Introduction

Our value perception of ancient textiles is strongly influenced by our views on contemporary fabrics, which, in turn, are based on a paradigm largely established during the Industrial Revolution, when mechanised mass production made these goods widely and cheaply available. Looking at the deep history of textiles, however, we can suggest that an equally significant ‘revolution’ in the way textiles were seen and valued occurred earlier in the human experience, when textiles started to serve more regularly as a means of differentiating individuals and groups within ancient societies and became part of ‘prestige economies’ (e.g. Soffer et al. 2000: 524). In particular, it has been argued that processes of societal differentiation and state formation have been accompanied by the production of textiles characterised by increasing added value in ways that made some products stand out from the mass of similar artefacts (McCorriston 1997; Halstead and Isakidou 2011). Time investment...
in raw materials and new technologies played a key role in this process: ancient Mediterranean societies represent an extreme example of the use of coloured textiles as status symbols (on textile value see Harris 2018), with the use of costly shellfish-based dyes an increasingly common strategy to mark societal differentiation during the Bronze Age and Iron Age (IA) in many cultures around the Mediterranean basin.

While archaeology and ancient history have long recognised the importance of shellfish-purple (on history of the studies see Haubrichs 2005), the discussion has often been compartmentalised, both regionally and chronologically, thus considerably limiting its analytical potential. Studies concerning the production of shellfish-purple dye in the second millennium BC in the Mediterranean have privileged the eastern region over the central-western Mediterranean and the question of primacy (e.g. Alberti 2006; Burke 2010; Brogan et al. 2012). For the first millennium BC, however, with Phoenician, Greek and particularly Roman expansion, it is the western Mediterranean that has been emphasised (e.g. Alfaro et al. 2004; González et al. 2017). The Mediterranean as a whole, despite being recognised as a connecting element across periods, is rarely considered (e.g. see the map in Kalaitzaki et al. 2017: 109). More importantly, the available data have never been synthesised in the attempt to reconstruct the entire chaîne opératoire of shellfish-purple-dyed textiles, the focus usually falling on a specific stage only (e.g. fishing, dye extraction or dyeing); all these data are rarely combined with an exploration of the social and economic implications of the development and expansion of purple technology.

In this regard, it is important to acknowledge considerable geographic and chronological differences in economic, political and social terms between eastern, central and western Mediterranean communities. During the Bronze Age, the eastern Mediterranean was mostly dominated by highly bureaucratic and structured states characterised by medium- to large-scale economies with long-distance exchange networks extending to the central Mediterranean; by the end of the period, these states were replaced by a cluster of petty polities and city states (Voutsaki and Killen 2001; Moreno-García 2016). Large populated centres and palatial elites based their power on control of the production, distribution and trade of goods, although private initiative was also involved, especially from the twelfth century BC onward. In contrast, in the central and western Mediterranean during the same period, the population was distributed in small-to-medium nucleated and hierarchically organised communities where craft production was small in scale and mostly regionally connected (Cruz-Berrocal et al. 2013; Attema et al. 2016). It was only in the eighth and seventh centuries BC that urban centres in the central Mediterranean region became fully immersed into long-distance trade, with Phoenician and Greek expansion westwards (Osborne and Cunliffe 2005), while urbanisation in the western Mediterranean came even later, in the late sixth to fifth century BC (Bonet-Rosado and Mata-Parreño 2015; Sanmartí 2015). These differences in the socio-political development of various Mediterranean societies also influenced the production and consumption patterns of shellfish-purple-dyed textiles.

The aim of this paper is thus threefold: (1) to combine the data and various approaches to propose a chaîne opératoire for the production of shellfish-purple-dyed textiles; (2) to synthesise the archaeological evidence on the production and consumption of such textiles known to date in the Mediterranean, from the Bronze Age through pre-Roman times, linking the eastern Mediterranean with the central and western regions; and (3) to discuss the social and political implications suggested by changes in production and consumption patterns across time and space.¹

The Evidence²

The term ‘shellfish-purple dye’ is generally used to refer to a violet dye composed of several
chemically related colourants and obtained from marine molluscs belonging to the *Muricidae* family; the colours range in shade from purplish-red to violet-blue (Cardon 2007: 553-87 with refs.). Three species were exploited for purple-dye production in the ancient Mediterranean: *Hexaplex trunculus* (formerly *Murex trunculus*), *Bolinus brandaris* (formerly *Murex brandaris*) and *Stramonita haemastoma* (formerly *Purpura haemastoma*). These species are ubiquitous in the Mediterranean Sea, with the last more common in the western region (Houart 2001).

