

LES SÉANCES DE LA SOCIÉTÉ PRÉHISTORIQUE FRANÇAISE

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La Société préhistorique française, fondée en 1904, est une des plus anciennes sociétés d'archéologie. Reconnue d'utilité publique en 1910, elle a obtenu le grand prix de l'Archéologie en 1982. Elle compte actuellement plus de mille membres, et près de cinq cents bibliothèques, universités ou associations sont, en France et dans le monde, abonnées au *Bulletin de la Société préhistorique française*.

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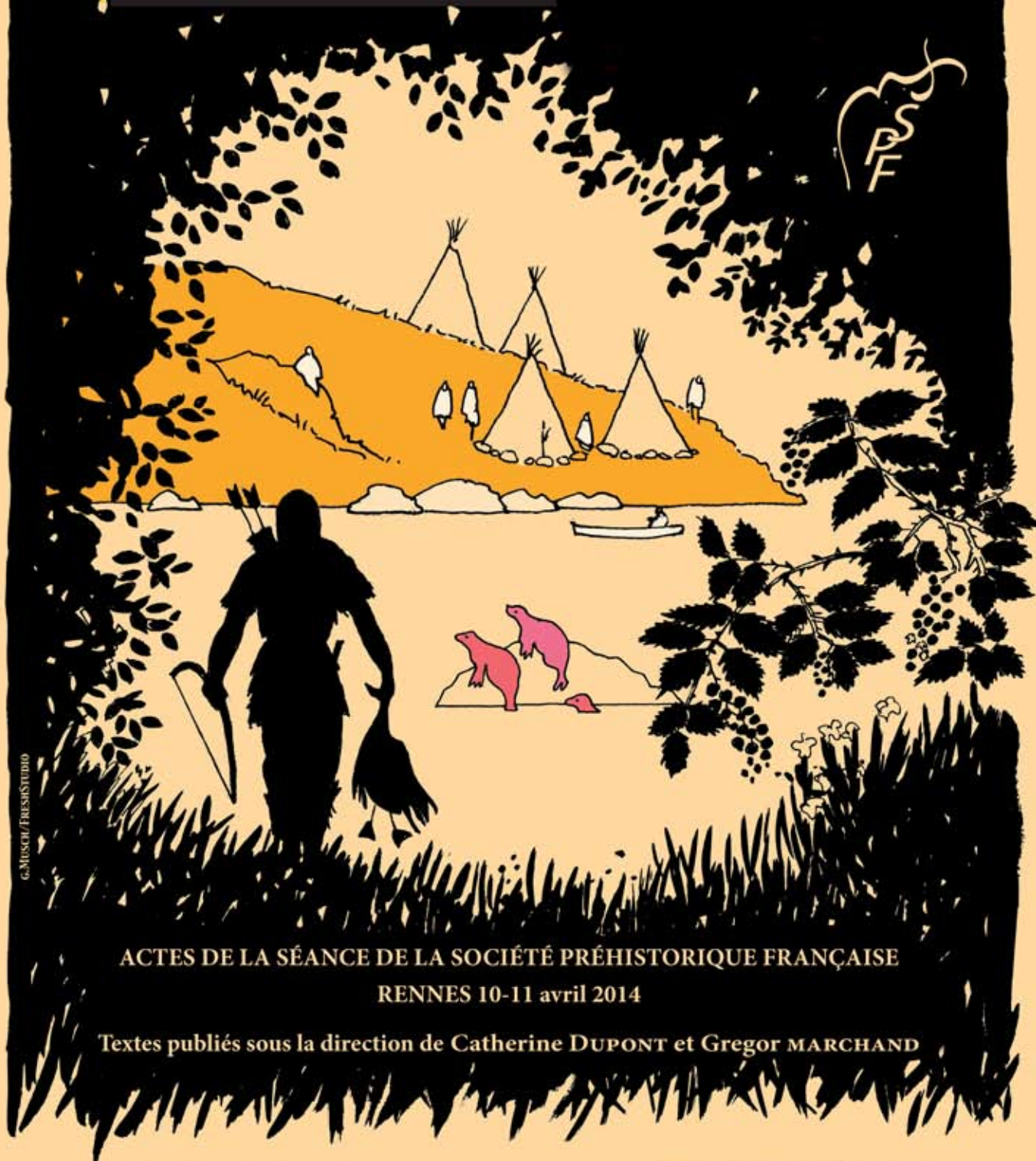
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ARCHÉOLOGIE DES CHASSEURS-CUEILLEURS MARITIMES

DE LA FONCTION DES HABITATS
À L'ORGANISATION DE L'ESPACE LITTORAL

ARCHAEOLOGY OF MARITIME HUNTER-GATHERERS

FROM SETTLEMENT FUNCTION
TO THE ORGANIZATION OF THE COASTAL ZONE



ACTES DE LA SÉANCE DE LA SOCIÉTÉ PRÉHISTORIQUE FRANÇAISE

RENNES 10-11 avril 2014

Textes publiés sous la direction de Catherine DUPONT et Gregor MARCHAND

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6

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L'organisation de cet événement a également été soutenue financièrement par de nombreux organismes publics et des projets de recherche : le projet européen « Arch-Manche » (Interreg IVA 2 Mers, fonds FEDER), le projet « SeaMeso » de la Maison des sciences de l'homme en Bretagne, le CNRS (DR 17), l'Observatoire des sciences de l'Univers de Rennes (OSUR), le ministère de la Culture (service régional de l'Archéologie de Bretagne) et la région Bretagne. L'université Rennes 1 a permis l'utilisation de l'amphithéâtre Donzelot. Enfin, nous tenons à remercier la Société préhistorique française d'avoir accepté de labelliser cet événement « Séance de la Société préhistorique française ».

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This international scientific event could not have taken place without the logistic support of the UMR 6566 'CReAAH'. Several of our colleagues from the Archaeosciences laboratory (Rennes 1 University) oversaw the reception of participants and the breaks during the session with their legendary efficiency and good nature: Francis Bertin, Annie Delahaie, Catherine Louazel, Catherine Gorlini and Laurent Quesnel. We also thank Diana Nukushina and Helena Reis for their help with the smooth running of the sessions. We are grateful to Franck Wellmann from the Rennes 1 University of for looking after the computer and multimedia installations in the conference room. We thank Louise Byrne for the correction in english of the abstracts and the texts.

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*Archéologie des chasseurs-cueilleurs maritimes.
De la fonction des habitats à l'organisation de l'espace littoral
Archaeology of maritime hunter-gatherers.
From settlement function to the organization of the coastal zone*
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Palaeolithic–Epipalaeolithic Seapeople of the Southern Iberian coast (Spain): an overview

J. Emili AURA TORTOSA, Jesús F. JORDÁ PARDO, Esteban ÁLVAREZ-FERNÁNDEZ,
Manuel PÉREZ RIPOLL, Bárbara AVEZUELA ARISTU, Juan V. MORALES-PÉREZ,
María José RODRIGO GARCÍA, Ricard MARLASCA, Josep Antoni ALCOVER, Paula JARDÓN,
Clara I. PÉREZ HERRERO, Salvador PARDO GORDÓ, Adolfo MAESTRO,
María Paz VILLALBA CURRÁS and Domingo Carlos SALAZAR-GARCÍA

Abstract: The significance of coastal areas to human survival and expansion on the planet is undeniable. Their ecological diversity and their use as communication routes are some of their most distinctive qualities. However, the evidence of exploitation of these resources has had an uneven preservation, which is limited to certain regions and more recent events, mainly sites with deposits from the Upper Pleistocene and Holocene. This paper analyses the data available on the use of marine resources between MIS 6 and MIS 1 (c. 150–9 ka BP) in Southern Iberia, one of the first regions in Europe where marine faunal remains were discovered, in archaeological deposits from Middle and Upper Palaeolithic. Therefore their presence here has not been a criterion of separation between Neanderthals and Modern humans, but it may be relevant to analyze changes in the use of small preys or assess the economic diversification in regions where this came at an early date. One of the aims of this study was to evaluate the diachronic trends of the different palaeobiological marine remains recovered from coastal and inland archaeological sites. This preliminary extract indicates that the analysis of marine resource exploitation cannot be classed as a mere listing of palaeobiological remains. This information may be relevant in the initial stages, but it is insufficient in the evaluation of techno-economic and sociocultural transformations that can be linked to the use of marine resources. The distribution of palaeobiological marine remains differs over time and also according to the location of the sites with respect to the changing coastline throughout the period analysed. The known sites that preserve evidence of the use of marine resources as a food source are located mainly on the present coastline, or in a range of less than 10 km. Invertebrate remains have been identified in most, whereas fish, bird and mammal bones only in certain sites. Molluscs used as ornaments or pendants and containers are more widely distributed than other species used for food. Because these data must be contextualized, bone and stone tools linked to the exploitation of the marine environment have been added to the palaeobiological information, drawing inferences based on the analogy between both ethnologically and archaeologically documented tools. Symbolic expressions have also been studied, given the significant number of painted and engraved marine fauna depictions, specifically pisciforms and mammals, found in southern Iberia. Lastly, available molecular data has also been evaluated, from the results of isotope analysis on human remains. This combination of palaeobiological, techno-economic, graphic-symbolic and molecular data, allows a first assessment of the use of marine resources in the region.

Throughout this temporal trajectory there are several gaps in the documented evidence that favour an episodic change rather than a cumulative and continuous process. It might be possible that these gaps are hidden aspects related to dietary processes of resource diversification. Either way, two different situations have been recognized:

First, a complementary, perhaps seasonal use of marine resources in Neanderthal occupations. Molluscs, mainly gastropods, and beached marine mammals are the most common types of marine resources. The anthropic contribution of birds is mainly concentrated in crows and pigeons, not in marine birds. The fish remains are unreliable and no technical equipment has been identified linked to the extraction and consumption of the mentioned resources.

Second, the identification of obvious maritime-orientated societies at the end of the Upper Palaeolithic. The exploitation of a large variety of invertebrates (gastropods, bivalves, crustaceans, and echinoderms) with a significant increase in bivalves, fish, birds and marine mammals is associated with equipment linked to their extraction and processing. The identification of marine fauna depictions in the Palaeolithic art and the concentration of sites along the coast of the Alboran Sea that accumulate deposits of marine fauna, add regional traits, which have not been described in the rest of the Mediterranean Iberian region or in much of southern Europe.

