Agata Ulanowska
Institute of Archaeology, University of Warsaw
a.ulanowska@uw.edu.pl
https://orcid.org/0000-0002-4946-2711

Innovative or Traditional? Diachronic Approach to Weaving Technology in Bronze Age Greece

Abstract

This paper aims at recognising potential innovations in weaving technology that may have occurred in Bronze Age Greece. It discusses whether these assumed developments may be examined diachronically. This discussion is based on archaeological evidence of textile implements, such as loom weights and presumed traces of warp-weighted looms, as well as knowledge of traditional craft and experimental archaeology. After a short introduction discussing how technical innovations could possibly be recognised in weaving, the paper explores possible changes in the construction and functionality of the warp-weighted loom and potential uses of other types of looms in Greece. A distribution pattern of specific forms of a loom weight, *e.g.* discoid loom weights in particular, is examined as an innovation responding to the demand for fabrics of specific technical qualities and appearance, possibly associated with a spread of new weaving techniques which accompanied the transmission of these tools. Social relations and modes of organisation of textile production are considered factors that must have had a significant impact on creativity and innovativeness in weaving technology. However, the final conclusion is that specific relations between the organisation of weaving and the occurrence of innovative processes cannot be clearly recognised based on the available evidence.

Streszczenie

Innowacyjna czy tradycyjna? Technologia tkacka w epoce brązu w Grecji w ujęciu diachronicznym

Celem artykułu jest próba rozpoznania innowacji, jakie zajść mogły w technologii tkackiej w epoce brązu w Grecji, oraz prześledzenie potencjalnych zmian w tradycjach tkackich w szerszej perspektywie czasu i przestrzeni. Podstawę dla dyskusji stanowią pozostałości archeologiczne, takie jak ciężarki tkackie i ślady po krosnach, analizowane w odniesieniu do rzemiosła tradycyjnego oraz archeologii eksperymentalnej. Po krótkim wprowadzeniu określającym czym mogły być innowacje w tkactwie, analizowana jest budowa i funkcjonalność krosna ciężarkowego, jego ewentualne zmiany w czasie oraz inne typy krosien, które być może były znane w Grecji. Geograficzne rozmieszczenie określonych typów ciężarków tkackich, jak np. dyskoidalnych, omawiane jest jako innowacja odpowiadająca zapotrzebowaniu na tkaniny o specyficznej strukturze i wyglądzie, odzwierciedlająca, być może, rozpowszechnienie się określonych technik tkackich. Stosunki społeczne i tryby produkcji rozważane są jako czynniki o istotnym znaczeniu dla kształtowania innowacyjności i kreatywności, z końcowym wnioskiem jednakże, że bezpośrednie relacje pomiędzy trybem produkcji a innowacyjnością, przy obecnym stanie badań nad włókiennictwem w Grecji epoki brązu, nie mogą być czytelnie rozpoznane.

Keywords: Bronze Age Greece, textile technology, weaving, warp-weighted loom, loom weights, innovation, tradition

To the memory of Jo Cutler

Introduction

Weaving in Bronze Age Greece has been acknowledged as an advanced technology that enabled production of substantial quantities of highly valued, fine quality textiles – goods of key importance to local economies (*cf.* Barber 1991; Tzachili 1997; Burke 2010; Shaw, Chapin 2016).[1] However, diachronic developments of weaving techniques are not easy to recognise or track through the archaeological evidence, neither are the potential innovations that may have enhanced growth in production and improvements in the quality of fabrics. Several elements in the archaeological evidence suggest that weaving was a rather traditional and, technically, unchanging craft, whereas others point out to innovativeness and dynamics of weaving (*cf.* Nosch 2015). All this makes the general picture of developments in weaving technology in Bronze Age Greece rather ambiguous.

The traditional and conservative character of weaving technology may be suggested, *e.g.*, by the continuous use of the warp-weighted loom. This type of loom, attested archaeologically by the presence of loom weights, had already been in use in Greece since the Neolithic and continued well after the end of the Bronze Age[2] (*cf.* Hoffmann 1964; Barber 1991; Andersson Strand, Nosch 2015a; Siennicka *et al.* 2018). Also, the parameters of archaeological textiles from Greece (*e.g.* choice of fibres, structure of yarns, and density of fabrics, that is a number of warp and weft threads per cm) seem to be rather homogenous throughout the entire Bronze Age (Spantidaki, Moulherat 2012: 187–194; *cf.* Skals *et al.* 2015 for an overview of archaeological textiles in the Neolithic and Bronze Age Mediterranean). Significant improvements in the quality of textiles and threads (increased density of fabrics, finer yarns, and different structure of yarns) and an increased number of woollen fabrics have only been observed at the transition from the Bronze to Iron Age, *e.g.* in the assemblage of textiles from the necropolis of Lefkandi (Spantidaki, Moulherat 2012: 194, 197, Tabs 7.2, 7.3). Yet, the actual textiles are rarely preserved in Greece and, due to the limited number, their technical parameters and structure cannot be seen as fully representative of the wide variety of fabrics that must have been produced in the Bronze Age. Moreover, with the notable exception of Akrotiri on Thera, the majority of preserved fabrics come from the funeral contexts where the preserved textiles were used to wrap mouths of clay jars or bronze objects (*cf.* Moulhérat, Spantidaki 2007; Spantidaki, Moulherat 2012).

Significant changes or developments may be observed in the exploitation of raw materials and in the growth of wool economy (Breniquet, Michel 2014; Nosch 2015), in the distribution pattern of loom weights and introduction of new loom weight forms, the organisation and scale of production, as well as the social relations of production and the mechanisms of transmission of knowledge and skills (*cf.* Burke 2010; Cutler 2012; 2016a; Andersson Strand, Nosch 2015a; Gorogianni *et al.* 2015; Ulanowska, Siennicka forthcoming).

Moreover, the iconography of textiles, especially those depicted in wall paintings, shows a variety of patterned fabrics, confirming the existence of textiles that were more sophisticated products than those that had actually been preserved (Jones 2015; Shaw, Chapin 2016; *cf.* Moulhérat, Spantidaki 2007; Spantidaki, Moulherat 2012: 187–188). Linear B tablets enumerate a variety of textile types and several professional designations of textile workers, which implies complex specialisation of the textile production that was controlled by the Mycenaean palaces (Killien 2007; Bruke 2010; Del Freo *et al.* 2010). All this suggests that textile production was actually dynamic and diversified, and innovations resulting in transmission of new skills and new weaving techniques occurred extensively during the Bronze Age.

