Textile tools from Ayia Triada

A total number of 102 objects are recorded in the database (figure 1). The objects are divided into eight different periods.

Context date	LW	Spool	SpW	Needle	KS whorl	Spining bowl	Perforated plaque	Total
EM I, 3300-2800	9							9
MM II-III, 1800-1600				1				1
MM III, 1700-1600	1							1
LM, 1600-1200	2							2
LM I, 1600-1450	68	4		1		1	1	75
LM IB, 1500-1450				1		4		5
LM III, 1400-1200			3		1			4
LM IIIA-B, 1400-1250	4			1				5
In all	84	4	3	4	1	5	1	102

Figure 1. The objects recorded in the CTR database.

4 objects (*ATR-*, *ATR-4005 ATR-3002* and *ATR-3003*) are recorded with slightly different object and context dates, and we decided to date these objects according to the context date.

Context date	Site type	Context type	LW	Spool	SpW	KS whorl	Needle	Spining bowl	Perforated plaque	Total
EM I	Settlement	other	6							6
	Other	other	3							3
MM III	Settlement	other	1							1
LM	Other	other	2							2
LM I	Settlement	household	18	3			1	1	1	24
		other	31							31
		workshop	10							10
	Other	other	5							5
	Villa	household	1							1
		other	3							3
LM IB	Settlement	household					1	4		5
LM III	Settlement	household	1		3	1				5
LM IIIA-B	Settlement	household	3							3
	In all		84	3	3	1	2	5	1	99

Figure 2. Chronological and contextual distribution of the recorded objects. Note that tools excluded from the analysis are excluded from this figure.

Spinning and spindle whorls in Ayia Triada

Only 4 spinning tools have been found in Ayia Triada: 3 objects are spindle whorls and 1 is a KS whorl. All 4 objects can be considered spinning tools. The 4 spindle whorls are dated to period LM III and found at the settlement in a household context. 3 of the whorls are made of stone and the KS whorl is made of clay. This whorl also has a cylindrical shape while 2 of the stone whorls are conical and 1 is concave conical (figure 3).

	Shape	Clay	Stone
LM III	cylindrical	1	
	conical		2
	concave conical		1

Figure 3. Distribution of spindle whorls in shape and material

A comparison of the complete spindle whorls and the spindle whorl with small fragments missing demonstrate that they fall within the same weight range. We have therefore decided to include the incomplete spindle whorl in this study.