Keywords : Marine fauna, Marine resource exploitation. Neanderthals, Modern humans, Palaeolithic, Southern Iberia.

Résumé : L'importance des zones littorales pour la survie et l'expansion des hommes sur la planète est indubitable. Leur diversité écologique et leur utilisation comme voie de communication sont quelques-unes de leurs qualités les plus signalées. Cependant, les preuves liées à l'exploitation de leurs ressources ont été inégalement préservées, se limitant à quelques régions du globe et aux épisodes plus récents de l'histoire de l'Humanité, et se trouvent principalement sur des sites du Pléistocène supérieur et de l'Holocène. Dans ce travail, nous analysons les données disponibles sur l'utilisation des ressources marines dans le sud de la péninsule ibérique entre MIS 6 et MIS 1 (*ca* 150-9 ka BP), une des premières régions européennes dans lesquelles des restes de faune marine ont été identifiés parmi les vestiges archéologiques du Paléolithique moyen et supérieur. Par conséquent, cette présence n'est pas un critère de distinction entre Néandertaliens et hommes modernes, même s'il peut être pertinent d'analyser les changements dans l'importance de petites proies ou d'évaluer la diversification économique lors des périodes les plus anciennes. L'un des objectifs initiaux de ce travail est d'évaluer les tendances diachroniques des différents restes paléobiologiques marins récupérés dans les contextes archéologiques des sites côtiers et continentaux. La distribution des restes paléobiologiques montre néanmoins des différences au fil du temps, ainsi qu'en fonction de la localisation des sites sur une ligne de côte au tracé fluctuant au cours de la période analysée. Les sites présentant des témoignages de l'utilisation des ressources marines comme aliment se trouvent majoritairement sur la côte actuelle, ou sur une bande de moins de 10 km. Dans la plupart d'entre eux, des restes d'invertébrés marins ont été identifiés, alors que des ossements de poissons, d'oiseaux et de mammifères n'ont été relevés que dans quelques sites seulement. Les mollusques utilisés comme parures-pendeloques ou récipients ont une distribution plus étendue que celle des espèces utilisées à des fins alimentaires. Cette description préliminaire indique que l'analyse de l'exploitation des ressources marines ne peut être considérée comme une simple énumération des restes paléobiologiques. Dans cette optique, nous avons ajouté à l'information paléobiologique, l'information sur les matériels de pierre et d'os qui ont été mis en relation avec l'exploitation du milieu marin. Il s'agit d'inférences basées sur l'analogie avec des matériels documentés autant par l'ethnologie que par l'archéologie. Les données se rapportant aux expressions symboliques ont également été incluses, étant donné que le sud de la péninsule ibérique rassemble un nombre significatif de représentations de faune marine peintes et gravées, pisciformes comme mammifères. Enfin, les données moléculaires disponibles sont aussi évaluées, à partir des résultats d'analyses d'isotopes de restes humains. La combinaison des données paléobiologiques, techno-économiques, grapho-symboliques et moléculaires permet une évaluation préliminaire des formes d'utilisation des ressources marines dans la région à partir d'une première caractérisation des ressources documentées et leurs zones d'obtention, jusqu'à la relation existante entre la contribution de différents types de ressources et la distance du gisement par rapport à la ligne de côte ou les possibles inférences sur les techniques d'extraction. Au cours de cette trajectoire temporelle, il existe certes des lacunes documentaires favorisant davantage une idée de changements épisodiques que d'un processus continu, accumulatif. Il est possible qu'elles occultent des nuances dans l'évolution générale. Dans un cas comme dans l'autre, nous avons reconnu deux situations différenciées :

Premièrement, une utilisation complémentaire des ressources marines, peut-être saisonnière, dans les occupations associées aux Néandertaliens. Les ressources exploitées se concentrent sur les mollusques, gastéropodes dans leur majorité, et sur les mammifères marins échoués sur les plages. La contribution anthropique des oiseaux a été identifiée majoritairement sur le continent et non sur le littoral. Les restes de poissons sont anecdotiques. Aucun matériel technique lié à l'extraction et à la consommation des ressources mentionnées n'a été relevé.

Deuxièmement, une claire orientation maritime des économies à la fin du Paléolithique supérieur. L'exploitation d'une grande variété d'invertébrés (gastéropodes, bivalves, crustacés et échinodermes) avec une augmentation significative des bivalves, de poissons, d'oiseaux et de mammifères marins est associée à des outils que nous avons mis en rapport avec leur extraction et leur traitement. La description des représentations de faune marine dans l'art paléolithique régional et la concentration de sites accumulant des vestiges de faune marine sur la côte de la mer d'Alboran confèrent à ces groupes des traits originaux, inconnus du reste de la région méditerranéenne ibérique et en bonne partie du Sud de l'Europe.

Mots-clés : Faune marine, exploitation du milieu marin, Néandertaliens, Humains modernes, Paléolithique, Espagne méridionale..

THE EXPLOITATION of marine resources is no longer an exclusive attribute of modern humanity (Henshilwood and Marean, 2003; Marean et al., 2007). The review of its importance in recent decades is a phenomenon that affects different regions and evolutionary processes (Erlandson, 2001; Foley, 2002; Bailey, 2004; Bailey and Milner, 2002). South African data on the exploitation of marine resources exceeds 160 ka BP (Marean et al., 2007; Avery et al., 2008, Jerardino, 2010), providing discussion on the shaping of modern human behaviour (McBrearty and Brooks, 2000). Equally, the timeline of Australian Colonization and the employed ways and means, are also another point of reference (Davidson, 2013). Other contributions have raised the advantages and social impact of incorporating small prey in the diet (Stiner et al., 2000, Stiner, 2013; Munro and Atici, 2009), or the nutritional content of marine molluscs in relation to the develop-

ment of cognitive abilities (Erlandson, 1988; Hockett and Haws, 2003).

In the Mediterranean regions—North Africa, Near East and Southern Europe—there are references to the use of marine resources prior to MIS 8, but most are from post-MIS 5, concentrated mainly between MIS 2 and 1 (Cleyet-Merle and Madelaine, 1995; Erlandson, 2001; Jordá Pardo et al., 2010; Álvarez-Fernández and Carvajal Contreras, 2010; Colonese et al., 2011; Álvarez-Fernández, 2010 and 2015; Ramos Fernández and Castillo, 2009; Cortés Sanchez et al., 2011; Brown et al. 2011; Steele and Álvarez-Fernández, 2012; Marean, 2014).

Most of the Western Mediterranean sites are caves and rock shelters, located on the same coastline or only a few kilometres apart. Despite this shared feature, there is a great diversity in the type and amount of evidence. The identification of mollusc remains is the most common, ranging from a small amount to tens of thousands. There

is a smaller presence of fish, bird and marine mammal remains. For most of these archaeological contexts there is no direct evidence of the techniques used for their extraction (harvesting equipment, fishing tools, etc.), the means used to locate the fish (static and mobile traps, transport), their processing and their consumption (traceology, residue analysis, preservation techniques etc.). In this regard, the regional data are not comparable to those of Northern Europe, resulting in discrepancies between our knowledge of the volume of known palaeobiological remains and the equipment used for their extraction.

The accepted low productivity of the Mediterranean Sea is at the origin of the lack of attention paid to these issues in the southern regions of Europe: “In terms of the productivity of the marine coastal zone itself then, once again, we must emphasize the greatly superior edible productivity of the Atlantic-shelf littoral, as opposed to the Mediterranean shallows, although both were certainly major resource zones. (...) The tideless, enclosed Mediterranean has a poorer ecology although its southern latitudinal advantage does once again produce larger yields of particular species in limited locations” (Clarke, 1976, p. 21–22).

A perspective supported so far by the results of isotope analyses on human remains, which shown a low use of marine resources (Salazar-García, 2012). Nitrogen isotope values ($\delta^{15}\text{N}$) from Neanderthal and modern human samples indicate a low intake of marine resources (Richards and Trinkaus, 2009) and a variable presence of freshwater resources (Fu et al., 2014) with a greater presence in the Mesolithic (Salazar-García et al., 2014). However, more accurate analysis of the consumption of freshwater resources is yet to be performed thanks to development of new types of isotopic analysis (Naito et al., 2013; Nehlich, 2015).

SOUTHERN IBERIA

Information on the use of marine resources in the western Mediterranean during the Palaeolithic focuses on sites that have two important qualities identified by D. R. Yesner (Yesner, 1980) and J. M. Erlandson (Erlandson, 2001): areas that concentrate the most primary productivity and coasts with steep bathymetry, which has helped to preserve the sites (Colonese et al., 2011).

Southern Iberia meets both these conditions and is therefore a good setting for the analysis of the exploitation of marine resources. Since the early twentieth century, depictions of marine fauna have been identified in the regional Palaeolithic parietal art (Breuil et al., 1915), and the first shell middens found, dated to the Upper Palaeolithic (Such, 1920; Aura Tortosa et al., 2013). The first data on molluscs, birds and marine mammals from the Gibraltar sites were published a few years later (Garrod et al., 1928), and more recently from Nerja Cave (Boessneck and Von den Driesch, 1980; Morales Muñiz and Martí, 1995; Pérez and Raga, 1998; Jordá Pardo, 1981; Aura Tortosa et al., 2002) and the Strait

of Gibraltar (Bernal Casasola, 2009; Ramos Fernández et al., 2011). This is one of the southernmost regions of Europe, and its analysis exceeds the scale of regional processes for its impact on various issues under discussion: the contribution of marine resources to the persistence of the southern European Neanderthals (Stringer et al., 2008), the relations between Iberia and Africa (Straus, 2001; Tiffagom, 2006; Ramos Fernández et al., 2011) or the first uses of marine molluscs for non-food purposes (Zilhão et al., 2010; Álvarez-Fernández, 2015).

The aim of this paper is to analyse marine resource exploitation by Neanderthals and modern humans who inhabited the Iberian coasts of the Alboran Sea between the marine isotope stages 6 and 1 (MIS 6 and MIS 1). In addition to the palaeobiological information, data on bone and stone tools related to the exploitation of the marine environment have been included, concentrated mainly in the Upper Palaeolithic and Epipalaeolithic. Data obtained from symbolic expressions have also been incorporated, due to the significant number of painted and carved depictions of marine fauna (fish and mammals) that have been found in Southern Iberia. Lastly, the first available molecular data have been evaluated, from the results of isotope analysis carried out on human remains.