The purple dye is not present in the living animal but is produced after its death through enzymatic hydrolysis of the colourless chemical precursors of the colourants present in the mollusc’s hypobranchial gland (Cardon 2007: 554; Cooksey 2017). The chemical reactions involved in the formation of different purple colourants are complex and the resulting colour depends on the chemical precursors present in specific mollusc species, as well as on the variations in the amounts of oxygen and light that the dye is exposed to. In particular, the shade of purple depends on the presence or absence of bromine, ranging from two atoms of bromine in 6,6’-dibromoindigotin, the main colourant in violet-red purple, to the absence of bromine in blue indigotin. The former has generally been connected with the ‘Tyrian purple’, known as *argaman* in the Bible and *argmn*/argamannu in Ugaritic and Assyrian texts (Soriga 2017), while the latter is interpreted as the biblical *tekhelet* (Koren 2005). Written sources from the second millennium BC through to the Byzantine period inform us of the great variety of purple shades, with particular tones being fashionable during specific periods (e.g. Meiers 2017). However, while much work elucidating the chemical processes involved has been carried out recently, many problems of purple dyeing remain to be solved (Cooksey 2017).

The study of shellfish-purple production is based on a number of sources; alongside written sources and living molluscs, as referred to above, there is also archaeological evidence consisting of installations, tools, surviving textiles and archaeomalacological material, and also ethnographic data (these are noted by e.g. Alberti 2008; Susmann 2015; Kalaitzaki *et al*. 2017). These sources all have their advantages and limitations, but most importantly they refer to very different aspects of shellfish-purple-dye history: archaeological studies of workshops and experimental archaeology deal primarily with the production side, while the actual textiles provide evidence of consumption. Ancient written sources offer potential insights into both aspects. However, these diverse types of evidence are rarely combined to produce a more holistic view of the production process and its social, economic and political implications. This is largely because they are typically investigated within different disciplines, such as analytical chemistry, biology, archaeomalacology, history and archaeology. Furthermore, shellfish-purple dying is often studied in isolation from other productive activities and economic processes with which it was inextricably intertwined (but see Bernal Casasola *et al*. 2011); its connection with the textile production process is rarely considered in detail, if at all. Yet if we look at the ancient written sources, the value of the dye was always subsumed in the social and political value of purple textiles, and so we need to consider purple-dye production as part of the textile operational sequence, rather than an industry in its own right.

**Chaîne opératoire of Shellfish-purple-dyed Textiles**

The main stages of the *chaîne opératoire* for creating shellfish-purple-dyed textiles in the ancient Mediterranean outlined below include mollusc harvesting, possible storage, dye extraction, dyeing, textile production and consumption of the finished product. These stages, however, should be understood within the broader operational sequence of textile production that would have
Figure 1. *Chaîne opératoire* of purple-dyed textile production (figure prepared by V. Herring).
included fibre procurement and processing, thread production, cloth weaving and finishing (Andersson Strand 2015). The combined sequence is presented in schematic form in Figure 1.

_Mollusc Harvesting_

The first step was obtaining the raw material, which involved harvesting the shellfish. Due to differences in their habitation environments, _Hexaplex trunculus_ and _Stramonita haemastoma_ could have been harvested by hand (Aristotle 5.15.599a.15), whereas _Bolinus brandaris_ likely required devices such as a net, a line or a baited trap (Cardon 2007: 567-68, 578, 583; Alfaro and Mylona 2014: 154-59). Experimental work suggests that a combination of collection by diving and baited baskets may be a particularly efficient way to collect purple shellfish (Ruscillo 2005; 2006: 808-17).

_Storage_

The shellfish had to be fresh for purple-dye production, although there is some evidence for the snails being kept alive in seawater, either in natural or artificial installations, in order to collect sufficient numbers to assure a steady supply of raw material. Aristotle (5-15.599a.15) mentions that fishermen kept snails in baskets, while Pliny the Elder (9.60) noted that snails could be kept up to 50 days in small containers. Such practices may have been present at the island of Chryssi south of Crete, in the eighteenth through to the fifteenth century BC (Apostolakou _et al._ 2016: 202), as suggested by small drill holes in the shells, which are not the result of gland extraction.

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_Figure 2._ _Hexaplex trunculus_ shell with hypobranchial gland exposed and purple dye on cloth, the result of direct dyeing. (M. Gleba).
but rather the outcome of cannibalism between snails (Spanier 1986: 467).

**Dye Extraction**

Shell debris, although providing indirect evidence for purple-dye production, is the main by-product of such production and survives well archaeologically. Interpretation of shell debris, however, has to be done with caution and careful consideration of archaeological context (Alberti 2008; Susmann 2015): the breaking of the mollusc shell to ensure the rupture of the hypobranchial gland was a crucial phase of the production process (Figure 2), and such fragmentation is one of the primary indicators used to distinguish alimentary consumption of muricid molluscs from their use for dyeing, as in the former case shells remain intact (Ruscillo 2005: 103).