Certainly, this paper does not attempt to explain all the ambiguities that have been briefly outlined above. It aims at examining what kind of potential technical developments in weaving may actually be recognised on the basis of the available archaeological evidence and experimental archaeology. It also discusses whether the assumed innovations may be traced diachronically and placed within a specific timescale, and, possibly, be related to a certain mode of organisation of textile production.

[1] This paper was based on the research carried out by the author during the internship grant at the Centre for Research on Ancient Technologies of the Institute of Archaeology and Ethnology, Polish Academy of Sciences, awarded by The National Science Centre in Poland (DEC-2015/16/S/HS3/00085). I would like to express my thanks to the anonymous reviewer for their helpful comments and suggestions. I also thank Paul Barford for improving my English.

[2] The Bronze Age in Greece is divided into three main chronological phases, *i.e.* Early Bronze Age (EBA): 3100 – 2200/2050 BCE, Middle Bronze Age (MBA): 2200/2050 – 1700/1675 BCE and Late Bronze Age (LBA): 1700/1675 – 1075/1050 BCE (Manning 2010: Tab. 1).

What are we looking for? About recognising potential inventions and innovations in weaving technology

In archaeology, an 'invention' may be defined as an event that creates a new concept in technology "that makes a new construction or system possible" (Kristiansen 2005: 113) and is substantially different from the technologies already existing. By adding a new solution, built upon the already existing structures or components, the invention introduces new social and economic practices (*cf.* Kristiansen 2005: 113–116; Hollenback, Schiffer 2010: 332; Burmeister, Bernbeck 2017). On the other hand, 'innovation' is a process that adds new methods, ideas, or practices to the existing technology and, by creating new varieties, leads to improvements, *e.g.* refining routines or increasing efficiency, and technological differentiation. As a result of innovations, technology is gradually modified and diversified (Kristiansen 2005: 113; Hollenback, Schiffer 2010: 332; see Jeffra 2011: 17–26; Bender Jørgensen *et al.* 2018 for a general discussion on the concept of innovation and creativity).

According to these definitions, all societies are, in general, more innovative than inventive, yet, according to K. Kristiansen, "the number of inventions increases with the development of complex societies and states which have not only new needs but also potential to fulfil them" (2005: 113, for a quotation see: 114). Both inventions and innovations require new skills and motor habits that have to be embodied and then transmitted. Both may change the perception of the environment and the manner in which the environment is manipulated and exploited (*cf.* Cutler 2016a: 174–175; Burmeister 2017: 31).

In weaving technology, the greatest invention may possibly be recognised in the creation of a loom – the first machine that, by a mechanism for shed changing, made weaving automatic (for a loom as "one of the first machines in human history" see Grömer 2016: 93; for an overview of "advanced textile techniques", including weaving, *cf.* Desrosiers 2010: 27, 39–45, Fig. 3.4). The date of this major invention has generally been placed in the Neolithic period and related to the creation of small implements for weaving narrow fabrics that preceded bigger looms (Broudy 1979: 9–11, 14–20; Barber 1991: 79–83, 254). The creation of the big looms, such as a horizontal ground loom and a warp-weighted loom, being dated to between the 7th and 6th millennia BCE (*cf.* Andersson Strand 2018; Siennicka *et al.* 2018 for the recent overview of the evidence), would thus be an important innovation that facilitated weaving of large pieces of fabric.

Other possible innovations may be sought in technical improvements of the existing looms (*e.g.* adding more heddles to the warp-weighted loom), introduction of new types of looms (*e.g.* a two-beam vertical loom), and introduction of new weaves, such as twills (*cf.* Nosch 2015). The knowledge of twill weaves and use of multiple heddle bars (or heddles) have already been attested in Bronze Age Central Europe and are considered a major technical innovation of this age (Bender Jørgensen, Rast-Eicher 2016: 80–86), whereas the two-beam loom, a new type of loom in the Egyptian weaving tradition, was in use in Egypt since *c.* the 15th century BCE (Broudy 1979: 44–46; Barber 1991: 113). An introduction of new types of loom weights may also be seen as a technical innovation responding to the demand for fabrics of a specific structure and appearance (*cf.* Andersson Strand, Nosch 2015a). Whether and when these important innovations may have occurred in Bronze Age Greece is discussed in the following sections.

According to Anne Brysbaert, "As such, creativity can sit in the organizing processes, resulting in the connecting efforts between tool, material and actors" (2017: 21). Therefore, substantial changes in the social relations of production and development of new modes of production that result in the increase of production or enhanced efficiency may also be seen as developments, even if they were not accompanied by any specific innovations in technology.

Construction of the warp-weighted loom in Bronze Age Greece

The general construction of the warp-weighted loom and the mechanics of its use in weaving have been recognised on the basis of evidence from observation of its traditional craft use, historical and iconographic records, and experimental archaeology (*cf.* Hoffmann 1964; Broudy 1979; Barber 1991; Tzachili 1997; Andersson Strand, Nosch 2015a). The construction of the warp-weighted loom that was specific for a certain period and area may be reconstructed based on *in situ* remains of the warp-weighted loom, such as loom weights or traces of loom uprights, and relevant iconography.

Archaeological evidence suggesting the general construction and size of the warp-weighted loom

In archaeological contexts from Bronze Age Greece, *in situ* discoveries of the warp-weighted looms have been rare. They are attested by the rows or concentrations of loom weights (*cf.* Kastanas: Aslanis 1985: 49–51, Abb. 23–24; Mauel 2009; 2012; Tiryns: Siennicka 2012: 67; forthcoming; Chania: Brunn-Lundgren *et al.* 2015: 199–200; Sitagroi: Elster *et al.* 2015: 305) and postholes or remains of wooden parts of the loom (for possible traces of decomposed or carbonised wood from looms, *cf.* Carington Smith 1975: 303–304; Myrtos: Warren 1972: 53; Barber 1991: 102; Lerna: Wiencke 2000:

Fig. 1. Two types of warp-weighted looms of modern construction: a) the Scandinavian type used in the Institute of Archaeology, University of Warsaw (photo by the author), b) the free standing type used in the Biskupin Archaeological Museum (photo by Łukasz Gackowski).