This combination of palaeobiological data with techno-economic, graphic-symbolic and molecular data, allows a first assessment of the use of marine resources in the region.

MATERIALS AND METHODS

The archaeological sites are situated between 36°–39°N latitude and are based in the present regions of Andalusia and Murcia (Spain). They are dated between MIS 6 and MIS 1 (c. 150–12 ka BP), although most of the obtained data is from after the LGM. The ordination of the sites has been performed using the MIS as the common chronometric scale for the different archaeostratigraphic units. Unless otherwise indicated, the chronology proposed by the researchers has been accepted, grouping the sites in three major series:

- 1) The Neanderthal contexts (MIS 6 to 4 and 3/MP = Middle Palaeolithic, c. 150–40 ka cal. BP);
- 2) The first modern human contexts pre-LGM and LGM (MIS 3/UP = Upper Palaeolithic, and MIS 2, c. 30–22 ka cal. BP), assemblages associated to Aurignacian, Gravettian and Solutrean industries;
- 3) The post-LGM contexts (MIS 2 to 1, c. 15–12 ka cal. BP), assemblages associated to the Magdalenian and the Epimagdalenian.

It is difficult, however, to establish benchmarks in sites from Middle Palaeolithic, Upper Palaeolithic and Epipalaeolithic-Mesolithic. What is sure is that the varying level of resolution of these archaeostratigraphic units and the chronometric data from each of them; in many cases there is no data on the total number of remains recovered from each stratigraphic and chronostratigraphic unit,

meaning that simple numeric values may be indicative of the consumption of marine resources, but not of their continuity or intensity, nor of the implications of their use or the techniques used.

Almost thirty sites have been used, although only twenty-one of these provide information that can be systematized, as demonstrated in [table 1](#). The sites have been divided into three groups according to their position on the coastline at the time of their respective occupations: sites along the same coastline, sites on the coastal plain (between 1 km and 10 km from the coast, according to the continental morphology) and the more inland sites (> 20 km). Several authors point out that resources were not transported further than 10 km from their place of origin between historic hunter-gatherers ([Meehan, 1977](#)); this is the limit between coastal and inland sites adopted in this paper.

Only anatomical specimens preserved in archaeological contexts of invertebrate, fish, bird and mammal species that inhabited this environment have been considered as marine remains. Some fish can migrate to freshwater rivers or inhabit lagoons and estuaries, but they are considered marine due to their natural habitat. Similarly, the seabirds that have been considered in this study are also strictly marine. The list of marine fauna taxa identified at the sites in Southern Iberia provides incomplete and inconsistent data. The studies dedicated to invertebrate assemblages are numerous, but data on fish and birds are limited to a small number of sites, in Gibraltar, the Nerja Cave and Cueva del Caballo.

There are studies on the origins of palaeobiological marine remains recovered in archaeological contexts which are referenced in each section. Due to the position of Gorham's Cave on the actual shore, the possibility of birds depositing the recovered molluscs and crustaceans has been raised ([Erlandson and Moss, 2001](#)), but no taphonomic studies have been carried out to confirm this. Changes in the coastline and its possible role in contributing to the invertebrate remains in sites at low altitude can provide data on the areas of exploitation, especially in the earliest stages ([Vera et al., 2004](#)). Therefore, in this study it has been assumed that the marine invertebrate and vertebrate contributions are anthropogenic, except in cases where taphonomic analysis suggests otherwise.

The palaeobiological data used have been organized into four general classes: invertebrates, fish, birds and marine mammals. Their analysis in this paper is limited to a description of the diversity of species and their diachronic changes. Where possible, indices have been obtained on the frequency of marine resources, in the sections on small prey (molluscs, fish, reptiles, birds, leporids and small carnivores) as well as mammals. In both cases the terrestrial and marine remains have been calculated separately, as the focus of this paper is on the analysis of marine resource exploitation.

As regards small prey the following indices have been obtained:

1) An index of small marine prey referring to vertebrates (ISMP), showing the proportion of terrestrial and

marine vertebrates (fish, birds and small mammals). NR/NISP counts have been used for quantification.

2) For medium and large mammals (> 25 kg), only an index of marine mammals (IMM) has been obtained, summarizing the proportion between terrestrial and marine mammal remains. NISP counts have been used for quantification.

3) Lastly, a global index of the relation between marine and terrestrial remains was obtained from the previous results (IM/T).

The presence of equipment related to hunting/fishing and the processing of marine resources, the depictions of marine fauna in Palaeolithic art, and the use of marine species for personal ornaments and containers, have been compiled. This study only reflects their presence or absence and tries to obtain information by the extraction techniques used. These data provide strong evidence for the exploitation of marine resources and the coastal-interior relationships.

PALAEOBIOLOGICAL REMAINS

Invertebrates

Marine invertebrates are the most widely studied group of archaeological samples, particularly the Gastropoda and Bivalvia classes of mollusc. To date, the earliest references were found at the Bajondillo site ([Cortés Sánchez et al., 2011](#)), and they have also been identified at the Gibraltar and Complejo Humo sites ([Garrod et al., 1928](#); [Waechter, 1951 and 1964](#); [Barton, 2000](#); [Fa, 2008](#); [Brown et al., 2011](#); [Ramos Fernández et al., 2014](#)). Throughout the period studied, the presence of shell remains is higher at the coastal sites (0–10 km from the coast at the time of human occupation) than at the inland sites. Changes in the composition and size of the samples indicate some trends that should be contextualized to assess their significance.

There is an increase in the number of Gastropoda and Bivalvia species at the coastal sites, which escalates after the Late Glacial Maximum (LGM; [fig. 1](#)). Between MIS 6 and MIS 3 an average number of six species of marine molluscs were registered in each archaeological site; after the LGM the number of species increases to between twenty and twenty-five; and, lastly, the greatest diversity is registered during GI 1 and GS 1: between twenty-five and thirty-four species. The number of invertebrate species is always lower at the inland sites.

A general trend is that the number of gastropods is greater than the number of bivalves prior to the LGM ([Jordá Pardo et al., 2016](#)). The bivalves increase considerably at sites dated post-LGM (references in [table 1](#)). At inland sites these trends tend to be affected by an increased presence of gastropods and scaphopods, used for making beads ([Simón Vallejo et al., 2006](#)). The presence of species used for food at inland sites only reaches significance after the LGM.

The remains of Crustacea, Cephalopoda and Echinoidea classes are fewer in number. The remains of a large barnacle, *Pollicipes pollicipes*, was used as a pendant during the Gravettian in Nerja (Avezuela Aristu et al., 2011). Also at the Nerja Cave two species of whale barnacle have been identified (*Tubicinella major* and *Cetopirus complanatus*), which have been linked to *Eubalaena glacialis/E. australis* (Álvarez-Fernández et al., 2014). Their presence in Upper Magdalenian contexts has been considered as indirect evidence of the use of large, beached cetaceans.

Remains of sea urchins have been identified at Vanguard Cave, Hoyo de la Mina, Complejo Humo and especially in Nerja, with thousands of NISP. *Paracentrotus lividus* is a species that could have been of interest for human consumption (Villalba Currás et al., 2007). The remains of crabs and cephalopods are not very common, but perhaps there is a bias, both in the recovery and the taxonomic identification (Álvarez-Fernández, 2010).

Marine fish

The first identification of marine fish and mammal remains from Palaeolithic times in Southern Iberia were found by M. Such (Such, 1920). The oldest remains have been identified in Vanguard Cave (Barton et al., 2000), Devil's Tower Cave (Garrod et al., 1928) and Gorham's Cave (Stringer et al., 2008). Our knowledge of the fish

fauna may be biased because of the recovery methods used in early excavations. However, the data obtained from recent excavations indicates that the number is low until the end of MIS 3, increasing significantly after LGM. The few remains prior to MIS 2 are divided between small species that inhabited estuaries and intertidal zones (Sparidae, Mugilidae) and large species (table 2).

From MIS 3, the data on the exploitation of marine fish during the Upper Palaeolithic and the Epipalaeolithic originate mainly from the Nerja Cave. The remains studied to date from the excavations conducted by F. Jordá Cerdá (1979–1987) include almost 10,000 NISP (Aura Tortosa et al., 2002 and 2010). The general trend indicates that the number of remains increases considerably in post-LGM deposits, with regard to human occupations pre-LGM and LGM.

The Sparidae family is the most predominant in all samples until the end of the Pleistocene, but the identified taxa show the exploitation of different environments: from estuaries (Mugilidae and Acipenseridae), to sandy (Sparidae and Carangidae) and rocky (Labridae) areas of the seabed.

Some of the identified species provide data on the palaeoecology of the western Mediterranean at the end of the Pleistocene; two examples may be illustrative. Firstly, *Salmo salar* (NR = 3) has been identified in the samples studied from the Solutrean occupations dated between 24–23 ka cal. BP, coinciding with the beginning of the LGM. This presence in the Mediterranean Palaeo-