Crushing requires a hard platform, such as a rock, and some type of hammer-like implement, which can be as simple as a small stone. A collection of pounding stones and platforms found in Rooms 2 and 3 at Bronze Age Chryssi have been interpreted as equipment for crushing shells (Apostolakou et al. 2016: 203). At Motya, a Phoenician colony just off the west coast of Sicily dated to the sixth and fifth centuries BC, stone hammers and four sperm whale vertebrae were identified as tools for shellfish processing (Reese 2005).

In order to control the oxidising reaction that transforms the whitish transparent mucus into a purple ink-like substance, exposure to direct sunlight should be limited. It is thus likely that many of the structures devoted to this specific purpose were roofed, as suggested by the evidence from Chryssi, where both the pounding equipment and shell debris were found inside a building (Apostolakou et al. 2016).

The extensive archaeological evidence for pre-Roman times is synthesised in Table 1.

**Table 1.** Sites with information about the production and organisation of the purple dye industry (F. Iacono and B. Marín-Aguilera). We can be sure that early traces of production in the Levantine area are underrepresented, as these will have been obliterated by later phases of production. Given space limitations, only the main or latest bibliographic references are provided here. We do not include sites where the number of shells was less than five (e.g. Tavira in Portugal, Castro Grande de Neixón in Galicia, Spain).

**Abbreviations:** Direct = direct evidence of production (e.g. structures or vessels with purple dye traces, purple-dyed textile fragments); Debris prim. = fragmented shell debris in primary production context; Debris redep. = fragmented shell debris redeposited in secondary context; BA = Bronze Age; EBA = Early Bronze Age; MBA = Middle Bronze Age; LBA = Late Bronze Age; EIA = Early Iron Age; Arch. = Archaic period; Class. = Classical period; Hell. = Hellenistic period.

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<td>Beirut</td>
<td>x</td>
<td>x</td>
<td></td>
<td>EIA–Class.</td>
<td>Peyronel 2008: 62</td>
</tr>
<tr>
<td>Sidon</td>
<td>x</td>
<td>x</td>
<td></td>
<td>EIA</td>
<td>Jensen and Jensen 1965: 5, 9, 22</td>
</tr>
<tr>
<td><strong>Libya</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Euesperides/Berenice</td>
<td>x</td>
<td></td>
<td></td>
<td>Class.–Hell.</td>
<td>Wilson et al. 2001</td>
</tr>
<tr>
<td><strong>Morocco</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mogador</td>
<td>x</td>
<td></td>
<td></td>
<td>EIA</td>
<td>Alberti 2008: 78 with refs.</td>
</tr>
<tr>
<td><strong>Spain</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cerro del Castillo</td>
<td>x</td>
<td></td>
<td></td>
<td>EIA</td>
<td>Bueno 2014</td>
</tr>
<tr>
<td>Huelva</td>
<td>x</td>
<td></td>
<td></td>
<td>EIA</td>
<td>McGovern and Michel 1984</td>
</tr>
<tr>
<td>Morro de Mezquitala</td>
<td>x</td>
<td></td>
<td></td>
<td>EIA</td>
<td>Schubart et al. 1969: 149</td>
</tr>
<tr>
<td>San Pablo</td>
<td>x</td>
<td></td>
<td></td>
<td>EIA</td>
<td>Fernández et al. 1997: 238</td>
</tr>
<tr>
<td>Teatro Cómino–Gadir</td>
<td>x</td>
<td></td>
<td></td>
<td>EIA</td>
<td>Gener et al. 2014</td>
</tr>
<tr>
<td>Toscanos</td>
<td>x</td>
<td></td>
<td></td>
<td>EIA</td>
<td>Uerpmann 1972</td>
</tr>
<tr>
<td>Cerro del Villar</td>
<td>x</td>
<td>x</td>
<td></td>
<td>Arch.</td>
<td>Aubet 1997: 200</td>
</tr>
<tr>
<td>Sa Caleta</td>
<td>x</td>
<td></td>
<td></td>
<td>Arch.</td>
<td>Alfaro and Costa 2008; Costa 2011</td>
</tr>
<tr>
<td>Bahía del Salado</td>
<td>x</td>
<td></td>
<td></td>
<td>Hell.</td>
<td>Mederos and Escrivan 2015: 362</td>
</tr>
<tr>
<td>Calle Luis Milena, San</td>
<td>x</td>
<td>x</td>
<td></td>
<td>Hell.</td>
<td>Bernal Cassola et al. 2011</td>
</tr>
<tr>
<td>Fernando–Gadir</td>
<td></td>
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</tr>
</tbody>
</table>
Preparation of Dyeing Substrate

The stage at which dyeing took place depended on the nature of the fibre and the effect desired, taking account of the design of the textile and economic considerations of dye cost and product distribution. Written sources invariably mention sheep wool as the fibre of choice and note that it was usually dyed in the fleece, which would ensure maximum colour penetration (Macheboeuf 2004: 138; see also Ramig et al. 2017).