140–142, Plan 26; Aghia Triada: Militello 2012: 205; Chania: Brunn-Lundgren *et al.* 2015: 199–200).

Since loom weights are often found scattered, it has been assumed that textile production may have been located on the upper floors of houses and workshops, especially in Crete and at Akrotiri, where good lighting could be provided by windows (*cf.* Carington Smith 1975: 302–303; Tzachili 1990; Sakellarakis, Sapouna-Sakellaraki 1991: 89; 1997: 225, 320; Gorogianni *et al.* 2015: 900–902; Militello *et al.* 2015b: 223; Poursat *et al.* 2015; Cutler 2016b; Hitchcock 2016). Sometimes, the looms were placed in rooms with an oven or hearth, *e.g.* in Room M, House I at Kastelli, Chania (Brunn-Lundgren *et al.* 2015: 198). Finally, larger concentrations of loom weights were often found in a storage facility, *e.g.* gathered together in – unpreserved now – baskets, cupboards, or shelves (*cf.* Burke 2010: 53, 56–58; Brunn-Lundgren *et al.* 2015: 200–201; Militello *et al.* 2015a: 209; 2015b: 223; Papadopoulou *et al.* 2015: 294; Poursat *et al.* 2015). Therefore, the exact position of the warp-weighted loom(s), as well as potential spatial arrangement of a workspace or traces suggesting a specific construction of the loom, have only been recognised occasionally.

The evidence suggests that two types of warp-weighted loom may have existed. The first type, such as the loom in Room 143 in Early Bronze Age Tiryns, was placed close to a wall (Siennicka 2012: 67; forthcoming) or pillars (Mauel 2009: Abb. 59; 2012: Pl. XXXVIb), and this was possibly similar to the Scandinavian warp-weighted loom that was supported by its upper part leaning against a wall. The second type, of a possibly freestanding construction, was placed in an open space (Militello 2012: 205; Brunn-Lundgren *et al.* 2015: 200) (Fig. 1). In *Casa delle Sfere Fittili* at Aghia Triada on Crete, four of the postholes in Room 9 were interpreted as possible remains of a warping frame that may have been placed in the vicinity of the warp-weighted loom (Militello 2012: 206–207).

The width of the warp-weighted loom, calculated on the basis of the width of the concentration of loom weights or distance between two postholes, could range between 89.5–100 cm (Chania, Brunn-Lundgren *et al.* 2015: 200) and 110 cm (*Casa delle Sfere Fittili*, Aghia Triada, Militello 2012: 206).

Heddle bar(s) and the number of rows of loom weights

The general construction of the warp-weighted loom allows the separation of the warp threads into two layers tensioned by two rows of loom weights accordingly. The front layer hangs over a shed bar, whereas the back layer hangs freely. This creates a natural shed. By means of the heddles knitted to a heddle bar, the warp threads from the back layer are moved back and forth (Fig. 2). This way an artificial or a counter-shed is created and weaving is made

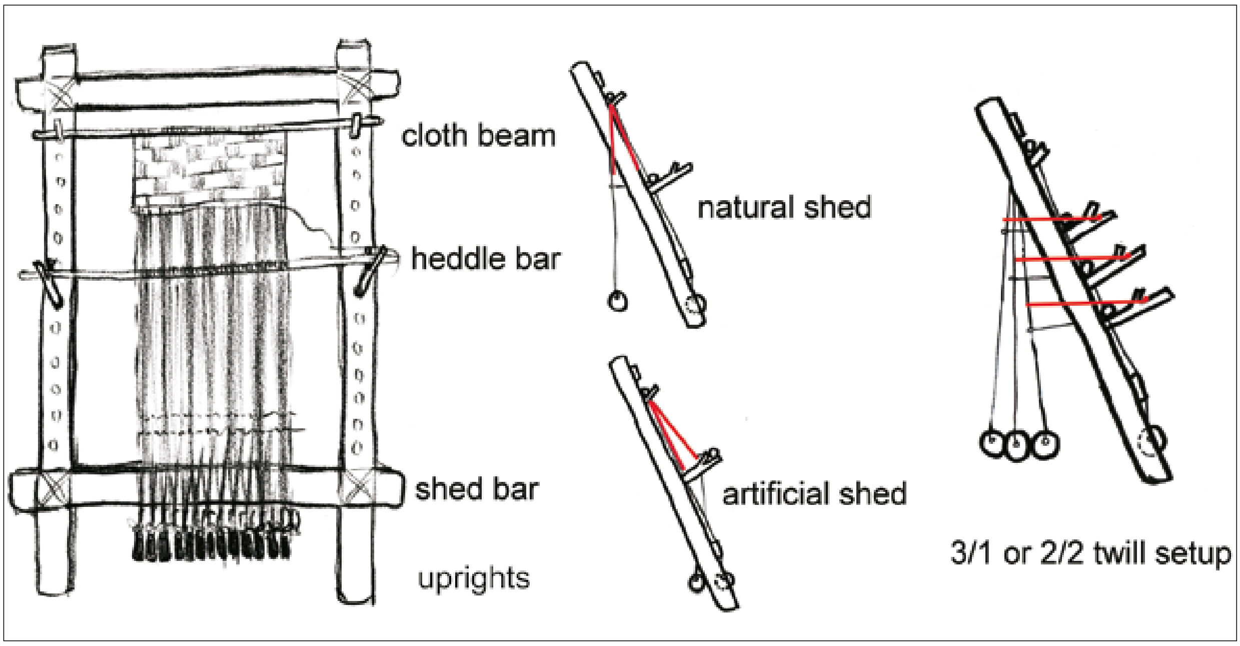

Fig. 2. The basic mechanics of the warp-weighted loom: construction of the loom, natural and artificial shed, setup for 3/1 or 2/2 twill weaves.

fully automatic. In more complex weaves, such as twills, the warp threads are divided into three or four layers and the heddle bar is multiplied to two or three accordingly.

