Sourcing African ivory in Chalcolithic Portugal

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A recent review of all ivory from excavations in Chalcolithic and Beaker period Iberia shows a marked coastal distribution – which strongly suggests that the material is being brought in by sea. Using microscopy and spectroscopy, the authors were able to distinguish ivories from extinct Pleistocene elephants, Asian elephants and, mostly, from African elephants of the savannah type. This all speaks of a lively ocean trade in the first half of the third millennium BC, between the Iberian Peninsula and the north-west of Africa and perhaps deeper still into the continent.

Keywords: Iberia, Portugal, Chalcolithic, Beaker period, Bronze Age, ivory, maritime, oceans, trade

History of investigation

In their monumental work on the megalithic tombs of the Iberian Peninsula, the Leisners included a list of the ivory objects from the southern part of the peninsula (Leisner & Leisner 1943: 474-5). Later, Gilman and Harrison produced an updated inventory list for ivory objects known from bibliographic sources (Harrison & Gilman 1977). Subsequently, there were specific studies of the relations between the Iberian Peninsula and north-west Africa during the Bell Beaker period (Poyato & Hernando 1988). After that, only a few regional works have been published, those of Spindler for Portugal and of Pascual Benito for the País Valenciano (Spindler 1981; Pascual Benito 1995).

As early as the late nineteenth century, Estácio da Veiga proposed that finished ivory objects found on Bronze Age sites, as well as the raw material itself, were imported from northern Africa (Veiga 1886-1891, vol. 1: 268-70, vol. 2: 212). Later, Siret differentiated between pieces made of elephant ivory and others from hippopotamus ivory (Siret 1913: 33) and argued that both groups were imported from Egypt as finished objects. Serra Ráfols pointed out that, on the contrary, there was really no evidence for an Egyptian origin, and that we should consider north-west Africa to be the source (Serra Ràfols 1925: 87). At

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the same time, Götze argued that local fossilised ivory was too fragile and brittle to have been used to the same technical advantage as raw ivory (Götze 1925: 87). Finally, Jodin and Camps connected the finds of ivory in the Iberian Peninsula to the appearance of Bell Beakers in north-west Africa (Jodin 1957; Camps 1960). Thus, a north-west African origin has been widely accepted (Harrison & Gilman 1977; Spindler 1981, but see Poyato & Hernando 1988 for an opposing view).

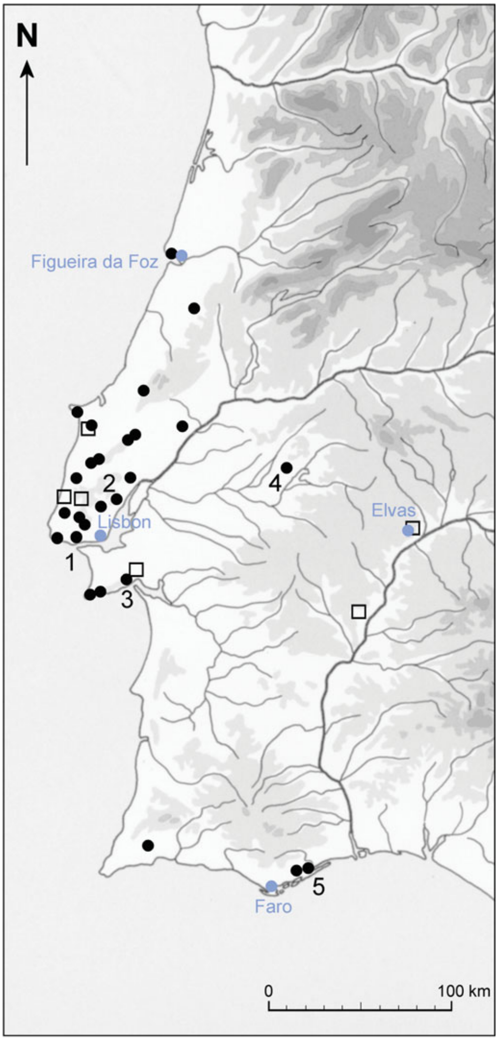

Figure 1. Portugal. Distribution of Chalcolithic ivory objects. Circles: ivory objects; squares: probably ivory. 1) Leceia; 2) Verdelha dos Ruivos; 3) Palmela; 4) Anta da Herdade da Capela; 5) Nora.

In a current research project, we are attempting to compile a new catalogue, as complete as possible, of all ivory objects from the Iberian Peninsula dated from the beginning of the Chalcolithic at about 3000 BC until the end of the Early Bronze Age, about 1650 BC, in the south-east (Schuhmacher & Cardoso 2007). Our preliminary work has revealed that the aggregate number of prehistoric ivory objects known, and thus the scale of ivory exchange, is much greater than previously thought. In fact, we have recognised 1060 objects from 130 sites. With few exceptions, the distribution of these finds is restricted to the southern part of the Iberian Peninsula.

In this article we will focus on the results associated with Portugal (Figure 1), seeking to identify the source of supply.

