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Visual Expression and Craft Production in the Definition
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NEW PERSPECTIVES ON BRONZE AGE TEXTILE PRODUCTION IN THE EASTERN MEDITERRANEAN. THE FIRST RESULTS WITH EBLA AS A PILOT STUDY

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Abstract

The systematic analyses of Bronze Age textile tools conducted by the Italian Ebla team (MAIS) and the Danish National Research Foundation's Centre for Textile Research (CTR) have made it possible to portray Ebla textile production. For weaving, the ground loom and the two-beam loom were the preferred technologies; the spinning tools, including spindle whorls, show gradual development and changes from the Early Bronze Age to the Middle Bronze Age, with the introduction of new types of tools and materials, reduced sizes and weights, likely indicating that thinner yarn and finer textiles were becoming more abundant.

1. Introduction and Project Description

In 2005, a collaboration agreement was made between the Italian Archaeological Expedition at Tell Mardikh-Ebla (MAIS) and the Danish National Research Foundation's Centre for Textile Research (CTR) and its research programme *Tools and Textiles - Texts and Contexts*.[1] The aim of this agreement is to conduct a collaborative international and interdisciplinary research programme on the Bronze Age textile production at Ebla. Ebla is the only site in the region with an entire monograph dedicated to the scientific analysis of archaeological textile tools[2] and it is a key site for investigating the development of textile activities during the Bronze Age. Moreover, it provides an opportunity for interdisciplinary investigation of textile production during the Early Syrian period, because it has yielded abundant epigraphical material, iconography, textile tools and archaeological textiles.[3]

The collaboration is based on three scientific axes:

1 For a general description and reports from the CTR project *Tools and Textiles*, see http://ctr.ku.dk/research tools_and_textiles.

2 Peyronel 2004; see also 2007.

3 Tell Mardikh-Ebla is the only site in Syria allowing a comparison between epigraphic and archaeological data of the Early Bronze Age. In contrast, during the Middle Bronze Age, the lack of epigraphic documents prevents this fruitful comparison. For this period, detailed information on the textile industry can be gathered from the archives discovered at Tell Hariri-Mari and Kültepe-Kanesh, although the archaeological materials related to the textile production at both sites are still unpublished or only briefly surveyed (Peyronel 2004: 121-124). For a recent overview of the textile industry in

- Textile tool investigation, conducted by Dr Luca Peyronel and Elena Felluca from the Ebla team, and Dr Eva Andersson, Dr Marie-Louise Nosch and the textile technicians Anne Batzer and Linda Mårtensson from the *Tools and Textiles* team.
- Textile investigation, conducted by the *Tools and Textiles* team, including Dr Eva Andersson, Dr Marie-Louise Nosch and Irene Skals, the textile conservator of the National Museum of Denmark.
- Textile terminology investigation, in collaboration with Prof. Franco Pomponio and Prof. Giovanna Biga and the *Texts and Contexts* team, including Dr Cécile Michel and Dr Marie-Louise Nosch.

In this paper, we will report on results from the tool analyses, as well as the analyses of archaeological textiles from Ebla.

The *Tools and Textiles* research programme combines three approaches: experimental testing, tool studies and context investigation. In order to follow this path, we need the specialist knowledge from various sites. We therefore collaborate with an international team of approximately 50 archaeologists investigating textile tools and technology in the Bronze Age Eastern Mediterranean from approximately 35 sites. These archaeologists have recorded textile tools from their sites in a specially designed database. As a result, the database contains information on app. 10,000 textile tools. Thus, there is sound statistical ground for discussing Bronze Age textile tools and technology. This provides the opportunity to compare not only developments in time but also the production within a large region.[4]

Textile production is well attested and documented in the Ebla written records.[5] The textile industry was indeed one of the most important sectors of the Eblaic economy:[6] lists of textile products (skirts, belts, tunics, cloaks) represent the vast manufacturing and distribution of thousands of items.[7] Textile manufacturing was entirely under the control of the palace administration, and the palace officials controlled all production processes, such as the plucking of the sheep, sorting wool, weighing, spinning, weaving, fulling, and dyeing. The textile workers were located in workshops inside the Royal Palace. The raw material was primarily wool (*siki*), but linen (*gada*) was also evident. The wool was kept in large storerooms, indicated by the term 'house of the wool' (*é-siki*), which also means 'Treasury'. Spinning and weaving took place in palace workshops, while dyeing and fulling were carried out in the outer periphery of the town where there was access to water. The personnel of the textile manufacture consist of both men and women. Men were mostly involved in controlling functions, such as overseers, officials, scribes, etc., but also for the physically demanding tasks of fulling and dyeing. Women were responsible for spinning and weaving, and female

Mesopotamia during the 4th-3rd Mill. BC, see Breniquet 2008.