Schematic depictions of the warp-weighted loom and bars with loom weights have been recognised in the imagery of the Middle Bronze Age seals from Crete (*cf.* Burke 1997: 418–419; 2010: 45–47; Ulanowska 2016; 2017) and in a graphic form of the Linear A sign 54 (Barber 1991: 91; Militello 2007: 41; Burke 2010: 48–49; Del Freo *et al.* 2010: 351–353, Fig. 17.11; Nosch 2012: 304–305, Fig. 1; Petrakis 2012: 78–79, Pl. CXXVI 1) (Fig. 3). Although details explaining the mechanics of the loom are generally absent in these simplified depictions, the presence of a bar or two bars above the loom weights motif on the Middle Bronze Age Minoan prismatic seals has been interpreted by the author as a possible indication of a heddle bar (Ulanowska 2017: 61–62). Also, a sporadic duplication of the loom weights motif on a seal face may be seen as a schematic reference to two rows of loom weights and a set-up for a tabby weave (Ulanowska 2017: 62–63).

The spatial distribution of the loom weights found *in situ* may also indicate whether the loom weights had been set-up in two rows for a tabby or for twill weaves when three or four rows of the loom weights are expected (for the *in situ* discoveries of the loom weights set-up for twill weaves, *cf.* Lassen 2013: 84; 2015: 127; Bender Jørgensen, Rast-Eicher 2016: 86–97; *cf.* Firth 2015: 181–184). However, no spatial distribution of loom weights that may clearly be connected with the set-up for twill has been compiled so far for Bronze Age Greece.

Functionality of the warp-weighted loom

The warp-weighted loom may be used to weave fabrics of various structures (*e.g.* tabby weave and, especially, twill weaves or possibly tapestry) of different parameters (from coarse to fine) and sizes (*cf.* Hoffmann 1964; Carington Smith 1975; Barber 1991; Tzachili 1997; Andersson Strand, Nosch 2015a; Andersson Strand 2018). In my own, still unpublished, experiments, I have used the warp-weighted loom to weave also gauze weaves and patterned textiles in tabby with supplemental weft. These possibly multifunctional uses may explain the wide dispersal of the warp-weighted loom in Europe and the Mediterranean. However, unless archaeological textiles are also preserved, it is difficult to reconstruct specific weaving technique(s) related to this implement.

The width of a fabric woven on the warp-weighted loom is related to its construction and the width of the cloth beam. In the case of the looms from Chania and *Casa delle Sfere Fittili* at Aghia Triada, it may be suggested that fabrics of more than 60 cm wide could have been woven. The length of a fabric depends on the length of the warp threads. Thus, it may exceed the height of the loom if the long warp threads are stored above the loom weights, *e.g.* by a chain stitch, and unravelled successively while weaving. However, there are no data that may suggest the length of fabrics woven in Bronze Age Greece.

Regardless of the technique, weaving on the warp-weighted loom has to be performed while standing and a textile is made from the top of the loom downwards (Figs 1, 2).

New types of loom weight as technical innovations

Complex and comprehensive analyses of the function of loom weights have been undertaken within the research programme 'Tools, Textiles, Texts and Contexts', carried out by the Centre for Textile Research in Copenhagen between 2005–2010 (Andersson Strand, Nosch 2015a). These studies were based on data comprising 3896 loom weights from Bronze Age Aegean and Eastern Mediterranean, together with the results of archaeological experiments, as well as the contextual analyses of tools (Andersson Strand, Nosch 2015c: 149, Fig. 5.1.7; Andersson Strand, Nosch 2015a). This research has demonstrated that functionally three main categories of loom weights should be distinguished: spherical, pyramidal, and discoid (Andersson Strand, Nosch 2015b: 371). These three basic forms, each comprising loom weights of different types, "mark the most distinct functional features" (Andersson Strand, Nosch 2015b: 371), *i.e.* the specific relationship between the weight and thickness of a loom weight which results from its geometry and determines what kind of textile may be produced using it (Andersson Strand, Nosch 2015b: 371; *cf.* Firth 2015: 168–180; Olofsson *et al.* 2015: 87–97). According to E. Andersson Strand, the variety of types within these basic forms of a loom weight reflects cultural and personal choices rather than any specific function (Andersson Strand, Nosch 2015b: 371; *cf.* Andersson Strand forthcoming).

Thus, according to this general understanding of the functionality of loom weights, an introduction of a new functional form, *i.e.* pyramidal, spherical, or discoid, may be considered as a technical innovation. In Greece, pyramidal and spherical loom weights were already present in the Neolithic (Carington Smith 1975: 122–123, 135–138, 154–157, 186; Barber 1991: 99–100), however, the discoid loom weights were a Bronze Age innovation.

Discoid loom weights

Discoid weights were recovered first at Mytros Phournou Koriphi on Crete, in an Early Bronze Age context (EBA II) (Warren 1972). By the transition from the Middle to the Late Bronze Age (MBA III/LBA I), they had spread all over Crete, the south-central Aegean islands, and the shores of Asia Minor (*cf.* Burke 2010: 56–58; Cutler 2012; 2016a; Pavúk 2012; Gorogianni *et al.* 2015; Kremer 2017). This has been thought to indicate 'Minoanisation',[3] if not traces of a physical presence of the Minoans (Carington Smith 1975: 276; Cutler 2012; 2014; 2016a; Gorogianni 2016). Moreover, since at the majority of sites in the southern Aegean the discoid weights are the only types of loom weights recovered, their transmission has been connected with the introduction or re-introduction of the warp-weighted loom technology in this area (Cutler 2016a: 172). In the Late Bronze Age, the discoid loom weights were still in use on Crete, in the southern Mainland, and in Troy (Carington Smith 1975: 276–286; 1992: 687–691; Tzachili 1990; Evely 2000: 498; Burke 2010: 56–58; Cutler 2012; 2016a; Pavúk 2012; Kremer 2017).

