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Fossil Tusk Shells (Mollusca, Scaphopoda) in Archaeological Sites in the South of the Iberian Peninsula (Spain)

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Abstract

The interest of human groups in fossil collecting from the Middle Pleistocene onwards has recently been highlighted. Among the taxa identified at several archaeological sites, a particular group of molluscs stands out: the scaphopods. This paper provides an exhaustive review of scaphopod (Mollusca, Scaphopoda) fossils recovered from archaeological sites in southern Iberia, particularly two sites: Cueva del Hoyo de la Mina and El Tesoro, both in the province of Málaga (southern Spain). The importance of using fossils of this mollusc from the Magdalenian to the Neolithic period has been confirmed at these sites. While the Iberian Peninsula is home to a rich diversity of scaphopod species, with 24 species belonging to nine genera during the Neogene period alone, our analysis reveals that only two species, *Paradentalium inaequale* and *Paradentalium sexangulum*, were chosen for symbolic purposes. Additionally, we provide a synthesis of the presence of these species and this group in other Iberian sites. A total of 258 scaphopods were found at eight Iberian archaeological sites ranging from the Solutrean to the Bronze Age. We also discuss some of their cultural connotations. The fossil scaphopod species have been reviewed and compared with palaeontological collections from southern Iberia.

Keywords: Iberian Peninsula; Andalusia; Málaga; scaphopods; molluscs; fossil; archaeological sites; Pliocene

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1. Introduction

Several studies have highlighted the interest of prehistoric societies in collecting fossils, from the Middle Pleistocene to the Bronze Age. Indeed, the authors of this paper identified over 633 pieces from 82 Iberian sites ranging from the Upper Palaeolithic to the Bronze Age (Cortés-Sánchez et al., 2020 [1]), as well as 15 specimens from the Mousterian site of Prado Vargas in Burgos, Spain (Navazo et al., 2024 [2]). The practise of collecting fossils seems to have become widespread in Europe during the Upper Palaeolithic, establishing exchange networks through which objects such as shells and fossils were transported from long distances (e.g., Taborin, 1993; Eriksen, 2002; Simetsberger, 1993; Steininger, 1995; Álvarez, 2009) [3–7]. The fossils include bones of large mammals, shark teeth, gastropods, bivalves, scaphopods, crinoids, echinoids, and ichnofossils (Cortés-Sánchez et al., 2020) [1].

However, the analysis of fossil specimens in archaeological sites is complex, mainly due to the lack of contextualisation with respect to the palaeontological site of provenance, in addition to the fact that in many cases these fossils have been manipulated by the collectors.

Tusk shells (Scaphopods, Molluscs) are a recurring feature of archaeological sites, such as the fossil scaphopods from the Miocene of Saucats-La Brède (France) and associated with the La Madeleine child burial (Vanhaeren et al., 2004) [8], or the scaphopod fossil shells collected in the vicinity of Belo Brdo at the outcrops of fossiliferous Neogene deposits and found at the Late Neolithic-Eneolithic site Vinča-Belo Brdo (Serbia) (Dimitrijević, 2014) [9]. This group is a prime example of the difficulty of classifying and identifying fossils in these sites. This is due, among other things, to the lack of diagnostic features. Scaphopods are small, and their features are often lost or altered when specimens are converted into ornaments (Cortés-Sánchez et al., 2020) [1] p. 1. In the Iberian Peninsula, we must also consider the diversity of this group, with no fewer than 24 species in nine genera in the Neogene alone (Vera-Peláez et al., 1993; Vera-Peláez & Lozano-Francisco, 2004) [10,11]. Despite these difficulties, correctly identifying the fossil specimens provides relevant chronological and geographical data. Based on this information, we can determine the areas of origin and trade routes during prehistoric times.

A total of 258 scaphopod shells have been located in the Iberian Peninsula from eight Iberian archaeological sites, ranging from the Solutrean to the Bronze Age (Cortés-Sánchez et al., 2020) [1]: Reclau Viver (Solutrean), Hoyo de la Mina (Magdalenian–Neolithic), Peña de la Abuela (Neolithic), Tesoro Cave (Neolithic), Señorío de Guzmán/Grave 5 (Cooper Age), Campo Real (Cooper Age), El Argar and El Oficio (Bronze Age) (Figure 1, Table 1). Scaphopod non-fossils are frequently in archaeological sites, these items have not been reported in this paper.

