Textile Tools from Tiryns

A total number of 172 objects were recorded in the database (figure 1). The majority of the tools are dated to LH IIIA-C (147 objects), while 14 spindle whorls and 11 loom weights are dated to EH. The LH IIIA-C tools are divided into more detailed phases e.g. LH IIIB early, LH III C advanced etc (figure 2). The number of tools found in the same contexts and thus dated to the same period is, however, small, and the tools are generally unevenly distributed in the different periods (figure 2 and 3). It is also important to note the great difference in duration of the two periods (EH: app. 1000 years and LH III: app. 300 years) which means that the results from the two periods are not directly comparable.

To conclude: these problems make it impossible to make any secure interpretations on the development of textile production in time and we have therefore decided to focus mainly on the functionality of the recorded tools.

The total number of textile tools from Tiryns is larger than the number recorded in the database (Rahmstorf *in press;* Rahmstorf presentation at the 1st Textile and Tools workshop in Athens January 2006). However, the tools recorded in the database are mostly from secured contexts. As can be seen in figures 2 and 3, all tools are from the settlement area and the majority of the objects are from 'other contexts', meaning areas outside the buildings. 70 tools are from household contexts and only 1 is from a workshop context. The detailed context descriptions and the excavation plans provide, in some cases, the opportunity to compare tools within the same context and period.

	Spindle whorl	Loom Weight	Conulus	KS whorl	In all
EH	13	11			24
EH?	1				1
LH III late, horizon 22?		2			2
LH IIIA late, horizon 14c2	2		1		3
LH IIIB, horizon 17a5			1		1
LH IIIB early, horizon 15a1			1		1
LH IIIB early, horizon 15a2			1		1
LH IIIB middle, horizon 16a7		1			1
LH IIIB middle-developed, horizon 16a7-17a0		1			1
LH IIIB developed, horizon 17a1			3		3
LH IIIB developed-end, horizon 17a3-4	1		2		3
LH IIIB end, horizon 17a4			5		5
LH IIIB end, horizon 17a4-5	1				1
LH IIIB end, horizon 17a5	1		5		6
LH IIIB end, horizon 18	2		3		5
LH IIIB end, horizon 18-19a0		1			1
LH IIIB end-LH IIIC early, horizon 18-19a0			1		1
LH IIIC early, horizon 19a	1		1	1	3
LH IIIC early, horizon 19a1	2		1		3
LH IIIC early, horizon 19a1-b0			1		1
LH IIIC early, horizon 19b		1			1
LH IIIC early, horizon 19b1		2			2
LH IIIC developed, horizon 20a0-a1		1			1
LH IIIC developed, horizon 20a2	1		2		3
LH IIIC developed, horizon 21a0		2	1		3
LH IIIC developed-advanced, horizon 20a2-21b0		7			7
LH IIIC developed, horizon 21 a1-b0	2				2
LH IIIC advanced, horizon 21a0		10	1		11
LH IIIC advanced, horizon 21a1			2		2
LH IIIC advanced, horizon 21a1-b			1		1
LH IIIC advanced, horizon 21a1-b0	2		4		6
LH IIIC advanced, horizon 21b0			1		1
LH IIIC advanced, horizon 21b1	2	4	3		9
LH IIIC advanced, horizon 21b1-c0	1		1		2
LH IIIC advanced, horizon 21c0	2	1			3
LH IIIC advanced, horizon 21 c1-d			1		1
LH IIIC late, horizon 22		18			18
LH IIIC late, horizon 22a0	1				1
LH IIIC late, horizon 22a1	1				1
LH IIIC late, horizon 22c0	1				1
LH IIIC late, horizon 22c1		3			3
LH IIIC late, horizon 22c1-d		2			2
LH IIIC late, horizon 22d	8	14			22
LH IIIC end, horizon 22d		1			1
LH IIIC late-E1, horizon 22d-23	1				1
In all	46	82	43	1	172
	Spindle whorl	Loom weight	Conulus	KS whorl	In all

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

		Spindle whorl	Conulus	Kylix stem	Loom weight	In all
EH	Household	1				1
	Other	12			6	18
	Not available				5	5
LH IIIA late	Household	2	1			3
LH IIIB early	Household		2			2
LH IIIB middle	Other				1	1
LH IIIB developed	Household		3			3
LH IIIB developed-end	Household	1	2			3
LH IIIB end	Household	2	8			10
	Other	2	5		1	8
LH IIIC early	Other	3	3	1	3	10
LH IIIC developed	Household	3	3		2	8
	Other				1	1
LH IIIC developed-advanced	Household				7	7
LH IIIC advanced	Household	5	12		5	22
	Other		2		10	12
	Workshop	1				1
	Not available	1				1
LH IIIC late	Household	4			7	11
	Other	7			29	36
	Not available				1	1
LH IIIC end	Other				1	1
In all		44	41	1	79	165

Figure 2. Detailed chronological and contextual distribution of the recorded objects.

		Spindle whorl	Conulus	Kylix stem	Loom weight	In all
EH	Household	1				1
	Other	12			6	18
	Not available				5	5
LH IIIA	Household	2	1			3
LH IIIB	Household	3	15			18
	Other	2	5		3	9
LH IIIC	Household	12	15		21	48
	Workshop	1				1
	Other	10	5	1	44	60
	Not available	1			1	2
In all		44	41	1	80	166

Figure 3. Chronological and contextual distribution of the recorded objects.

Spindle Whorls and Conuli – spinning in Tiryns

86 objects from Tiryns are recorded as spinning tools. 46, of which 44 have come from secured stratified layers, are recorded as spindle whorls. Furthermore, 43 conuli (41 from stratified layers) are interpreted as spinning tools in the database, and finally, 1 kylix stem is recorded (figures 1, 2 and 3). The recorded kylix stem (TIR-Ti LXI 39/65 XIIIb), however, is excluded from this analysis, as this whorl is too irregular to function as a spindle whorl. Of the 46 spindle whorls 12 are pierced sherds and these objects will be discussed separately.