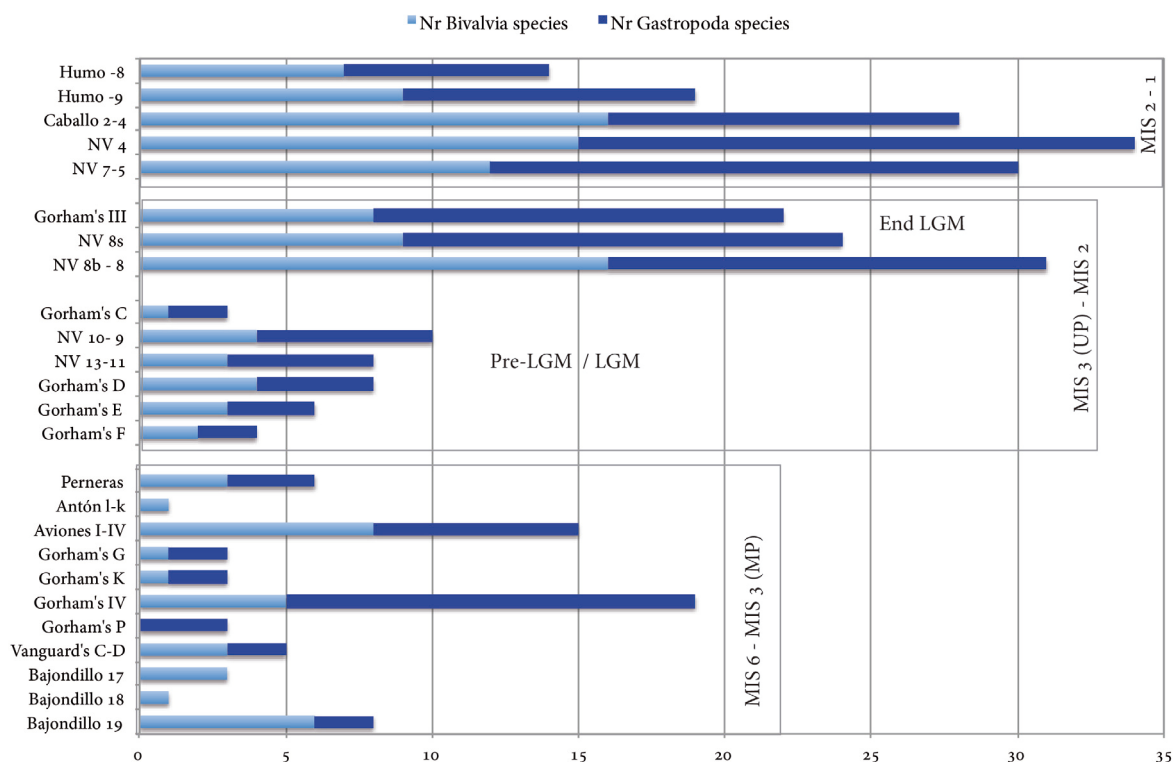


Fig. 1 – Number of marine invertebrate species identified in the Southern Iberian sites, ordered chronologically (references in table 1).

Fig. 1 – Nombre d'espèces d'invertébrés marins identifiées dans les gisements du Sud de la péninsule Ibérique, ordonnées chronologiquement (références dans le tableau 1).

	MIS	Phase	Shell-fish	Fish	Marine birds	Marine mammals	Ornaments	Contenedor	Harpoons	Gorges	Art	Reference
Marine fauna depictions												
Cueva del Tesoro	2-1	UP										Cantalejo et al., 2006
Cueva de Nerja	2-1	UP			Duck?			Lamps				Sanchidrián, 1990; Medina et al., 2010
La Pileta	2	UP										Sanchidrián, 1990
Ardales	3-2	UP			Wader							Cantalejo et al., 2006
Sites/levels												
Complejo Humo 8	2-1	UP										Ramos et al., 2006
Cueva del Caballo 2-4	2	UP										Martínez Andreu, 1989
Nerja NV 4	2-1	UP										Aura et al., 2002, 2010
Complejo Humo 9	2	UP										Ramos et al., 2006
Nerja NM 16-14	2	UP										Jordá Pardo, 1986
C Higuerón	2-1	UP		?								Giménez Reyna, 1946; Fortea, 1973
C. Victoria	2-1	UP		?								Giménez Reyna, 1946; Fortea, 1973
Hoyo de la Mina	2	UP										Such, 1920; Cortés et al., 2006
Nerja NV 7-5	2	UP										Aura et al., 2002 and 2010
El Pirulejo 4-2	2	UP										Cortés et al., 2008
Gorham's III	2	UP		NISP: 6								Stringer et al., 2008; Brown et al., 2011
Gorham's B (1951-54)	2	UP										Waechter, et al., 1964; Eastham, 1967
Nerja NV 8/s	2	UP										Aura et al., 2002, 2010
Nerja NV 8'-8	2	UP										Aura et al., 2002, 2010
El Pirulejo 5	2	UP										Cortés et al., 2008
Tajo de Jorox	2	UP										Simón et al., 2006
Ambrosio II	2	UP										Jordá Pardo & González, 1988
Ambrosio IV	2	UP										Jordá Pardo & González, 1988
Ambrosio VI	2	UP										Jordá Pardo & González, 1988
Nerja NV 10-9	2	UP										Aura et al., 2002, 2010
Gorham's D (1951-54)	2	UP										Waechter, et al., 1964; Eastham, 1967
Gorham's E (1951-54)	2	UP										Waechter, et al., 1964; Eastham, 1967
Gorham's F (1951-54)	3-2	UP										Waechter, et al., 1964; Eastham, 1967

Table 1 – Southern Iberian sites; presence of marine faunas, symbolic elements (depictions and ornaments) and equipment that could be related to its extraction.
 Tabl. 1 – Sites de la península Ibérica ; présence de faune marine, éléments symboliques (représentations et décorations) et outils en relation avec son extraction.

MIS	Phase	Shell-fish	Fish	Marine birds	Marine mammals	Ornaments	Contenidor	Harpoons	Gorges	Art	Reference
Sites/levels											
3	UP										Aura et al., 2013
3	MP										Walker et al., 2004
3	MP										Montes, 1988; Zilhão et al., 2010
3	MP										Zilhão et al., 2010
3	MP										Montes, 1988; Zilhão, 2010
3	MP										Jennings et al., 2009
4–3	MP										Ramos et al., 2011-12
3	MP										Waechter, et al., 1964; Eastham, 1967
3	MP										Waechter, et al., 1964; Eastham, 1967
4	MP										Waechter, et al., 1964; Eastham, 1967
3	MP		NISP: 4								Stringer et al., 2008; Brown et al., 2011
3	MP										Barton et al., 2012
4–5	MP										Waechter, et al., 1964; Eastham, 1967
4–5	MP										Waechter, et al., 1964; Eastham, 1967
4–5	MP										Barton et al., 2012
5	MP		NISP: 1								Barton et al., 2012
4–3	MP		'Few'								Bate in Garrod et al., 1928
4–5	MP	?									Barton et al., 1999
4	MP										Cortés et al., 2011
5	MP										Cortés et al., 2011
6	MP										Cortés et al., 2011

Table 1 (end) – Southern Iberian sites; presence of marine faunas, symbolic elements (depictions and ornaments) and equipment that could be related to its extraction. *Tabl. 1 (suite et fin) – Sites de la péninsule Ibérique ; présence de faune marine, éléments symboliques (représentations et décorations) et outils en relation avec son extraction.*

lithic sites had been cited by several authors (Juan Muns i Plans, 1985; Le Gall, 1994; Morales Muñiz and Roselló Izquierdo, 2008), and more recently also in Nerja (Cortés Sanchez et al, 2008), in a collection without archaeostratigraphical support (Aura Tortosa et al., 2010). The second example is the predominance of the Gadidae family in some of the samples dated from the Younger Dryas (YD), with remains of pollock and haddock that exceed the Sparidae (Rodrigo García, 1991; Aura Tortosa et al., 2002). Both these examples indicate that the ecological conditions of the fini-Pleistocene Mediterranean are not comparable to the present conditions (Kettle et al., 2011), which must have influenced the primary productivity of the Alboran Sea.

Marine birds

The information on Palaeolithic seabirds in Southern Iberia is concentrated at five sites: Devil's Tower Cave, Ibex Cave, Vanguard Cave, Gorham's Cave (Garrod et al., 1928; Waechter, 1951 and 1964; Cooper, 2012a and 2012b) and Nerja Cave (table 3).

There could be several reasons for the presence of seabird remains at archaeological deposits and not all related to human contributions (Stewart, 1994). The absence of cut-marked bird bones at Vanguard Cave and Gorham's Cave raises reasonable doubts about their anthropogenic accumulation in these Neanderthal contexts, although it must not be ruled out that this prey

could have been treated by hand (Cooper, 2012a and 2012b). Recently, marks have been identified among the remains of raptors and corvids that show the extraction of feathers (Finlayson et al., 2012), and among pigeons (Blasco et al., 2014).

Over 1,000 NISP of Palaeolithic and Epipalaeolithic birds (MIS 3–1) have been studied in Nerja (Eastham, 1986; Hernández Carrasquilla, 1995; Alcover, unpublished data). Most of the ducks and waterfowl found in Nerja are post-LGM. The seabirds, for their part, represent one third of the total and are concentrated at the end of MIS 2, mainly between GI 1 and GS1, when the coastline was located approximately 3–4 km from the site.

From the available data it can be affirmed that the bones of marine birds found in different areas of Nerja are an anthropogenic accumulation. Anthropogenic fractures have been identified along with signs of fire, and other marks are being analysed (cuts, human bite marks, etc.). One indicative detail is the use of marine bird bones to make tools (Aura Tortosa and Pérez Herrero, 1998; Cortés Sanchez et al., 2008).

Marine mammals

Seals and dolphins were resources exploited by humans in Southern Iberia throughout the period under review (table 4). A publication dedicated to Hoyo de la Mina Cave cites the first remains of an unidentified marine carnivore (Such, 1920), and the first remains of Mediter-

Site	Fish species identified	NISP	MIS	Reference
Nerja NV 4	Gadidae, Labridae, Sparidae	4,774*	2/1	Aura et al., 2002
Nerja NV 5–7	Sparidae, Carangidae, Belonidae, Gadidae, Scombridae	3,825*	2 Post-LGM	Aura et al., 2002
Nerja NV 8s	Sparidae, Gadidae, Labridae	356	2 End LGM	Aura et al., 2002
Nerja NV 8'–8	Sparidae, Mugilidae, Gadidae, Labridae, Scombridae	223	2 LGM	Aura et al., 2002
Nerja NV 10–9	Sparidae, Mugilidae, Labridae	28	2 Pre LGM	Aura et al., 2002
Nerja NV 13–11	Mugilidae	4	3	Aura et al., 2002
Nerja NT 12–13 M80 6–8	Sparidae, Carangidae, Scombridae, Belonidae, Labridae	215	2–1	Roselló et al., 1995
Nerja NT 9–6	Sparidae, Serranidae, Gadidae, Carangidae, Scombridae	326	2/1	Boessneck & von den Driesch, 1980
Vanguard's Cave	Sparidae Scombridae	1 ()	5	Barton et al., 1999; Brown et al., 2011
Gorham's Cave		III: 6 IV: 4	3	Stringer et al., 2008
Devil's Tower	Percooid, cf. Late	(few)	4/3	Bate in Garrod et al., 1928
Hoyo de la Mina	Sparidae - Labridae Scombridae	() ()	2/1	Such, 1920

Table 2 – Fish remains identified in the Southern Iberian sites.