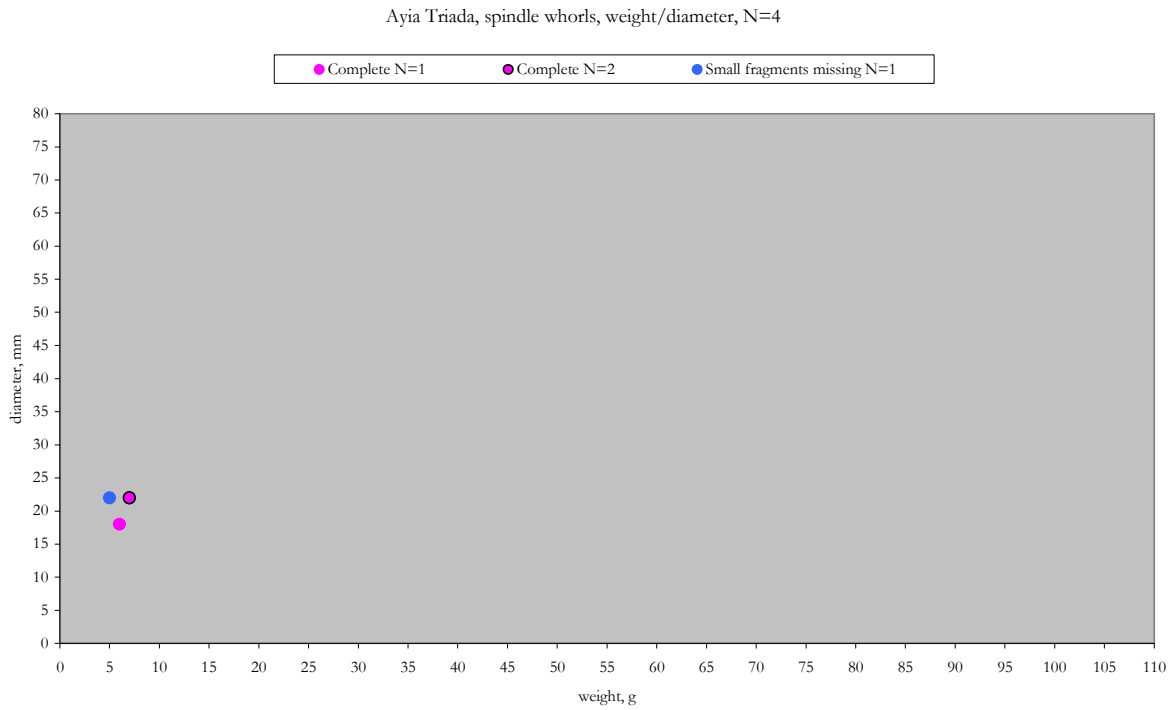

Figure 4. The relationship between weight/diameter.

As can be seen in figure 4, the whorls vary in weight from 5g to 7g and the diameter varies from 18 mm to 22 mm. 2 whorls, one spindle whorl made of stone and the KS whorl, have exactly the same weight and diameter.

Whorls of this size and shape would function well as spindle whorls but it would only have been possibly to spin a very fine and thin thread with these tools. The fibres that would have been used for this type of spinning must have been of a high quality and very well prepared. Yarn spun with these whorls could have been used to produce a high quality fabric.

WEAVING AND LOOM WEIGHTS

Loom weights and spools

84 objects have been recorded as loom weights and 4 objects as spools. 1 spool (*ATR-2004*) has been excluded since this object is described as a "clay disc". In LM, LM III and LM IIIA-B there are just 6 findings of loom weights and we have therefore decided to combine them with finds from LM I in one group called 'LM I-III'

Material and type

The material and type have been recorded for all objects. The type, however, seems unclear on 5 objects *ATR-0006, ATR-0011, ATR-0036, ATR-0042 and ATR-0076* and they have therefore been excluded in figure 5 (see comments in dB).

All loom weights from period EM I are made of stone. From period MM II-III only one loom weight has been discovered and during period LM I-III the majority of the recorded loom weights are made of fired clay (figure 5). This suggests a change in material between the earlier and later periods.

The analysis, however, does not demonstrate any change in the loom weights' shapes between the different periods (figure 5). During all period the majority of the loom weights are spherical but other types do also appear. Spools are only found in LM I.

		fired clay	stone
EM I	conical truncated		
	cylindrical short		1
	cylindrical standard		
	discoid		
	discoid elliptical		
	discoid rounded		
	discoid tabulated		
	flat rectangular		1
	spherical ovoid		5
	spherical rounded		1
	spool		
MM III	conical truncated		
	cylindrical short		
	cylindrical standard		
	discoid	1	
	discoid elliptical		
	discoid rounded		
	discoid tabulated		
	flat rectangular		
	spherical ovoid		
	spherical rounded		
	spool		
LM I-III	conical truncated		1
	cylindrical short		
	cylindrical standard	3	
	discoid	7	
	discoid elliptical	3	
	discoid rounded	1	
	discoid tabulated	1	
	flat rectangular		
	spherical ovoid	9	
	spherical rounded	45	
	spool	3	
	Total	73	9

Figure 5. The relationship between date and type/material. Note that 69 of the loom weights are dated to LM I.

Weight/diameter

42 loom weights with intact weight and thickness have been found in dated contexts and we have focused on them in the following analysis. 4 loom weights with small fragments missing have also been included in the analysis. The rest of the material is unfortunately too insecure to use.

Only one of 9 loom weights from period EM I has intact weight and thickness, and the calculated weight of the 8 fragmentary loom weights weight vary from 200g to 840g. Only a single fragmentary loom weight is preserved from period MM III.

