

Food & more: Marine Mollusks Exploitation during the Upper Paleolithic and Mesolithic in Cantabrian Spain and in the Ebro Valley

ESTEBAN ÁLVAREZ-FERNÁNDEZ

Instituto Internacional de Investigaciones Prehistóricas de Cantabria (III PC)
Unidad asociada al C.S.I.C. Edif. Interfacultativo de la Universidad de Cantabria.
Avda. de los Castros s/n 39005 Santander. España
estebanalfer@hotmail.com

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ABSTRACT: This paper focuses on the exploitation of marine mollusks within a cultural and an ecological context, from the archaeological excavations in the prehistoric sites in the Cantabrian Region (North of Spain) and along the Ebro Valley. This research analyzes different species, on one hand used as ornaments or tools and, on the other hand as food, during the Upper Paleolithic and Mesolithic. These mollusks are examined for taxonomic diversity among cultural phases. Our research focuses on two main issues: the first one refers to which species of mollusks were selected and transformed into personal ornaments and the second to which ones were collected for their dietary interest.

KEY WORDS: MARINE MOLLUSCS, MALACOLOGICAL DIET, PERSONAL ORNAMENTS, UPPER PALEOLITHIC, MESOLITHIC, CANTABRIAN REGION, EBRO VALLEY

RESUMEN: En este artículo se analiza la explotación de los moluscos marinos procedentes de yacimientos de la Cornisa Cantábrica y del Valle del Ebro a través de su contexto cultural y ecológico. En esta investigación se analizan diferentes especies documentadas en el Paleolítico superior y en el Mesolítico, unas utilizadas como objetos de adorno-colgantes o artefactos, otras como alimento. Estos moluscos son estudiados desde un punto de vista taxonómico en diferentes periodos, haciendo hincapié principalmente en dos aspectos. Así, por un lado se investiga qué tipo de especies han sido seleccionadas para transformalas en objetos de adorno-colgantes; por otro, se analizan aquellas que han sido recogidas por su valor bromatológico.

PALABRAS CLAVE: MOLUSCOS MARINOS, DIETA MALACOLÓGICA, OBJETOS DE ADORNO-COLGANTES, PALEOLÍTICO SUPERIOR, MESOLÍTICO, CORNISA CANTÁBRICA, VALLE DEL EBRO

INTRODUCTION

The northern coastal strip of Spain, universally recognized as a distinct geographic and ecological unit, consists, from east to west, of the provinces of Guipúzcoa, Vizcaya, Cantabria and Asturias. Cantabrian Spain is bounded to the North by the Cantabrian Sea, to the South by the Cantabrian Cordillera, to the East by the Pyrenees, and to the West by the gentler relief of the ancient shieldrock landscapes of Galicia. The distance between the present Atlantic shore and the crestline of the Cordillera, with summits generally ranging between about 1500-2500 m above the sea level ranges between only 25-50 km. During interglacial times, the Gulf Stream had a considerable warming effect on the Bay of Biscay and hence on the adjacent coastal strip, although this was not the case under glacial conditions, when, in fact, large ice flows covered substantial areas of Picos de Europa and several other sectors of the Cordillera, in many cases reaching northward to within only a few hundred meters above sea level and relatively short distances from the shores. That, because of the very narrow continental shelf, were displaced northwards by sea level regression only some 6-12 km during glacial maxima.

The Ebro Valley is bounded in the North by the Pyrenees and to the South by the Iberian Cordillera, which together enclose the Ebro Depression. It is a continental region, generally distant from the influence of the sea. The River Ebro acted as a vertebrating axis in the Upper

Paleolithic and Mesolithic; a way of communication between the Mediterranean Sea and the Cantabrian Coast. It crosses several Spanish autonomous communities (La Rioja, Aragón, etc.). Until recently it was thought that this area was not colonized by groups of hunter-gatherers in the Upper Paleolithic and Mesolithic, but the research undertaken in the last 15 years now indicates quite the contrary.

MATERIALS AND METHODS: STUDY OF MARINE MALACOFUNA IN THE CANTABRIAN REGION AND THE EBRO VALLEY DURING THE UPPER PALEOLITHIC AND MESOLITHIC

Marine malacofauna is an important potential source of information about the relationships of the groups of hunter-gatherers with the coast in Prehistory. The information provided by the different mollusk species, such as gastropods, bivalves and scaphopods is varied, telling us about their gathering strategies, why some species were picked and not others, the time of year when they were collected, the paleoclimate of a particular period, of exchanges between the groups of hunter-gatherers, etc.

The marine malacofauna to be studied in this paper come from a series of sites with layers belonging to the Solutrean, Magdalenian, Azilian and Mesolithic periods (Figures 1 and 2), that have been excavated recently:



FIGURE 1

Upper Palaeolithic and Mesolithic sites in Cantabrian Spain and in the Ebro Valley have been studied.