Tabl. 2 – Restes de poissons identifiés dans les gisements du Sud de la péninsule Ibérique.

Table 3 – Marine birds from the southern main Iberian sites.*Tabl. 3 – Oiseaux marins des sites principaux du Sud de la péninsule Ibérique.*

	DEVIL'S TOWER Bate in Garrod et al., 1928	VANGUARD'S CAVE C-D Cooper, 2012b	GORHAM'S CAVE 1951-54 Eastham, 1967	GORHAM'S CAVE 1995-98 Cooper, 2012a	CUEVA DE NERJA Boessneck & von der Driesch, 1980	CUEVA DE NERJA Eastham, 1986	CUEVA DE NERJA Hernández Carrasquilla, 1995	CUEVA DE NERJA Alcover, unpublished
	MIS 4–3	MIS 5	MIS 4–2	MIS 4–3	MIS 2–1	MIS 2–1	MIS 2–1	MIS 3–1
<i>Fulmarus glacialis</i>		+		+				
<i>Pterodroma</i> sp.				+				
<i>Calonectris diomedea</i>	+				+		+	+
<i>Puffinus</i> (cf. <i>griseus</i> , <i>gravis</i> , <i>puffinus</i> , <i>yelkouan</i>)			+					
<i>Puffinus puffinus</i>			+		+			
<i>Puffinus gravis</i>					+			
<i>Puffinus griseus</i>						+		
<i>Puffinus</i> aff. <i>griseus</i>							+	
<i>Puffinus yelkouan</i>							+	
<i>Calonectris/Puffinus</i>							+	
<i>Hydrobates pelagicus</i>				+				
<i>Sula bassana</i>					+	+	+	+
<i>Phalacrocorax carbo</i>	+						+	+
<i>Phalacrocorax aristotelis</i>	+		+	+			+	+
<i>Stercorarius skua</i>							+	
<i>Larus</i> sp.				+				
<i>Larus canus</i>				+	+		+	
<i>Larus argentatus/fuscus/cachinnans</i>	+	+		+	+	+	+	+
<i>Larus ridibundus</i>		+	+	+		+		
<i>Larus marinus</i>				+			+	
cf. <i>Rissa tridactyla</i>		+		+				
<i>Sterna</i> sp.	+			+				
<i>Chilidonias</i> sp.				+				
<i>Pinguinus impennis</i>	+		+	+	+	+	+	+
<i>Alca torda</i>		+		+	+		+	+
<i>Plotus alle</i>			+					
<i>Fratercula arctica</i>		+	+	+				
<i>Uria aalge</i>	+	+			+	+	+	
Marine birds bones		15	30	75	131	18	132	67
Birds bones identified (Passeriformes excluded)		115	477	2,333	288	106	371	254

ranean seals at Devil's Tower Cave (cf. *Monachus albi-venter*), in a Middle Palaeolithic context (Garrod et al., 1928).

Cetacean remains are rare until the end of MIS 2, when there is an increase and also the appearance of a greater diversity of species. At least three species of Delphinidae: *Delphinus delphis*, *Tursiops truncatus* and

Grampus griseus have been identified. Additionally, there is mention of a rib belonging to a large Delphinidae. The remains found at the archaeological sites correspond to the skull and jaws, vertebral elements and ribs. Their exploitation has been linked to the use of beached specimens (Boessneck and von den Driesch, 1980; Morales Muñiz and Martí, 1995; Pérez and Raga, 1998).

Table 4 – Marine mammal remains identified in the Southern Iberian sites.

Tabl. 4 – Restes de mammifères marins identifiés dans les gisements du Sud de la péninsule Ibérique.

	DEVIL'S TOWER Bate in Garrod et al., 1928	VANGUARD'S CAVE C-D Stringer et al., 2008	GORHAM'S CAVE 1951-54 Waechter, 1964	GORHAM'S CAVE 1995-98 Barton et al., 2012	CUEVA DE NERJA Boessneck & von der Driesch, 1980	CUEVA DE NERJA Morales & Martí, 1995	CUEVA DE NERJA Pérez & Raga 1998; Álvarez-Fernández et al., 2014	HOYO DE LA MINA Such, 1920
	MIS 4-3	MIS 5	MIS 4-2	MIS 4-3	MIS 2-1	MIS 2/1	MIS 2-1	MIS 2-2
<i>Halichoerus grypus</i>			6					
<i>Monachus monachus</i>	1	4	1	2	2		52	(+)
<i>Phoca vitulina</i>							2	
<i>Delphinus delphi</i>		2					30	
<i>Tursiops truncatus</i>		1			4			
<i>Grampus griseus</i>					1			
<i>Delphinidae</i>		1						
<i>Cetacea sp.</i>			12			1		
Whale barnacles							(167)	
Marine mammals bones	1	8	19	2	3	1	84	

The presence of *Balaenoptera* (*Eubalaena australis* / *Eubalaena glacialis*) has also been inferred at Nerja, based on the presence of the aforementioned barnacles. The absence of *Eubalaena* sp. skeletal parts has been interpreted as evidence of a different form of handling compared to the Delphinidae family, perhaps relatable to their size. Their presence is identified as evidence of the contribution of chunks of whale meat for the skin, fat and meat (Álvarez-Fernández et al., 2014).

Three species of seal have been identified at the analysed sites, of which two today are found in the North Atlantic. The only surviving Mediterranean seals can be found in isolated colonies off North Africa and the coasts of Turkey and Greece, with occasional sightings on the islets of the Alboran Sea.

At Vanguard Cave there is evidence of immature marine mammals in Middle Palaeolithic contexts (Stringer et al., 2008), whereas at the end of MIS 2 there are signs of different ages (Pérez and Raga, 1998). This may be related to the different forms of exploitation during breeding periods on the beaches, when hunting became more feasible.

HUNTING AND FISHING EQUIPMENT

In the Southern Iberian sites, bone and stone tools have been identified that have not been found at inland sites. These tools date back to the Upper and Final Magdalenian (c. 15–12 ka cal. BP), nor is there any presence of them at the same sites pre-LGM and LGM levels. Two types of

tools have been found that can be linked to extraction and processing activities, for their association with abundant marine resources.

The first type is a fine bone point, often short and bipointed. Some are made from long humeri bones from gannets (*Sula basana*), one is made from a rabbit scapula (*Oryctolagus cuniculus*), and mesofauna blanks. Since the first synthesis work dedicated to Prehistoric fishing (Rau, 1884), it has been accepted that some short and thin, bipointed bone points may have served as straight hooks (fig. 2). Their ethnographic parallels show that they could have been used as gorges (Read, 1910) for fishing (assembled as a projectile, as a compound hook or on a line) or even for hunting birds (Averbouh, 2003). Eleven harpoons have also been found made from bone and antler (Nerja, Higuero, Victoria and Hoyo de la Mina), a small number in comparison to findings further north, at sites where the remains of marine fish are quite rare.

No fine and short bone points have been identified to date at sites oriented towards the hunting of land mammals, where no marine resources have been documented. Their thickness, and also their length, differentiate them from the smooth and serrated Magdalenian points found at inland hunting sites. The largest collection has been found at Nerja Cave (n = 73), and they have also been identified at Hoyo de la Mina (Such, 1920; Aura Tortosa et al., 2013). Outside the Mediterranean region, recent excavations have recovered a significant collection at the Mesolithic site of Aizpea (Barandiarán, 2001).

Despite the identification of Delphinidae and whale barnacle remains, to date the use of their skeletal parts for

the creation of bone tools has not been recognized, as is the case at sites further north (Pétillon, 2008).

The second class of artefacts discovered are macrolithic tools assembled on beach ridges and associated with deposits containing thousands of marine remains along the coast of Malaga (Aura Tortosa et al., 2013), documented at several coastal sites: Nerja, Complejo Humo, Hoyo de la Mina, Victoria Cave and Higuero Cave.

These macrolithic tools present signs of cutting and percussion, as well as remains of ochre. Macroscopic observation has revealed polished grooves that could be related to the work of soft materials, possibly leather, although they could have been caused by several other activities (fig. 3). This data and the association with marine resources make the macrolithic tools specific to the coastal sites, as they have not been identified at any of the inland sites (Aura Tortosa and Jardón Giner, 2006).

MARINE MOLLUSC PERSONAL ORNAMENTS, CONTAINERS AND LAMPS

Marine bivalve shells from the Middle Palaeolithic have been gathered on the beach, some with natural perforations. They were used as containers for oxides at Aviones Cave, or transported over long distances (Higueral de Valleja and Anton's Cave) (Jennings et al., 2009; Zilhão et al., 2010), both located between 50 and 60 km from the present coastline.

With the exception of the previous reference, the first data on marine mollusc pendants date back to the Aurignacian and Gravettian cultures (Martínez Martínez, 2015). These objects become more widespread during the Upper Palaeolithic and the Epipalaeolithic, and have been found hundreds of kilometres from their places of origin, as is the case at El Pirulejo, Cueva Ambrosio and Maltravieso Cave (Avezuela Aristu and Álvarez-



Fig. 2 – 'Gorges' from the Nerja Cave (MIS 2, c. 15–11 ka cal. BP). Examples of the use of gorges among the populations of the north-western coast of North America (based on Read, 1910, fig. 237).

Fig. 2 – Hameçons droits (gorges) de la grotte de Nerja (MIS 2, ca 15-11 ka cal. BP). Exemples de l'utilisation des hameçons droits parmi les peuples de la côte nord-ouest de l'Amérique du Nord (à partir de Read, 1910, fig. 237).