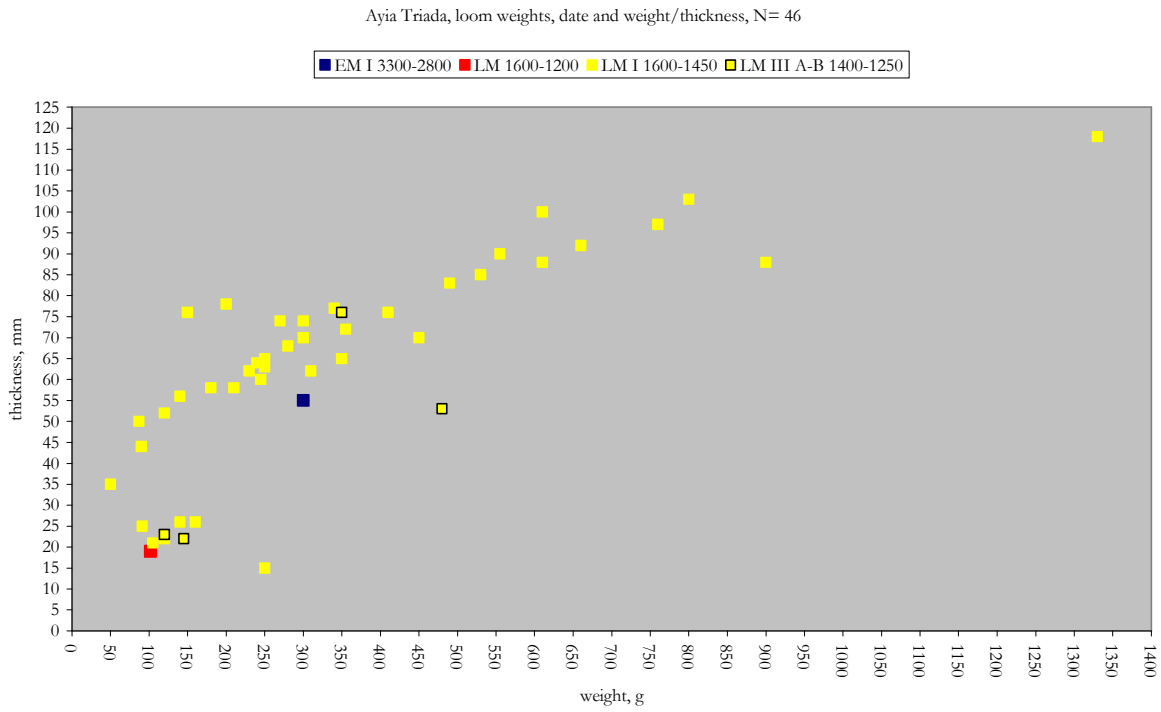

Figure 6. The relationship between date and weight/thickness. With 'thickness' we refer to the measurement that affects the loom setup (see p. 5 in the introduction). In dB this measurement has been recorded in different ways depending on which type of loom weight that has been recorded, and we have therefore chosen to include data that is not recorded as thickness but actually is the "thickest part" which affects the loom setup and the fabric.

