper Palaeolithic (Santa Catalina, Vizcaya, Spain; Berganza and Arribas, 2014a; Nerja, Málaga, Spain; Álvarez-Fernández et al., 2014; Morales-Pérez et al. 2019). Depending on the region, these adaptations potentially included the consumption of marine fish and birds, echinoderms, molluscs, crustaceans, as well as the exploitation of marine mammals (i.e., seals and cetaceans) and tortoises (Sonneville-Bordes and Laurent, 1983; Cleyet-Merle, 1990; Cleyet-Merle and Madelaine, 1995; Álvarez-Fernández, 2006; 2011; Álvarez-Fernández et al., 2014; Corchón et al., 2008; Pétillon, 2013, 2016 ; Castaños, 2014; Laroulandie, 2014; Morales-Pérez et al., 2019; Zilhão et al., 2020). Depictions of marine animals in rock and mobiliary art, as well as the use of sea mammal teeth or marine shell for mobiliary art and personal ornaments, comprise a growing body of evidence for the symbolic use of marine resources from the beginning of the European Upper Palaeolithic (Poplin, 1983; Taborin, 1993, 2004; Serangeli, 2003; Álvarez-Fernández, 2011; Pétillon, 2018).

Evidence for the exploitation of cetaceans by European hunter-gatherers follows a similar trend; being rare in the first part of the Upper Palaeolithic and becoming more numerous in the second half, especially during the middle and upper phases of the

Magdalenian (19-13 cal ka BP) (Pétillon, 2018). During this latter period, several unworked (Duruthy, Nerja) and worked (Las Caldas, Mas d'Azil) odontocetes teeth (i.e., Delphinidae, P. macrocephalus, G. melas), whale barnacle plates from Las Caldas and Nerja (suggested to have been imported still adhering to the skin), as well as a cut-out contour (*contour découpé*) and a pendant, both possibly on large cetacean bones, have been documented from Isturitz and Balmori, respectively (Poplin, 1983; Corchón et al., 2008; Rivero, 2014; Aura et al., 2016; Boneta et al., 2018). Over the last decade, this list has been supplemented by several dolphin remains (mandibles and vertebrae) from Nerja as well as 41 unworked whale rib and vertebra fragments from Santa Catalina (Álvarez-Fernández et al., 2014; Castaños, 2014; Morales-Pérez et al., 2019).

In addition to evidence for the exploitation of cetaceans by Magdalenian groups to fulfil subsistence and symbolic needs, more than one hundred whale bone tools and weapons have been recovered from sites north of the Pyrenees (Fig. 1), to which can be added a foreshaft from Andernach-Martinsberg (Rhineland, Germany), a grey whale bone projectile point from La Madeleine (Dordogne, France) and two points from Las Caldas (Asturias, Spain) (Pétillon, 2013; Langley and Street, 2013; Corchón and Ortega, 2017; Pétillon et al., 2019). These discoveries shed light on interactions between prehistoric hunter-gatherer groups and coastal areas, including the long-distance transport of whale bone objects for technical needs. Taken together, the Magdalenian appears to witness the emergence of the earliest regular and diversified coastal economies in prehistory (Marín-Arroyo, 2013; Pétillon, 2016).

In this context, the near total absence of whale bone objects during the Magdalenian in the Cantabrian region is particularly surprising as; (1) Magdalenian sites in this area have produced rich osseous industries (Utrilla, 1981; Mújica, 1983; González Sainz, 1989; Adán, 1997; Corchón and Ortega, 2017; Duarte and Rasilla, 2020); (2) eastern sites in the region are in close geographic continuity with sites north of the Pyrenees that produced the first evidence for whale bone objects; and (3) Cantabrian sites are generally closer to the Atlantic coast than those in the Pyrenees. The morphology of the continental shelf, which is particularly narrow and abrupt in the Cantabrian region, limited the displacement of the paleoshoreline following the last marine transgression. While the Cantabrian coast has been submerged only 10 to 20 km since the Last Glacial Maximum (LGM), the coastline has retreated 10 km in the French Basque Country and almost 150 km in the Charente-Maritime and Vendée *départements* (Fig. 1-2). Consequently, there is a much higher probability of identifying evidence for the exploitation of marine resources in the south of the Bay of Biscay (Cantabrian region), than on the Landes coast. Finally, the region has already produced substantial evidence for the use of marine resources, including the first instance of whale bone objects from a Magdalenian context in Spain (Corchón and Ortega, 2017). Here we explore whether the use of whale bone was a strictly local phenomenon limited to the Pyrenean region or was more widely shared amongst hunter-gatherer groups along the Atlantic coast by documenting whale bone artefacts from sites outside the Pyrenees.

2. The western Pyrenean and Cantabrian regions: geographical, paleoenvironmental and archaeological contexts

Located along a middle latitude, the Cantabrian region is limited to the north by the Cantabrian Sea, the southernmost portion of the Bay of Biscay, which also forms the western limit of the Pyrenean region (Fig. 1-2). The high mountains of the Pyrenees currently lie around 80 km from the present-day coast and are constituted in their western limit by the medium-altitude mountains of the Adour Valley. The Pyrenean chain is connected to the Cantabrian coast and Ebro Valley by the Basque-Cantabrian Basin. The Cantabrian Mountains, which are closer and run parallel to Cantabrian coastline, reach lower altitudes. The Cantabrian region comprises a 40 to 70 km littoral band extending east-west over approximately 350 km, from the Bidasoa River in eastern Guipúzcoa to the Nalón River in central Asturias. The hydrological system is predominantly organised north-south, apart from several rare instances of waterways following east-west oriented structural depressions of the Nervión, Saja, Cares, or Nalón Rivers (Fig. 2, Hernández-Pacheco, 1932; Hernández-Pacheco et al., 1957; Bernaldo de Quirós, 1982; González Sainz, 1989; Hoyos, 1995; Jordá et al., 2014; Rasilla et al., 2020).

Cantabrian Magdalenian sites are particularly close to the paleoshore and generally occupy altitudes ranging from 20 to 300 m.a.s.l. (cf. Fig. 2) (Rasilla and Straus, 2004; García-Moreno, 2013). Most Magdalenian sites are limestone caves and rock-shelters, with the relative absence of open-air sites reflecting the history of excavations and field surveys. Notwithstanding potential biases introduced by fieldwork, river valleys and permanent snow cover seem to have impacted the north-south occupation of the Cantabrian region during most of the Magdalenian. Raw material transfers (Piedramuelle, Piloña and Flysch flints) evince connections with the southern slope of the Cantabrian chain only from the Mesolithic onwards (Herrero-Alonso et al., 2020). To the west, the lack of Magdalenian sites reflects the absence of karstic networks providing natural shelters but also field surveys (Duarte et al., 2016). The currently submerged littoral zone is abrupt and includes a well-developed karstic system (Roca et al., 2011; Tugend et al., 2014; Pedreira et al., 2015; Pedrera et al., 2017; Cadenas et al., 2018; Teixell et al., 2018; Arias, 2020).

The period following the Last Glacial Maximum witnessed substantial climatic instability. During the Older Dryas (ca. 18.5 to 15 cal ka BP), open grasslands composed essentially of heaths were colonised by multiple pioneer taxa (e.g., Juniperus, Salix, Hippophae rhamnoides), marking a transition from wet to dry conditions (Naughton et al., 2007, 2009; Cuenca-Bescós et al., 2009; Iriarte et al., 2015; Uzquiano, 2019). In the Bay of Biscay, marine records reflect improved climatic conditions emerging with Heinrich event 1 (HE1) from around 19-14.8 cal ka BP. Ice sheet breakup in the North Atlantic Ocean resulted in cooler surface waters and the deposition of ice-rafted sediments (Cacho et al., 2001; Pailler and Bard, 2002). Benthic foraminifera in sea-floor deposits from the south-east of Bay of Biscay are consistent with extremely cold waters, high trophic levels, and variable oxygenation throughout MIS 2 (ca. 27-14.8 cal ka BP), with particularly unstable environmental conditions prevailing during HE1 (Pascual et al., 2020). The incorporation of coastal species in benthic foraminifera records indicates increasing riverine input during the middle of HE1 (ibid.)

With the end of the Older Dryas and the abrupt Bølling-Allerød interstadial warm phase (ca. 15-13 cal ka BP), pine and junipers forests became more widespread in parallel with the expansion of highly diverse deciduous forests, which were previously limited to the south of the Iberian Peninsula (Cuenca-Bescós et al., 2009; González-Sampériz et al., 2010). Like other peninsulas in southern Europe, the Cantabrian region served as a refuge for animals and humans during cold climatic conditions (i.e., the LGM; Consuegra et al., 2002; Meiri et al., 2013; Fu et al., 2016) and a source area for re-expanding populations coincident with the return of more temperate climates (Villalba-Mouco et al., 2019).

The earliest phase of the Magdalenian, the Initial Magdalenian (IM: ca. 20.5 to 20 cal ka BP), is poorly represented during the LGM (Fontes, 2016; Utrilla et al., 2020). The number of Magdalenian sites then increases rapidly, numbering 40 to 60 for the Cantabrian Lower Magdalenian (CLM: ca. 20 to 17.5 cal ka BP) and Middle Magdalenian (MM: ca. 17.5 to 16 cal ka BP) to around 65 to 70 sites during the Upper and Late Magdalenian (ULM: ca. 16 to 13.5 cal ka BP) (Straus, 2015; chrono-cultural phases based on data from Utrilla, 2004; González Sainz and Utrilla, 2005; Aura et al., 2012; Fontes, 2016; Langlais, 2020). Cantabrian Magdalenian sites reflect multi-season occupations by nomadic groups, who primarily exploited red deer and ibex depending on the biotope (see for example Altuna, 1972; Costamagno and Mateos Cachorro, 2007; Marín-Arroyo, 2010; Portero et al. 2019). While the exact mobility systems of the region's Magdalenian hunter-gatherer groups is still a matter of some debate, rich and regularly available resources favoured stable territories (Butzer, 1986, Straus, 1986) integrated within a long-distance settlement network (Sieveking, 1976; Conkey, 1980; Bahn, 1984; Utrilla and Martínez-Bea, 2008; Rasilla and Duarte, 2018).

3. Materials and methods

3.1. Osseous industries and study design

We carried out a systematic review of the largest osseous industries from the Cantabrian Magdalenian (Table 1, Fig. 2). Magdalenian levels from 64 sites were selected based on the cultural attributions proposed by the excavators or subsequent revisions (Table 1). In two cases (Bolinkoba and Cueto de la Mina), Solutrean collections were integrated for comparison. Except for teeth, all worked osseous (bone, antler, ivory) artefacts (tools, weapons, mobiliary art and personal ornaments) were examined, including complete objects, waste products and by-products. As some collections derive from early excavations (before the 1960s), available contextual information varies between assemblages and is usually affected by recovery biases due to pre-modern excavation methods as well as the fact that worked osseous artefacts are unlikely to have been systematically recovered. The relative importance of whale bone artefacts in each osseous industry was calculated by dividing the number of whale bone artefacts by the total number of osseous artefacts (cf. Tab. 2). This, however, was only possible when the relevant data was available in the literature or provided by the excavator (e.g. Santa Catalina).

The study area comprises the present autonomous communities of Asturias, Cantabria, the Spanish Basque Country (provinces of Vizcaya and Guipúzcoa), and Navarra. The examined Magdalenian sites are found in four zones (ca. 1,000-8,000 km^2) that more or less correspond to modern administrative borders: [A] Central Asturias, [B] Eastern Asturias, [C] Cantabria and [D] the Spanish Basque Country and Navarra (Fig. 2). The number of sites varies between zones: zones D (n=22) and

C (n=21) contain the highest number of sites followed by zones B (n=14) and A (n=7). All distances are reported as the crow flies.

In order to generate the most robust relative chronology for the exploitation of whale bones, we assessed available radiocarbon dates for each level and the reliability of associating each date with the identified whale bone artefacts (Text S1). Dates were calibrated using the IntCal20 atmospheric radiocarbon curve (Reimer et al., 2020) and the Marine20 curve (Heaton et al., 2020) for terrestrial and marine samples, respectively. Then marine reservoir effect was corrected by applying an updated local ΔR value of -426 ± 92 years based on data from the CLM level E of Cualventi (in Monge Soares et al., 2016). This coefficient should be considered with caution, as it does not incorporate variations in marine carbonates linked to whale behaviour. Depending on the species, whales can spend a considerable portion of their lives in deep seas where they accumulate significant reserves of old carbon. Despite these shortcomings, this ΔR value is nevertheless the most precise currently available for the Cantabrian region.