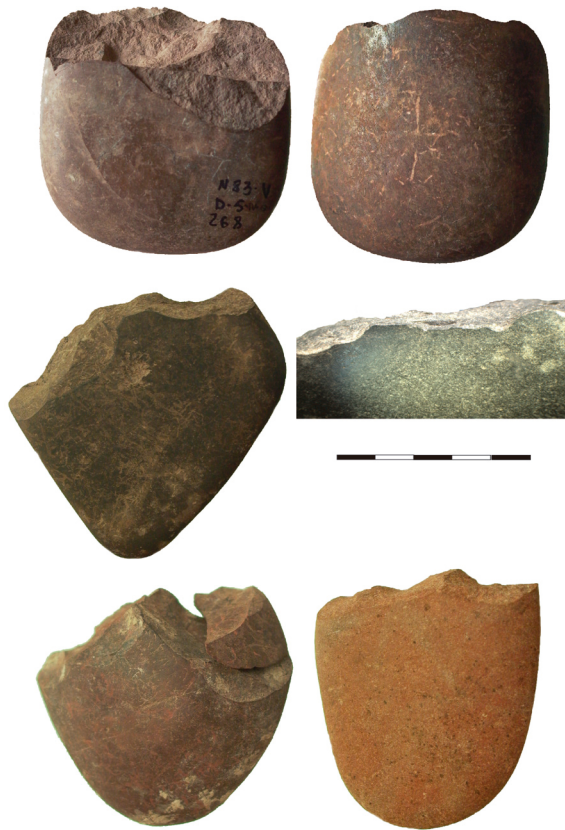


Fig. 3 – Macrolithic tools associated with Late Glacial occupations and signs of their use.

Fig. 3 – Outils macrolithiques associés aux occupations du Tardiglaciaire et traces de leur utilisation.

Fernández, 2013). Some species of gastropods currently have an Atlantic distribution (*Littorina littorea*, *L. saxatilis*, *Nucella lapillus*), but ecological data indicates that they could have inhabited the Mediterranean during the stadial phases (Jordá Pardo et al., 2011a).

Lastly, several *Pecten* sp. were used in Nerja Cave as lamps when accessing the deeper chambers, sometimes associated with cave paintings (Medina et al., 2012). Their use as containers has already been referenced in L. Pericot's descriptions of the excavations carried out at Parpalló Cave (Pericot, 1942).

DEPICTIONS OF MARINE FAUNA

Depictions of marine fauna in Palaeolithic parietal art are not very common (Cleyet-Merle, 1990). Six pisciform and seven seal figures have been identified over four sites in Southern Iberia (fig. 4). They have mainly been painted with black paint (La Pileta and Tesoro Caves) or and red paint (Nerja Cave), except for one pisciform figure found at Ardales (Sanchidrián Torti, 1990 and 1994; Ramos Fernández and Castillo, 2009; Cantalejo et al., 2006). The pisciforms are large and often in a vertical position, and it has not been possible to identify

a particular species. They are usually isolated compositions, separated from other more common species (ibex, aurochs, horse, deer, etc.). In Nerja Cave six seals have been found arranged vertically on three stalagmites, and in La Pileta there are two fish in a small chamber, as well as another large fish in a central location giving name to the chamber, known as 'The Big Fish', and within which an anthropomorph or a seal can be recognized (Breuil et al., 1915; Sanchidrián Torti, 1990).

As no exact dating is available, the chronology of these depictions is based on technical, formal and stylistic criteria. Many different chronologies have been proposed between the ends of MIS 3 and MIS 2 based on this criteria, although there is some agreement on the Magdalenian chronology (end of MIS 2) of the marine fauna depictions. This chronology is given for the two most important groups of pisciform and seal depictions (Sanchidrián Torti, 1990).

ISOTOPE ANALYSIS

To date, only a few isotopic studies have been performed about dietary reconstructions from the Palaeolithic to the Mesolithic periods in the Iberian Mediterranean region. The results reveal the absence of marine protein consumption during the Middle Palaeolithic, or at least an insufficient consumption to be reflected in the bone collagen (Salazar García et al., 2013). There are no data yet on carbon and nitrogen stable isotope analyses in the area from the Upper Palaeolithic, although research carried out at the Pyrenean site of Balma Guilanyà has revealed a diet based on land resources with no evidence of marine resource consumption (García Guixé et al., 2009). It is not until the beginning of the Mesolithic that the consumption of marine resources becomes significant enough to be reflected in bone collagen from the eastern Iberian population. However, the consumption was variable between individuals, and never dominant, given that the protein intake of individuals with evidence of marine resource consumption, in El Collado (García Guixé et al., 2005), Santa Maira and Cingle del Mas Nou (Salazar-García et al., 2014), is based mainly on C₃ land resources. At some sites dated to the same period, for example La Corona (Fernández López de Pablo et al., 2013) and Peña del Comptador (Salazar-García et al., 2014), there is no evidence whatsoever of marine resource consumption.

The results of these previous studies, which reveal either no evidence of the consumption of marine resources, or a detectable but very low proportion, are surprising when considering the close location to the coast of many of the sites. Although zooarchaeological evidence detected a very limited consumption of marine resources in the Middle Palaeolithic, the abundant marine fauna found in some sites from the Upper Palaeolithic such as Nerja Cave is surprising. The results of stable isotope analysis on human remains found in Nerja from

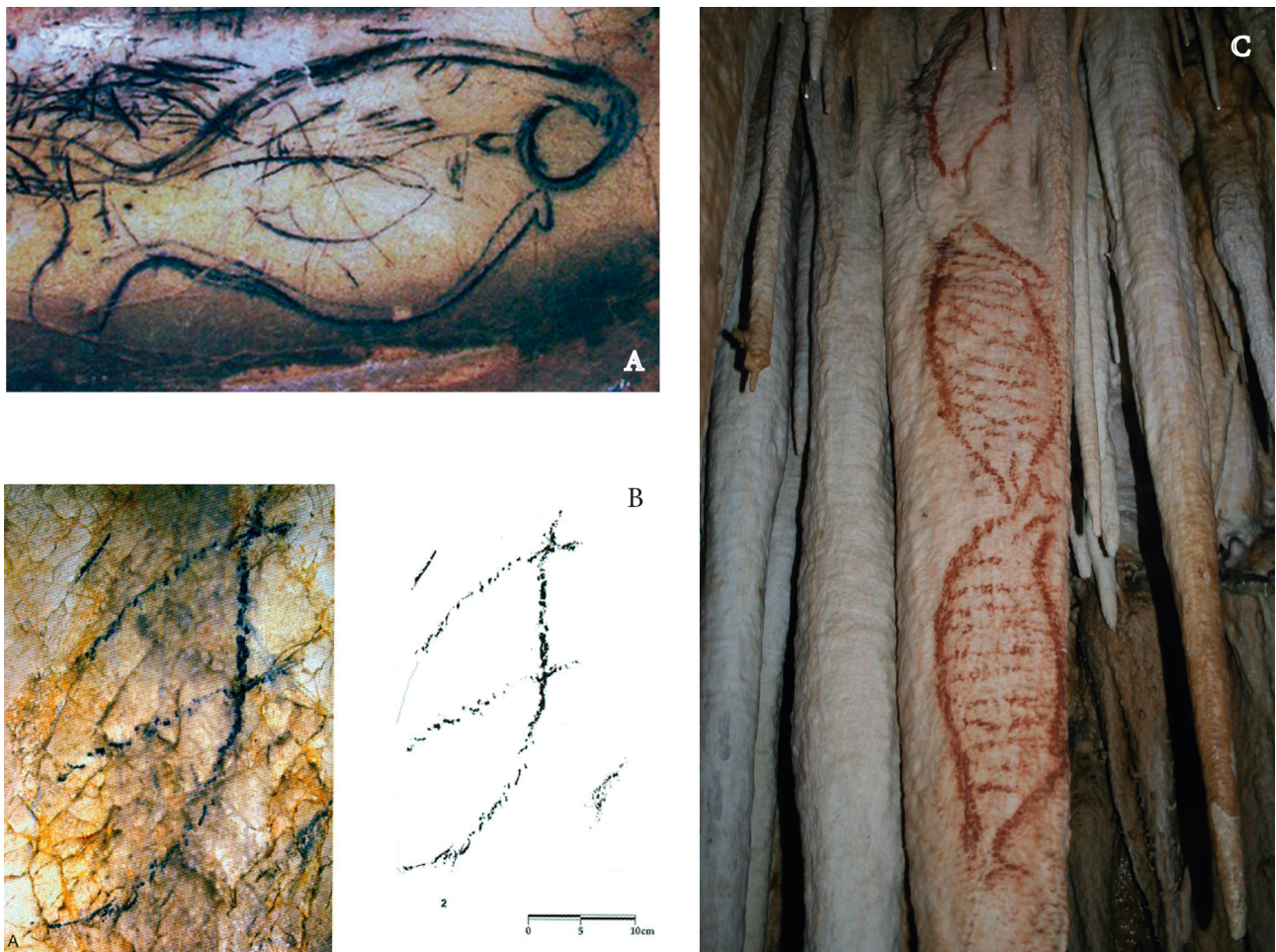


Fig. 4 – Palaeolithic depictions of marine fauna in the Southern Iberian sites (photographs after Sanchidrián Torti, 1994 and Cantalejo et al., 2006).

Fig. 4 – Représentations paléolithiques de faune marine dans les sites du sud de la péninsule Ibérique (photos d’après Sanchidrián Torti, 1994 et Cantalejo et al., 2006).

the Upper Palaeolithic and the Epipalaeolithic-Mesolithic are key to test whether this pattern of low, but present, consumption of marine resources is also repeated in the southern peninsula, or if on the contrary these populations consumed a greater amount of marine protein, as suggested by zooarchaeology.

DISCUSSION

Tables 5 to 7 show the documented marine resources for the three horizons studied, grouping the sites by their distance from the coast (shoreline, coastal and inland). The potential areas of procurement, the techniques used for their extraction, and the functional and symbolic use, are described for each one along with a quantitative comment. There remain many unresolved issues (no data on density remains, spacial, stratigraphical and taphonomical studies, representation of skeletal parts, sizes, seasonality, processing, preservation techniques, etc.), but this is a starting point.

First, Neanderthal occupations (MIS 6 to MIS 3/MP) have yielded mollusc assemblages containing a few hundred, up to thousands of remains. The number may reflect the contribution of shellfish as a complement to a diet based on land mammals. Marine gastropods are more common than bivalves. This suggests that gastropods were more common prior to the LGM, or it could be that they were more frequently transported to the sites. However, some bivalve shells were used and transported over long distances from the present coastline (Jennings et al., 2009; Zilhão et al., 2010). Echinoderms are also mentioned in Vanguard (Brown et al., 2011). Ichthyofauna has a minor presence. For Vanguard Cave “very few fish remains, mostly indeterminable” are cited (Bate in Garrod et al., 1928, p. 109), and during recent excavations ten remains have been recovered from Gorham’s Cave and one from Vanguard Cave (*Diplodus sargus/vulgaris*), as well as undetermined *Thunnus thynnus* remains (Brown et al., 2011).