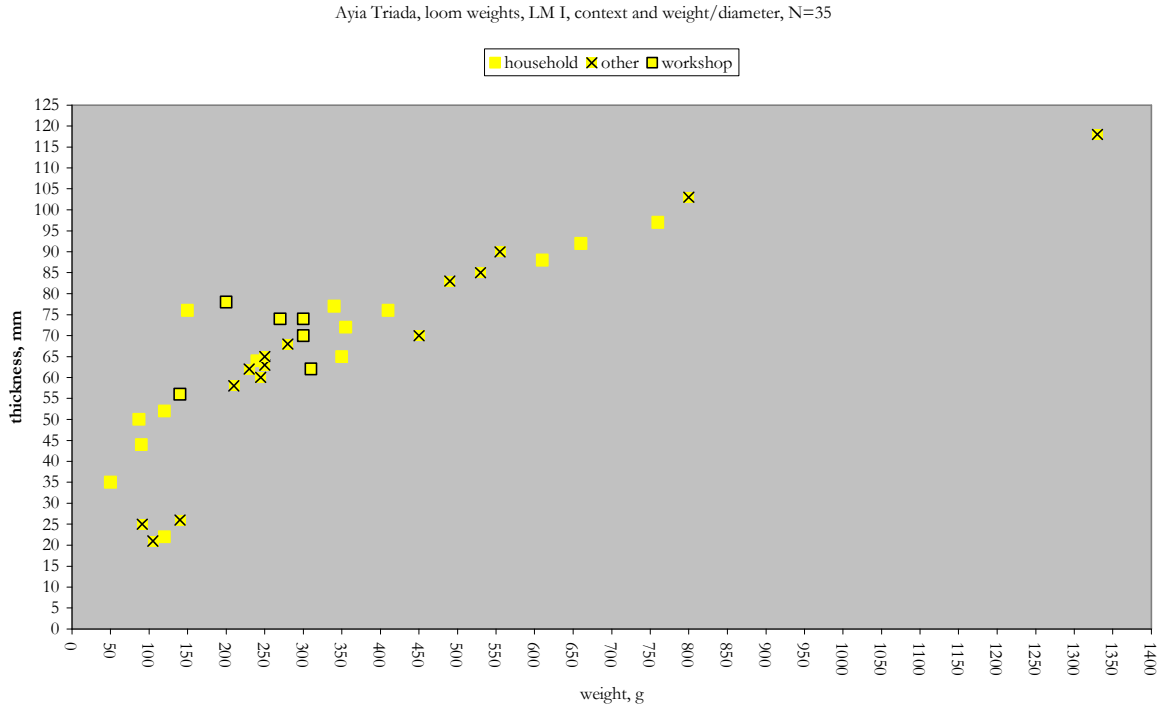

Figure 7. The relationship between loom weights from period LM I context and weight/thickness.

LM I loom weights and contexts

71 loom weights from period LM I have been found in different site contexts, mostly in the settlement area (62 objects). Only 4 weights are found in the Villa area and 5 loom weights are from other site contexts.

The majority of these loom weights are spherical rounded in shape, but several other shapes, like discoid and cylindrical standard, also occur.

35 loom weights with intact weight and thickness have come from the settlement area. As can be seen in figure 7, there is no clear difference in the loom weights' weight and thickness between the loom weights from household, workshop and other contexts. The loom weights from workshop contexts are more homogenous in weight and thickness than the weights found in household and other contexts. This could suggest that the production in the workshops was more specialised than the production in the households.

The variations in weight and thickness within the group of loom weights demonstrate a variation in production.

To elucidate our interpretation of the loom weights we have calculated possible loom setups on the basis of three weights from the settlement area and suggested which fabrics we consider the most likely result. We have chosen two of the lightest loom weights but with different thicknesses, the heaviest loom weight and finally one with a weight of 450g and a thickness of 70 mm. 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 ATR-0050: weight 105g, thickness 21 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	10	5	3-4	2-3
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	20	10	6-8	4-6
Warp threads per cm	9-10	4-5	3-4	2-3
TTTCs' evaluation of suitability of the tool	TTTC' choice	Possible	Unlikely	Unlikely

.Figure 8. Calculation of possible loom setups with loom weight ATR-0050.

The calculation demonstrates that a warp thread of 10g tension would function well with loom weight ATR-0050 (figure 8). The fabric produced with this loom setup would have had 9-10 thread per cm in warp and weft (if weft faced 18-20 threads per cm)

When focusing on ATR-0050 TTTC choice A, (figure 8) we suggest the following loom setup:

Loom setup (ATR-0050) calculated on 10g warp tension
Starting border (width of the fabric): 100 cm
Number of loom weights needed: 96
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

The calculations also demonstrate that the amount of yarn needed is substantial. According to the TTTC experiments it would take approximately 117-175 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 finishing.

Loom weight ATR-0060 weight 120g, thickness 52 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	12	6	4	3
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	24	12	8	6
Warp threads per cm	4-5	2	1-2	1
TTTCs' evaluation of suitability of the tool	TTTC' choice	Unlikely	Unlikely	Unlikely

Figure 9. Calculation of possible loom setups with loom weight ATR-0060.

The calculation demonstrates that a warp thread of 10g tension would function on loom weight ATR-0060 (figure 9). The fabric produced with this loom setup would have had 4-5 thread per cm in warp and weft (if weft faced 8-10 threads per cm in weft)

When focusing on TTTC choice A, (figure 9) we suggest the following loom setup:

Loom setup (ATR-0060) calculated on 10g warp tension
Starting border (width of the fabric): 100 cm
Number of loom weights needed: 40
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 58-87 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 is time for preparing the set up, weaving and finishing.

