Technical Textile Tools Report

Arslantepe, Turkey

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PREFACE

We thank you for your cooperation in the first part of the Tools and Textiles – Texts and Contexts (TTTC) research programme and we look forward to your reactions to our tool analysis and the technical report. A synthesis of all technical reports will be published in 2009 (Andersson, E. and Nosch, M-L. *Tools, Textiles, and Contexts*, Oxbow Books, Oxford).

This technical report is written for you; it forms the basis of your context description which we look forward to receiving.. In future research, you are most welcome to use the results of the report in other publications and articles about your site and textile production. Please remember to quote the Danish National Research Foundation's Centre for Textile Research.

INTRODUCTION

One of the main objectives of the TTTC research program has been to record as many textile tools from as many types of sites as possible within our target area and date, Eastern Mediterranean in the Bronze Age. The majority of the registered tools are spindle whorls and loom weights, but other tools such as needles, shuttles, and spinning bowls have been recorded (a category termed 'uncertain' has been reserved for possible or unidentified textile tools).

The initial goal was to create a database to gather information on such diverse topics as textile tools in the neo-palatial and post-palatial periods; changes in loom weight shapes at a specific site; spindle whorls from different contexts in a particular period, and so on.

We have now processed the data from the sites investigated. The next step will be for all collaborators to incorporate the results in their individual site context description. After that, we will be able to attain the research program's primary aim: to elucidate the economic and cultural impact of textiles and the textile manufactures in Bronze Age Aegean and Near Eastern societies.

It is our hope that this will create new knowledge and also demonstrate the possibilities in this research field and encourage scholars to continue the work. This is the beginning, not the end.

This report is based solely on the information gathered from the textile tools, giving you the results of our analyses, which concern the physical material – its dimensions, material and find context: we have only given our interpretation from a "tool and textile craft perspective". It is up to you how you interpret this information and incorporate it into your context description.

While processing the data we have compiled all functional parameters, i.e. such parameters that affect textile production according to our experiments and knowledge. We have then compiled and compared the results chronologically and contextually. Following the main body of text you will find a short summary and our interpretation of the textile production based on your recordings, on the analyses of the material in the database, and on the site contexts.

As our interpretation is also based on different experiments you will in the beginning of the report find a short summary of the five experimental tests that have been conducted at CTR in the TTTC research program. For more detailed information please refer to the Experimental Archaeological TTTC reports that have been published on our webpage (www.hum.ku.dk/ctr).

In the new database file, which you receive with this report, you will find comments on tools that we have excluded as textile tools (in those cases they are also marked with a question mark in the field *Find Category*. Sometimes the data you provided, e.g. *the* *maximum length* or *weight,* is not plausible. This is also commented upon, and in those cases we have changed your recordings and written what we have done and why. If you have sent us pictures and/or drawings they are now linked to the database. To open them you have to click on the *Picture.*[1]

The questions we have processed in the database are saved in tables. You will find them under *Table,* but please note that they are not linked with the original tables. In this report you will find several tables and diagrams, and they are also available in the enclosed excel file.

Should there be any questions, please contact Eva, who will be happy to help.

[1] The program we have used to process the pictures is Microsoft Photo Editor and you need to have access to this program to be able to open them. The program was included in Microsoft Office until 2002 and you can download it from Microsoft's webpage.

Definitions

SPINDLE WHORLS

For the different types of spindle whorls please see the CTR Database Manual. Spindle whorl is abbreviated *SpW* in diagrams and tables. The spindle whorl measurements are presented in graphs. If both weight and diameter are recorded, these parameters are presented in the same diagram. In some cases the parameters are presented in separate diagrams (for example, if just the weight is recorded).

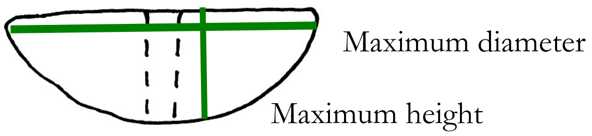

Figure 1. Example of spindle whorl demonstrating maximum diameter and height.

LOOM WEIGHTS

For the different types of loom weights please see CTR Database Manual. Loom weight is abbreviated *LW* in diagrams and tables. The loom weight measurements will be presented in diagrams. If both weight and thickness are recorded, these parameters will be presented in the same diagram. In some cases the parameters could be presented in separate diagrams (for example, if just the weight or the thickness is recorded).

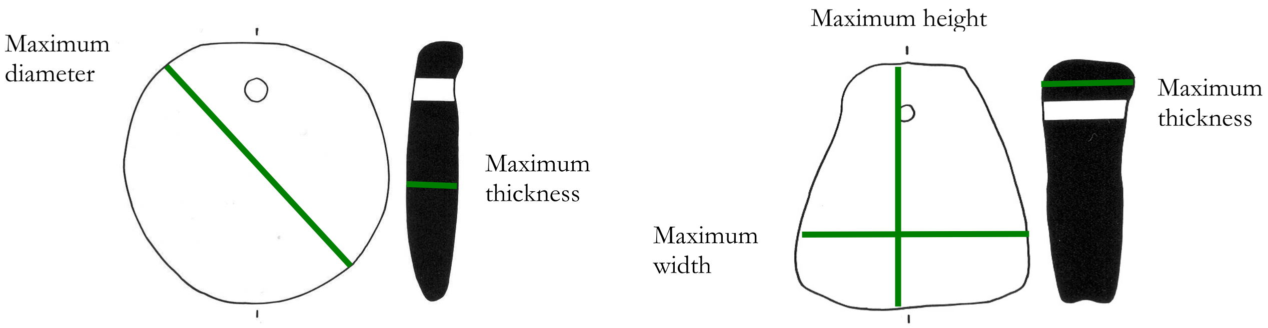

Figure 2. Example of loom weights demonstrating maximum diameter, thickness and width.

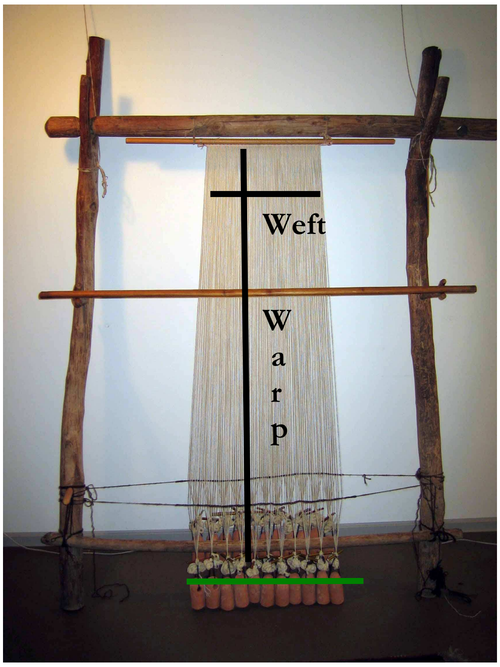

Figure 3. Warp weighted loom with the total width of loom weights in one setup.

Weaving Techniques

Different types of weaving techniques will also be discussed. The figures below demonstrate different technical expressions and techniques mentioned in the text. Evidence of tabby weaving exists from Bronze Age Crete. Since tabby weaving is considered the most common weaving technique during the Bronze Age, we have based our calculations on this type of fabric. A balanced tabby has more or less the same number of threads and the same type of threads in both warp and weft (figure 4a, 4c, 4d and 4e). A weft faced tabby is when the weft is covering the warp threads and there are more weft threads than warp threads (figure 4b). A fabric can also be open (figure 4a) or closed (figure 4d). However, one must bear in mind that there is an infinite amount of different types of tabbies. To our knowledge, the only preserved examples of twill (see figure 4f) are fragments from Alishar in Turkey dated to the late 4th millennium (Fogelberg and Kendall, 1937, 334-35; Barber 1991, 167-168).

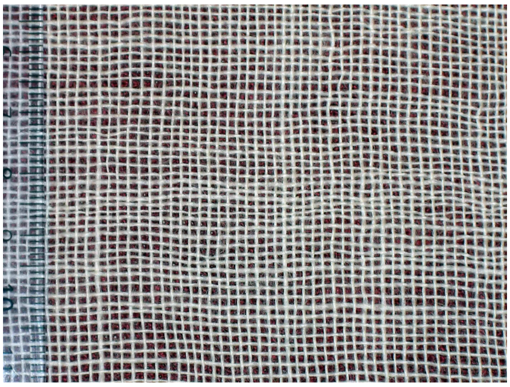

Figure 4a. Balanced open tabby, with an average of 6.1 warp threads and 7.4 weft threads per cm (wool fabric).

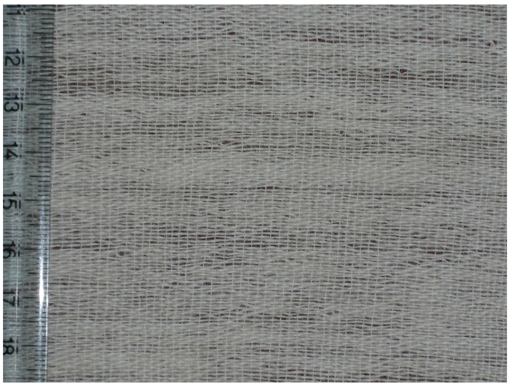

Figure 4b. Weft faced tabby, with an average of 5.8 warp threads and 14.8 weft threads per cm (wool fabric).

Figure 4c. Balanced tabby, 9 warp and 9 weft threads per cm (wool fabric).

Figure 4d. Balanced tabby, 14 warp and 14 weft threads per cm (linen fabric).

Figure 4e. Balanced tabby, 10 warp and 8 weft threads per cm (nettle fabric).

Figure 4f. 2/1 twill, 8 warp and 5 weft threads per cm (wool fabric). Note that this figure is only an example of a twill fabric; it is not a reconstruction of the fragment found in Turkey.

SPINNING[2]

The most common archaeological evidence for spinning consists of spindle whorls[3] and by analysing them one can gain knowledge of what types of yarn could be produced. Spindle whorls are generally used when working with a suspended spindle (figure 5).

[2] For more information, see also Mårtensson *et al.* 2006a; 2006b; 2006c.

[3] It is of course also possible to spin without a whorl, and whorls can be made of perishable materials. The absence of spindle whorls in the archaeological record is thus not an indication of the lack of spinning activity.

The spinning experiments with suspended spindles conducted in the TTTC program have confirmed that it is primarily the quality of fibres and the weight of the spindle whorl that affect the finished product, i.e. the spun yarn.

The spindle whorls tested in the TTTC experiments weighed 4g, 8g and 18g. The tests confirmed that when spinning with a suspended spindle and a similar type of fibres, the lighter the spindle whorl, the thinner thread will be (Mårtensson *et al.* 2006a; Mårtensson *et al.* 2006b; Mårtensson *et al.* 2006c). Previous tests with heavier spindle whorls have also demonstrated that the heavier the spindle whorl the thicker the thread will be (Holm 1996; Andersson 2003; Andersson and Batzer 1999; Mårtensson 2006).