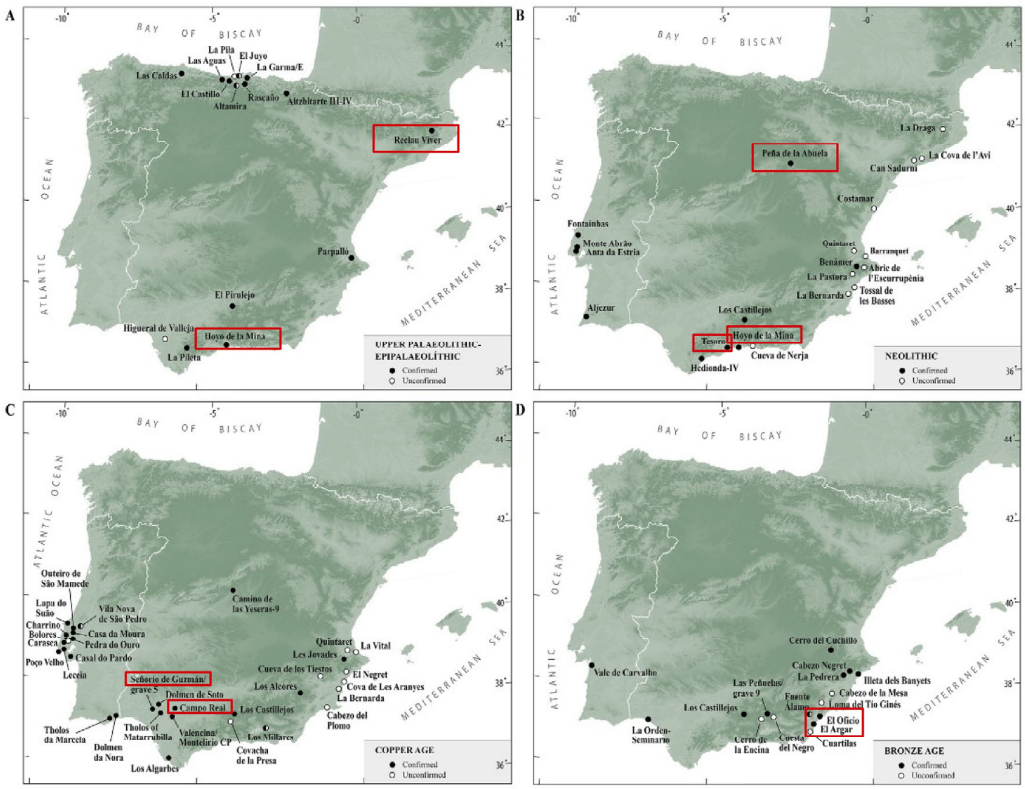

Figure 1. Distribution of the Iberian archaeological sites featuring animal fossils. (**A**) Upper Palaeolithic–Epipalaeolithic; (**B**) Neolithic; (**C**) Copper Age; (**D**) Bronze Age (modified from [1] Cortés-Sánchez et al., 2020). In red sites where fossil scaphopods have been identified.

Table 1. Fossil Tusk shells are found in archaeological sites. Absolute dates specify the age of the level where fossils were retrieved. Fossil codes as follows: AS (archaeological site), MNI (minimum number of individuals). ky (kiloyears BP), SU (symbolic use), FRA (fossil record age), FO (nearest fossil outcrops). * Fragments, non MNI.

AS	Species	SU	MMI	Cultural Stage	ky BP	FRA	FO
Reclau Viver	*Paradentalium sexangulum*	necklace beads	49	Solutrean	20-19	Tortonian–Piacenzian	Alt Penedès basin (Girona) (Pliocene)
Hoyo de la Mina	*Paradentalium inaequale*	necklace beads	1	Upper Magdalenian	13.5-11	Tortonian–Piacenzian	Málaga basin (Pliocene)
Hoyo de la Mina	*Paradentalium sexangulum*	necklace beads	6	Epipalaeolithic	11-8	Tortonian–Piacenzian	Málaga basin (Pliocene)
Hoyo de la Mina	*Paradentalium sexangulum*	necklace beads	2	Epipalaeolithic-Neolithic		Tortonian–Piacenzian	Málaga basin (Pliocene)
Hoyo de la Mina	*Paradentalium sexangulum*	necklace beads	4	Neolithic	7-6	Tortonian–Piacenzian	Málaga basin (Pliocene)
Hoyo de la Mina	*Antalis inaequicostatum*	necklace beads	2	Neolithic	7-6	Late Pliocene	Málaga basin, (Pliocene)
Peña de la Abuela/Grave	*Paradentalium sexangulum*	necklace beads	154 *	Neolithic	7-6	Tortonian–Piacenzian	Baix Ebre (Pliocene)
Tesoro	*Paradentalium sexangulum* *Paradentalium inaequale*	necklace beads	15 11	Neolithic	6-5	Tortonian–Piacenzian	Torremolinos basin (Pliocene)
Campo Real (Open-air)	*Paradentalium sexangulum*	necklace beads	2	Cooper Age	4.2-3.9	Tortonian–Piacenzian	Guadalquivir basin (Sevilla) (Pliocene)
Senorío de Guzmán (Tholos)	*Paradentalium inaequale*	necklace beads	1	Cooper Age	4.2-3.9	Tortonian–Piacenzian	Guadalquivir basin (Huelva) (Pliocene)
El Oficio/Grave Open air	*Paradentalium inaequale* *Paradentalium sexangulum*	bracelet bracelet	2 1	Bronze Age	3.8-3.3	Tortonian–Piacenzian	Murcia (Plioceno)
El Argar (settlement)	*Antalis vulgaris*	necklace beads	8	Bronze Age	3.8-3.3	Late Pliocene	Cabo de Gata-Níjar basin (Pliocene)
TOTAL	4 species		258				

In this paper, the authors present new data on two caves in southern Spain: Tesoro in Torremolinos (Málaga), and Hoyo de la Mina in Málaga. Although the specimens analysed in this study were briefly presented in Cortés et al. (2020) [1], non-detailed analysis was performed. The current study is of interest due to the abundance of specimens, the particular species selection, and the area under study's symbolic significance (Figure 1).