Cultural, chronological and economic context of the ivory objects

The Chalcolithic of Portuguese Estremadura is subdivided into three principal cultural phases, seen for example in the stratified sequence at Leceia, supported by almost 40 published radiocarbon dates (Cardoso & Soares 1996). Some types of ceramics emerge as true cultural markers (Figure 2), valid not only at Leceia, but over other settlements of the same cultural area (Portuguese Estremadura). According to the general sequence, the oldest occupation of the site (Period 1: Layer C4; Construction Phase 1 on Figure 2) dates to the fourth and beginning of the third millennia BC. Two ceramic types are characteristic of this late Neolithic cultural phase: the carinated bowls and

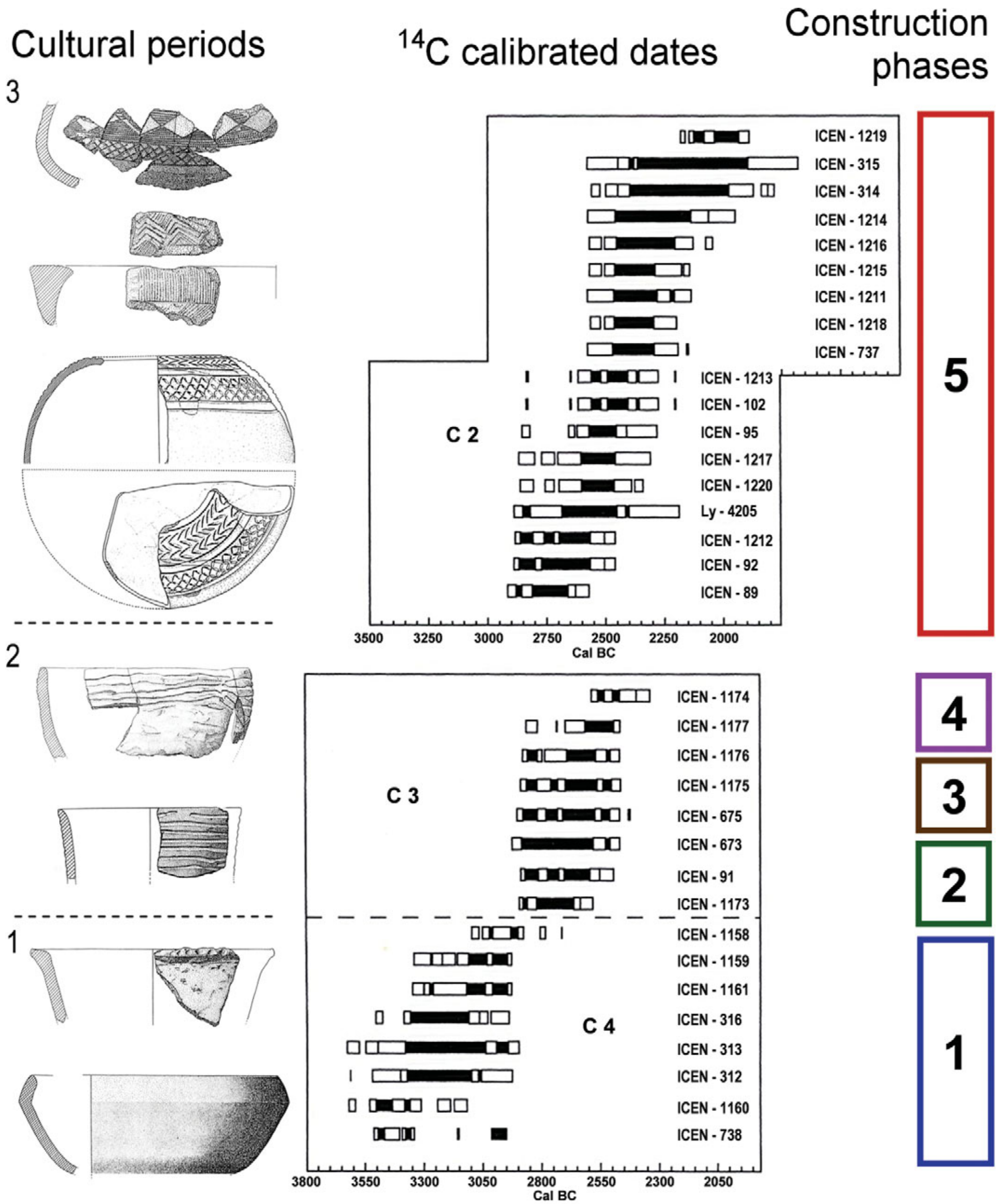

Figure 2. Leceia: relationship between the cultural phases, the construction phases and the absolute chronology of the successive occupations of the prehistoric fortified site (after J.L. Cardoso 2007).

the vases with denticulated edges. The second cultural phase (Period 2: Construction Phases 2-4 on Figure 2) is characterised by the 'copos' and bowls decorated by smooth channelled lines, the so-called 'Importkeramik' of the literature of past decades. This phase corresponds to the construction and utilisation of a complex fortification, organised in three sets of walls (Figure 3), between 2800 and 2600/2500 cal BC (Early Chalcolithic).

