Technology and Production of Reddish Purple Vegetable Dye in the Bronze and Iron Age: Written Sources and Textile Remains in the Iberian Peninsula

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Abstract:

The knowledge of dyeing techniques dates back to very early times; colour has been an important part of the most ancient cultures. Red hue dyes, such as reddish purple, have played an important role as distinctive marks of social and religious status, especially since these may have been intimately connected to the symbolism and archetype of blood from prehistoric times.
Threads dyed in red shades have been found in some Neolithic settlements in the Middle East, in ancient Mesopotamia and at Charavines, Isère, France (c. 2450 BC). Due to their early date, there are no written sources which describe the exact nature of the colourants used for reddish purple ancient textile remains. It is likely that the inhabitants of the Iberian Peninsula, during the Bronze Age, also dyed their clothes in a reddish purple colour - as found with other Mediterranean cultures. Since no records of the raw material exist, we can only speculate about material used and the methods of extraction required to obtain such dyes. To develop an understanding of this process, this paper reviews the oldest written sources concerning these dyes, together with the information about the dyes obtained through dye analysis of the extant ancient textiles. These considerations leave little doubt that the natural dyes used for reddish purple dye were primarily of local origin and therefore autochthons to the Iberian Peninsula.

Key words: *Colour, Dyes, Bronze Age, Iberian Peninsula, Textiles.*

Resumen:

El conocimiento de las técnicas de teñido se remonta épocas muy tempranas; El color fue un aspecto considerado en las culturas más antiguas. Los tintes de color rojo, como el púrpura rojizo, desempeñaron un importante papel como marcas distintivas de estatus social y religioso, especialmente porque estos colores posiblemente estuvieron íntimamente relacionados con el simbolismo y el arquetipo de la sangre desde tiempos prehistóricos.
Se han encontrado hilos teñidos en tonos rojos en algunos asentamientos neolíticos en el Medio Oriente, en la antigua Mesopotamia y en Charavines, Isère, Francia (c. 2450 a.C.). Debido a su temprana datación, no tenemos fuentes escritas que describan la naturaleza exacta de los colorantes utilizados para estos restos textiles. Es probable que los habitantes de la Península Ibérica, durante la Edad de Bronce, también tiñeran sus ropas en un color púrpura rojizo, como se sabe que se hizo en otras culturas mediterráneas. Dado que no existen registros de las materias primas usadas para este fin, solo podemos especular sobre las materias tintóreas utilizadas y sobre los métodos de extracción requeridos para obtener dichos tintes. Para desarrollar una comprensión de este proceso, este artículo revisa y aúna la información de las fuentes escritas más antiguas al respecto, junto con la información obtenida a través del análisis de colorantes de los restos textiles pertenecientes a este periodo. Estas consideraciones confirman que los tintes naturales utilizados para obtener el color púrpura rojizo fueron, principalmente, de origen local y, por lo tanto, autóctonos de la Península Ibérica.

Palabras clave: *Color, Tintes, Edad del Bronce, Península Ibérica, Textiles.*

INTRODUCTION

The use of natural colouring materials – pigments and dyes – goes back to prehistory in Europe. The abundance of wild plants in Northern Europe and along the Mediterranean coast encouraged the development of textile dyeing with vegetal dyes. Certain colours and plant species were especially favoured in ancient times (Bradley 2009: 189; Martínez García 2013: 151-153). The acquisition of dyestuffs from plants or animals has always been linked to the availability of the local raw materials, easily accessible to the inhabitants of a particular region (Martínez García 2011: 209).

Textiles were at that time, as at present, a necessity of life. They were used daily and satisfied a variety of functions. Basic uses included clothing, sacks, covers, scabbard and sword handles, wall hangings, etc. Textiles also functioned as indicators of status, gender or age. Therefore, the preference of particular colour was also linked to symbolism (Martínez García 2014: 526-549). For example, many cultures, from prehistoric times, considered the colour red to be special, it being the colour of blood, and also associated it with certain magical powers leading to the development of rich ritual and social symbolism (Wunderlich 1925: 1-69).