Figure 5. Textile technician Linda Mårtensson is spinning with an 8g suspended spindle.

If one tries to spin a thin thread with few fibres per metre with a heavy spindle, the thread will break because of the weight of the spindle. On the other hand, if one spins a thick thread on a light spindle, the spindle will only rotate with much effort, and the yarn will not be strong enough to be used in a weave. It should, however, be noted that it is also of greatest importance how the fibres were prepared before spinning.

Sometimes the differences between types of yarn are not visible to the eye. One possibility, though, is to record how many meters of yarn can be produced when spinning identical fibres with different spindle whorls. The TTTC spinning tests clearly demonstrated that the lighter the whorl, the more yarn can be produced (figure 6). In general, a thin thread contains a smaller amount of fibre.

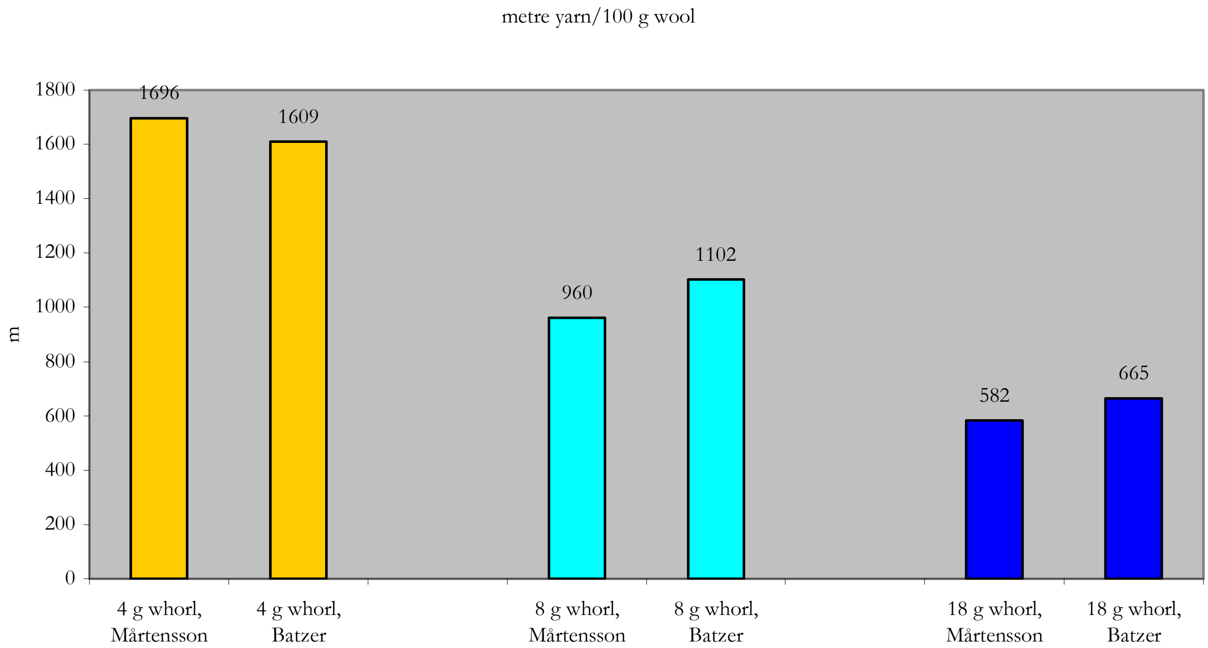

Figure 6. Length of spun yarn obtained from 100g wool, spun on 4g, 8g and 18g whorls respectively. The difference in yarn length can be explained by the fact that there is less fibre per meter in the thread spun with the 4g spindle than the 8g and the 18g spindle. The graph also demonstrates the relatively similar results obtained by the two spinners when using identical tools.

A yarn can be described in far more detailed ways than just as a thin or a coarse thread: as for example: hard or loosely twisted. This can be measured in the yarn twist angle. The twist angle is the angle at which the fibres are positioned in the spun thread, and is a measurement of how hard twisted the yarn is (figure 7). Previous tests have demonstrated that the relation between the weight and the diameter of the spindle whorl can affect the twist angle. If one is working with a light spindle whorl with a large diameter, the thread will be more hard twisted than if the whorl had a smaller diameter. The reason is that the whorl will rotate longer in the first case than in the second. It should, however, be noticed that it is possible to rotate the whorl additionally by hand, although this would take considerably more time (Holm 1996, 113-116). If the thread is loosely twisted, the fabric in general feels soft, and if the thread is very hard twisted the fabric can feel harder. These parameters do of course affect the quality of a fabric but without any textile finds it is difficult to estimate a specific twist angle just by analysing the diameter of the spindle whorls.

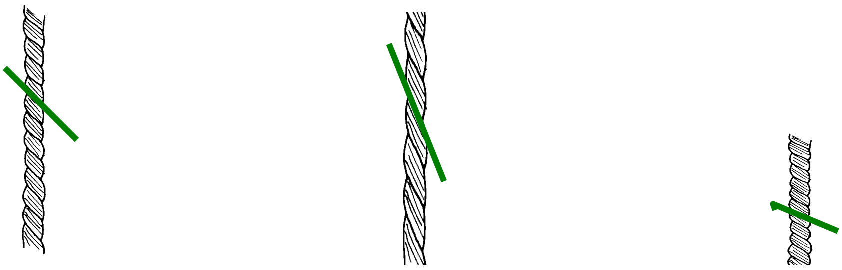

Figure 7. Twist angles.

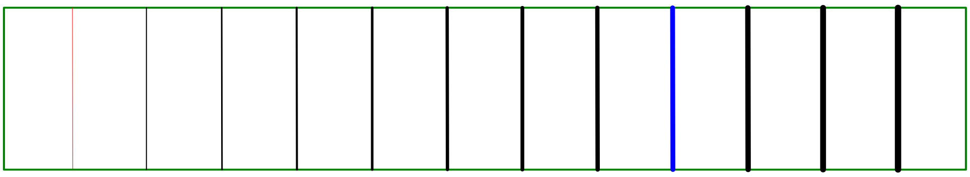

Figure 8. Variations from thinner to thicker "threads". The first line (red left) corresponds to a thread spun with the 4g spindle whorl, while the ninth line (blue) corresponds to a thread spun with a 44g spindle whorl.

According to our experience the height of the spindle whorl is of minor importance for the finished product.

As it is practically impossible to determine which types of yarn have been produced, we will just refer to thinner or thicker yarn (figure 8).

Different degrees of yarn coarseness also require different weight tension when the yarn is used as a warp on a warp weighted loom. If the tension on the warp threads is too low it will be difficult to change the shed. On the other hand, if the tension is too high the warp threads will break. According to our results a thread spun with a 4g spindle whorl requires a tension of 10g per warp thread and a thread spun with the 8g requires 20g. No weaving test was made in the TTTC program on the thread spun on an 18g spindle whorl, but previous tests confirm that the thicker the thread the more tension is needed. A yarn spun with a 44g spindle whorl needs approximately 40g tension (Batzer pers. com.).

WEAVING[4]

In the Aegean and Central Turkey, the most common archaeological evidence for weaving consists of loom weights used on a warp weighted loom. Since most parts of the vertical warp weighted loom were made of perishable materials they do not usually survive in the archaeological record. It is also possible that other types of looms were used, such as the vertical two beam loom, the back strap loom, or the horizontal loom - but since these types of loom are of completely perishable materials, it is hard to find any archaeological remains. The conclusion is that one cannot *exclude* weaving, when no loom weights are found.

[4] For more information see Mårtensson *et al.* 2006a; 2006b; 2006c; 2007a; 2007b.

Figure 9. Two rows of loom weights.

When producing a tabby weave, the loom weights are hanging from two thread layers (front and back). Every other warp thread is attached to a loom weight in the front layer, and every other warp thread to a loom weight in the back layer.[5] The loom weights in each row are positioned side by side (figure 9).

It is important that the warp threads are hanging vertically and evenly distributed. It is preferable that the row of loom weights has a total width which is identical or slightly larger than the width of the fabric to be produced (figure 10a). If the warp threads are slanting outwards (figure 10b), or inwards (figure 10c), the warp threads will not be evenly distributed, and this will affect the weaving and the resulting fabric negatively (Mårtensson *et al.* 2007a).

In previous tests (Batzer pers.com.), different scholars have established that the weight of loom weights influences weaving on a warp weighted loom. Different types of yarn need different tension and this limits how many warp threads can be attached to one loom weight. If the yarn needs 20g tension per warp thread, and the loom weight weighs 500g, one can attach approximately 25 warp threads to this loom weight. If, however,

[5] The warp weighted loom can be operated in several ways, depending on for example which weaving technique is employed, such as tabby or twill. The construction of the loom encourages creativity and personal ways of operating. Our assumption is that weaving was well-planned. By this we mean that planning and preparing of weaving as well as the selection of equipment was done consciously. Furthermore, that the weaver was experienced and knew what decisions should be taken in order to facilitate optimal production of textiles and to reach a desired result.

one uses a yarn that requires 50g tension, one can only attach 10 warp threads to the loom weight. Likewise, if one uses a loom weight with a weight of 300g, and a yarn that needs a tension of 20g per warp thread, one can attach only 15 warp threads to each loom weight, but if the required tension is 10g per warp thread, then the weaver can attach 30 warp threads.

The experiments conducted in the TTTC program have also clearly demonstrated that the thickness of a loom weight does play an important role when weaving, and hence that the choice of loom weights affects the fabric (Mårtensson *et al.* 2007a; Mårtensson *et al.* 2007b).

Figure 10a. The warp threads are hanging vertically and are evenly distributed.

Figure 10b. The warp threads are slanting outwards.

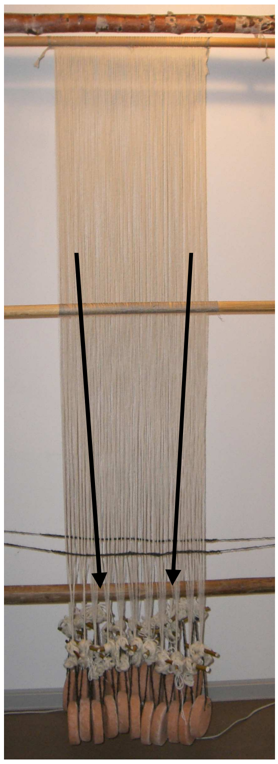

Figure 10c. The warp threads are slanting inwards.

The distribution of warp threads depends on the weight and the thickness of the loom weights. The experiments demonstrate that there is no advantage in attaching more than 30 threads to one loom weight. If more threads are attached, it will create problems during the set up and weaving, thereby affecting the final product. On the other hand, if just a couple of threads are attached to one loom weight, considerably more loom weights will be needed, thus also creating problems.