Wool had to be washed and degreased before being subjected to dyeing, to ensure chemical bonding between the fibre and the dye colourants (Cardon 2007: 11; see also Pliny the Elder 9.62). One of the vats at Middle Minoan Pefka on Crete had conspicuous traces of lanolin, indicating that it may have been used for washing raw wool (Koh et al. 2016). Dyed fibre would subsequently have to be spun and woven into fabric.

Yarn dyeing, meanwhile, would have required prior fibre preparation and spinning, with the threads carefully wound in loose skeins in order to prevent tangling and to ensure maximum dye penetration before introducing them into the vats. The advantage of dyeing fleece or yarn is that it would make it possible to use purple only on parts of the fabric, thereby saving on the precious material. In fact, most of the extant shellfish-purple-dyed textiles contain colourants in only one of the thread systems (see below).

Piece dyeing of the entire textile requires relatively large vessels to immerse it and move it around to ensure dye penetration, which would be more difficult because of the compact overlapping threads within the cloth. There appears to be little evidence for piece dying before the Roman period.

Dyeing

Given that dye components form quickly on exposure to air and light, it is likely that the first and simplest method was direct dyeing, achieved by rubbing the fibres/yarn/fabric with the mucus from the hypobranchial gland of the mollusc (see Figure 2, above; McGovern and Michel 1990: 154).

However, much better results are obtained by vat dyeing (Cardon 2007: 562), which involves reducing the indigoid colourants to their leuco form (the soluble form of the dye), so they can bind chemically to the textile fibre and become colourfast (McGovern and Michel 1990: 154-56). For this, we have ethnographic evidence of traditional dyeing in Morocco. The process is achieved by adding wood ash lye or another source of alkali to the vat, to achieve pH 9. The vat is heated to approximately 50°C and kept under constant temperature, with light excluded, for seven to ten days. Wool is immersed in the vat for a few hours (see Figure 3), after which it is transferred into a covered container with
water for an hour, where it achieves its final colour. The quantity of shellfish required in the ancient Mediterranean depended on the amount of fibre/yarn/cloth to be dyed and the desired colour hue, but experiments show that the early estimates, which reported a miniscule 0.1 mg of dye per mollusc, were excessively small, as they were based on the amount of pure dye extract provided per mollusc (Burke 2010: 36). In fact, a significantly lower number of molluscs are needed (Koren 2005; Hopkins 2013).

Given that none of the dyeing tools or installations were specialised in the ancient Mediterranean, recognising a dye workshop is not straightforward, especially since dye extraction and dyeing need not have taken place in the same location. It is only the combination of structures, tools and residues that can provide sufficient evidence for interpreting a specific site as a purple-dye workshop.

The direct evidence for shellfish-purple dyeing is provided by containers that preserve purple traces, analytically proven to contain purple dye components. One of the earliest instances of such purple-stained vessels with crushed shells was found at the Middle Minoan site of Pefka on Crete (Apostolakou et al. 2016: 205). It has been claimed but not substantiated that two vats with purple residue were found in the so-called ‘Textile Room’ at Pyrgos Mavroraki on Cyprus, dated to the nineteenth century BC (Lentini 2009: 153–71). Purple-stained pottery fragments or vessels have also been identified at Sarepta in Lebanon, dated to the thirteenth century BC (McGovern and Michel 1984: 67–68), at Tell Keisan in Israel and Tyre in Lebanon, both dated to the ninth century BC (Karmon and Spanier 1987: 149–51) and at various later IA sites in Israel (Koren 1995). In most of these cases, dyeing appears to have been performed in relatively small containers, which in its turn suggests a small quantity of the resulting product.

Even so, because the temperature for vat dyeing does not need to exceed 50°C, it is not incon-
ceivable that wooden vats could have been used (Cardon 2007: 4). In Iberia, there is no evidence of purple-dye workshops until the third century BC, but it has been argued that, before Roman times, purple-dye installations were made of perishable materials (Alfaro and Costa 2008: 199).

The simplest heating facilities were probably hearths. Traces of burning mixed with crushed shells are usually considered as indicators of shellfish-purple production (Alberti 2008; Veropoulidou et al. 2008: 175; Apostolakou et al. 2016). Fuel sources are rarely considered in discussions of purple dyeing, although consistent access to fuel would have been fundamental in the process, given that heating would have been required at various stages (Hopkins 2013: 123). At Chrysi near Crete, the ash layer contained olive pits and almond shells, which were presumably used as fuel (Apostolakou et al. 2016: 203).