3.2. Criteria for identifying whale bone artefacts

Cetacean bone is a biomaterial with singular characteristics. Long bones lack a medullary cavity and the skeleton is generally highly porous, reflecting cetaceans' skeletal adaptions for improved hydrostatic locomotion (buoyancy control) and deep-sea diving (Gray et al., 2007). In the terms of histology, cetacean bone presents no clear distinction between compact and cancellous tissue, unlike antler and most terrestrial mammal bones. Cetacean compact bone tissue is generally a thin layer at the periphery of the bone, although it can be denser towards the proximal part of ribs (e.g., Bowhead whale; Betts, 2007) and in the mandible of certain odontocetes (O'Connor, 1982; Mulville, 2002). Compared to most other osseous materials, such as antler, ivory, or terrestrial mammal bone, cetacean compact bone tissue is porous with an evenly spaced network of alveoli (for more details see Felts and Spurrell 1965; Currey 1979; Margaris 2006; 2014; Pétillon 2008; Reiche et al. 2011).

These characteristics make it possible to distinguish cetacean bone from other osseous raw materials, particularly artefacts made on rod blanks (i.e., projectile points). Antler objects present opposing surfaces with clearly different aspects, one compact, the other cancellous, whereas cetacean bone objects display a more homogeneous mass of highly dense porous tissue. Cetacean bone objects are also lighter due to the porosity of the tissue, which also helps distinguish it from ivory as well as from most terrestrial mammal bones. This latter material represents the most probable risk of confusion when determining cetacean bone uniquely from macroscopic features (e.g., Boneta et al., 2018). The largest terrestrial mammal specimens (*Mammuthus primigenius*, *Coelodonta antiquitatis)* are poorly documented in the Iberian Peninsula during MIS 2, and were likely relatively rare after the LGM (Álvarez-Lao et al., 2009; Álvarez-Lao and García, 2010, 2011). Nevertheless, the risk of confusion with large terrestrial species (e.g., *Bison priscus*, *Bos primigenius*) cannot be entirely excluded.

The large size of the cetacean bone artefacts identified in the Magdalenian collections is consistent with a determination as whale bone (Pétillon, 2008; 2013; Pétillon et al., 2019; Langley and Street, 2013) rather than a smaller cetacean (e.g.

dolphin or porpoise). An object being made in whale bone was thus considered as “certain” when: (1) the object displayed a very homogeneous osseous tissue without a clear distinction between compact/cancellous tissue and there was no evidence of a medullary cavity, (2) the artefacts were made from an extremely dense porous tissue, and (3) the artefacts were lighter compared to objects of similar size and undoubtedly manufactured from terrestrial mammal bone or antler. Artefacts were classed as ‘possible’ if any of these three criteria were absent.

4. Results

4.1. The whale bone assemblage

Our examination of Magdalenian worked osseous assemblages from 64 sites in the Cantabrian region produced 54 whale bone objects (Tab. 2), 26 of which were classed as ‘certain’ given the presence of all three criteria outlined above. The porosity of the material is probably the most distinctive identification criteria. Here, it was confirmed through the distribution of alveoli, which appear evenly distributed in cross-section (Fig. 3: 1a, 2c, 3e, 4g) and on the surface of the artefacts, where they are intersected longitudinally by striations left by scraping (e.g., Fig. 3: 1b, 2d, 3f, 4h).

The variable structure of the remaining 28 artefacts meant they were classified as ‘possible’. Four non-exclusive factors condition this variability: (1) inter-site differences in taphonomic alteration affecting the preservation of the osseous tissues, (2) intra-species anatomical variability linked to the age or sex of whales, or the anatomical part concerned (e.g., mandibles, ribs or cranial elements), (3) inter-specific anatomical variability (e.g., grey, fin or sperm whale), and (4) an error in determination. Nevertheless, when the 28 ‘possible’ whale bone artefacts are excluded from the analysis, the geographical and the chronological distributions remain the same, demonstrating that, while some identification bias cannot be excluded, its potential effect on the sample is relatively minor.

Although all 54 whale bone objects had been previously studied (see references in Table 1 and 2), raw materials were not analysed in detail and, therefore, artefacts were generally identified as antler, bone or indeterminate bone/antler. Of the two objects from Las Caldas previously reported as whale bone (Corchón and Ortega, 2017, 364: 1281; 534: 1967), our analysis only confirmed the first one. Owing to lingering doubts about the nature of the raw material (Boneta et al., 2018), we also excluded the large pendant from Balmori.

4.2. Techno-typological characteristics of the assemblage

The large majority of these artefacts are made on rod blanks (*baguette*). Projectile points (n=37) are best represented (Tab. 3) and are characterised by the presence of a pointed distal extremity (n=29) and/or proximal hafting modification (n=8). These artefacts can be grouped into three types (in descending order): four double-bevelled points (Fig. 4: 1-2), three massive-based points (Fig. 4: 5-6) and one fork-based point (Fig. 4: 7).

All 37 point fragments are quadrangular, triangular, or circular in cross-section, as are the antler specimens (Adán, 1997; Utrilla, 1981; González Sainz, 1989; Corchón and

Ortega, 2017; Duarte and Rasilla, 2020). All of these points find typological equivalents in the much more frequent antler points from Cantabrian assemblages. As is the case with most of the hafted elements (projectile points and foreshafts), the bevelled surfaces bear parallel, transverse striations commonly described as related to better fixing the point on the haft (Allain and Rigaud, 1986, 1989; Julien, 1999; Weniger, 2000). Four whale bone examples from the MM levels IX and X of Las Caldas all bear several longitudinal grooves on one or both surfaces of the shaft (e.g., Fig. 4: 3-4). These modifications were very likely designed to receive bladelets fixed with an adhesive in order to improve the efficiency of the weapon to shred flesh upon entry (see, for example, Allain and Rigaud, 1986; Houmard and Jacquot, 2009; Pétillon et al., 2011).

In terms of size, projectile points are relatively large, measuring on average 12 mm in width and 9.3 mm in thickness (cf. Tab. 5). Accurately estimating their initial average length is, however, challenging given use-related (Pétillon et al. 2016a) or post-depositional fractures. The three almost-complete points comprise a 112 mm-long fork-based point from Las Caldas-VI (Fig. 4: 7), a 185 mm-long massive-based point from Urtiaga-E (Fig. 4: 6), and a larger, less regular 200 mm long massive-based point from Ermittia-III (Fig. 4: 5). The only longer piece is a mesio-distal fragment of a massive point from Ermittia-III: 214 mm-long (Fig. 7: 1).

The weaponry assemblage is completed by a much smaller number of possible foreshafts (n=4) (Fig. 5). Although they are difficult to distinguish from projectile points owing to their fragmentary nature, certain morpho-technical aspects set them apart (Cattelain, 1993; Pétillon, 2006), particularly parallel or divergent edges. Independent of the hafting system, stand-alone points always have convergent edges forming a distal point. The parallel or divergent edges of a specimen from Las Caldas (Fig. 5: 1) and the longest specimen from El Pendo (Fig. 5: 2) both argue in favour of a hafting arrangement involving both ends of the piece. With a quadruple-bevelled base forming a pyramid, the hafting arrangement of the Las Caldas piece is relatively rare in Magdalenian bone tool assemblages (Corchón and Ortega, 2017). In certain cases, the hafting arrangement can allow foreshafts to be distinguished from stand-alone points, as is the case with the concave single-bevelled point from El Pendo (Pétillon, 2006), or the double-bevel of a specimen from La Viña-IV (Fig. 5: 3). The length of the bevels combined with the lateral shaping of their edges rather than surfaces (see Delporte and Mons, 1988 for more details) distinguish this specimen from the stand-alone points from La Viña-IV as well as those from other Cantabrian assemblages (see for example González Sainz, 1989; Corchón and Ortega, 2017; Duarte and Rasilla, 2020). Finally, a piece from Ermittia-III has a forked base with a central groove on the shaft (Fig. 5: 4), a trait absent on stand-alone fork-based points (Pétillon, 2006). These four pieces therefore appear to have been arranged in an intermediate hafting position between the shaft and point as part of composite weapons (Cattelain, *op. cit.*; Pétillon, *op. cit.*). The last two foreshaft types (Fig. 5: 3-4) are generally associated with MM fork-based points, which are numerous at La Viña-IV and rare at Ermittia-III (González Sainz, 1989; Duarte and Rasilla, 2020). The single-bevelled foreshaft from El Pendo could be associated with single-bevelled points, as this combination has already been reported from El Juyo (Barandiarán, 1985). As no complete pyramidal-based foreshafts ("quadruple-bevelled base" *sensu* Corchón and Ortega, 2017) are currently known in the Cantabrian region, it is impossible to determine the type of projectile point associated with this potential hafting arrangement.

All these weapon elements bear impact fractures (Fig. 4: 1, 2, 4; Fig. 5: 1-2; Fig. 6: 1-2) and traces of subsequent maintenance and reworking. A point from Ermittia-III was re-sharpened (Fig. 4: 9), while three additional waste products bear traces of sectioning on one extremity that according to Chauvière and Rigaud (2005, 2008) reflect manufacturing or maintenance processes. These pieces result from the re-centring or shortening of a point during shaping (Fig. 4: 8) or the shortening of a preform (Fig. 6: 4), while the third, a foreshaft from La Viña (Fig. 5: 3), bears traces potentially linked to maintenance or shaping.

We also identified a blunt tool with a smoothed distal extremity (Fig. 6: 5), as well as several indeterminate objects made on rod blanks. These include a noteworthy specimen from Tito Bustillo (Fig. 6: 3), whose short bevel and parallel edges are comparable with the foreshaft from El Pendo, although the flattened cross-section is more compatible with a wedge. This is also the case for a spatula-shaped, distal extremity of an object from La Viña-IV, which could be interpreted as the reworking of the proximal portion of a point due to the presence of at least two bevels, each shaped on an edge (Fig. 6:1). Finally, a potential part of a rod blank from El Juyo (Fig. 6: 6) could be consistent with a projectile point blank in terms of its size and shape. This relatively short fragment (81mm) has a triangular, irregular cross-section and is slightly larger than most whale bone projectile points we identified (16 x 13 mm) (Tab. 5). How this implement was manufactured is not evident and may have incorporated fracturing techniques (see among others Christensen, 2016).

Some of the worked whale bone objects bear little decoration or, at most, display several grooves or geometric motifs. However, several rare examples stand out given their more complicated decoration, such as the foreshaft from El Pendo (Fig. 5: 2) that bears opposed curvilinear motifs filled with short longitudinal and transverse lines (Corchón, 1987: 432). One point fragment from Ermittia-III (Fig. 7: 1-1a) has a series of geometric motifs on each edge, seemingly protuberances (González Sainz, 1989) or “barbs” of so-called proto-harpoons (Barandiarán and Utrilla, 1975; Corchón, 1987, Cattelain, 1995). A wide mesial fragment, also from Ermittia-III, has a complex geometric decoration on each surface and edges (Fig. 7: 2-2b; González Sainz, 1989: Fig. 42: 12).

In addition to the large majority objects made on rod blanks, two possible thin whale bone plaquettes were recovered from level D of Urtiaga. One example is entirely shaped and bears a series of aligned, rounded protrusions (Fig. 7: 4; González Sainz, 1989: 51.16). The second shares the same size and morphology as well as histological traits but is unshaped (Fig. 7: 3). The unique characteristics of the blanks (fine bone plaquettes, compact porous tissue; Fig. 7: 3d-4e) could suggest the use of a different anatomical part compared to the other whale bone objects made on rod blanks.