Figure 3. Leceia. Plan of the area excavated with the location of the ivory artefacts from Layer C3 (Period 2; Early Chalcolithic) and Layer C2 (Period 3; Full Chalcolithic) (after J.L. Cardoso 2007).

After 2600/2500 cal BC (Full Chalcolithic, Period 3: Construction Phase 5 on Figure 2) the defensive system enters progressively into ruin and the last inhabitants of the site live literally over the collapsed walls in small huts that contrast with the round houses of the Early Chalcolithic. However, the decline of the constructive techniques and the ruin of the fortification itself are not accompanied by any decrease in the capacity of the occupants to acquire goods. On the contrary, it is precisely in this period that we see an intensification of the exchange on a trans-regional scale, well illustrated by the supply of amphibolites from the Ossa-Morena region (Cardoso 2004), accompanied by copper metallurgy using ores from the same region (Müller & Cardoso 2008). This was due to a successful agro-pastoral economy that permitted the accumulation of surplus (e.g. cereals and silex). This surplus also explains the presence of 'prestige' items, like some ivory artefacts.

The third cultural period corresponds to the emergence of the Beaker 'phenomenon', before the middle of the third millennium BC, and their subsequent wide adoption. Thus, the presence in the Portuguese Estremadura of Beaker implements is, in part, contemporary with the end of the Full Chalcolithic, characterised by the generalisation of metallurgic productions and by ceramics with regional decorative patterns, as 'acacia leaf' and 'cruciferae'.

The ivory finds

As a consequence of our work we have increased the number of known ivory objects from Portugal to 163 compared to the mere 18 cited by Spindler (1981: 99, 243, Pl. 46). Of these, 108 are clearly ivory objects and 55 are probable ivory objects. One hundred and six objects belong to the Pre-Beaker Chalcolithic and 40 to the Beaker Chalcolithic. Others are not datable with precision. Fifty-two percent of the Pre-Beaker Chalcolithic and 55% of the Beaker Chalcolithic objects constitute part of the offerings associated with deposits found in collective tombs. They were deposited in artificial caves, corbelled tombs and megalithic tombs, and especially in the Beaker Chalcolithic part of a reutilisation. The percentage of the ivory objects found in artificial caves varies over time especially, ranging from 7.6% to 22.5%. Furthermore 26% of the ivory objects in the Pre-Beaker Chalcolithic and 18% in Beaker times have been found in natural caves, mostly as part of a burial. In many other cases we can at least suspect the same, although we do not have clear excavation reports. Only 21% of the finds in Pre-Beaker and 28% in Beaker times came out of settlements.

Based on visual examination we could identify a maximum of five ivory objects among the finds of Leceia (Figure 4) (Schuhmacher & Cardoso 2007). These finds are of special importance because they do have a clear stratigraphic context. They include two of the so-called vase headed pins (Spindler 1981, 238, Pl. 44; Camps-Fabrer 1991b). A fragment of a cylindrical idol with narrowed neck ('*cilindros ou ídolos de gola*') seems also to be worked in ivory. All three objects come from Period 3 (Layer C2; Construction Phase 5) and belong to the Full Chalcolithic (2600/2500-2200 cal BC). We also found a pin with its upper extremity in the form of a nail head (Camps-Fabrer 1991a; Cardoso 2003). The head is not horizontal but slightly inclined. The Leceia example is the only pin of this type which has