4 Andersson, Nosch (eds) *in press*.

5 See especially Archi 1999 and Pasquali 1997.

6 Peyronel 2004: 92-97.

7 Several texts record the monthly disbursement of textiles from the palace: cf., in particular, Biga, Milano 1984; Archi 1985; Sollberger 1986; Pomponio 2008.

workers and the elite women carried out these functions.

Finally, the written evidence also provides the textile tool terminology for some textile tools: *giš-bala*, 'wooden spindle' (and spindle-whorl?); na_4 - KIN - *zi-ri*, 'wool measures' (weights?) system with a ratio of 1:2:4;[8] and *giš-zum* 'comb' (the wooden comb for combing wool?). [M.-L. Nosch, L. Peyronel]

2. The Ebla Textile Tools Data-Base and Experimental Archaeology

Quantitative and Distributive Data from the Database

139 textile tools dated to the Early and Middle Bronze Age were found at Tell Mardikh-Ebla during the 1964-2006 excavations, including spindle-whorls, loom-weights, needles, pin-beaters and spindles, and widespread in several public and private architectural contexts (palatial buildings, domestic quarters, temples, graves (Table 1). Several objects can be ascribed to primary archaeological deposits, associated with floors or with the debris of collapsed walls, although others are related to refuse pits or to filling levels, without a direct connection to their original location of use. In the CTR-Tools DataBase, the Eblaic corpus is chronologically divided into the following periods: Early Bronze Age IVA (c. 2400-2300 BC), Early Bronze Age IVB (c. 2300-2000 BC), Middle Bronze Age I (c. 2000-1800 BC), Middle Bronze Age II (c. 1800-1600 BC) and Middle Bronze Age I-II (c. 2000-1600 BC).[9]

The textile industry is primarily testified by spindle-whorls, with 101 specimens (Table 2): 38 spindle-whorls were found in Early Bronze Age IVA contexts; 27 come from the Royal Palace G; 3 from Building P4 in the Lower Town; and the others cannot be ascribed directly to buildings. The textile equipment also includes bone tools: 26 bone pin-beaters (or piercing tools) and 6 needles; 14 pin-beaters and 2 needles were found in Royal Palace G; 7 pin-beaters and 4 needles in Building P4; 5 pin-beaters from other contexts.[10]

The most useful documentation is represented by spindle-whorls and other textile tools found in Royal Palace G, probably indicating textile activities performed by high-ranking individuals in the palace, whereas Public Building P4 is a multi-functional unit, as part of the centralised organisation of Ebla.[11]

A few specimens can be dated to the Early Bronze Age IVB, among which are three spindle-whorls found in the vicinity of the late Early Syrian temple in Area HH, possibly indicating the symbolic meaning of this instrument.[12]

8 Zaccagnini 1984.

9 Out of 141 objects recorded in the CTR database, two spindle-whorls have been excluded here because one was found in EB III level and the other one is dated to the Late Bronze Age. The group of specimens generically dated to MB I-II is represented by tools coming from MB contexts, which cannot be linked with certainty to a building phase or to an MB sub-phase.

10 Peyronel 2004: 132-145; *in press*. For a description of these archaeological contexts and the distribution of textile tools, see Peyronel 2004: 100-104, 114-115, 137-138.

11 Peyronel 2004: 379-383.

12 For a preliminary description of the temples in Area HH, see Matthiae 2006a: 458-493.

Out of 60 spindle-whorls found in Middle Bronze Age contexts,[13] 42 came from the Lower Town, 25 of which were widespread in houses of Area B East, palatial buildings (Northern Palace P and Western Palace Q), cultic buildings (Temple HH and *favissa* F.5238 in Area P South) and royal tombs (*hypogea* under the Western Palace). Only one spindle-whorl was found in the Royal Palace E, on the top of the Acropolis, and two in the Western Fort, on the defensive rampart. Two bronze spindles and two spindle-whorls were found inside *favissa* F.5238 in Ishtar's Sacred Area, five spindle-whorls were found in relation to Temples HH 2-3, and two spindle-whorls came from the so-called Tomb of the Cisterns in the Royal Necropolis, as funerary offerings, suggesting a specific symbolic/ideological meaning of textile tools, possibly related to the religious sphere.

Only two terracotta, conical loom-weights were discovered so far at Ebla, possibly associated with a late building phase (MB IB/MB IIA, c. 1900-1750 BC) of the Archaic Palace.[14]

Textile Tools	EB III	EB IVA	EB IVB	MB I	MB I-II	MB II	LB
Spindle-whorls	1	38	3	1	21	38	1
Loom-weights					2		
Needles		6	1				
Pinbeaters/Piercing Tools		26	1				
Spindles						2	

Table 1: Chronological distribution of Bronze Age textile tools recorded in the database.