In terms of technology, the heavily finished aspect of almost all the objects makes it extremely difficult to reliably infer associated production methods. The possible blank from El Juyo might involve fracturing techniques (Fig. 6: 6), as suggested by fracture planes on both edges (for more details concerning fracturing methods applied to whale bone see Christensen, 2016). However, it is impossible to rule out the use of other manufacturing techniques (i.e., grooving). Sub-actual hunter-gatherer groups employ multiple blank production techniques, including fracturing and grooving (Betts, 2007; Wells, 2012; Cunliffe and Brooks, 2016). No debitage waste products were identified in any of the studied assemblages, only those related to manufacturing or maintenance. This does not necessarily reflect the technical choices of Magdalenian groups but is likely tied to the fact that we focused on worked osseous artefacts rather than on an overall revision of entire faunal assemblages. This being the case, the likelihood that waste products are present in faunal collections from early excavations cannot be ruled out, as many have not been or have only been partially revised. However, given the large dimensions of whale bone and despite the high fragmentation rate of the faunal assemblages, it is doubtful that debitage waste products were overlooked during excavations or subsequent analyses. Nevertheless, their absence from inland collections confirms that the first phases of blank reduction and debitage occurred closer to the now-submerged paleoshore of the Atlantic Ocean (Pétillon, 2013). Faced with the small number of blanks, it seems that the shaping of whale bone objects equally took place near the coast. In some instances, however, unworked blanks would have been transported for future shaping, demonstrating both a chronological and geographical segmentation of production activities.

Despite the absence of blocks of raw material, certain morphometric characteristics of the assemblage provide indirect information concerning raw material selection patterns. The straightness and length of specific points (>200 mm), their large calibre, and the fact they comprise essentially compact albeit porous tissue, sheds light on their possible anatomical origin. Like certain Canadian Inuit hunter-gathers (Betts, 2007), and perhaps several paleo-Eskimo groups in Newfoundland (Wells, 2012), who also manufactured large whale bone objects on rod blanks (i.e., foreshafts, wedges, sled runners), it is highly likely that Magdalenian objects come from the straightest, most dense parts of the skeleton of large cetaceans (i.e., mandibles or ribs).

4.3. Chronological distribution

Among these 54 whale bone artefacts, the foreshaft from El Pendo is currently the only directly dated from the Cantabrian region (Barandiarán, 1988; Fig. 5: 2). Of the 25 archaeological levels that produced whale bone objects (Tab. 2), six have not been dated: level III of Tito Bustillo (Área de Estancia, García Guinea excavations), level D of Cueto de la Mina, level 2 of El Pendo, level 8 of El Juyo, level IV of Bolinkoba, and level E of Urtiaga. In total, we collated 46 dates from 19 Magdalenian levels. When the context and quality of the excavations precluded a reliable association between the dated samples and the whale bone objects in each archaeological level, the dates were excluded (see S1 for selection criteria). Of the 46 available dates, only 16 were retained (Table 4); five obtained using conventional radiocarbon dating and ten with AMS (the date from Urtiaga-D was published without methodological information, Areso-Barquín et al., 2018).

Once calibrated, the dates range from 19.3 and 13 cal ka BP, with a slight concentration around 17.8 to 15.5 cal ka BP (Fig. 8). This chronology broadly corresponds to the development of the Middle Magdalenian (MM) in the Cantabrian region and overlaps slightly with the emergence of the Upper Magdalenian (UM) (González Sainz, 1989; Utrilla, 2004; González Sainz and Utrilla, 2005; Corchón, 2017; Duarte and Rasilla, 2020). In fact, around two-thirds of the objects (n=35, see Table 2) come from the MM or MM/UM levels of three sites: Las Caldas (Corchón and Ortega, 2017), La Viña (Duarte and Rasilla, 2020), and Ermittia (González Sainz, 1989; Esparza and Mujika, 1999).

However, a handful of whale bone artefacts argue in favour of the lower phase of the Magdalenian (Cantabrian Lower Magdalenian, CLM) seeing the emergence of this phenomenon during the Late Glacial. At El Pendo, a potential CLM occupation is essentially suggested by dates too old to be consistent with the Middle Magdalenian (MM) (Barandiarán, 1988). While at Tito Bustillo, the majority of dates from level 1 are compatible with the CLM (Álvarez Fernández et al., 2018) and therefore could fill the gap between the date from level 4 of Rascaño and the rest of the sequence (Fig. 8). The diagnostic CLM material from Tito Bustillo is, however, mixed with typical MM and ULM artefacts (Álvarez Fernández, 2013). Finally, levels 4/4b of Rascaño yielded both a date and a lithic assemblage compatible with the CLM (González Echegaray and Barandiarán, 1981). The oldest whale bone objects are based on chrono-cultural attribution of the level from which they were recovered rather than an associated radiocarbon date and come from Bolinkoba, Cueto de la Mina, and El Juyo. At Bolinkoba, level IV was initially attributed to the Middle or Late Solutrean (Barandiarán, 1950) and subsequently reassigned to the Late or Final Solutrean (Barandiarán, 1967). However, potential mixing with the overlying Magdalenian levels cannot be excluded (Utrilla, 1976; Barandiarán, 1950; Iriarte and Arrizabalaga, 2015b). Level D of Cueto de la Mina (Vega del Sella, 1916; Utrilla, 1981) and level 8 of El Juyo (González Echegaray and Freeman, 1992-1993) both yielded typical CLM assemblages. In the latter case, dates from overlying level 7 and underlying level 11 (I-10737: 14,440 ± 180 BP uncal. and 15,300 ± 700 BP uncal. respectively) provide an indirect chronology compatible with the CLM. Inter-level admixture is unlikely as no other Magdalenian phases were identified at the site. Consequently, it is highly probable that the exploitation of whale bone first appeared at the end of the Cantabrian Lower Magdalenian or around 18-17.5 cal ka BP.

Reliable data documenting the end of this phenomenon is still lacking. The retained date from level II of Santa Catalina (11,155 ± 80 BP uncal.) appears in Figure 8 as an outlier. It comes from the base of the level (close to the whale bone object), almost in direct contact with top of level III, dated to ca. 12 ka BP uncal. (Berganza and Arribas, 2014c). As both levels produced unworked whale bones (Castaños, 2014), it is impossible to rule out possible admixtures at the interface between levels II and III. This potential chronological boundary appears highly uncertain given the nature of the currently available data.

The overall chronological trend is not biased by the nature of the raw materials considered. The removal of the 28 “possible” whale bone artefacts, all from Santa Catalina-II, Ermittia-III, and Urtiaga-D, does not alter the general chronological pattern (Fig. 8). Methodological biases are more likely to affect the chronological distribution. In addition to undated contexts, the fact that the dates come from multiple labs (the Centre for Radiocarbon Dating at Lyon, the Svedberg and Angström labs at the University of Uppsala, Teledyne Isotopes in New Jersey, and the Radiocarbon Lab at British Museum) using different dating techniques (AMS and conventional) with varying levels of accuracy suggest considerable caution when interpreting them.

Although most of the specimens identified come from unreliable contexts (Tab. 2), several chronological patterns are nevertheless evident. The single-bevelled foreshaft from El Pendo, directly dated to around 17.6 cal ka BP (tab. 4), is assigned to the CLM-to-MM transition, where this type of artefact had been previously documented (Barandiarán, 1985). Grooved, double and fork-based points, as well as fork and pyramidal-based foreshafts, are associated with the MM (see, e.g., Gonzalez Sainz, 1989; Corchón and Ortega, 2017; Duarte and Rasilla, 2020). On the other hand, reliable dates are currently unavailable to precisely position Magdalenian massive-based points.

4.4. Geographical distribution and the distance to paleoshore

The 54 whale bone objects come from 12 sites spread across the entire Cantabrian region (Fig. 9, Tab. 2). Most (n=30) of the 54 identified whale bone objects derive from central Asturias [A], with the highest density of objects coming from two sites separated by 10 km: Las Caldas (n=19) and La Viña (n=9). The Spanish Basque Country [D] produced the second highest density of objects (n=14), followed by eastern Asturias [B] (n=6) and Cantabria [C] (n=4). This geographical distribution appears relatively stable between 17.8 and 15.5 cal ka BP in the Cantabrian region. This does not mean that there were no phases of contraction or expansion rather that the current chronological resolution is too imprecise to track such phenomenon.

Once again, this geographical distribution is not biased by raw material determinations. When the 28 ‘possible’ whale bone artefacts are excluded from the analysis, artefacts remain equally distributed. More than half of the objects (n=18) come from central Asturias, a further quarter (n=4) from the Basque Country, with the other two areas producing only two whale bone artefacts. There is also no bias induced by the number of sites examined per zone: while only seven sites were studied from central Asturias, compared to 21 from Cantabria and 22 from the Spanish Basque Country (Tab. 1), central Asturias delivered the majority of whale bone artefacts. On the other hand, given that certain collections, such as Las Caldas, yielded a substantially larger osseous industry assemblage compared to the others, we weighed the number of whale bone artefacts by the total number of worked osseous materials in each assemblage to test whether assemblage size could potentially bias their representation (Tab. 2).

Although the site of Las Caldas produced the most whale bone artefacts, it is one of the least rich assemblages in terms of the proportion of whale bone artefacts in the osseous industry (0.6%). Conversely, Ermitta yielded only nine whale bone objects, however they represent 8.6% of the overall osseous tool assemblage. When all weighed and un-weighed artefacts proportions are considered together, two areas separated by approximately 280 km clearly stand out: central Asturias [A] and the Spanish Basque Country [D]. On the other hand, sites in eastern Asturias [B] and Cantabria [C] only produced small numbers of whale bone artefacts.

Obviously, these proportions should be viewed with considerable caution bearing in mind the small number of whale bone objects in certain studied assemblages. This is notably the case for level E of Urtiaga (14.3%), which was excluded from the analysis due to the small size of the osseous industry (n=7). Other factors can also influence the proportion of bone tools in the assemblages. In the case of Santa Catalina, the only whale bone artefact from the site was recovered from the base of level II, attributed to the ULM (Berganza and Arribas, 2014b). When the large assemblage of unworked whale bones from underlying level III, also attributed to the ULM (Castaños, 2014), are included, the percentage of whale bone objects decreases from 0.7% to 0.1%. At Tito Bustillo, available counts of osseous artefacts only reflect the first three years of Moure Romanillo's excavations (González Sainz, 1989). Several authors of this study are currently revising the osseous assemblage from this site and initial estimations suggest substantially greater numbers of worked osseous objects (approximately 600) than shown in Table 2. Finally, as the revision of the La Viña faunal assemblage is on-going (by L. Torres), the total number of worked osseous artefacts is likely to change. Consequently, the percentage of whale bone artefacts from the latter two sites could eventually prove be lower than calculated here.

The distance of sites from the coast should also be considered. Although whale bone artefacts have been identified beyond the Cantabrian region in the Pyrenees, the Dordogne, and the Rhineland, attesting to their diffusion several hundred kilometres from the coast, the Palaeolithic occupation of the region is limited to a ca. 50 km wide coastal strip, circumscribed to the south by the Cantabrian foothills. Put differently, this coastal territory is not wide enough for objects to be transferred over long distances towards the south. At a smaller scale, questions can be raised as to what extent distance from the coast affected the circulation of whale bone artefacts. A comparison of distance from the paleoshore to sites yielding whale bone artefacts reveals no clear relationship between these two parameters (Fig. 10). The sites that produced the most whale bone objects are neither the closest to the paleoshore (i.e., Las Caldas, La Viña) nor the furthest away (i.e., Ermittia, Tito Bustillo). The concentration of whale bone objects at a limited number of sites would be in line with the existence of *receptor sites* (*sensu* Pétillon, 2013) where finished whale bone objects were imported. These sites would have been incorporated within a structured network connecting multiple valleys and extending into the Pyrenean region.

5. Discussion

5.1. Structured communication networks in the Pyreneo-Cantabrian region

The exploitation of whale bone during the Magdalenian was not a local phenomenon limited to the north of Pyrenees, but a more extensive practice shared amongst Magdalenian groups across the greater Pyreneo-Cantabrian region. The Cantabrian assemblages reveal the circulation of these objects as part of structured networks centred around key *receptor sites,* independent of their distance from the coast. The overall distribution of these *receptor sites* depicts one or several diffusion systems in the south(-west) of the Bay of Biscay (Fig. 11). The absence of objects from the eastern limits of the Bay of Biscay (i.e., the French Landes coast) can be explained in several ways. Beyond the fact that the submersion of the paleo-coast by the marine transgression removed any evidence of coastal occupations, the "Sable des Landes" region was equally a relatively inhospitable periglacial desert that restricted Magdalenian settlement (Bertran et al., 2013). Between 17.5 and 15.5 cal ka BP, this occupational hiatus extends north of the Sable des Landes into the northwest Aquitaine Basin, potentially coincident with climatic conditions of HE1 (Naughton et al. 2016; Pétillon et al., 2016b, Laroulandie et al. 2017).