The weaving tests have confirmed that if the weaver wants to produce an open fabric using thick yarn, (s)he would have to choose heavy and thicker loom weights; if (s)he wants to weave a coarse and dense fabric, (s)he would have to choose heavy but thinner loom weights. On the other hand, if (s)he wanted to produce an open fabric or a weft faced fabric using thin yarn, (s)he would have to choose light and thick loom weights.

Finally, if (s)he would like to weave a dense fabric using fine yarn with many threads per cm, she would prefer light and thin loom weights (Mårtensson *et al.* 2007a; Mårtensson *et al.* 2007b).

In conclusion, recording weight and maximum thickness of loom weights and combining this data with the results of experimental weaving, makes it possible to suggest the kind of textiles that could have been produced with a given yarn quality.

FROM LOOM WEIGHT RESEARCH TO INTERPRETATIONS OF FABRICS.

In this report, we will give some examples of what types of fabric could have been produced with your recorded loom weights. Based on the calculations we have made an evaluation of what we interpret as the most likely choice of tool in relation to fabric. Please note that these suggestions are based on our experience and experiments but are on the other hand conjectural as to what is optimal.

With the loom weights from your site, we have made an assessment of the various types of loom setups and possible resulting fabrics, dividing them into the *TTTC choice*, *Possible*, and *Unlikely*.

- The *TTTC choice* means that 5-30 warp threads per loom weight would be the most functional choice for an optimal production
- *Possible* means that 30-40 or 4 warp threads per loom weight could be possible but not optimal. More than 30 warp threads will create problems during the set up and during weaving. Too many warp threads on one loom weight will make it difficult to distribute the warp threads evenly in the fabric. Less than 4 warp threads per loom weight require very many loom weights in the set up, and here the thickness becomes essential in that consequently only thin loom weights can be accommodated in a row corresponding to the total width of the fabric. Although such scenarios are possible, they remain impractical and hence not optimal.
- *Unlikely* means that attaching more than 40 or less than 4 warp threads to one single loom weight is not functional and even counterproductive; we consider these setups unlikely on a loom.

We will show the results in tables and you will also find a calculation of the fabric, which we consider the most likely to produce with the specific loom weights. We have based our calculations on a warp length of 2 m and a width of 1 m. There is also an estimate of how many loom weights and how many metres of yarn would be needed for such a loom setup. The calculations will illustrate the specific textile production on the site.

However, please note that several loom weights could be used for various types of fabrics and that consequently there can be more than just one *TTTC choice*.

The example below is not based on any archaeological loom weight, but demonstrates how the calculations are made. There is also an estimate of how many loom weights and how many metres of yarn would be needed for such a loom setup. The calculations will illustrate the specific textile production on the site.

To elucidate our interpretation of loom weights and our suggestions of TTTC choice of tools for a fabric you will find an example below.

The following is our interpretation of the fabrics resulting from the use of a loom weight with a weight of 150g and a thickness of 20 mm. The example demonstrates how such a loom weight functions with various types of warp yarn. The weight of the 150g loom weight defines how many warp threads can be attached to it.

If a thread requires 10g warp tension (A), the weaver must attach 15 threads to each loom weight. On the other hand, if a warp thread requires 30g tension (C), the weaver can only attach 5 warp threads to each loom weight.

The loom weight has a thickness of 20 mm. In case A, the 15 warp threads from the loom weight in the front layer and the 15 warp threads from the back layer must be packed in the space of 20 mm. The result is a dense fabric with 15 warp threads per cm. In case C, the 5 warp threads in the front layer and the 5 warp threads in the back layer will be packed in the space of 20 mm. The result is an open weave with 5 warp threads per cm.

Loom weight TTTC-XXX: weight 150g, thickness 20 mm				
	A	B	C	D
Warp threads requiring	10g warp tension	20g warp tension	30g warp tension	40g warp tension
Numbers of warp threads per loom weight	15	7.5	5	3
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	30	15	10	6
Warp threads per cm	15	7.5	5	3
TTTCs' evaluation of suitability of the tool	TTTC choice	TTTC choice	TTTC choice	Unlikely

Figure 11. Calculations of loom setups with a loom weight weighing 150g and with a thickness of 20 mm.

As suggested in figure 11 this type of loom weight is suitable when weaving with thin yarn requiring little tension. Both a warp thread with 10g tension (A) and 20g tension (B) would function well but the fabric with the 20g tension will become more open (or weft faced). If the warp thread of 30g tension (C) is used, the weaver can just attach 5 warp threads per loom weight and the fabric will become quite open (or weft faced). Finally, if the weaver chooses a thread with a 40g (D) warp tension, (s)he can only attach 3-4 threads per loom weight and the fabric will be very open. In case D it would have been much easier to choose a heavier and thicker loom weight.

If we focus on the best choice A, we can hypothesise the following loom setup:

Loom setup (calculated on 10g warp tension)
Starting border (width of the fabric): 100 cm
Number of loom weights needed: 100
Numbers of warp threads: 1500 threads, 2 m each = 3000 m
Weft 1: if a balanced tabby = 3000 m
Weft 2: if a weft faced tabby = 6000 m
Total amount of yarn with weft 1 (+ 2%) = 6120 m
Total amount of yarn with weft 2 (+2%) = 9180 m

It is possible to calculate the necessary yarn for producing specific fabrics. The required amount of yarn depends on the number of threads per square cm.

The calculations are all based on a fabric with a length of 2 m and a width of 1 m. If the fabric contains 15 warp threads and 15 weft threads per cm, 3000 m warp threads and 3000 m weft threads is needed, in total 6000 m. However if it is weft faced, the double amount of weft thread is needed, in thus a total 9000 m

A tabby is the result of two thread systems crossing each other at right angels. Even if both the warp and weft threads are taut, the threads will never be fully stretched or lie completely straight since they cross over and under each other. Furthermore, it is not technically possible to weave the last part of the warp, meaning that there will always be some waste warp yarn. For these reasons, one has to add approximately 2-5% more yarn when calculating the need of yarn for one setup. In our calculations, we have chosen to add 2% more yarn for the calculated setups.

The never-ending work with textile production

The time needed to spin a specific amount of yarn is difficult to calculate and it depends on a variety of parameters such as the spinner's skill, the quality of the fibres, and the tool. The TTTC experiments demonstrated that our two technical technicians spun a similar length of wool yarn when using identical tools and fibres. Furthermore, they spun at a similar speed. In average they spun:

- 35 m yarn per hour when spinning with a 4g spindle whorl,
- 40 m yarn per hour when spinning with an 8g spindle whorl, and
- 50 m yarn when spinning with an 18g spindle whorl.

To this the time for sorting wool and preparation of fibres must be added.

The example above (A) demonstrates the substantial requirements of yarn. According to the TTTC experiments, the production of thread for a balanced tabby would take approximately 175 hours to spin on a 4g spindle whorl, and 262 hours to spin the thread on a 4g spindle whorl for a weft faced tabby (Mårtensson *et al.* 2006a; 2006c).

No time study of the weaving process was conducted in the TTTC experiments but earlier experiments state that about 70 cm could be woven per day on a warp weighted loom (pers.com. Anne Batzer). To this must be added time for setting up the loom and for finishing.

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Textile tools from Arslantepe, Turkey

A total number of 312 objects were recorded in the database (figure 1). As can be seen in figure 2, 275 of the 312 objects could be divided into different contexts and periods.

	LW	SpW	P R Sherd*	P R stone	Brush	Comb	Double pointed tool	Pointed tool	Needle	Shuttle	Spool	Beater	In allr
VII?		1											1
VII	23	40	12						3		1		79
VII / VI A			1										1
VI A?		1											1
VIA	21	8				1			1	5	1		37
VI A / VI B			2										2
VI A / VI B1			1							1			2
VI A / VII		1											1
VI B1	1	2	3							1			7
VI B1-2			1										1
VI B2	1	12	7						1				21
VI B2 / VI C			1							1			2
VI C?			1										1
VI C	1	4	9			1				2			17
VI C/D		1							1				2
VI C / VI D1		1											1
VI D?		1											1
VI D	1	4	4			1							10
VI D / V A			1										1
VI D2		2	2			1			1		4		10
VI D2 / V A	1												1
VI D3					1								1
V?			1										1
V	1	1											2
VA?	2	2	1							1			6
VA	64	1	8	1	2		1	1	1	7	2		88
VA1	1												1
VA2			1							1			2
?		6	4						1			1	12
In all	117	88	60	1	3	4	1	1	9	19	8	1	312
	LW	SpW	P R Sherd*	P R stone*	Brush	Comb	Double pointed tool	Pointed tool	Needle	Shuttle	Spool	Beater	In all

* pierced rounded, pierced or rounded

Figure 1. The total number of objects recorded in the CTR database.

			LW	Spool	SpW	P R Sherd*	P R stone*	Other textile tools	In all
VII	Settlement	Household	23	1	19	10		1	54
		Pit			5			2	7
		Other			14	2			16
		Workshop			2				2
VI A	Settlement	Household	19		3			1	23
		Pit	1					3	4
		Other						2	2
	Palace	Household			1				1
		Other	1	1	4			1	7
VI B1	Settlement	Household			1	3			4
		Pit	1						1
		Other			1			1	2
VI B2	Settlement	Household	1		8	4		1	14
		Pit			3	3			6
		Other			1				1
VI C	Settlement	Household			1	1			2
		Pit	1		2	1		3	7
		Other			1	7			8
VI D	Settlement	Household		4	2	2		2	10
		Pit			1	1		1	3
		Other	1		3	3		1	8
V	Settlement	Household	57			4		3	64
		Pit	4		1	3	1	6	15
		Other	5	2	1	2		4	14
	In all		114	8	74	46	1	32	275

* pierced rounded, pierced or rounded

Figure 2. Chronological distribution of the recorded objects.

Spinning and spindle whorls in Arslantepe

88 objects from Arslantepe are spindle whorls, of which 74 have come from stratified layers. As can be seen in figure 2 and 3, 40 spindle whorls are dated to period VII, 32 spindle whorls are dated to phases in period VI, and 2 are dated to period V (figure 2 and 3).

Material

The majority of the spindle whorls from period VII are made of bone. During the periods VI-V, the types of material change slightly, in particular during period VIB2 where there is an equal distribution of spindle whorls made of clay, stone or bone (figure 3). It can also clearly be seen that the bone spindle whorls differs from the stone and clay spindle whorls in that that they form a more homogeneous group regarding weight and diameter (figure 4). A problem is, though, that it is hard to calculate if and how much weight the bone whorls have lost over time. It is reasonable to believe that they originally were slightly heavier. Interesting is also that the bone whorls' diameter is much larger in relation to weight compared to the whorls made of stone and clay. This could of course be due to the fact that the bone whorls are mostly made of *bos femur* heads which naturally have large diameter. A functional reason could be that whorls with a large diameter are well suited for spinning a hard spun thread (see below).