Tesoro cave (Torremolinos, Málaga) (see Figure 1) is a cavity in the Travertine Formation of Torremolinos (Ferre et al., 2004) [12] that originally had a surface area of around 20 m^2 (Navarro, 1884) [13]. It was discovered after being partially destroyed by quarrying activities. Identification of the remains of at least nine human individuals, performed along with a study of the site, revealed that it was used as a necropolis during the recent

prehistoric period (Navarro, 1884) [13]. The material culture enables us to date the site to the Neolithic period (see review in Simón-Vallejo et al., 2021) [14].

Due to various circumstances, the archaeological materials from Tesoro were dispersed among different institutions. This study focuses on the specimens deposited in the National Museum and Research Centre of Altamira (Santillana del Mar, Cantabria, Spain).

Hoyo de la Mina Cave (Figure 1) is located at the eastern end of the municipality of Málaga, approximately 600 m from the coastline and at 110 msl, forming part of the group of sites with prehistoric material that dominate the Bay of Málaga (Baldomero et al., 2003) [15]. From a geological point of view, the sector in which the cave is located belongs to the Maláguide Complex, included in the Inner Zones of the Betic Cordilleras. The appearance of this cavity, along with other fractures and diaclases, has occurred thanks to the strong karstification of the Jurassic dolomitic-limestone mass of the La Araña area (Ferre et al., 2004) [12].

Hoyo de la Mina has been known since the 19th century, but it was Miguel Such's rediscovery in 1917 and the subsequent excavations (Such, 1920) [16] that established its current importance in the context of the prehistory of the Mediterranean Iberian Peninsula. During the excavations, a large quantity of archaeological material was recovered, much of which is now housed in the Provincial Archaeological Museum of Málaga under the name 'Such Collection'. Such presents a stratigraphic sequence using the nomenclature in force at the time. Beginning with the lower level, known as the Capsian, which is related to the advanced stages of the Upper Palaeolithic, he then moves on to the level considered to be the Late Eneolithic or Epipalaeolithic. After, a level was described that he calls 'mixed', containing elements from both the previous level and the upper level. In this case, the upper level is Neolithic, and he recognises the existence of some elements from the first phases of the Eneolithic or Copper Age, albeit in a minority [16].

Recent studies determine the stratigraphic sequence from the Solutrean to the Neolithic. From this cultural context (Neolithic), radiocarbon dating has been carried out (Baldomero et al., 2003) [15] which shows a series of anthropic occupations of the cave between the 6th and 5th millennia B.C. The University of Málaga, in the year 2000, carried out a new archaeological excavation campaign in the Hoyo de la Mina cave, carrying out new studies (Baldomero et al., 2003) [15]. Among the different studies on the material elements recovered in these archaeological interventions in Hoyo de la Mina, the analysis of the decorative elements is performed. These decorative elements include the use of fossil scaphopods, either maintaining their original morphology or as discoidal beads, with the latter being the ones that stand out on a quantitative level.

2. Material and Method

This paper analyses the malacological materials from the Tesoro cave deposited in the National Museum and Research Centre of Altamira (Santillana del Mar, Cantabria, Spain) which correspond to record numbers DE00474, DE00492, DE00518, 00055 and a Neolithic chronology and those from the material obtained in the archaeological excavation of the Hoyo de la Mina carried out in the 2000 campaign under the reference MA/HM/2000 (Museum of Málaga), corresponding to the chronocultural segments Final Upper Palaeolithic (levels HM6 and HM7), Epipalaeolithic (HM5) and Neolithic (HM4 and HM3) (Table 2).

Table 2. Synthetic correlation of different cultures and excavated levels in Hoyo de la Mina (Málaga) (excavated between 1998 and 2000) with scaphopods (Baldomero et al., 2003) [15].

Chronocultural Segments Stratigraphic Levels	Chronocultural Segments. Stratigraphic Levels
Neolithic	HM3–4
Epipalaeolithic	HM5
Magdalenian	HM6
Solutrean	HM7

For taxonomic determination, the following has been analysed:

(a) The external ornamentation: number and arrangement of primary and secondary axial costules.

(b) Biometry, section of the shell wall, diameter of the oral and aboral openings, fragment length, expansion rate and curvature. The biometric analysis of each specimen has been carried out by taking measurements of the diameters of the oral and aboral openings, shell length and sections of the shell wall thickness (Vera-Peláez et al., 1993) [10].

(c) For fossil assignment and chronostratigraphic dating, it has been compared with fossil species of scaphopods. In our case, *Paradentalium sexangulum* (Gmelin, 1791) and *Paradentalium inaequale* (Bronn, 1831) fossils from the Upper Zanclean (Lower Pliocene) of the four subsectors of the marine basins of Málaga (from west to east Málaga-Torremolinos, Vélez-Málaga, Mijas and Estepona) and Castell'Arquatto (Piemonte-Liguria basin, Italy) (Vera-Peláez et al., 1993; Vera-Peláez and Lozano-Francisco, 2004; Aguirre et al., 2005) [10,11,17].