The marine avifauna is represented by several taxa in the Gibraltar sites (Gorham’s, Devil’s, Ibex and Vanguard). Anthropogenic marks are rare, but some authors

MIS 6-4–MIS 3 /MP	Shoreline sites	Coastal sites	Inland sites
Sites	Devil's Tower Gorham's cave Vanguard cave Bajondillo Complejo Humo 3	Cueva de los Aviones Pernas Sima de las Palomas	Higueral de Valleja (\pm 50 km) Cueva Antón (\pm 60 km)
Marine resources brought to the sites	Number of Gastropoda highest than Bivalvia Marine mammals: skull, vertebral and ribs elements	Gastropoda Bivalvia without nutritional value (containers)	Bivalvia with not nutritional value
Transport to the sites		Bivalvia with natural perforation. Containers	<i>Pecten</i> sp.
Procurement areas	1. Rocky substrates: shell-fish, marine birds? 2. Beachs and sandy areas: shell-fish, <i>Monachus monachus</i> , Delphinidae	1. Rocky substrates: shell-fish 2. Beachs and sandy areas: shell-fish, <i>Monachus monachus</i> , Delphinidae	
Inferred extraction techniques	Shell-fish gathering Mammals stranded on beach Birds collected on the beach Coastal fishing? No technical equipment linked to the extraction	Shell-fish gathering No technical equipment linked to the extraction	 No technical equipment linked to the extraction
Comments	Low number of evidences. No data on density of remains.	Low number of evidences. No data on density of remains	Unique number of evidences

Table 5 – Phase MIS 6–MIS 3/PM. Marine resources brought to the sites, their areas of procurement and the inferred extraction techniques; their presence is indicated for shoreline, coastline and inland sites.

Tabl. 5 – Phase MIS 6–MIS 3/PM. Ressources marines apportées aux sites, leurs zones d'exploitation et les techniques d'extraction utilisées; leur présence est indiquée pour des sites sur les rivages, la côte et à l'intérieur des terres.

have suggested that they were a common prey for humans (Brown et al., 2011), and others state that they may have been collected occasionally on the beaches (Cooper, 2000, 2012a and 2012b). Therefore, fish and birds could be caught by hand, in shallow waters, in nesting colonies or on the beach.

Lastly, Delphinidae and seals are not very common compared to other mammals: Gorham's Cave IV = 0.1%; Vanguard Cave: 0.8% (Stringer et al., 2008), lower than the remains studied by A. Sutcliffe (in Waechter, 1964). The marine mammals correspond to beached animals or dead animals washed up on the beach.

Second, in pre-LGM and LGM contexts (MIS 3/UP and MIS 2), gastropods from rocky substrates continued to be the most common species, with a significant increase in bivalves. The ichthyofauna also shows a clear progression at the end of the LGM, but the obtained data originate from just one site: Nerja Cave, located between 4 and 5 km from the coastline during the LGM. The number of marine mammal remains from the Solutrean occupations is low in Gorham's Cave III (0.5%) and Nerja Cave (0.1–0.2 %), compared to the land mammals.

The data in table 6 don't show any big changes compared to the previous horizon. There was an increase in

the diversity of marine molluscs and fish, and the finding of marine mammal remains in sites on the Portuguese Atlantic coast at distances of over 40 km from their place of procurement can be highlighted, as is the case in Lapedo and Vale Boi, where one Cetacea sp. piece has been found in each (Bicho and Haws, 2008; Moreno García and Pimenta, 2002). This characteristics coincides with the generalization of the use of marine molluscs as a support for making pendants, which have been found dozens of kilometres from their places of origin since the Aurignacian (Cotino Villa and Soler Mayor, 1998; Álvarez-Fernández, 2006; Avezuela Aristu et al., 2011; Martínez Martínez, 2015). Similarly to the previous horizon, most of these resources were obtained from the continental shelf through strictly coastal activities.

Third, at the end of the Late Glacial (end of MIS 2) the sites with accumulations of marine resources multiplied, but so far the cause of this has not been studied in detail (Aura Tortosa et al., 2013). Shell-middens have been identified in coastal and shoreside caves throughout two millennia, all descriptions suggesting assemblages of thousands of remains, with high taxa diversity and the presence of extraction equipment (table 7).

The gathering of all types of invertebrates is registered in shoreside and coastal sites, with very high

MIS 3/UP–MIS2 Pre-LGM & LGM	Shoreline sites	Coastal sites	Inland sites
Sites	Gorham's Cave III Gorham's Cave F-E	Nerja (30–20 ky cal. BP) NV 13–NV8/s	El Pirulejo (150 km) La Boja, FDM, Cueva Ambrosio (60 km)
Marine resources brought to the sites	Number of Gastropoda highest than Bivalvia Delphinidae	Increase of Bivalvia Phocidae	
Transport to the sites		Marine molluscs (nutritional and ornamentakl use) Few marine fish bones	Marine molluscs for ornamental use Cueva Ambrosio: bivalvia with nutritional value? (<i>Cardidae</i> , <i>Veneridae</i>) [Punctual presence of Cetacea sp. in inland sites: Vale Boi or Lapedo, Portugal]
Procurement areas	1. Rocky substrates: shell-fish, marine birds? 2. Beachs and sandy areas: shell-fish, <i>Monachus monachus</i> , Delphinidae 3. Inhshore waters: fish	1. Rocky substrates: shell-fish 2 Beachs and sandy areas: shell-fish, <i>Phoca vitulina</i> , <i>Monachus monachus</i> 3. Inhshore waters: fish	
Inferred extraction techniques	Shell-fish gathering Mammals stranded on beach Birds collected on the beach Coastal fishing? No technical equipment linked to the extraction	Shell-fish gathering Mammals stranded on beach Birds collected on the beach Coastal fishing No technical equipment linked to the extraction	No technical equipment linked to the extraction
Comments	Low number of evidences No data on density of remains	Increase in the number of marine resources (invertebrates, fish and mammals)	Low number of evidences

Table 6 – Phase MIS 3/PS–MIS 2 (pre-LGM and LGM). Marine resources brought to the sites, their areas of procurement and the inferred extraction techniques; their presence is indicated for shoreline, coastline and inland sites.

Tabl. 6 – Phase MIS 3/PS–MIS 2 (pré-DMG et DMG). Ressources marines apportées aux sites, leurs zones d'exploitation et les techniques d'extraction utilisées; leur présence est indiquée pour des sites sur les rivages, la côte et à l'intérieur des terres.

values for species from rocky substrates (*Mytilus* sp.) and sandy areas (*Ruditapes* sp.). These two areas indicate the source of most Late Glacial fishing, known primarily from Nerja. Rocky cliffs, small coves and estuaries are the areas of procurement of sea breams, wrasses, mullets, and some sturgeons. This is classed as coastal fishing, but coinciding with the Younger Dryas, a significant change can be seen in the species, as between 50 and 85% of the remains come from migratory pelagic and demersal species: Gadidae, Carangidae and Scombridae (Aura Tortosa et al., 2002).

In the case of Nerja, despite its location of 3–4 km from the coast, the exploitation of marine birds has been combined with fishing. A significant percentage of the remains correspond to northern gannet and shearwater, and the highest number of *Pinguinus impennis* remains have been identified during the Younger Dryas.

The contribution of beached cetaceans shows a certain diversity of species: common dolphins, bottlen-

ose and Risso's dolphins, and the remains of a large whale, along with the identification of whale barnacles (Álvarez-Fernández et al., 2014). Alongside the noted changes in fishing for the Younger Dryas, there is an increase in monk seal remains and a drastic reduction in cetaceans. In Valencia, five Phocidae remains are mentioned in Les Cendres, located more than 10 km from the coast (Villaverde et al., 1999). Also in Valencia, a marine fish and mollusc assemblage has also been identified in Santa Maira, despite the fact that the cave was over 25 km from the coastline during the MIS 2-1 transition (Aura Tortosa et al., 2014).

Two bone tools can be associated to the exploitation of the marine environment: harpoons and gorges. The first were documented in southern Iberia coastal sites dated between 14.5 and 13.5 ka cal. BP. Their disappearance coincides with the start of the Younger Dryas and is contradictory to the continuation of fishing activities. On

MIS 2-1–Post-LGM	Shoreline sites	Coastal sites	Inland sites
Sites	Gorham's Cave III Hoyo de la Mina Higuerón - Victoria Complejo Humo 6 Algarrobo - Mejillones	Nerja NV 7–NV4 Nerja NM 16–NM13 Cueva del Caballo	El Pirulejo
Marine resources brought to the sites	Invertebrates (Bivalvia are dominant) Delphinidae	Invertebrates Marine fish Marine birds Marine mammals	Marine molluscs for ornamental use
Transport to the sites	Marine molluscs (nutritional and ornamental use)	Marine molluscs (nutritional, ornamental, containers and lamps use)	Marine molluscs for ornamental use
Procurement areas	1. Rocky substrates: invertebrates (Crustacea, Echinoidea Bivalvia, Gastropoda), marine birds? 2. Beachs and sandy areas: Shell-fish, <i>Monachus monachus</i> , Delphinidae 3. Inshore waters: fish	1. Rocky substrates Invertebrates (Crustacea, Echinoidea Bivalvia, Gastropoda), marine birds 2. Beachs and sandy areas: invertebrates (<i>Monachus monachus</i>), Delphinidae, Cetacea 3: Inshore waters: fish 4 Deep waters: fish	
Inferred extraction techniques	Shell-fish gathering Coastal fishing Harpoons and gorges Macrolithic tools	Shell-fish gathering Fowling and sealing Mammals stranded on beach Coastal and deep waters fishing Harpoons and gorges Macrolithic tools	No technical equipment linked to the extraction
Comments	High number of evidences No data on density of remains	High number of marine resources (invertebrates, fish, birds and mammals)	Low number of evidences

Table 7 – Phase MIS 2–MIS 1 (post-LGM). Marine resources brought to the sites, their areas of procurement and the inferred extraction techniques; their presence is indicated for shoreline, coastline and inland sites.

Tabl. 7 – Phase MIS 2–MIS 1 (post-DMG). Ressources marines apportées aux sites, leurs zones d'exploitation et les techniques d'extraction utilisées; leur présence est indiquée pour des sites sur les rivages, la côte et à l'intérieur des terres.

the contrary, the short and fine bipoints do have a close association with coastal fishing.