Please note, that we will refer to *whorls* when spindle whorls, conuli and pierced sherds are discussed together.

13 spindle whorls are dated to EH (figure 4). From LH IIIA-C 31 objects are recorded as spindle whorls, of which 11 are pierced sherds and 41 conuli (figure 5). As can be seen in figure 5 the majority of spinning tools from LH IIIB consists of conuli, and from LH IIIC 15 objects are recorded as spindle whorls, 9 as pierced sherds and 19 as conuli.

		Spindle whorls	Conuli	Pierced sherds
EH	biconical			
	concave conical			
	conical			
	convex	13		
	cylindrical			
	discoid			
	other			
	spherical			
	various shapes with hollow top			

Figure 4. Distribution of types of whorls during EH

		Spindle whorls	Conuli	Pierced sherds
LH IIIA	biconical			
	concave conical			
	conical		1	
	convex			
	cylindrical			
	discoid			1
	other			
	spherical			
	various shapes with hollow top	1		
LH IIIB	biconical	2		
	concave conical		1	
	conical	1	17	
	convex			
	cylindrical	1		
	discoid			1
	other			
	spherical			
	various shapes with hollow top		3	
LH IIIC	biconical	2		
	concave conical	3	1	
	conical	6	15	
	convex		1	
	cylindrical			
	discoid			9
	other	1		
	spherical	1		
	various shapes with hollow top	2	2	

Figure 5. Chronological distribution of whorls shape during LH III A-C

Material and shape

The spindle whorls from EH are all made of clay and have a convex shape (figure 6).

		Clay	Stone
EH	biconical		
	concave conical		
	conical		
	convex	13	
	cylindrical		
	discoid		
	other		
	spherical		
	various shapes with hollow top		

Figure 6. The distribution of spindle whorls in shape and material during EH.

As can be seen in figure 7, the whorls during LH III are made of clay and stone. The stone whorls are mostly conical while there is a larger variation in the shapes of the clay whorls (figure 7). It should, however, be noted that the stone whorls are, in fact, mostly conuli and only 1 conulus is made of clay. The spindle whorls (and the pierced sherds) are all made of clay.

		Clay	Stone
LH IIIA	biconical		
	concave conical		
	conical		1
	convex		
	cylindrical		
	discoid	1	
	other		
	spherical		
	various shapes with hollow top	1	
LH IIIB	biconical	2	
	concave conical		1
	conical	1	17
	convex		
	cylindrical	1	
	discoid	1	
	other		
	spherical		
	various shapes with hollow top		3
LH IIIC	biconical	2	
	concave conical	3	1
	conical	7	14
	convex		1
	cylindrical		
	discoid	9	
	other	1	
	spherical	1	
	various shapes with hollow top	2	2

Figure 7. Chronological distribution of whorls in shape and material during LH III A-C.

Fragmentary whorls - estimated weight

A comparison between the complete whorls (22 objects) and the whorls with an estimated weight and a recorded diameter (46 objects) demonstrates that they all fall within the same weight range. We estimate the margin of error in the calculation of weight to be less than 10% (1g for a whorl weighing ≤10g, 2g for a whorl weighing ≤20g, and so on). This variation of 10% would not have affected the finished product of the whorl and we have therefore decided to include the whorls with an estimated weight in this study (figure 10).

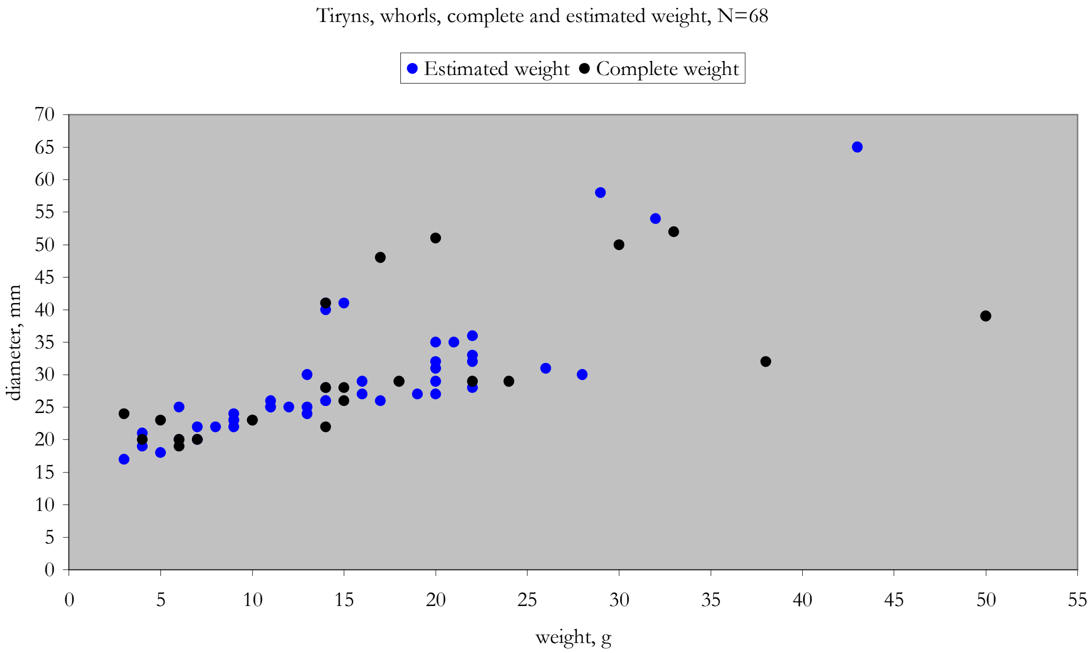

Figure 8. Complete whorls and whorls with an estimated weight.