Only very thin thread can be used on the loom with light loom weights such as ATR-0050 and ATR-0060. The types of fabrics that could have been produced with these two types of loom weights would be of very fine quality. However, the fabrics would visually be completely different. The first fabric would be quite dense while the second fabric would be very open and veil-like. If the fabrics were weft faced they would differ even more (figure 10).

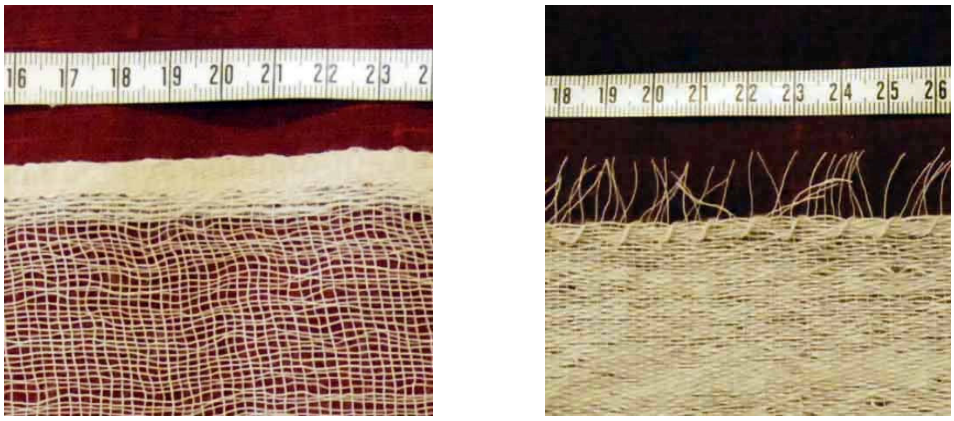

Figure 10. Two fabrics, both woven with threads requiring 10g warp tension. Left a tabby, average: 5 warp threads per cm and 8 weft threads per cm. Right a weft faced tabby, average: 5.8 warp threads per cm and 14.8 weft threads per cm.

Loom weight ATR-0029: weight 1350g, thickness 118 mm					
	A	B	C	D	E
Warp threads requiring	10g warp tension	20g warp tension	30g warp tension	40g warp tension	50g warp tension
Numbers of warp threads per loom weight	135	67-68	45	34	27
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	270	135	90	68	54
Warp threads per cm	23	11	7-8	5-6	4-5
TTTC's evaluation of suitability of the tool		Unlikely	Unlikely	Possible	TTTC' choice

Figure 11. Calculation of possible loom setups with loom weight ATR-0026.

The calculation demonstrates that a warp thread of 40-50g tension would function on loom weight ATR-0026 (figure 11). The fabric produced with this loom setup would have had 4-6 thread per cm in warp and weft (if weft faced 8-12 threads per cm). The thread needed for producing this fabric would have been much thicker than the threads that could have been used in the first two examples. This demonstrates that the fabric produced with this loom weight setup would have much coarser than the other two.

When focusing on TTTC choice D, (figure 11) we suggest the following loom setup:

Loom setup (ATR-0026) calculated on g warp tension
Starting border (width of the fabric): 100 cm
Number of loom weights needed: 20
Numbers of warp threads: 540 threads 2 m each= 1080 m
Weft 1: if a balanced tabby = 1080m
Weft 2: if a weft faced tabby = 2160 m
Total amount of yarn with weft 1 (+ 2%) = 2204 m
Total amount of yarn with weft 2 (+ 2%) = 3122 m

The calculations also demonstrate that the amount of yarn needed is substantial. According to the TTTC experiments it would take approximately 44-63 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 is time for preparing the set up, weaving and finishing.

Loom weight ATR-0032: weight 450g, thickness 70 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	45	22,5	15	11
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	90	45	30	22
Warp threads per cm	13	6	4	3
TTTC's evaluation of suitability of the tool	Unlikely	TTTC choice	Possibly	Unlikely

Figure 12. Calculation of possible loom setups with loom weight ATR-0032.