The wide distribution of the discoid loom weights has been seen as a result of the transmission of specific textile techniques that originated on Crete and were accompanied by the introduction of these tools (Cutler 2012: 149; 2016a). According to J. Cutler, the 'horizontal' transmission of technical skills (and the discoid loom weights) between members of the same generation in various communities resulted from the mobility of

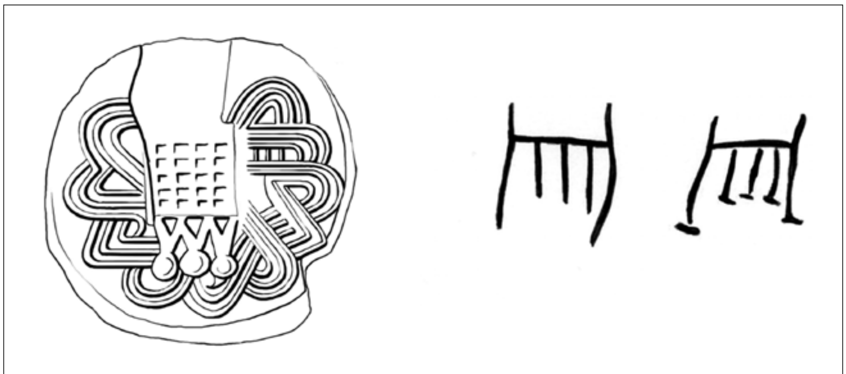

Fig. 3. Iconography of the warp-weighted loom in Minoan glyptic: face a of the cuboid seal from Aghia Triada (drawing by M. Jagodzińska after CMS II.1 64a) and Linear A sign AB 54 (drawing by the author after Del Freo *et al.* 2010: Fig. 17.11).

[3] On the processes of Minoanisation and Mycenaeanisation, *cf.* Gorogianni *et al.* 2016.

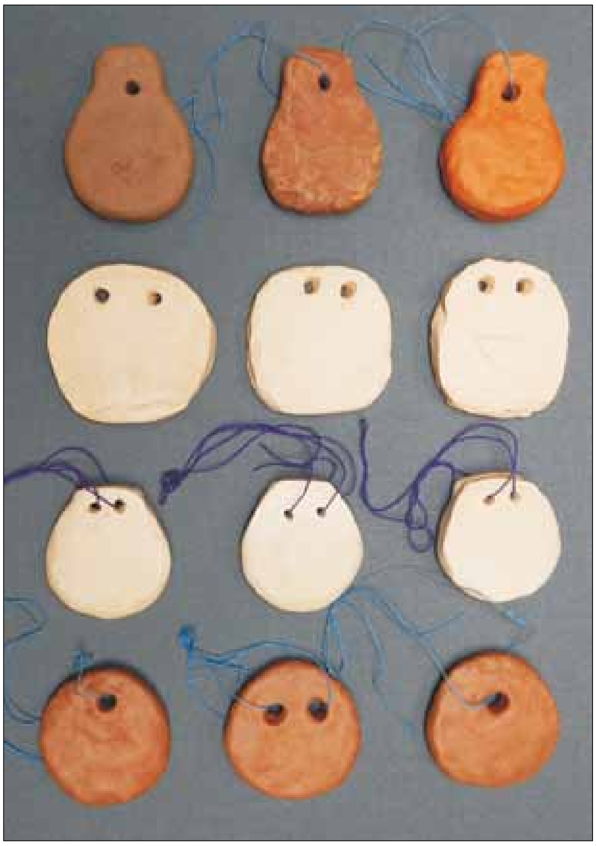

Fig. 4. Different forms of copies of discoid loom weights made by students of the Institute of Archaeology, University of Warsaw. The top row: weights modelled after a template from the Loom Weights Basement in Knossos (Burke 2010: 57, Fig. 36); the third row: weights modelled after a template from Myrtos, cat. no. 75 (Warren 1971: 243, Fig. 96); the second and fourth rows: weights modelled from rolls of clay cut into slices with a string (for the production method, *cf.* Cheval 2008) (photo by the author).

female weavers, originally from Crete and then from the southern Aegean communities that had already adopted Cretan weaving techniques. These weavers travelled around the Aegean as brides, migrants, captives, slaves, or as textile workers exchanged by the elites (Cutler 2012: 150; 2014: 139; 2016a: 175; Gorogianni *et al.* 2015).

Since the discoid loom weights were sometimes found in large concentrations, comprising hundreds of weights (*cf.* Tzachili 1990; Burke 2010: 56–58; Andersson Strand, Nosch 2015a), it may also be suggested that they were expedient tools for a larger scale textile production. Recently, the broad distribution of the discoid weights in the Mediterranean has also been connected to the transmission of the purple-dye technology from Crete (Kremer 2017: 101).

The discoid weights are flat discs featuring one to three perforations. The general category encompasses rounded, elliptical, pear-shaped ("discoid tabulated"), trapezoid, rectangular, and semi-discoid shapes (Mårtensson *et al.* 2009: Fig. 2; Andersson Strand 2015: Fig. 5.1.4) (Fig. 4). The diameter of these tools ranges between 5–11 cm, their weight between 50–350 g, and thickness between 1.5–3 cm (Carington Smith 1975: 276-277; Tzachili 1990: 383; Evely 2000: 498; Cheval 2008: 19; Burke 2010: 57; Firth 2015: 170–173, Fig. 5.2.20). The generally low weight cluster of the discoid loom weights (the majority of them weigh between 100–200 g), their small thickness (mostly ranging between 2–3 cm), as well as the small thickness/weight ratio makes them suitable for weaving low-tension, dense, possibly warp-faced fabrics, *i.e.* with more warp threads than wefts per cm (Andersson Strand 2015: 143, Figs 4.5.5, 4.5.6; Firth 2015: 170–173, Fig. 5.2.23; Ulanowska forthcoming).

It may be suggested, therefore, that the introduction of the discoid weights was related to the need for the manufacture of more dense and fine textiles (*cf.* Andersson Strand, Nosch 2015a). However, based on the functional analysis of the discoid weights and experimental archaeology, it is difficult to recognise clearly any specific weaving techniques that may have been used to make these fine fabrics, *e.g.* tabby, twill weaves, or tapestry (Andersson Strand 2015; Firth 2015: 170–173; Ulanowska forthcoming).

The use of the discoid loom weights continued in Archaic, Classical, and Hellenistic Greece (*cf.* Quercia, Foxhall 2014; Lawall 2014: 161–166; Spantidaki 2016: 180–213), but it should be noted that it is not possible to prove a direct continuation of this form from the Bronze Age to later Antiquity.