Middle Bronze Age Spindle-whorls (Total = 60)	
Acropolis:	
Royal Palace E	1
Other	13 (2 E; 1 F; 8 G; 2 R)
Lower Town:	
Domestic Quarter B Est	4
Northern Palace P	4
Favissa F.5238 (Area P South)	2
Western Palace Q	8
Tomb of the Cisterns (*Hypogea* in Area Q)	2

13 Peyronel 2004: 168-173.

14 Peyronel 2004: 200; 2007: 30. Cf. Matthiae 2006b for the chronological sequence of the Archaic Palace.

Temples HH 2-3	5
Other	17 (1 A; 3 N; 10 P; 3 Q)
Rampart:	
Western Fort	2
Other	2 (1 L; 1 AA)

Table 2: Spindle whorls found in Middle Bronze Age contexts at Tell Mardikh-Ebla. Spatial distribution.

Typology of Spindle-Whorls, Spindles and Loom Weights

The EB IV spindle-whorls show the absolute predominance of plano-convex shapes and stone materials (especially limestone, basalt, siliceous stone and steatite). The most attested type is the small high-domed whorls (with weights clustered between 6 and 20 g) in limestone or basalt.[15] This type is documented by several specimens found scattered in the Royal Palace G, probably related to the 'common' spinning activity of high-ranking members of the palace, and not to the 'industrial' textile workshops mentioned in the administrative documents. Wooden spindles and probably spindle-whorls were in fact employed in the ateliers, as suggested by the term *giš-bala* in the texts. Moreover, the fact that the spindle-whorls were usually small and lightweight probably indicates that they were employed for spinning thin fibre and a small quantity of it (cf., *infra*, the experimental archaeology). The complete lack of clay or stone loom-weights seems to indicate the exclusive use of horizontal ground-looms, such as those found in Mesopotamia.

Stone spindle-whorls during the Middle Bronze Age indicate the predominance of steatite, followed by basalt and limestone, and they are always domed-shape with a flat base, a perforation 4-5 mm in diameter and a mass clustered between 15 and 25 g. Light bone-flattened whorls, sometimes decorated with geometric motifs, appear in this period. They are usually highly polished and they weigh from 4 to 10 g, with a tiny, central hole. Their use as fly-wheels is suggested by their connection with spindles discovered in Megiddo tombs, given as funerary gifts. The paucity of whorls strongly suggests that wooden spindles and spindle-whorls were the common tools for spinning during the Middle Bronze Age as well.

The symbolic/ideological meaning of this kind of textile equipment, possibly related to the religious sphere of the main goddess of the city, is testified by two bronze spindles from a *favissa* in the sacred area of Ishtar (Fig. 1). They are simple, circular rods in sections thinner at one end. A small whorl, with its surface completely covered by engraved geometric patterns, was also found in the same *favissa*. These important specimens could be considered 'symbolic' gifts, thrown into the well during ritual

15 Peyronel 2004: 104-114.

festivity linked to the cult of Ishtar. Another important piece of evidence attesting to the symbolic value of the spinning devices is a beautiful agate spindle-whorl found in the so-called Tomb of the Cisterns, one of the three royal *hypogea* excavated under the Western Palace, the crown prince's residence.

Only two possible terracotta loom-weights are present in the archaeological contexts dating from the Middle Bronze Age (Fig. 2). They are bell-shaped, with a hole on top, and weighing 300 g. Their interpretation as loom-weights is strengthened if we look at the documentation of the Syro-Palestinian regions during the Middle Bronze Age.[16]

Textile Tools and Experimental Archaeology

The Danish National Research Foundation's Centre for Textile Research from 2005 to 2007 conducted systematic spinning tests with exact replicas of such tools, and the results are outlined here.

As discussed above, Ebla has yielded many textile tools, foremost spindle-whorls. The spindle-whorl was fixed on a spindle that was generally made of wood. We cannot know where the spindles-whorls at Ebla were fixed: in the middle, on the top or at the bottom of the spindle-whorl. Anatolia has a specific tradition of using the middle whorl; Europeans tend to use the low whorl, and Egyptians the high whorl.

Two experienced and skilled spinners, Anne Batzer and Linda Mårtensson, conducted experimental tests over a period of app. 6 months. They tested three weight classes of spindle-whorls: 18 g, 8 g and 4 g. All of the tests were conducted under controlled conditions and according to the guidelines established by the programme for all experimental tests.[17]

Spinning tests: From written sources, it is known that both flax and wool fibres were used in Ebla. Wool fibres were tested on spindle-whorls of 18 g, 8 g and 4 g, respectively; flax fibres were only tested on the 8 g whorl. In the present paper, the results from the systematic tests of spinning with wool fibres are presented. Before spinning, all fibres must be prepared carefully, otherwise the thread will not be strong enough to hold in the fabric. The preparation processes include: sorting the fibres from the fleece; separating the fibres and combing the fibres; sometimes, especially when spinning very thin threads, washing the fibres.