The location of dyeing workshops was likely affected by multiple factors, including the ecology of shellfish and access to water, salt and fuel, as well as to wool sources as seen, for example, at Taranto in Italy (Alfaro and Fernández 2017: 146). Furthermore, different types of production requiring the same or very similar equipment and resources were likely combined or located in close vicinity. At Pefka on Crete, there were multipurpose dyeworks (Apostolakou et al. 2016: 205 n. 34), whilst at Ugarit in Syria dye installations were connected with other sea activities in the harbour (Schaeffer 1951: 188-89); at Gadir in Spain, dyeworks and fisheries shared the same location (Bernal Cassola et al. 2011).

Product

Discussions of shellfish-purple dyeing often finish without considering the end product itself, even though extant textile remains containing brominated compounds constitute the most important evidence and irrefutable proof of shellfish-purple dyeing (see Table 2). They also provide an important geographical, chronological and technological dimension to our understanding of shellfish-purple consumption (Figure 4).

Although not numerous, extant shellfish-purple-dyed textiles provide information about the types and qualities of textiles dyed with shellfish-purple—their raw material and technical characteristics—and allow us to draw some conclusions about the stage in the textile production process during which dyeing took place (Figures 5 and 6). Most textiles are of very high quality.

Where identified, the material is sheep wool. Most of the textiles are weft-faced tabbies which have at least twice as many wefts as warp threads per unit of length. In all but one of these weft-faced tabbies, shellfish-purple colourants are present only in one system, the weft. In contrast, the only tablet-woven textile, a technique typical for Italy and central Europe but so far unattested in Greece and the Near East (Gleba 2017), has purple warp. Thus in both techniques it is the more visible thread system that was coloured: the precious dye was not wasted on the less prominent structural element. This provides irrefutable evidence that most of the textiles were dyed at either wool or skein stage, not as finished cloth, as frequently suggested; this also confirms information provided by written sources and archaeometric analyses of existing dye vats (e.g. Koh et al. 2016).

The Emergence of Shellfish-purple

Most of the early archaeological purple-dyed textiles come from high-prestige contexts (Qatna in Syria, Stamna in Greece). Indeed, the social significance and potentially high value appear to have been common attributes of purple-dyed textiles in the Near East and the Aegean at least since the Bronze Age, when they seem to be regularly connected to royalty and gods. Purple-dyed textiles were widely used to pay tribute to both royal courts and temples, according to administrative records in the Near East (Soriga 2017: 90-91). Ugarit, for instance, sent an annual tribute to the Hittites that included blue-purple wool and 500 shekels
Table 2. Sites with purple-dyed textile remains (M. Gleba).

<table>
<thead>
<tr>
<th>Site</th>
<th>Context</th>
<th>Chronology</th>
<th>Textile type(s)</th>
<th>Material</th>
<th>Purple element</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Greece</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Stamna</td>
<td>Burials in bronze cauldrons</td>
<td>ca. 1200–1000 BC</td>
<td>Weft-faced tabby</td>
<td>Wool?</td>
<td>Weft bands</td>
<td>Kolonas et al. 2017</td>
</tr>
<tr>
<td>Corfu</td>
<td>Tomb 24</td>
<td>Late 7th–early 6th cent. BC</td>
<td>Weft-faced tabby</td>
<td>Wool</td>
<td>Unknown</td>
<td>Metallinou et al. 2009</td>
</tr>
<tr>
<td>Kalyvia, Attica</td>
<td>Burial</td>
<td>5th cent. BC</td>
<td>Weft-faced tabby with purple stripe</td>
<td>Wool</td>
<td>Weft of stripe</td>
<td>Spantidaki 2016: 110 cat. nos. 6, 121</td>
</tr>
<tr>
<td>Kerameikos, Athens</td>
<td>Burial</td>
<td>5th cent. BC</td>
<td>Weft-faced tabby</td>
<td>Wool</td>
<td>weft</td>
<td>Margariti et al. 2013; Spantidaki 2016: 112 cat. no. 12, 128-29</td>
</tr>
<tr>
<td>Maroussi, Attica</td>
<td>Burial</td>
<td>5th cent. BC</td>
<td>Weft-faced tabby</td>
<td>Wool</td>
<td>Warp and weft</td>
<td>Spantidaki 2016: 113 cat. nos. 18, 135</td>
</tr>
<tr>
<td>Aigai (Vergina)</td>
<td>Burials of Philip II and young woman</td>
<td>4th cent. BC</td>
<td>Tapestry</td>
<td>Wool?</td>
<td>Unknown</td>
<td>Andronikos 1984: 164, fig. 140; Cardon 2007: 573</td>
</tr>
<tr>
<td><strong>Italy</strong></td>
<td></td>
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<tr>
<td>Cumae</td>
<td>Burial, Fondo Artiaco 104, attached to bronze cauldron</td>
<td>ca. 730 BC</td>
<td>Weft-faced tabby</td>
<td>Wool</td>
<td>Weft</td>
<td>Gleba and Vanden Berghe 2018</td>
</tr>
<tr>
<td>Tarquinia, Doganaccia</td>
<td>Burial, Tomba dell’aryballos sospeso, inside bronze pyxis</td>
<td>ca. 600 BC</td>
<td>Tablet weave</td>
<td>Wool</td>
<td>Warp</td>
<td>Gleba et al. 2017b</td>
</tr>
<tr>
<td>Strozzacapponi, Perugia</td>
<td>Burials</td>
<td>2nd cent. BC</td>
<td>Weft-faced tabbies</td>
<td>Unknown</td>
<td>Weft, discontinuous</td>
<td>Gleba et al. 2017a</td>
</tr>
<tr>
<td><strong>Spain</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gadir</td>
<td>Burial, monumental tomb, mixed with plaster and gold threads</td>
<td>6th cent. BC</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Domínguez-Bella et al. 2011</td>
</tr>
<tr>
<td><strong>Syria</strong></td>
<td></td>
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<tr>
<td>Chagar Bazar</td>
<td>Burials 110, 118</td>
<td>18th–16th cent. BC</td>
<td>Looping or knotless netting</td>
<td>Wool</td>
<td>Decorative element?</td>
<td>Breniquet et al. 2018</td>
</tr>
<tr>
<td>Qatna (Tell Mishrife)</td>
<td>Royal Burial, floor of the burial</td>
<td>Bronze Age, <em>terminus ante quem</em> 1340 BC</td>
<td>Tabby</td>
<td>Wool</td>
<td>Unknown</td>
<td>James et al. 2009; Reifarth and Drewello 2011</td>
</tr>
</tbody>
</table>