The ancient Mediterranean world experienced significant social, political and technological changes from the 13th century BC onwards. These were probably a result of an expansion by the Eastern Mediterranean populations. One of the most important indicators of cultural transmission are the luxurious textiles, with multi-coloured geometric decorations and a predominance of dark red colours, along with other special elements. Luxury textiles help to conform the social prestige of a nascent aristocracy (Cáceres 1997: 127-130). Imagery of the new "pro-men" is attested in the *stelae* from the southwestern Iberian Peninsula, and also by the existence of a circulation of prestige goods, from the middle of the 10th century BC (Belén *et al*. 1991: 247-248; Torres 1999: 54-55). In the Iberian Peninsula, the increasing importance of livestock represents a means of accumulating wealth and facilitating the consumption of prestige goods (Cáceres 1997: 135). Archaeological evidence points to an increase in the cattle economy, as can be seen in archaeological sites of Soto de Medinilla (Morales *et al*. 1995: 469-470), Conimbriga (Cardoso 1995) or Peña Negra (González Prats 1983).

Textiles developed as a component of a visual language during the Bronze Age in the Mediterranean world (Sherrat and Sherrat 1993: 364). One of the principal functions of dress, defining group status, requires the use of luxury textiles. Polychrome textiles required expensive dyes and the mordanting process necessary for colourfast colours. Therefore, it seems likely that the first hierarchical societies held a predilection for red and blue as solid colours – evidenced by the large proportion of European textiles in which these two colours are found, belonging to this period. Yellow dye components rarely survive in archaeological samples, although likely they were the most common since a large variety of plants could be used to obtain yellow dyes. Red, purple and blue colours could be obtained by using the dye from marine molluscs, which later would become a symbol of royalty, prestige and social status (Alfaro 2013: 75-99; Martínez García 2013: 151; see also Dionysius of Halicarnassus 3.61.1; Diodorus Siculus 31.15.2; Appian, *Bell*. *Pun*. 8.9.66; Plutarch, *Comp*. *Cim*. *et Luc*. 3.4.). The economic importance of reddish purple textiles goes back to the second and first millennia BC (Reinhold 1969: 300-304; see Marín-Aguilera *et al*. 2019 for the latest evidence on purple-dyed textiles in the Pre-Roman Mediterranean). According to Reinhold, purple already had a high prestige value as early as the first half of the 14th century BC. Red-purple dyes were widely used from 2000 BC in Ugarit, Hattusa, Babylon and Assyria. Likewise, they were also probably used by Minoans and Mycenaeans (Reinhold 1970: 10-12, 17). The excavations at Ugarit (Ras Shamra) revealed that purple was being manufactured there in the middle of the second millennium BC, and Ugaritic documents showed that purple garments were sent as tribute by King Niqmad of Ugarit to King Suppiluliumas, the mighty ruler of the Hittite Empire (Reinhold 1969: 300-304).

TEXTILE REMAINS

Chronologically, the oldest known coloured textile material consists of the black threads found in the Cave of the Warrior in Israel, dated to around the fourth millennium BC. Remains of textiles coloured with ochre of reddish and brown tones were discovered in the pyramid of Seti I and Merenres in Egypt, pertaining to the IV dynasty in the third millennium BC (Barber 1991: 224). Some reddish textiles found in Switzerland and Charavines