		Clay	Stone	Bone	Metal	Not available	
VII	Spherical		1				Spherical
	Convex	1		17			Convex
	Discoid		7			1	Discoid
	Conical	1		10			Conical
	Biconical	1		1			Biconical
	Cylindrical						Cylindrical
	Not available						Not available
VI A	Spherical						Spherical
	Convex			4	1		Convex
	Discoid		1				Discoid
	Conical						Conical
	Biconical						Biconical
	Cylindrical		1				Cylindrical
	Not available				1		Not available
VI B1	Spherical						Spherical
	Convex			1			Convex
	Discoid						Discoid
	Conical			1			Conical
	Biconical						Biconical
	Cylindrical						Cylindrical
	Not available						Not available
VI B2	Spherical						Spherical
	Convex		2	3			Convex
	Discoid						Discoid
	Conical		2				Conical
	Biconical	4		1			Biconical
	Cylindrical						Cylindrical
	Not available						Not available
VI C	Spherical						Spherical
	Convex						Convex
	Discoid						Discoid
	Conical		2	1			Conical
	Biconical	1					Biconical
	Cylindrical						Cylindrical
	Not available						Not available
VI D	Spherical						Spherical
	Convex		1	2			Convex
	Discoid						Discoid
	Conical			2			Conical
	Biconical			1			Biconical
	Cylindrical						Cylindrical
	Not available						Not available
V	Spherical	1					Spherical
	Convex			1			Convex
	Discoid						Discoid
	Conical						Conical
	Biconical						Biconical
	Cylindrical						Cylindrical
	Not available						Not available
		Clay	Stone	Bone	Metal	Not available	

Figure 3. Chronological distribution of spindle whorls in shape and material.

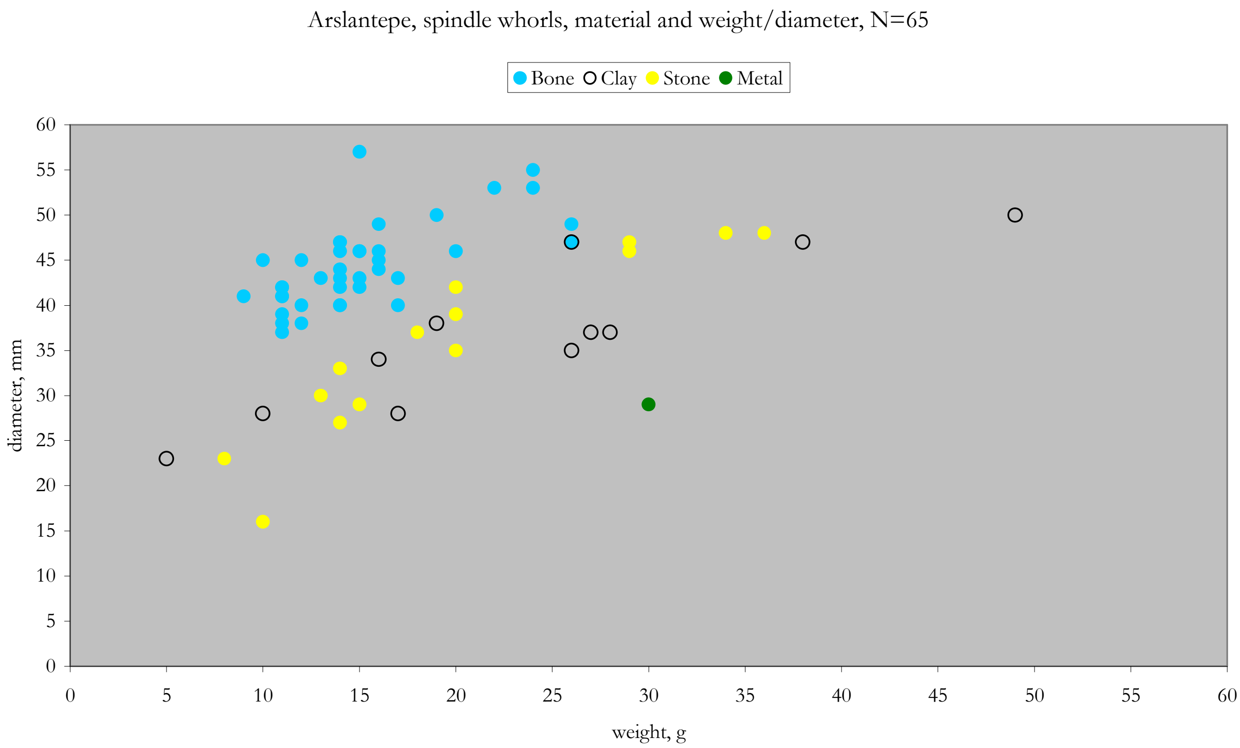

Figure 4. The relationship between material and weight/diameter.

Shape

No changes can be seen in shape over the time span. The spindle whorls made of bone are generally convex or conical in shape. The shape of the spindle whorls made of clay is mostly biconical or conical, while the spindle whorls made of stone frequently have a discoid or convex shape (figure 5). Thus, there is a clear relation between shape and material. However, there is no clear relation between the shape of the spindle whorls and their weight/diameter. As can be seen in figure 6, conical, biconical, convex, discoid and spherical shapes are recorded for a large variety of weights and diameters.

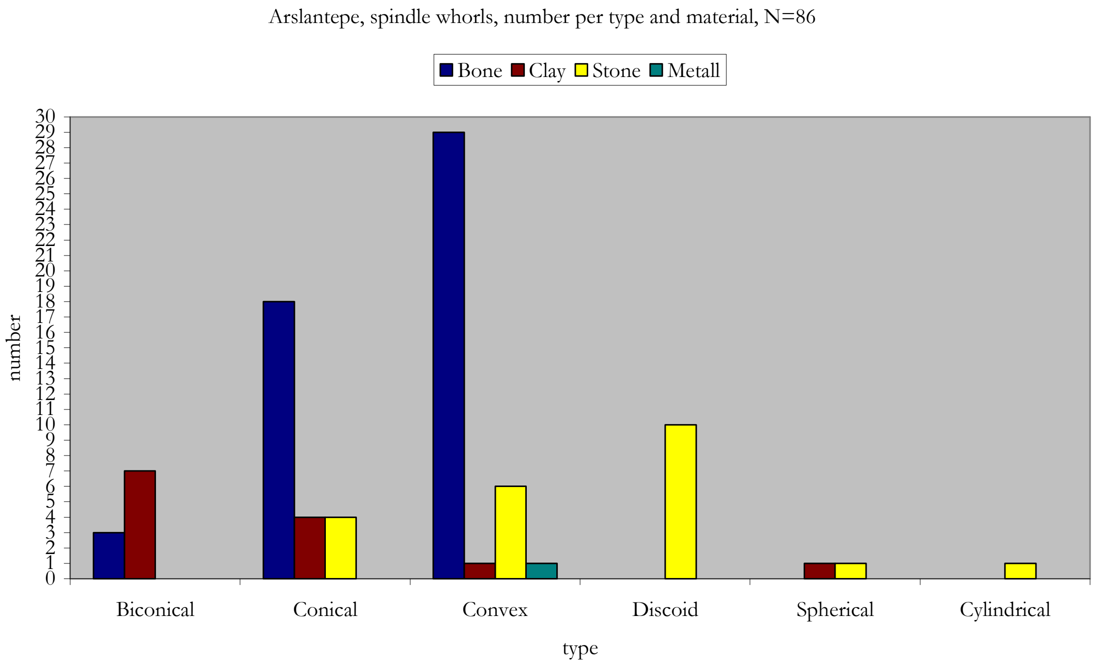

Figure 5. The relationship between shape and material.

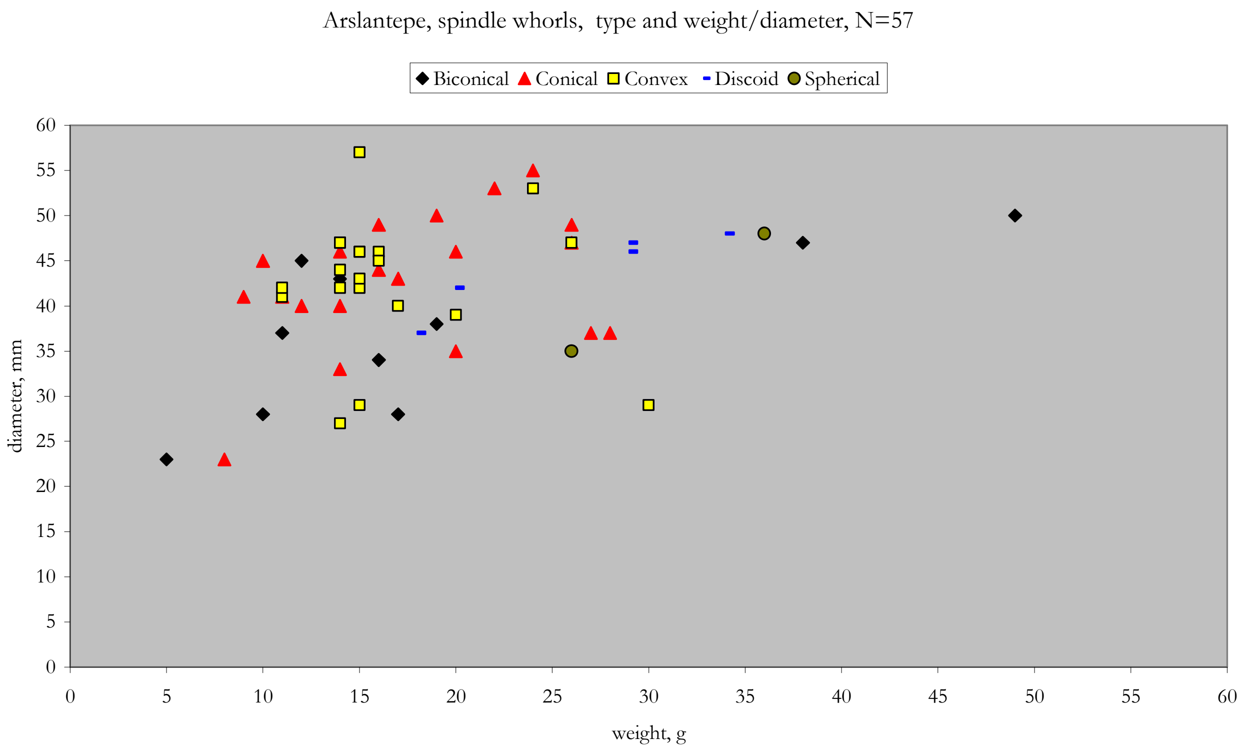

Figure 6. The relationship between shape and weight/diameter.

Fragmentary spindle whorls - Calculated weight

A comparison between the complete spindle whorls (45 objects) and the spindle whorls with small fragments missing (20 objects) demonstrates that they all fall within the same weight range. We estimate that the margin of error in the calculation of weight of whorls with small fragments missing is less than 10% (1g for a spindle whorl weighing 10g, 2g for a spindle whorl weighing 20g, and so on). This variation of 10% would not have affected the finished product of the spindle whorls and we have therefore decided to include the spindle whorls with small fragments missing in this study (figure 7).