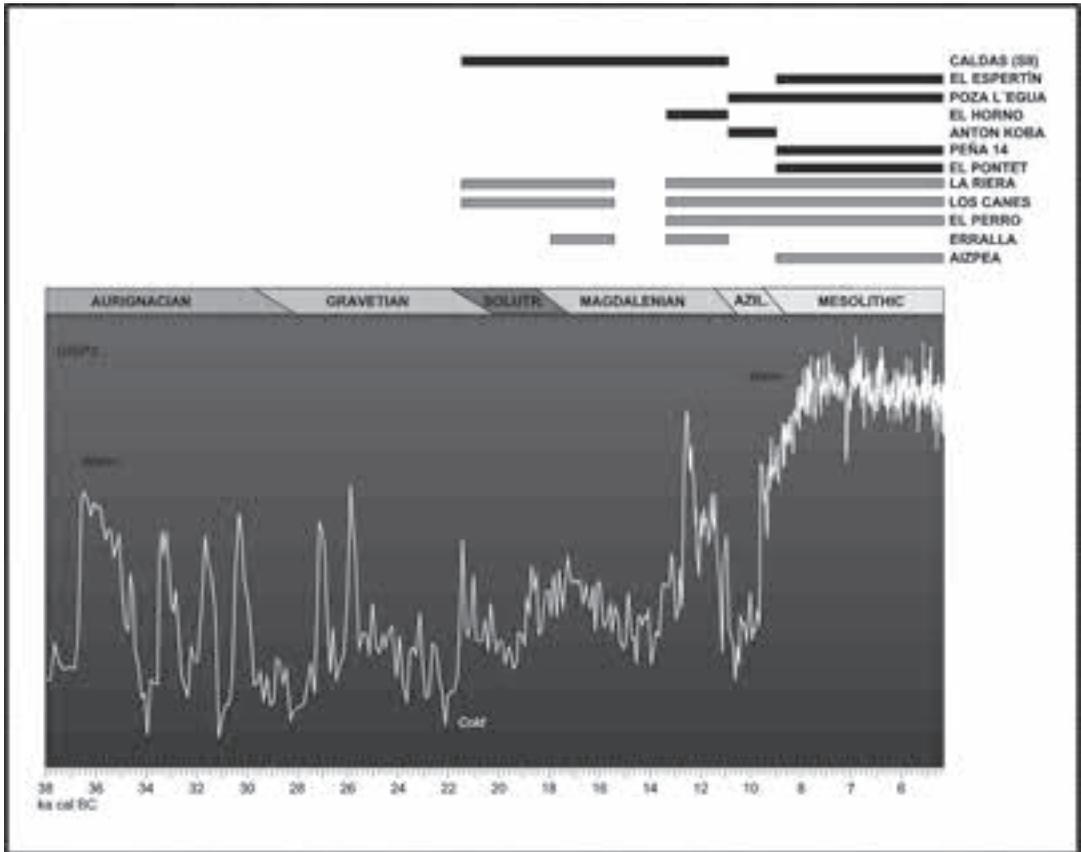


FIGURE 2

Calibrated radiocarbon dates of the Upper Palaeolithic and Mesolithic technocomplexes in Cantabrian Spain and in the Ebro Valley in relation to the Greenland GISP2 ice core record in the time-window 38.0-5.2 ky cal BC. The Pleistocene and Holocene dates have been calibrated with the CalPal 2005_SFCP curve, using the program CalPal (Weninger *et al.*, 2005).

- Sites on the Cantabrian Coast: Chamber II at Las Caldas: levels 0 to XIII (Magdalenian) and level XIV (Solutrean) (Corchón *et al.*, 2005, 2008); El Espertín: lower archeological layer (Mesolithic) (Neira *et al.*, 2004); La Poza l'Egua: two Asturian layers (layers 1 and 2) y one Azilian (layer A) (Arias *et al.*, 2007); El Horno: levels 1 to 3 (late-final Magdalenian) (Fano, 2005) and Anton Koba: Level VIII (Azilian) (Armendáriz, 1997).
- Sites in the Ebro Valley: Peña 14: level b (macrolithic Epipaleolithic) (Montes, 2001-2002) and El Pontet: level e (geometric Epipaleolithic) (Utrilla *et al.*, 1998; Álvarez-Fernández, 2003).

In the same way, we have studied the data about marine malacology from other published sites. To select these sites, we have employed the following criteria:

- that they are within the same time scale that we have studied (from c. 22,000 cal BC to c. 5,000 cal BC).
- that they were dug after the 1960s, permitting much more exhaustive data gathering about marine malacology than what was obtained at sites excavated in earlier periods.
- that the publication gives the figures of the MNI.
- that they give information about the marine malacological fauna with and without dietary

interest and about their possible modification by humans.

The sites that were chosen are as follows:

- Sites on the Cantabrian Coast: La Riera (G. A. Clark's digs in 1969, and L.G. Straus and G.A. Clark's excavations between 1976 y 1979): The archaeological material comes from level 29 (Asturian;), from level 28 (Azilian), from level 27 (Azilian/late Magdalenian), from levels 26-19 (late and early Magdalenian), from levels 18-2 (Solutrean and from level 1 («Pre-Solutrean»; NMI: 5580) (Ortea, 1986)¹; Los Canes: levels 10, 9, 6 y 5 (Mesolithic), levels 4 y 3c (Azilian), level 3 (late Magdalenian-Azilian), level 2C (late Magdalenian), level 2B (early Magdalenian) and level 2A (Solutrean) (Arias, 2002; Vázquez & Rosales, in press); La Peña del Perro: Mesolithic shell-midden (level 1), Azilian shell-midden (levels 2a and 2b) and the level corresponding to the late Magdalenian (level 2c) (Moreno, 1994, 1995) and Erralla: level II (late Magdalenian) and level V (early Magdalenian) (Altuna, 1985).
- Sites in Ebro Valley: Aizpea: level I (geometric Epipaleolithic) (Barandiarán, 2001).

In order to carry out this study of the malacology, we have established three groups of sites:

- Group 1: sites located less than 10 km from the coast: La Riera, La Poza L'Egua and La Peña del Perro.
- Group 2: sites located between 10 and 30 km from the coast: Las Caldas, Los Canes, El Horno, Anton Koba and Erralla.
- Group 3: sites located over 30 km from the coast: El Espertín, Aizpea, Peña 14 and El Pontet.

The species recorded² have been placed into two groups:

¹ The marine malacological fauna was classified by J. Ortea, who studied 16% of the material collected in the dig in the Asturian shell-midden in 1969, and 85-90% of the material from the excavations carried out between 1976 and 1979. J. Ortea counted all the mollusks when their MNI was less than 500/600; for the *Patella*, genus, the only one with a higher number, he took a representative sample. He only gives us data on the MNI and not the NR. Here we include, as well as the counts made by J. Ortea our own study of the objects of adornment and pendants made out of marine malacological fauna.