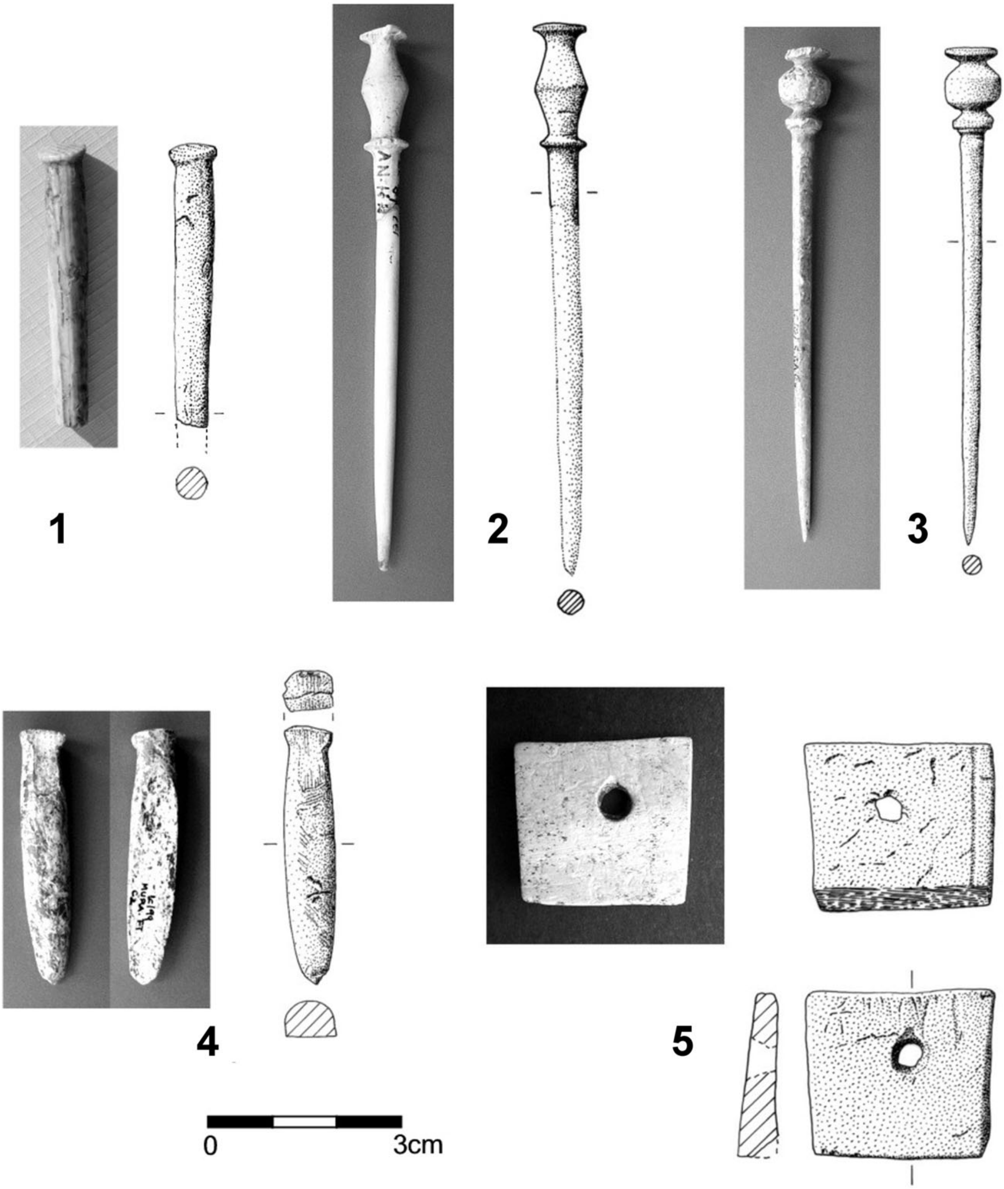

Figure 4. Ivory artefacts from Leceia (photographs J.L. Cardoso, drawings by B.L. Ferreira. Collection of the Centro de Estudos Argueológicos do Concelho de Oeiras, Câmara Municipal de Oeiras).

a stratigraphic context. This piece was found during the 2002 campaign inside the second defensive line, in a layer of greyish colour (within Period 2 (Layer C3; Construction Phases 2-4), the Early Chalcolithic of the general sequence). Thus, the chronology of these pins falls between 2800-2600/2500 cal BC.

The last object made of ivory is a quadrangular flat plaque, from Period 3 (Layer C2; Construction Phase 5), i.e. the Full Chalcolithic occupation of the site. The plaque has one perforation slightly moved out of the centre of the basic area and thus appears to have been fixed on another object, most likely a perishable material, such as wood.

Sourcing the ivory

Where bone is well preserved, as in Chalcolithic Portugal, it can be difficult to distinguish ivory by eye, and objects are often recorded as bone. The present paper demonstrates the utility of non-destructive optical and spectroscopic methods for recognising the sources (Drauschke & Banerjee 2007). Ivory is taken from walrus, mammoth, hippopotamus, sperm whale, and three kinds of elephant: African savannah elephant (*Loxodonta africana africana*), African forest elephant (*Loxodonta africana cyclotis*) and Asian elephant (*Elephas maximus*).

Ivory supplied by the three kinds of elephants varies in hardness, translucency and chemical composition due to their habitat, diet and geology. The tusk of an elephant has three distinct regions: pulp cavity in the centre, dentine in the middle and cementum in the outmost border. Dentine, the main component of ivory, is formed by the mineralisation of connective tissue in the tusk of elephants. The organic component of dentine is collagen and the inorganic component of dentine consists of the mineral dahllite, which is a carbonate hydroxyl phosphate. Dentine contains microscopic tubules, called dental tubules. These micro canals radiate outward through the dentine from the pulp cavity to the exterior of the cementum border. These canals have different configurations in different types of ivory and their diameter ranges between 0.8 and 2.2 micron. The length of the dental tubules is dictated by the radius of the tusk. The three dimensional configuration of the dental tubules is under genetic control and is therefore characteristic to the order of Proboscidea. The configuration of the dental tubules are observed on the polished cross sections of elephant tusks and are called 'Schreger structure', named after W. Schreger (1800), who first studied it. Although the main chemical components of all types of ivory are almost the same, the size and shape of the crystallites of dahllite and their arrangements in the dentine mass are found to vary in different types of ivory. This is the basic reason why different types of elephant ivory can be distinguished from one another.