This network incorporated more than 160 objects from 23 *receptor sites* spread over ca. 600 km, ranging from Las Caldas, in northwest Spain, to La Vache, in southwest France. The French and Spanish Basque Country play a central role in this network, particularly Isturitz. This site produced the highest concentration of whale bone objects (n=63; Pétillon, 2013), exceeding the total from all Cantabrian sites (n=54) as well as those from the rest of the Pyrenean region (n=46; *ibid.*). This high concentration of whale bone objects likely reflects the strategic position of the site at the intersection of several zones (the Cantabrian region, the Pyrenees, and the Aquitaine Basin). In addition, other typical Magdalenian objects are equally best represented at this site, leading to it being considered as an *aggregation site* (Sieveking, 1976; Bahn, 1984; Conkey, 1992; Pétillon, 2006; Utrilla and Martínez-Bea, 2008; Rivero, 2014; Elorrieta, 2016; Rasilla and Duarte, 2018 among others). Less expected, Ermittia equally plays a key role in this network, as evident by both the number of whale bone objects (n=9) recovered from the site and their proportion within the osseous industry (8.6%, Table 2). The Basque Country therefore appears to form a sort of “hub” in the Pyreneo-Cantabrian network, as this area is located both at the centre of this communication network and at the interface between the Cantabrian region, the western Pyrenees, the Aquitaine Basin as well as the Ebro Valley and Central Meseta (Arrizabalaga et al., 2016).

The two others ‘poles’ of the network lie 380 km west of Isturitz, in central Asturias (Las Caldas, La Viña, and La Paloma), and 240 km to the east, with the Ariege sites (Mas d'Azil, La Vache, and Tuc d'Audoubert). Curiously, these two regions produced comparable numbers of whale bone artefacts (n=30 for central Asturias and n=20 for the Ariege) despite their differing distances from the Atlantic coast. The overall east-west organisation of the network follows the general distribution of Magdalenian sites in the region and mirrors the distribution of other Magdalenian cultural markers.

Up until now, connections between Pyrenean and Cantabrian groups during the Magdalenian period, broadly speaking, were evinced by the distribution of certain antler weapons (e.g. Lussac-Angles points, fork-based points, type A2 spearthrowers, multibarbed points, half-round rods with specific decoration; Pétillon, 2007 ; Lefebvre, 2011; Cattelain and Pétillon, 2015; Sécher, 2017; Barandiarán et al., 2019), stone tool types (i.e., scalene triangles ; for a synthesis see Sécher, 2017), and also by specific production methods applied on lithic raw material (Cazals, 2000; Cazals and Langlais, 2006; Langlais, 2007). The distribution of mobiliary art or personal ornaments (e.g. perforated bone discs and shells, notched and pointed incisors, cut-out contours; Taborin, 1993; Sauvet et al., 2008; Álvarez Fernández, 2006; Corchón et al., 2012), as well as shared graphic norms in both mobiliary and rock art (e.g. claviform motifs, depictions of both caprids seen from the front and marine animals; Fritz et al., 2007; Corchón et al., 2012; Sauvet et al., 2014; Pétillon, 2018) also evince connections between these two regions (Utrilla and Martínez-Bea, 2008; Lucas, 2012; Duarte and Rasilla, 2020). Similarly, the diffusion of lithic raw materials from the Pyrenees (Tarriño, 2001; Tarriño et al., 2015; Corchón et al., 2009; Elorrieta, 2016) has already provided evidence for the movement of human groups across the western extremity of the Pyrenean mountain range.

Available chronological data demonstrates the exploitation of whale bone to be broadly contemporary in the Pyrenean-Cantabrian region, with the practice reaching its peak between 17.8 and 15 cal ka BP. This chronology would overlap with the MM and beginning of the UM in Cantabria and the Late MM followed by the Early UM to the north of Pyrenees (for more details concerning the different phases of the Magdalenian north of the Pyrenees see, for example, Langlais et al., 2012). It is during this period that the network of *receptor sites* reached its maximum extension and received the largest number of whale bone objects. It remains possible that some dates are older in the Cantabrian region (probably around 18 cal ka BP), coincident with the end of the CLM. Regrettably, current radiometric data is still too imprecise to identify variations on the order of 500 years. At a larger scale, it is also possible that whale bone was exploited by Palaeolithic foragers before and after the Magdalenian period; however, this possibility has yet to be explored systematically. The apparent general contemporaneity between these two regions equally poses broader socio-economic questions, including the interconnected development of these neighbouring cultural territories (e.g., Fritz et al., 2007; Corchón et al., 2012; Langlais and Pétillon, 2019 or Utrilla et al., 2020).

5.2. Unity and dynamics of the Pyreneo-cantabrian network(s)

Comparative techno-typological data for assemblages from Cantabrian Spain and the Pyrenees reveals both shared norms and local particularities. Firstly, a majority of what are essentially finished objects were transported over substantial distances from the sea, suggesting that the acquisition and transformation of raw materials occurred in both regions near the Atlantic coast. No data is currently available to shed light on exactly how whale bone was acquired; although the most parsimonious hypothesis remains the scavenging of beached whale carcasses on the Atlantic coast, as initially proposed by Pétillon (2013). Weapon elements figure most prominently amongst transported whale bone objects; massive-based points, certain foreshafts, and multiple grooved points circulated in both regions. While the calibre (width and thickness) of Cantabrian projectile points is comparable to what is seen with Pyrenean examples (Tab. 5), comparisons in terms of length are more complicated. At first glance, points from the Cantabrian region appear slightly shorter; although this could be connected to differences in the frequency of breakage in assemblages from the two regions, especially given the comparable calibres of points.

Assemblages from both regions equally portray certain differences, particularly in terms of artefact typology. Wedges (n=9) and half-round rods (n=2) were identified in the Pyrenees but not in the Cantabrian assemblages. On the other hand, certain whale bone weapons were not found across the study area, i.e., the single-bevelled foreshaft from El Pendo, as well as the pyramidal-based foreshaft and the fork-based point from Las Caldas. These typological differences become even more marked further away from the “hub”; the above-mentioned hunting equipment appears uniquely in the western Cantabrian region while massive-based points are found from sites in the Spanish Basque Country (Ermittia and Urtiaga) as well as surrounding parts of the Pyrenees. Overall, despite evidence suggesting the relatively contemporaneous exploitation of whale bone north of the Pyrenees and in the Cantabrian region, this may have involved independent networks of acquisition, production, and circulation on both sides of the Basque Country. In sum, both regions afforded direct access to the Atlantic coast for the acquisition of whale bone but depict typological differences between them, with the circulation of whale bone artefacts dependent on two distinct communication routes.

5.3. Coastal (in)visibility in the Cantabrian region

The lack of whale bone objects in some Cantabrian sites close to the paleoshore is striking. Santa Catalina shows that, despite its proximity to the coast (Fig. 10) and the availability of raw material (41 whale remains, Castaños, 2014), the presence of only one potential whale bone artefact effectively excludes the location being a primary *receptor site*. The scarcity of high-resolution MM sites in the Cantabrian region could partially explain this situation (Duarte and Rasilla, 2020). In this sense, on-going research at La Garma, where only a few osseous implements have been recovered to date from MM level L3 (La Garma A, Arias et al., 2005) or from the lower gallery (Arias et al., 2011), could increase the frequency of whale bone objects in Cantabria [C]. Moreover, intermediate territories with less developed karstic systems near the present-day coastline, where 'secondary camps' and *aggregation sites* would be expected (Álvarez-Alonso et al., 2014; Rasilla and Duarte, 2018), have not been explored to the same extent as other regions (i.e., Villaviciosa in the central area of Asturias)

5.4. Why use whale bone?

The exploitation of whale bone by Magdalenian hunter-gatherers is concentrated in a period roughly coeval with HE1 (ca. 19-14.8 cal ka BP), which is characterised in the Bay of Biscay by cooler seawater temperatures and higher trophic levels in benthic foraminifera (Pascual et al., 2020). These ecological conditions potentially favoured an increase in the number of whales frequenting the deep coastal waters off the Cantabrian coast after the LGM, thus increasing the availability of this unique raw material on the region's shores. New data on the species of marine mammals exploited and their individual behaviour is, however, necessary to test the potential link between environmental conditions and raw material procurement patterns (Pétillon et al., 2019).

This phenomenon could also be linked to the large size of this unique raw material. According to Petillon (2013: 541): "when evaluating the suitability of osseous materials for the manufacture of projectile tips, whale bone seems to rank first for size potential but second for fracture resistance". A comparison of metrical data for identical artefact types manufactured in whale bone and antler from the early Upper and Late Magdalenian of Isturitz (Pétillon, 2006; Lefebvre, 2016) to measurements for a fork-based point from Las Caldas, double-bevelled points from the Cantabrian region, 26 foreshafts, and 8 massive-based points, primarily found from Pyrenean sites; demonstrates whale bone artefacts to be generally comparable in size to the largest antler examples (Table 6).

Why, then, did Magdalenian groups seek to maximise the size of these objects? In some cases, the production of outsized items may have conferred them a special status; for example, the possible whale bone cut-out contour from Isturitz (Rivero, 2014) or the engraved object on a massive rod from Ermittia (e.g., Fig. 7: 2). However, as most artefacts are relatively undecorated weapon elements (Pétillon, 2013), the use of whale bone could also be linked to techno-economic concerns. In highly mobile nomadic societies (see, for example, Delvigne, 2016; Sécher, 2017), the transport of raw materials represents a non-negligible energy expenditure, potentially mitigated by replacing the movement of blocks of raw material by the production of tools with long use-lives. Weapon elements from both the Pyrenees (n=5) and the Cantabrian region (n=3) were consistently managed, as evidenced by traces of recycling and re-sharpening in assemblages from both areas. Maximising blank length increases the number of potential re-sharpening or recycling opportunities and, thus, prolongs the tool's use-life. Put differently, the initial dimensions afforded by whale bones succinctly fulfilled the mobility requirements of these hunter-gatherer groups. This likelihood is consistent with what has been suggested for stone tools from the same period. The production of large, regular blade blanks in south-western France during the Middle Magdalenian already suggests a raw material provisioning strategy geared around the selection of large, high-quality blocks of raw material (Angevin and Langlais, 2009).

5. Conclusion

As demonstrated by previous studies (Petillon, 2008; 2013; Pétillon et al., 2019; Langley and Street, 2013), the re-examination of collections from old excavations can produce surprising results. The systematic search for whale bone implements in Magdalenian assemblages from the Cantabrian region provides invaluable information about the earliest known exploitation of whales. The discovery of whale bone implements in the Cantabrian region reveals the circulation of this unique raw material in southwest Europe not to be conditioned uniquely by distance from the sea but also by social and/or economic factors. More broadly, the growing body of evidence for the exploitation of marine resources during the Magdalenian further reinforces the Bay of Biscay being the backdrop to the emergence of the first regular, diversified and organized coastal economies during the period between 19 and 14 cal ka BP.