The spinners measured and calculated carefully the time consumption for each tool during the spinning tests. Thus, the first important result concerns time consumption.

The yarn output / hour of an experienced and skilled spinner is as follows:[18]

- 50 m/h on an 18 g spindle-whorl;
- 40 m/h on an 8 g spindle-whorl;

16 Groups of clay objects, sometimes with impressions of Hyksos scarabs, very similar in shape to the Mardikh specimens, were found in several sites, bringing into question the introduction of the warp-weighted loom during the first half of the 2nd Mill. BC in Palestine: Peyronel 2004: 200-212.

17 Mårtensson 2007.

18 Andersson *et al.* 2008.

– 35 m/h on a 4 g spindle whorl.

We must also add the quite substantial time for preparing the fibres, depending on the fleece quality and the wool for the spinning. Please keep in mind that an average piece of textile of app. 1 m^2 requires 2 km of thread.

The experiments confirmed that it is primarily the weight of the spindle-whorl that affects the fineness of the spun yarn. Second, the quality of the fibres and the degree of fibre preparation also had a significant effect on the spun yarns. Figure 4 clearly demonstrates, however, that the two spinners spun rather similar threads when using identical tools. This proves that it is not the individuality of the spinner that defines the thread quality; it is the tool - the spindle-whorl. Figure 4 illustrates how long threads can be spun from 100 g of prepared wool. The figure represents the average output for the two spinners.[19]

The difference in yarn length per 100 g spun fibres can be explained by the fact that there is less fibre /m in the thread spun with the 4 g spindle-whorl than in thread spun on the 8 g and 18 g spindle-whorls. Therefore, a spindle-whorl's weight is a clear defining parameter for the quality of the thread spun with the tool.

Spinning at Ebla. The total number of spindle-whorls from Ebla is relatively small, and the analysis cannot be considered statistically representative for all Ebla. However, the variation of the spindle-whorls' weight during EB IVA demonstrates that the spinners in Ebla could spin many different types of yarn from thin to thick and therefore also produce many different qualities of fabrics. The comparison of spindle-whorls from EB IVA and MB suggests a small but significant difference between the two sets of data: EB IVA spindle-whorls are mainly of stone, while one third of the MB spindle-whorls are of bone; spindle-whorls from the later period in general are smaller and lighter indicating a more specialised production of finer, spun yarn. A similar development is evident at Arslantepe in the same period.[20]

Weaving at Ebla. It is assumed that the Ebla population used the ground loom or the two-beam loom since this is the most common technology in Syrian and Mesopotamia during the Early and Middle Bronze Ages, and since so few loom weights have been found from the Levant.

This loom technology, the ground loom or the two-beam loom, barely leaves archaeological remains. The spindle-whorls, the iconography and the epigraphical evidence, however, document an extensive textile production, probably manufactured on these loom types.

It therefore came as quite a surprise when two loom weights were found at Ebla, since the loom type using loom weights - the warp-weighted loom - is known to have been in wide use in Anatolia and in Europe, and in Southern Levant, probably for highly specialised productions, but not in Inner Syria in the Bronze Age. These two items provide the opportunity to demonstrate the textile quality that can be obtained

19 The results are based on a total of 42 spinning tests conducted by the two spinners in the winter of 2005-2006. All tests were documented.

20 Frangipane *et al. in press*.

using these loom weights in a warp-weighted loom.

- Loom Weight EBL-TM.94.P.607 weighs 303 g, and is 5.5 cm thick (Fig. 2)
- Loom Weight EBL-TM.94.P.461 weighs 322 g, and is 5.4 cm thick

The following calculations are based on Loom Weight EBL-TM.93.P.607.

In the warp-weighted loom, the warp threads are attached to loom weights in order to obtain a downward tension, which facilitates the passing of the weft. If the tension is too low, the loom weights will move too much and the fabric is out of shape; if the warp tension is too high, the weaver risks breaking the warp threads during weaving. The correct warp tension depends of the warp threads: how fine they are, how hard spun and how the fibres have been prepared. If a warp is made of thin threads, each thread will only need/can only take 10 g warp tension. The weaver using a 303 g loom weight will thus attach 30 warp threads to it.

Another functional parameter of a loom weight, however, is its thickness.[21] In the most basic weave (the so-called tabby), every second warp thread is attached to a loom weight in the front layer, and every second loom weight is attached to a loom weight in the back layer. Thus, the warp threads of the front-layer loom weights and the warp threads of the back-layer loom weights have to be held within the available space defined by the thickness of the loom weight. In the present example, the 60 warp threads thus must be hanging straight down, with the space of 5.5 cm giving a thread count of 11 threads/cm.