The identification of the species was facilitated by comparison with collections of Pliocene fossil specimens from the basins of Estepona, Málaga and Vélez Málaga (Málaga), Guadalquivir (Huelva), Alt Empordà and Baix Llobregat (Catalonia) in Spain, and Monteu Roero (Asti, Turin) and Castell'Arquatto (Piacenza) in Italia, as well as modern scaphopods from the coasts of Málaga belonging to the collections deposited at the University of Málaga, University of Barcelona (Spain) and the Regional Museum of Natural History of Turin (Italy). The dentitionals were observed with a Kyowa SDZ-TR-P stereo microscope and photographed with a Nikon Coolpix W300 camera. A MEDID digital calliper with an error of 0.01 mm was used for biometry.

Taphonomic analysis was carried out using a stereo microscope (Kyowa SDZ-TR-P) to evaluate alterations to the remains, differentiating those occurring before, during and after fossilisation, as well as those occurring after collection and deposition in the palaeontological and archaeological sites, in order to distinguish between natural and anthropic alterations. Taphonomic processes were then determined using reference collections and specialised literature on taphonomy in palaeontology (Bromley, 1981) [18] and experimental archaeology (Pascual, 1998; Taborin, 2004) [19,20].

3. Results

3.1. Cave of Tesoro (Torremolinos, Málaga)

The collection analysed consists of 70 ornaments (Navarro, 1884) [13], 26 of which are Neogene fossil scaphopods. Three typologies can be distinguished:

(a) 17 fragments of scaphopods attributable to Pliocene fossil species (Figure 2), (number DE00492), of which 15 fragments correspond to the species *Paradentalium sexangulum* Gmelin, 1790 and two fragments to *Paradentalium inaequale* Bronn, 1831.