The capture of migratory deep-water species that seasonally came closer to the shore could have been due to the combination of two variables. The first was the morphology of the continental shelf led to there being a greater column of seawater close to the shore during the Younger Dryas (Jordá Pardo et al., 2011b). This phenomenon brought the migratory species closer to the shore, enabling their capture. The second and more hypothetical variable suggests that, during the Younger Dryas, equipment was developed to intercept or direct these banks towards the shore. Macrolithic tools may have been used in the making of this equipment (fig. 3). Carved ridges with dense striations and intense rounding on the edges have been related to the processing of soft materials. Cobbles with striae and polished areas are spread over the surface suggest their use in hide-softening procedures, possibly leather (Aura

Tortosa and Jardón Giner, 2006). As a hypothesis, these macrolithic tools could have been used to build boats, combining leather, plant fibres or wood, to navigate in coastal waters.

The indexes of marine resources obtained for the three horizons studied in the paper allow us to recognize different dietary ranges (fig. 5). The procurement of marine protein took place in Neanderthal sites, but data are too sparse (Klein and Steele, 2008). The presence of invertebrates, marine mammals and some marine fish remains is also listed for different sites (table 1). This earliest coastal exploitation is attested by global indexes of marine and terrestrial remains (IM/T), higher than that from the following horizon, probably due to sporadic exploitation of rabbits. However, the low presence in the Middle Palaeolithic of marine resources should not be related to the Neanderthal technical capacity; a more appropriate framework can be seen in their economy and mobility strategies (Marean and Assefa, 1999).

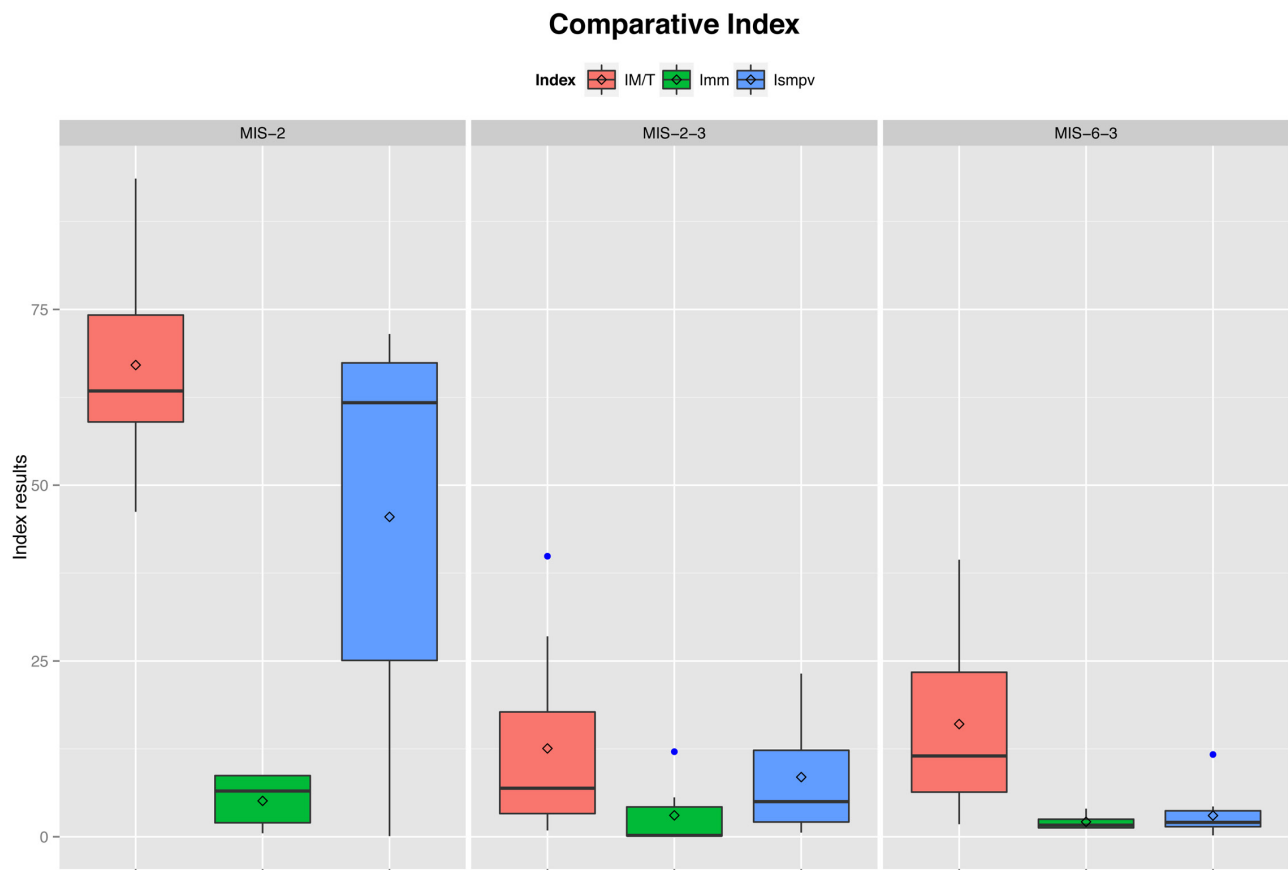


Fig. 5 – Indices of marine resources for the three phases covered in the paper, showing the proportion of small marine vertebrate prey (fish and birds), the frequency of marine mammals and the total proportion of marine resources compared to terrestrial resources.

Fig. 5 – Index de ressources marines pour les trois phases décrites dans le texte montrant la proportion des petites proies de vertébrés marins (poissons et oiseaux), la fréquence de mammifères marins et la proportion totale des ressources marines par rapport aux ressources terrestres.

Were human societies from these time periods generalistic foragers? Or are we already facing the earliest phases of the process of—broader—diversification and use of small preys? It is complex, however to establish benchmarks (Blasco et al., 2013) and it is particularly difficult to compare the densities of paleobiological remains in relation to the duration of the archaeostratigraphic units from the Middle Palaeolithic, Upper Palaeolithic and Epipalaeolithic-Mesolithic periods.

In pre-LGM and LGM contexts (MIS 3/UP and MIS 2), there was an increase in the number and diversity of marine remains, but according to zooarchaeology, most of the diet is still provided by ungulates and terrestrial small game (cf. IM/T). As in previous time periods, it is possible to raise a complementary, perhaps seasonal, use of marine resources during the first anatomically modern human occupations. However, no technical equipment has been identified linked to the extraction and consumption of the marine resources at that time.

Despite some gaps and discontinuities, there are significant changes, and at the end of the Palaeolithic there is a clear economic shift towards marine resources exploit-

ation. All indexes show a systematic use of marine species with high reproduction rates (fig. 5). This process does not seem to vary with climate-driven environmental changes, and it might be a response to anthropogenic eco-dynamics (Barton et al., 2013).

The identification of caves and shelters along the coast of the Alboran Sea that accumulate deposits of marine fauna is a regional feature (Aura Tortosa et al., 2013). These are palimpsests that may relate to simple economic, but maybe also to social practices (Milner, 2005). The seasonal consumption of some species or of beached cetaceans could have encouraged group interaction, without implying a directional evolutionary trend towards greater complexity (Rowley-Conwy, 2001).

These data indicate that even in regions where the use of small prey occurred in early dates, it is possible to note a trend towards intensification and diversification of resources, especially marine (Binford, 1968; Flannery, 1969; Straus, 1986; Stiner, 2001). A process that also occurred here, at the end of the Pleistocene (Munro and Atici, 2009; Aura Tortosa et al., 2009).

CONCLUSION

Southern Iberia has an extensive record of coastal and shoreside sites, preserved due to the morphology of the continental shelf. Its coasts have high ecological productivity thanks to its connection with Atlantic waters, which are very attractive for human occupation as has already been pointed out in other regions (Bicho and Haws, 2011). The available Palaeolithic data have allowed a first assessment of the use of marine resources by Neanderthals and modern humans, who in most cases consumed these resources in coastal areas.

During Neanderthal occupations (MIS 6 to MIS 3/MP), there is evidence of the gathering of molluscs, mainly gastropods, and the use of beached marine mammals. There are different perspectives with regard to seabirds, and a reduced number of fish and echinoderm remains have been identified. The presence of bivalves with no nutritional value in coastal and inland sites dated to MIS 3/MP has been a prominent feature recently.

No equipment related to the extraction of marine resources has been recognized, although in other Neanderthal sites signs of use related to fish processing have been identified, but no bone remains (Hardy et al., 2013). Nor has marine protein been identified in the collagen of human remains from this period in the Iberian Mediterranean region.

There are less data to evaluate for the first part of the Upper Palaeolithic (MIS 3/UP and MIS 2), when there was a certain increase in marine resources in coastal sites, and they were also transported to inland sites, where marine molluscs were essentially used as objects of adornment. The transport of two cetacean remains has also been identified, outside this study area. The low number of marine remains and their recurring presence in the Neanderthal sites with a longer sequence suggest a continued, but complementary use. In any case, it is difficult to make comparisons between archaeo-

stratigraphic units from MIS 4–3/MP and those from MIS 3/UP.

These changes do not appear to be due to either technical or cognitive differences between the two populations. They must be evaluated in the context of subsistence strategies, occupational pattern and socio-ecological dynamics. At the end of the Late Glacial there were significant changes. From 15 ka cal. BP, marine resources represent a substantial part of the economy in Southern Iberian populations. This is apparent from the concentration of coastal sites and the large assemblages of marine fauna remains. Even in sites such as Nerja, located around 3 km from the coastline, there is evidence of the exploitation of all kinds of marine resource: invertebrates, fish, marine birds and mammals. These resources are associated with tools that have been related to equipment for their extraction, and which to date have not been found in other sites in the Iberian Mediterranean region, nor in inland sites in Southern Iberia. The transport of marine resources used as food also indicates changes in the management of these resources, although this is best known in neighbouring regions to the current study area.

Finally, we should mention that most of the painted depictions of fish and seals have been dated to the Late Glacial, both in coastal (Nerja and Tesoro Caves) and inland sites (La Pileta and Ardales), coinciding exactly with these changes. These depictions, and the identification of extraction equipment, highlight the economic and social value of these kinds of resources.

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