² Updated here after the CLEMAM Taxonomic Database on European Marine Mollusca of the Musée National d'Histoire

- Marine malacological fauna with food value, which gives us information about the malacological diet. The main species that were gathered in the studied territory are: Gastropods: *Patella vulgata*, *Patella intermedia*, *Patella ulyssiponensis*, *Patella rustica*, *Littorina littorea* and *Osilinus lineatus*. Bivalves: Mytilidae Family, *Mytilus galloprovincialis*, *Cerastoderma edule*, Verenidae Family, *Pecten maximus* and Ostreidae Family.
- Marine malacological fauna with no dietary value, which mainly provides data about the use of mollusks for purposes of adornment. The species are mainly gastropods, of which the most important are: *Littorina obtusata*, *Littorina saxatilis*, *Littorina fabalis*, *Trivia* sp. (cf. *T. monacha/T. arctica*), *Nucella lapillus*, Naticidae Family and *Columbella rustica*.

Equally, we have studied the ecological characteristics of these species in order to obtain data about the environmental evolution of the Cantabrian Coast during the late glacial and post glacial periods.

RESULTS

THE MARINE MALACOFAUNA FROM SITES ON THE CANTABRIAN COAST AND THE EBRO VALLEY DURING THE UPPER PALEOLITHIC AND THE MESOLITHIC (Figure 3, Table 1).

Species with dietary value

Solutrean (c 22,300-19,000 cal BC)

Group 1 Sites:

We only have data from the Solutrean levels at La Riera. The malacological diet is represented by only three species that come from a hard (rocky) surface, namely *P. vulgata*, *P. rustica* and *L. littorea*. *P. vulgata* is represented in all levels with very high percentages (above 99%) and in nine levels it amounts to 100% of the marine mollusks gathered. *P. rustica* is only found in level 4 (0.19%). The gastropod *L. littorea* appears in ten of the seventeen Solutrean levels and its highest percentage is about 2%, except in level 18 (c. 15%).

Naturelle (Paris) (available at <http://www.somali.asso.fr/clemam>). To classify the different habitats of the mollusk species on the Cantabrian coast see, for example, Palacios & Vega (1997).

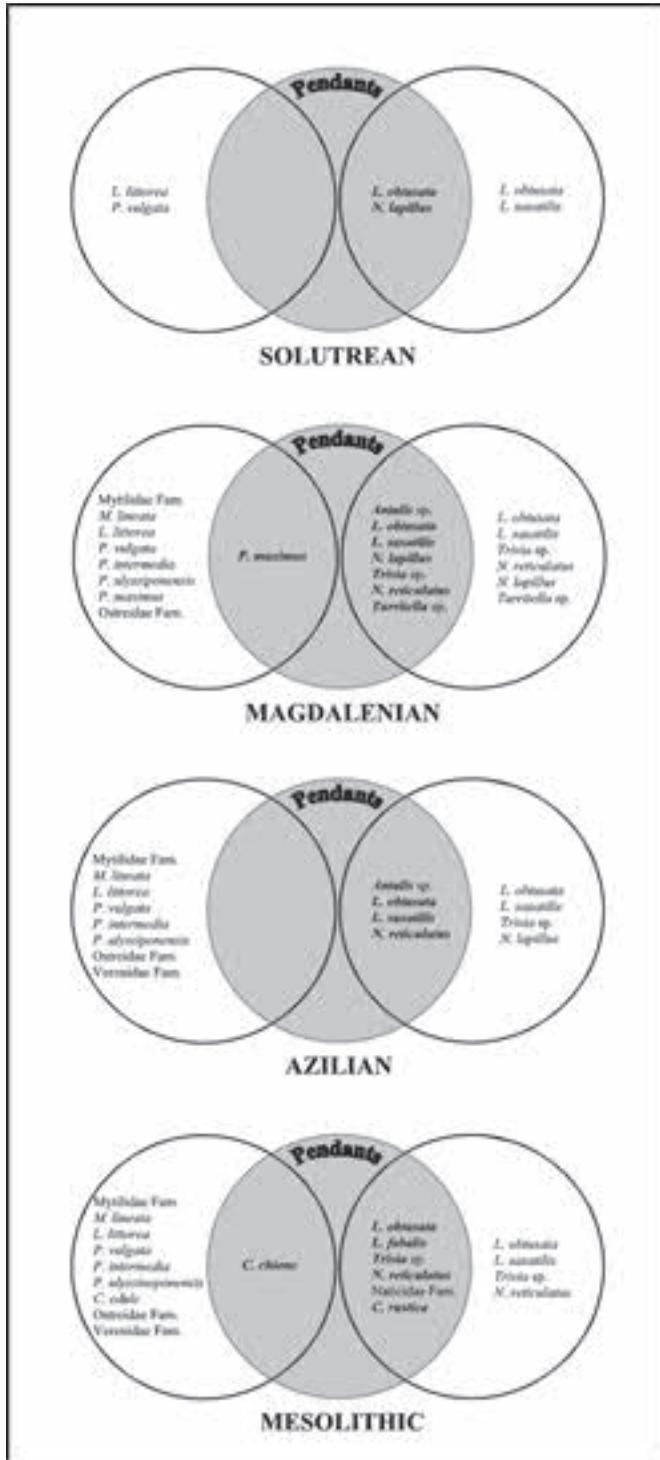


FIGURE 3

Marine species with/without dietary value from sites on the Cantabrian Coast and the Ebro Valley during the Upper Paleolithic (Solutrean, Magdalenian and Azilian) and the Mesolithic. Circles on the right, mollusks without dietary value; on the left, with dietary value.