Specific forms for specific techniques? Cuboid and crescent-shaped loom weights

Despite the functional relation between the form of a loom weight and the structure and appearance of a woven fabric, certain forms of the loom weights, *e.g.* crescents and four-holed cubes, have been acknowledged especially expedient for specific weaving techniques (on the crescent-shaped weights, *cf.* Lassen 2013; 2015; Ulanowska 2018; Grömer forthcoming; on the cuboid weights, *cf.* Carington Smith 1975: 186–187, 294; Burke 2010: 60; Ulanowska forthcoming).

The cuboid weights with four perforations appeared first in the Middle Neolithic stratum at Knossos on Crete (Evans 1964: 180, Pl. 56.2, 57.2; Carington Smith 1975: 185–186). Continuation in the use of this form from the Middle Neolithic to the Middle and Late Bronze Age in Crete has been regarded possible (Carington Smith 1975: 186; Evely 2000: 498; Burke 2010: 59). The use of the cuboid weights as tablets in tablet weaving has been primarily suggested on the basis of the number of perforations (Carington Smith 1975: 186–187). Generally, the cuboid form demonstrates functional parameters similar to the spherical loom weights (Firth 2015: 176) and is optimal for weaving balanced or weft-faced fabrics.[4]

Crescent-shaped weights

Based on experimental archaeology, several specific uses of the crescent-shaped weights have been suggested. *Inter alia*, they have been recognised as tools suitable for creating an off-loom device for band weaving made of two crescents and heddles (Feldtkeller 2003; Grömer 2006; 2016: 100, Fig. 51; 2018; Ulanowska 2018). They have also been considered practical as possible weights tensioning warps on a twining frame. In this case, the crescent-shaped weights, while being turned around their axes, twined the warp threads they tensioned (Grömer 2018).

The crescent-shaped loom weights have been acknowledged as practical for making tabby and twill weaves in weaving on the warp-weighted loom (Cornaggia Castiglioni 1964; Baioni *et al.* 2003; Lassen 2013; 2014; Ulanowska 2018). In both techniques, each crescent-shaped weight tensions two layers of warp threads. For the 2/2 or 3/1 twill weaves and four layers of warp threads, two sets of the crescent-shaped weights are required (Lassen 2013; 2015) (Fig. 5). For the 2/1 twill and three layers of warp threads, one set of the crescents should be combined with another type of a loom weight that is tensioning the front layer of warp threads, *i.e.* the one hanging over the shed bar (Firth 2015: 181; Ulanowska 2018) (see Fig. 5).

In Greece, only a few crescent-shaped weights have been discovered in contexts dating to the Early Bronze Age, with the largest number recorded at Tiryns (*cf.* Siennicka 2012: 70; Rahmstorf *et al.* 2015: 272). Although it is impossible to say with certainty for what

Fig. 5. Crescent-shaped weights used as loom weights in the setup for tabby and twill: 2/1 twill in combination with spherical eights; 3/1 and 2/2 twill (photos by the author and K. Żebrowska).

[4] In my unpublished weaving experiments with the cuboid loom weights, I used them to weave open tabbies (by setting up one row of large cuboid weights for tensioning the front and back warp layers simultaneously, and by setting up two rows of small weights for the front and back warp layers separately). They were also used for twill weaves (small weights, 2/2 goose eye twill). They also appeared practical when used as tablets, however, according to our experience, turning more than four small unsupported cuboid weights cannot be controlled securely. Braiding with two or four small cubes was very effective and simple.

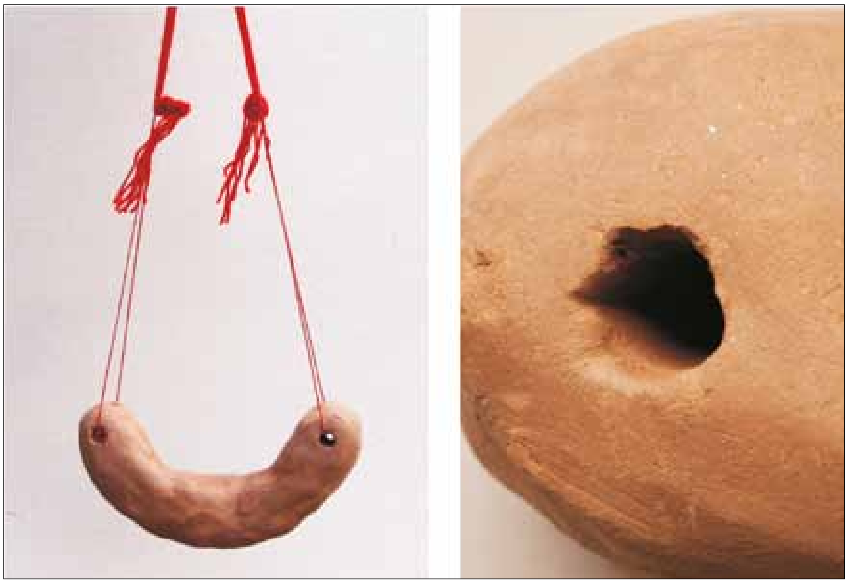

Fig. 6. The manner of suspension and the use-wear marks on the copies of the crescent-shaped weights from Tiryns used for tabby and twill weaving (photos by the author, M. Bogacki, and M. Dąbski).

textile technique these crescent-shaped weights were used, the archaeological context of the crescent-shaped weights found *in situ* in Demircihüyük, in Early Bronze Age Anatolia (Korfmann 1981: 33–34, Fig. 45), indicates that the crescent-shaped weights were indeed used as loom weights, most probably for 2/1 twill weaving (*cf.* Lassen 2013; 2015; Firth 2015: 181–186). The observed use-wear marks on the actual weights from Tiryns, and their copies used in experimental weaving carried out by the author, additionally imply that these tools functioned as loom weights (Ulanowska 2018) (Fig. 6). However, no difference in use-wear that may reflect the type of weave produced, *e.g.* tabby or twill, has been observed on the copies of the tools.