As can be seen in figure 9 the group of whorls made of stone forms a much more homogeneous group than the group of clay whorls. The majority of the stone whorls are conical.

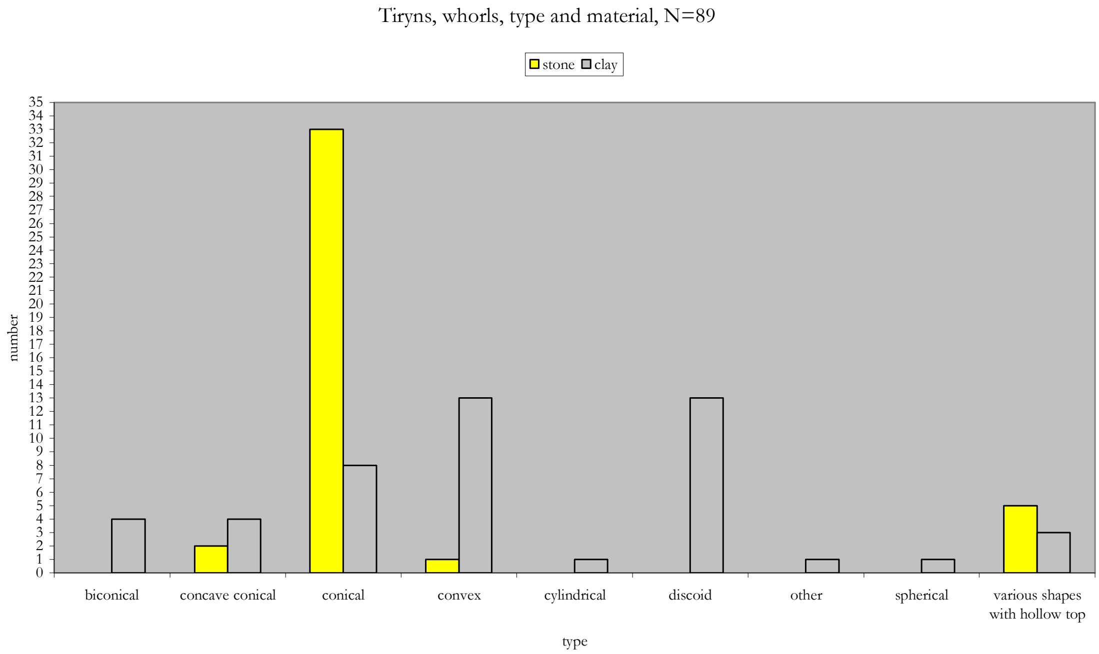

Figure 9. The relationship between type and material.

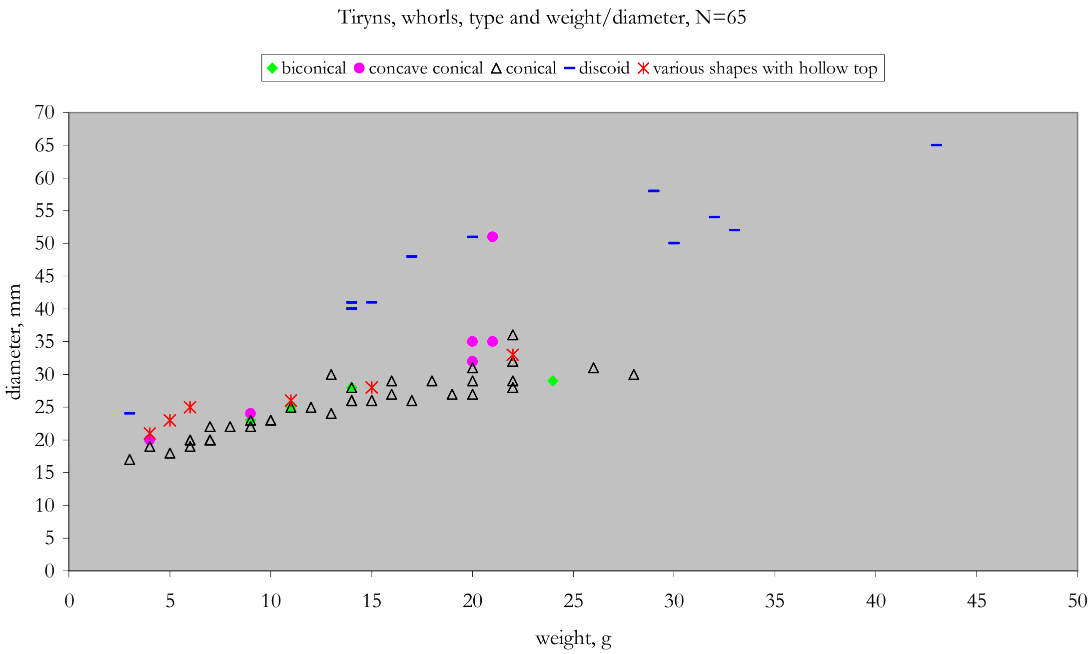

Figure 10. The relationship between type and weight/diameter. Please note, that types that are represented by only a single whorl are excluded from this figure.

On the other hand, there is no clear relation between type and weight/diameter. As can be seen in figure 10 conical, concave conical and various shapes with hollow top are recorded for a large variety of weights and diameters. The majority of whorls with a discoid shape have a larger diameter than whorls with other shapes.

Weight, diameter and height

No weight was recorded for the whorls from EH. However, the relationship between the recorded diameter and height gives the impression that these whorls are, with one exception, quite heavy compared with the whorls from LH III. The spindle whorls from EH have most likely been used for spinning thicker threads (figure 11).