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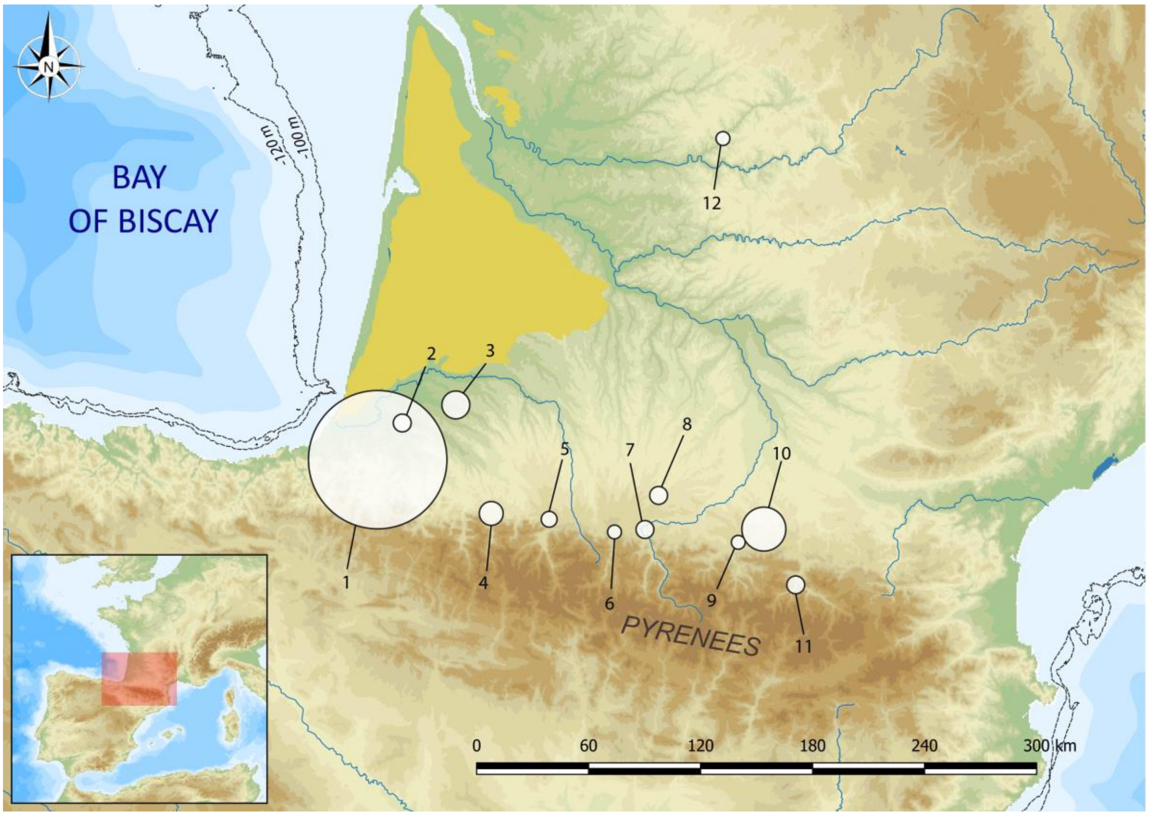

Figure 1. Distribution of whale bone objects in the south-west of the current French territory during the Magdalenian (whale data from Pétillon, 2013; Pétillon et al, 2019). White circles represent the number of whale bone artefacts per site (the size of the circles is proportional to the numbers of artefacts identified). The marine levels -120 m and -100 m correspond, respectively, to the LGM and Bølling-Allerød interstadial (Benjamin et al., 2017). Relief is derived from altimetric data available in Reuter et al., 2007 and Jarvis et al., 2008, and bathymetric data are from Natural Earth (www.naturalearthdata.com). The "Sables des Landes" region appears in yellow (data from Sitzia, 2014). 1: Isturitz, 2: Duruthy, 3: Brassempouy, 4: Arudy, 5: Espélugues, 6: Lortet, 7: Gourdan, 8: Harpons, 9: Tuc d'Audoubert, 10: Mas d'Azil, 11: La Vache, 12: La Madeleine.

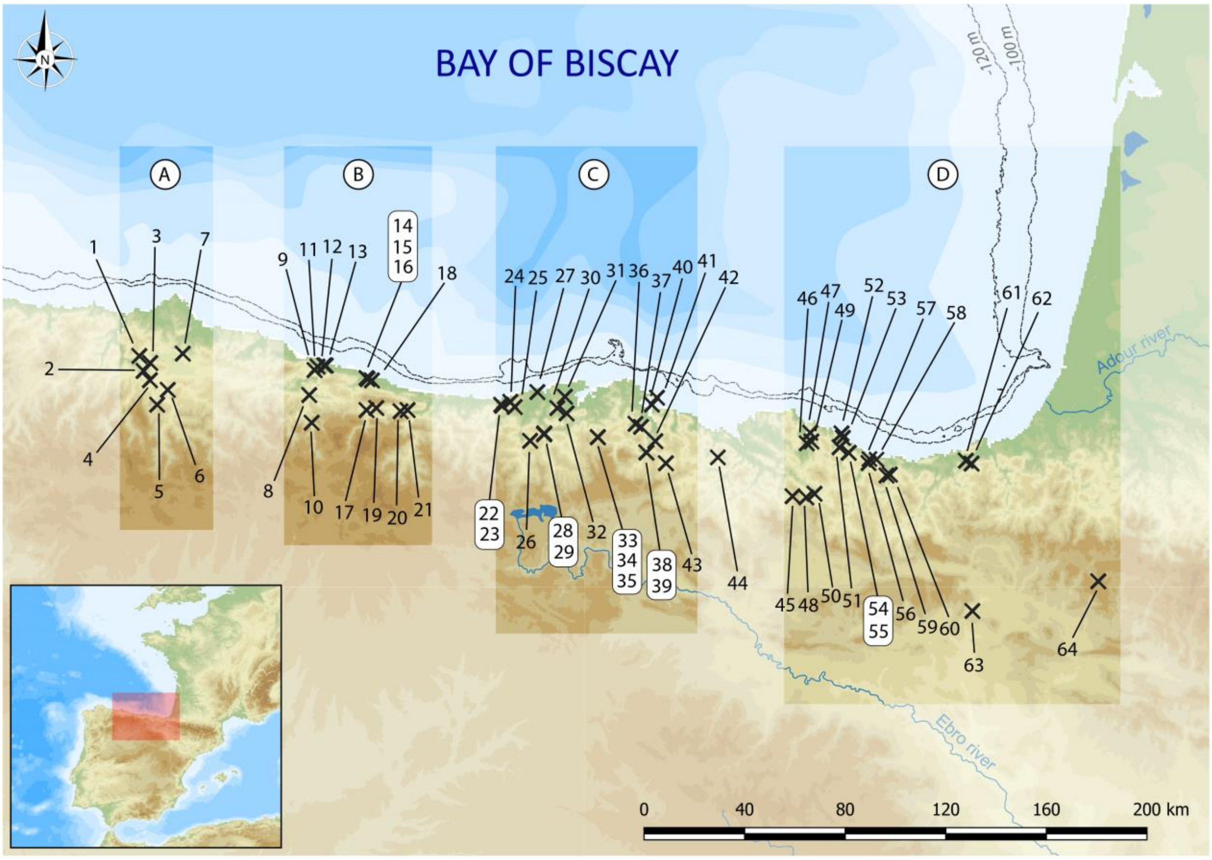

Figure 2. Distribution of Cantabrian Magdalenian sites examined in this study. A: central Asturias, B: eastern Asturias, C: Cantabria, D: Spanish Basque Country and Navarra (see Fig. 1 for map data).

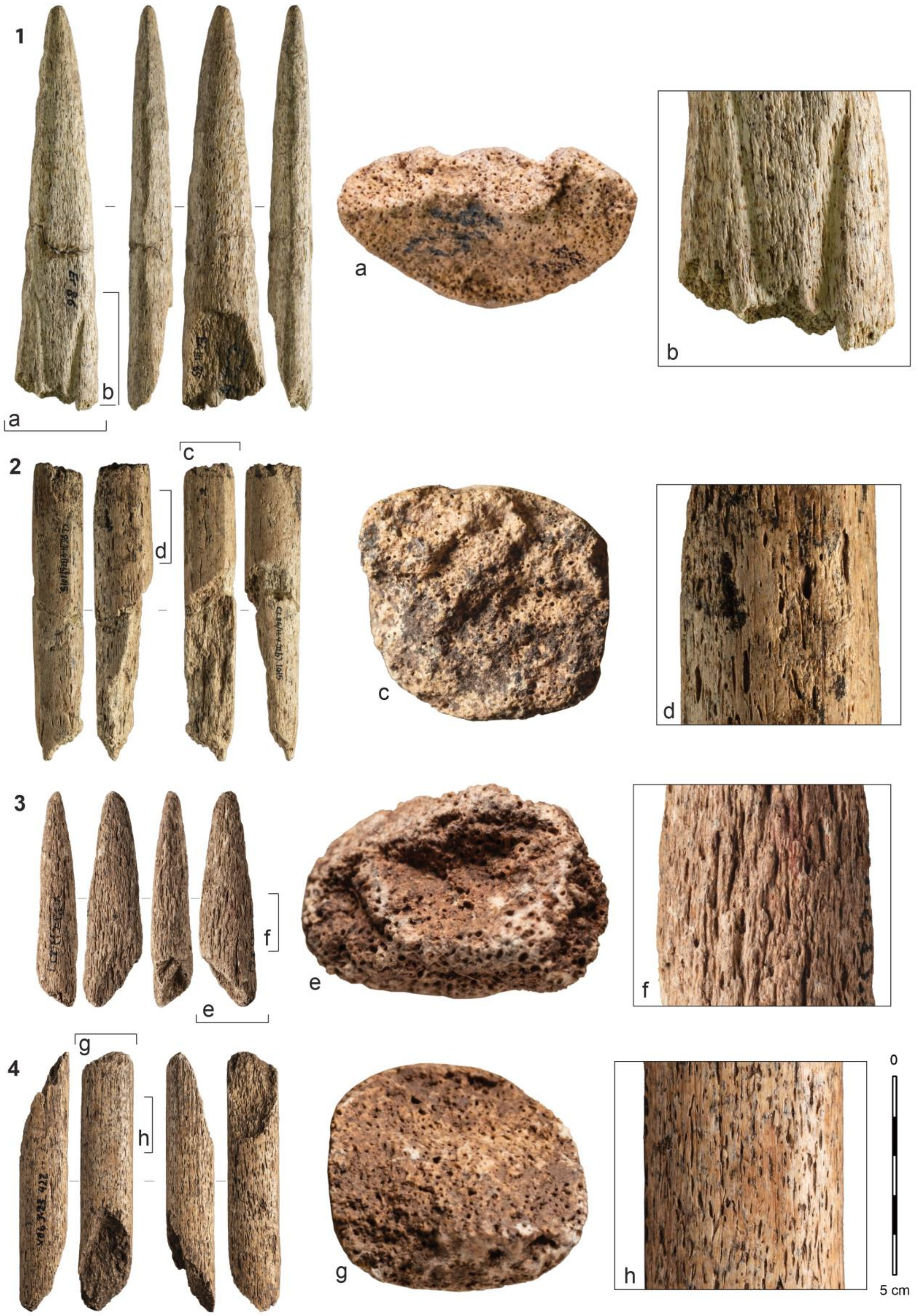

Figure 3. Examples of whale bone artefacts identified in the Cantabrian Magdalenian collections; 1-3: projectile points, 2-4: indeterminate objects made on a rod; 1: Ermittia-III, 2: Las Caldas-level IIb, 3-4: La Viña-IV; a-h: close-up of the material.

Figure 4. Whale bone projectile points; 1-2: double-bevelled points, 3-4 : mesial fragment of point with longitudinal grooves, 5-6: massive-based points, 7: fork-based point, 8-9: distal extremities of points with traces of manufacturing/maintenance ; a: close-up views; 1:Las Caldas-VI, 2: Las Caldas-IIIc-IV, 3: Las Caldas-VIII, 4: Las Caldas-VIb, 5: Ermittia-III, 6: Urtiaga-E, 7: Las Caldas-VI, 8-9: Ermittia-III.

Figure 5. Possible whale bone foreshafts; 1: Las Caldas-VI (140 x 13 x 11 mm), 2: El Pendo (184 x 12 x 13 mm), 3: La Viña-IV (68 x 9 x 7 mm), 4: Ermittia-III (49.5 x 10.5 x 9 mm), a-b: close-up.

Figure 6. Various whale bone artefacts; 1-4: indeterminate objects on a rod, 1: La Viña-IV, 2: El Rascaño-4b, 3: Tito Bustillo-III, 4: Las Caldas-III, 5: blunt tool (Las Caldas-IV), 6: possible blank (El Juyo-8); a and b: close-up of the material.

Figure 7. Various whale bone objects; 1: massive (214 x 17 x 13 mm) decorated point (Ermittia-III); 2: massive (81 x 19 x 16 mm) decorated object on rod (Ermittia-III); 3: possible plaquette blank (Urtiaga-D); 4: indeterminate object on plaquette (Urtiaga-D); a, b, c, d, e: close-up views.