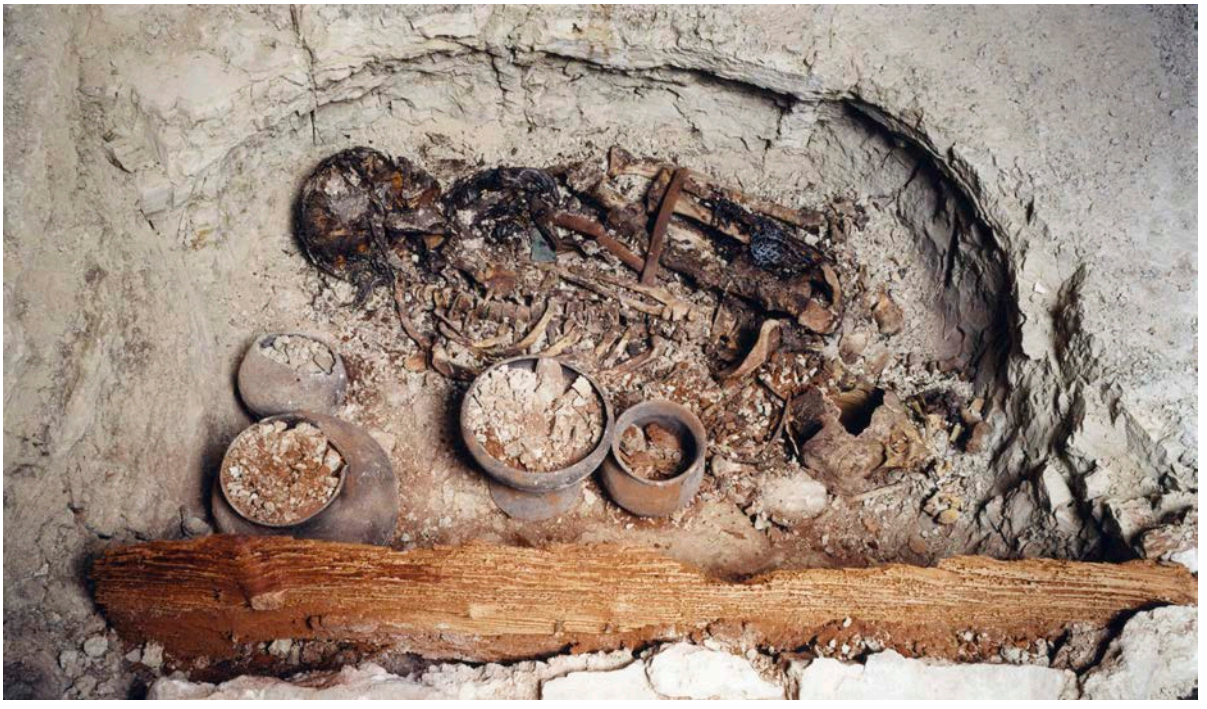

Fig. 1: Grave 121 of Castellón Alto: "The Man of Galera" (image courtesy of Museum of Galera, Granada).

(France) are still preserved today (Barber 1991: 174-175). Only a few textile fragments have been preserved from the Aegean area, dating to the period immediately after 1200 BC. Among these, are the textile remains found at Lefkandi on the Euboea island, dated on the Late Bronze Age and Early Iron Age – where linen textiles with bands decorated with supplementary warp floats in a pattern of zig-zags, chevrons and diamonds, as well as meanders (Barber 1991: 197, 312).

Bronze and Iron Age textiles have been preserved in specific environments, such as the salt mines of Hallstatt, which date between 1500-400 BC and include some of the earliest dyed textiles in Europe (Hofmann-de Keijzer *et al*. 2013: 125-131; 2016: 140-166). The technique of dyeing seems to have been quite developed and widespread in Europe since the Bronze Age, as evidenced by the textile remains found in Hallstatt, and other European Iron Age contexts such as the Villanovan burials of Sasso de Furbara in Italy (Bonfante 2003).

What raw materials were used to obtain the reddish purple colour in the Bronze Age and at the beginning of the Iron Age in the Iberian Peninsula? According to archaeological remains, the evidence of production and use of dyes in these periods is very scarse, and we must proceed with some caution when addressing the use of dyes by Bronze and Iron Age peoples of the Iberian Peninsula. The evidence of textile production found in the Bronze Age contexts of the Iberian Peninsula is mostly limited to plant fibre textiles made of flax, esparto grass and other monocot species. The latter were specifically used for the manufacture of basketry, sacks and ropes, rather than for the making of garments (Alfaro 1984). Possible animal fibre, maybe wool, has been documented in grave 121 of Castellón Alto (fig. 1) (Molina *et al*. 2003: 157; Rodríguez-Ariza *et al*. 2004: 14; Jover *et al*. 2013: 150). However, there are no extant textiles woven in this material until much later in the first millennium BC.

In the Bronze Age archaeological contexts of the south-eastern Iberian Peninsula, over 100 small fragments of linen textiles belonging to clothing, shrouds or covers have been documented in graves and living quarters of 22 settlements. All of them are found in the Argaric contexts – except that of Cabezo Redondo (Villena) near the Terlinque settlement, where some textile imprints were documented (Jover *et al*. 2001: 178-184; Jover *et al*. in this volume). Most fragments have been preserved in contact with copper alloy objects, which sometimes

Fig. 2: Egyptian textile dyed with Ochre. Collection Katoen Natie, Ref. 703, (H. Maertsen) (image courtesy of C. Verhecken Lammens).

resulted in a characteristic green colour of the remains (Badal *et al*. 2005: 235-237). The only textiles found in domestic contexts come from the deposits of El Oficio, house V at Castellón Alto and level IV from department VII of Cabezo Redondo. These are fragments of linen of whitish-brown colour.