Las Caldas	L. 0-II	L. III	L. IV-V	L. VI-IX	L. X-XII
WDV	3	5	5	18	-
NoDV	3	1	-	8	2
Total	6	6	5	26	2

El Espertín	L. inf.
WDV	-
NoDV	1
Total	1

Poza L'Egua	L. 1	L. 2	L. A
WDV	1204	397	29
NoDV	1	1	-
Total	1205	398	29

El Horno	L. 1-3
WDV	3
NoDV	22
Total	25

Anton Koba	L. VIII
WDV	1
NoDV	2
Total	3

Peña 14	L. b
WDV	-
NoDV	2
Total	2

El Pontet	L. e
WDV	-
NoDV	6
Total	6

La Riera	L. 1-18	L. 19-19/20	L. 21/23-26	L. 27-28/29	Shell midden
WDV	5580	471	710	12416	499
NoDV	23	6	3	11	1
Total	5593	477	713	12427	500

Los Canes	L. 6II	L. 6III	L. 5,6,9,10	L. 4-3	L. 2C
WDV	1	-	720	14	4
NoDV	65	2	24	2	11
Total	66	2	744	16	15

TABLE 1

NMI of shells with (WDV) and without dietary value (NoDV) per Levels in the different sites on the Cantabrian Coast and Ebro Valley during the Upper Paleolithic.

Los Canes	L. 2B	L. 2A
WDV	-	1
NoDV	1	-
Total	1	1

El Perro	L. 1	L. 2a-2b	L. 2c
WDV	15024	13658	930
NoDV	218	570	47
Total	15242	14228	977

Erralla	L. II	L. V
WDV	2	141
NoDV	-	3
Total	2	145

Aizpea	L. I
WDV	-
NoDV	6
Total	6

(contin.) TABLE 1

Group 2 Sites:

Only one example of the gastropod *P. vulgata* was found at Los Canes, and at Las Caldas there were no signs of exploitation of the marine malacological fauna.

Magdalenian (c 19/17,000-12,000 cal BC)

Group 1 Sites:

Species from a rocky bed such as *P. vulgata*, *P. intermedia*, *L. littorea*, *O. lineatus*, were classified from the Magdalenian at La Riera, as well as a single example of *C. tuberculatum*, coming from a mixed bed (sand/ mud/pebble). The most common species is *P. vulgata*, which is present in all the levels, with a percentage oscillating from 83.92% to 94.17%). *L. littorea* is also present in all the levels and is the second most frequent species (between 5.31% and 16.07%). *P. intermedia* and *O. lineatus* do not appear in all the levels and are not representative. At La Riera it can therefore be seen that the species typical of rocky estuaries shores predominate (*P. vulgata* y *L. littorea*).

Marine species typical of a hard substrate, such as *Patella* sp., *L. littorea*, *M. galloprovincialis*, y *O. lineatus* are represented in the late Magdalenian

at La Peña del Perro, as well as bivalves corresponding to soft beds, above all the Ostreidae family. There is a clear predominance of the hard bed species, with a percentage of 99.47%. The consumption of *Patella* sp. predominates, with 63.54%, followed by *L. littorea* with 28.06%, *M. galloprovincialis*, with 4.8%, and finally by *O. lineatus*, with 3.01%. The Ostreidae family has only a minimum presence (0.32%). Therefore, in this level at La Peña del Perro there is evidence of the gathering of marine mollusks from a hard, wave-beaten bed, (*M. galloprovincialis*) and from a hard estuary bed (*L. littorea*).

Group 2 Sites:

In the Magdalenian levels in Chamber II of Las Caldas, the malacological fauna is represented by two species: *Pecten* sp. (cf. *Pecten maximus*), characteristic of a soft sandy bed, and highly fragmented examples of the Mytilidae family, typical of a hard bed. *Pecten* sp. (cf. *Pecten maximus*) and the Mytilidae family are recorded in many Magdalenian layers. The MNI collected in the different levels in Chamber II is very low: nine individuals of the Mytilidae family, eight of *Pecten* sp. and three of *P. maximus*.

The sample of marine mollusks at Los Canes (late Magdalenian) is of little significance; only four individuals have been recorded, three of them belonging to the *Patella* sp. genus (hard bed) and one to the *Acanthocardia* sp. genus (soft sandy/stony bed).

In the case of the levels at El Horno, only the Mytilidae family is represented. Lastly, in the Magdalenian at Erralla, marine mollusks coming from a hard bed have been recorded (*Patella* sp., *L. littorea* and *O. lineatus*), and from a soft sandy substrate (*P. maximus*). Among the hard bed species, the estuary species predominate (*P. vulgata* y *L. littorea*). In level V (late Magdalenian) the examples from a hard bed predominate, with 98.58%. Of these, the most common is *P. vulgata* (82.97%), followed by *L. littorea* (14.89%); *O. lineatus* is hardly represented (0.70%). In the case of level II, the sample is not significant.

Azilian (c 12,000-10,000 cal BC)

Group 1 Sites:

In the case of La Poza L'Egua, the only marine mollusks recorded come from a hard substrate: *Patella* sp. (*P. vulgata*, *P. intermedia* and *P. ulyssiponensis*) and *O. lineatus*. There is no evidence of bivalves of the Mytilidae family. The predominant genus is *Patella* sp. (96.55%), with *P. vulgata* as the most common species (79.31%). In this level, the malacofauna corresponding to a rocky estuary bed is predominant.

In the case of La Peña del Perro, the species from a hard bed, mainly from an estuary, are predominant (99.26%). *L. littorea* is the most common species (56.14%), followed in importance by *Patella* sp. (37.97%). The species *M. galloprovincialis* and *O. lineatus* are much less common (with 4.19% and 0.83%, respectively). Comparing the data obtained from the azilian levels with the Magdalenian level, the species from a soft bed increase slightly in importance, with species from the Ostreidae and Veneridae families being the most frequent (0.63% of the total of mollusks recovered).

Group 2 Sites:

No evidence of marine mollusks was recorded for the azilian level at Los Canes.

A single example of *A. tuberculata* (mixed sea bed) was found in level VIII at Anton Koba. This

was gathered on a beach, as it has been eroded by wave action.