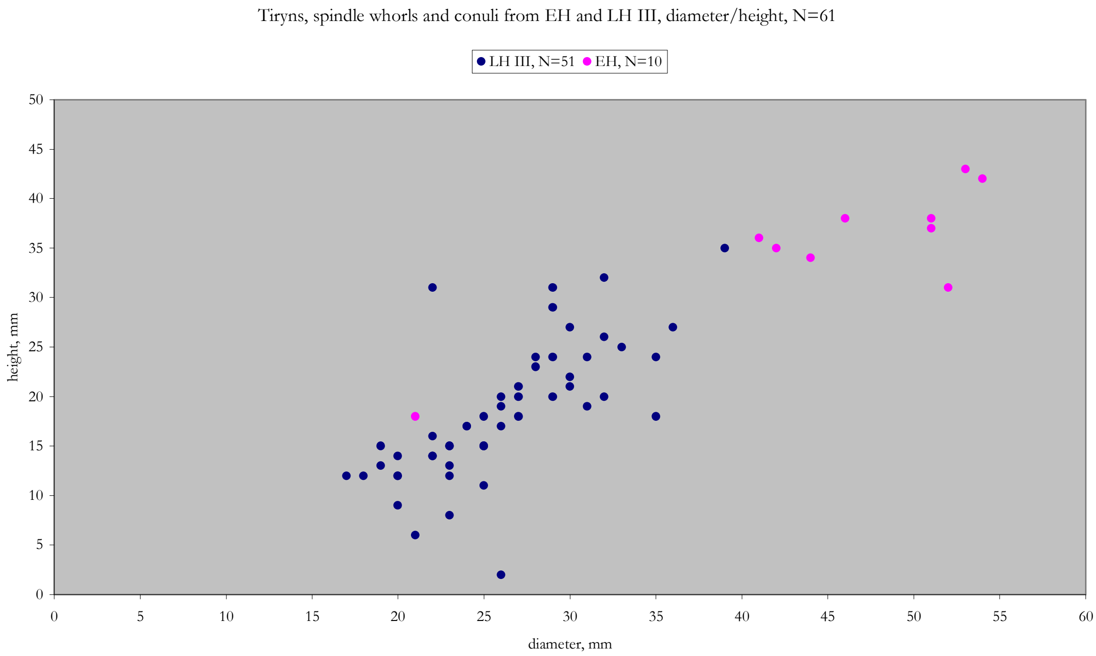

Figure 11. The relation between spindle whorls and conuli, diameter and height.

As can be seen in figure 12 the whorls from LH III vary in weight from 3g to 50g and in diameter from 17-65 mm indicating a production of several types of yarn from very thin to thick.

Furthermore, there is a clear difference between on one hand the spindle whorls and conuli and on the other the pierced sherds (figure 12). The pierced sherds generally have a larger diameter than the spindle whorls and conuli. According to the recordings in the database, the pierced sherds are also often irregular in shape and would therefore not function well as spindle whorls. Another difference is that the hole shape of the pierced sherds is always double-conic (figure 13). It would be very difficult to fix a spindle whorl with a double-cone hole firmly on the spindle - the whorl would most likely wobble too much. To conclude, the pierced sherds would not function well as spindle whorls and can not be interpreted as spinning tools. We have therefore excluded the pierced sherds from the following analysis.

The groups of spindle whorls and the conuli are more homogeneous in weight, diameter and hole shape than the pierced sherds (figure 12). The weight and the diameter vary within these two groups but there is a more or less standardised relationship between these two parameters. The yarn spun with the lightest conulus would be much thinner than the yarn spun with the heaviest conulus. The thin type of yarn would demand well prepared raw materials and the spinners had to be experienced. The fabrics produced with these fine threads would have taken a considerable period of time to make. The yarn produced with the heaviest conulus would be thicker and the fabric coarser.

To conclude, the spindle whorls supplement the conuli and together they indicate a varied production of different types of yarns.

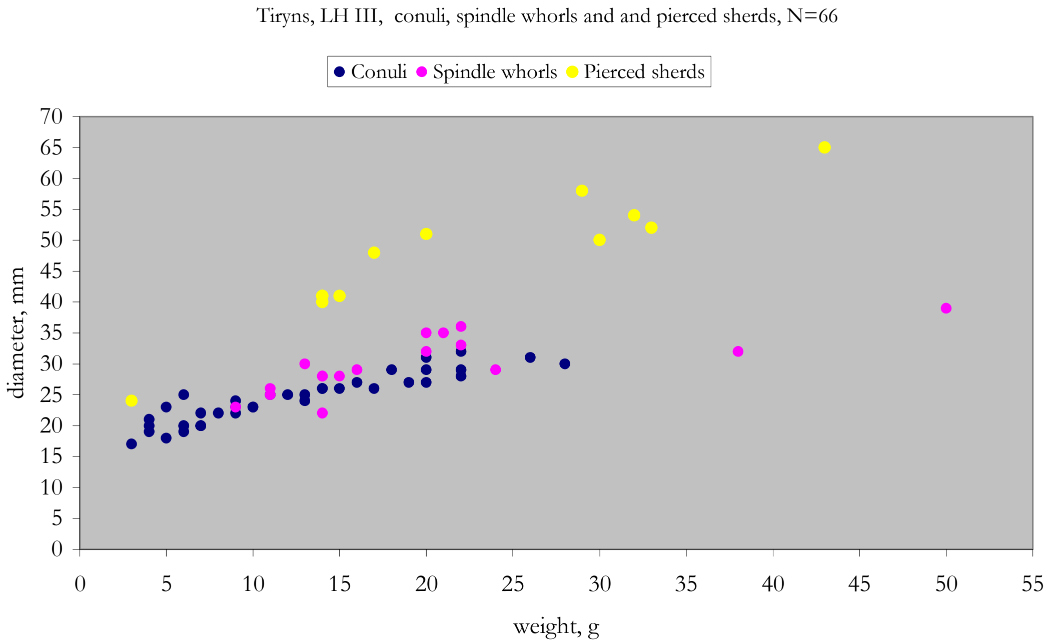

Figure 12. The relationship between whorl type and weight/diameter.

	plain	cone	double cone	not available	In all
SpW	30	4			34
Conuli	39	1		3	43
Pierced sherds			11	1	12
In all	69	5	11	4	89

Figure 13. The relationship between whorl type and hole shape.