Loom Weight EBL-TM.94.P.607: weight 303 g, thickness 5.5 cm				
Warp threads requiring:	10 g warp tension	20 g warp tension	30 g warp tension	40 g warp tension
Number of threads per loom weight	30	15	10	7-8
Number of threads per two weights (one in front layer one in back layer)	60	30	20	14-16
Warp threads per cm	11	5-6	4	3
Evaluation of suitability of the tool	Optimal	Optimal	Possible	Unlikely

Table 3: Technical evaluation of the MB loom weight from Ebla.

As is evidenced in the table above, these loom weights function well with thin warp threads requiring 10-20 g warp tension. Loom setups with thicker warp threads of 30-40 g tension are not optimal since 3-4 warp threads / cm will give a very loose and open fabric. If the loom weights were used with thin warp threads requiring 10 g warp tension, it would give a fabric with 11 warp threads /cm and 11 weft threads/ cm in a balanced fabric (Fig. 4).[22] To produce 2 m^2 of such cloth, it would require 4,468 m

21 Mårtensson *et al. in press*.

22 A balanced fabric means a fabric with the same number of threads in warp and weft. This is opposed to, for example, a weft-faced fabric, which will have many more weft threads than warp threads.

thread. The yarn quality requiring only 10 g warp tension is the quality obtained with light spinning tools such as a 4 g spindle whorl.[23] The time consumption calculations demonstrate that the spinning would take app. 128 hours.[24] To this must be added substantial time for fibre preparation, especially for such fine threads - and time for weaving and finishing.

The loom weights of this type are flexible tools that can also be used for thicker yarn. If the loom weights were used with slightly thicker warp threads requiring 20 g warp tension, this would give a balanced fabric with 5-6 warp threads / cm, and 5-6 weft threads /cm. This would also result in a rather fine thin fabric (Fig. 5).[25] To produce 2 m^2 of such cloth would require 2,448 m thread. The yarn quality requiring 20 g warp tension is the quality obtained with spinning tools such as an 8 g spindle-whorl. The time consumption calculations demonstrate that the spinning would take app. 62 hours. Again, substantial time for fibre preparation and time for weaving and finishing must be added to the estimate. [E. Andersson, E. Felluca, L. Peyronel]

3. Archaeological Textiles from Ebla:Technical Analysis of Mineralised Fibrous Material Preserved on Human Bones from an Excavation at Tell Mardikh-Ebla[26]

Several fragments of textile remains were discovered on human bones from a collective shaft tomb located (P.8680) under the Southern Palace in Area FF.[27] The tomb is dated to MB II (1800-1600 BC) and contains more than fifty skeletons.[28] The human remains associated with the textiles sampled are a pelvic bone from a child, perhaps a child's or small adult's upper arm, and a skull fragment from an adult (Fig. 6). The human bone fragments derive from two separate levels of a funerary shaft-tomb.

Methods of Analysis

The fibrous materials were studied using optical microscopes, to examine traces of fibres and manufacturing techniques. Longitudinal sections of single fibres were examined using light-transmitting microscopes for possible identification of the

23 Andersson *et al.* 2008.
24 Andersson *et al.* 2008.
25 We warmly thank Joy Boutrup, Kolding School of Design, Denmark, for the graphic representations of the fabric types.
26 The analyses were carried out by conservator Irene Skals at the Department of Conservation, National Museum of Denmark in spring 2008. Preliminary examination was undertaken by conservator Maj Ringgaard in spring 2007. The SEM analyses were performed by Michelle Taube, conservation scientist, The National Museum of Denmark. The ATR-FTIR analyses were performed by Mikkel Christensen, chemist, The National Museum of Denmark. The analyses were financed with kind support from the Danish Research Council for the Humanities.
27 Matthiae 2004: 326-344.
28 Mogliazza, Polcaro in this volume.

origin.

Samples of textile material from each bone fragment were analysed by Attenuated Total Reflectance - Fourier Transform Infra Red Spectroscopy (ATR-FTIR) to determine whether a molecular combination similar to known plant fibres could be ascertained. The surface structure of the fibrous material from level 5 was analysed with a JEOL 5310 environmental SEM. The images were taken using a backscattered electron detector, while the elements present were determined with an energy dispersive x-ray detector. Sampling for the SEM analysis was not possible due to the extent of degradation of the material and to perform the analyses the entire bone fragment had to be placed in the vacuum chamber. This complicated the process and the analyses unfortunately have been limited to only one of the bones so far.

Visually Based Description of the Material (Fig. 6)

The fibrous material in all cases is mineralised and its surface is so fragile that the slightest touch or handling causes deterioration of the structure. This means an unavoidable but continuous disturbance of the surface every time the bones are examined, no matter how carefully they are handled, and it means that signs of a possible manufacturing technique are difficult to discern. In areas without fibrous material, the bone surface is deteriorated.

From layer 5:

Crescent-shaped bone fragment (no number), measuring 9 cm by 4 cm, and is 1.5 cm thick. Fibrous material covers the front side completely and can be seen in layers at right angles to each other.