The subject of colour in these textiles has been hotly debated since the period of their first discoveries by the Siret brothers. The main evidence of the possible presence of dyed textiles in the Argaric area continue to be the finds referred to by the Siret (Siret and Siret 1890: 200-201). These include the cinnabar bands which appeared on the female skulls from graves 356 and 129 of El Argar, as well as a series of cloth imprints covered with a cinnabar layer, preserved on clay pellets from tomb 797 (López Padilla *et al*. 2013: 274-276). It has been suggested that the bones became stained red as a result of corpse staining, following some kind of funerary ritual; this would imply that the textiles took on a reddish colour by contact transfer (Helbaek 1963: 41, 43; Barber 1991: 223). However, found in domestic contexts were containers and tools linked to the storage, processing and application of inorganic pigments – the oxides of iron, ochre and cinnabar – that could be used to stain the linen textiles, but would not have dyed them as these do not form chemical bonds with the fibre. These were documented at sites such as San Antón de Orihuela, where they are described as: *dying substances with the corresponding mortar of stone to grind*; or at Cerro de El Cuchillo, where a small ceramic vessel was found, containing the remnants of powder of an intense red colour, interpreted as ochre (Lopez Padilla *et al*. 2013). The technique of staining textiles red with ochre dates back to a very early period in Egypt, as can be seen in a linen band coloured pink with ochre, from important collection Katoen Natie (inv. 703-05) (De Moor *et al*. 2008: 65) (fig. 2). It is therefore likely that the knowledge of adding red and brown colours to textiles was present in the Iberian Peninsula at least since the Bronze Age. Mineral dyes are not true dyes since they do not penetrate into the fibre, instead only adhering to the fibre surface, but the technique is the easiest method of colouring a cloth.

Leaving aside pigmentation of red textiles, it is worth noting a spectacular discovery in the Cueva Sagrada at Sierra de la Tercia (Lorca, Murcia) – two complete tunics and some fragments of linen dress that retained traces of reddish-coloured dye (fig. 3). Unlike the tunics, linen textiles found in the sacred cave at Lorca are of a small size (Alfaro 1984; 1992; Ayala 1987). These remains deserve our attention, since chemical dye analysis verified the presence of a vegetal dyestuff derived from madder (*Rubia tinctorum* L). This was one of the plants most commonly used to dye textiles since the prehistoric period, and one of the raw colouring materials used to obtain the reddish purple colour in the Hellenistic and Roman times, the so-called vegetal purple (Steigerwald 1986: 1-57; Martínez García 2011: 207-209; Alfaro and Martínez García 2013: 55-56; Martínez García 2018: 240-244). Although this is the only example in the Iberian Peninsula that validates the hypothesis that the processes of dyeing with plants were already known and practiced in the Bronze Age, numerous research projects, particularly in Central and Northern Europe, have considerably advanced the knowledge of the processes of textile dyeing during prehistoric times (Grömer 2016: 140-166).

Experimental reproduction of dyed textiles from prehistoric Hallstatt has served to increase the knowledge of raw materials involved in the dyeing processes. The use

Fig. 3: Fragment of linen dress. Sacred Cave at Sierra de la Tercia Lorca, Murcia (A. Gueimer).

of Scanning Electron Microscopy (SEM) complemented the knowledge of Bronze Age textiles through analysis of fibres, mordants, and dyes. Furthermore, mordants and dyes were identified by using SEM with Energy Dispersive X-ray analysis (SEM-EDS) and High Performance Liquid Chromatography with Photodiode Detection (HPLC-PDA) (Hofmann-de Keijzer 2010; 2013). Experimental reproduction, together with analysis of dyed textiles and mordants using the techniques mentioned above have not been applied in Spain for the study of dyes in Bronze Age textiles. Therefore, we can only discuss the dyes in this region on the basis of analytical results of linen textiles from Cueva Sagrada at Lorca, mentioned above, and the local plant species with dyeing properties, which would have been typical in the Iberian Peninsula during the Bronze Age (Alonso and Buxó 1995: 21; Buxó 1997: 140, 266, 326).