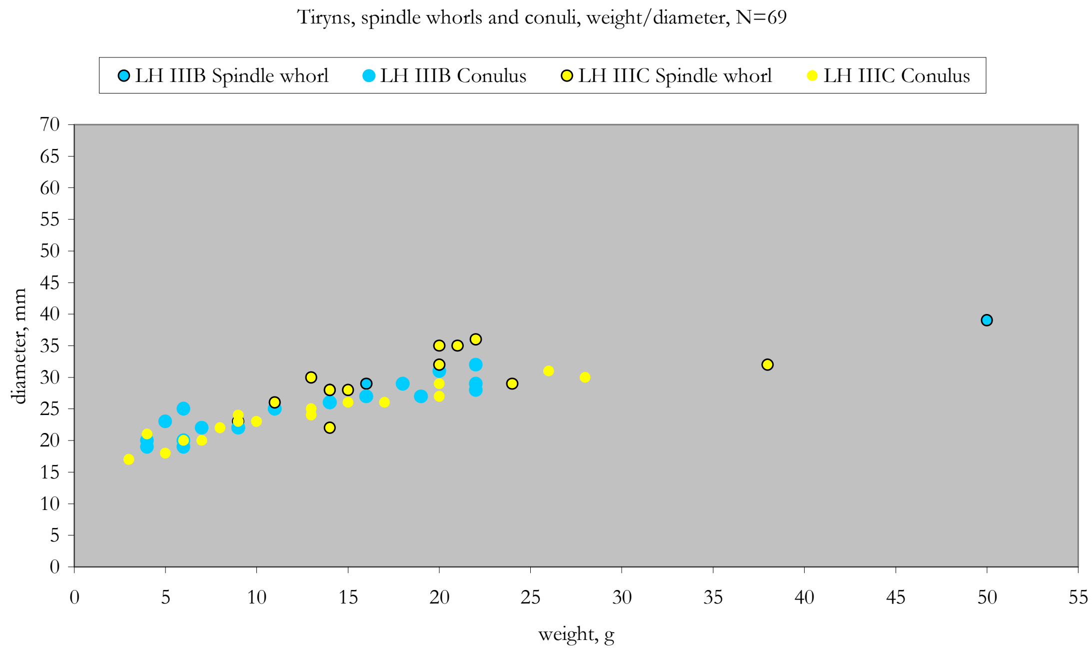

Figure 14. The relationship between date, whorl type and weight/diameter.

Spinning in Tiryns – Changes over time

Only 1 spindle whorl and 1 conulus derive from LH IIIA late and no conclusions can be drawn from these two objects.

During LH IIIB the number of conuli recorded in the database (21) is higher than the number of spindle whorls (5). The weight and diameter of the whorls from this period suggest a production of varied types of yarn from ‘very thin’ to ‘thick’.

During LH IIIC the number of conuli recorded in the database is more or less the same as the number of recorded spindle whorls, 19 and 24 respectively. The analysis demonstrates however, despite this change from LH IIIB, the same variety of yarns, from very thin to thick as during LH IIIB. The change is thus typological in character rather than functional.

LOOM WEIGHTS AND WEAVING IN TIRYNS

A total number of 82 loom weights were recorded in the database. The majority of the loom weights (68 objects) are from LH IIIC, 11 loom weights are from EH and 3 are from LH IIIB (figures 1 and 3). The loom weights from EH are made of fired clay and have a conical, crescent or cylindrical shape. The loom weights from LH IIIB (3 objects) are made of fired clay and have a discoid shape. During LH IIIC the majority of the loom weights recorded in the database are made of fired clay and are spool shaped (figure 15). 12 spool-shaped loom weights from LH IIIC are made of unfired clay.

		Fired clay	Unfired clay	Other
EH	conical	5		
	cresent	2		
	cylindrical long	4		
	cylindrical short			
	discoid			
	discoid elliptical			
	discoid tabulated			
	spool			
LH IIIB	conical			
	cresent			
	cylindrical long			
	cylindrical short			
	discoid			
	discoid elliptical	2		
	discoid tabulated	1		
	spool			
LH IIIC	conical			
	cresent			
	cylindrical long			
	cylindrical short	2		
	discoid	1		
	discoid elliptical			
	discoid tabulated	1		
	spool	48	12	2

Figure 15. The relationship between date and type/material.

Weight and thickness

It has been possible to estimate the weight of 6 loom weights from EH and it varies between 483g and 800g. The thickness is, unfortunately, not recorded.

From LH III 7 loom weights are recorded as complete and 35 are recorded as loom weights with small fragments missing; the weight was estimated on 79 loom weights. The thickness of the loom weights is available on 49 weights (figure 16). In this study we have decided to include the loom weights with an estimated weight.