From layer 7:

Bone fragment no.152: Ca. 9.5 cm of an extremity bone, in four pieces, with a circumference of ca. 4 cm. A thin layer of fibrous material with parallel fibres is preserved on one side.

Bone fragment no.174: Square-shaped bone fragment, which measures 6 cm by 6 cm and is 1 cm thick. A layer of fibrous material with parallel fibres partially covers the front side.

Bone fragment no.175: Part of a small pelvic bone, which measures 10 cm by 5 cm and is 3 cm thick. Fibrous material is partially preserved on the front side of the bone. The fibres mostly appear parallel, but in a few places a second layer of fibres can be seen at an angle to the top layer. In a wavy line across the middle of the parallel fibres, a bundle of fibres with a diameter of ca. 2 mm can be seen. Perhaps it is a loose accidental Z-plied thread/cord, but the structure seems to be intentional, although the function of the thread cannot be fully discerned. It could be a single thread/cord with no twist, interlinking with the underlying material as a horizontal wrapping element holding the vertical fibres in place.

Results of the ATR-FTIR Analyses

The mineralisation is so advanced that the ATR-FTIR spectra only have absorption bands corresponding to phosphate, which derives from the bones.

Manufacturing Technique

The structures of the arrangement of the fibres seem to signify some manufacturing techniques, but not with the common textile characteristics. Fibres are combined into bundles, but no twisting can be ascertained with certainty and there are no real signs of any interlacing of the combined fibres.

The material on the bones from level 7 appears to be one of parallel fibres purposely arranged. This brings to mind some sort of grass or bast fibres. The thread/cord on bone no. 175 could be interpreted as a twining cord tying the fibres together as in basketry or matting. The layered structure of the fibres arranged at an angle to each other, which can be seen in the material on the bone from level 5, is more consistent with a material such as papyrus. An interesting characteristic supporting this interpretation is that some fibres appear to be connected in flat strips (Fig. 7).

Fibre Identification

Although the mineralisation is advanced, it has been possible to obtain and study small pieces of single fibres from each bone, but the material is poor. It is also too fragile and too scarce to enable a decisive conclusion regarding the fibre types at this point, and it has not been possible to distinguish a definite difference between the fibres from the two different layers of the burial shaft.

The appearance of the fibres is definitely that of plant fibres, but similar characteristics seem to appear in both groups. Some fibres are flattened with pronounced edges, a medulla can be seen in some of the samples from both groups, the fibre tips or frazzled ends do not give definite indications, and polarisation does not help to distinguish a difference. Fibre diameter measurements vary from minimum 12-20 microns to a maximum 50-60 microns, which is higher than what we see in plant fibres used for textiles.

Conclusion

The information obtained from the results of these analyses does not give definitive answers. We are certain that the material is plant fibre, but are unable at this point to determine the exact type. We are interpreting the results of the technical analyses to be that of basketry or matting in the case of the material from level 7, and to resemble papyrus in the case of the material from level 5. This information will hopefully become a part of reference material regarding the development of the manufacturing techniques used for the fibrous materials, and perhaps even the burial customs of the area and the time from which the material stems.

The careful excavation, to which the preservation of these finds bears witness, must be emphasised. In spite of extreme fragility, the fibrous material was recognised and carefully packed without any adhesive stabilizer, which could have rendered some analyses impossible. The material will still be preserved and is available for future studies when improved technological analytical methods make it possible to obtain more information. [I. Skals, M.L. Nosch]

4. Discussion, Further Perspectives and Conclusion

The textile tool analysis indicates the types and qualities of textiles that may be produced with the specific tools. The analysis of the spindle-whorls at Ebla demonstrates that they were suitable for producing many types of threads. This informs us about the variety of textiles that the Eblaite population produced, from fine to coarse, confirming the picture offered by the administrative documents from the Royal Palace G, but also indicating that the trend towards diversification of products and quality continued during the Middle Bronze Age.

The experiments and systematic tests of textile tools also provide a better understanding of the function of textile tools, in particular the bone-pointed tools of different types, which could be considered weaving implements, according to use wear analyses and ethnographic comparisons.

The traditional morpho-typological and contextual approaches reveal important hints for the correct evaluation of spinning at Ebla, and represent the necessary starting point for experimental archaeology and archaeometric analysis, which can contribute to solving problems and/or to posing new questions in regards to the challenge of reconstructing textile industry during the Early and Old Syrian periods at Ebla.