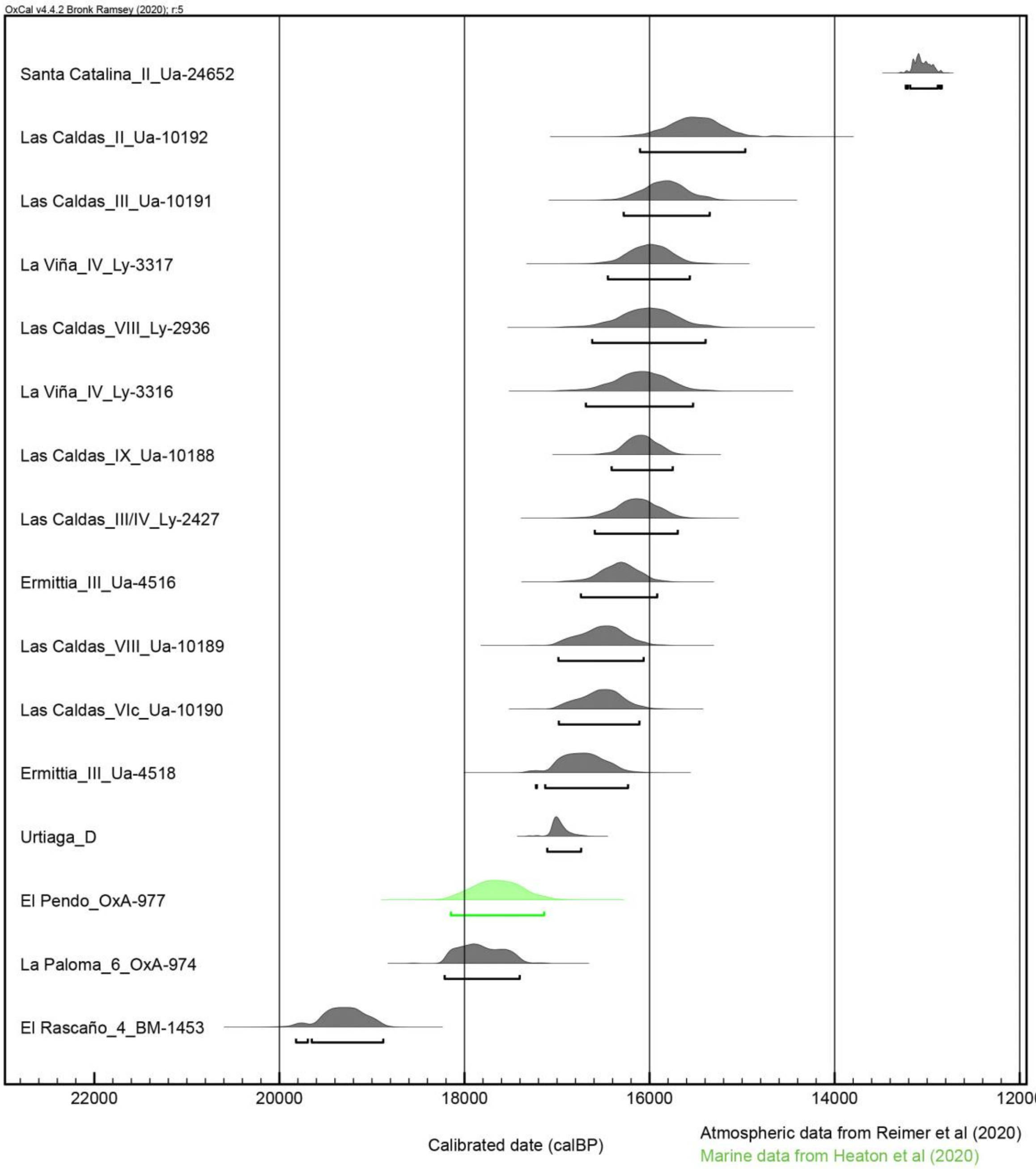

Figure 8. Calibrated radiocarbon dates for Magdalenian levels yielding whale bone objects in the Cantabrian region expressed at two sigma. Calibration: OxCal v4.4.2. (Bronk Ramsey, 2017); IntCal20 and Marine20 dataset (Heaton et al., 2020; Reimer et al., 2020) appear, respectively, in grey and green; ΔR local offset updated from Monge Soares et al. (2016) (see detail in the text).

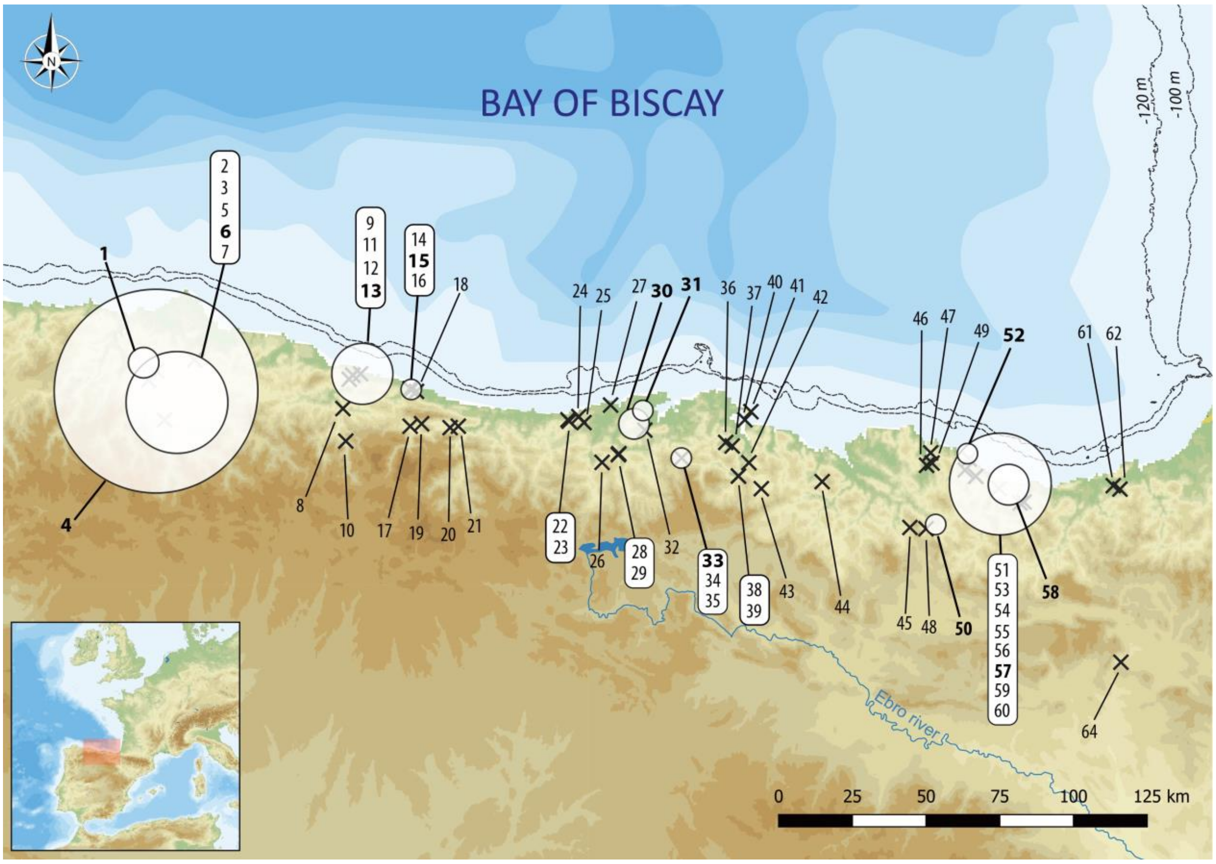

Figure 9. Distribution of whale bone artefacts from Cantabrian Magdalenian sites (see Table 1 for site names, and Figure 1 for the details of the map data). White circles represent the number of whale bone artefacts per site (the size of the circles is proportional to the numbers of artefacts identified). Black crosses represent sites that did not yield whale bone objects. Receptor sites appear in bold: 1 - La Paloma, 4 – Las Caldas, 6 – La Viña, 13 - Tito Bustillo, 30 – El Pendo, 31 – El Juyo, 33 - El Rascaño, 50 – Bolinkoba, 52 – Santa Catalina, 57 – Ermittia, 58 – Urtiaga.

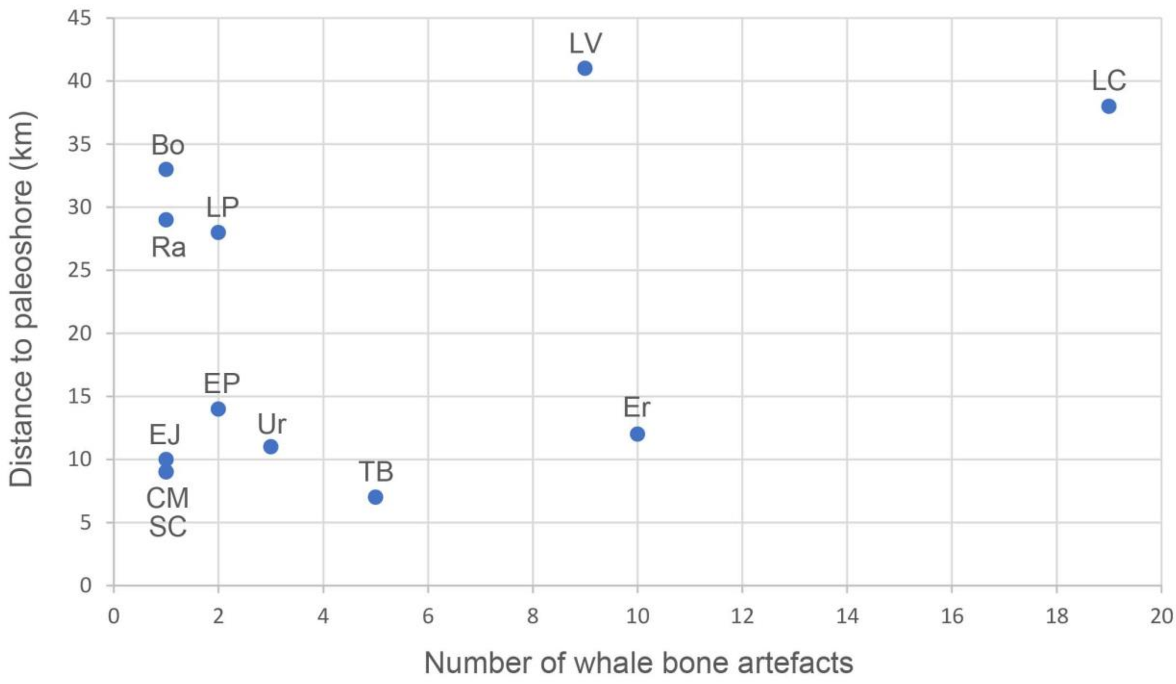

Figure 10. Relationship between the distance to the Atlantic paleoshore of sites yielding whale bone artefacts and the number of whale bone artefacts (NWBA) per site. The shortest distance to the paleoshore is measured from marine level -100 m, which corresponds to Bølling-Allerød sea levels (Benjamin et al., 2017). Sites: TB: Tito Bustillo, CM: Cueto de la Mina, SC: Santa Catalina, EJ: El Juyo, Ur: Urtiaga, Er: Ermittia, EP: El Pendo, LP: La Paloma, Ra: Rascaño, Bo: Bolinkoba, LC: Las Caldas, LV: La Viña.