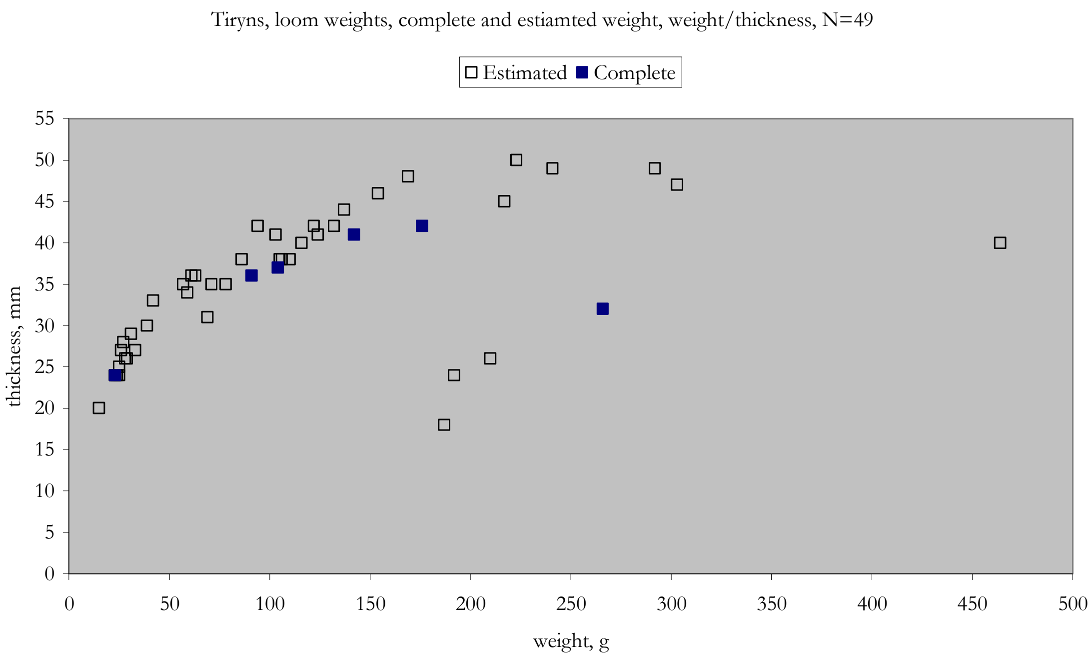

Figure 16. Complete loom weights and loom weights with an estimated weight. By 'thickness' we refer to the measurement that affects the loom setup (see p. 5 in the introduction). In dB this measurement has been recorded in different ways depending on which type of loom weight which has been recorded, 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.

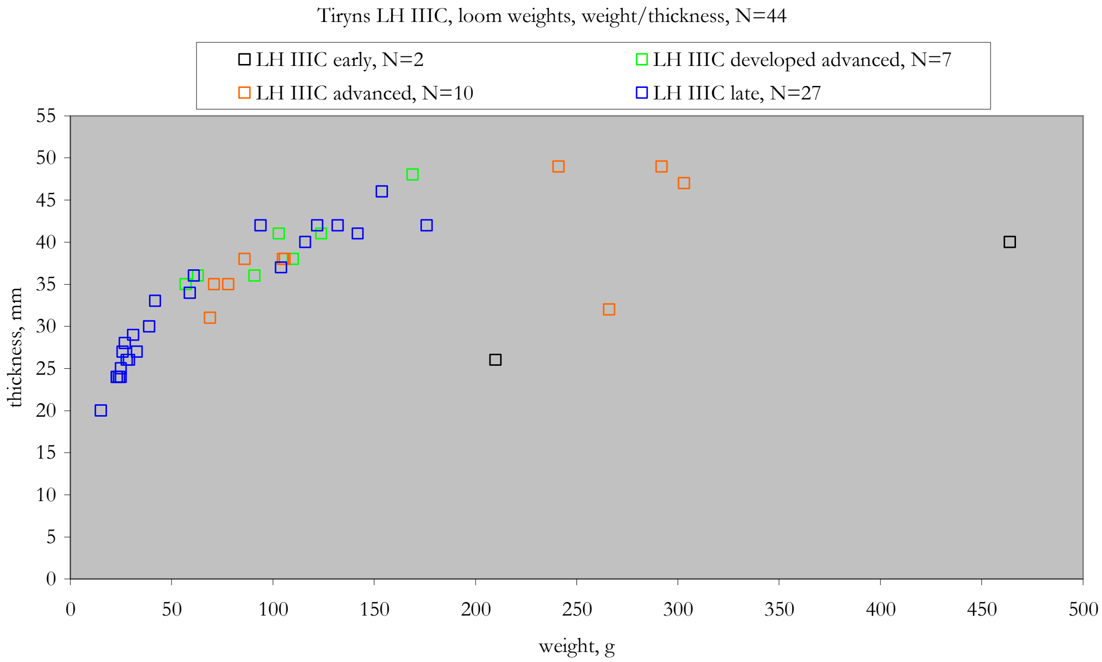

Figure 17. The relationship between loom weights dated to LH IIIC, and weight/thickness.

The loom weights from LH IIIC vary in weight from 15g to 464g and their thickness varies from 18 mm to 50 mm (figure 17). However, since a majority of the loom weights (25 weights) are from LH IIIC late it is important to note that this analysis cannot be considered completely statistically representative and the result cannot be used to interpret the development of textile production during LH. The loom weights do not reveal any changes in production during LH IIIC.

Weaving with spools?

As mentioned above, spools are the most common type of loom weight recorded in the database but the weight and the thickness varies within this group (figure 18). In the TTTC research program two weaving tests have demonstrated that it is possible to use spools as loom weights (Mårtensson et al. 2007). The spools tested in these experiments weighed 100g and 285g, and so the experiments still leave the important question whether spools weighing less than 100g could function as loom weights in a warp weighted loom. A large part of the spools from Tiryns weigh less than 100g (figure 18).