Dye analyses conducted on the Hallstatt textiles have demonstrated that *Rubiaceae* family plants were used to dye during the European Bronze Age (Hofmann-de Keijzer 2016: 159). The pure reds would be obtained from the roots of *Rubia tinctorum* L., which is rich in alizarin and purpurin colorants. Textile dyes containing only purpurin, which produce a more purple hue, could be made from roots of *Galium* species native to Europe, or wild madder, *Rubia peregrina* L., a plant native to Mediterranean Europe, the Middle East, and the southern British Isles. Based on the Neolithic period remains found in Switzerland, Forbes cited other plant species that could be used to obtain the red colour, such as: *Chenopodium album* L. and *Gallium palustre* L. (Grömer 2016: 156).

The use of *Rubia tinctorum* L. to obtain red dyestuff possibly dates even earlier, to the Neolithic times (*c*. 2700 BC), as evidenced by the remains of madder pollen found in the Charavines (Isère) archaeological site (Cardon 1998: 3-21). There is also evidence for the use of madder in cotton textiles found in Mohenjo Daro, dated to around 3000 BC. According to Forbes it is not known when it was introduced in Mesopotamia, although its use was known, since it is mentioned in recipes for the dyeing of wool dating to the Neo-Babylonian period (seventh century BC) (Forbes 1964: 103-104; Cardon 2003: 97-100; 2007: 119-122). Among the ancient Egyptians its use was frequent. The red dye for their dresses was obtained from the madder. In some purplish-blue textiles found in Amarna, madder was part of a mixture of dyes used to obtain this colour. The dark brown colour of the remains from the tomb of Tutmosis IV was also obtained by mixing madder with other dyes. Some authors identify madder plant with one that appears in heraldic iconography of Upper Egypt and inscriptions of Edfu that mention it in

Fig. 4: *Rubia tinctorum* L., Valencia, Spain (J. Martínez García).

connection with a red dye (Maniche 2006, 154; Hall 2008: 10-11). The use of this plant is thus known from early times and continued till Roman times, as demonstrated by the results of the analyses carried out on Gallo-Roman textiles (Moulherat 2002: 68), textile fragments found at Masada and Cave of Letters in Israel (Granger Taylor 2000: 151-154), Palmyra in Syria (Pfister 1934; 1937; 1940; Böhmer and Karadag 2003), etc. (fig. 4).

Another source of red dye during the European Bronze Age, identified via the analysis of textiles with red motifs, is orchil lichen (*Rocella* sp.), identified by the presence of orcein. In Roman times its colour was valued and used to make a purple dye call Gaetulian purple (Blázquez 2004: 689-704). Orchil lichen grows on Mediterranean coasts, including the Balearic Islands. The most famous red lichen in antiquity grew on Cretan coasts and on Amorgos Island; in the latter case, the dye contributed to the fame of red textiles made on the island (Martínez García 2014: 412-423).

Finally, some more recent finds should be mentioned, such as that of grave 121 from Argaric deposit at Castellón Alto, dated around 1900-1600 BC. Partially mummified remains of an adult and a child associated with various textile remains have been documented at this settlement. The adult was dressed in a type of tunic and linen trousers, of which several fragments are preserved. Found on his right leg was a net of braided esparto, along with possible wool fibres. The child was wearing a cap of woven wool covered with leather, and was dressed in a tunic or linen suit (Molina *et al*. 2003: 157; Rodríguez-Ariza *et al*. 2004: 14; Jover *et al*. 2013: 150). A total of 11 tombs were documented in the archaeological site of Tabayá Argaric settlement. The presence of various textile fragments, possibly of linen, on some ribs, arms and hips, enable the consideration that the deceased were dressed in a tunic or shroud. Fragments of linen were also recovered from a child's burial at Monte Bolón de Elda caves, associated with the settlement of Peñón del Trinitario and dated to 1775 BC (Jover and López 2013: 154). Therefore, for the moment and for Bronze Age of Iberian Peninsula there is only evidence of dying using *Rubia tinctorum* L.

WRITTEN SOURCES

The classical authors are not very explicit when talking about the techniques and the plant materials used to dye within the Iberian Peninsula among the pre-Roman peoples, and do not mention anything regarding the preceding periods.

The Greek and Roman authors, far from offering us a description of dyes, tell us only about the dresses and colours used by the Iberians, highlighting black and purple. For example:

Strabo describes the black veils worn by women (Strab. III, 4, 17).

Livy speaks of the mercenary forces of Hannibal from the Iberian Peninsula and says: «Hispanics were noted for their linen tunics interwoven with purple» (Liv., 22, 46, 5). This could be a vegetal purple or made with kermes.