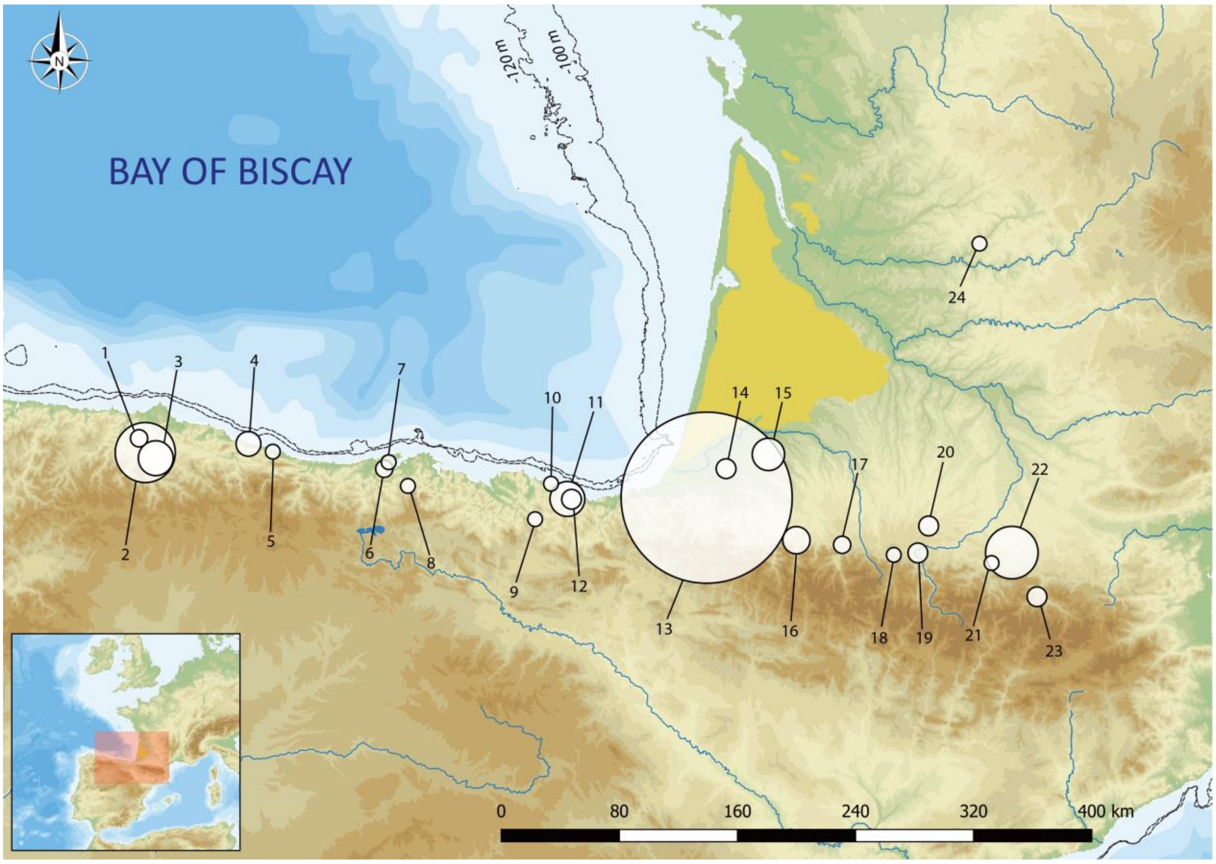

Figure 11. General distribution of Magdalenian whale bone artefacts from southwestern Europe (see Figure 1 for the details of the map data). White circles represent the number of whale bone pieces by site (the size of the circle is proportional to the number of artefacts identified). Whale bone data comes from Pétillon, 2013; Pétillon et al., 2019, and this study. This map does not include the pendant from Balmori (Boneta et al., 2018) and the cut-out contour from Isturitz (Rivero, 2014). Sites: 1: La Paloma, 2: Las Caldas, 3: La Viña, 4: Tito Bustillo, 5: Cueto de la Mina, 6: El Pendo, 7 : El Juyo, 8 : El Rascaño, 9 : Bolinkoba, 10: Santa Catalina, 11: Ermittia, 12: Urtiaga, 13: Isturitz, 14: Duruthy, 15: Brassempouy, 16: Arudy, 17: Espélugues, 18: Lortet, 19: Gourdan, 20: Harpons, 21: Tuc d'Audoubert, 22: Mas d'Azil, 23: La Vache, 24: La Madeleine.

#	Site	Zone	Collection	Archaeological levels	Chrono-cul. attribution	Conservation institutions
1	**La Paloma**	A	E. Hernández Pacheco *et al.*	8, 6, 4, 3*	CLM, MM, ULM	MAA, MAN, MNCN, MNCIA
2	**Sofoxó I**	A	Conde de la Vega del Sella and H. Obermaier	Ind.	Mag.	MAA
3	**Oscura de Ania**	A	J. M. Gómez Tabanera and M. Pérez Pérez	3, 3a, 3b	MM, ULM	MAA
4	**Las Caldas-Sala II**	A	M.S. Corchón Rodríguez	XIII to I, -III - II, -I (Sala II)	CLM, MM, ULM	MAA
5	**Entrefoces**	A	M. R. González Morales	A, B, C, D, E	CLM, ULM	MAA, UC
6	**La Viña**	A	F. J. Fortea Pérez	I, III, IV	MM, ULM	MAA + FFL
7	**El Olivo**	A	D. Álvarez-Alonso	2b	MM	UCM
8	**Los Azules I**	B	J. Fernández-Tresguerres Velasco	6	ULM	MAA
9	**Cova Rosa**	B	F. Jordá Cerdá *et al.*	Upper level/B6	CLM	MAA
10	**Collubil**	B	Conde de la Vega del Sella and H. Obermaier	Ind.	Mag	MAA
11	**El Cierro**	B	F. Jordá Cerdá *et al.*	2, 3/F, G, G1	CLM	MAA, US
12	**La Lloseta**	B	H. Hernández Pacheco and P. Wernert/F. Jordá Cerdá	1, 2	CLM, ULM	MAA, MAN
13	**Tito Bustillo-Área de estancia**	B	M. A. García Guinea/J. A. Moure Romanillo/R. de Balbín Behrmann *et al.*	1,1C1,1C2, 1C3, 1C4 (Área de Estancia) + Área de las Pinturas	Mag.	MAA, MUPAC, US
14	**La Riera**	B	Conde de la Vega del Sella/J. M. Gómez Tabanera/L. G. Straus and G. A. Clark	ind/26-19	CLM, ULM	MAA, MNCN
15	**Cueto de la Mina**	B	Conde de la Vega del Sella/F. Jordá Cerdá/M. de la Rasilla Vives	B, C, D/II,III,IV	Sol, CLM, MM, ULM	MAA, MAN, MNCM, MNCIA
16	**Bricia**	B	F. Jordá Cerdá	E, C	CLM, ULM	MAA
17	**Los Canes**	B	P. Arias Cabal	2B, 2C	CLM, ULM	MAA
18	**Balmori**	B	Conde de la Vega del Sella	"Nivel Magdaleniense" = Magdalenian level	Mag.	MAA, MNCN
19	**Arangas**	B	P. Arias Cabal and C. Pérez Suárez/P. Arias Cabal	F	CLM	US
20	**Coimbre**	B	D. Álvarez-Alonso *et al.*	4, 2, 1 (Zone B)	CLM, MM, ULM	UCM
21	**Llonín**	B	F. J. Fortea Pérez *et al.*	VIII-X (Cono Anterior), II-III (Vestíbulo), I-II (Galería)	MM, ULM	MAA, FFL
22	**Las Aguas**	C	J. A. Lasheras Gurruchaga	B, C	CLM/MM?	MNCIA
23	**El Linar**	C	J. Sanguino and R. Montes Barquín	"Sondeos A y C" = Test pit A and C	CLM (+MM?)	MUPAC
24	**Cualventi**	C	M. A. García Guinea	5/E	CLM/ULM	MUPAC, MNCIA
25	**Altamira**	C	H. Alcalde del Río *et al.* /H. Breuil and H. Obermaier/L. G. Freeman and J. González Echegaray	Upper levels	CLM	MIUPAC, MNCIA
26	**Hornos de la Peña**	C	H. Alcalde del Río *et al.*	Ind.	Mag.	MAN
27	**La Pila**	C	C. Gutíerrez Saez and F. Bernaldo de Quirós Guidotti	IV.1 - IV.4	ULM/Az.	MUPAC, MNCIA
28	**La Pasiega**	C	J. Carballo and García Lorenzo/J. González Echegaray and E. Ripoll Perelló	Ind.	Sol./Mag.	MUPAC
29	**El Castillo**	C	H. Obermaier *et al.* /J. Carballo	6-8	Mag.	MUPAC, MNCIA, MAN
30	**El Pendo**	C	J. Carballo *et al.* /J. Martínez Santaolalla *et al.* /Edgard Camarós	II(b), IV	Sol./Mag.	MUPAC, MNCIA, MAN, MNCN, UC
31	**El Juyo**	C	P. Janssens *et al.* /L. G. Freeman and J. González Echegaray	III-X/4-11	CLM	MUPAC, MNCIA
32	**Morín**	C	Conde de la Vega del Sella/J. Carballo/J. González Echegaray *et al.*	Mag., 2	ULM	MUPAC, MAN, MNCN
33	**Rascaño**	C	J. González Echegaray and I. Barandiarán Maestu	2, 2b, 3, 4(b), 5	IM/Bad., CLM, ULM	MNCIA, MNCN
34	**Pielago II**	C	M. A. García Guinea	5, 6	ULM?	MUPAC
35	**Pielago I**	C	A. García Guinea/M. A. García Guinea	5	ULM?	MUPAC
36	**El Otero**	C	J. González Echegaray *et al.*	2-3	ULM	MUPAC
37	**La Chora**	C	J. González Echegaray and M. A. García Guinea	ind	ULM/Az.	MUPAC
38	**El Horno**	C	M. A. Fano Martínez	1-3	ULM	MUPAC, MNCIA
39	**El Mirón**	C	M. González Morales and L. G. Straus	12-17 (Cabaña), 108 (Trinchera), 102.1/108/110-119 (Corral)	IM, CLM, ULM	UC
40	**La Peña del Perro**	C	M. González Morales and Y. Díaz Casado	2c	ULM	MUPAC
41	**La Fragua**	C	M. R. González Morales *et al.*	4	ULM	MUPAC
42	**El Valle**	C	L. Sierra/H. Breuil and H. Obermaier/M. P. García-Gelabert	ind	ULM	MUPAC, MAN, MNCN
43	**Polvorín**	D (v)	R. Ruiz Idarraga and F. d'Errico	Upper level (Sala interior intermedia)	ULM	MAV
44	**Arenaza I**	D (v)	J. M. Apellaniz Castroviejo and J. Altuna Echave/J. A. Fernández Lombera	VI	ULM?	MAV
45	**Balzola**	D (v)	J. M. de Barandiarán/L. Zapata Peña	7, 8	ULM	MAV
46	**Atxeta**	D (v)	J. M. de Barandiarán	E	ULM	MAV
47	**Antoliña**	D (v)	J. M. de Barandiarán/M. Aguirre Ruiz de Gopegui	Lgc	CLM/ULM	MAV
48	**Silibranka**	D (v)	J. M. de Barandiarán and T. de Aranzadi	I-IV	ULM?	MAV
49	**Santimamiñe**	D (v)	T. de Aranzadi *et al.* /J. M. de Barandiarán/J. C. López Quintana	Csn-Camr/IX, Almp/VIII, Slnc/VI	Mag.	MAV
50	**Bolinkoba**	D (v)	J. M. de Barandiarán and T. de Aranzadi/M. J. Iriarte Chiapusso	IV (D), III (C) , II (B)	Sol., CLM, ULM/Az. (+MM?)	MAV
51	**Abittaga**	D (v)	J. M. de Barandiarán/J. M. Apellaniz Castroviejo	VI, VII	ULM (+ Az?)	MAV
52	**Santa Catalina**	D (v)	E. Berganza Gochi	II, III	ULM	MAV
53	**Lumentxa**	D (v)	J. M. de Barandiarán and T. de Aranzadi/J. L. Arribas Pastor	IV, V, VI	ULM (+ CLM?)	MAV
54	**Laminak II**	D (v)	E. Berganza Gochi and J. L. Arribas Pastor	II	ULM	MAV
55	**Atxurra**	D (v)	J. M. de Barandiarán and T. de Aranzadi	III	ULM	MAV
56	**Preaileaitz I**	D (v)	X. Peñalver	III, IV	CLM/ULM	Gor
57	**Ermittia**	D (g)	J. M. de Barandiarán and T. de Aranzadi	III	MM/ULM (+CLM?)	Gor
58	**Urtiaga**	D (g)	J. M. de Barandiarán (and T. de Aranzadi)	D, E, F	Mag.	Gor
59	**Ekain**	D (g)	J. M. de Barandiarán and J. Altuna Echave	VI a and b/ VII	CLM, ULM	Gor
60	**Erralla**	D (g)	J. Altuna Echave	II, III, V	CLM/ULM	Gor
61	**Aitzbitarte IV**	D (g)	Conde de Lersundi/J. M. de Barandiarán	I inf/ I, III	ULM (+ MM ?)	Gor
62	**Torre**	D (g)	A. Laburu *et al.*	ind	ULM?	Gor
63	**Abauntz**	D (n)	P. Utrilla and C. Mazo	e, 2r	MM/ULM	MN
64	**Zatoya**	D (n)	I. Barandiarán Maestu	IIb	ULM	MN