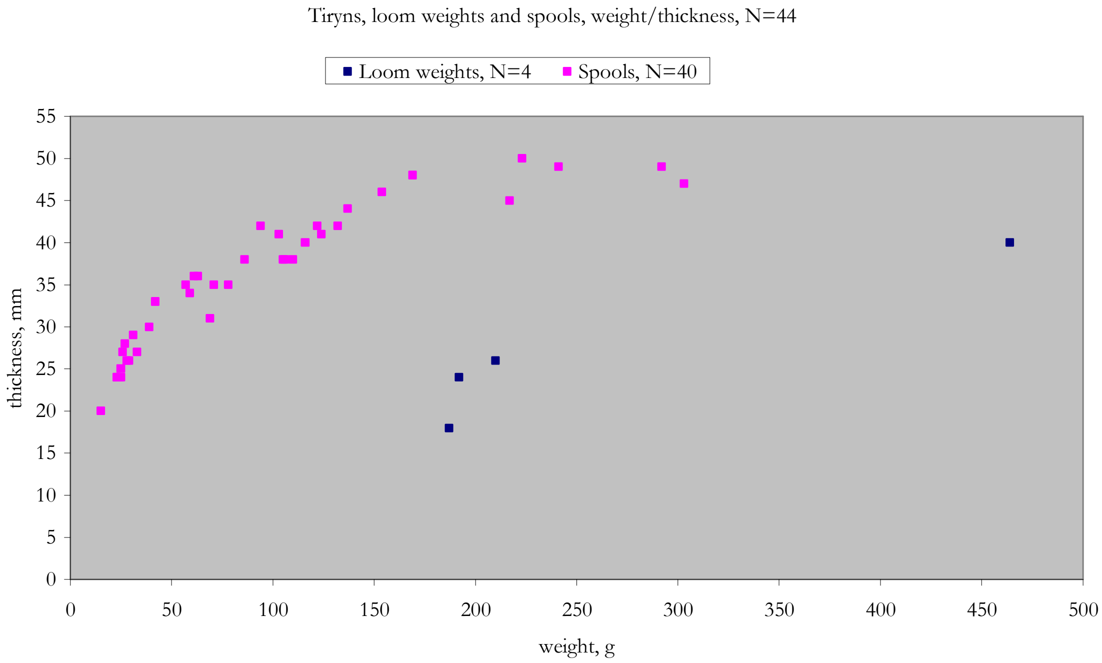

Figure 18. The weight and thickness of the spools and loom weights.

To elucidate our interpretation of the loom weights we have calculated possible loom setups on the basis of four spools from the Tiryns settlement area and suggested which fabrics we consider the most likely result. Please note, that these suggestions are based on our experience and experiments but are on the other hand conjectural as to what is optimal. We have chosen four spools with different weight and thickness.

Loom weight (spool) TIR-Ti LXII 42/70 V G9 (d): weight 15g, 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	1-2	1		
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	2-4	2		
Warp threads per cm	1-2	1		
TTTC's evaluation of suitability of the tool	unlikely	unlikely	unlikely	unlikely

Figure 19. Calculation of possible loom setups with spool TIR-Ti LXII 42/70 V G9 (d).

Loom weight (spool) TIR-Ti LXI 41/5 IVa: weight 40g, thickness 33 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	4	2		
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	8	4		
Warp threads per cm	2-3	1		
TTTC's evaluation of suitability of the tool	unlikely	unlikely	unlikely	unlikely

Figure 20. Calculation of possible loom setups with spool TIR-Ti LXI 41/5 IVa

Loom weight (spool) TIR-Ti LXII 42/59 IV G9 (a): weight 122g, thickness 42 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		
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	24	12		
Warp threads per cm	6	3		
TTTC's evaluation of suitability of the tool	TTTC choice	unlikely	unlikely	unlikely

Figure 21. Calculation of possible loom setups with spool TIR-Ti LXII 42/59 IV G9 (a).

Loom weight (spool) TIR-Ti LXI 41/5 IVa (a): weight 223g, thickness 50 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	22	11	7	5-6
Numbers of warp threads per two loom weight (one in front layer, one in back layer)	44	22	14	10-12
Warp threads per cm	9	4-5	3	2-3
TTTC's evaluation of suitability of the tool	TTTC choice	Possible	Unlikely	Unlikely

Figure 22. Calculation of possible loom setups with spool TIR-Ti LXI 41/5 IVa (a).

As can be seen in figures 19 and 20, the light spools below 100g cannot be considered functional as loom weights in a warp weighted loom as such. Attaching less than 4 warp threads to one single loom weight is not functional and even counterproductive. Using spools below 100g requires a very large number of loom weights in the setup, and although such scenarios are possible, they remain impractical, not optimal and hence highly unlikely. The thickness of the spools also becomes essential because consequently, if using a light but thick weight the fabric will become very open and not functional as a fabric; therefore we consider these two setups (figure 19 and 20) unlikely on a warp weighted loom. On the other hand, these types of spools can be very useful as weights for tablet weaving, where one adds two to four threads per tablet or for other types of band weaving and braiding (see Gleba forthcoming). Also the fabric woven with a loom setup with spools with a weight of 122g and a thickness of 42 mm (figure 21 and 23) would become quite open and veil like (if it was not woven as a weft faced fabric) while the fabric woven with spools like in the last example (figure 22) could be woven more densely or with thicker threads. To conclude: spools (and other loom weights) with a weight less than 100g and with a wide thickness would not function optimally as loom weights on the warp weighted loom.