Archaeological ivory undergoes considerable changes after its burial under the earth due to diagenetic processes under the soil. Collagen, the organic matrix of dentine, is partly or totally lost by hydrolysis or by bacterial attacks. For this reason, the entire inner structure of ivory also collapses. Like collagen, dahllite also shows chemical changes due to the fact that elements from the soil infiltrate into the micro tubules of dentine and react with the crystals of carbonate hydroxyl apatite. Part of the phosphate from carbonate hydroxyl apatite crystals may also be leached out by percolating water.

Method

After analysing altogether 71 prehistoric Chalcolithic and Early Bronze Age archaeological ivory objects from different Spanish Museums and collections (e.g. Museo Arqueológico Nacional Madrid, Museo Arqueológico Sevilla and Museo Arqueológico Alicante (MARQ)), the first 15 samples of Portuguese ivory, among them two objects belonging to the settlement of Leceia, were studied in the laboratory of the International Centre of Ivory Study (INCENTIVS) in the University of Mainz (Germany). Permission for investigation was given under the restriction that all the objects must be investigated only by non-destructive methods. The aim of the investigation was to identify the type and source of ivory that had been used for these objects.

Because archaeological samples are often very valuable, only non-destructive methods like optical microscopy, Fourier Transform Infra Red (FTIR) Reflection spectroscopy and Raman spectroscopy are permitted for analysis. For most archaeological samples Raman spectroscopy did not provide satisfactory results, because the dentine was too degraded (Long *et al.* 2008). However, optical microscopy and FTIR spectroscopy proved more successful.

Under favourable circumstances archaeological samples of ivory may show the typical Schreger structure under the optical microscope (Banerjee 2004). The Schreger structure is observed when light is reflected on the polished cross section of a tusk of elephant. It is composed of two systems of radiating curved lines, which cross at different angles, depending on the species of elephant: Asian elephants (112°), African savannah elephant (118°) and African forest elephant (123°). Accordingly, the type of elephant from which a piece of archaeological ivory came can be identified by measuring the Schreger angle accurately on the surface of the ivory sample with the help of a computer program.

In cases where the microscopic examination failed to produce any satisfactory results, the samples were investigated with the help of FTIR Reflection spectroscopy (Drauschke & Banerjee 2007) using a Perkin Elmer 1760 with a Specular Reflectance Accessory. According to the working principle of infrared spectroscopy, the infrared light reacts with the organic and inorganic components of ivory and produces reflection bands of collagen and carbonate hydroxyl apatite in the spectrum of the sample under investigation. Ivory from different types of elephants can be differentiated from one another according to the typical fingerprint bands in their FTIR spectra.

Results

According to the FTIR spectra the ivory plaque with round perforation from Leceia (Figure 4, no. 5) was made of ivory of the Pleistocene European forest elephant (*Elephas Palaeoloxodon antiquus*) and the pin with a nail's head out of ivory (Figure 4, no.1) matches to the present-day African savannah elephant (*Loxodonta a. africana*). In the case of the other Portuguese objects analysed and belonging to the collection of the Museo Nacional de Arqueologia (Lisbon) three are of ivory from the African savannah elephant (Anta da Herdade da Capela, Palmela tomb 3 and Nora) (Leisner & Leisner 1943: 233, Pl. 73.1.40; Leisner 1959: 79, Pl. 15.3.65; Leisner 1965: 127, Pl. 102, 140) (Figure 5). The piece from the megalithic tomb of Nora, in Algarve, is a possible decorated lid of a cylindrical box: The other pieces are two big beads in barrel form, one from the megalithic tomb of Anta da Herdade da Capela, in the Alto Alentejo region, and the other from the artificial burial cave Palmela 3, near the Sado estuary. All these finds probably belong to the Pre-Beaker Chalcolithic.

Five V-perforated buttons with two big trapezoidal appendices, which have been found accompanying the burials in the cave of Verdelha dos Ruivos, near the right bank of the Tagus