Mesolithic (c 10,000-5,000/4,700 cal BC)

Group 1 Sites:

In the Asturian levels at la Poza L'Egua, the malacological diet is represented exclusively by mollusks gathered from a hard sea bed, both open-share and estuarine. *Patella* sp. is represented with 82.88% (the three species collected, *P. intermedia*, *P. vulgata* and *P. ulyssiponensis*, have similar percentages). *O. lineatus* (16.67%) and *M. galloprovincialis* (0.43%) were also present.

In the case of the shell-midden dug at La Riera in 1969, almost all the marine mollusks that were collected come from a rocky substract, predominantly the species gathered from wave beaten areas. *Patella* sp. are the most common (71.34%), with a clear predominance of *P. ulyssiponensis* (80.89%) compared with *P. vulgata* (10.11%). *O. lineatus* is represented with 27.45%. *L. Littorea* does not appear and neither are there any examples of the Mytilidae family. The presence of *C. edule* in this level (0.8%) is the only evidence of the gathering of mollusks from a sandy sea bed.

At La Peña del Perro, the species gathered from a rocky bed are the most common (94.3%), in comparison with those gathered from a sandy or sandy/pebbly substract (5.7%). Among the species gathered from a rocky bed, those from wave-beaten zones predominate: there are two common species: *M. galloprovincialis* (51.34%) and *Patella* sp. (34.80%), while others such as *O. lineatus* and *L. littorea* are much less common (13.45% and 0.38%, respectively). Out of the species coming from a soft bed, the most frequent are examples of the Ostreidae family (89.95%), and to a lesser extent of the Veneridae family (8.29%). In the Mesolithic level, the percentage of species from a soft bed is greater than in the Azilian and Magdalenian levels.

Group 2 Sites:

At Los Canes, the only species recorded come from a hard bed, and the examples of *Patella* sp. predominate, with 89.15%, (mainly *P. ulyssiponensis*, with 40.96%, followed by *P. vulgata*, with 16.86%). *O. lineatus* is represented with 8.43% and *M. galloprovincialis* with 2.40%. It can there-

fore be seen that there is a predominance of mollusks gathered from a hard, wave-beaten zone.

Group 3 Sites:

There is no evidence of the consumption of marine mollusks at the Mesolithic sites situated more than 30 km from the coast (El Espertín, Aizpea, Peña 14 and El Pontet).

As well as being gathered as food, the marine mollusks with dietary value may have been collected for other purposes:

In the case of the examples of *Pecten* sp. (cf. *Pecten maximus*) recorded at the studied sites, there is no evidence of it being gathered in its natural habitat. Thus, in the case of the examples found in Chamber II at Las Caldas, the fragmentation of the individuals and their poor state of preservation does not allow us to determine for certain if these mollusks were part of the diet in the Magdalenian, or if these were dead individuals gathered on a beach and brought to the site for other purposes (manufacture of utensils, like spoons, or as containers for inorganic substances, etc.). In relation with this, it should be pointed out that all the remains found at the site belong to concave valves and not flat ones (except a fragment of a flat valve that was intentionally perforated). The same is true, for the same period at this site, of the examples of the Mytilidae family, brought to the site for other purposes (spoons?). These arguments can also be applied to the examples of this family found in the late-final Magdalenian layers at El Horno.

We have also recorded examples of other species with dietary value that were gathered on the coast when they were already dead, and which were later modified by humans. This is the case of the perforated example of *C. chione* in the Mesolithic grave at Los Canes (Grave II) or the perforated flat valve of *P. maximus* from the middle Magdalenian level at Las Caldas. All these examples had been affected by wave action.

Species with no dietary value

After being collected on the coast, these gastropods were brought to the site by humans. They appear in the deposits, either without signs of being modified by the humans (normally they are whole individuals) or with an intentional modification in the form of a perforation in the shell.

Most of the examples that have been classified are characterized by signs of having been exposed to wave action, and for this reason the shells of these gastropods generally have an eroded apex and their outer decoration has been worn away to a greater or lesser degree. This shows that they have been gathered on the beach when they were already dead, and not in their natural habitat.

In the case of the scaphopods, the evidence all points to them being gathered on beaches, as they are eroded by wave action. Their use as objects of adornment-pendants is proven by comparing them with the examples that present day hunter-gatherers collect, and by their presences in graves in the Paleolithic and Mesolithic in Europe.

The existence in the deposits of species with no evidence of human modification should be explained as the result of their intentional collection on beaches. In our interpretation, they are clear evidence of raw material to be used for making objects of adornment or pendants.

In the case of the examples of *N. lapillus* that have been classified, they are all found transformed into objects of adornment-pendants, except for the ones recorded at La Peña del Perro. In the three levels at this site, whose malacological remains we have not studied directly, the MNI is very high (18 in the Mesolithic, 164 in the Azilian and 16 in the level corresponding to the late Magdalenian). These gastropods either formed part of the diet or were gathered on the coast in order to make objects of adornment, for example, and their presence in the site has to be considered as raw material for making these objects. We could say the same for other species that appear in the layers at this site, such as *N. reticulatus*, *L. obtusata*/*L. fabalis* or *L. saxatilis*. These species, when they are recorded at archaeological sites, normally appear perforated by humans³.

If we study the malacological fauna with no dietary value according to periods, the following can be stated:

³ In the case of *N. lapillus*, *L. saxatilis* and *L. obtusata*, there is no reason «a priori» why they could not have been consumed, except for the fact that these species are not usually consumed at the present time (Borja, 1990: 269; Moreno, 1994: B27). However, the examples belonging to these species that we have studied directly have been gathered on beaches. In the case of the examples from La Peña del Perro, we are only indicated that they are highly fragmented, and not whether they were gathered in their natural habitat or dead on beaches (Moreno, 1994).