The weaving at Ebla was probably mainly done without loom weights; however, the presence at Tell Mardikh of two conical pierced loom-weights could be considered an important 'missing link' between Anatolia (where the vertical warp-weighted loom was used since the Neolithic period) and Northern Palestine during the Middle Bronze Age. In the 'diffusion' of this new kind of loom and its respective technical skills (which however never replaced the predominance of the horizontal ground-loom during the Bronze Age), the role played by coastal and north-inner Syria might be relevant, and we need a deeper investigations of the materials coming from Western Syria. In fact, Ebla may represent the 'missing link' between Anatolia and its warp-weighted loom technology and the Levant with its ground loom and two-beam loom.[29] The investigation of the two Eblaite loom weights brings us to the north: in central and eastern Turkey thousands of loom weighs have been unearthed in EB and MB settlements.[30] The two Eblaic loom weights raise more questions than answers: how did they arrive in Ebla? Like the Assyrians, the Eblaites also travelled and traded in Anatolia; perhaps the loom weighs at Ebla 'came to Syria with a trader, who brought back someone proficient in weaving on a warp weighted loom, for instance an Anatolian

29 Peyronel 2007: 26.
30 Cf., i.e., Griffin 1980; Richmond 2006; Frangipane *et al. in press*.

wife, or Anatolians may have settled in Syria during this period and bringing their own textile technology', as was suggested by A. Wisti Lassen.[31] However, several terracotta loom weights are attested in southern Levant during MB (i.e., at Megiddo, Gezer, Kabri), indicating that the warp-weighted loom was introduced in that area during the II Mill. BC, although it never substituted the traditional horizontal ground loom.[32] What is the relation between these weights and the Anatolian evidence? We can suppose a technological link through the Syrian towns or we might look to interactions with Cyprus and the Aegeum.

In a wider perspective, Ebla seems to be located at the cross road between areas using different looms and thus different weaving technologies.[33] The fabrics resulting from the three loom types are, however, the same. But the technology differs greatly between the warp-weighted loom, the ground loom and the two-beam loom. Future investigations of the textile production in Syria should include an analysis of the internal developments from Early to Late Bronze Age at key sites such as Qatna, Hama and Umm El-Marra, and for the interactions between Ebla and other focal sites where loom technologies met, an investigation of the Middle Bronze Age to Late Bronze Age tools at 'Amuq sites and Alalakh.

Regarding Tell Mardikh-Ebla, the implementation of the CTR Database, adding new materials discovered in Area HH and Area G, continues, such as the analysis of other textile fragments (mineralised on metal objects) and the study of the textile impressions on sealings. Lastly, an interdisciplinary project combining experimental archaeology, textual data and iconography has been started, with the aim to investigate Early and Middle Bronze Age Syrian clothing and dress. [E. Andersson, M.L. Nosch, L. Peyronel]

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31 Wisti Lassen 2008: 73.

32 The lack of loom weights in the Levant during the Early Bronze Age seems to indicate that the vertical loom was unknown in Syria-Palestine at that time. However, the recently published excavation from the EB settlement of Tell Abu al-Kharaz in Jordan has given evidence for a possible use of pierced stones as loom weights, suggesting that the weaving technology was occasionally employed also in the southern Levant already in the 3rd Mill. BC: Fischer 2008: 51-52, 353-354, Figs 36, 39, 314.

33 Peyronel 2007: 33-34; Fig. 8.

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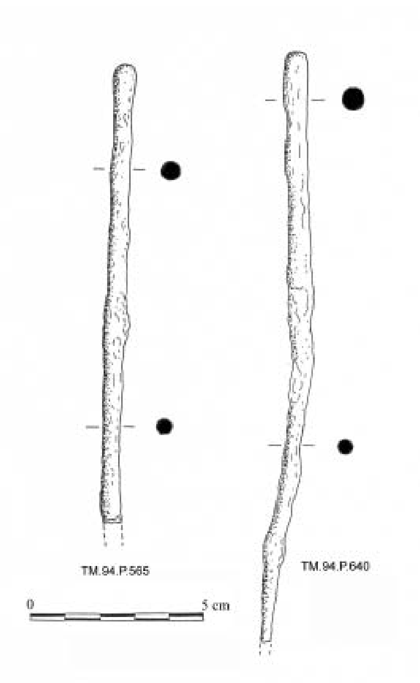

Fig. 1: Bronze spindles EBL-TM.94.P.565 and EBL-TM.94.P.640from F.5238.
Source: Copyright MAIS.

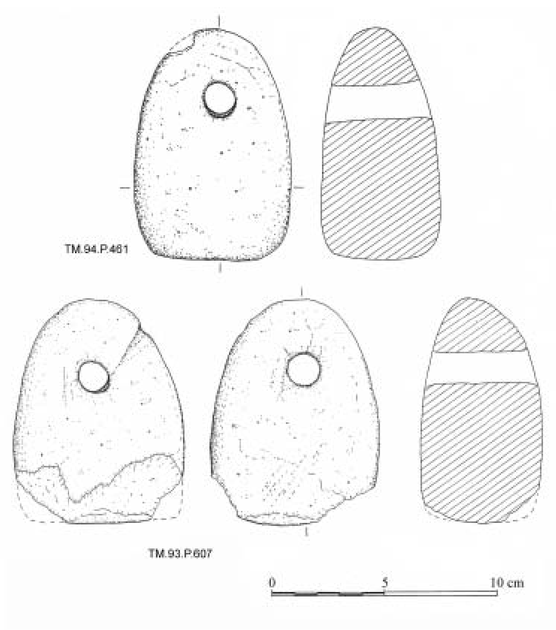

Fig. 2: Clay loom weights EBL-TM.93.P.607 and EBL-TM.94.P.461.
Source: Copyright MAIS.