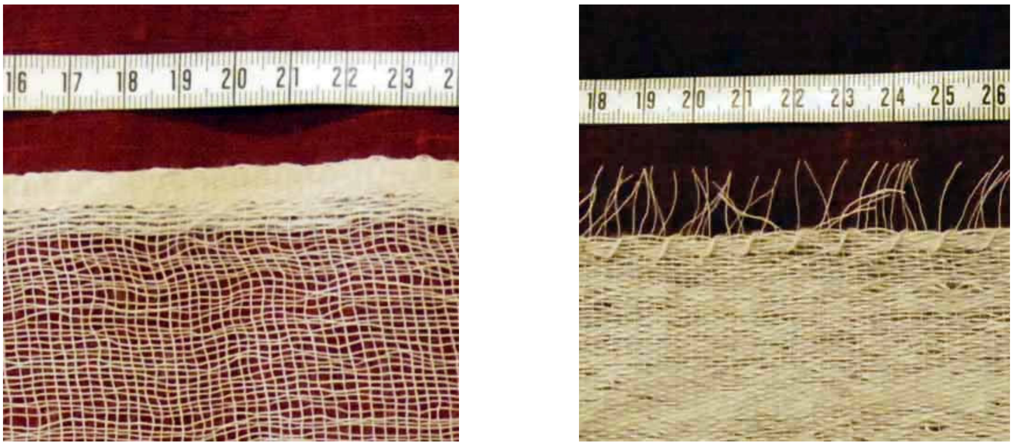

Figure 23. Two fabrics, both woven with threads requiring 10g warp tension. Left: a tabby with app. 5 warp threads per cm and 8 weft threads per cm. Right: a weft faced tabby with app. 6 warp threads per cm and 15 weft threads per cm. The spools that were used in this experiment weigh in average 100g and have a thickness of 40 mm (Mårtensson et al. 2006).

Loom weights and spools in contexts, an example

In some cases several spools are found together. For example, 11 spools made of fired clay are recorded in the database to the same context (Ti LXII 42/59 IV G9). 8 of these spools have a weight between 23g to 28g and the thickness between 24 mm to 26 mm. On the other 3 spools the weight varies from 104g to 122g and the thickness from 37-42 mm (figure 24). According to plate 141 (Rahmstorf forthcoming) these spools were found together but according to their weight and thickness they are clearly divided in two groups demonstrating that they would not be optimally functional together in a regular setup in a warp weighted loom. Nearby, another 9 spools from the same period have been found (Ti LXII 42/70 IV G9). The weight and thickness are estimated on 4 of these spools; the weight varying from 33g to 15g and the thickness varying from 20 mm to 27 mm, which demonstrates that they could have been used together with the other 8 spools from Ti LXII 42/59 IV G9 (figure 24). However, they would not be functional as loom weights on a warp weighted loom but could have been used for braiding, tablet weaving etc.

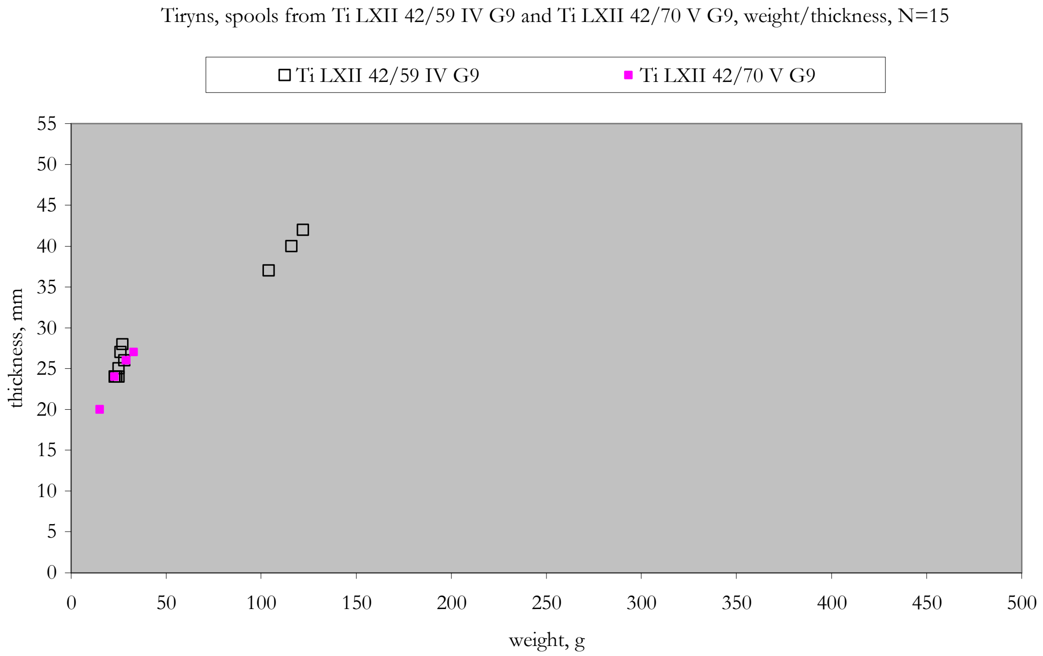

Figure 24. Spool from contexts Ti LXII 42/59 IV G9 and Ti LXII 42/70 V G9

Textile production in Tiryns

The number of tools from EH is small and no detailed conclusions about EH textile production can be drawn from these items.

During LH IIIB there are several findings of whorls, above all conuli, demonstrating a varied production of different yarns from very fine spun to thicker. In this period, however, there are few loom weights recorded and therefore it is almost impossibly to suggest which types of fabrics were produced. The analysis of the whorls suggests a varied production of different types of fabrics woven with very thin thread to fabrics woven with thick thread. To spin and weave with the thinnest threads would have been time consuming and demanded specialist knowledge.

There is a distinct increase in spindle whorls recorded from LH IIIC and it is interesting to note that these spindle whorls are within the same range in weight and diameter as the conuli. The analysis of the whorls from LH IIIC does not demonstrate any changes from LH IIIB in the production of different or new types of yarn despite the typological change in spindle whorls. During LH IIIC 68 loom weights are recorded in the database, of which the majority are spool shaped. Even if we exclude loom weights weighing less than 100g the variation in weight and thickness of the other loom weights demonstrate a production of 'very fine' and 'fine' fabrics.

In conclusion the textile tools from LH IIIB and LH IIIC demonstrate a production of 'very fine' and 'fine' fabrics. It is likely that other coarser textiles, for example sails, were also produced in Tiryns, but this production seems to be invisible and was probably performed with other types of spindles and looms, if not at another location. The visible production, however, demonstrates high quality textiles that would have demanded well prepared raw material, was time consuming to produce (compared to coarser textiles) and demanded skilled crafts people.