Table 1. Magdalenian worked osseous assemblages from the Cantabrian region (from west to east) assessed in this study. Institutions where the collections are housed: MN: Museo de Navarra (Pamplona), Gor: Gordailua (Irun, Guipúzcoa), MAV: Museo Arqueológico de Vizcaya (Bilbao), MUPAC: Museo de Prehistoria y Arqueología de Cantabria (Santander), MNCIA: Museo Nacional y Centro de Investigación de Altamira (Santillana del Mar), MAN: Museo Arqueológico Nacional (Madrid), MNCN: Museo Nacional de Ciencias Naturales (Madrid), IIIPC-UC: Instituto Internacional de Investigaciones Prehistóricas de Cantabria-Universidad de Cantabria (Santander), MAA: Museo Arqueológico de Asturias (Oviedo), UO:

Universidad de Oviedo (Oviedo), UCM: Universidad Complutense de Madrid, US: Universidad de Salamanca. Chrono-cultural periods: Az.: Azilian, ULM: Upper and Late Magdalenian, MM: Middle Magdalenian, CLM: Cantabrian Lower Magdalenian, IM: Initial Magdalenian, Mag.: Magdalenian, Bad.: Badegoulian, Sol.: Solutrean, US: Upper Solutrean, Ind: Indeterminate. See the bibliographical references for the correspondence between the levels and the chrono-cultural adscription. *The numbering of the levels of La Paloma corresponds to the study of Hoyos et al. (1980).

#	Zone	Site	Collection	Levels/Layers	Chrono-cul. attribution	TNOA	NWBA	% WBA	Main bibliographic references
1	A	La Paloma	E. Hernández Pacheco et al.	6	MM	219	1	0.5	Adán, 1997
				4	ULM	144	1	0.7	González Sainz, 1989
			Total			363	2	0.6	
4	A	Las Caldas-Sala II	M. S. Corchón	IX-V	MM	3775	9 [+4]	0.3	Corchón, 2017
				IV/III	MM/ULM	1010	2 [+2]	0.4	
				II, I, -III, -II, -I	ULM	480	1 [+1]	0.4	
			Total			5265	12 [+7]	0.4	
6	A	La Viña	J. Fortea Pérez	IV, III	MM	509	4 [+5]	1.8	Duarte and Rasilla, 2020
13	B	Tito Bustillo-Área de estancia	M. A. García Guinea	3	Mag.	12	1	8.3	García Guinea, 1975
				3/4	Mag.	2	0 [+2]	100	
			J. A. Moure Romanillo	1A	Mag.	89			González Sainz, 1989
				1A/B	Mag.	6			
				1B	Mag.	86			
				1B/C	Mag.	11			
				1C(2)	Mag.	100	1 [+1]	2	
				Sala de pinturas	Mag.	6			
			Total			312	2 [+3]	1.6	
15	B	Cueto de la Mina	Conde de la Vega del Sella	D	CLM	266	0 [+1]	0.4	Adán, 1997
30	B	El Pendo	J. Carballo and B. Larín	East or West depot?	Mag.	NC	1		Carballo, 1960
			M. Santa-Olalla	2	Mag.	NC	0 [+1]		González Echegaray, 1980
31	B	El Juyo	L. G. Freeman and J. González Echegaray	8	CLM	NC	0 [+1]		Barandiarán et al., 1985
33	C	El Rascaño	J. González Echegaray et I. Barandiarán	4b	CLM	166	1	0.6	Barandiarán, 1981b
52	D	Santa Catalina	E. Berganza	II	ULM	142	0 [+1]	0.7	E. Berganza, pers. com.
				III	ULM	707			
			Total			849	0 [+1]	0.1	
57	D	Ermittia	J. M. de Barandiarán and T. de Aranzadi	III	MM/ULM(+CLM?)	104	3 [+4]	6.7	Mújica, 1983
58	D	Urtiaga	J. M. de Barandiarán (and T. de Aranzadi)	D	Mag.	185	0 [+2]	1.1	Mújica, 1983
				E	Mag.	12	0 [+1]	8.3	Mújica, 1983; Pers. obs.
			Total			197	0 [+3]	1.5	
		Total					27 [+28]		

Table 2. Whale bone artefacts identified in this study expressed in number and percentage within each worked osseous assemblage (bone, ivory and antler). TNOA: Total Number of Osseous Artefacts, NWBA: Number of Whale bone Artefacts, % WBA: Percentage of Whale Bone Artefacts in the Osseous Industry. Chrono-cultural periods: ULM: Upper and Late Magdalenian, MM: Middle Magdalenian, CLM : Cantabrian Lower Magdalenian, Mag. : Magdalenian, US : Upper Solutrean. Regions: A: central Asturias, B: eastern Asturias, C: Cantabria, D: Spanish Basque Country. Bracketed numbers refer to specimens whose identification as whale bone is likely but not certain (see details in text).

	US ?	CLM	MM	MM/LUM	ULM	Mag.	Total
Projectile points (total)	1	2	16	3	2	14	37
Double-bevelled points			*3*	*1*			*4*
Massive-based points						*3*	*3*
Fork-based point			*1*				*1*
Indeterminate	*1*	*2*	*11*	*2*	*2*	*11*	*29*
Possible foreshafts			2			2	4
Blunt tool			1				1
Indeterminate objects on rod			4	1	2	2	9
Indeterminate object on plaquette						1	1
Possible blanks		1				1	2
Total	1	3	23	4	4	20	54

Table 3. Typological and chronological attributions of the whale bone artefacts from Cantabrian assemblages. Chrono-cultural periods: CLM : Cantabrian Lower Magdalenian, MM : Middle Magdalenian, ULM : Upper and Late Magdalenian, Mag.: Magdalenian, US: Upper Solutrean

#	Site	Level/Layer	Chrono.c atribution	Age in radiocarbon years BP	Calibrated age in years BP (95.4%)	Laboratory code	Nature of the sample dated	Method	Main bibliographic reference
52	Santa Catalina	II	ULM	11,155 ± 80	13,232 - 12,843	Ua-24652	Bone	AMS	Berganza and Arribas, 2014c
4	Las Caldas	II (Sala II)	ULM	12,960 ± 190	16,103 - 14,966	Ua-10192	Bone	AMS	Corchón, 1995
4	Las Caldas	IIIb-IIIc (Sala II)	MM/ULM	13,185 ± 155	16,280 - 15,350	Ua-10191	Bone	AMS	Corchón, 1995
6	La Viña	IV	MM	13,300 ± 150	16,451 - 15,566	Ly-3317	Bone	β count	Fortea, 1990
4	Las Caldas	VIII (Sala II)	MM	13,310 ± 200	16,620 - 15,395	Ly-2936	Bone	β count	Corchón, 1995
6	La Viña	IV	MM	13,360 ± 190	16,688 - 15,530	Ly-3316	Bone	β count	Fortea, 1990
4	Las Caldas	IX (Sala II)	MM	13,370 ± 110	16,410 - 15,750	Ua-10188	Bone	AMS	Corchón, 1995
4	Las Caldas	IV/III (Sala II)	MM	13,400 ± 150	16,592 - 15,696	Ly-2427	Bone	β count	Evin et al., 1983
57	Ermittia	III	MM/ULM (+CLM?)	13,525 ± 125	16,742 - 15,918	Ua-4516	Bone	AMS	Esparza and Mujika, 1999
4	Las Caldas	VIII (Sala II)	MM	13,640 ± 150	16,985 - 16,064	Ua-10189	Bone	AMS	Corchón, 1995
4	Las Caldas	VIc (Sala II)	MM	13,650 ± 140	16,981 - 16,110	Ua-10190	Bone	AMS	Corchón, 1995
57	Ermittia	III	MM/ULM (+CLM?)	13,795 ± 155	17,228 - 16,233	Ua-4518	Bone	AMS	Esparza and Mujika, 1999
58	Urtiaga	D (bottom)	ULM (+MM?)	13,960 ± 50	17,106 - 16740	NA	NA	NA	Areso-Barquín et al., 2018
1	La Paloma	6	MM	14,600 ± 160	18,215 - 17,403	OxA-974	Half-round rod (antler)	AMS	Barandiarán, 1988
30	**El Pendo**	**Excavations J. Carballo and B. Larín**	**Mag.**	**14,830 ± 170**	**18,147 - 17,139**	**OxA-977**	**Foreshaft made in whale bone**	**AMS**	**Barandiarán, 1988**
33	Rascaño	4	CLM	15,988 ± 193	19,820 - 18,878	BM-1453	Bone	β count	Barandiarán, 1981a

Table 4. Absolute radiocarbon dates from Magdalenian levels yielding whale bone objects in the Cantabrian region. In bold, the only direct date on a whale bone object currently available from the Bay of Biscay. Chrono-cultural periods: ULM: Upper and Late Magdalenian, MM: Middle Magdalenian, CLM: Cantabrian Lower Magdalenian, Mag.: Magdalenian.

	Width (mean and SD in mm)	Thickness (mean and SD in mm)	Length of the three longuest (sub)complete specimens in mm	Length of the three longuest fragments in mm	Number of fragments up to 100 mm in length
Cantabrian projectile points made in WB (n = 38)	12 ± 2,5	9,3 ± 1,6	112 - 185 - 200	139 - 145 - 214	4
Pyrenean projectile points made in WB (n = 52)	11,4 ± 2,9	9,7 ± 2,6	NA	190,5 – 275 – 352	12

Table 5. Comparison of the dimensions of Cantabrian and Pyrenean whale bone (WB) projectile points. Data for Pyrenean projectile points made in WB come from Pétillon, 2013: 535.

	Width (mean and SD in mm)	Thickness (mean and SD in mm)	Lenght of complete specimens (mean and SD in mm)
Cantabrian fork-based point made in WB	6 (n=1)	13 (n=1)	112 (n=1)
Pyrenean fork-based points made in RA from Isturitz I/F1	7,7 ± 1,3 (n=88)	10,1 ± 2,2 (n=88)	97 ± 22 (n=42)
Cantabrian double-bevelled points in WB	9,2 ± 1,8 (n=4)	11 ± 2,1 (n=4)	
Pyrenean double-bevelled points made in RA from Isturitz I/F1	9,5 ± 2,4 (n=20)	8 ± 1,6 (n=20)	
Pyreno-Cantabrian foreshafts made in WB	11,6 ± 1,8 (n=26*)	10,6 ± 1,6 (n=26*)	171 ± 0,4 (n=2)
Pyrenean foreshafts made in RA from Isturitz-F1	8,5 ± 0,9 (n=16)	10,4 ± 1,1 (n=16)	69 ± 14,1 (n=2)
Pyreneo-cantabrian massive-based points in WB	12,5 ± 2 (n=17)	10,8 ± 7 (n=17)	192,5 ± 7,5 (n=2)
Pyrenean massive-based points made in antler from Isturitz-Eω/SI	11,9 ± 1,6 (n=10)	9 ± 1,2 (n=10)	131,9 ± 104 (n=3)

Table 6. Comparative metrical data for whale bone (WB) and reindeer antler (RA) artefacts from Pyreneo-Cantabrian assemblages. * WB foreshafts include 22 examples from the Pyrenees and four from the Cantabrian region. Data for Pyrenean fork-based points made in RA from Isturitz I/F1 come from Lefebvre, 2016: 159. Data for Pyrenean double-bevelled points made in RA from Isturitz I/F1 come from Lefebvre, 2016: 160. Data for Pyrenean foreshafts and massive-based points made in antler from Isturitz (levels F1-Eω/SI) come from personal observations.