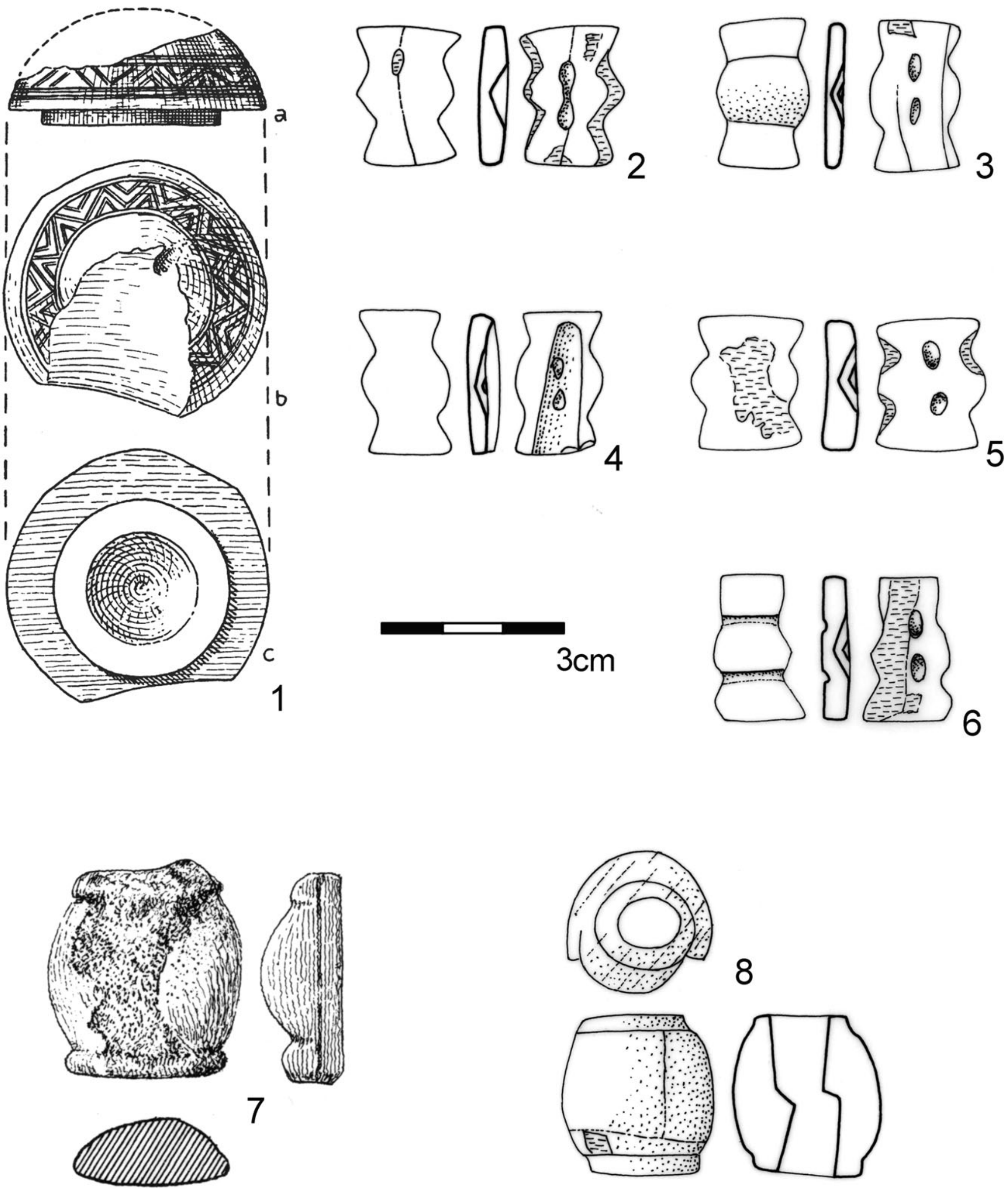

Figure 5. Ivory objects analysed: 1) Nora; 2-6) Verdelha dos Ruivos; 7) Palmela tomb 3; 8) Anta da Herdade da Capela. (1 after Leisner & Leisner 1943: 233, Pl. 73.1.40; 2-6 & 8 drawings by Schuhmacher & Fernández, DAI Madrid; 7 Leisner 1965: 127 Pl. 102, 140).

Estuary, are made out of teeth from sperm whale (Leitão *et al.* 1984: Figure 2, 6.8.9.19; 3, 24). Although female and young sperm whales live almost the whole year in tropical or sub-tropical waters, males migrate to higher latitudes. We could therefore suppose the hunting of sperm whales already in the Chalcolithic, but a provenience of the ivory from dead animals occasionally found along the littoral seems more probable.

The other five objects analysed were determined as bone and as such highlight the difficulties with distinguishing bone from ivory. The results of FTIR investigation of the objects were confirmed also by the Schreger structure. Red pigment present in the decoration of the object of Nora was confirmed to be cinnabar (compare Delibes 2000).

Discussion

The outcome of the present study is very promising. It shows that the type and source of ivory, which had been used for prehistoric archaeological objects, can be identified by non-destructive methods. The presence of *Elephas antiquus,* which was identified among some of the Spanish ivory analysed, as well as the plaque from Leceia, is hard to explain (Schuhmacher & Cardoso 2007). It seems difficult to believe that such old ivory was used in any significant quantities. In Portugal the only almost complete tusk of Pleistocene *Elephas antiquus* known, comes from a lower terrace level of the river Tagus (at Carregado, Azambuja, Lisbon) and is too fossilised and too fragile to be carved. The same is true for the even older fragment attributed to the Cromerian that is in the Museo Monográfico de Conimbriga (Antunes & Cardoso 1992). Alternative models might be considered, such as the import of such ivory from other regions with better conservation of such material, as for example Central Europe.

Another surprising result was the identification of one of the Leceia pins and three other contemporary objects from the Early Chalcolithic Portugal as ivory from the African savannah elephant (*Loxodonta a. africana*). In 1977 Harrison and Gilman developed a hypothesis on the ivory exchange between northern Africa and the Iberian Peninsula, based on the work of Jodin and Camps (Jodin 1957; Camps 1960; Harrison & Gilman 1977). They supposed this involved an exchange of prestige-goods, African ivory and ostrich egg-shells for Iberian metallic and ceramic productions (Palmela points, tanged swords, halberds, axes and Bell Beakers). In fact, it appears that this kind of exchange really can be demonstrated for the Bell Beaker period because of the quite large quantity of such products of Iberian typology in northern Africa, along both the Mediterranean and Atlantic coasts.