Polybius also mentions this and points out that: «The Iberians wore thin linen robes, with a purple border according to the use of their regions» (Pol. 1, 17, 4).

Regarding the quality of the dresses, Athenaeus of Naucratis speaks of the *sumptuous dresses* of the Iberians (Athen. Naucr., *The Deinoph*., 1, 33).

With regard to the raw dye materials, Strabo mentions that there are a large number of useful roots for dyes (Strab. III, 4, 16). Pliny the Elder also emphasizes that Roman Hispania beats Italy in terms of the beauty and quality of its dyes (Plin. *NH*, XXXVIII, 13, 203).

We are therefore faced with an absence of reliable data which would attest to the use of other dyeing materials, in addition to *Rubia tinctorum* L., during the Bronze Age. For the study of this subject we only have the dye data, and the technical recipes described in written sources from Bronze Age Mediterranean cultures, such as Mycenaean Linear B archives.

The Akrotiri wall paintings depict youngsters dressed in red, blue and yellow colourful skirts. This indicates that these types of dyed textiles were common in the Aegean Bronze Age. Linear B references provide written testimonies that make reference to sites dedicated to textile production and dyeing. Also, in the Mycenaean evidences referring to textiles, the term *e-ru-ta-ra-pi* appears to connect a red dye to alum for cloth, and *po-ni-ki-ja e-tu- pte-t* refers to red dye for leather (Martínez García 2014: 81- 82). Melena (1974: 187) suggested that it refers to the madder and that it is an appellation of Mycenaean origin that refers to its function (Melena 1974: 187).

The oldest recipe known for dyeing with madder is the above mentioned Neo-Babylonian tablet of the seventh-sixth century BC, currently in the British Museum (fig. 5). This recipe describes basic operations to obtain a bath of madder dye from three different species (Finkel and Taylor 1999): *hat-huritu*, *inza-huritu* and ordinary madder or *huratu*. The Akkadian term *hurratu* refers to the *Rubia tinctorum* L., so it is likely that this is what on the tablet is distinguished as ordinary madder (Cardon 2003: 101). The other varieties could be some autochthonous species in the Middle East such as *Rubia peregrina* L., *Rubia albicaulis Boiss*, or *Rubia dolichophylla Schrenk*.

According to this tablet the first operation prescribed is wool mordanting with alum: «To dye natural wool red, tabarru. You comb the wool. You boil it with alum, an equal weight of each and you boil it in water on a fire» (Cardon 2007: 114). The next phase would be the preparation of a madder bath by adding madder root to boiling water. The recipe specifies root and wool quantities, demanding the same weight of each to obtain a good red colour. This technique for dyeing wool red with madder is the easiest and most traditional Mediterranean recipe, and it is still used today to obtain a dye of pure red (Finkel and Taylor 1999; Cardon 2007: 113-114).

Fig. 5: Neo-Babylonian tablet dated about VII-VI century BC (image courtesy of Dr. J. Taylor, British Museum, © The Trustees of the British Museum).

RECENT ANALYSES

Skeletal remains from some important Bronze Age Argaric burials, such as those of El Argar and Fuente Alamo (Almería), Calle de los Tintes, and Convent of the Mercedarian mothers (Lorca), Cerro de la Encina (Granada), Illeta dels Banyets and San Antón (Alicante), have been subjected to spectroscopic and chromatographic analyses, Scanning Electron Microscopy and X-ray imaging, providing some new data. According to the analytical results conducted on the red stained bones, aluminium (Al), magnesium (Mg), potassium (K) and iron (Fe) ions were detected on the bone surfaces with red stains, while sediment spectrum X-ray diffraction analyses indicate the presence of calcium (Ca) ions and aluminium silicates (López Padilla *et al*. 2012: 281-286). Delibes, as well as other authors, suggested that the bones were not dyed for ornamental purposes; rather, their colour was a result of contact transfer from other coloured material such as textiles (Delibes de Castro 2000). In some of the analysed remains, skeletal areas that have a greater amount of the red colourant, correspond to the zones that could have been in contact with textiles; thus it cannot be confirmed if the dye was transferred from the clothes to the corpse, or vice versa. Therefore, there is still no absolute proof that Argaric textiles were dyed red. There is even less evidence regarding inorganic colourants such as cinnabar, even though this pigment is present in many red linen samples. It should be noted that the red residues on skeletal remains are primarily associated with female burials containing important grave goods, which indicates a distinguished social position, and possibly a relationship

Fig. 6: *Anchusa azurea*, Ibiza, Pou des Lleo (J. Martínez García).

with femininity, the menstrual cycle and motherhood (Wunderlich 1925: 11; Eliade 1975: 54-55; 1999: 44-47; Martínez García 2014: 541-543).