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Figure 4. Distribution of extant pre-Roman purple-dyed textiles (F. Iacono).
of red-purple wool (Singer 2008: 29). A later inscription of Shalmaneser III states that Tyre and Sidon sent blue and red woolen textiles to the Assyrian king (Soriga 2017: 80).

In the Aegean world, Burke (2010) suggests, purple-dyed textiles contributed to the development of the Minoan economy and long-distance trade. Purple-dyed textiles are mentioned in the Linear B archives of Knossos, suggesting the palace’s interest in these goods. Whether this translated into an active control of their production (and/or consumption) is unclear, although the association of the term po-pu-re-ja (Linear B equivalent of purple) with wa-na-ka-te-ro (‘palace, house of the king’) in the tablet KN X 976 clearly suggests that at least some subset of purple textile production was considered to be ‘royal’ (Burke 2010; Del Freo et al. 2010).

With the Late Bronze Age collapse of the palatial systems in the Near East and the Aegean, however, the social and political value of purple-dyed textiles arguably changed. Indeed, as Bronze Age notions of royalty and authority were changing, so too were the symbols related to them. Western influences in eastern societies of post-collapse Bronze Age also entailed the appropriation of new ideas about clothing, embodied in the wide distribution of objects such as fibulae (Sherratt 2000; Iacono 2013). These ideas, arguably, blended with pre-existing
Figure 6. Shellfish-purple-dyed textiles: (a-b) Cumae, Italy, eighth century BC; (c-d) Tarquinia, Italy, sixth century BC; (e-f) Strozzacapponi, Italy, second century BC (M. Gleba).
palatial textile traditions, creating a new taste. Such transformations almost certainly would have repercussions in the will to continue to use the highly valued purple-dyed textiles, which, as we have seen, were a long-lasting symbol of ‘palatial elites’. The fact that purple-dye production possibly continued into the first millennium BC at Lefkandi in Greece, where ‘westernising’ features are attested, may be indicative of some continuity, but with the adaptation of purple dyeing (and related textiles) to new tastes (Reese 2006; Morgan 2014). Indirect evidence of wool dyeing is also provided by Homer’s description of Helen of Troy, who is depicted as wielding a golden distaff decorated with violet wool (Odyssey 4.133-36).

In the central Mediterranean, early evidence for purple production is concentrated in Apulia (Italy), with the site of Coppa Nevigata presenting evidence for shellfish processing from the nineteenth and eighteenth centuries BC onwards (Cazzella et al. 2005; Minniti 2005). It has been suggested (Cazzella et al. 2005) that purple technology at Coppa Nevigata was connected to external demand from the Aegean world, but it is more likely that the principal sphere of circulation and consumption of purple-dyed textiles was local. Coppa Nevigata had declined by the thirteenth to twelfth century BC, and purple production re-emerged again in the area only after the foundation of the Greek settlement of Tarentum in the late eighth century BC, suggesting that rather than presenting technological continuity, the area had favourable ecological and economic conditions for purple exploitation. Over the course of the first millennium BC, the evidence for shellfish-purple production increases across the central Mediterranean (see Table 1). The number and distribution of sites with evidence of purple production increased and expanded westward during the Bronze Age and IA (Figures 7 and 8), with the western Mediterranean and the north and northwest coast of Africa developing purple-dye production only during the latter period, in close connection with the arrival of the Phoenicians (see Table 1). Crushed purple-shell debris has been found on Phoenician and Punic sites in these regions, and its quantity increased in number from the sixth century BC onwards, as at Carthago Nova in Murcia, Spain (Carrasco 2004) and on the Balearic island of Ibiza (Costa 2011). However, there are fewer purple-producing sites in the central and western Mediterranean than in the east, and while in the eastern regions there is both direct evidence (stained vessels, vats, hearths, workshops) and indirect evidence (debris) of purple production, the archaeological record in the centre and west points only to indirect evidence, with the exception of Motya (off the west coast of Sicily), Cerro del Villar and Gadir (respectively, in southeast and southwest Iberia)—elsewhere, there is no evidence of burning mixed with crushed shells.