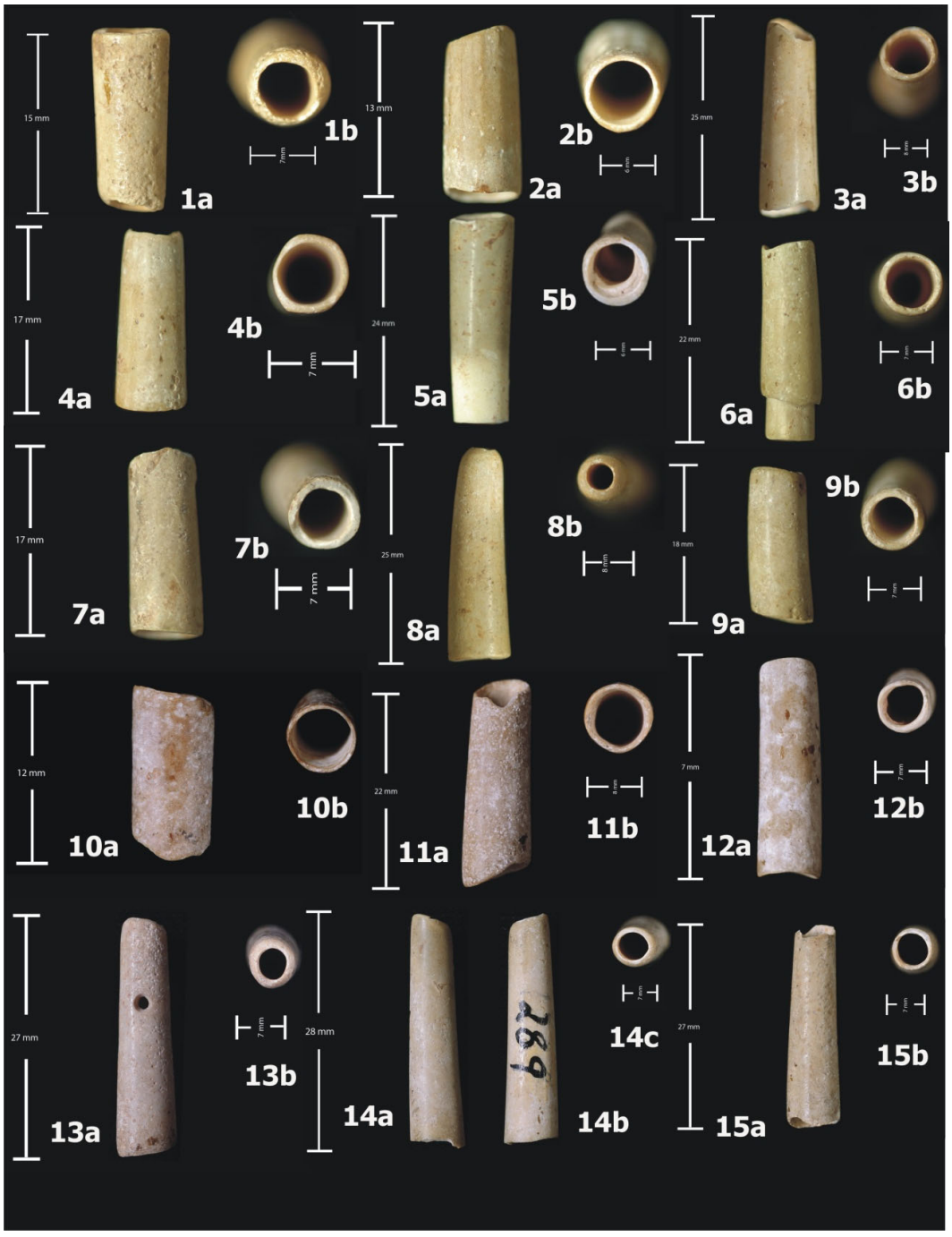

Figure 2. Tesoro. Fragments of fossil *Paradentalium* in lateral and apical view. 1–7, 9–11, 13–15: *Paradentalium sexangulum*; 6: contains two individuals, one shell inside the other acting as a closure; 8 and 12: *Paradentalium inaequale.* All are Circum-Mediterranean Pliocene species. The scales are in mm. (Elaborated from photographs courtesy of Alfredo Prada Alfredo Prada, Museum of Altamira).

These scaphopod fragments have an average length of 17.88 mm, the shell sections have 1.41 mm at the aboral opening and 1.14 mm at the oral opening, while the thickness of the shells ranges on average from 1.41 mm at the apex to 1.14 mm at the base. These measurements exclude any of the actual scaphopod species present in the Mediterranean (Steiner, 1997) [21] (Table 3).

Table 3. Neolithic *Paradentalium* shells from Tesoro. All measurements are taken in mm. 2 * Only shell fragments in which the well-preserved sculpture can be observed; 14 axial ribs can be distinguished towards the middle of the shell length and a typical hexagonal section, both characteristic of *Paradentalium sexangulum* (Gmelin, 1790). 6 * Two shells of *P. sexangulum* fitted one inside the other acting as a clasp of a necklace. Nº Inv: inventory number; Øoral: oral diametre; Øaboral: aboral dimetre.

N. inv.	Length	Øoral	Øaboral	Wall Section Apex/Base	Observations Identification
DE00492-1	15.34	6.57	5.84	1.45/1.11	Hexagonal section
DE00492-2 *	13.48	6.2	5.65	-	Hexagonal section *P. sexangulum* 14 axial ribs
DE00492-3	24.4	7.42	6.3	1.04/0.91	Hexagonal section
DE00492-4	17.66	7.62	6.33	-	Hexagonal section
DE00492-5	24.31	6.38	5.2	-	Hexagonal section
DE00492-6 *	18.77	7.19	6.3	-	mayor shell (outside) Hexagonal section
DE00492-6 *	14.62	5.89	5.14	-	minor shell (inside) Hexagonal section
DE00492-7	17.71	7.1	6.34	-	Hexagonal section
DE00492-8	25.54	7.55	5.2	1.90/1.60	High expansion rate Hexagonal section *P. inaequale*
DE00492-9	19.43	7.73	7	very thin	*P. sexangulum*
DE00492-10	12.54	6.05	5.91	-	Expansion rate = 0 *P. sexangulum*
DE00492-11	22.52	7.48	6.21	-	*P. sexangulum* Hexagonal section
DE00492-12	25.56	7.44	6.72	-	*P. sexangulum* Hexagonal section *P. inaequale*
DE00492-13	27.55	7.15	5.6	-	Bioerosion: *Oichnus paraboloides*
DE00492-14 (289)	28	7.31	5.52	1.25/0.95	Hexagonal section
DE00492-15	26.85	7.28	5.74	-	Hexagonal/oval base section

Most of the specimens show *post-mortem* bioerosion on the surface in the form of small, shallow, punctate perforations, probably produced by lichens, algae or fungi, and sometimes carbonation. They are generally polished and show a clear anthropic action on the edges.

DE00492-3 and DE00942-6 have thinned and highly polished shells both internally and externally. In addition, another fragment of the same species is embedded and strongly adhered inside.

DE00492-13 shows bioerosion produced by the radula of naticid gastropods: it is the ichnofossil *Oichnus paraboloides* Bromley, 1981 [18].

(b) 'Disc' type ornaments: 26 items, of which 9 were manufactured from P. sexangulum specimens (record number 00474), identified by their hexagonal section, shell wall

thickness and shell diameter; six were obtained from P. inaequale specimens, clearly showing the characteristic sculpture of this species (Figure 3).

Figure 3. Tesoro. Discoidal fragments: 26 items, of which 9 correspond to *P. sexangulum* (record number 00474), identified by their hexagonal section, shell wall thickness and shell diameter; six have been obtained from specimens of *P. inaequale*, clearly showing the characteristic sculpture of this species.

3.2. Cueva Del Hoyo De La Mina (Málaga)

A total of 11 fossil dentigerid specimens have been identified, also corresponding to the species *P. sexangulum* and *P. inaequale* (Table 4):

(a) 10 fragments of *Paradentalium sexangulum* shells, all of them missing the apex and the base; therefore, they correspond to medium-apical shell fragments. These specimens have been identified in Neolithic levels (levels HM3, HM4), Epipalaeolithic (level HM5) and in the final Upper Palaeolithic (levels HM6) (Figure 4).