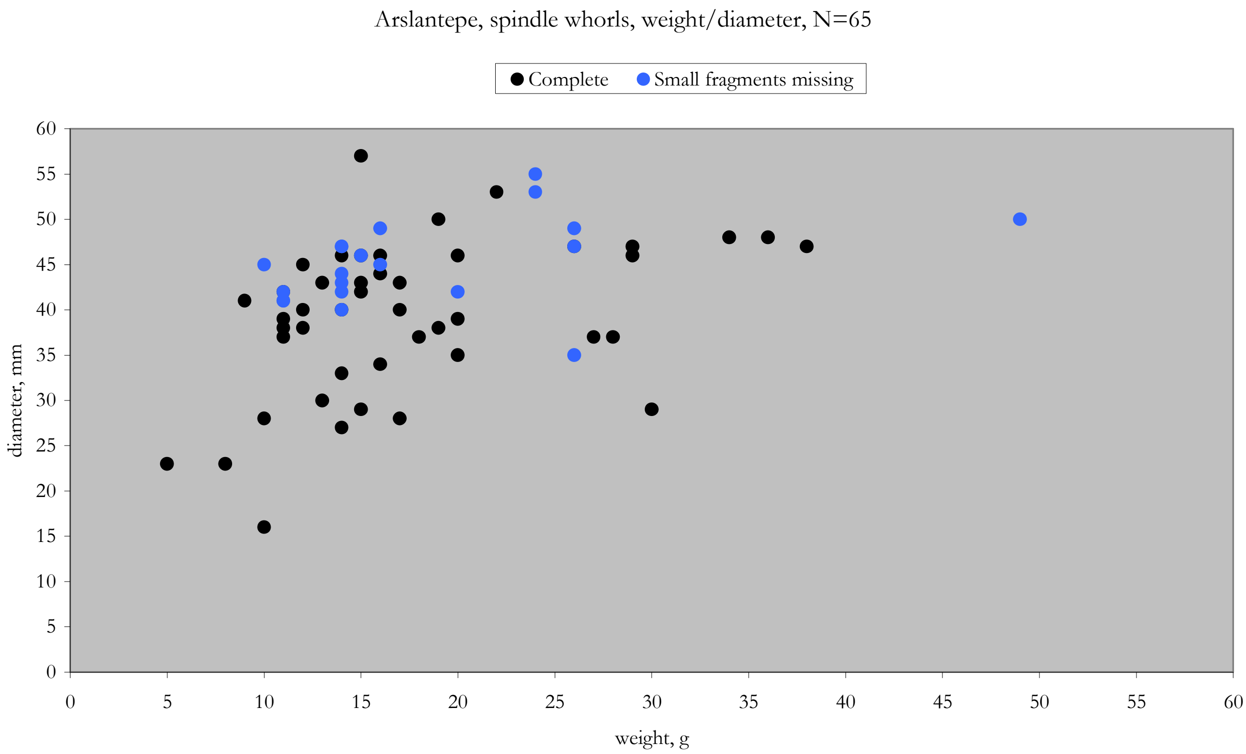

Figure 7. Complete and slightly fragmentary spindle whorls.

Weight and diameter

As can be seen in figure 7 the whorls vary in weight from 5g to 49g and the diameter varies from 23 mm to 55 mm. 51 spindle whorls with preserved weight and thickness have been found in dated contexts. During period VII, all whorls weighing less than 26g are made of bone, while the during periods VI-V the light whorls are also made of other materials such as clay and stone. These light clay and stone whorls, however, have a smaller diameter than the bone whorls of period VII.

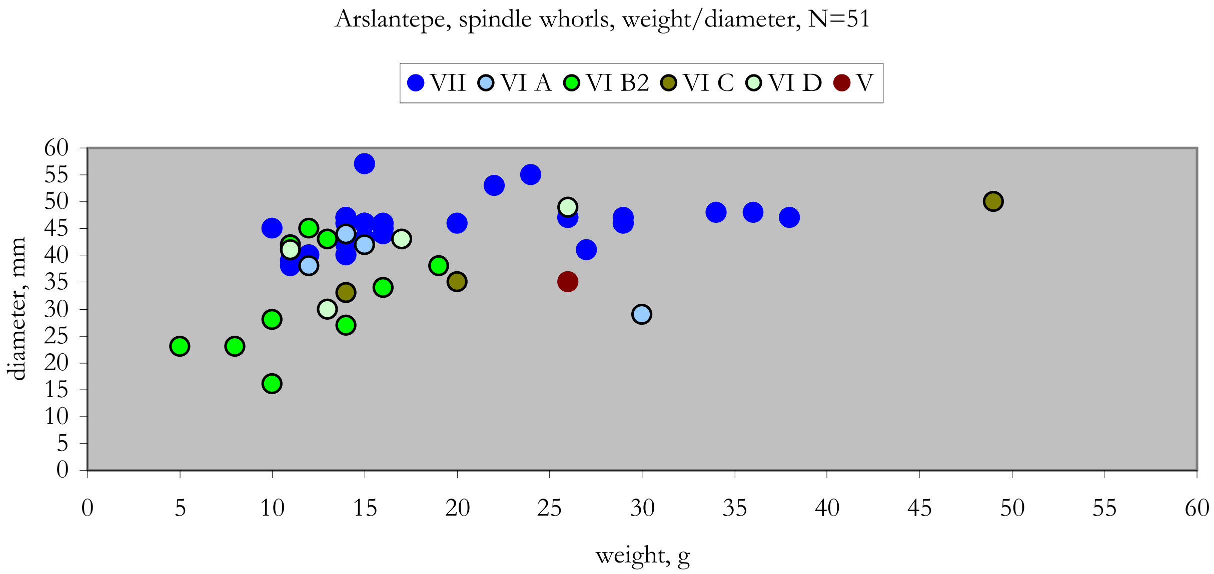

Figure 8. The relationship between date and weight/diameter.

Figure 8 clearly shows that spindle whorls from period VII form a distinct group and so do the spindle whorls from period VI B2. One could suggest a shift in textile production starting in period VI B2. Regarding the few spindle whorls (4 objects only) in the intermediate period VI A, they can not be placed securely in neither the VII group or in the "new" VI B2 group (figure 8).There is small, but significant, difference between period VII and periods VI-V in the variation of the spindle whorls' weight and diameter (figure 8). The weight of the whorls varies between 10g and 38g during period VII, while it falls between 5g and 49g during period VIB2-V. In diameter the whorls vary between 38 mm and 57 mm during period VII, and between 23 mm - 50 mm during period VI-V. Thus, the range of weights and diameters in spinning tools of period VI-V seems larger than in the previous period. The textile production seems to evolve into a larger variety of yarns from period VII to periods VI-V.

Context

During all periods from VII to V, spindle whorls are most frequently found in household contexts (figure 2). There is no larger variation in weight and diameter in period VII between spindle whorls found in household contexts, pits or other contexts. During period VI, the spindle whorls found in household contexts are more concentrated in the weight range of 10-20g compared to the whorls found in pits and other contexts which have a larger weight distribution. There is no visible variation between spindle whorls occurring in the palace area and spindle whorls occurring in the settlement area. However, these observations are based on very few objects.

Discussion

How can these results be interpreted? According to the tools, the variation of the whorls' weight during period VII demonstrates that the spinners in Arslantepe could spin different types of yarn, from thin to thick. Since the whorls' diameter generally is quite large, the yarn must generally have been quite hard spun.

From VI B2 a change in the spindle whorls can be observed: The variations in weight and diameter within the group of spindle whorls from this period increase compared to previous periods. In general, in periods VI B2-V, the whorls are lighter and the diameter smaller compared to period VII, which demonstrates that the spinners in Arslantepe in period VI B2-V could spin very thin but also less hard spun yarn in comparison to the earlier periods. The change in the whorls' diameter demonstrates the possibility to produce a softer and more loosely spun yarn. There is still a production of thicker yarn from period VI B2, but the production seems smaller than in previous periods.

The observed change in the textile tools may be due to several factors. The number of objects is small and the analysis cannot be considered statistically correct or representative for Arslantepe in general. Still, the change is quite visible according to the recorded spindle whorls. One possible explanation could be a change in the fibre material. The spindle whorls from Arslantepe can be used for spinning both wool and linen yarn but when spinning plant fibre it is preferable to use a spindle whorl with a large diameter. The sheep's wool did also evolve during this time span and it is likely that the wool fibres became more varied in quality. As a result, the fibres could be sorted into several more quality categories than previously (see also Mårtensson 2007a). The categories would be used to produce textiles in a variety of qualities.

PIERCED ROUNDED SHERDS

59 objects from Arslantepe are pierced rounded sherds and 1 is a pierced stone. As can be seen in figure 2 these objects occur in all periods, VII-V, but are most common in period VIB-VIC. They are found in the settlement areas and in different contexts: households, pits and others. Figure 9 shows that the weight of the objects generally varies from 8g to 125g and their diameter vary from 34 mm to 84 mm. During period VII, the objects' weight varies from 8g-56g and their diameter vary from 34 mm to 74 mm. However, during period VI and V, the variation in weight is larger: the weight varies from 11g to 125g and the diameter varies from 34 mm to 84 mm (figure 9). Most of these objects are rounded but the shape is in general irregular and the hole is often not centred. If a spindle whorl does not have a regular shape it will not rotate in an optimal way: it will be hard to spin with and the spun yarn is likely to be unevenly spun. 51 out of 61 of these pierced objects are made in a poor production quality. For these reasons it is difficult to interpret these objects as spinning tools, since they cannot have functioned in an optimal way.