- a presence in all the periods studied of marine gastropods with no dietary value, modified or not by humans after being gathered on a beach. The variability of the species gathered is greater during the Magdalenian, Azilian and Mesolithic. Only the species *L. obtusata* appears in the four periods, both perforated and unperforated. The examples of the Naticidae family and of *Columbella rustica*, recorded exclusively in the Mesolithic, are always found modified by humans (perforations located on the edge of the lip). The presence of marine mollusks with no dietary value that have been perforated by humans is a characteristic of sites situated between 10 and 30 km from the present coastline (in the Magdalenian at Los Canes and Erralla, and in the Azilian at Los Canes and Anton Koba) and exclusive of sites located over 30 km away from the coast, as we have seen in all the Mesolithic sites we have studied (El Espertín, Aizpea, Peña 14 and El Pontet).
- The presence of scaphopods in the sites we have studied is of little significance (four individuals) and they all show signs of marine erosion. They come from the early Magdalenian at Erralla, the late Magdalenian in Chamber II at Las Caldas, and the Azilian shell-midden at La Peña del Perro.

COMPARATIVE STUDY OF THE MALACOLOGICAL FAUNA WITH AND WITHOUT DIETARY VALUE (Figure 4)

On one hand, we shall compare the percentage of marine mollusks with dietary value (% WDV) with the percentage of mollusks without dietary value (% WtDV) in the layers of each site that is studied. Later, this data is compared with the results from other sites ascribed to the same period. Depending on their distance from the coast, these sites have been divided into the three groups already described at the beginning of this chapter (G1, G2 y G3).

Equally, within the group of mollusks without dietary value, we have differentiated the ones that have not been modified by humans and which we consider as raw material for making objects of adornment-pendants, from the mollusks that have been intentionally modified. To do this, we have only used the data referring to gastropods, as the

number of scaphopods is minimal. In this case, all the individuals studied are considered as objects of adornment, although we have not observed any modification of their surface by humans, as a consequence of the surface erosion of the examples. Neither do we include the bivalves in this comparison, as there are very few perforated examples (one example of *C. chione* from Grave II at Los Canes and an example of a flat *P. maximus* valve from the middle Magdalenian in Chamber II at Las Caldas). In this way, we compare the percentage of gastropods with no human modification (% GRW: Gastropod Raw Material) with the percentage of objects of adornment-pendants made from gastropods (% GOA)⁴.

Solutrean

The number of studied sites is small, as we only have data from one site in Group 1 (La Riera) and two from sites in Group 2 (Las Caldas and Los Canes). In the case of the Solutrean levels at La Riera, the malacofauna with dietary value predominates over the gastropods without dietary value, a little over 50% of the examples are perforated, while the rest show no human modification. No malacological remains were recorded for the Solutrean level at Las Caldas. In the case of Los Canes, all the malacofauna recovered has dietary value.

Mollusks perforated by humans have only been recorded in the Solutrean levels at La Riera. These are the following gastropod species: *N. lapillus*, *Trivia* sp., *L. obtusata*, *Littorina* sp. and *Sipho* sp.

Magdalenian

Two sites belonging to Group 1 have been studied: La Riera and La Peña del Perro. Four sites were studied in Group 2: Las Caldas, Los Canes, El Horno and Erralla.

At the sites located less than 10 km from the coast line (La Riera and La Peña del Perro) the malacofauna WDV predominates (> 95%). This contrasts with Group 2, where the mollusks WDV have an average percentage of 52% (in the case of Los Canes and El Horno, the percentage is <30%).

⁴ We have not included the remains of unidentified gastropods.