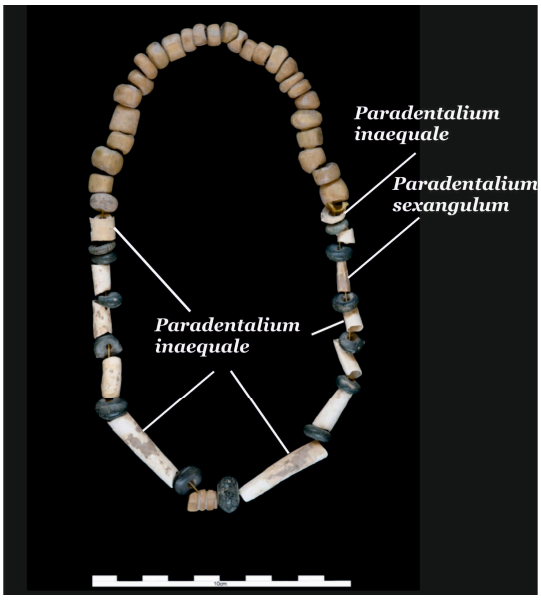

Figure 4. Recreation of the necklace found in Hoyo de la Mina (Málaga) (Elaborated from photograph courtesy of Verónica Schulmeister Guillén).

Table 4. Hoyo de la Mina. Biometry, excavation characteristics (cut, square, level and number of reference) and other topics of the excavation MA/HM/2000. Abreviatures: H: height, Ømax.: biggest section (maximum diameter); Ømin.: smallest section (minimum diameter); Nº Inv: inventory number. * non-fossil individuals.

MA/HM/2000						
SP	**H**	**Ømax**	**Ømin**	**Level**	**N. inv.**	**Observation**
P. inaequale	24.3	5.45	4.2	E-5		polished
P. sexangulum	25.75	6.85	5.5	Cont. 3–4	(995-2)-5	polished
P. sexangulum	27.6	6.9	5.3	E-4	142-5	outer shell
P. sexangulum	20.7	5	4.2	E-4	142-5	inner shell
P. sexangulum	34.3	6.3	4.3	E-3	24	polished
P. sexangulum	14.4	6.6	6.2	E-5	490-5	polished
P. sexangulum	13.6	5.8	5.5	surface	1444-5	no details, hexagonal section
P. sexangulum	19.1	7.6	6.5	Cont. 3–4	(462-2)-5	inner shell
P. sexangulum *P. sexangulum*	3.9	7.6	-	E-6-6′	554-5	no details hexagonal section
P. sexangulum *P. sexangulum*	4.6	6.35	-	E-3	23-may	no details hexagonal section
P. sexangulum *P. sexangulum*	13.15	5.3	-	E-5	(1019-5)-5	no details circular section
Antalis inaequicostatum *	8	2.9	2.6	E-6	685-5	pearlescent, polished
A. inaequicostatum *	13.2	3.3	2.6	Cont. 4–5	144-5	pearlescent, polished
A. inaequicostatum *	16.7	2.9	2.4	E-5	81-5	pearly, fissure apical anthropic
A. inaequicostatum *	10.5	3.25	2.55	E-5	237.5	no wear and tear
Antalis rubescens *	11.35	4.7	4.4	E-5	1419	polished, circular-oval section
A. rubescens *	11	3	2.5	E-5	176-5	pearlescent
Antalis sp. *	25.4	5	3.7	E-5	463-5	inner shell circular section
Antalis sp. *	18.3	5.85	5.55	Cont. 5–6	415-5	no details burnt

The fragments found correspond to the morphotype *P. sexangulum acutangularis* Cocconi, 1873. Polish by anthropic action is observed on the external surface of the shells and both ends. Traces of red ochre are present. The fossil shells have been emptied with the Pliocene sediment that filled them internally in order to use them as ornaments. They have external wear, and there is also some deterioration on the outside of the dentigerous shells, with decalcification of the endostraca. In the particular case of the individual inventoried as 142-5, the inner and outer shells are separated, with axial striations on the inner shell. On the edge of these two shells there are red ochre particles and carbonation on the surface.

(b) An apical fragment of the shell of *Paradentalium inaequale*, missing the apex and the base; therefore, it is a medium-apical fragment. It has been identified in Epipalaeolithic

levels (level HM5). The length of the fragment is 24.30 mm, and the maximum diameter is 5.45 mm.

Traces of ochre can be seen all over the surface of the shell, which is partially polished.

4. Discussion

Eduardo Navarro assigned the Tesoro scaphopods to the species *Dentalium elephantinum* and reported that "... are abundantly found among the numerous fossils found in the famous blue mud of the Tejares near this city [Málaga] corresponding to the Pliocene and perhaps even to the Miocene period..." (Navarro, 1884: 40) [13].

The taxonomic identification must have been suggested by one of the founding members of the "Sociedad Malagueña de Ciencias" (1872), of which Navarro was a member, as well as the geologist Domingo de Orueta, who had shortly before published a study on the aforementioned sources (Orueta, 1874) [22]. The taxonomy used is outdated, but it is the first reference to the use of these species in Iberian prehistoric sites.