This may reflect the point made above that purple dye installations were made of perishable materials and thus did not survive. The absence of workshops in these areas could also be related to the fact that many ancient sites cannot be (fully) excavated because they are covered by modern habitations. It could also indicate small-scale production (Veropoulidou et al. 2008). Another possibility might be that dyers in these regions used direct rather than vat dyeing. This would mean that the number of dyed textiles and thus the scale of production were potentially more limited than in the eastern Mediterranean during the same period.

The Social Value of Purple-dyed Textiles

Globalisation of Shellfish-purple

Over the course of the first millennium BC, purple technology appears to spread more widely across the Mediterranean. The seventh century BC, generally coinciding with the so-called Orientalising period, has been key in linking the eastern Mediterranean with the central and western regions (Burkert 1992; Celestino and Jiménez 2005; Riva 2010), in particular
Figure 7. Distribution of purple-producing sites in the Mediterranean basin during the third and second millennia BC (F. Iacono).
Figure 8. Distribution of purple-producing sites in the Mediterranean basin during the first millennium bc, before the Roman expansion (E. Iacono).
through the establishment of Phoenician and Greek settlements (Aubet 2001; Hurst and Owen 2005; Tsetskhladze 2006). The renewed connectedness of this period, framed as a globalisation process (Hodos 2017: 4), was characterised by the development of shared practices across the Mediterranean and by an increasing awareness of cultural differences.

Like other elements of the Mediterranean package such as oil and probably wine (Riva 2010), after an initial period of parallel multi-regional ‘incubation’, shellfish-based dye technology gradually spread throughout the Middle Sea. Phoenicians and Greeks were crucial in promoting the spread of common ideologies and consumption practices among distant elites in the Near East, Greece, Italy, northwest Africa and Iberia (Celestino and Jiménez 2005; Feldman 2014). In these shared practices, the consumption of purple-dyed textiles likely played a key role in elite discourses and self-legitimation. The intense colour of these textiles was also of importance for the development of a community of shared style among Mediterranean elites (sensu Feldman 2014), insofar as it was associated in the east with royalty and priesthood (Jensen and Jensen 1965). Especially important was the fact that shellfish-dyed textiles were colourfast, i.e. their colour could remain bright for centuries after manufacture. These associations, together with the time-consuming production process, made these textiles particularly desired across the Mediterranean and into a status symbol indicating the elevation of certain social groups over others.

However, in the globalised world of the late first millennium BC Mediterranean, production and consumption did not necessarily coincide. Thus, Iberia initially appropriated the chromatic grammar of the purple dye only from a consumption perspective. Shells of all three mollusc species used for the production of purple dye have been identified on various Iberian sites, but appear to have been used only for alimentary purposes (Pascual 2014). There is only one indigenous site, San Pablo, located 6 km from the Phoenician colony of Cerro del Villar, that has provided evidence of shell debris (Fernández et al. 1997). Otherwise, no evidence for the production of shellfish-purple dye has been recovered from indigenous sites in pre-Roman Iberia. This indicates that indigenous communities in Iberia, the Balearics, the Canary Islands and North Africa were likely consuming but not producing purple-dyed textiles before Roman times. It also points to an exclusive Phoenician and Punic control of production and trade of shellfish-purple-dyed textiles within local communities in these territories.

Democratisation of Shellfish-purple

By the third century BC, there was an expansion of purple dye workshops and a significant increase in the number and size of crushed shell heaps across the Mediterranean basin, the Atlantic coast of North Africa and the Canary Islands. The production and consumption of shellfish-dyed textiles became democratised in the sense of reaching across the social spectrum, despite simultaneously and paradoxically reinforcing social differentiation. For the first time in history, purple-dyed textiles became easily available not only to royalty, aristocracy and the high priesthood, but also to other social strata. Undoubtedly, fully purple-dyed textiles would have been extremely expensive, but small quantities of fine purple yarn could go a long way to satisfy what Pliny the Elder (9.60) later called the ‘purple mania’. Indeed, the latest in our list of extant shellfish-purple-dyed textiles from Strozzacapponi, in central Italy, derives from a quarry workers’ cemetery (Gleba et al. 2017a).