Potential use of other types of looms

An apparent lack or noticeably reduced number of loom weights in archaeological contexts dating to the Middle and Late Bronze Age on the Greek mainland, and prior to the Middle and Late Bronze Age in the southern Aegean, suggests diachronic and regional variability in the use of the warp-weighted loom in Bronze Age Greece. This may imply that other types of looms might have been known and used at this time (*cf.* Andersson Strand, Nosch 2015b; Cutler 2016a). But it also suggests that the warp-weighted loom technology may have been temporarily neglected and then again adopted in several regions of Greece (*cf.* Cutler 2016a).

The use of different types of looms has been attested in many societies of the past (*cf.* Broudy 1979; Andersson Strand 2018). Thus, in the Late Bronze Age, the horizontal ground loom and the vertical two-beam loom were used simultaneously in Egypt, albeit by different weavers who, it is assumed, would have specialised in producing different types of textiles (Broudy 1979: 38–47; Barber 1991: 83–91, 113–116; Andersson Strand 2018). However, according to E. Andersson Strand and M.-L. Nosch, the Neolithic depiction of possibly two different looms on a bowl from Badari may suggest that the use of two implements beside each other goes back to much earlier times (Andersson Strand, Nosch 2015b: 362). The simultaneous use of different types of looms, *e.g.* the horizontal ground loom and the vertical loom, as well as possibly the warp-weighted loom or the two-beam loom, has also been discussed in regard to Bronze Age Mesopotamia (Breniquet 2008: 140–149, 157–166, 175–180, 297–303, 326–328).

Although in Bronze Age Greece no direct evidence suggesting any other specific type of loom has been discovered, the horizontal ground loom and the two-beam loom are considered possible choices (Carington Smith 1975: 403-410; Tzachili 1990: 386; Pavúk 2012: 123–126; Andersson Strand, Nosch 2015b: 362). Both implements were in use in the neighbouring areas that were connected with Bronze Age Greece via networks of various economical and socio-political contacts (*cf.* Antoniadou, Pace 2007).

A potential use of a type of the horizontal loom has also been proposed in relation to numerous finds of spools or reels from mainland Greece and the north-central Aegean dated to the Middle Bronze Age (Carington Smith 1975: 403–410; Pavúk 2012: 123–126; Cutler 2016a: 174; Siennicka, Ulanowska 2016: 33). According to J. Carington Smith, a special kind of a spool which is characterised by a narrow waist and flaring ends may serve as a part of *διάστρες* – a device for measuring equal lengths of the warp threads that are required for setting up the horizontal loom (Carington Smith 1975: 404–405, 408–409). The potential use of the vertical two-beam loom has been specifically discussed in regard to sail production at Akrotiri (Tzachili 1999: 859; *cf.* Tzachili 2007: 192) and the introduction of the technique of tapestry (Andersson Strand, Nosch 2015b: 362; *cf.* Broudy 1979: 44–47; Barber 1991: 158; Smith 2012; 2013).

Organisational modes of textile production

By analysing particular components of textile production, *e.g.* its location and intensity, surplus, standardisation of tools and products, specialisation of production, *etc.*, various modes of production have been distinguished (*cf.* Costin 1991; 2005; 2007; Andersson 2003; Andersson Strand 2011; Andersson Strand, Heller 2016). These defined modes, such as household, individual, or embedded production, individual specialisation, also ritual production, and finally attached production controlled by palaces, proved to be useful in analysing archaeological and textual evidence from Bronze Age Greece (Ulanowska, Siennicka forthcoming). However, even when specific evidence indicates a certain mode of production, the dynamics of organisation of textile production cannot be seen as linear, evolutionary developments. On the contrary, several modes of production, while being complex, multifarious, and largely overlapping processes, may have coexisted at the same time (Ulanowska, Siennicka forthcoming). What may be suggested, however, is a diachronically increasing scale of textile production, with the assumed peak represented by the industrial level of textile production controlled by the Mycenaean palaces (*cf.* Barber 1991; Burke 2010; Nosch 2014; Rougemont 2014).

The question whether and how a specific production mode and the social relations related to it may have prompted creativity and technical innovations in weaving lies beyond the scope of this paper (*cf.* Gorogianni *et al.* 2015; Cutler 2016a). Moreover, since the possible innovations in weaving technology may only exceptionally be attributed to a certain site or *loci*, the available data for attributing a specific innovation to a specific production mode and a specific social context seems generally insufficient.

However, if the discoid loom weights were indeed introduced at Myrtos Phournou Koriphi on Crete, this innovation may possibly be related to the household mode of production or to household industry, *i.e.* the mode in which production is still undertaken on the household basis but exceeds the needs of producers (for textile production components and social relations at Myrtos, *cf.* Warren 1972; Whitelaw 1983; 2007; for household and household industry mode of production, *cf.* Andersson 2003: 47, Fig. 1; Andersson Strand 2007: 151–152).

Moreover, the wide distribution of the discoid loom weights throughout the southern Aegean in the Middle and the early Late Bronze Age may be tracked chronologically. As J. Cutler has demonstrated, the weights at first appeared at Aghia Irini, Kolona, Ialysos, and in the northern part of Rhodes, Miletus, and Lerna (early Middle Bronze Age). They then appeared at Phylakopi and Liman Tepe (MBA), at Koukonisi and Akrotiri (late MBA), at Kastri, Iasos, and Vathy Cave on Kalymnos (at the transition from the Middle to the Late Bronze Age), and finally in the Late Bronze Age at Teichioussa and Çeşme-Bağlararasi (early LBA I), at Serraglio on Kos, Heraion on Samos, and possibly on Anitikythera, Naxos, and Karpathos (later phases of LBA I) (Cutler 2016a: 175). The overall timespan of their spread may thus be estimated to a period of *c.* 250 years, which corresponds roughly to *c.* 10 generations, starting from the moment of the first appearance of these loom weights outside Crete.