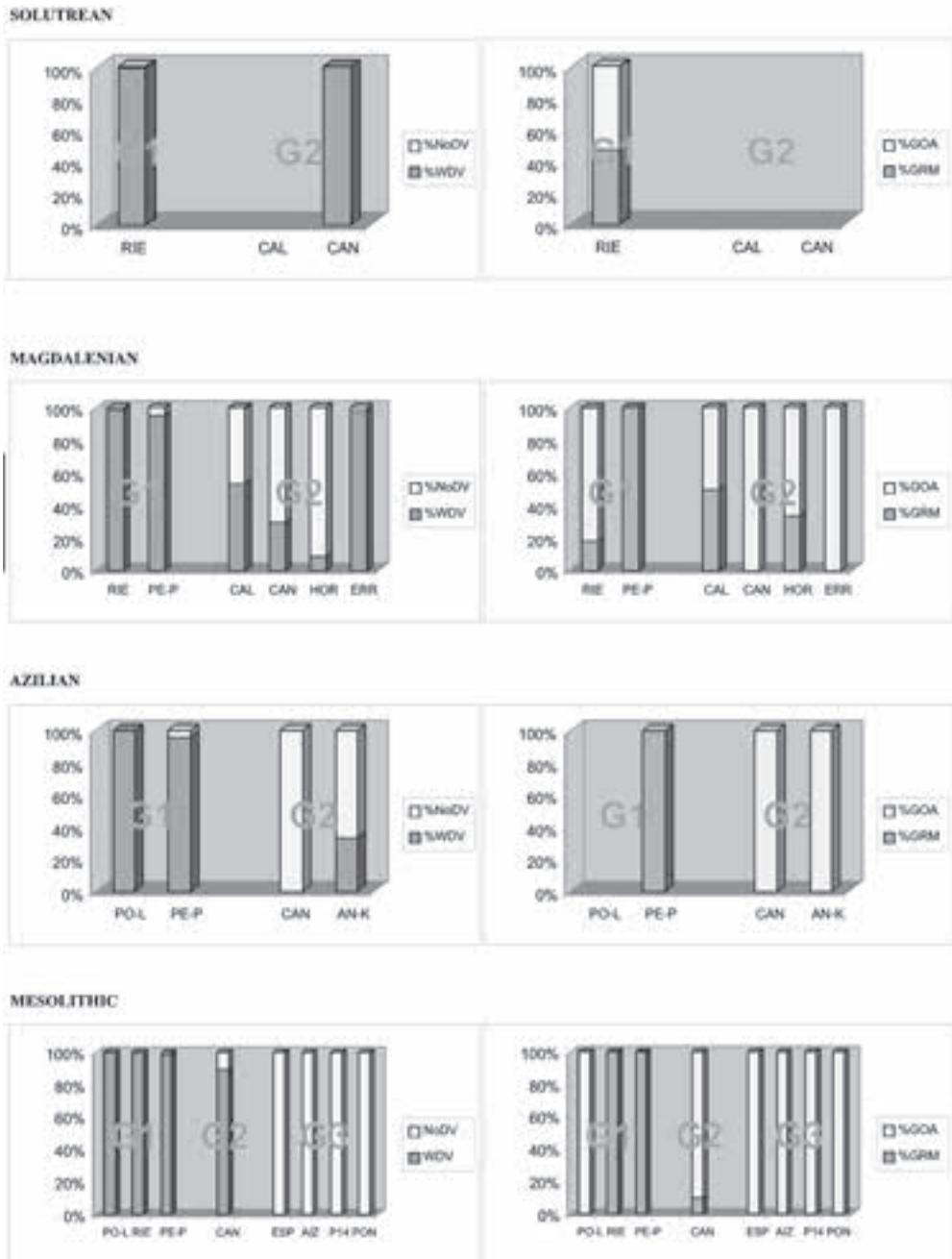


FIGURE 4

Comparative study of the malacological fauna with and without dietary value from sites on the Cantabrian Coast and the Ebro Valley during the Upper Paleolithic (Solutrean, Magdalenian and Azilian) and the Mesolithic. On the left: percentage of marine mollusks with dietary value (%WDV) versus without dietary value (%WtDV). On the right: percentage of gastropods with no human modification (%GRM: Gastropod Raw Material) versus objects of adornment-pendants made from gastropods (%GOA). G1: Group 1: sites located less than 10 km from the coast; G2: Group 2: sites located between 10 and 30 km from the coast; G3: Group 3: sites located over 30 km from the coast. Sites: AIZ: Aizpea; AN-K: Anton Koba; CAL: Las Caldas; CAN: Los Canes; ERR: Erralla; ESP: El Espertín; HOR: El Horno; P14: Peña 14; PE-P: La Peña del Perro; PO-L: La Poza l'Egua; PON: El Pontet; RIE: La Riera.

In reference to the comparison between GRW and GOA, it can be seen that in both Group 1 and Group 2, the gastropods WtDV that have been perforated by humans predominate (with 100% in the case of Los Canes and Erralla), apart from La Peña del Perro.

The gastropods used as objects of adornment are: *Trivia* sp. (El Horno, La Riera and Los Canes), *L. obtusata* (Las Caldas, El Horno, La Riera and Los Canes), *N. lapillus* (Las Caldas and El Horno), *N. reticulatus* and *Turritella* sp. (El Horno).

Examples of scaphopods have only been recorded at Las Caldas (two examples) and Erralla (one example), as well as a single example of a perforated *P. maximus* at Las Caldas.

Azilian

The studied sites belonging to Group 1 are: La Poza L'Egua and La Peña del Perro. Belonging to Group 2, there are Los Canes and Anton Koba. A clear difference can be seen in the comparison between the malacology WDV and WtDV at the sites located less than 10 km from the coast and those situated at a distance of between 10 and 30 km. Thus, at those nearer the coast the species WDV predominate (<95%), in contrast with those further away, where the percentage of mollusks WtDV is more important (>80%).

In the case of the GRW and GOA comparison, clear differences between the two groups can be identified. In the first group, it is seen that at La Peña del Perro, the gastropods WtDV that have not been modified by humans represent 100% (at La Poza L'Egua there are no gastropods without dietary value). In the case of the sites located between 10 and 30 km from the coastline (Los Canes and Anton Koba) all the documented gastropods WtDV have been perforated by humans.

The gastropod species used as objects of adornment during the Azilian are: *L. obtusata*, *L. saxatilis* (Anton Koba) and *N. reticulatus* (Los Canes). Also, an example of *Antalis* sp. has been recorded at La Peña del Perro.

Mesolithic

The malacology of a greater number of sites (8 in total) has been studied for this period. The three

groups that have been defined contain the following archeological sites: La Poza L'Egua, La Riera and La Peña del Perro (G1), Los Canes (G2), El Espertín, Aizpea, Peña 14 and El Pontet (G3).

In the question of the comparison of the species WtDV with the species WDV, clear differences can be seen between the three Groups: the levels belonging to Group 1 have over 98% of species WDV; in level 5 at Los Canes, the mollusks WDV predominate (>90%). Yet, in the case of the sites located over 30 km from the coast (Group 3), only species WtDV have been recorded.

If we compare the percentages of GRW with that of GOA, again, clear differences can be seen between the three Groups. G1: in the levels at La Poza L'Egua all the gastropods WtDV have been modified by humans, in contrast with the results from La Riera and La Peña del Perro, where there are none. G2: Los Canes the GOA predominate with 90%. G3: all the examples of gastropods that have been documented were modified by humans.

The gastropod species that were perforated during the Mesolithic are: *Trivia* sp. (El Espertín, El Pontet, Los Canes), *L. obtusata* (La Poza L'Egua, Los Canes), *N. reticulatus* (La Poza L'Egua, Los Canes, Aizpea), *C. rustica* (Peña 14, El Pontet, Aizpea), as well as *L. fabalis* and Naticidae family (Los Canes).

We only know of a single example of a bivalve with dietary value that was perforated by humans; this is a *C. chione* valve from Grave II at Los Canes.

DISCUSSION AND CONCLUSIONS

Our assessment of marine malacological fauna from the Cantabrian Coast and the Ebro Valley in the period between c. 22,000-5,000 cal BC can be summarized in the following points:

The use of marine malacological resources is patently clear at the sites nearest to the coastline (Group 1) through all the periods we have studied. However, the data indicates, a greater importance of the use of marine mollusks with dietary value starting in the Magdalenian and above all, during the Mesolithic. Their presence at sites located between 10 and 30 km from the coast is less notable, although in level 5 at Los Canes (Mesolithic) visits to the coast are more common in this period than during the Solutrean, Mag-

dalenian or Azilian. At the sites that are over 30 km from the coast (either the Cantabrian or Mediterranean coasts) and which form Group 3, the only marine mollusks that are represented are species without dietary value that were modified by humans for use as objects of adornment-pendants.