Navarro (1884) [13] attributes the presence of scaphopods at the Tesoro archaeological site to the persistence of this species until the present day. *Paradentalium sexangulum* Gmelin, 1790 is a large species reaching up to 100 mm in maximum length with a large cross-section (maximum oral diameter of 8 mm described). Its taxonomy has been described by Vera-Peláez et al. (1993) and Vera-Peláez and Lozano-Francisco (2004) [10,11]. According to these authors, *P. sexangulum* has a hexagonal cross-section throughout ontogeny. The shell wall at the thick, hexagonal apex becomes slightly thinner during ontogeny. There is no apical fissure. The spiral sculpture consists of fine growth lines, while the axial sculpture comprises six broad, protruding ribs that start from the apex and taper towards the base. Between each pair of primary ribs, one or two thin, protruding secondary ribs may be present, which can divide into two thinner secondary ribs in adult forms near the oral end. In this respect, the species shows great variability. The rate of expansion is very small. The shell is moderately curved. This species is found from the Upper Miocene to the Pliocene (Zanclean and Piacenzian) (Malatesta, 1974; Vera-Peláez & Lozano-Francisco, 2004) [11,23].

Paradentalium inaequale Bronn, 1831 (Vera-Peláez et al., 1993; Vera-Peláez & Lozano-Francisco, 2004) [10,11] also has a large shell with a maximum measured length of 120 mm and a large section with a maximum measured oral diameter of 11.80 mm. The shell has a hexagonal section at the apex, which is up to half the length of the shell and becomes circular during ontogeny. The apex is hexagonal with a very thick shell wall which thins during ontogeny until it becomes very thin at the oral end. There is no apical fissure. The spiral sculpture consists of fine growth lines only, while the axial sculpture comprises six broads, slightly protruding primary ribs that start from the apex and taper towards the base. Four very thin secondaries, which are less prominent than the primaries, appear between each pair of primary ribs during ontogenetic development. All ribs are doubled until, in adult individuals, there are 64 very fine ribs equidistant from each other at the oral end. The shell expands quickly and becomes highly curved. Similar to the previous species, *P. inaequale* is distributed across the Upper Miocene and Pliocene (Zanclean and Piacenzian) periods (Malatesta, 1974; Vera-Peláez & Lozano-Francisco, 2004) [11,23]. *P. inaequale* is the largest dentigerous species in the European Pliocene in terms of both length and shell wall thickness, showing a higher expansion rate than *P. sexangulum* as well as a very different ornamentation pattern.

Biometry of the specimens identified at Tesoro indicated that the average length of the beads was 17.88 mm and the cross-sections ranged from 6.08 to 6.87 mm in diameter. The shell wall section ranges from 1.41 mm at the aboral opening to 1.14 mm at the oral opening. Comparison of these data from Tesoro with fossil specimens from the Zanclean of

Málaga, Huelva and Italy show sizes very similar to those of adults of *P. sexangulum* s.s. and section sizes within the mean of those of *P. inaequale* (Table 3).

In summary, 15 of the remains analysed can be assigned to *P. sexangulum*. These items have a more or less marked hexagonal or oval hexagonal section, characteristic of this species. Two others belong to *P. inaequale*, as they have a shell thickness of 1.90 mm at the apex and 1.60 mm at the base, exceeding the average thickness of the former species.

From the point of view of provenance, it is very likely that the material was collected in the Pliocene basins of Málaga-Torremolinos or in the nearby Guadalhorce Basin, where these species are very abundant in the blue loams or yellow sands of the Upper Zanclean and are exceptionally well preserved (Aguirre et al., 2005; Vera-Peláez et al., 1993) [10,17].

The specimens from Hoyo de la Mina correspond to the species identified at Tesoro, being this site where they are represented over a wider chronocultural period (Magdalenian-Neolithic) while at Tesoro they are only found during the Neolithic. The Lower-Middle Pliocene palaeontological sites in the province of Málaga, where the fossil scaphopods found in the Hoyo de la Mina could come from, are found more or less continuously along the coastline of the province of Málaga, extending in some places, such as the Guadalhorce Basin to Coín and Álora, in Vélez Málaga, in Estepona and in Manilva (Málaga).

These fossils are frequent in Messinian deposits of Upper Zanclean grey marls of the basins of Vélez-Málaga, Málaga, Mijas and Estepona (Vera-Peláez et al., 1993; Vera-Peláez and Lozano-Francisco, 2004) [10,11]. Although a prospection to 5 km^2 area around Hoyo de la Mina failed to spot any Pliocene outcrops (Ferre et al., 2004) [10], we believe the lower Pliocene beds of the Málaga coast were the most likely source areas of these specimens. Those beds range from less than 10 km (basin of Málaga) to 20 km from the site (Vélez-Málaga basin) (Aguirre, 1995, 2000; Aguirre et al., 2005) [17,24,25]. *P. inaequale* is especially frequent in the Vélez-Málaga basin yet unknown in Mijas and Estepona basins. If one were to take the similar proportions of both species at Hoyo de la Mina as a reflection of those in the source area, then the basin of Vélez-Málaga would be the most likely place of collection (Vera-Peláez et al.,1993; Vera-Peláez and Lozano-Francisco, 2004) [10,11].