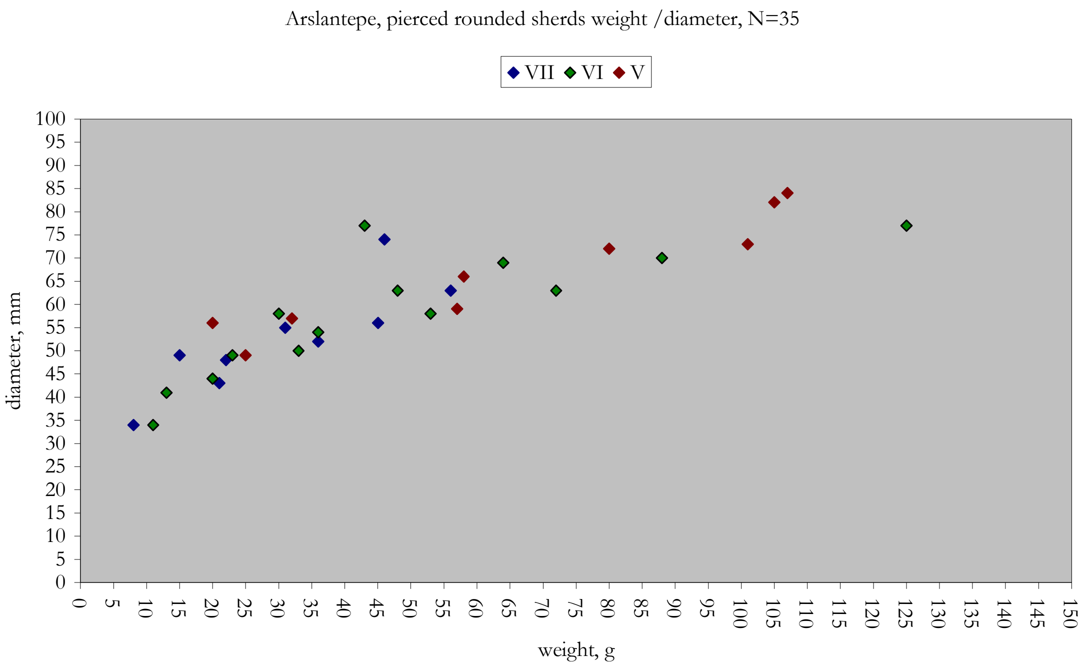

Figure 9. The relationship between date and weight/diameter.

Weaving and loom weights

Loom weights

117 objects have been recorded as loom weights of which 114 come from stratified layers (figure 1 and 2). One weight (ARS-033) was excluded as loom weight because its weight is so low (25g) that it would not have been functional as a weight in a warp weighted loom. 23 loom weights are dated to period VII; 25 loom weights are dated to period VI; and 66 loom weights are dated to period V.

Spools

Eight objects have been recorded as spools, and they occur during all periods VII-V (figure 2). Seven of the eight spools are very light: the weight varies from 5g-40g, and these spools cannot have been functional in a warp weighted loom. The spools are therefore excluded from this discussion of weaving and loom weights**.** Two of the spools with a weight of 31g and 40g respectively could have been used as weights in a band weave, but the other five spools are too light even for this type of weaving (figure 10).

It is difficult to interpret these tools' function, but one possible suggestion is that the spools were used when the weavers were warping for the setup (see Mårtensson *et al.* 2007b). Another suggestion is that they were used as shuttles on which the weft yarn was winded up.

Figure 10. Spool ARS -197.

Material

All 23 loom weights from period VII are made of unfired clay. In period VI, the use of material changes and instead the majority of the loom weights (25 of 26 objects) are made of fired clay. Also during period V, the majority of the loom weights (38 of 66 objects) are made of fired clay and only 16 loom weights are made of unfired clay (figure 11).

Shape and type

The analysis of the distribution of different types of loom weights demonstrates a clear change in the loom weights' shapes between the different periods (figure 11). During period VII, 18 of 23 loom weights have a hemispherical shape; during period VI 17 of 25 loom weights have a conical shape; and, finally, during period V 36 loom weights have a discoid elliptical shape.

However, all 23 loom weights from period VII are from the same context (*area A923*). 18 loom weights dated to period VI A are also from one single find context namely *Square D7 (2), residential room* A933. During period VI, no less than 55 of 66 loom weights are from one single context, *Square D8(4), room A58*. To conclude: we are dealing with three periods and three distinct contexts. The difference in material and type between the three periods does not necessarily represent a change over time or in the production, but may be due to the nature of the three different contexts.

Fragmentary loom weights - Calculated weight

49 loom weights are recorded as *complete* or *small fragments missing*. A comparison between the complete loom weights and the loom weights with small fragments missing demonstrates that they all fall within the same range (figure 12). We judge that the margin of error is less than 10% and have included loom weights with small fragments missing in this analysis.

		fired clay	unfired clay	stone	not available
VII	conical				
	discoid elliptical				
	flat rectangular				
	flat trapezoidal				
	hemispherical		18		
	spherical ovoid				
	spherical rounded				
	not available		5		
VI A-VI B1	conical	17			
	discoid elliptical	1			
	flat rectangular				
	flat trapezoidal				
	hemispherical	1			
	spherical ovoid	2			
	spherical rounded			1	
	not available				
VI B2-VI D	conical				
	discoid elliptical	2			
	flat rectangular				
	flat trapezoidal				
	hemispherical				
	spherical ovoid	1			
	spherical rounded				
	not available				
V	conical				
	discoid elliptical	28	8		1
	flat rectangular	2	2		
	flat trapezoidal	2			
	hemispherical	1	1		
	spherical ovoid				
	spherical rounded				
	not available	5	5	2	9

Figure 11. The relationship between date and type/material.

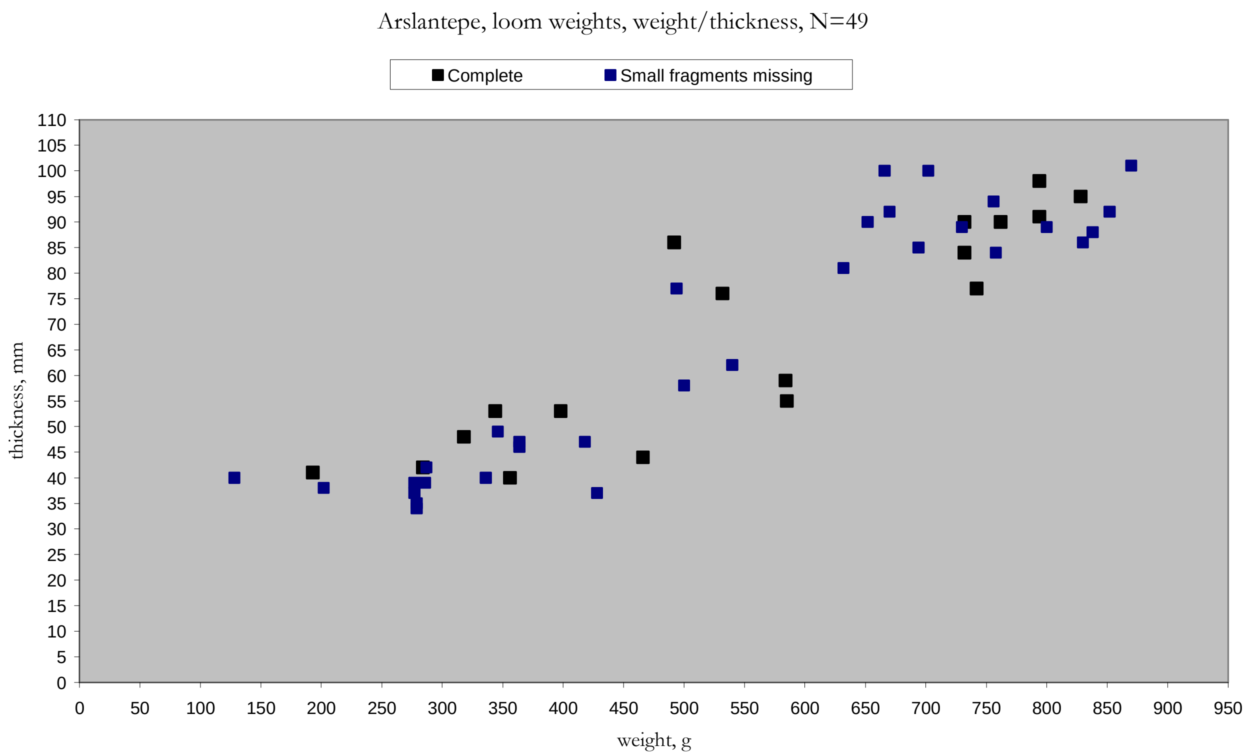

Figure 12. Complete and slightly fragmentary loom weights..

Weight and thickness

46 loom weights with intact weight and thickness have been found in dated contexts and we have focused on them in the following analysis. The is a clear difference in the loom weights' weight and thickness between the loom weights from on one hand period VII and VI A and on the other hand the loom weights dated to period V. The loom weights from period VII and VIA are generally heavier and thicker than the loom weights from period VI (figure 13).

Period VII, Area A923

The 23 loom weights found in context Area A923 are all made of unfired clay. 18 loom weights have a hemispherical shape. It has not been possible to determine the shape of 5 weights. We have calculated the weight and thickness of 12 loom weights: the weight varies from 492g to 870g and the thickness varies from 77 mm to 101 mm (figure 13).

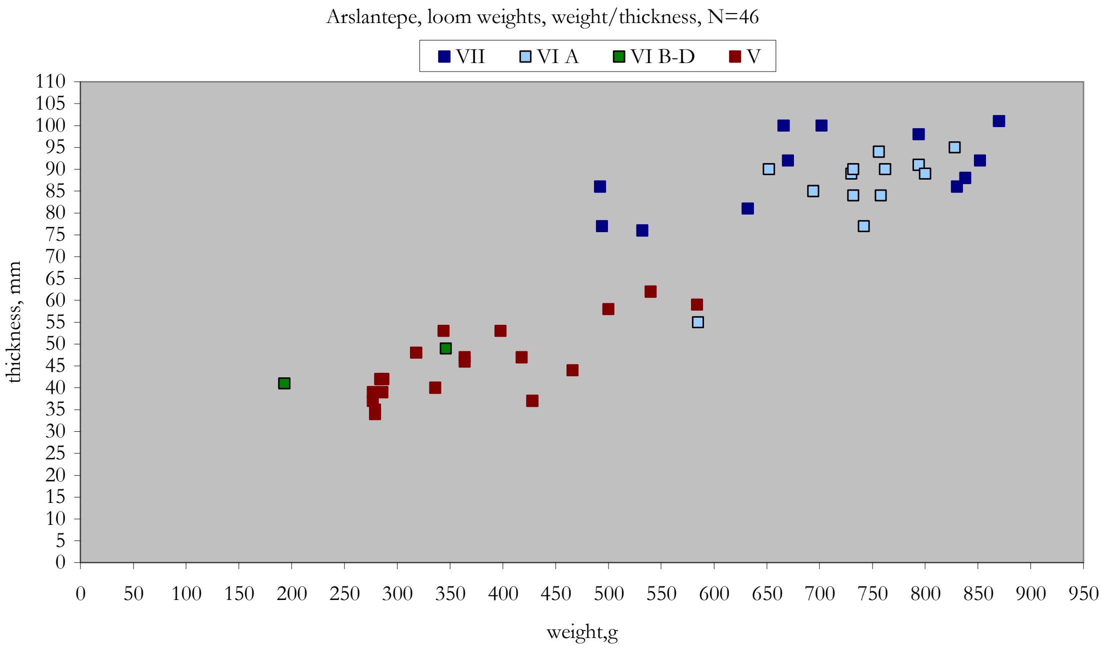

Figure 13. The relationship between date and weight/thickness.

To elucidate our interpretation of the loom weights we have calculated possible loom setups on the basis of three weights from this context and suggested which fabrics we consider the most likely result. We have chosen the lightest loom weight, the heaviest loom weight and finally the loom weights which represent the average of the loom weights. Please note, that these suggestions are based on our experience and experiments but are on the other hand conjectural as to what is optimal.