Harrison and Gilman had already noticed the difficulties of applying this scheme to the Pre-Bell Beaker Chalcolithic, commenting, '*. . . no characteristic Millaran or VNSP pieces have been found in Northern Africa*'. And they asked themselves, '*. . . why were no VNSP channelled, pattern-burnished* copos *(the so called* Importkeramik*) sent to North Africa like the luxury ware of a later time (Beakers)?*' But nevertheless they argued that the hypothesis need not be discarded out of hand.

Although the number of ivory samples analysed is still small, it seems we can observe some early trends. Whereas in Portugal we find a majority of African savannah elephant in the Early Chalcolithic, in south-eastern Spain on the contrary we cannot identify this type of ivory before the Early Bronze Age (end of the third and first half of the second millennium BC). So the analysis of ivory from various tombs from the necropolis of Los Millares (Almeria) revealed a majority of Asian ivory (*Elephas maximus*) (Figure 6). The situation in south-western Atlantic Spain, on the other hand, coincides with the one in Portugal, where African savannah elephant ivory can be found in the Early Chalcolithic.

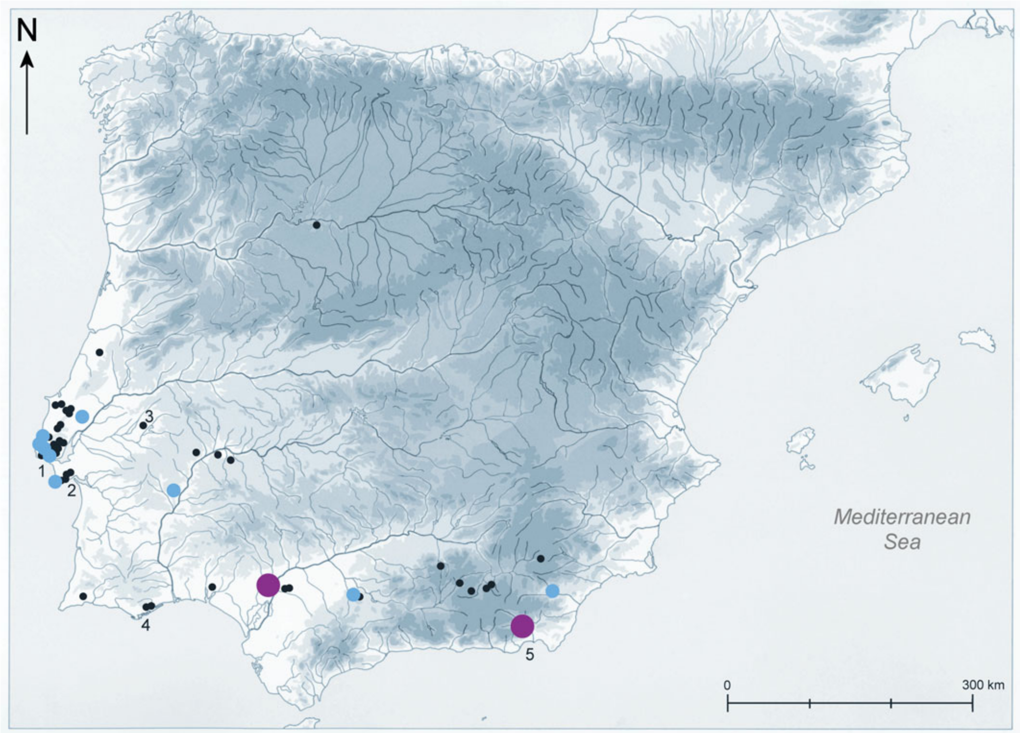

Figure 6. Pre-Beaker Chalcolithic of the Iberian Peninsula. Geographical distribution of ivory objects by number: black circles = 1-5 objects; blue circles = 6-20 objects; purple circles = more than 20 objects. 1) Leceia; 2) Palmela; 3) Anta da Herdade da Capela; 4) Nora; 5) Los Millares.

This speaks for the existence of an Atlantic route of contact and exchange for the western part of the Iberian Peninsula already in the first half of the third millennium BC. Finds like the necropolis of Rouazi-Skhirat (Morocco) with cylindrical ivory containers similar to others from the Iberian Peninsula, could, in fact, sustain this idea (Daugas 2002). Could it therefore be possible that the African savannah elephant ivory coming from Atlantic North Africa is in agreement with the mentioned hypothesis of Harrison and Gilman?