Since the discoid loom weights were also found in large concentrations, the transmission of these weights may have reflected an increasing scale of production. Yet, at some sites, *e.g.* at Phylakopi on Melos, only a few discoid loom weights were discovered suggesting that the adoption of new weaving techniques could have been on a limited scale (Cutler 2016a: 175–176, 181). Thus, the archaeological context of the discoid loom weights, *e.g.* Northern Sector at Aghia Irini, Kea (Gorogianni *et al.* 2015), may suggest a household industry as well as more complex modes of organisation of production, *e.g.* in the Loom Weight Basement at Knossos (*cf.* Burke 2010: 57–58) and at four houses at Akrotiri: West House and Complexes A, B, and Δ (*cf.* Tzachili 1990; 1997: 190–192; Karnava 2008; Tzachili *et al.* 2015; Cutler 2016a: 175–176; Hitchcock 2016).

Therefore, the transmission of the discoid loom weights could have possibly been connected with the production of technically similar, perhaps standardised fabrics, undertaken within various modes of production, such as household, as well as, for instance, workshop production for trade, individual specialisation, or even attached production (*cf.* Andersson 2003: 47, Fig. 1; Andersson Strand 2007: 151–152; Cutler 2016a; Ulanowska, Siennicka forthcoming). As suggested by J. Cutler, the fabrics woven with the discoid loom weights may have had a 'Cretan-like' visual appearance and reflected a desire to copy 'Cretan' cloth worn by the Minoans and by the local elites at a later date. Yet, since more types of loom weights were in use on Crete and, presumably, more diversified fabrics were produced, Minoan weaving technology was only partially adopted outside Crete (Cutler 2016a: 176–178, 181).

Conclusions

Although the available evidence does not allow the reconstruction of any detailed outline of technical developments in weaving throughout the Bronze Age in Greece, certain technical innovations may be recognised and placed geo-chronologically within a time scale.

The conservative, traditional character of weaving has been suggested by the continued use of the warp-weighted loom from the Neolithic throughout the entire Bronze Age to the Iron Age, Classical Greece, and later. However, the presence of loom weights in archaeological contexts provides convincing evidence for such an uninterrupted weaving tradition only on Crete. At several sites of mainland Greece, the warp-weighted loom technology may have been rejected for *c.* 700 years, with a possible break dating from the end of the Early Bronze Age to the Late Bronze Age II (*cf.* Cutler 2016a: 178).[5] In the southern Aegean, however, the warp-weighted loom technology may have only appeared at the end of the Middle Bronze Age together with the discoid loom weights. Potential re-introduction of the warp-weighted loom technology in the areas where it was already in use demonstrates that, in the *longue durée*, once acquired and adopted weaving traditions could be rejected and acquired again according to, for example, the technical, economic, cultural, or aesthetic choices of the craftspeople or the organisers of production and their customers.

The temporal ratio of the transmission of the discoid loom weights and warp-weighted loom technology into the southern Aegean, counted in years and generations, suggests that this innovative 'package' has been acquired at a slow speed. However, according to my teaching experience,[6] the warp-weighted loom technology is not very difficult to acquire, since it does not require any specific manual dexterity. Again, based on my experience, I would suggest that a period between three to six months would be enough to acquire some proficiency in weaving tabbies by modern and unexperienced novices. More time would be required to weave twills and patterned textiles, *e.g.* with a supplemental weft. Thus, the long period of transmission of the new weaving techniques seems to reflect socio-cultural and economic processes, such as the speed of the mobility of individual weavers and culturally-biased (un)willingness to acquire a new technology, rather than the time required for the mere transfer of the new weaving skills.

The invention of a new functional form of loom weight, *i.e.* the discoid loom weight, may be seen as one of the most successful and long lasting innovations in weaving dated to the Aegean Bronze Age. This innovation reflects not only the need for finer and denser, and perhaps standardised, textiles, but also the high expediency of the discoid weights in the warp-weighted loom technology. The technical success of the discoid loom weights may be analysed further to explain the engendering of the craft of weaving, the social processes standing behind the transmission of textile knowledge and skills, and the general mechanism of acculturation (*cf.* Cutler 2012; 2013; 2016a; Gorogianni *et al.* 2015).

On the other hand, the limited distribution of the crescent-shaped weights in the Early Bronze Age may be seen as a reflection of a rejected innovation that, despite the potential (multi)functionality of these tools, was seemingly not much appreciated or required.

Except for the changes in the form of loom weights, potential modifications of the loom itself, *e.g.* its construction and size, are not traceable through time.

The suggested introduction of other types of looms may have been another important technical innovation, yet it is difficult to date. If spools with narrow waists and flaring ends could indeed be related to the use of the horizontal loom, this innovation must have been quite widespread in Middle Bronze Age mainland Greece and the Aegean. The potential introduction of the two-beam loom cannot be related to any specific area. Technically, it may have accompanied the transmission of more sophisticated weaving techniques, such as tapestry, and thus could possibly be dated, like in Egypt, to the first half of the Late Bronze Age (*cf.* Broudy 1979: 44–46; Barber 1991: 157–162).

This paper aimed at recognising possible innovations in weaving technology based on archaeological evidence combined with experimental archaeology. However, the phenomenon of the embodiment and transmission of innovations may be analysed in a broader socio-cultural context (*cf.* Cutler 2012; 2016a; Gorogianni *et al.* 2015). The wide adaptation of certain textile techniques, or

[5] For a possible use of spools as loom weights, *cf.* Cutler 2016a; Siennicka, Ulanowska 2016.

[6] This observation is based, at present (*i.e.* May 2018), on my seven years' experience in academic teaching about textile technology and hands-on experience in weaving on the warp-weighted loom with *c.* 116 students of archaeology and scholars.

certain types of fabrics, may reflect the transmission of fashion and a specific cloth or textile culture (*cf.* Cutler 2016a: 176–177). The term "cloth culture", originally coined by S. Harris (2012: esp. 62–63), now encompasses the practical use of fibres, skins, and textiles, as well as the cultural preferences for specific raw materials, cloths and fabrics, aesthetics, and values (Harris 2012; Gleba 2017: esp. 1206). It seems that the transmission of a technological 'package', comprising the mobility of the craftspeople with specific textile knowledge and skills, tools, and possibly raw materials, was an inevitable part of the process of Minoanisation (*cf.* Gorogianni 2016; Gorogianni *et al.* 2016). However, other possible patterns of the transmission of weaving techniques, to be traced on the basis of archaeological evidence, cannot be presently related to any specific socio-cultural contexts.

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Abbreviations:

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