Loom weight ARS-165: weight 492g, thickness 86 mm				
	A	B	C	D
Warp threads requiring	10g warp tension	20g warp tension	30g warp tension	40g warp tension
Numbers of warp threads per loom weight	49	25	16	12
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	98	50	32	24
Warp threads per cm	11	6	4	3
TTTC's evaluation of suitability of the tool	Unlikely	TTTC choice	Possible	Unlikely

Figure 14. Calculation of possible loom setups with loom weight ARS-165.

Loom weight ARS-163: weight 666g, thickness 100 mm				
	A	B	C	D
Warp threads requiring	10g warp tension	20g warp tension	30g warp tension	40g warp tension
Numbers of warp threads per loom weight	67	33	22	17
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	134	66	44	34
Warp threads per cm	13	7	5	3
TTTC's evaluation of suitability of the tool	Unlikely	Possible	TTTC choice	Unlikely

Figure 15. Calculation of possible loom setups with loom weight ARS-163.

Loom weight ARS-159: weight 870g, thickness 101 mm				
	A	B	C	D
Warp threads requiring	10g warp tension	20g warp tension	30g warp tension	40g warp tension
Numbers of warp threads per loom weight	87	44	29	22
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	174	88	58	44
Warp threads per cm	17	8	6	4-5
TTTC's evaluation of suitability of the tool	Unlikely	Unlikely	TTTC choice	TTTC choice

Figure 16. Calculation of possible loom setups with loom weight ARS-159.

The calculations demonstrate, that the fabrics produced with these loom weight would have had 5-6 threads per cm in warp and weft (if weft faced 10-12 weft threads per cm). A warp thread of 30g tension would function well on the loom weights ARS-163 and ARS-159. A warp thread of 20g tension would also function well with the light loom weight ARS-165 and a warp tension of 40g would function on the heavy loom weight.

According to our experience, the calculations demonstrate that it would be possibly to use the loom weights ARS- 163 and ARS 159 in the same set up, since one can use a warp thread with 30g tension. Nevertheless, it would be optimal if one chose to work with just the lighter and thinner loom weights, or just the heavier and thicker in different setups. We therefore assume that these loom weights belong to 2 to 3 different sets of loom weight used in different setups.

When focusing on ARS-163 TTTC choice C, (figure 15) we suggest the following loom setup:

Loom setup (ARS 163) calculated on 30g warp tension
Starting border (width of the fabric): 100 cm
Number of loom weights needed: 20
Numbers of warp threads: 500 threads 2 m each= 1000 m
Weft 1: if a balanced tabby = 1000 m
Weft 2: if a weft faced tabby = 2000 m
Total amount of yarn with weft 1 (+ 2%) = 2040 m
Total amount of yarn with weft 2 (+ 2%) = 3060 m

The calculations also demonstrate that the amount of yarn needed is substantial. According to the TTTC experiments it would take approximately 41-61 hours to spin the thread needed to produce the fabric in this set up. Time for sorting and preparing the fibres is not included, neither nor time for preparing the set up, weaving and after finishing.

Period VI A, Room of a residential unit A933

All 18 loom weights from this context are made of fired clay. 17 loom weights have a conical shape and 1 is discoid elliptical.

6 objects are found in G1 and 11 in G2 and 1 loom weight is an isolated archaeological find. The weight and thickness of the loom weights are intact in 15 objects. As can be seen in the figure below, the weight varies from 585g to 828g, and the thickness of the loom weights varies from 55 mm to 95 mm (figure 13). The loom weight that was found alone is discoid elliptical in shape and is both lighter and thinner than the other loom weights.

To elucidate our interpretation of the loom weights, we have calculated possible loom setups on the basis of two weights from this context and suggested which fabrics we consider the most likely result. We have chosen the loom weight that was found alone, and the loom weight which represents the average of the loom weights in the two contexts. Please note that these suggestions are based on our experience and experiments but are on the other hand conjectural as to what is optimal.

Loom weight ARS-119: weight 585, thickness 55 mm				
	A	B	C	D
Warp threads requiring	10g warp tension	20g warp tension	30g warp tension	40g warp tension
Numbers of warp threads per loom weight	58	29	20	15
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	116	58	40	30
Warp threads per cm	21	11	7	6
TTTC's evaluation of suitability of the tool	unlikely	TTTC choice	TTTC choice	TTTC choice

Figure 17. Calculation of possible loom setups with loom weight ARS-119.

Loom weight ARS-244: 758 weight, thickness 84 mm				
	A	B	C	D
Warp threads requiring	10g warp tension	20g warp tension	30g warp tension	40g warp tension
Numbers of warp threads per loom weight	76	38	25	19
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	152	76	50	38
Warp threads per cm	18	9	6	4
TTTC's evaluation of suitability of the tool	Unlikely	Possible	TTTC choice	Possible

Figure 18. Calculation of possible loom setups with loom weight ARS-244.

The calculations demonstrate that the fabric in example ARS-119 could have had 6-11 warp and weft threads per cm. Warp threads with a tension from 20g to 40g would function best on this loom weight (figure 17).

The TTTC choice in example ARS-244, demonstrates a fabric with 6 warp threads per cm. A warp thread with a tension of 30g would function best on this loom weight (figure 18).

The 17 loom weights found together would probably function very well in the same loom setup and according to our experience a production with these loom weights could be considered optimal (figure19). Note, however, that the 17 loom weights cannot constitute a complete set of loom weights, as an equal number of weights is needed on the loom. Even if ARS 119 could function together with the other loom weights from this context we assume that it belongs to another set of loom weights.

The average of the weight and diameter of the 17 loom weights found in P VI A, ARS: weight 748g, thickness 88 mm				
	A	B	C	D
Warp threads requiring	10g warp tension	20g warp tension	30g warp tension	40g warp tension
Numbers of warp threads per loom weight	75	38	25	19
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	150	76	50	38
Warp threads per cm	17	9	6	4
TTTC's evaluation of suitability of the tool	Unlikely	Possible	TTTC choice	Possible

Figure 19. Calculation of possible loom setups with loom weights from Period VI A Room of a residential unit A933 G1 and G2.

The TTTC choice demonstrates a fabric with 6 warp threads per cm with 30g tension on each thread (figure 19).

If we focus on the TTTC choice C in this example we can hypothesise the following loom setup:

Loom setup: Loom weight with a weight of 748g and a diameter of 88 mm calculated with a warp thread with a 30g warp tension:
Starting border (width of the fabric): approximately 88 cm
Number of loom weights needed: 18
Numbers of warp threads: 528 threads 2 m each= 1056 m
Weft 1: if a balanced tabby = 1056 m
Weft 2: if a weft faced tabby = 2112 m
Total amount of yarn with weft 1 (+ 2%) = 2155 m
Total amount of yarn with weft 2 (+ 2%) = 3231 m

The calculations also demonstrate that the amount of yarn needed is substantial. According to the TTTC experiments it would take approximately 43-64 hours to spin the thread needed to produce the fabric in this set up. Time for sorting and preparing the fibres is not included, neither nor time for preparing the set up, weaving and after finishing.

Period V A Square D8(4), room A58

55 loom weights were found in this room; 13 of the loom weights were found on the first floor and the 42 of the loom weights were found on floor P2 or floor removal rP2.

Few parameters were available on the loom weights from the first floor, and they will therefore be excluded from this analyse. We will instead focus on the 42 loom weights found on floor P2.

As can be seen in figure 20 below, the majority of the loom weights were made of fired clay and of a discoid elliptical shape.

Type of loom weight	Fired clay	Unfired clay
Discoid elliptical	21	8
Flat rectangular	1	2
Flat trapezoidal	2	
Not available	4	4

Figure 20. The relationship between type/material.

It has been possible to ascertain the weight and thickness of 16 of the loom weights (figure 13). The weight of the loom weights varies from 277g to 584g, and the thickness of the loom weights varies from 37 mm to 59 mm. No variation in weight and thickness in relation to type or material can be seen.

To elucidate our interpretation of the loom weights we have calculated possible loom setups on the basis of three weights from this context and suggested which fabrics we consider the most likely result. We have chosen the lightest loom weight, the heaviest loom weight and finally the loom weights which represent the average of the loom weights. Please note, that these suggestions are based on our experience and experiments but are on the other hand conjectural as to what is optimal.

Loom weight ARS-139: weight 279, thickness 35 mm				
	A	B	C	D
Warp threads requiring	10g warp tension	20g warp tension	30g warp tension	40g warp tension
Numbers of warp threads per loom weight	28	14	9	7
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	56	28	18	14
Warp threads per cm	16	8	5	4
TTTC's evaluation of suitability of the tool	TTTC choice	TTTC choice	TTTC choice	Possible

Figure 21. Calculation of possible loom setups with loom weight ARS-139.

The calculation demonstrates that this type of loom weight could be very functional for quite a number of different fabrics with a variation yarn qualities (figure 21). Very thin thread can only be used on the loom with light and thin loom weights, like ARS-139. A setup of this type, however, requires a large number of loom weights, in this case at least 56 loom weights to produce a fabric with a width of one meter.

If we focus on the TTTC choice A on this example (ARS-139) we can hypothesise the following loom setup:

Loom setup (ARS 139) calculated on 10g warp tension

Starting border (width of the fabric): 100 cm
Number of loom weights needed: 56
Numbers of warp threads: 1600 threads 2 m each= 3200 m
Weft 1: if a balanced tabby = 3200 m
Weft 2: if a weft faced tabby = 6400 m
Total amount of yarn with weft 1 (+ 2%) = 6528 m
Total amount of yarn with weft 2 (+ 2%) = 9792 m

According to the calculation this fabric could be quite dense with 16 warp threads and 16 weft threads per cm, or if weft faced, 16 warp threads and 32 weft threads per cm. The calculations also demonstrate that the amount of yarn needed is substantial. According to the TTTC experiments it would take approximately 186-279 hours to spin the thread needed to produce the fabric in this set up. Time for sorting and preparing the fibres is not included, neither nor time for preparing the set up, weaving and after finishing. The time consumption and thread density suggest that this must have been a very valuable piece of cloth.

Loom weight ARS-128: weight 364g, thickness 46 mm				
	A	B	C	D
Warp threads requiring	10g warp tension	20g warp tension	30g warp tension	40g warp tension
Numbers of warp threads per loom weight	36	18	12	9
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	72	36	24	18
Warp threads per cm	15	8	5	4
TTTC's evaluation of suitability of the tool	Possible	TTTC choice	TTTC choice	Possible

Figure 22. Calculation of possible loom setups with loom weight ARS-128.

The TTTC choices demonstrate a fabric with 5-8 warp threads per cm with 20-30g tension on each thread and also this type of loom weight could be very functional for quite a number of different fabrics with a variation yarn qualities (figure 22).