The Iberian Peninsula has significant Neogene fossil deposits, in which the species documented in Tesoro and Hoyo de la Mina are found. These species become increasingly prevalent over time, suggesting the symbolic value attributed to scaphopods and the continuity of their use during the recent prehistoric period (Cortés et al., 2020) [1]. In fact, a total of 55 fossilised scaphopods have been identified at three other Neolithic sites on the Iberian Peninsula (Cortés et al., 2020) [1]. These include six *P. sexangulum* and *P. inaequale* individuals from Hoyo de la Mina, as well as 23 *P. sexangulum* individuals from Peña de la Abuela in Soria (Álvarez-Fernández et al., 2003; Vera-Peláez & Lozano-Francisco, 2004) [11,26]. In the Upper Palaeolithic, 49 specimens of the latter species were found in the Solutrean of Reclau Viver (Girona), while one specimen of *P. inaequale* and six specimens of *P. sexangulum* were found in the Magdalenian of Hoyo de la Mina in the Epipalaeolithic, as well as two more specimens for a chronocultural segment between the Upper Palaeolithic and the Neolithic. During the Copper Age, one *P. inaequale* was found in Señorío de Guzmán (Seville), and two *P. sexangulum* were found in Campo Real (Carmona, Seville) (Cortés et al., 2020) [1] (Table 5).

Of those identified, 72.09% of the fragments were assigned to the Neolithic period and 49% to the Solutrean period. The lowest representation was detected during the Magdalenian period (Table 6). Four different species of fossil scaphopod were identified at all Iberian sites. These species date from the Upper Miocene (Tortonian) to the Upper Pliocene (Piacenzian) and are characteristic of the Neogene basins close to the archaeological sites (Table 1, Figure 1).

Table 5. Number of fossils scaphopod remains at each archaeological site, corresponding cultural stage and dating. The number of total fragments is indicated. (1) This paper; (2) Cortés et al. (2020) [1]; (3) Avezuela and Alvarez (2012) [27]; (4) Alvarez-Fernández et al. (2003) [26]; (5) Schuhmacher et al. (2013) [28].

Archaeological Site	SC (Pendant)	Cultural Stage	Cal ka BP
Reclau Viver (cave) (2, 3)	49	Middle Solutrean	20-19
	1	Upper Magdalenian	13.5-11
Hoyo de la Mina (cave) (1, 2)	6	Epipalaeolithic	11-8
	2	Upper Palaeolithic-Neolithic	
	6	Neolithic	7-6
Peña de la Abuela (Open-air site, Grave) (4)	154	Neolithic	7-6
Tesoro (burial cave) (1, 2)	26	Neolithic	6-5
Campo Real (Open-air settlement) (2)	2	Copper Age	4.2-3.9
Señorío de Guzmán/5 (Tholos) (2, 5)	1	Copper Age	4.2-3.9
El Argar (Open-air settlement) (2, 5)	8	Bronze Age	3.8-3.3
El Oficio (Grave 269. Open-air settlement) (2)	3	Bronze Age	3.8-3.3
Total fragments	258		

Table 6. Number of identified fossil scaphopod fragments (SC) per Period and the percentage of these (%SC).

Period	SC	%SC
Solutrean	49	18.99
Magdalenian	1	0.39
Epipalaeolithic	6	2.33
Neolithic	186	72.09
Copper Age	3	1.16
Bronze Age	11	4.26
Unspecified layer	2	0.78

In general, the scaphopods have been described under generic names, so it is highly likely that the number of sites and items will increase exponentially once a palaeontological analysis of the Iberian archaeofaunal collections has been carried out systematically.

5. Conclusions

Scaphopods, and fossil scaphopods in particular, are a recurring element among objects of symbolic use throughout the Iberian Peninsula. In previous works, the authors identified and catalogued a total of 258 scaphopod specimens from eight Iberian archaeological sites, ranging from the Solutrean to the Bronze Age (Figure 1, Table 1) (Cortés-Sánchez et al., 2020) [1].

This paper analyses the presence of these fossils at two sites in southern Spain: El Tesoro Cave and Hoyo de la Mina Cave, both in the province of Málaga (Andalusia). A total of 37 Neogene fossil scaphopods that were used as ornaments have been identified: 26 were found in El Tesoro Cave and 11 in Hoyo de la Mina Cave. This represents 14.40% of the total number of fossils scaphopods identified across the entire Iberian Peninsula, spanning a chronocultural period from the Magdalenian to the Neolithic. However, non-fossil scaphopods are frequently present on these same sites, and these items have not been reported in this paper.

Taxonomic identification does not indicate the use of only two species of fossil scaphopods and that the provenance of these specimens is from the Neogene Basin near the archaeological sites.

Although up to 24 species of 9 genera (*Paradentalium* [5 species], *Fissidentalium* , *Antalis* [8 species], *Pseudoantalis* [1 species], *Fustiaria* [3 species], *Gadilina* [1 species], *Entalina* [1 species], *Pulsellum* [1 species] and *Cadulus* [3 species]) can be found in these Neogene basins, only two fossil species are selected as ornamental objects: *Paradentalium sexangulum* (Gmelin, 1791) and *Paradentalium inaequale* (Bronn, 1831).

The present work constitutes the first record of the Pliocene fossil scaphopod species *Paradentalium sexangulum* (Gmelin, 1791) and *Paradentalium inaequale* (Bronn, 1831) for the chronocultural segments between the Late Upper Palaeolithic and the Neolithic in the prehistoric context of the Iberian Peninsula. In all cases the specimens are anthropically altered and show clear evidence of use.

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