The calculation demonstrates that a warp thread of 20-30g tension would function on loom weight ATR-0032 (figure 12). The fabric produced with this loom setup would have had 4-6 thread per cm in warp and weft (if weft faced 8-12 threads per cm). This fabric would not have been as thin as the first two examples (figure 8 and 9) but not as coarse as in the third example (figure 11).

When focusing on TTTC choice B, (figure 11) we suggest the following loom setup:

Loom setup (ATR-0032) calculated on 20 g warp tension
Starting border (width of the fabric): 100 cm
Number of loom weights needed: 28
Numbers of warp threads: 600 threads 2 m each= 1200 m
Weft 1: if a balanced tabby = 1200 m
Weft 2: if a weft faced tabby = 2400 m
Total amount of yarn with weft 1 (+ 2%) = 2448 m
Total amount of yarn with weft 2 (+ 2%) = 3672 m

The calculations also demonstrate that the amount of yarn needed is substantial. According to the TTTC experiments it would take approximately 61-92 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 finishing.

Summary

The number of objects from period LM I is relatively small, and the analysis cannot be considered statistically representative. However, the variations in the loom weights' weight and thickness demonstrate a very large range of different qualities of fabrics in the production.

Even if several of the suggested fabrics have a thread count of 4-6 threads in warp and weft per cm they would be very different both visually and in quality.

It is also interesting that the fabrics that could be produced with the two lighter loom weights (figure 8, 9 and 10) would be visually very different: one dense and the other very open. It is possibly to produce weft faced fabrics and especially loom weight ATR-0060 would be suitable for this type of weave. Weft faced fabrics can be very visually different both in relation to the tabbies that could be produced and to the different types of loom setups.

The time it took to produce the thread differs much from textile to textile. In the examples discussed above the labour consumption, 40 hours at least and 179 hours at

most, also indicate the value of these textiles. From our experience we can also say that it would have taken much more time the do the setup and weave with the ATR-0050 loom weight.

Other textile tools

The number of other textile tools is small. It is hard to interpret a function for the perforated plaque since no picture was available. Because of the object's weight and shape it can have functioned as a loom weight, but in that case the type is, to our knowledge, very rare.

Only 1 of 4 'needles' can be interpreted as sewing needles (ATR-) as no needle eyes is recorded.

The findings of 5 spinning bowls are very interesting but since we unfortunately have been unable to identify the pictures we can not interpret these objects.

DISCUSSION

The number of objects is relatively small and the analysis cannot be considered statistically correct or representative for Ayia Triada in general. The only indication of change in the material that can be demonstrated is the variation of loom weight material between EM and LM. The variation in the loom weight type, weight and thickness during LM I demonstrate a very large variation in production of different qualities, from very fine to quite coarse fabrics. There is no visible variation in production between the different context types at the site. It is also interesting that there are no findings of spindle whorls. The production of the fabrics during LM I required a substantial amount of yarn in many different qualities, from the finest to the coarsest thread. The production of the finest fabrics would have taken a considerable period of time to make and demand well prepared raw materials, even-spun threads and a developed knowledge on weaving techniques. There could be several explanations why there are no finds of spindles or spindle whorls. The yarn could have been spun on a spindle without a whorl, the spindle whorls could have been made of perishable material and finally the yarn could have produced at other locations, although it should be noted that four spinning bowls have been found at the site in LM IB.

It should also be noted that the loom weights dated to LM I are primarily of good or medium quality.

The 4 spindle whorls found in period LM III are suitable to spin very thin thread but unfortunately from this period only 4 loom weights have been found. Of these 4 loom weights 2 have a discoid shape and are comparable to the discoid loom weights from LM I. The weight of these two loom weights are 145g and 120g and the thickness 22 mm and 23 mm respectively. The thread spun with the contemporary spindle whorls would have been suitable for this type of loom weight. The other 2 loom weights from LM III are heavier (350g and 480g respectively) and a thicker thread would be needed.

It is important to take into consideration that textile tools made of perishable materials, both spindles and looms, were been used. Even so, the material at hand reveals a well-developed and very varied textile production, especially during LM I.