If we focus on the TTTC choice B on this example (ARS-128) we can hypothesise the following loom setup:

Loom setup (ARS 128) calculated on 20g warp tension

Starting border (width of the fabric): 100 cm
Number of loom weights needed: 44
Numbers of warp threads: 800 threads 2 m each= 1600 m
Weft 1: if a balanced tabby = 1600 m
Weft 2: if a weft faced tabby = 3200 m
Total amount of yarn with weft 1 (+ 2%) = 3264 m
Total amount of yarn with weft 2 (+ 2%)= 4896 m

According to the TTTC experiments, it would take approximately 81-123 hours to spin the thread needed to produce the fabric in this set up. Time for sorting and preparing the fibres is not included, neither nor time for preparing the set up, weaving and after finishing.

Loom weight ARS-126: weight 584g, thickness 59 mm				
	A	B	C	D
Warp threads requiring	10g warp tension	20g warp tension	30 g warp tension	40g warp tension
Numbers of warp threads per loom weight	58	29	19	15
Numbers of warp threads per two loom weight (one in front layer one in back layer)	116	58	38	30
Warp threads per cm	20	10	6	5
TTTC's evaluation of suitability of the tool	Unlikely	TTTC choice	TTTC choice	TTTC choice

Figure 23. Calculation of possible loom setups with loom weight ARS-126

The TTTC choices demonstrate a fabric with 6-10 warp threads per cm with 20-30g tension on each thread.

If we focus on the TTTC choice B on this example, ARS-126 we can hypothesise the following loom setup:

Loom setup (ARS 126) calculated on 20g warp tension
Starting border (width of the fabric): 100 cm
Number of loom weights needed: 34
Numbers of warp threads: 1000 threads 2 m each= 2000 m
Weft 1: if a balanced tabby = 2000 m
Weft 2: if a weft faced tabby = 4000 m
Total amount of yarn with weft 1 (+ 2%) = 4080 m
Total amount of yarn with weft 2 (+ 2%) = 6120 m

According to the TTTC experiments, it would take approximately 102-153 hours to spin the thread needed to produce the fabric in this set up. Time for sorting and preparing the fibres is not included, neither nor time for preparing the set up, weaving and after finishing.

Summary

All three loom weights could be very functional for producing different fabrics with a variation of thread qualities. A lighter and thinner loom weight is more flexible and can be use for a larger variation of different fabrics than the heavier and thicker weight. The needed number of loom weights, however, is considerable larger if one is using smaller loom weights. It seems illogical to produce a lot of small loom weights if one can use larger and fewer weights, unless one wants to weave with very fine thread. According to our experience, the calculations demonstrate that it would be possible to use all the loom weights in the same set up since one can use a warp thread with 20g-30g tension to all the loom weights in study. Nevertheless, it would be better, if one chose to work with just the lighter and thinner loom weight or just the heavier and thicker in different set ups. We assume that these loom weights belong to 2 to 3 different sets of loom weight used in different setups.

Discussion

The number of objects is relatively small, and the analysis cannot be considered statistically correct or representative for Arslantepe in general. The observed change in the textile tools may be due to several factors. One is that the nearly all loom weights from the same period also where found in the same context. Another critical problem is that just three loom weights were dated to period VI B-D

During period VII the weavers in Arslantepe produced fabrics with 5-6 warp threads and 5/10-6/12 weft threads per cm with different types of yarn The warp yarn needed different tension but a warp yarn with 30g tension per thread seems have been the most suitable type.

During period VIA the loom weights show variation in materials and types; it is, however, one single object that demonstrates a variation in production - namely the discoid elliptical shaped loom weight. With this type of loom weight you can produce several different types of fabrics with 6-11 warp threads per cm and with different yarn qualities, yarn that need a warp tension from 20g to 40g.

Since there are just three loom weights from the rest of period VI it is not possibly to give any interpretation on development.

In period V the tools have changed radically both in type, thickness and weight. Important is, that even if these loom weights differ from previous periods it is still possible to produce the same type of fabrics with them. It is, however, also possible to produce more dense fabrics and fabrics with thinner threads that just need a warp tension of 10g per thread, with this type of loom weights.

OTHER TEXTILE TOOLS

The numbers of other tools are too small for any statically analyses and in the following we will just give our interpretation of the objects as textile tools.

			Brush	Comb	Needle	Shuttle	Pin beater
VII	Settlement	Household			1		
		Pit			2		
		Other					
		Workshop					
VI A	Settlement	Household					1
		Pit					3
		Other			1		1
	Palace	Household					
		Other		1?			
VI B1	Settlement	Household					
		Pit					
		Other					1
VI B2	Settlement	Household			1		
		Pit					
		Other					
VI C	Settlement	Household					
		Pit		1?		1?	1
		Other					
VI D	Settlement	Household		1?	1		
		Pit		1?			
		Other	1				
V	Settlement	Household			1	1?	1
		Pit	2				4
		Other					4
	In all		3	4	7	2?	16

Figure 24. Chronological distribution of recorded textile tools according to our interpretation. ?=the interpretation is insecure.

19 objects have been recorded as shuttles of which 16 comes from stratigraphically determined layers (figure 1 and 2) but none are dated to period VII. As can be seen in figure 25 the objects vary in length from 55 to 170 mm and in thickness from 2 to 22 mm.

According to our experience it is more likely that at least 12 of the 19 objects have functioned as so-called pin beaters (see also comments in dB). These 12 objects have all one or two pointed ends. A pin beater is a multifunctional weaving tool. It was thrust up between the warp threads at regular intervals in order to drive the weft home, and it was also used for pushing up the weft after changing the shed (Hoffmann 1964, 135).

Also the pointed and doubles pointed tools could have had a function as pin beaters.

Seven objects have been recorded as needles of which 5 comes from stratigraphically determined layers (figure 1, 2 and 24). They could all function as sewing needles.

One object has been recorded as a beater but this tool could also have functioned as a shuttle.

Finally have 4 combs and 3 brushes bee recorded in the dB. The teeth on the combs are short (2-4 mm) but it is difficult to determined how bad the preservation on the surface is. The combs could have functioned as weaving combs but they could also have been used as scrapers for fibres like flax or nettle. The three brushes could, according to ethnographic sources, been used for removing the last parts the broken stems when preparing flax or nettle fibres.

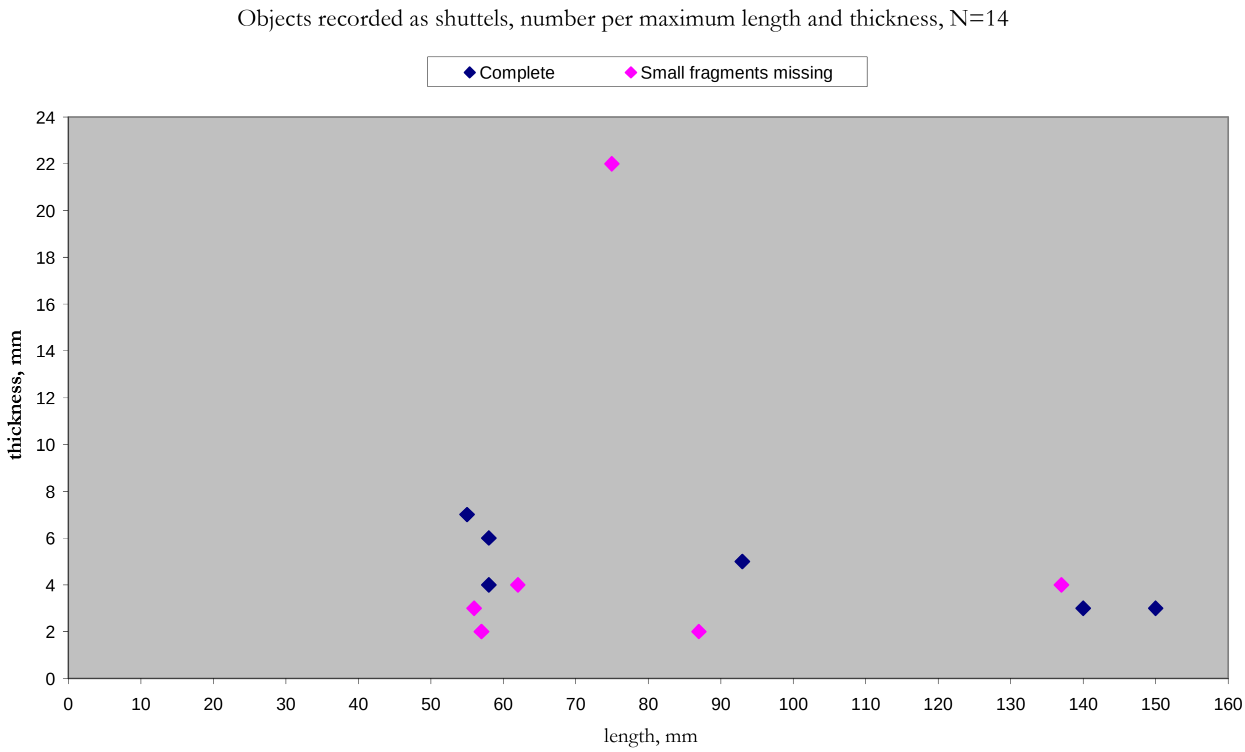

Figure 25. Objects recorded as shuttles. The relationship between length and thickness.

TEXTILE PRODUCTION IN ARSLANTEPE

The number of objects is small and this analysis cannot be considered statistically correct or representative for Arslantepe in general. The differences between the three periods do not necessarily represent a change over time or in the production but may be due to the nature of different contexts.

However, the results suggest a change during the time span. From VI B2 a change in the spindle whorls can be observed: The variations between single whorls in weight and diameter become larger than during previous periods. In general, in periods VI B2-V, the whorls are lighter and the diameter smaller compared to period VII which demonstrates that the spinner now also could spin very thin and less hard yarn compared to the previous period.

From period V changes in the loom weights can be observed: The variations between loom weights in weight and thickness become larger than during previous periods. In general, in periods VI B2-V, the weights are lighter and the thickness smaller compared to period VII. During period VII the weavers produced fabrics with 4-6 warp threads and 4/8-6/12 weft threads, during period V they produced fabrics with 4-16 warp threads and 4/8-6/32 weft threads.

The conclusion is that the variation in production of different qualities of threads and fabrics is bigger during the later period. Important is, though, that the qualities which were produced during period VII were still produced during VI and V. Unfortunately, there are few finds of spindle whorls from period V and few finds of loom weights from period VI B-D, so it is not possibly to suggest that the change in spinning and weaving coincided. It should also be considered that it would probably have taken more time to produce the finer threads and fabrics.

An interesting observation is also that loom weights and spindle whorls are not or very rarely found together in the same context.

Regardless of period the majority of all the recorded loom weights and spindle whorls are considered to have been made in a good or medium production quality. This supports the notion that the spinners and weavers in Arslantepe in all periods most likely were skilled crafts people, they knew how spin and how to weave and which tools they needed to produce certain qualities.