However, another hypothesis can be postulated on the basis of the presence of metal ions associated with iron oxides in the Argaric textiles. Possibly, this may be due to other reasons, such as mordant remains used for dyeing reddish linens utilising some *Rubiaceae* species. The presence of aluminium silicates and potassium provide certain indications about the use of alum as a mordant. Likewise, iron oxides have been widely used in Egypt to dye brown textiles (De Moor *et al*. 2008: 65) There are certain fugitive plant dyes, such as alkanet or orchil lichen, which give rise to red dyes of great beauty and brilliance (Pfister 1935; Martínez García and Martínez 2013: 96). If used, these dyes would have disappeared from textiles and could not be detected by dye analysis. It is only the presence of the metal ions typical for the mordants that may indicate their possible use in the past (Martínez García 2013: 167).

Archaeobotanical studies demonstrate the presence of pollen from wild dye species at a number of important Bronze Age sites. Alkanet pollen has been found at Cabezo Redondo Villena and Rincon de Almendricos (Alonso 2000: 221-238) (fig. 6). The most frequent wild dye plant species in the archaeobotanical record of western Catalonia landscape are *Chenopodium album* L. and *Chenopodium glaucum* L. (present in the Bronze Age Minferri deposit, Cova de Punta Farisa, Masada del Ratón and Iron Age I phase of Els Villars) and *Gallium* species, such as *Gallium aparine* L. found in the Minferri deposit and Els Villars. *Gallium* species of the *Rubiaceae* family produce very bright dyes, which provide textiles with a brilliant purplish red colour. Yellow dye plants such as weld (*Reseda* sp.) are present in Cova Punta Farisa and Els Villars (Alonso 2000: 221-238).

Finally, some considerations regarding alkanet dyestuff should be noted. Alkanet's principal dye component is alkannin. This dyestuff is only partially soluble in organic natural compounds. We can hypothesize, with caution, that the red colour of the human bones from the Argaric burials could come from the red textiles, dyed with *Alkanna tinctoria* (L.) Tausch. The prolonged contact of the dyed clothes with a body in decomposition, together with soil and humidity, would have facilitated the transfer of the dye from the textiles to the human remains. Protein, glycogen, lactic acid and mineral salts such as Na, K, Ca and P, are important chemical components of the human body. The affinity of this dye for organic matter would therefore facilitate the dye fixation. The alkanet is a native plant of Mediterranean regions, and has been used in Egypt since ancient times. According to Greek papyri found at Thebes (Papyrus X Leiden and P. *Graecus Holmiensis*), alkanet was a source for red dye. In pharaonic medicine, it was used in medicinal potions (Maniche 2006: 74). Theophrastus mentions alkanet for dyeing perfume red (Theoph., VI, 31). It is also likely it was used as a textile dye in the Aegean Bronze Age. The lack of analysis, using colorimetric techniques, to detect its presence in the stained bones does not allow us to confirm our hypothesis. Reconstruction of burial conditions, as well as the old alkanet dyeing techniques, would create a reference enabling the application of these colorimetric techniques. This would therefore contribute a new body of data regarding the knowledge and use of vegetal dyes used in the Iberian Bronze Age.

CONCLUSION

To summarize, this paper has demonstrated that the knowledge of dyeing techniques, known from the Greeks and Romans, could have been present as early as the Bronze Age in most of Europe, including the Iberian Peninsula. The data examined included: results of the dye analyses of textile remains from the Iberian Peninsula and Hallstatt, Austria; the description of dyes in Linear B, and madder dyeing recipe described in a Neo-Babylonian tablet. Direct dyeing using tannins and mordants

used for red and yellow colours, was already known in the Bronze Age. Possibly, these techniques only applied to very specific items, such as stripes, bands and other ornaments, that adorned the linen tunics of this period. Based on the presence of inorganic pigments in the Argaric textiles, it is possible that in addition to dyeing with plants, a simpler textile colouring technique, based on using pigments, was used to colour textile surface and give them polychromy.

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