During all the cultural periods, the mollusk species with dietary interest gathered from an area with a hard sea bed predominate over the species gathered from a soft substratum.

Among the species gathered from a hard bed during the Solutrean (La Riera), the Magdalenian (La Riera, La Peña del Perro, Erralla) and the Azilian (La Poza L'Egua, La Peña del Perro) a predominance of marine mollusks from a hard estuary substratum is noted (*P. vulgata*, *L. littorea*), whereas the gathering of mollusks from a hard, wave-beaten littoral is of lesser importance (*P. intermedia*, *O. lineatus*, *M. galloprovincialis*), and only becomes of significance in the late Magdalenian at La Peña del Perro. In the case of the examples of *M. galloprovincialis* at sites located about 30 km from the present day coastline (Magdalenian at Las Caldas and Magdalenian at El Horno) we cannot be sure if they were gathered and taken to the caves for consumption, if they were consumed at the coast and their empty valves taken to the site, or if these valves were gathered on beaches, as their state of preservation and their highly fragmented nature does not allow us to reach conclusions. As regards the Mesolithic sites we have studied, at those nearest to the coast, there is a predominance of species from rocky wave-beaten shores (La Poza L'Egua, La Riera, La Peña del Perro), and the same is true at Los Canes.

The species gathered from a soft, sandy bed (*Pecten maximus*) or mixed bed (Ostreidae family) are little represented in the cultural periods studied here. There is no indication of their exploitation in the Solutrean, and although there are examples in the Magdalenian, it is not clear whether they were collected for food. Except for the examples gathered in level 2c at La Peña del Perro (where there is an important presence of examples of the Ostreidae family), the MNI of the species that appear in the other sites we have studied (*Pecten maximus*, *Cardium tuberculatum*, *Acanthocardia* sp.) is very low. In the case of the examples of *Pecten* sp. (cf. *Pecten maximus*) in the middle, middle-late and late Magdalenian at Las Caldas, owing to the poor state of preservation of the remains and their frag-

mentation, we cannot be sure if they were gathered in their natural habitat and therefore formed part of the diet, or if their valves were picked up on beaches and taken to the site in order to make objects of adornment-pendants or other artifacts. However, our opinion is that all except one of the individuals found in the Magdalenian levels correspond to concave valves of *Pecten* sp. These valves could have been brought from the coast in order to be used as recipients (spoons, containers for ocher, etc.); the only example of a flat valve of *Pecten maximus* classified at Las Caldas has a perforation.

It seems that it is in the Azilian and above all in the Mesolithic when the gathering of marine mollusks from soft beds is intensified. At La Peña del Perro this occurs in the Magdalenian, with a percentage of 0.53% and it slowly increases in importance until the Mesolithic (with 0.74% in the Azilian and 5.7% in the Mesolithic). The mollusks that are most frequently collected, in all the periods, belong to the Ostreidae family, with a percentage that is always above 70% of the total of mollusks gathered from a sandy or mixed bed. However, the percentage of shells from soft substrates is always much lower than that of the species gathered from a hard bed.

At the sites nearest to the shores of the Cantabrian Sea, we can observe changes in the exploitation of certain species with dietary value. As regards the gastropods, we can see a gradual substitution of *L. littorea* for *O. lineatus* at the end of the late Glacial period, a fact that has been noted since the times of the research of Conde de la Vega del Sella (Vega del Sella, 1916; González Morales, 1982: 75; Fano, 1998), and confirmed by new research at La Riera (Ortea, 1986) and at La Peña del Perro (Moreno, 1994, 1995). In the same way, since the start of the last century, it has been noted that there was a decrease in the size of the examples of *Patellae* from the end of the Upper Paleolithic to the Mesolithic, possibly owing to environmental changes or an increase in their exploitation (Vega del Sella, 1916: 82; González Morales, 1982: 75; Moreno, 1994: 291; Craighead, 1999; cf. Bailey & Craighead, 2003); the decrease in the size of *Patella vulgata* has been shown at La Riera (Ortea, 1986) and perhaps at La Poza L'Egua (Arias *et al.*, 2007). While the presence of gastropods has been documented from the end of the Middle Paleolithic onwards, for example at Cueva Morín (Madariaga de la Campa, 1971; cf. Álvarez-Fernández, 2005), the intense

exploitation of bivalves did not take place until the Holocene. In the case of *M. galloprovincialis*, this bivalve has been recorded in levels from the middle Magdalenian onwards (Chamber II at Las Caldas, level 1 c at Tito Bustillo) (cf. Moreno, 1994). As regards the Ostreidae family, its exploitation is seen to commence at the end of the late Glacial period, with its maximum exploitation during the Mesolithic; this has only been shown in the sequence at La Peña de El Perro (Moreno, 1994, 1995).

In relation to the malacological fauna with no food value, mostly gastropods were gathered. These mollusks show evidence of marine erosion, an indication that they were gathered on beaches when already dead. After being gathered, most of these gastropods were perforated by humans; the specimens that are found without a perforation are considered to be raw material. The species modified by humans are varied and are found both in the late Glacial and in the post-glacial periods, but only the species *L. obtusata* is found in the four cultural periods that we have studied. In the Mesolithic sites situated over 30 km from the coast the only marine mollusks that are found have no dietary interest and were transformed into objects of adornment-pendants (Álvarez-Fernández, 2003).

There is a very low presence of scaphopods and they were all gathered on beaches. The only examples of marine bivalves modified by humans were equally gathered on beaches (*C. chione* and *P. maximus*), already dead.

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