According to some authors (Zeuner 1963: 279-83; Scullard 1974: 60-63), the elephant resident in prehistoric North Africa, extinct in late Roman time, was *Loxodonta africana cyclotis*, the African forest elephant. Ansell (1971) suggested two subspecies of forest elephants, the living *Loxodonta a. cyclotis* and the extinct North African elephant, *Loxodonta africana pharaonensis*. But none of these African forest elephants show up in any Iberian ivory we have analysed.

The identification of the North African elephant seems to depend primarily on Punic and Roman images and literary sources indicating that African elephants are smaller than Indian ones. This small size would fit *Loxodonta a. cyclotis,* but not *Loxodonta a. africana* (the African savannah elephant). As Sukumar says, however, size is not a good criteria to differentiate between the different species, as even among living *Loxodonta a. africana* we can observe a great variation in size depending on their living conditions (Sukumar 2003: 86-7).

Thus he mentions various alternatives to resolve this problem, among them the possibility that North African elephants might have been in fact of a species or subspecies dissimilar to *Loxodonta a. cyclotis*, perhaps *Loxodonta a. africana* or a completely different subspecies, as suggested by recent genetic evidence (compare Eggert *et al.* 2002).

In a former article (Schuhmacher & Cardoso 2007), while still awaiting the results from Portugal, we asked ourselves whether it would not be possible that a species of *Elephas,* maybe *E. iolensis,* survived much longer than supposed and evolved into the North African elephant, extinguished in Late Roman times (Schuhmacher & Cardoso 2007; cf. Todd 2001: 696 claiming a revision of the African *Elephantidae*). So in fact, Northern Africa was populated by relatives of the Asian elephant, *E. recki* and *E. iolensis*, until the Late Pleistocene, when *Loxodonta africana* spread into Northern Africa.

Following our attribution of the ivory pieces from Leceia, Palmela 3, Anta da Capela and Nora, to the African savannah elephant, it seems highly probable that the North African elephant was an African savannah elephant, and not the forest elephant. To confirm this we analysed ten samples of ivory raw material from the cave Kehf-el-Baroud (Zaïda, Ben Slimane, Rabat) in Morocco (Mikdad 1998). There are reasons to suggest that this ivory in fact comes from elephants that lived in the environment of the cave. And in fact we could identify these samples as belonging to African savannah elephant by FTIR-analysis. This is also the case for the elephant present in Egypt until Early Dynastic times, as evidenced by the analysis of the two elephant burials in Pre-Dynastic Hierakonpolis (Van Neer *et al.* 2004). This coincides with the identification of other remains of *Loxodonta africana* all over northern Sahara from Mauretania to Sudan and Egypt, dating until the end of the fourth or the third millennium BC (Gautier *et al.* 1994). Therefore the savannah elephant must have been native to western North Africa in the Chalcolithic.

Conclusions

The context for the rise of an ivory industry would seem to be the rise of centralised settlement. In the Iberian Peninsula, since the beginning of the fourth millennium BC (Final Neolithic), we observe a process of concentration of population in large centres in the regions more favourable for agriculture (Molina & Cámara 2005: 100-108). In Portuguese Estremadura, a hierarchical settlement develops, with proto-urban fortified sites, corresponding to a complex social structure. The elites have a growing need for exotic materials. Among these is ivory. The developing middle-range and maybe long-range exchange networks permit the acquisition of ivory raw material and also finished products (Schuhmacher 2004, in press).

We suppose that in most cases the raw material was imported and then locally worked, although there are contemporary imported finished objects. But for Portugal, evidence of raw ivory is seen only among some of the finds from the *tholoi* of Alcalar. The most important of these items was found in Alcalar 4: that being a longitudinal-sectioned tusk, with a correspondent diameter of 0.10m (Veiga 1889: 213, 223). Chronologically this necropolis belongs to a later phase of the Chalcolithic, the only absolute radiocarbon analysis indicating the second half of the third millennium BC (Morán & Parreira 2004: 117).

For the Beaker Chalcolithic, the abundance of V-perforated ivory buttons enhances the argument for a local production, because buttons of the types in question are a specific west European form. The local origin of some of this ivory is also possible, as indicated by the analysis of the five buttons from Verdelha dos Ruivos cave, proven to be sperm whale ivory. In addition, in a pre-Beaker level of Leceia, a bone of a cetaceous animal used as an anvil was found (Cardoso 1995).

The identification of African savannah elephant ivory, especially in Leceia, demonstrates for the first time the existence of connections between Early Chalcolithic Portugal and Africa. If the North African elephant in fact proves to be of African savannah elephant species, which seems the most likely identification, then the most probable communication route would be from Atlantic Morocco following an Atlantic sea route to central Portugal. This therefore would demonstrate the existence of exchange between the coast of Atlantic Morocco and the littoral of Algarve and Portuguese Estremadura and answers the doubts about a Pre-Beaker relationship between the margins of the two continents presented by Harrison and Gilman (1977). But of course we still cannot exclude an even more distant, Sub-Saharan origin of this African savannah elephant ivory. The exact geographic origin of the elephants which delivered the ivory used in Chalcolithic Portugal might be achieved by another type of analysis, namely strontium isotope analysis of ivory. This will be employed in the second stage of our project.

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