The very fact that Pliny (9.64) distinguished between low- and high-quality purple textiles is indicative of the existence of a spectrum of differentiated products. Their value depended on the colour and its saturation, which in turn depended on the fashion of the moment (e.g. Marzano 2013: 148; Meiers 2017). Because of the high value of shellfish-purple, it did not take
long before it began to be imitated using other dye sources, for example the combination of red dye from the roots of the Rubiaceae family and blue dye derived from the woad plant, *Isatis tinctoria* (Wouters et al. 2008), or by using lichens such as *Roccella tinctoria* (Mederos and Escribano 2015: 349-54). Given the popularity of the colour purple and the variety of shades available, it was not always easy to distinguish between real shellfish-purple and counterfeit products.

Thus at Strozzacapponi we have a paradoxical situation, where one of the richest tombs contained a textile dyed with non-shellfish purple, while the finest shellfish-purple-dyed cloth was found in a humble coarse-ware ossuary (Gleba et al. 2017a). To what extent the consumers could (or cared to) distinguish between 'true' and 'fake' purple is a different matter.

**Concluding Remarks**

Discussions of purple dyeing in the ancient Mediterranean have permeated academic books, articles and debates for over a century, to a degree that perhaps exaggerates the scale of mollusc dye production. Much of Bronze Age and IA production seems to have been small in scale, with outputs limited in size and quantity. This is suggested by the small size of many of the vessels and vats used for production, as well as the small scale of the facilities themselves. Apart from a very few exceptions, there is no increase in scale until Roman times, when workshops grow immensely in size, resulting in a greater production output and accessibility of the product.

The local and regional context is crucial to the understanding of production, consumption and significance of purple-dyed textiles. Used mainly by the palace and temple elites in the Near East and Aegean during the Bronze Age, purple-dyed textiles became more widespread during the IA. In Italy, their production appears to have been limited to Apulia during the Bronze Age and expanded more widely only during the first millennium BC, whereas in the western Mediterranean and along the Atlantic coast of Morocco, it only began in the IA, associated with the establishment of permanent Phoenician/Punic settlements. The increase and spread of workshops and production areas across the Mediterranean was decisive for the circulation and adoption of purple-dyed textiles among Mediterranean elites, and was closely connected with the appropriation of a series of practices and objects originally from the Near East. If in the seventh and sixth centuries BC purple-dyed textiles served as a social and political legitimation tool for Mediterranean elites, by the second century BC wider segments of the population had appropriated them to access new social ladders, e.g. those connected to the new social organisation of large Hellenistic kingdoms and related emerging urban markets (whose analysis goes beyond the scope of this paper). The purple-dyed cloth found in the humble clay ossuary at Strozzacapponi mentioned above blurred social boundaries, as the deceased and their family apparently tried to display greater social and economic status than was actually the case. An elite tomb in the same cemetery, by contrast, opens an interesting discussion on the dyers' advanced skill in imitating purple-dyed textiles using vegetal dyes (Gleba et al. 2017a). Was this a case of deliberate fraud? Did it even matter that the dye was not derived from the precious shellfish as long as everyone else thought it was?

Over time, the consumption of purple-dyed textiles mutated, starting out as the privilege of kings, trickling down to increasingly wider social groups and finally becoming democratized by the end of the first millennium BC, only to become a monopoly of Roman and Byzantine rulers before the technology was lost.

The comparison of different Mediterranean regions, the study of the full chaîne opératoire of purple-dyed textiles, and the examination of the local context has enabled us to gain a better, albeit more complex, understanding of the production, consumption and significance of these textiles in pre-Roman times. Future
chemical analysis of purple-dyed textiles will no doubt expand the corpus of evidence regarding their technological and consumption patterns. More detailed work on shell fragmentation, archaeobotanical remains and geomorphology should allow a much deeper interpretation of production sites. It is also our hope that classical scholarship dealing with purple dye will explore more peripheral yet fundamental aspects of purple production and consumption, as has been done recently with regard to fishing rights in ancient Greece (Alfaro and Fernández 2017). As the field of purple studies accumulates an ever-greater mass of evidence, it is time we start using it to explore broader questions.

Notes

1. BMA collected data on purple-dye production in Cyprus, the Near East, North Africa, Portugal and Spain; FI collected data in Greece, Italy and Turkey and produced the maps; MG collected data on the chaîne opératoire and textile analyses. All authors contributed to the writing and organisation of the paper.

2. It is impossible to provide a complete list of references on shellfish-purple in the space allotted; we therefore limit ourselves to the most recent or seminal publications, which can be consulted for additional references. For an extensive and up-to-date bibliography, see http://www.chriscooksey.demon.co.uk/tyrian/cjcbiblio.html.

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