4g whorl Mårtens-son	4g whorl Batzer		8g whorl Mårtens-son	8g whorl Batzer		18g whorl Mårtens-son	18g whorl Batzer
1696	1609		960	1102		582	665

Fig. 3: Length of spun yarn obtained from 100 g prepared wool. Copyright and courtesy by the Danish National Research Foundations Centre for Textile Research.

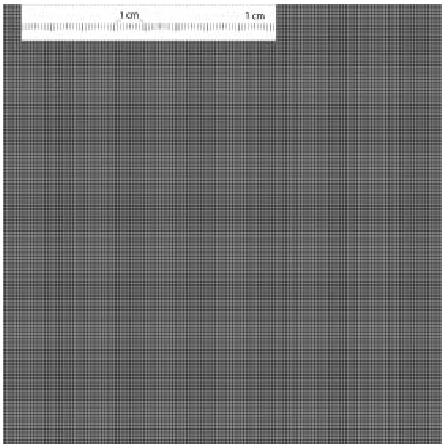

Fig. 4: Fabric of 11 warp threads and 11 weft threads / cm2. Calculated from loom-weightsEBL-TM.93.P.607,and a warp tension of 10 g. Source: Copyright and courtesy of Joy Boutrup, Kolding School of Design, Denmark.

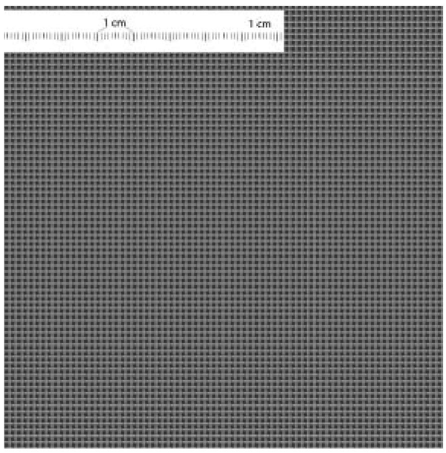

Fig. 5: Fabric of 5-6 warp threads and 5-6 weft threads / cm2. Calculated from loom weights EBL-TM.93.P.607, and a warp tension of 20 g. Source: Copyright and courtesy of Joy Boutrup, Kolding School of Design, Denmark.

Fig. 6: Overview of the bone fragments from Ebla.
Source: Photo by Irene Skals, National Museum of Denmark.

Fig. 7: Some fibre on bone fragment from level 5 are connected to each other in flat stripes (12 X magnification).
Source: Photo by Irene Skals, National Museum of Denmark.

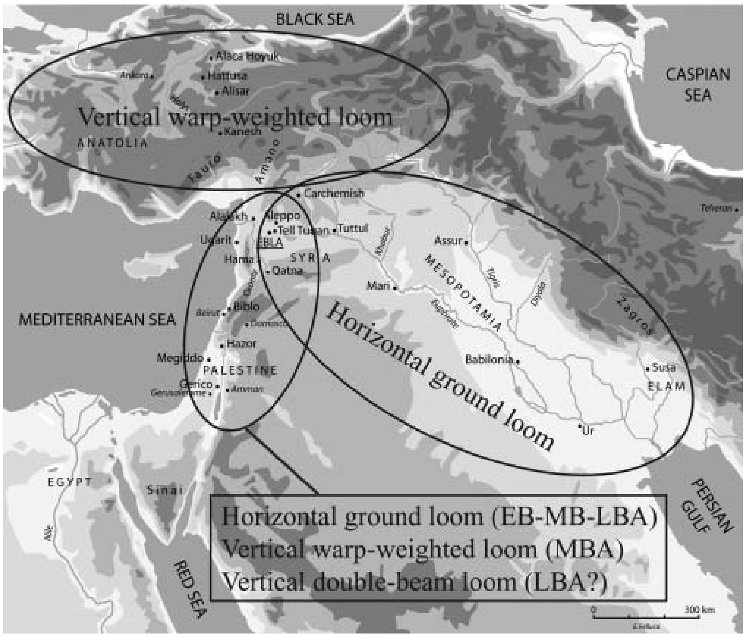

Fig. 8: Distribution map of the three loom types, with Ebla as focal point.